Nevada
Environmental
Restoration
Project

DOE/NV-1444

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 372: Area 20 Cabriolet/Palanquin Unit Craters
Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

April 2011

Environmental Restoration
Project

U.S. Department of Energy
National Nuclear Security Administration
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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 372: AREA 20 CABRIOLET/PALANQUIN UNIT CRATERS NEVADA NATIONAL SECURITY SITE, NEVADA

U.S. Department of Energy
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Las Vegas, Nevada

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CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 372: AREA 20 CABRIOLET/PALANQUIN UNIT CRATERS NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/Kevin Cabble Date: 4-20-11

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For Robert F. Boehlecke
Federal Project Director
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List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
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
CD	Certificate of Disposal
CED	Committed effective dose
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
Cm	Curium
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
CR	Closure report
Cs	Cesium

List of Acronyms and Abbreviations *(Continued)*

CSM	Conceptual site model
CZ	Contamination zone
day/yr	Days per year
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
FY	Fiscal year
g/yr	Grams per year
GPS	Global Positioning System
GWS	Gamma walkover survey
GZ	Ground zero
HASL	Health and Safety Laboratory
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
ICRP	International Commission on Radiological Protection

List of Acronyms and Abbreviations *(Continued)*

ID	Identification
IDW	Investigation-derived waste
in.	Inch
LCS	Laboratory control sample
LLW	Low-level waste
m	Meter
m^2	Square meter
m/yr	Meters per year
MDC	Minimum detectable concentration
mg/day	Milligrams per day
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
Nb	Niobium
NDEP	Nevada Division of Environmental Protection
N-I	Navarro-Intera, LLC
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
NNSS	Nevada National Security Site

List of Acronyms and Abbreviations *(Continued)*

NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site
PAL	Preliminary action level
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
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual Radioactive
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMS	Radioactive Waste Management Site
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SSTL	Site-specific target level
TBD	To be determined
TED	Total effective dose
Th	Thorium

List of Acronyms and Abbreviations *(Continued)*

TLD	Thermoluminescent dosimeter
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VSP	Visual Sample Plan
yd^3	Cubic yard

Executive Summary

This Corrective Action Decision Document (CADD)/Closure Report (CR) has been prepared for Corrective Action Unit (CAU) 372, Area 20 Cabriolet/Palanquin Unit Craters, located within Areas 18 and 20 at the Nevada National Security Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). Corrective Action Unit 372 comprises four corrective action sites (CASs):

- 18-45-02, Little Feller I Surface Crater
- 18-45-03, Little Feller II Surface Crater
- 20-23-01, U-20k Contamination Area
- 20-45-01, U-20L Crater (Cabriolet)

The purpose of this CADD/CR is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 372 based on the implementation of the corrective action of closure in place with administrative controls at all CASs. Corrective action investigation (CAI) activities were performed from November 9, 2009, through December 10, 2010, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 372: Area 20 Cabriolet/Palanquin Unit Craters.*

The approach for the CAI was divided into two facets: investigation of the primary release of radionuclides and investigation of other releases (migration in washes and chemical releases). The purpose of the CAI was to fulfill data needs as defined during the data quality objective (DQO) process. The CAU 372 dataset of investigation results was evaluated based on a data quality assessment. This assessment demonstrated the dataset is acceptable for use in fulfilling the DQO data needs.

Investigation results were evaluated against final action levels (FALs) established in this document. A radiological dose FAL was established of 25 millirem per year based on the Remote Work Area exposure scenario (336 hours of annual exposure). Radiological doses exceeding the FAL were found to be present at all four CASs. It is assumed that radionuclide levels present within the Little Feller I and Cabriolet high contamination areas and within the craters at Palanquin and Cabriolet exceed the FAL. It is also assumed that potential source material in the form of lead bricks at Little Feller I and lead-acid batteries at Palanquin and Cabriolet exceed the FAL. Therefore, corrective

actions were undertaken that consist of removing potential source material, where present, and implementing a use restriction and posting warning signs at each CAS. These use restrictions were recorded in the FFACO database; the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Facility Information Management System; and the NNSA/NSO CAU/CAS files.

Therefore, NNSA/NSO provides the following recommendations:

- No further corrective actions are necessary for CAU 372.
- A Notice of Completion to NNSA/NSO is requested from the Nevada Division of Environmental Protection for closure of CAU 372.
- Corrective Action Unit 372 should be moved 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) 372, Area 20 Cabriolet/Palanquin Unit Craters, located at the Nevada National Security Site (NNSS), 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 March 2010). The NNSS (formerly the Nevada Test Site [NTS]) is located approximately 65 miles northwest of Las Vegas, Nevada.

Corrective Action Unit 372 comprises the four corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 18-45-02, Little Feller I Surface Crater
- 18-45-03, Little Feller II Surface Crater
- 20-23-01, U-20k Contamination Area
- 20-45-01, U-20L Crater (Cabriolet)

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 372: Area 20 Cabriolet/Palanquin Unit Craters* (NNSA/NSO, 2009).

1.1 Purpose

This document provides documentation and justification for the closure of CAU 372, including a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The investigative activities were conducted in accordance with the CAIP (NNSA/NSO, 2009) except as noted herein. The corrective actions include removal of contamination and the implementation of use restrictions (URs) for remaining contamination that exceed the final action levels (FALs). Based on the implementation of these corrective actions, no further corrective actions are necessary at CAU 372. The CAIP provides information relating to site history as well as the scope and planning of the investigation. Therefore, this information will not be repeated in this document.

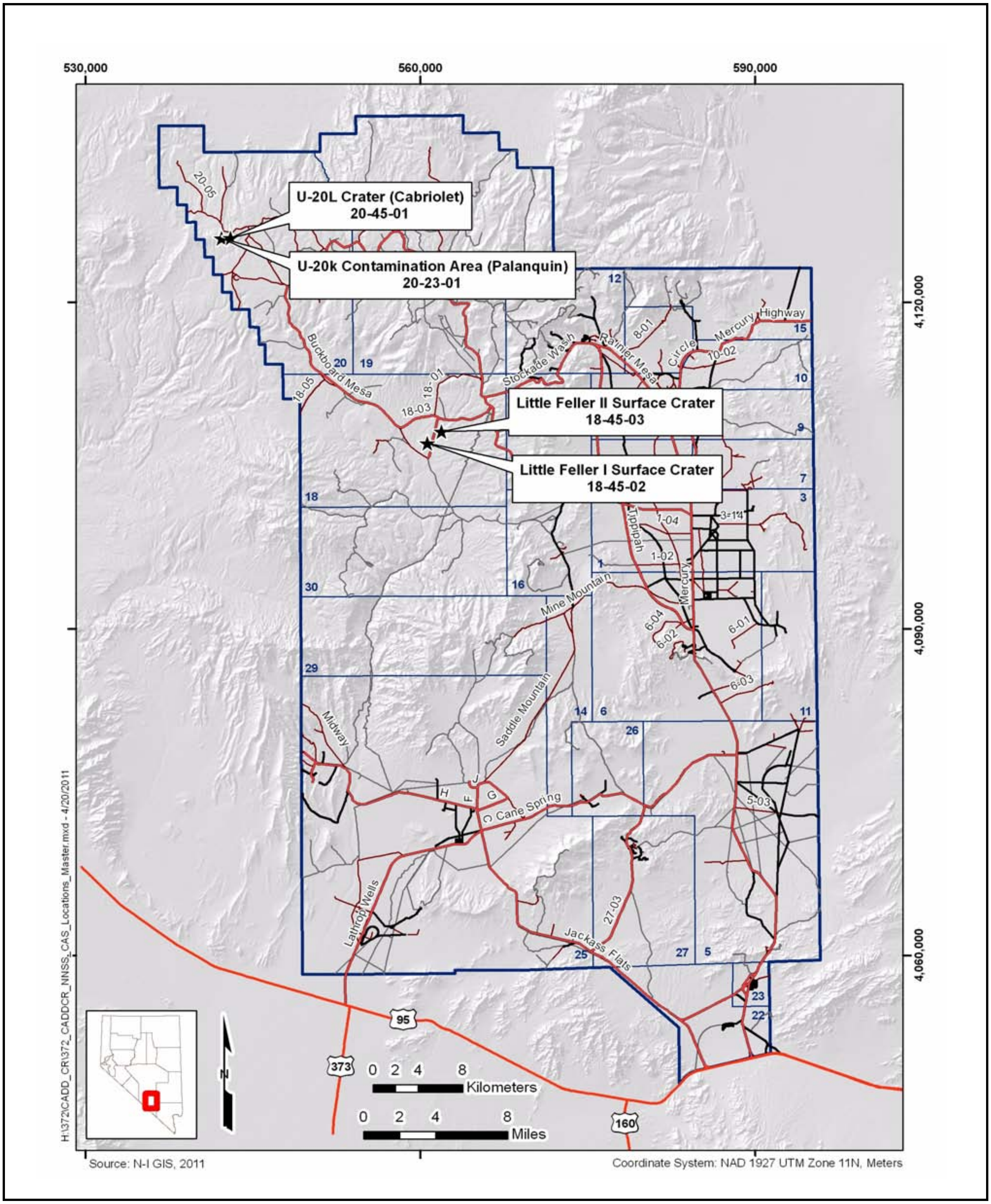

Figure 1-1
CAU 372, CAS Location Map

Corrective Action Unit 372 consists of four inactive sites on the NNSS. Corrective Action Site 18-45-02 (referred to as Little Feller I in this document) is located in Area 18 and consists of a release of radionuclides to the surrounding soil surface from the Little Feller I weapons-effects test. Little Feller I was a weapons-effects test of a Davy Crockett device and was detonated approximately 1 meter (m) above ground surface, which resulted in a fallout plume oriented generally in a northern direction (Schoengold et al., 1996; BN, 1999; DOE/NV, 2000).

Corrective Action Site 18-45-03 (referred to as Little Feller II in this document) is located in Area 18 and consists of a release of radionuclides to the surrounding soil surface from the Little Feller II weapons-effects test. Little Feller II was also a test of a Davy Crockett device and was detonated approximately 1 m above ground surface. This resulted in a fallout plume oriented generally in a northern direction (Schoengold et al., 1996; BN, 1999; DOE/NV, 2000).

Corrective Action Site 20-23-01 (referred to as Palanquin in this document) is located in Area 20 and consists of a release of radionuclides to the surrounding soil from the Palanquin test conducted under the Plowshare Program. The device was buried approximately 85 m below ground surface (bgs) and the test resulted in a fallout plume oriented in a northern direction (Schoengold et al., 1996; DOE/NV, 2000; BN, 1999). Because this test was conducted underground, radioactive contamination at this site also includes the prompt injection of radioactive material from the test detonation that remains within the crater and ejecta mounds surrounding the crater. A crater measuring approximately 24 m deep with a radius of 36 m was formed from this test (Gibson, 1965).

Corrective Action Site 20-45-01 (referred to as Cabriolet in this document) is located in Area 20 and consists of a release of radionuclides to the surrounding soil from the Cabriolet test conducted under the Plowshare Program. The device was buried at approximately 52 m bgs and the test resulted in crater and a fallout plume oriented in a northern direction (Schoengold et al., 1996; BN, 1999; DOE/NV, 2000). Because this test was conducted underground, radioactive contamination at this site also includes the prompt injection of radioactive material from the test detonation that remains within the crater and ejecta mounds surrounding the crater.

1.2 Scope

The corrective action investigation for CAU 372 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs) that exist at each CAS. (Note: For nuclear test release sites, a COC is defined as the presence of radionuclides that combined present a dose to a receptor exceeding the FAL of 25 millirem per year [mrem/yr]).

The collection of samples was not feasible at some locations. Therefore, the following assumptions were necessary:

- Contaminants of concern exist in the subsurface in the craters at Palanquin and Cabriolet.
- A dose greater than 25 millirem per Industrial Area year (mrem/IA-yr) exists within the high contamination areas (HCAs).
- Lead is present as a COC within the area of the lead bricks at Little Feller I.

The scope of the investigation activities at CAU 372 included performing visual surveys, collecting environmental and quality control (QC) samples, and placing TLDs. The scope of the corrective action activities included evaluating corrective action alternatives (CAAs), performing limited removals of potential source material (PSM), establishing and posting URs, and documenting and justifying closure activities.

1.3 CADD/CR Contents

This document is divided into the following sections and appendices:

Section 1.0, "Introduction," summarizes the document purpose, scope, and contents.

Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities and the results of the investigation, and justifies why 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). Sections A.3.0, A.4.0, A.5.0, and A.6.0 provide specific information regarding field activities, sampling methods, and 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 FALs.

Appendix D, *Closure Activity Summary*, provides details on the completed closure activities and includes supporting documentation.

Appendix E, *Evaluation of Corrective Action Alternatives*, provides a discussion of the results of the CAI, the alternatives considered, and the rationale for the recommended alternative.

Appendix F, *Sample Data*, provides tabular compilations of validated analytical results that provide a basis for the internal radiological dose estimates and the tabular compilations of TLD sample data that provide a basis for the external radiological dose estimates.

Appendix G, *Sample Location Coordinates*, presents the northing and easting coordinates for each sample plot, the biased sample locations, 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:

- CAIP for CAU 372, Area 20 Cabriolet/Palanquin Unit Craters (NNSA/NSO, 2009)
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002)
- FFACO (1996, as amended March 2010)

1.3.2 Data Quality Assessment Summary

A data assessment summary as discussed in Section 2.2.2 is presented in Appendix B and evaluates the degree of acceptability and usability of the reported data in the decision-making process. Based on this evaluation the nature and extent of COCs at CAU 372 have been adequately identified to implement the corrective actions. 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 and investigation results, and justify why no further corrective action is required at CAU 372. Detailed investigation activities and results for individual CAU 372 CASs are presented in Appendix A of this document.

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAU 372 CAIP (NNSA/NSO, 2009) from November 9, 2009, through December 10, 2010. The purpose of the CAU 372 CAI was to provide the additional information needed to resolve the following project-specific DQOs:

- Determining whether COCs are present in the soils associated with CAU 372.
- Determining the extent of identified COCs.
- Ensuring adequate data have been collected to evaluate closure alternatives under the FFACO (1996, as amended March 2010).

The scope of the CAI included the following activities:

- Performing visual surveys.
- Performing radiological surveys.
- Collecting environmental samples for laboratory analysis.
- Collecting QC samples.
- Placing, collecting, and analyzing TLDs.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases** (referred to as “test releases” in the CAU 372 CAIP) – This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface that has not been displaced through excavation or migration. Contamination associated with the primary release is limited to the top 5 centimeters (cm) of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition following nuclear testing at the NTS have shown that 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983 and 1985;

Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases** (referred to as “non-test releases” in the CAU 372 CAIP [NNSA/NSO, 2009]) – This release category includes any radionuclide contamination from test activities that is not limited to the upper 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration (such as in the drainages at the sites). This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the prompt injection of radionuclides into native material from the nuclear detonation (such as in the Cabriolet and Palanquin craters) and the deposition of ejecta piles around the Cabriolet and Palanquin craters. Also included are other chemical or radiological contamination that may be discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release (e.g., releases to the soil from batteries, lead bricks, or spills). The depth of radiological contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil contamination using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that contamination is present based on process knowledge.

For the primary release at CAU 372 CASs, sample plots were established judgmentally based on aerial radiation surveys (BN, 1999; NNSA/NSO, 2010) and the results of the gamma walkover surveys (GWSs). Within each sample plot, probabilistic sample locations were established based on a randomized grid. For other releases at CAU 372 CASs, judgmental sample locations were determined based on biasing criteria such as elevated radiological readings, sediment accumulation areas, PSM, and stained soil.

Confidence in judgmental sampling scheme decisions was established qualitatively through validation of the CSM and verification that the selected plot locations meet the DQO criteria. Confidence in probabilistic sampling scheme decisions was established by validating the CSM, justifying that sampling locations are representative of the plot area, and demonstrating that a sufficient number of samples were collected to justify statistical inferences (e.g., averages and 95 percent upper confidence limits [UCLs]).

The potential internal dose at each sample location was determined based on the laboratory analytical results of soil samples taken at each location and residual radioactivity material guidelines (RRMGs) that were calculated using the RESRAD computer code (Yu et al., 2001) (see Appendix C, Attachment C-1). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause a receptor to receive an internal dose equal to the radiological FAL. The internal doses from each of the radionuclides is then summed to produce the total potential internal dose.

The potential internal dose at each TLD location where soil samples were not collected was conservatively estimated using the potential external dose from the TLD and the ratio of internal dose to external dose from the plot with the maximum internal dose. This was done under the assumption that the internal dose at any CAU 372 location would constitute the same percentage of the total dose as at the plot where the maximum internal dose was observed. Therefore, at each CAS, the ratio of the internal to external dose was determined at the plot with the highest internal dose by dividing the internal dose by the external dose. This CAS-specific ratio was then multiplied by the external dose measured at each TLD location (where soil samples were not collected) to estimate the internal dose.

The potential external dose at each TLD location was determined from the readings of a TLD placed at a height of 1 m above the soil surface. The net external dose (the gross TLD dose reading minus the background dose) was divided by the number of hours the TLD was exposed to site contamination resulting in an hourly dose rate. That hourly dose rate was then multiplied by the number of hours per year (hr/yr) that a site worker would be present at the site (i.e., the annual exposure duration) to establish the maximum potential annual external dose a site worker could receive. The appropriate annual exposure duration in hours is based on the exposure scenario used (as defined in this section).

The calculated total effective dose (TED) (the sum of internal and external dose) for each sample location is an estimation of the true radiological dose (true TED). The TED is defined in 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2011) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

Because a measured TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the measured TED were significantly different than the true TED, a decision based on the measured TED could result in a decision error. To reduce the probability of making a false negative decision error, a conservative estimate of the true TED is used to compare to the FAL instead of the measured TED. This conservative estimate (overestimation) of the true TED was calculated as the 95 percent UCL of the average TED measurements. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the measured TED.

As described in Appendix C, the TED to a receptor from site contamination is a function of the time the receptor is present at the site and exposed to the radioactively contaminated soil. Therefore, TED is reported in this document based on the following three exposure scenarios:

- **Industrial Area –** Assumes continuous industrial use of a site. This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (225 days per year [day/yr], 10 hours per day [hr/day] for 25 years). The TED values calculated using this exposure scenario are the TED an industrial worker receives during 2,250 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- **Remote Work Area –** Assumes non-continuous work activities at a site. This scenario addresses exposure to industrial workers exposed to contaminants in soil during a portion of an average workday. This scenario assumes that this is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be on the site for an equivalent of 336 hr/yr (or 8 hr/day for 42 day/yr) for an entire career (25 years). The TED values calculated using this exposure scenario are the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Remote Work Area year (mrem/RW-yr).

- **Occasional Use Area –** Assumes occasional work activities at a site. This scenario addresses exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site. This scenario assumes that this is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hr/yr (or 8 hr/day for 10 day/yr) for 5 years. The TED values calculated using this exposure scenario are the TED an occasional use worker receives during 80 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

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

2.1.1 Little Feller I

Sampling activities at Little Feller I included the collection of composite soil samples from 16 sample plots established along 3 vectors radiating outward from near the HCA to measure internal dose. In addition, TLDs were placed at the center of each sample plot and at 3 field background locations outside the fallout plume at Little Feller I to measure external doses. Although lead bricks that were identified based on visual surveys were removed (see Section A.3.1.1), it cannot be assumed that lead concentrations exceeding the FAL do not remain at this location. Therefore, it is assumed that this area exceeds the FAL for lead. Refer to Section A.3.1 for additional information on investigation activities at Little Feller I. Results of the sampling effort are reported in Section 2.2.1.1.

The basis for the CSM and associated discussion for this CAS are provided in the CAU 372 CAIP (NNSA/NSO, 2009). The contamination pattern of the radionuclides at Little Feller I is consistent with the CSM in that the radiological contamination generally decreases with distance from ground zero (GZ) and is biased in the northerly (downwind) direction. Information gathered during the CAI validates the CSM as presented in the CAU 372 CAIP. No modification to the CSM was needed.

2.1.2 Little Feller II

Sampling activities included the collection of composite soil samples from 12 sample plots established along 3 vectors radiating outward from near GZ to measure internal dose. In addition, TLDs were placed at the center of each sample plot, at the sediment accumulation areas, at other locations of interest identified during the GWS, and at 3 field background locations outside the fallout plume at Little Feller II to measure external doses. Refer to Section A.4.1 for additional information on investigation activities conducted at Little Feller II. Results of the sampling effort are reported in Section 2.2.1.2.

Sampling activities at Little Feller II also included the collection of biased samples from two sediment accumulation areas within the downgradient portion of the major drainage at the site. Samples were collected at 5-cm lifts from the surface to 30 cm bgs within each of the two sediment accumulation areas. Samples were field screened, and the sample with the highest field-screening result (FSR) from each location was sent to the laboratory for analysis. Refer to Section A.4.1.4 for additional information on field screening conducted at Little Feller II.

The basis for the CSM and associated discussion for this CAS are provided in the CAU 372 CAIP (NNSA/NSO, 2009). The contamination pattern of the radionuclides at Little Feller II is consistent with the CSM in that the radiological contamination generally decreases with distance from GZ and is biased in the northerly (downwind) direction. Information gathered during the CAI validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.3 Palanquin

Sampling activities included the collection of composite soil samples from 16 sample plots established along 3 vectors radiating outward from north of the crater area. In addition, TLDs were placed at the center of each sample plot, at the sediment accumulation areas, at other locations of interest identified during the GWS, and at 4 field background locations outside the fallout plume at Palanquin to measure external doses. Refer to Section A.5.1 for additional information on investigation activities conducted at Palanquin. Results of the sampling effort are reported in Section 2.2.1.3.

Sampling activities at Palanquin also included the collection of biased samples from two sediment accumulation areas within the downgradient portion of the major drainage at the site. Samples were collected at 5-cm lifts from the ground surface to 25 cm bgs within each of the two sediment accumulation areas. Samples were field screened, and the sample with the highest FSR from each location was sent to the laboratory for analysis. Refer to Section A.5.1.4 for additional information on field screening conducted at Palanquin. Although batteries were identified and removed from the site, sampling was not conducted at the battery locations because they were intact and no biasing factors were identified.

The basis for the CSM and associated discussion for this CAS are provided in the CAU 372 CAIP (NNSA/NSO, 2009). The contamination pattern of the radionuclides at Palanquin is consistent with the CSM in that the radiological contamination generally decreases with distance from GZ and is biased in the northerly (downwind) direction. Information gathered during the CAI validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.4 Cabriolet

Sampling activities included the collection of composite soil samples from 10 sample plots established along 3 vectors radiating outward from the edge of the crater to measure internal dose. In addition, TLDs were placed at the center of each sample plot, at the sediment accumulation areas, and at 4 field background locations outside the fallout plume at Cabriolet to measure external doses. Refer to Section A.6.1 for additional information on investigation activities conducted at Cabriolet. Results of the sampling effort are reported in Section 2.2.1.4.

Sampling activities at Cabriolet also included the collection of biased samples from two sediment accumulation areas within the downgradient portion of the major drainage at the site. Samples were collected at 5-cm lifts from the ground surface to 30 cm bgs within each of the two sediment accumulation areas. Samples were field screened, and the sample with the highest FSR from each location was sent to the laboratory for analysis. Refer to Section A.6.1.4 for additional information on field screening conducted at Cabriolet. Although batteries were identified and removed from the site, sampling was not conducted at the battery locations because they were intact and no biasing factors were identified.

The basis for the CSM and associated discussion for this CAS are provided in the CAU 372 CAIP (NNSA/NSO, 2009). The contamination pattern of the radionuclides at Cabriolet is consistent with the CSM in that the radiological contamination generally decreases with distance from GZ and is biased in the northerly (downwind) direction. Information gathered during the CAI validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.2 Results

The data summary provided in Section 2.2.1 defines the COCs identified at CAU 372. Section 2.2.2 summarizes the assessment made in Appendix B, which concluded that the investigation results satisfy the DQO data requirements.

The preliminary action levels (PALs) and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 372 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NSO, 2009) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,250 hours (i.e., the Industrial Area exposure scenario defines that a site worker would be exposed to site contamination for 225 day/yr at 10 hr/day). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 336 hours (i.e., the Remote Work Area exposure scenario defines that a site worker would be exposed to site contamination for 42 day/yr at 8 hr/day). To be comparable to these action levels, the CAU 372 investigation results are presented in terms of the dose a receptor would receive from site contamination under the Industrial Area (mrem/IA-yr), Remote Work Area (mrem/RW-yr), and Occasional Use Area (mrem/OU-yr) exposure scenarios.

2.2.1 Summary of Analytical Data

Results for both the primary releases and other releases are presented in the following sections. For radioactivity, results are reported as TED based on the remote work area exposure scenario comparable to the radiological FAL as established in Appendix C. The FALs as established in Appendix C are based on the annual exposure duration of the Remote Work Area scenario (336 hr/yr). Calculation of the TED for each sample was accomplished through summation of internal and external dose as described in Sections A.3.2.3, A.4.2.3, A.5.2.3, and A.6.2.3.

2.2.1.1 Little Feller I

Discussions of the results for samples collected at Little Feller I are grouped by the type of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-1.

The TEDs for surface soils exceeded the FAL of 25 mrem/RW-yr at sample plots AM, AN, AQ, and AR, which are located to the south and north of the posted HCA as shown on Figure A.3-3.

Other Release

Drainage samples were not collected at Little Feller I because major drainages were not identified leaving the site and biasing factors that would indicate the potential for other releases were not identified.

Summary of Investigation Results at Little Feller I

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Little Feller I, surface radiological contamination exceeds the FAL for the radiological dose (25 mrem/RW-yr) at sample

Table 2-1
Little Feller I TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
AA	23.0	**30.6**	3.7	4.9	1.1	1.5
AB	4.6	6.8	0.7	1.0	0.2	0.3
AC	2.3	5.8	0.4	0.9	0.1	0.2
AD	1.9	5.5	0.3	0.8	0.1	0.2
AE	0.0	2.3	0.0	0.3	0.0	0.1
AF	1.5	3.2	0.2	0.5	0.1	0.1
AG	5.6	8.4	0.8	1.3	0.2	0.3
AH	**42.0**	**57.9**	7.0	9.6	2.2	3.0
AJ	**39.2**	**57.1**	6.5	9.4	2.1	2.9
AK	**35.6**	**44.8**	6.0	7.5	2.0	2.4
AL	14.6	22.2	2.4	3.6	0.7	1.1
AM	**185.2**	**223.1**	**30.4**	**36.8**	9.4	11.5
AN	**231.9**	**294.0**	**38.7**	**49.4**	12.5	16.2
AP	14.9	19.3	2.5	3.2	0.8	1.1
AQ	**380.8**	**524.7**	**63.8**	**88.6**	20.7	**29.3**
AR	**152.6**	**199.8**	**25.8**	**33.9**	8.5	11.4

Bold indicates the values exceeding 25 mrem/yr.

plots AM, AN, AQ, and AR (Table 2-1). It is assumed that lead contamination at the location of the lead bricks and dose within the HCA exceed the FALs. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is the limited removal of the lead bricks and closure in place with a UR. A UR was established around the area that exceeds a dose of 25 mrem/RW-yr, the HCA, and the area of the lead bricks as shown on Figure A.3-4 and in Attachment D-2 of Appendix D.

2.2.1.2 Little Feller II

Discussions of the results for samples collected at Little Feller II are grouped by the type of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-2.

Table 2-2
Little Feller II TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BA	3.5	7.3	0.6	1.1	0.2	0.3
BB	12.2	21.4	2.0	3.5	0.6	1.0
BC	8.5	13.3	1.3	2.0	0.4	0.5
BD	**54.3**	**61.2**	8.4	9.5	2.2	2.5
BE	**226.1**	**264.9**	**34.7**	**40.9**	9.0	10.8
BF	5.5	10.8	0.9	1.7	0.2	0.4
BG	7.6	14.7	1.2	2.3	0.4	0.6
BH	24.8	**31.4**	3.8	4.8	1.0	1.3
BJ	4.7	6.0	0.7	0.9	0.2	0.2
BK	8.6	10.7	1.3	1.6	0.3	0.4
BL	17.7	**31.7**	2.8	5.0	0.8	1.4
BM	**48.0**	**68.7**	7.8	11.3	2.4	3.6
TLD Location BT10	**195.9**	**225.5**	**29.3**	**33.7**	7.0	8.0
TLD Location BT19	**393.5**	**463.5**	**58.8**	**69.2**	14.0	16.5
Location BX01	4.7	8.1	0.7	1.2	0.2	0.3
Location BX02	4.5	7.9	0.7	1.2	0.2	0.3

Bold indicates the values exceeding 25 mrem/yr.

The TEDs from surface soil exceeded the FAL of 25 mrem/RW-yr at sample locations BE, BT10, and BT19 as shown on Figure A.4-3.

Other Release

Samples were collected from two sediment accumulation areas (locations BX01 and BX02) located within the main drainage leaving the site. A TLD was placed at each sediment sample location to measure the external dose. The TEDs from surface soil did not exceed the FAL of 25 mrem/RW-yr at either sediment sample location. Values for the average TED and the 95 percent UCL for the TED for each scenario are presented in Table 2-2.

Summary of Investigation Results at Little Feller II

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Little Feller II, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at sample locations BE, BT10, and BT19 (Table 2-2). Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. A UR was established around the area that exceeds the FAL of 25 mrem/RW-yr as shown on Figure A.4-4 and in Attachment D-2 of Appendix D.

2.2.1.3 Palanquin

Discussions of the results for samples collected at Palanquin are grouped by the type of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-3.

The TEDs for surface soils exceeded the FAL of 25 mrem/RW-yr only at sample plot CP, which is located north of the crater area (see Figure A.5-4).

Other Release

Samples were collected from two sediment accumulation areas (locations CX01 and CX02) located within the main drainage leaving the site. A TLD was placed at each sediment sample location to measure the external dose. The TEDs from surface soil did not exceed the FAL of 25 mrem/RW-yr at either sediment sample location. Values for the average TED and the 95 percent UCL for the TED for each scenario are presented in Table 2-3.

Table 2-3
Palanquin TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
CA	7.8	9.4	1.2	1.4	0.3	0.3
CB	9.8	11.9	1.5	1.8	0.4	0.4
CC	**71.5**	**78.6**	10.9	12.0	2.8	3.1
CD	5.0	6.8	0.7	1.0	0.2	0.2
CE	2.1	3.7	0.3	0.6	0.1	0.1
CF	3.8	5.8	0.6	0.9	0.1	0.2
CG	4.3	6.7	0.6	1.0	0.2	0.2
CH	**55.5**	**61.9**	8.4	9.4	2.1	2.4
CJ	**27.9**	**33.4**	4.3	5.1	1.1	1.3
CK	19.3	21.1	3.0	3.2	0.8	0.8
CL	20.9	24.4	3.2	3.7	0.8	1.0
CM	12.4	14.0	1.9	2.1	0.5	0.5
CN	**32.6**	**35.5**	4.9	5.4	1.2	1.3
CP	**848.2**	**932.9**	**129.7**	**143.5**	**33.3**	**37.5**
CQ	**31.4**	**34.8**	4.7	5.2	1.2	1.3
CR	17.1	19.2	2.6	2.9	0.6	0.7
TLD Location CT16	16.9	22.1	2.5	3.3	0.6	0.8
TLD Location CT17	24.0	**32.5**	3.6	4.9	0.9	1.2
TLD Location CT20	4.6	8.4	0.7	1.3	0.2	0.3
TLD Location CT21	1.0	6.0	0.2	0.9	0.0	0.2
TLD Location CT22	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
Location CX01	9.2	14.1	1.4	2.1	0.3	0.5
Location CX02	6.3	9.0	0.9	1.3	0.2	0.3

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

Summary of Investigation Results at Palanquin

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Palanquin, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at sample plot CP (Table 2-3). It is also assumed that subsurface contamination present in the crater exceeds the FAL due to prompt injection of radionuclides into the subsurface soil and ejecta mounds surrounding the crater from the nuclear test. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. A UR was established around the area that exceeds the FAL of 25 mrem/RW-yr, the crater area, and ejecta mounds surrounding the crater as shown on Figure A.5-5 and in Attachment D-2 of Appendix D.

2.2.1.4 Cabriolet

Discussions of the results for samples collected at Cabriolet are grouped by the type of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-4.

The TEDs for surface soils exceeded the FAL of 25 mrem/RW-yr at sample plots DA and DK, which are located near the crater (Figure A.6-4). It is assumed that contamination within the HCA exceeds the FAL.

Other Release

Samples were collected from two sediment accumulation areas (locations DX01 and DX02) located within the main drainage leaving the site. A TLD was placed at each sediment sample location to measure the external dose. The TEDs from surface soil did not exceed the FAL of 25 mrem/RW-yr at either sediment sample location. Values for the average TED and the 95 percent UCL for the TED for the three scenarios are presented in Table 2-4.

Summary of Investigation Results at Cabriolet

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Cabriolet, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at

Table 2-4
Cabriolet TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
DA	**176.9**	**190.9**	**27.5**	**29.8**	7.4	8.1
DB	**29.7**	**34.4**	4.6	5.3	1.2	1.4
DC	**72.4**	**78.9**	11.0	12.0	2.8	3.1
DD	5.8	9.0	0.9	1.3	0.2	0.3
DE	4.7	6.0	0.7	0.9	0.2	0.2
DF	**116.3**	**128.8**	17.8	19.7	4.6	5.1
DG	**26.7**	**30.7**	4.1	4.8	1.1	1.3
DH	11.0	12.9	1.7	2.0	0.4	0.5
DJ	6.2	8.1	0.9	1.2	0.2	0.3
DK	**199.1**	**216.8**	**30.5**	**33.3**	7.9	8.7
Location DX01	13.6	19.1	2.1	2.9	0.5	0.7
Location DX02	9.8	13.5	1.5	2.0	0.4	0.5

Bold indicates the values exceeding 25 mrem/yr.

sample plots DA and DK (Table 2-4). It is assumed that contamination within the HCA exceeds the FAL. Additionally, it is assumed that subsurface contamination present in the crater exceeds the FAL due to prompt injection of radionuclides into the subsurface soil and ejecta mounds surrounding the crater from the nuclear test. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. A UR was established around the area exceeding the FAL of 25 mrem/RW-yr, the posted HCA, the crater area, and ejecta mounds surrounding the crater as shown on Figure A.6-5 and in Attachment D-2 of Appendix D.

2.2.2 Data 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 are 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 composed 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 results of the DQI evaluation show that precision was the only indicator that did not meet the associated criterion. The only analyte that failed to meet the precision criterion was uranium (U)-234. As presented in Appendix B, there is a negligible potential for this precision deficiency to cause a false negative decision error. Therefore, the U-234 results that were qualified for precision can be confidently used to calculate TED. All other DQI criteria were met. The DQA determined that information generated during the investigation support the CSM assumptions and the data collected support their intended use in the decision-making process. Based on the results of the DQA presented in Appendix B, the DQO requirements have been met.

2.3 Justification for No Further Action

No further corrective action is needed for the four CASs within CAU 372 based on implementation of the corrective action of closure in place with a UR. This corrective action was selected to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2008) based on an evaluation of risk, feasibility, and cost effectiveness (see Appendix E).

2.3.1 Final Action Levels

The establishment of the FALs (presented in Appendix C) was based on risk to receptors. The radiological risk to receptors from contaminants at CAU 372 is due to chronic exposure to radionuclides (i.e., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use of all four sites determined that workers may only be present at these sites for a limited number of hours per year, and it is not reasonable to assume that any worker would be present at this site on a full-time basis (DOE/NV, 1996). Under the current land use at each of the CAU 372 CASs, the most exposed worker (Section C.1.10) would be the military trainee, who would not be present at any site for more than 40 hr/yr.

In the CAU 372 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAU 372 CAIP [NNSA/NSO, 2009]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 372 CASs. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr. However, as the corrective action requirements at each of the CAU 372 CASs would not be significantly different if based on the Remote Work Area exposure scenario, it was conservatively determined to use the Remote Work Area exposure scenario. Therefore, the radiological FAL determined under this exposure scenario was based on the assumption that a worker would be exposed to site contamination for 336 hr/yr.

3.0 Recommendation

Corrective actions for all four CASs were based on the risk assessment presented in Appendix C and the corrective action evaluation presented in Appendix E. In the risk assessment, it was determined to use the Remote Work Area exposure scenario (with an exposure duration of 336 hr/yr of site worker exposure) as the FAL for DQO decisions.

The corrective actions for all CAU 372 CASs include closure in place with URs. To determine the extent of the URs, a correlation of radiation survey values to the 95 percent UCL of Remote Work Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010] and the site-specific GWS). The 2009 aerial radiological surveys are continuous representations of the distribution of contaminants at each of the sites. The GWS consists of discrete point data with a location and a value that represents the instrument response at that point relative to uncontaminated background. The GWS values were interpolated using a kriging technique to create a distribution map similar to the 2009 aerial surveys. In accordance with the Decision II process described in the CAIP, the radiation survey method with the best fit to TED results would be used to determine the corrective action boundaries. Using the 95 percent UCL TED for the remote work area scenario, a goodness of fit was calculated statistically for each radiation survey. At each CAS, the GWS proved to correlate best with TED.

Little Feller I radiological contamination exceeds the FAL of 25 mrem/RW-yr at four sample locations. It is also assumed that radioactivity within the HCA and lead contamination within the location of the lead bricks exceed FALs. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead bricks and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (see Section A.3.3), the HCA, and the area of the lead bricks as shown on Figure A.3-4 and in Attachment D-2 of Appendix D.

Little Feller II radiological contamination exceeds the FAL of 25 mrem/RW-yr at three sample locations. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (see Section A.4.3) as shown on Figure A.4-4 and in Attachment D-2 of Appendix D.

Palanquin radiological contamination exceeds the FAL of 25 mrem/RW-yr at one sample location. It is also assumed that radioactivity within the crater and in ejecta piles around the crater that exceed the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead-acid batteries and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (see Section A.5.3), the crater area, and ejecta mounds surrounding the crater as shown on Figure A.5-5 and in Attachment D-2 of Appendix D.

Cabriolet radiological contamination exceeds the FAL of 25 mrem/RW-yr at two sample locations. It is also assumed that radioactivity within the crater and in ejecta piles around the crater that exceed the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead-acid batteries and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (see Section A.6.3), the crater area, and ejecta mounds surrounding the crater as shown on Figure A.6-5 and in Attachment D-2 of Appendix D.

As a best management practice (BMP), any area at any CAS where an industrial land use of the area could cause a future site worker to receive a dose exceeding 25 mrem/yr (assuming the worker would be exposed to site contamination for a period of 2,250 hr/yr) was identified, and an administrative UR was established in addition to its FFACO UR. To determine the extent of this area, a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010] and the site-specific GWS). The radiation survey with the best correlation was the GWS. The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The administrative UR boundary was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/IA-yr. This would restrict any future industrial land use activities that would result in a site worker exceeding the exposure time assumed under the current land use scenario (Remote Work Access scenario of 336 hr/yr).

At Little Feller I, the TED from surface soils exceeded a dose of 25 mrem under the Industrial Area scenario (25 mrem/IA-yr) at plots AA, AH, AJ, AK, AM, AN, AQ, and AR (Table 2-1). The administrative UR boundary was established to encompass the GWS value corresponding to 25 mrem/IA-yr (see Section A.3.3 and Figure A.3-4). The administrative UR is presented in Attachment D-2 of Appendix D.

At Little Feller II, the TED from surface soils exceeded a dose of 25 mrem/IA-yr at locations BD, BE, BH, BL, BM, BT10, and BT19 (Table 2-2). The administrative UR boundary was established to encompass the GWS value corresponding to 25 mrem/IA-yr (see Section A.4.3 and Figure A.4-4). The administrative UR is presented in Attachment D-2 of Appendix D.

At Palanquin, the TED from surface soils exceeded a dose of 25 mrem/IA-yr at locations CC, CH, CJ, CN, CP, CQ, and CT17 (Table 2-3). The administrative UR boundary was established to encompass the GWS value corresponding to 25 mrem/IA-yr (see Section A.5.3 and Figure A.5-5). The administrative UR is presented in Attachment D-2 of Appendix D.

At Cabriolet, the TED from surface soils exceeded a dose of 25 mrem/IA-yr at locations DA, DB, DC, DF, DG, and DK (Table 2-4). The administrative UR boundary was established to encompass the GWS value corresponding to 25 mrem/IA-yr (see Section A.6.3 and Figure A.6-5). The administrative UR is presented in Attachment D-2 of Appendix D.

The URs are 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.

No further corrective action is required at CAU 372 based upon implementation of corrective actions at the CAU 372 CASs. These corrective actions are evaluated in Appendix E based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short and long-term feasibility; and cost. The FFACO URs implemented at each CAS will protect site workers from inadvertent exposure. These FFACO URs require annual inspections to certify that postings are in place, intact, and readable. Maintenance or replacement of postings may be conducted without prior approval from NDEP. The corrective actions for CAU 372 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer are valid, additional evaluation may be necessary.

The administrative URs at all four CAU 372 CASs are not part of the corrective action but were implemented as BMPs. In accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), if the Remote Work Area or Occasional Use Area scenarios are used for any site to calculate a FAL, an administrative UR will be recorded to protect workers from future work activities that would cause an exposure exceeding the 25 mrem/yr. An administrative UR will be controlled in the same manner as the FFACO URs, but will not require postings or inspections. Any proposed activity within this use restricted area that would potentially change the land-use scenario and cause an exposure exceeding the exposure limits would require NDEP approval. The administrative URs are discussed and shown in Attachment D-2 of Appendix D.

The NNSA/NSO requests that NDEP issue a Notice of Completion for this CAU and approve transferring 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 372. Corrective Action Unit 372 consists of the following four CASs located in Areas 18 and 20 of the NNSS (Figure A.1-1):

- 18-45-02, Little Feller I Surface Crater
- 18-45-03, Little Feller II Surface Crater
- 20-23-01, U-20k Contamination Area
- 20-45-01, U-20L Crater (Cabriolet)

Corrective Action Site 18-45-02 (referred to as Little Feller I in this document) is located in Area 18 of the NNSS, west of Airport Road. This CAS consists of a release of radionuclides to the surrounding soil surface from the Little Feller I weapons-effects test.

Corrective Action Site 18-45-03 (referred to as Little Feller II in this document) is located in Area 18 of the NNSS, east of Airport Road. This CAS consists of a release of radionuclides to the surrounding soil surface from the Little Feller II weapons-effects test.

Corrective Action Site 20-23-01 (referred to as Palanquin in this document) is located in Area 20 of the NNSS, south of Pahute Mesa Road. This CAS consists of a release of radionuclides to the surrounding soil from the Palanquin test conducted under the Plowshare Program. Because this test was conducted underground, radioactive contamination at this site also includes the prompt injection of material into the crater and ejecta mounds surrounding the crater.

Corrective Action Site 20-45-01 (referred to as Cabriolet in this document) is located in Area 20 of the NNSS, south of Pahute Mesa Road. This CAS consists of a release of radionuclides to the surrounding soil from the Cabriolet test conducted under the Plowshare Program. Because this test was conducted underground, radioactive contamination at this site also includes the prompt injection of material into the crater and ejecta mounds surrounding the crater.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 372 CAIP (NNSA/NSO, 2009).

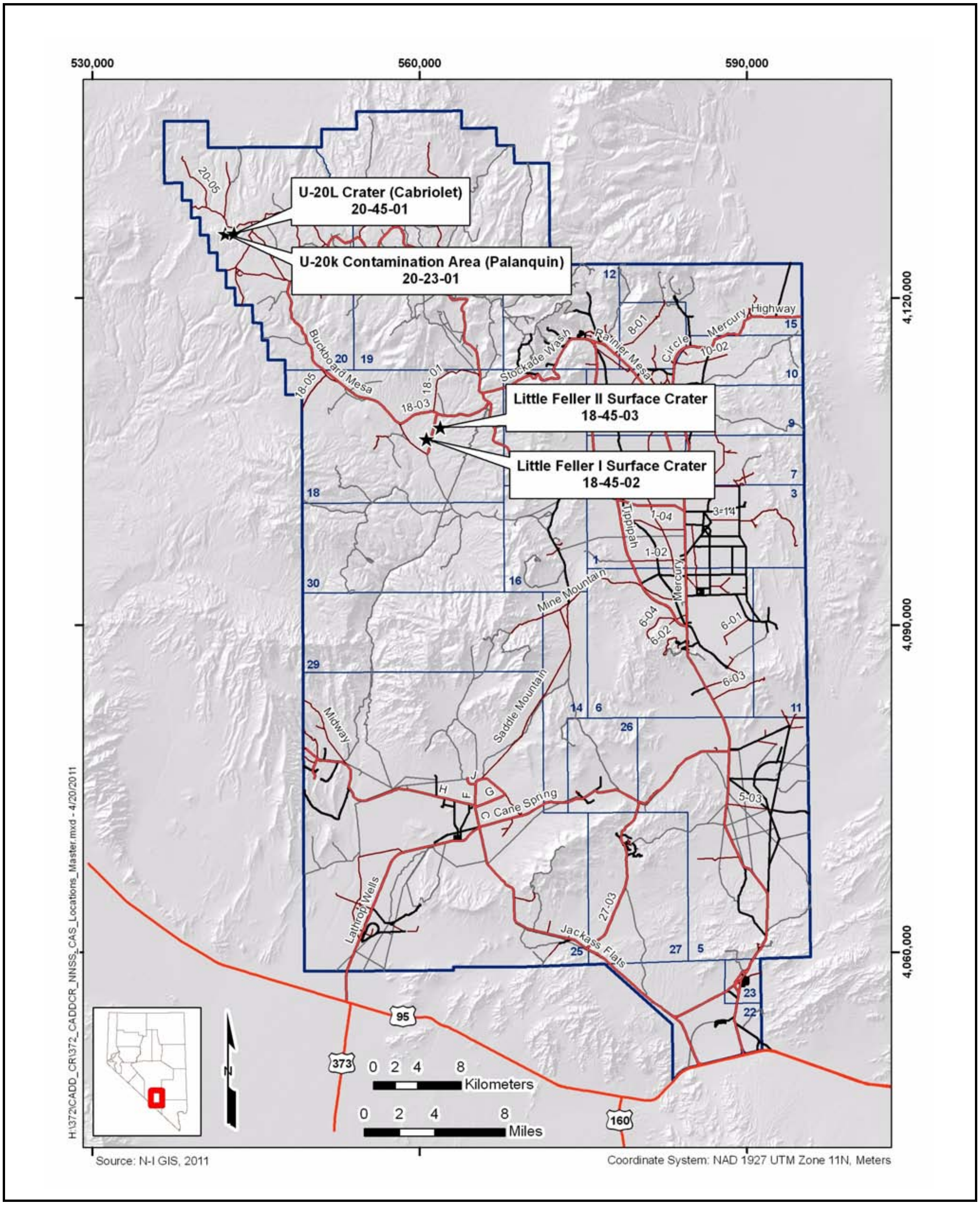

Figure A.1-1
CAU 372, CAS Location Map

A.1.1 Project Objectives

The objective of the investigation was to provide sufficient information to complete corrective actions and support the recommendation for closure of each CAS in CAU 372. This objective was achieved by identifying the nature and extent of COCs; and by evaluating, selecting, and implementing acceptable CAAs.

The selection of soil sample locations was based on the strategy developed during the DQO process as presented in the CAU 372 CAIP (NNSA/NSO, 2009) and adjusted as necessary based on site conditions. The sampling strategy for the CASs in CAU 372 included the judgmental selection of sample plot locations and the probabilistic selection of composite sample (aliquot) locations within each plot. Sample plot locations were chosen based upon results of the GWS and the 1994 aerial radiological survey (BN, 1999). 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. Within major drainages, the internal dose to a receptor was estimated based on analytical results from individual judgmental soil grab samples and the external dose to a receptor was determined from TLDs.

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 investigation overview.
- Sections A.3.0 through A.6.0 provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.7.0 summarizes waste management activities.
- Section A.8.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.9.0 provides a summary of the investigation results.
- Section A.10.0 lists the cited references.

The complete field documentation and laboratory data—including field activity daily logs, sample collection logs (SCLs), analysis request/chain-of-custody forms, soil sample descriptions, laboratory certificates of analyses, and analytical results—are retained in project files as hard copy files or electronic media.

A.2.0 Investigation Overview

The following field investigation and sampling activities for the CAU 372 CAI were conducted from November 9, 2009, through December 10, 2010:

- Inspected and verified the CAS components identified in the CAIP (NNSA/NSO, 2009).
- Performed site walkovers to identify biased sample locations.
- Conducted GWSs.
- Established sample plots and composite sample aliquot locations.
- Staged TLDs at soil sample plots, background locations, and additional locations of interest.
- Collected and submitted TLDs for analysis.
- Collected soil samples from sample plots and biased sample locations.
- Submitted soil samples for offsite laboratory analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest.
- Collected QC samples

The investigation and sampling program adhered to the requirements set forth in the CAU 372 CAIP (NNSA/NSO, 2009). Samples were collected, documented, and analyzed as prescribed in the CAIP. Quality control samples (e.g., duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a) and the CAU 372 CAIP.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases** (referred to as “test releases” in the CAU 372 CAIP) – This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface that has not been displaced through excavation or migration. Contamination associated with the primary release is limited to the top 5 cm of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition following nuclear testing at the NTS have shown that 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases** (referred to as "non-test releases" in the CAU 372 CAIP) – This release category includes any radionuclide contamination from test activities that is not limited to the upper 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration (such as in the drainages at the sites). This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the prompt injection of radionuclides into native material from the nuclear detonation (such as in the Cabriolet and Palanquin craters) and the deposition of ejecta piles around the Cabriolet and Palanquin craters. Also included are other chemical or radiological contamination that may be discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release (e.g., releases to the soil from batteries, lead bricks, or spills). The depth of radiological contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil contamination using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that contamination is present based on process knowledge.

The CASs were investigated by collecting TLD samples for external radiological dose measurements and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP with exception of minor deviations that are described in the Corrective Action Investigation Activities subsections of each CAS section.

A.2.1 Sample Locations

Investigation locations selected for sample plots were based on interpretation of site-specific GWSs and historical investigations (1994 and 2009 aerial radiological surveys [BN, 1999; NNSA/NSO, 2010]). Soil sampling for the primary releases at CAU 372 consisted of the collection of surface soil samples (as defined in Section A.2.0) within sample plots. Four composite samples were collected within each sample plot, and TLDs were located at the center of each sample plot. Each composite sample was composed of nine randomly located aliquots. The randomly located aliquot locations were identified using a predetermined random-start, triangular grid pattern. The random sample location coordinates were generated in Visual Sample Plan (VSP) software (PNNL, 2007).

Sample locations for other releases were selected based on biasing factors such as visual identification of sediment collection areas in drainages, elevated radiological readings, and soil staining. Actual environmental sample locations are shown on the figures included in Sections A.3.0 through A.6.0.

Each sample location was recorded with a GPS instrument. Appendix G presents these data in a tabular format. The environmental sample and TLD sample locations for the CASs in CAU 372 are shown on Figures A.3-2, A.4-2, A.5-2, and A.6-2.

A.2.2 Investigation Activities

The investigation activities performed at CAU 372, as listed in Section A.2.0, were consistent with the field investigation activities specified in the CAU 372 CAIP (NNSA/NSO, 2009). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each CAS. The following sections describe the specific investigation activities that took place at CAU 372.

A.2.2.1 Radiological Surveys

Aerial and ground-level radiological surveys were conducted at the CAU 372 CASs. Aerial radiological surveys were performed at the sites in 1994 at an altitude of 200 feet (ft) with 500-ft flight-line spacing (BN, 1999). Another aerial survey was conducted at the CASs in 2009 at an altitude of 50 ft with 100-ft flight line spacing (NNSA/NSO, 2010a) to provide better resolution of site radioactivity.

Ground-level GWSs were performed to identify specific locations for sample plots and biased sample locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator. Count-rate and position data were collected and recorded at 1-second intervals, via a Trimble Systems GeoXT GPS unit. The walkover speed was approximately 1 to 2 meters per second with the radiation detector held at a height of approximately 18 inches (in.) above the ground surface.

A.2.2.2 Field Screening

The CAS-specific sections of this document identify the locations where field screening was conducted and how the field-screening levels (FSLs) were used to aid in the selection of samples submitted for analysis. The FSRs are recorded on SCLs that are retained in project files.

A.2.2.3 Soil Sampling

Soil sampling for the primary releases at CAU 372 consisted of the collection of surface soil samples from within sample plots. Within each plot, four composite samples were collected. Each composite sample was composed of nine randomly located aliquots, resulting in a total of 36 randomly located aliquots collected from each plot. Each aliquot was collected using a "vertical-slice cylinder and bottom-trowel" method. This required the insertion of a 3.5-in. inside diameter cylinder to a depth of 5 cm, excavation of the outside soil along one side of the cylinder (to permit trowel placement), and horizontal insertion of a trowel along the bottom of the cylinder. This method captured a cylindrical-shaped section of the soil from 0 to 5 cm bgs.

After collection, each aliquot was carefully placed atop a sieve (#4 mesh) fitted into a bottom pan (with a plastic bag lining the pan, which limited dust generation during transfer to a sample container [metal can]). Each aliquot was slowly sieved, and oversized material that did not pass through the sieve was returned to the original sample location. After each sample was field screened, it was transferred to an empty metal can. Each metal can was then sealed with a lid and a locking ring, and shaken using a paint shaker for three minutes to homogenize the soil.

For sampling at other releases, the drainage locations were sampled at 5-cm intervals vertically from the surface to a maximum depth of 30 cm. These samples were radiologically field screened, and the interval for each sample with the highest FSRs was sent to the laboratory for analysis.

A.2.2.4 Internal Dose Estimates

Internal dose was estimated using the radionuclide analytical results from soil samples and the corresponding residual radioactive material guideline (RRMG) (see Appendix C, Attachment C-1). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr (under the appropriate exposure scenario) independent of any other radionuclide (assumes that no other radionuclides contribute dose). The internal dose RRMG for each detected radionuclide (in picocuries per gram [pCi/g] of soil) was derived using Residual Radioactive (RESRAD) computer code (Yu et al., 2001) under the appropriate exposure scenario.

The total internal dose corresponding to each surface soil sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal RRMG to yield a fraction of the 25-mrem/yr dose. The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample. The sum of fractions were then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. For the primary release samples, a 95 percent UCL was calculated for the internal dose in a sample plot using the results of all soil samples collected in that plot. For other release samples where only one sample was collected, statistical inferences could not be calculated and the single analytical result was used to calculate the internal dose.

For TLD locations where soil samples were not collected, the internal dose was estimated using the external dose measurement from the TLD and the internal to external dose ratio from the plot with the maximum internal dose. The internal dose for each of these locations was calculated by multiplying this ratio (from the plot with the maximum internal dose) by the external dose value specific to each location.

A.2.2.5 External Dose Measurements

Thermoluminescent dosimeters (specifically, Panasonic UD-814 TLDs) were placed at each CAS in CAU 372 with the objective of collecting *in situ* measurements to determine the external radiological dose. The TLDs were placed in locations beyond the expected plume influences around each site; at the approximate center of each sample plot; at biased sample locations within selected drainages; and at other locations of interest. All TLDs were placed at a height of approximately 1 m to be consistent with the NNSS Environmental Monitoring Program. Once retrieved from the field locations, the TLDs were submitted to the Environmental Technical Services group for analysis. The TLD results are discussed in Sections A.3.2.1, A.4.2.1, A.5.2.1, and A.6.2.1.

The TLDs were analyzed using automated TLD readers that are calibrated and maintained by the NNSS management and operating (M&O) contractor. This approach allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.8.5. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

Each TLD used in this CAI contains four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4 from each of the TLDs at a specific location, and each of the elements is considered a single sample in the statistical calculation of external dose. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation and, therefore, was not included in the external dose calculation. A 95 percent UCL was then calculated for each TLD location using the results from the three TLD elements contained within each TLD.

Estimates of external dose, in mrem/IA-yr, at the CAU 372 sites are presented as net values (e.g., the exposure from control TLDs and from the natural or field background has been subtracted from the raw result). The control TLDs measured the amount of dose received by the TLDs before being deployed in the field. The field background TLDs measured the amount of dose received by TLDs in areas unaffected by the CASs. Background dose at CAU 372 was slightly higher in Area 20 than in Area 18. Overall background dose ranged from an average of 33.8 to 41.5 mrem/IA-yr.

A.2.3 Total Effective Dose

The TED represents the sum of the internal dose (calculated from soil sample results) and the external dose (calculated from TLD measurements) for each sample location. The average TED calculated from sample results is an estimate of the true (unknown) TED. It is uncertain how well the average TED represents the true TED. If an average TED were directly compared to the FAL, any significant difference between the true TED and the sample TED could lead to decision errors. To reduce the probability of a false negative decision error, a conservative estimate of the true TED (i.e., the 95 percent UCL) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. Therefore, the probabilistic sampling design, as described in the CAIP for CAU 372 (NNSA/NSO, 2009), requires using the

95 percent UCL of the TED to estimate dose at each sample plot. The 95 percent UCL of the TED was calculated as the sum of the 95 percent UCLs of the internal and external dose.

The potential internal dose at each sample plot locations was determined based on the laboratory analytical results of soil samples taken at each plot and RRMGs that were calculated using the RESRAD computer code (Yu et al., 2001) (see Appendix C, Attachment C-1). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause a receptor to receive an internal dose equal to the radiological FAL. The internal doses from each of the radionuclides is then summed to produce the total potential internal dose.

A.2.4 Laboratory Analytical Information

Radiological analyses of the collected soil samples were performed by Eberline Services of Oak Ridge, Tennessee; and ALS Laboratory Group, of Fort Collins, Colorado. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in Table A.2-1. 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.2-1
Laboratory Analyses and Methods, CAU 372 Investigation Samples[a]

Analysis	Analytical Method[b]
Isotopic U	Aqueous/Non-aqueous - DOE EML HASL-300[c] U-02-RC
Isotopic Pu	Aqueous - DOE EML HASL-300[c] Pu-10-RC Non-aqueous - DOE EML HASL-300[c] Pu-02-RC
Isotopic Am	Aqueous - DOE EML HASL-300[c] Am-03-RC Non-aqueous - DOE EML HASL-300[d] Am-01-RC
Gamma Spectroscopy	Aqueous - EPA 901.1[d] Non-aqueous - DOE EML HASL-300[c] Ga-01-R
Sr-90	Aqueous - EPA 905.0[d] Non-aqueous - DOE EML HASL-300[c] 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 (NNES, 2009).
[c]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[d]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).

ASTM = American Society for Testing and Materials
EML = Environmental Measurements Laboratory
EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
NIOSH = National Institute for Occupational Safety and Health
Am = Americium
Pu = Plutonium
Sr = Strontium

Validated analytical data for CAU 372 have been compiled and evaluated to determine the presence of COCs and to define the extent of COC 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 each CAS are presented in Sections A.3.0 through A.6.0.

The analytical parameters were selected through the application of site process knowledge as described in the CAIP (NNSA/NSO, 2009).

A.2.5 Comparison to Action Levels

The PALs and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 372 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NSO, 2009) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,250 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 225 day/yr and 10 hr/day). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 336 hours (i.e., the Remote Work Area exposure scenario in which a site worker is exposed to site contamination for 42 day/yr and 8 hr/day).

Results for both the primary releases and other releases are presented in Sections A.3.2, A.4.2, A.5.2, and A.6.2. Radiological results are reported as doses that are comparable to the dose-based FAL as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the CAS-specific results tables (see Sections A.3.0 through A.6.0).

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 actions must be considered for the CAS.

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and the contaminants would be released to the surrounding media. The following will be used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.
- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
  - For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (following degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For liquid wastes, the resulting concentration of contaminants in the surrounding soil will be calculated based on the concentration of contaminants in the waste and the liquid holding capacity of the soil. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

A.3.0 CAS 18-45-02, Little Feller I Surface Crater

Little Feller I is located in Area 18 of the NNSS, west of Airport Road. The CAS consists of a release of radionuclides to the surrounding soil surface from the Little Feller I surface weapons-effects test (DOE/NV, 2000). Additional detail on the history of Little Feller I is provided in the CAU 372 CAIP (NNSA/NSO, 2009).

A.3.1 Corrective Action Investigation Activities

A total of 68 probabilistic environmental samples (64 primary release samples and 4 field duplicates [FDs] from 16 sample plots) were collected during investigation activities at Little Feller I. All samples were analyzed for gamma spectroscopy; Sr-90; and isotopic U, Pu, and Am. The sample numbers, locations, depth, matrix, and purpose are listed in Table A.3-1. A total of 35 TLDs (representing a total of 105 sample elements) at 19 locations (3 field background locations and 16 CAS locations) were used to calculate the external dose to site workers. The TLD numbers, locations, dates placed, dates removed, and purpose are listed in Table A.3-2. The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2009) are described in the following sections.

Table A.3-1
Samples Collected at Little Feller I
(Page 1 of 4)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
AA	372AA01	0 - 5	Soil	Environmental
	372AA02	0 - 5	Soil	FD of #372AA01
	372AA03	0 - 5	Soil	Environmental
	372AA04	0 - 5	Soil	Environmental
	372AA05	0 - 5	Soil	Environmental
AB	372AB01	0 - 5	Soil	Environmental
	372AB02	0 - 5	Soil	Environmental
	372AB03	0 - 5	Soil	Environmental
	372AB04	0 - 5	Soil	Environmental

Table A.3-1
Samples Collected at Little Feller I
(Page 2 of 4)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
AC	372AC01	0 - 5	Soil	Environmental
	372AC02	0 - 5	Soil	Environmental
	372AC03	0 - 5	Soil	Environmental
	372AC04	0 - 5	Soil	Environmental
AD	372AD01	0 - 5	Soil	Environmental
	372AD02	0 - 5	Soil	Environmental
	372AD03	0 - 5	Soil	Environmental
	372AD04	0 - 5	Soil	Environmental
AE	372AE01	0 - 5	Soil	Environmental
	372AE02	0 - 5	Soil	Environmental
	372AE03	0 - 5	Soil	Environmental
	372AE04	0 - 5	Soil	Environmental
AF	372AF01	0 - 5	Soil	Environmental
	372AF02	0 - 5	Soil	Environmental
	372AF03	0 - 5	Soil	Environmental
	372AF04	0 - 5	Soil	Environmental
AG	372AG01	0 - 5	Soil	Environmental
	372AG02	0 - 5	Soil	Environmental, Full Lab QC
	372AG03	0 - 5	Soil	Environmental
	372AG04	0 - 5	Soil	Environmental
	372AG05	0 - 5	Soil	FD of #372AG04
AH	372AH01	0 - 5	Soil	Environmental
	372AH02	0 - 5	Soil	Environmental
	372AH03	0 - 5	Soil	Environmental
	372AH04	0 - 5	Soil	Environmental
	372AH05	0 - 5	Soil	FD of #372AH04

Table A.3-1
Samples Collected at Little Feller I
(Page 3 of 4)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
AJ	372AJ01	0 - 5	Soil	Environmental, Full Lab QC
	372AJ02	0 - 5	Soil	Environmental
	372AJ03	0 - 5	Soil	Environmental
	372AJ04	0 - 5	Soil	Environmental
AK	372AK01	0 - 5	Soil	Environmental
	372AK02	0 - 5	Soil	Environmental
	372AK03	0 - 5	Soil	Environmental
	372AK04	0 - 5	Soil	Environmental
AL	372AL01	0 - 5	Soil	Environmental, Full Lab QC
	372AL02	0 - 5	Soil	Environmental
	372AL03	0 - 5	Soil	Environmental
	372AL04	0 - 5	Soil	Environmental
AM	372AM01	0 - 5	Soil	Environmental
	372AM02	0 - 5	Soil	Environmental
	372AM03	0 - 5	Soil	Environmental
	372AM04	0 - 5	Soil	Environmental
AN	372AN01	0 - 5	Soil	Environmental
	372AN02	0 - 5	Soil	Environmental
	372AN03	0 - 5	Soil	Environmental
	372AN04	0 - 5	Soil	Environmental
AP	372AP01	0 - 5	Soil	Environmental
	372AP02	0 - 5	Soil	FD of #372AP01
	372AP03	0 - 5	Soil	Environmental
	372AP04	0 - 5	Soil	Environmental
	372AP05	0 - 5	Soil	Environmental, Full Lab QC

Table A.3-1
Samples Collected at Little Feller I
(Page 4 of 4)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
AQ	372AQ01	0 - 5	Soil	Environmental
	372AQ02	0 - 5	Soil	Environmental
	372AQ03	0 - 5	Soil	Environmental
	372AQ04	0 - 5	Soil	Environmental
AR	372AR01	0 - 5	Soil	Environmental
	372AR02	0 - 5	Soil	Environmental
	372AR03	0 - 5	Soil	Environmental
	372AR04	0 - 5	Soil	Environmental

Table A.3-2
TLDs at Little Feller I
(Page 1 of 2)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
AT01 (Plot AA)	4893	12/07/2009	05/10/2010	Sample plot
AT02 (Plot AB)	4514	12/07/2009	05/10/2010	Sample plot
AT03 (Plot AC)	5138	12/07/2009	05/10/2010	Sample plot
AT04 (Plot AD)	4866	12/07/2009	05/10/2010	Sample plot
AT05 (Plot AG)	5113	12/21/2009	05/10/2010	Sample plot
AT06 (Plot AF)	5137	12/21/2009	05/10/2010	Sample plot
AT07 (Plot AE)	5135	12/21/2009	05/10/2010	Sample plot
AT08 (Plot AH)	4932	12/21/2009	05/10/2010	Sample plot
AT09 (Plot AJ)	4798	12/21/2009	05/10/2010	Sample plot
AT10 (Plot AK)	4810	12/21/2009	05/10/2010	Sample plot
	4888	09/27/2010	12/09/2010	Sample plot
AT11 (Plot AL)	4354	12/21/2009	05/10/2010	Sample plot

Table A.3-2
TLDs at Little Feller I
(Page 2 of 2)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
AT12 (Plot AM)	4782	01/08/2010	05/10/2010	Sample plot
	4723	09/29/2010	12/09/2010	Sample plot
	4340	09/29/2010	12/09/2010	Sample plot
	5109	09/29/2010	12/09/2010	Sample plot
AT13 (Plot AN)	4812	01/08/2010	05/10/2010	Sample plot
	4513	09/29/2010	12/09/2010	Sample plot
	4881	09/29/2010	12/09/2010	Sample plot
	4691	09/29/2010	12/09/2010	Sample plot
AT14	4301	12/21/2009	05/10/2010	Background TLD location
AT15	4813	12/21/2009	05/10/2010	Background TLD location
AT16	4700	12/07/2009	05/10/2010	Background TLD location
AT17 (Plot AQ)	4606	09/29/2010	12/09/2010	Sample plot
	4576	09/29/2010	12/09/2010	Sample plot
	4440	09/29/2010	12/09/2010	Sample plot
	5059	09/29/2010	12/09/2010	Sample plot
AT18 (Plot AR)	4474	09/29/2010	12/09/2010	Sample plot
	4430	09/29/2010	12/09/2010	Sample plot
	4442	09/29/2010	12/09/2010	Sample plot
	4931	09/29/2010	12/09/2010	Sample plot
AT19 (Plot AP)	4345	09/27/2010	12/09/2010	Sample plot
	4777	09/27/2010	12/09/2010	Sample plot
	4582	09/27/2010	12/09/2010	Sample plot
	4518	09/27/2010	12/09/2010	Sample plot

A.3.1.1 Visual Inspections

Various inspections were conducted over the course of the field investigation. Scattered debris and lead bricks were identified. No other biasing factors were identified, and no additional samples were collected as a result of the visual inspection.

A.3.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were performed at Little Feller I during the CAI. The GWSs were conducted at the site (outside the posted HCA) to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest radiological readings was detected adjacent to the south side of the posted HCA. This location was not sampled because it had removable contamination at HCA levels. Therefore, a sample plot (plot AM) was established adjacent to the location with the maximum detected radiological readings. Figure A.3-1 presents a graphic representation of the data from the GWSs.

In addition to the GWSs, the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a) were used to determine the locations of the vector soil sample plots at the Little Feller I site. The aerial radiological surveys covered the area of the plume, which extends north outside the contamination area. Sample locations were selected along the plume (Figure A.3-2).

A.3.1.3 Sample Collection

A.3.1.3.1 TLD Samples

The 35 TLDs listed in Table A.3-2 and shown at the locations on Figure A.3-2 were used at Little Feller I to measure external doses. The TLDs at locations AT14 through AT16 were placed at field background locations. Sample plots were associated with TLD locations AT01 through AT13 and AT17 through AT19. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.8.0.

A.3.1.3.2 Soil Samples

For the determination of internal dose at the primary release, 68 composite surface soil samples (including 4 FDs) were collected from 16 plots within the Little Feller I area. Sample plots were established along each of three sampling vectors based on the isopleths from the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a). Four sample plots (AE, AF, AG, and AQ) were established along the southwest vector; five sample plots (AA, AB, AC, AD, and AR) were established along the northeast vector; and six sample plots (AH, AJ, AK, AL, AN, and AP) were established along the north vector. One additional sample plot (AM) was established south of the

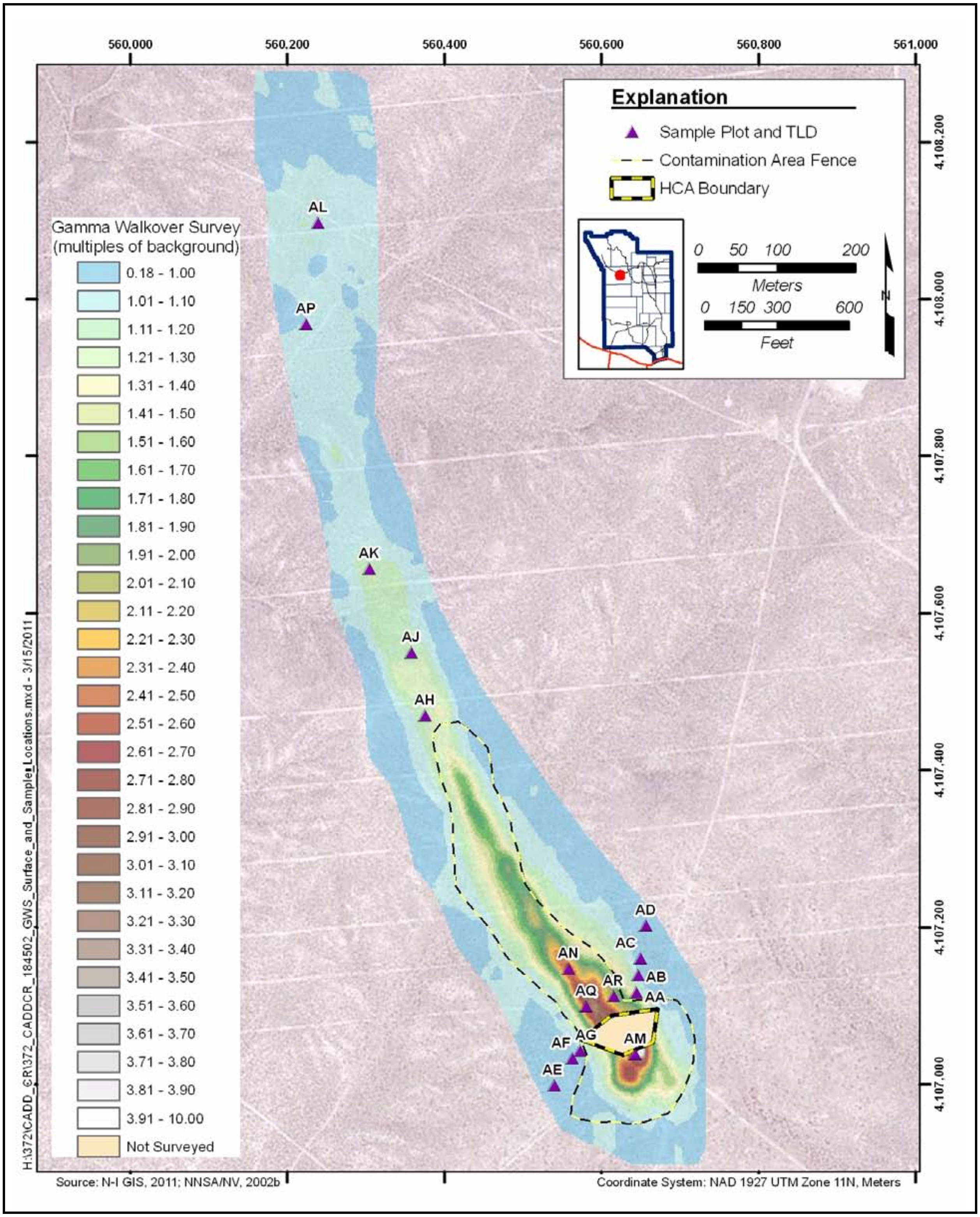

Figure A.3-1
Gamma Walkover Surveys of Selected Locations at Little Feller I

HCA adjacent to location of the highest GWS reading. Sample locations (Table A.3-1) are shown on Figure A.3-2.

No other release samples were collected at Little Feller I.

A.3.1.4 Deviations

The CAU 372 CAIP (NNSA/NSO, 2009) states that "one sample plot will be established judgmentally at a location most likely to exceed a 25-mrem/yr-dose constraint..." The highest GWS readings were identified at a location near the boundary of the HCA. Removable contamination exceeding HCA criteria were present at this location. Therefore, it was decided to consider this area as part of the HCA, assume that the dose in this area exceeds FALs (consistent with the HCA), and not to collect soil samples. Because the plot established adjacent to this location (plot AM) demonstrated that TED exceeds the FAL outside the HCA, there is no impact to DQO Decision I.

The CAU 372 CAIP also states that the corrective action boundary will be established based on the distance along each vector that corresponds to the 25-mrem/yr FAL and the radiation survey isopleth that encompasses these locations. However, it was determined that the corrective action boundary could be better defined by performing the following:

- Directly correlating TED from all sample locations to the radiation survey values at each location.
- Using the radiation survey isopleth value correlating to the 25-mrem/yr FAL as the corrective action boundary with the stipulation that the boundary encompasses all locations with a TED that exceeds the FAL.

Although this is a minor deviation to the method described in the CAIP, it provides an improvement in the process in that the TED values are directly correlated to radiation survey values rather than correlating them to distance along vectors, which has no direct relationship to dose. This deviation is not expected to have any significant impact on the resulting corrective action boundary while providing a more robust and defensible process.

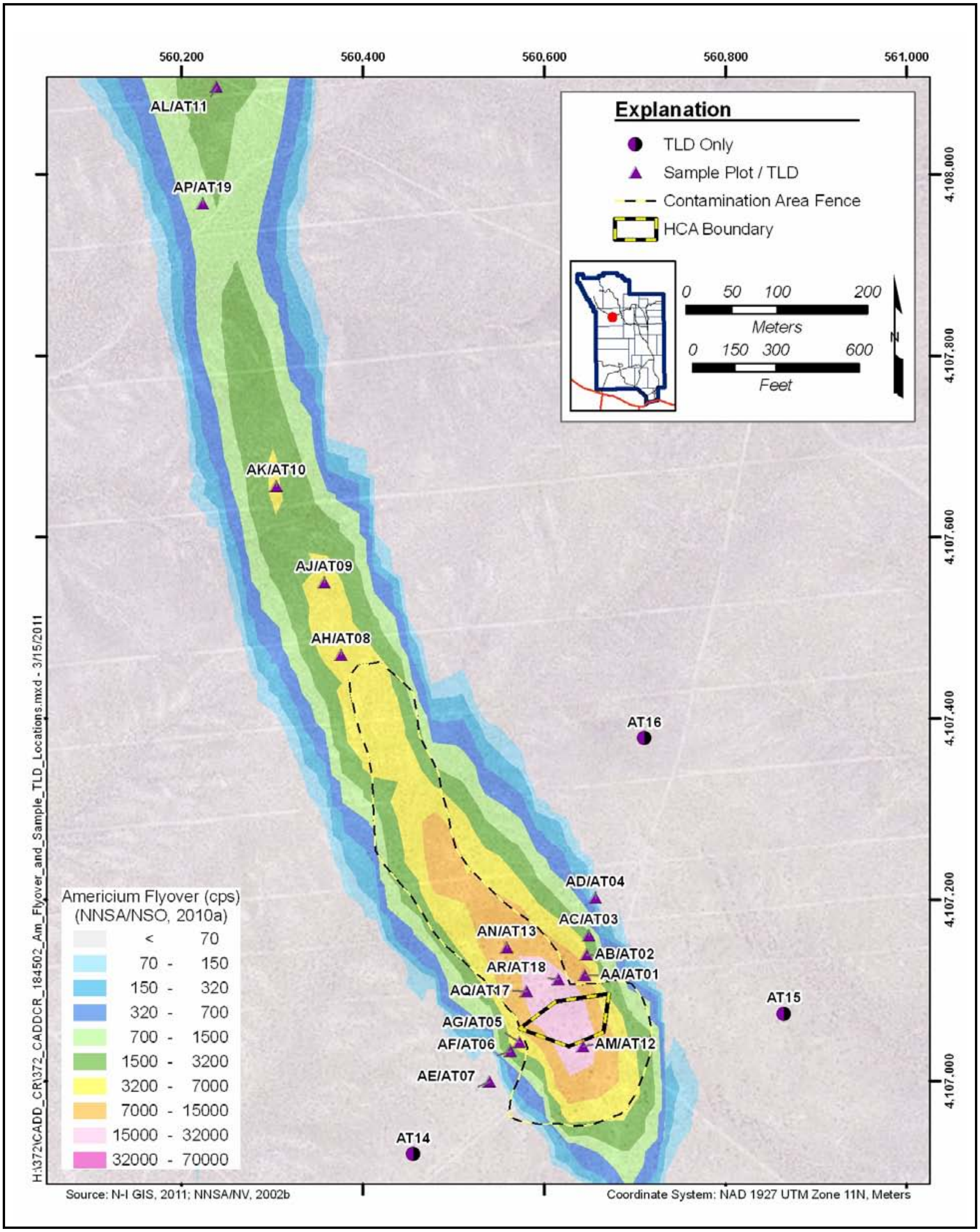

Figure A.3-2
Little Feller I Sample and TLD Locations

A.3.2 Investigation Results

The following sections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAU 372 CAIP (NNSA/NSO, 2009). The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2009), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location. External doses for TLD locations are summarized in Section A.3.2.1. Internal doses for each sample plot are summarized in Section A.3.2.2. The TEDs for each sampled location are summarized in Section A.3.2.3.

A.3.2.1 External Radiological Dose Measurements

The external dose estimates at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use Area exposure scenarios. The minimum sample size was met for all TLD locations. The standard deviation, number of elements, minimum sample size, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table A.3-3.

A.3.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Little Feller I were determined as described in Section A.2.2.4. Table A.3-4 presents a comparison of the internal and external doses at each sample plot. This demonstrates that internal dose at Little Feller I comprises a large percentage of TED and exceeds external dose at many sample plots. As shown in Table A.3-5,

Table A.3-3
Little Feller I 95% UCL External Dose for Each Exposure Scenario

Plot	Standard Deviation	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot AA	0.41	3	1.4	15.6	2.3	0.6
Plot AB	0.18	3	1.4	5.9	0.9	0.2
Plot AC	0.26	3	1.4	4.7	0.7	0.2
Plot AD	0.31	3	1.4	5.3	0.8	0.2
Plot AE	0.21	3	1.4	2.3	0.3	0.1
Plot AF	0.15	3	1.4	3.0	0.4	0.1
Plot AG	0.23	3	1.4	7.9	1.2	0.3
Plot AH	0.62	3	1.4	20.3	3.0	0.7
Plot AJ	0.86	3	1.4	23.7	3.5	0.8
Plot AK	0.73	6	1.4	12.7	1.9	0.5
Plot AL	0.45	3	1.4	10.9	1.6	0.4
Plot AM	2.62	12	1.6	**87.4**	13.0	3.1
Plot AN	1.89	12	1.5	**76.8**	11.5	2.7
Plot AP	0.39	12	1.4	5.5	0.8	0.2
Plot AQ	3.78	12	1.9	**120.0**	17.9	4.3
Plot AR	0.73	12	1.4	**38.0**	5.7	1.4

Bold indicates the values exceeding 25 mrem/yr.

the minimum sample size was not met for plots AN and AQ. Therefore, it is assumed that dose at these locations exceeds the FAL. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for each exposure scenario are presented in Table A.3-5. The analytical results for the individual radionuclides in each composite sample and the corresponding calculated internal dose are presented in Appendix F.

A.3.2.3 Total Effective Dose

The TED for each sample plot and TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for each exposure scenario are presented in Table A.3-6. The TED for sample locations exceeds the FAL

Table A.3-4
Little Feller I Ratio of Calculated Internal Dose to External Dose at Each Plot (mrem/RW-yr)

Plot	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
Plot AA	2.10	1.63	3.73	1.29
Plot AB	0.12	0.58	0.70	0.21
Plot AC	0.10	0.26	0.36	0.38
Plot AD	0.02	0.27	0.29	0.074
Plot AE	0.01	0[a]	0[a]	0[a]
Plot AF	0.02	0.20	0.22	0.1
Plot AG	0.05	0.79	0.84	0.063
Plot AH	4.99	2.00	6.99	2.5
Plot AJ	4.41	2.09	6.49	2.11
Plot AK	4.70	1.30	6.00	3.62
Plot AL	1.52	0.88	2.40	1.73
Plot AM	18.68	11.69	**30.37**	1.6
Plot AN	**28.24**	10.49	**38.73**	2.69
Plot AP	1.86	0.63	2.49	2.95
Plot AQ	**47.84**	15.96	**63.80**	3.0
Plot AR	20.46	5.30	**25.76**	3.86

[a]Where the result was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

(the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at plots AM, AN, AQ, and AR (Figure A.3-3).

A conservative estimate of future dose at this site (considering radioactive decay mechanisms only with no consideration of dispersion [erosion and transport mechanisms]) is that dose will continually decrease and the area exceeding the FAL will continually decrease. However, based on the long half-lives of the radionuclides present at the site (e.g., Am-241, Pu-239/240), TED will not significantly decay in the next 1,000 years. The effective half-life for this site is about 346.6 years.

Table A.3-5
Little Feller I 95% UCL Internal Dose for Each Exposure Scenario

Plot	Standard Deviation	Number of Samples	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot AA	0.54	5	1.4	15.0	2.6	0.9
Plot AB	0.03	4	1.4	0.9	0.2	0.1
Plot AC	0.08	4	1.4	1.1	0.2	0.1
Plot AD	0.002	4	1.4	0.1	0.0	0.01
Plot AE	0.001	4	1.4	0.1	0.0	0.004
Plot AF	0.01	4	1.4	0.2	0.0	0.01
Plot AG	0.03	5	1.4	0.5	0.1	0.03
Plot AH	1.64	5	1.5	**37.5**	6.6	2.3
Plot AJ	1.22	4	1.4	**33.4**	5.8	2.1
Plot AK	0.77	4	1.4	**32.1**	5.6	2.0
Plot AL	0.38	4	1.4	11.3	2.0	0.7
Plot AM	4.27	4	2.1	**135.7**	23.7	8.4
Plot AN	8.24	4	4.04	**217.2**	**37.9**	13.4
Plot AP	0.58	5	1.4	13.8	2.4	0.9
Plot AQ	19.43	4	16.3	**404.7**	**70.7**	**25.0**
Plot AR	6.63	4	3.1	**161.8**	**28.3**	10.0

Bold indicates the values exceeding 25 mrem/yr.

A.3.2.4 Results for Other Release at Little Feller I

Lead bricks identified at the site are assumed to be PSM and require corrective action. Although a corrective action was implemented to remove all lead bricks that were identified based on visual surveys (Section A.3.1.1), it cannot be assured that lead concentrations exceeding the FAL do not remain at this location. Therefore, it is assumed that this area exceeds the FAL for lead and requires the corrective action of closure in place with a UR. No additional other releases were identified for Little Feller I.

Table A.3-6
Little Feller I TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Plot AA	23.0	**30.6**	3.7	4.9	1.1	1.5
Plot AB	4.6	6.8	0.7	1.0	0.2	0.3
Plot AC	2.3	5.8	0.4	0.9	0.1	0.2
Plot AD	1.9	5.5	0.3	0.8	0.1	0.2
Plot AE	0[a]	2.3	0[a]	0.3	0[a]	0.1
Plot AF	1.5	3.2	0.2	0.5	0.1	0.1
Plot AG	5.6	8.4	0.8	1.3	0.2	0.3
Plot AH	**42.0**	**57.9**	7.0	9.6	2.2	3.0
Plot AJ	**39.2**	**57.1**	6.5	9.4	2.1	2.9
Plot AK	**35.6**	**44.8**	6.0	7.5	2.0	2.4
Plot AL	14.6	22.2	2.4	3.6	0.7	1.1
Plot AM	**185.2**	**223.1**	**30.4**	**36.8**	9.4	11.5
Plot AN	**231.9**	**294.0**	**38.7**	**49.4**	12.5	16.2
Plot AP	14.9	19.3	2.5	3.2	0.8	1.1
Plot AQ	**380.8**	**524.7**	**63.8**	**88.6**	20.7	**29.3**
Plot AR	**152.6**	**199.8**	**25.8**	**33.9**	8.5	11.4

[a]Where the result was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

A.3.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, COCs were identified at this CAS at sample plots AM, AN, AQ, and AR. It is assumed that lead contamination at the location of the lead bricks and the area within the HCA exceed the FALs. Therefore, corrective action is required. The selected corrective action (see Appendix E) is removal of lead bricks and closure in place with a UR. To determine the extent of the area where the Remote Work Area TED exceeds the FAL, a correlation of radiation survey values to the 95 percent UCL of Remote Work Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010] and the

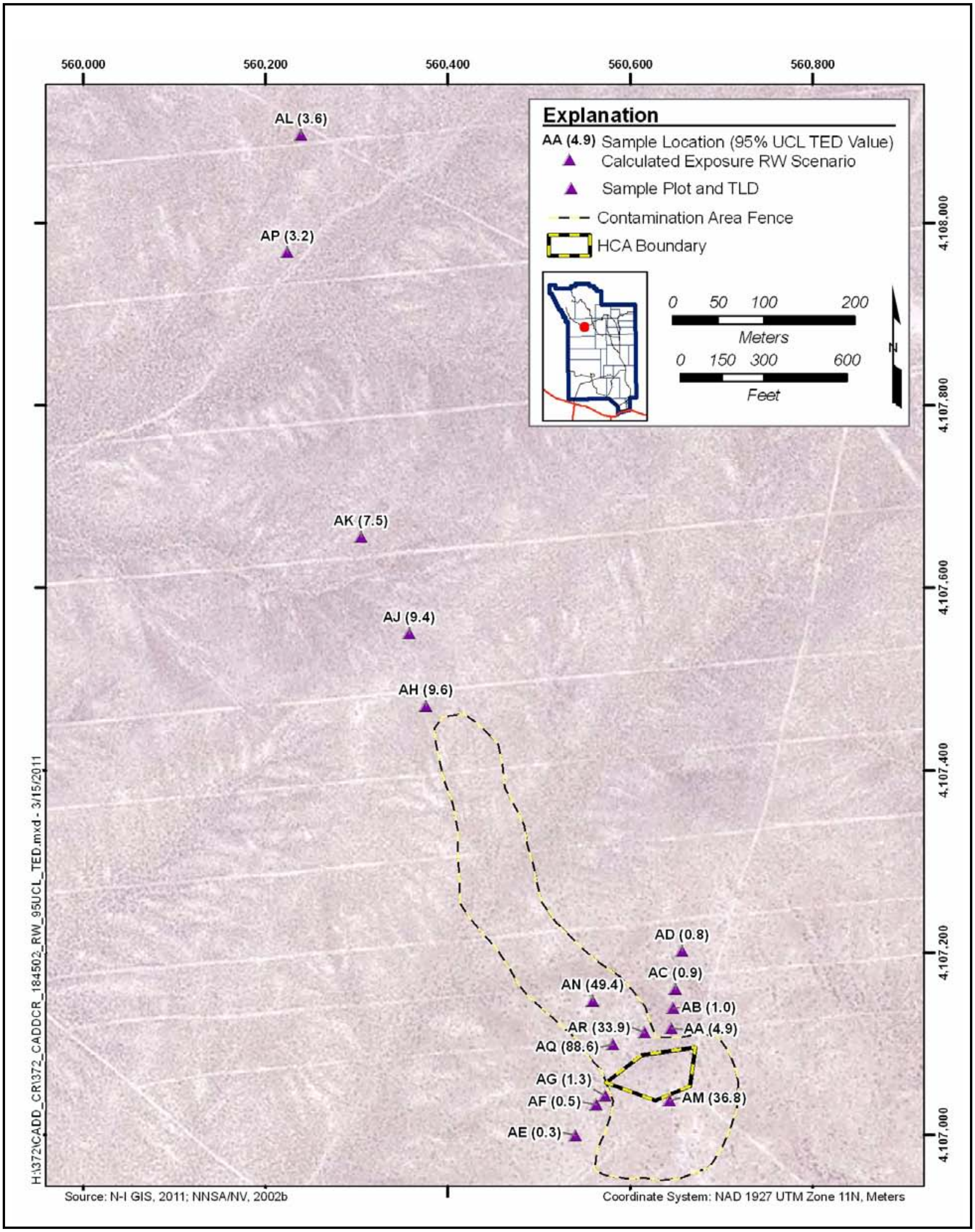

Figure A.3-3
95% UCL of the TED at Little Feller I

site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The isopleth of 1.73 multiples of background corresponds to the 25-mrem/RW-yr FAL and was identified as the corrective action boundary. This corrective action boundary encompassed the other areas where contamination was assumed to exceed the FALs (i.e., the HCA and area of the lead bricks) as shown in Figure A.3-4. An FFACO UR was established to encompass this area and was defined as the final corrective action boundary. The UR is presented in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,250 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of the area where the Industrial Area TED exceeds the FAL (Industrial Area scenario), a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys and the site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). Based on this correlation, the radiation survey value that corresponds to 25 mrem/IA-yr is 1.14 multiples of background (Figure A.3-4). The administrative UR boundary established to encompass this area is presented in Attachment D-2 of Appendix D.

A.3.4 Revised Conceptual Site Model

The CAU 372 CAIP requirements (NNSA/NSO, 2009) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 372. Therefore, no revisions were necessary to the CSM.

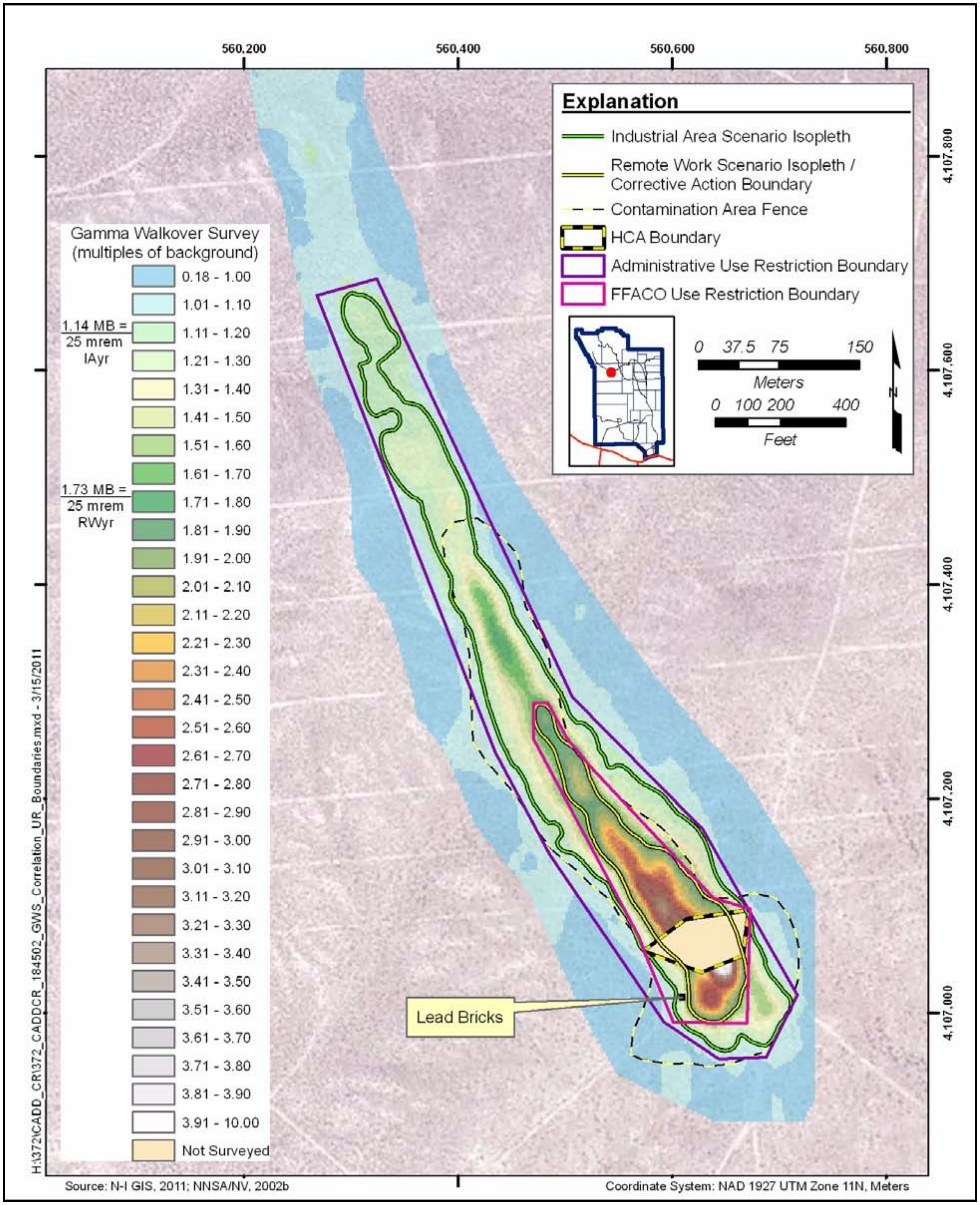

Figure A.3-4
Little Feller I Correlation of GWS Isopleth Values to 95% UCL of TED

A.4.0 CAS 18-45-03, Little Feller II Surface Crater

Little Feller II is located in Area 18 of the NNSS, east of Airport Road. The CAS consists of a release of radionuclides to the surrounding soil surface from the Little Feller II surface weapons-effects test (DOE/NV, 2000). Additional detail is provided in the CAU 372 CAIP (NNSA/NSO, 2009).

A.4.1 Corrective Action Investigation Activities

A total of 53 environmental samples (48 probabilistic primary release samples and 3 FDs from 12 plots, and 2 judgmental other release samples from 2 sediment accumulation areas) were collected during investigation activities at Little Feller II. All primary release and other release drainage samples were analyzed for gamma spectroscopy; Sr-90; and isotopic U, Pu, and Am. The sample numbers, locations, depth, matrix, and purpose are listed in Table A.4-1. A total of 32 TLDs (representing a total of 96 sample elements) at 19 locations (3 field background locations and 16 CAS locations) were used to calculate the external dose to site workers. The TLD numbers, locations, dates placed, dates removed, and purpose are listed in Table A.4-2. The specific CAI activities conducted to satisfy the CAU 372 CAIP (NNSA/NSO, 2009) requirements at this CAS are described in the following sections.

Table A.4-1
Samples Collected at Little Feller II
(Page 1 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BA	372BA01	0 - 5	Soil	Environmental
	372BA02	0 - 5	Soil	Environmental
	372BA03	0 - 5	Soil	Environmental
	372BA04	0 - 5	Soil	Environmental
BB	372BB01	0 - 5	Soil	Environmental, Full Lab QC
	372BB02	0 - 5	Soil	Environmental
	372BB03	0 - 5	Soil	Environmental
	372BB04	0 - 5	Soil	Environmental

Table A.4-1
Samples Collected at Little Feller II
(Page 2 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BC	372BC01	0 - 5	Soil	Environmental
	372BC02	0 - 5	Soil	Environmental
	372BC03	0 - 5	Soil	Environmental
	372BC04	0 - 5	Soil	FD of #372BC03
	372BC05	0 - 5	Soil	Environmental
BD	372BD01	0 - 5	Soil	Environmental
	372BD02	0 - 5	Soil	Environmental
	372BD03	0 - 5	Soil	Environmental
	372BD04	0 - 5	Soil	Environmental
BE	372BE01	0 - 5	Soil	Environmental
	372BE02	0 - 5	Soil	Environmental
	372BE03	0 - 5	Soil	Environmental
	372BE04	0 - 5	Soil	Environmental
BF	372BF01	0 - 5	Soil	Environmental
	372BF02	0 - 5	Soil	Environmental
	372BF03	0 - 5	Soil	Environmental
	372BF04	0 - 5	Soil	Environmental
BG	372BG01	0 - 5	Soil	Environmental
	372BG02	0 - 5	Soil	Environmental
	372BG03	0 - 5	Soil	Environmental
	372BG04	0 - 5	Soil	Environmental
BH	372BH01	0 - 5	Soil	Environmental
	372BH02	0 - 5	Soil	Environmental
	372BH03	0 - 5	Soil	Environmental, Full Lab QC
	372BH04	0 - 5	Soil	Environmental

Table A.4-1
Samples Collected at Little Feller II
(Page 3 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BJ	372BJ01	0 - 5	Soil	Environmental
	372BJ02	0 - 5	Soil	Environmental
	372BJ03	0 - 5	Soil	Environmental
	372BJ04	0 - 5	Soil	FD of #372BJ03
	372BJ05	0 - 5	Soil	Environmental
BK	372BK01	0 - 5	Soil	Environmental
	372BK02	0 - 5	Soil	FD of #372BK01
	372BK03	0 - 5	Soil	Environmental
	372BK04	0 - 5	Soil	Environmental
	372BK05	0 - 5	Soil	Environmental, Full Lab QC
BL	372BL01	0 - 5	Soil	Environmental
	372BL02	0 - 5	Soil	Environmental
	372BL03	0 - 5	Soil	Environmental
	372BL04	0 - 5	Soil	Environmental
BM	372BM01	0 - 5	Soil	Environmental
	372BM02	0 - 5	Soil	Environmental
	372BM03	0 - 5	Soil	Environmental
	372BM04	0 - 5	Soil	Environmental
BX01	372BX02	5 - 10	Soil	Environmental
BX02	372BX01	5 - 10	Soil	Environmental

A.4.1.1 Visual Inspections

Various inspections were conducted over the course of the field investigation. Scattered debris was identified. A drainage flowing downgradient from the site was identified as a potential migration pathway for contaminated sediments. The only biasing factors identified at the site were sediment accumulation areas located within the drainage. The sediment accumulation areas identified for sampling are shown on Figure A.4-1.

Table A.4-2
TLDs at Little Feller II
(Page 1 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
BT01 (Plot BH)	4587	11/09/2009	02/17/2010	Sample plot
BT02 (Plot BG)	4745	11/09/2009	02/17/2010	Sample plot
BT03 (Plot BF)	4641	11/09/2009	02/17/2010	Sample plot
BT04 (Plot BL)	4309	11/09/2009	02/17/2010	Sample plot
BT05 (Plot BK)	5025	11/09/2009	02/17/2010	Sample plot
BT06 (Plot BJ)	4590	11/09/2009	02/17/2010	Sample plot
BT07 (Plot BC)	5197	11/09/2009	02/17/2010	Sample plot
BT08 (Plot BB)	5270	11/09/2009	02/17/2010	Sample plot
BT09 (Plot BA)	4709	11/09/2009	02/17/2010	Sample plot
BT10	4883	11/09/2009	02/17/2010	TLD only
	4528	09/22/2010	12/09/2010	TLD only
	4598	09/22/2010	12/09/2010	TLD only
	4476	09/22/2010	12/09/2010	TLD only
BT11 (Plot BE)	5183	11/09/2009	02/17/2010	Sample plot
	4772	09/22/2010	12/09/2010	Sample plot
	4895	09/22/2010	12/09/2010	Sample plot
	5083	09/22/2010	12/09/2010	Sample plot
BT12 (Plot BD)	4625	11/09/2009	02/17/2010	Sample plot
	4357	09/22/2010	12/09/2010	Sample plot
	5251	09/22/2010	12/09/2010	Sample plot
	4918	09/22/2010	12/09/2010	Sample plot
BT13	4408	11/09/2009	02/17/2010	Background TLD location
BT14	5271	11/09/2009	02/17/2010	Background TLD location
BT15	4389	11/09/2009	02/17/2010	Background TLD location
BT16 (Location BX01)	4339	09/21/2010	12/09/2010	Sediment sample location
BT17(Location BX02)	4533	09/21/2010	12/09/2010	Sediment sample location
BT18 (Plot BM)	4428	09/22/2010	12/09/2010	Sample plot
	5120	09/22/2010	12/09/2010	Sample plot
	4600	09/22/2010	12/09/2010	Sample plot

Table A.4-2
TLDs at Little Feller II
(Page 2 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
BT19	4451	09/22/2010	12/09/2010	TLD only
	5002	09/22/2010	12/09/2010	TLD only
	5162	09/22/2010	12/09/2010	TLD only

A.4.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were performed at Little Feller II during the CAI. The GWSs were conducted at the site to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest radiological readings was at TLD location BT19. This location was not sampled because it had removable contamination at HCA levels. Therefore, a sample plot (plot BE) was established adjacent to the location with the maximum detected radiological readings. Figure A.4-1 provides the results of the GWSs.

In addition to the GWSs conducted at Little Feller II, the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a) were used to determine the locations of the vector soil sample plots at the Little Feller II site. The aerial radiological surveys covered the area of the plume, which extends north outside the contamination area. Sample plot locations were placed along the plume (Figure A.4-2).

A.4.1.3 Sample Collection

A.4.1.3.1 TLD Samples

The 32 TLDs listed in Table A.4-2 and shown at the locations on Figure A.4-2 were used at Little Feller II to measure external doses. The TLDs at locations BT13 through BT15 were placed at field background locations. Sample plots were associated with TLD locations BT01 through BT09, BT11 and BT12, and BT18. Sample plots were not associated with TLD location BT10 or BT19 because those TLDs were located within the area identified during the GWS to have readings that were approaching or equal to HCA levels. Sediment samples were collected in the same location as TLD

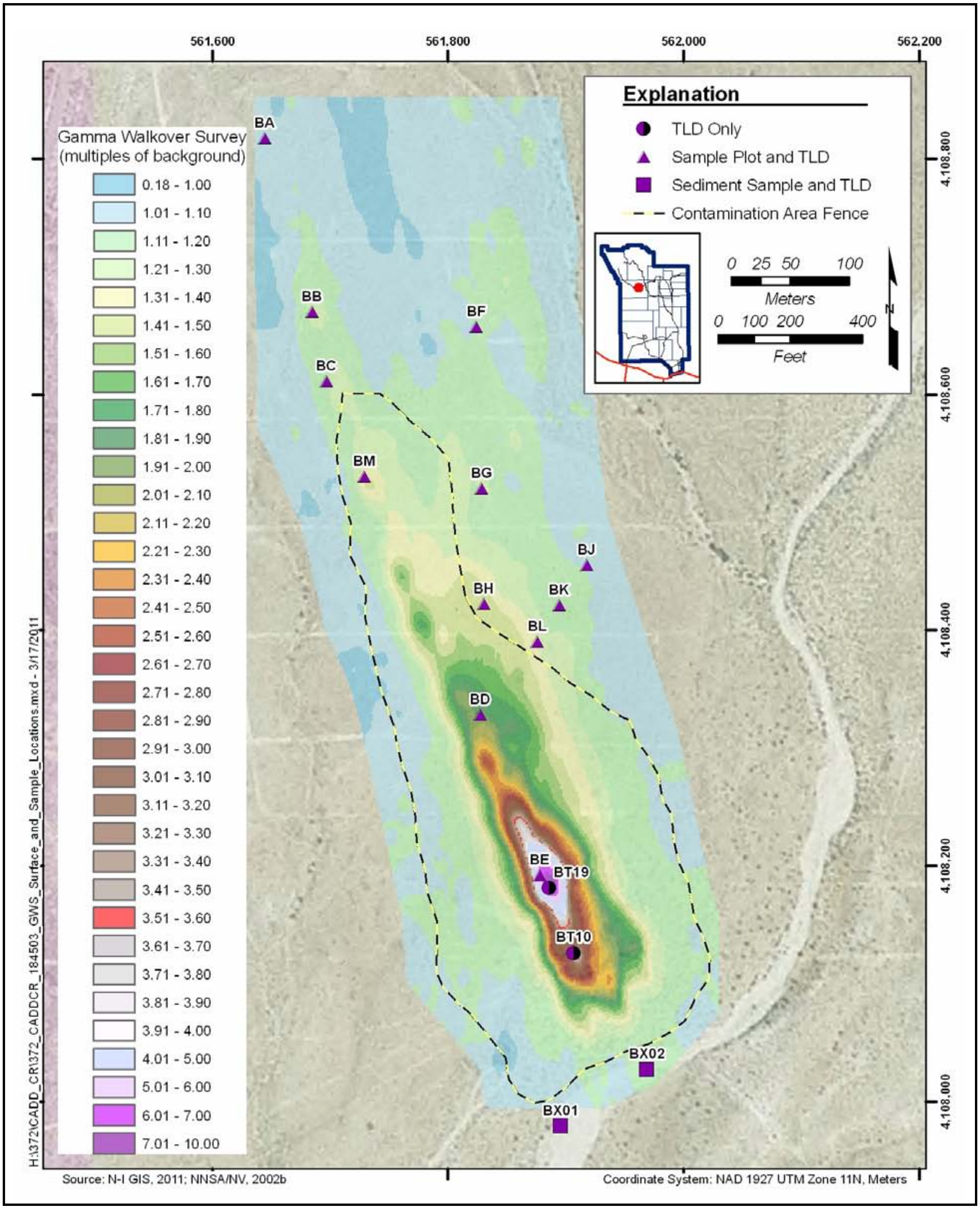

Figure A.4-1
Gamma Walkover Surveys of Selected Locations at Little Feller II

locations BT16 and BT17. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.8.0.

A.4.1.3.2 Soil Samples

For the determination of internal dose at the primary release, 51 composite surface soil samples (including 3 FDs) were collected from 12 plots within the Little Feller II area. Five sample plots (BA, BB, BC, BD, and BM) were established along the northwest vector; three sample plots (BF, BG, and BH) were established along the north vector; and three sample plots (BJ, BK, and BL) were established along the northeast vector. One additional sample plot (BE) was established northwest of GZ adjacent to the area of highest radiological readings as detected during the GWS. Sample plots along each of three sampling vectors were established based on the isopleths from the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a) and the results of the GWS; and the sample plot BE was established based on the results of the GWS conducted at the site. Sample plot locations are shown on Figure A.4-2.

For the other releases at Little Feller II, one sample at 5 to 10 cm bgs was collected from each of two sediment accumulation areas (locations BX01 and BX02) within the major drainage (downgradient of GZ) to determine whether migration away from the test area has occurred. The first two sediment areas anticipated to be outside the 25-mrem/yr boundary were sampled. These samples were collected based on the criteria presented in Section A.4.1.4. The sediment sample locations are shown on Figure A.4-2.

A.4.1.4 Field Screening

The FSRs were used for selection of the vertical samples collected from the sediment accumulation areas. For these samples (collected between 0 and 30 cm bgs from each of two locations) the 5- to 10-cm depth at location BX02 exhibited the highest field-screening values for alpha and beta. For location BX01, the 5- to 10-cm depth for sample location BX01 exhibited the highest field-screening value for alpha. It did not exhibit the highest value for beta; however, the beta FSL value was not exceeded for any of the intervals collected at location BX01. Therefore, the 5- to 10-cm interval sample was submitted to the laboratory for analysis for both sediment accumulation area locations

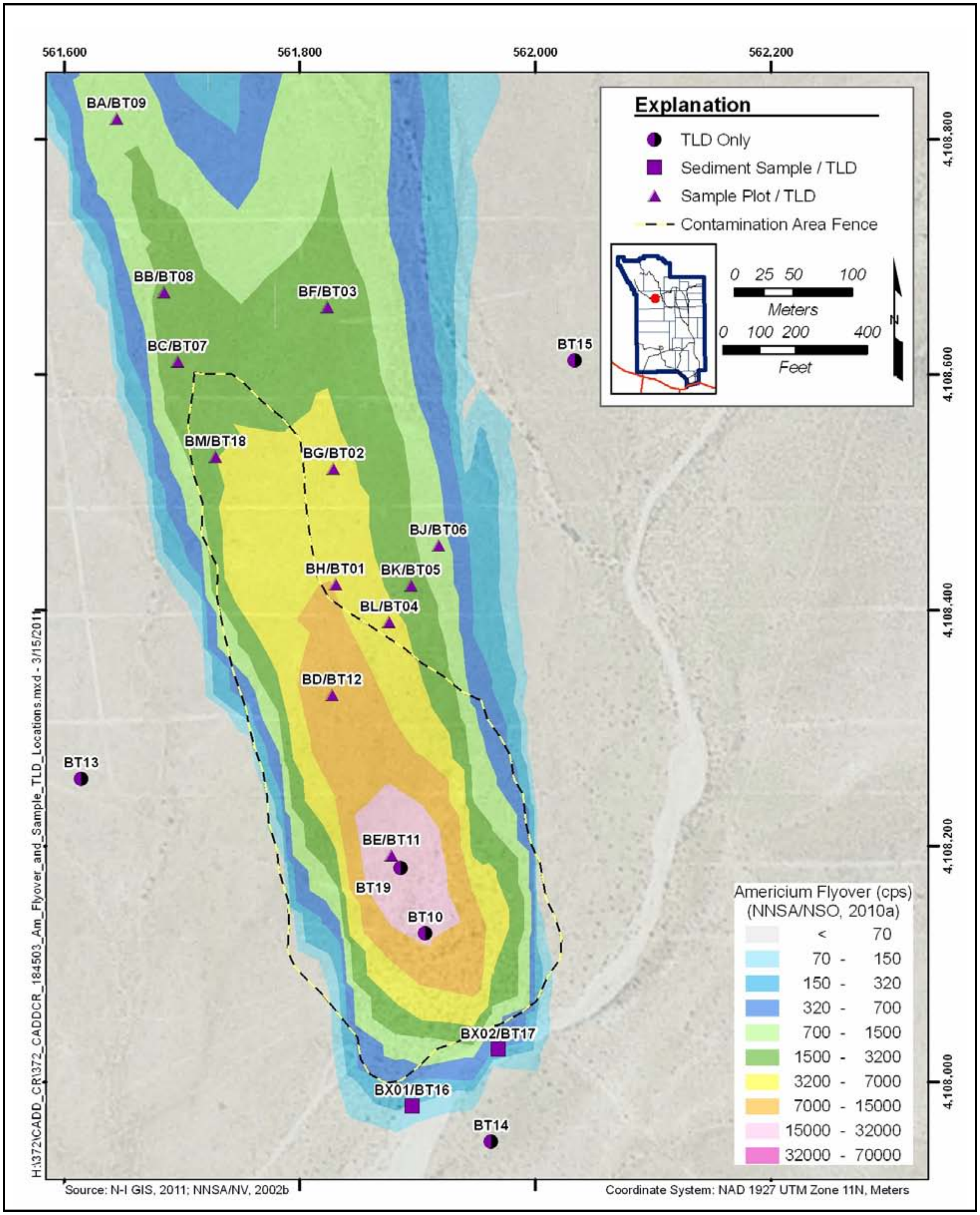

Figure A.4-2
Little Feller II Sample and TLD Locations

(BX01 and BX02). These field-screening data were recorded on SCLs, which are retained in the project files.

A.4.1.5 Deviations

The CAU 372 CAIP (NNSA/NSO, 2009) states that "one sample plot will be established judgmentally at a location most likely to exceed a 25-mrem/yr-dose constraint..." The highest GWS readings were identified at a location where removable contamination levels appeared consistent with the levels of an HCA, and a sample plot was not established in this area because of worker safety considerations. Therefore, it was assumed that the dose in this area exceeds FALs. Because the plot established adjacent to this location (plot BE) demonstrated that TED exceeds the FAL, there is no impact to DQO Decision I.

The CAU 372 CAIP also states that the corrective action boundary will be established based on the distance along each vector that corresponds to the 25-mrem/yr FAL and the radiation survey isopleth that encompasses these locations. However, it was determined that the corrective action boundary could be better defined by performing the following:

- Directly correlating TED from all sample locations to the radiation survey values at each location.
- Using the radiation survey isopleth value correlating to the 25-mrem/yr FAL as the corrective action boundary with the stipulation that the boundary encompasses all locations with a TED that exceeds the FAL.

Although this is a minor deviation to the method described in the CAIP, it provides an improvement in the process in that the TED values are directly correlated to radiation survey values rather than correlating them to distance along vectors (which has no direct relationship to dose). This deviation is not expected to have any significant impact on the resulting corrective action boundary while providing a more robust and defensible process.

A.4.2 Investigation Results

The following sections provide the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAU 372 CAIP (NNSA/NSO, 2009). The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2009), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location. External doses for TLD locations are summarized in Section A.4.2.1. Internal doses for each sampled location are summarized in Section A.4.2.2. The TEDs for each sampled location are summarized in Section A.4.2.3.

A.4.2.1 External Radiological Dose Measurements

The external dose estimates at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use exposure scenarios. Because the minimum sample size was not met for TLD location BT19, it is assumed that dose at this location exceeds the FAL. The standard deviation, number of elements, minimum sample size, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table A.4-3.

A.4.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Little Feller II were determined as described in Section A.2.2.4. For TLD locations where soil samples were not collected, the internal to external dose ratio from the plot with the maximum amount of internal dose was used to estimate internal dose. As shown in Table A.4-4, the maximum internal dose was at plot BE, and the resulting internal to external dose ratio at this site was 0.23.

As shown in Table A.4-5, the minimum sample size was met for all plots at Little Feller II. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for each exposure scenario are presented in Table A.4-5. The analytical results for the individual

Table A.4-3
Little Feller II 95% UCL External Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot BA	0.30	3	1.4	5.7	0.8	0.2
Plot BB	0.32	3	1.4	10.9	1.6	0.4
Plot BC	0.42	3	1.4	11.0	1.6	0.4
Plot BD	1.61	12	1.5	**48.5**	7.2	1.7
Plot BE	6.87	12	3.2	**212.4**	**31.7**	7.6
Plot BF	0.41	3	1.4	8.7	1.3	0.3
Plot BG	0.49	3	1.4	9.8	1.5	0.3
Plot BH	0.53	3	1.4	**25.7**	3.8	0.9
Plot BJ	0.08	3	1.4	5.0	0.7	0.2
Plot BK	0.16	3	1.4	9.3	1.4	0.3
Plot BL	0.82	3	1.4	22.1	3.3	0.8
Plot BM	0.96	9	1.4	**26.5**	4.0	0.9
TLD Location BT10	7.12	12	3.4	**188.1**	**28.1**	6.7
TLD Location BT19	14.07	9	9.2	**386.5**	**57.7**	13.7
BX01	0.30	3	1.4	8.0	1.2	0.3
BX02	0.30	3	1.4	7.9	1.2	0.3

Bold indicates the values exceeding 25 mrem/yr.

radionuclides in each composite sample and the corresponding calculated internal dose are presented in Appendix F.

A.4.2.3 Total Effective Dose

The TED for each sample plot, sediment sample location, or TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for each exposure scenario are presented in Table A.4-6. The TED for sample locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at plot BE and locations BT10 and BT19 (Figure A.4-3).

Table A.4-4
Little Feller II Ratio of Calculated Internal Dose to External Dose at Each Location (mrem/RW-yr)

Plot	Average Internal Dose	Average External Dose	Average TED	Internal to External Dose Ratio
Plot BA	0.20	0.35	0.55	0.57
Plot BB	0.85	1.09	1.95	0.78
Plot BC	0.37	0.95	1.32	0.39
Plot BD	2.00	6.4	8.40	0.31
Plot BE	6.56	**28.15**	**34.71**	0.23
Plot BF	0.24	0.61	0.86	0.39
Plot BG	0.56	0.65	1.21	0.86
Plot BH	0.88	2.95	3.83	0.3
Plot BJ	0.09	0.62	0.71	0.15
Plot BK	0.21	1.11	1.32	0.19
Plot BL	0.84	1.92	2.76	0.44
Plot BM	4.45	3.36	7.81	1.32
Location BX01	0.01	0.69	0.70	0.014
Location BX02	0.01	0.67	0.68	0.015
BT10	4.86	24.39	**29.25**	0.2
BT19	9.76	**49.00**	**58.76**	0.2

Bold indicates the values exceeding 25 mrem/yr.

A conservative estimate of future dose at this site (considering radioactive decay mechanisms only with no consideration of dispersion [erosion and transport mechanisms]) is that dose will continually decrease and the area exceeding the FAL will continually decrease. However, based on the long half-lives of the radionuclides present at the site (e.g., Am-241, Pu-239/240), TED will not significantly decay in the next 1,000 years. The effective half-life for this site is about 346.6 years.

A.4.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, COCs were identified at this CAS at sample locations BE, BT10, and BT19. Therefore, a corrective action is required. The selected corrective

Table A.4-5
Little Feller II 95% UCL Internal Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Samples	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot BA	0.071	4	1.4	1.6	0.3	0.1
Plot BB	0.82	4	1.4	10.4	1.8	0.6
Plot BC	0.023	5	1.4	2.3	0.4	0.1
Plot BD	0.19	4	1.4	12.7	2.2	0.8
Plot BE	2.22	4	1.5	**52.5**	9.2	3.2
Plot BF	0.11	4	1.4	2.1	0.4	0.1
Plot BG	0.24	4	1.4	4.8	0.8	0.3
Plot BH	0.099	4	1.4	5.7	1.0	0.4
Plot BJ	0.084	5	1.4	1.0	0.2	0.1
Plot BK	0.043	5	1.4	1.5	0.3	0.1
Plot BL	0.71	4	1.4	9.6	1.7	0.6
Plot BM	2.48	4	1.6	**42.2**	7.4	2.6

Bold indicates the values exceeding 25 mrem/yr.

action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. To determine the extent of the area where the remote work area TED exceeds the FAL (Remote Work Area scenario), a correlation of radiation survey values to the 95 percent UCL of Remote Work Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010a] and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The isopleth of 3.26 multiples of background corresponds to the 25-mrem/RW-yr FAL and was identified as the corrective action boundary as shown in Figure A.4-4. An FFACO UR was established to encompass this area. The UR is presented in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,250 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of the area where the Industrial Area TED exceeds the FAL (Industrial Area scenario) a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED

Table A.4-6
Little Feller II TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Plot BA	3.5	7.3	0.6	1.1	0.2	0.3
Plot BB	12.2	21.4	2.0	3.5	0.6	1.0
Plot BC	8.5	13.3	1.3	2.0	0.4	0.5
Plot BD	**54.3**	**61.2**	8.4	9.5	2.2	2.5
Plot BE	**226.1**	**264.9**	**34.7**	**40.9**	9.0	10.8
Plot BF	5.5	10.8	0.9	1.7	0.2	0.4
Plot BG	7.6	14.7	1.2	2.3	0.4	0.6
Plot BH	24.8	**31.4**	3.8	4.8	1.0	1.3
Plot BJ	4.7	6.0	0.7	0.9	0.2	0.2
Plot BK	8.6	10.7	1.3	1.6	0.3	0.4
Plot BL	17.7	**31.7**	2.8	5.0	0.8	1.4
Plot BM	**48.0**	**68.7**	7.8	11.3	2.4	3.6
TLD Location BT10	**195.9**	**225.5**	**29.3**	**33.7**	7.0	8.0
TLD Location BT19	**393.5**	**463.5**	**58.8**	**69.2**	14.0	16.5
Location BX01	4.7	8.1	0.7	1.2	0.2	0.3
Location BX02	4.5	7.9	0.7	1.2	0.2	0.3

Bold indicates the values exceeding 25 mrem/yr.

values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys, and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr FAL is 1.29 multiples of background (Figure A.4-4). The administrative UR boundary established to encompass this area is presented in Attachment D-2 of Appendix D.

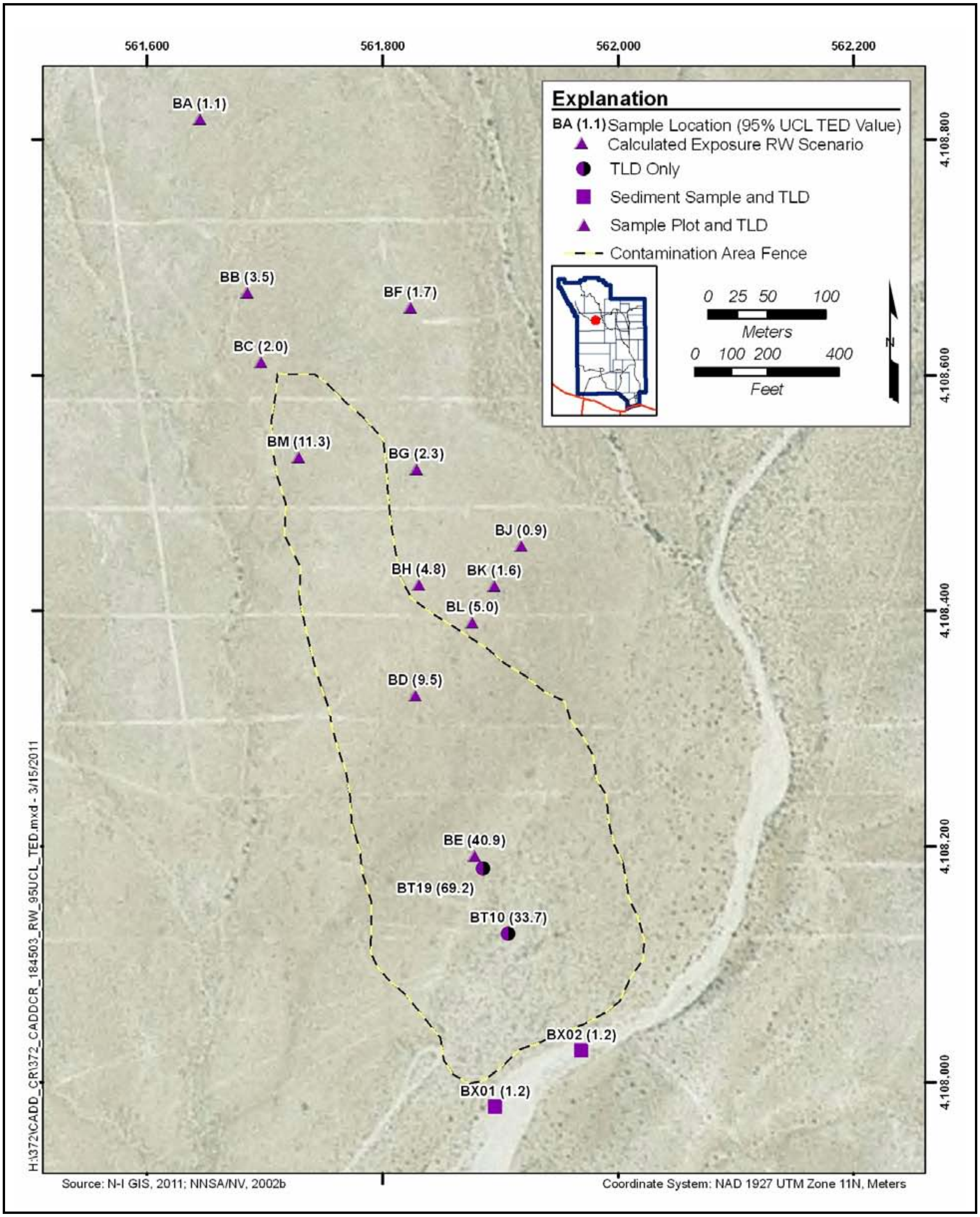

Figure A.4-3
Values for the 95% UCL of the TED at Little Feller II

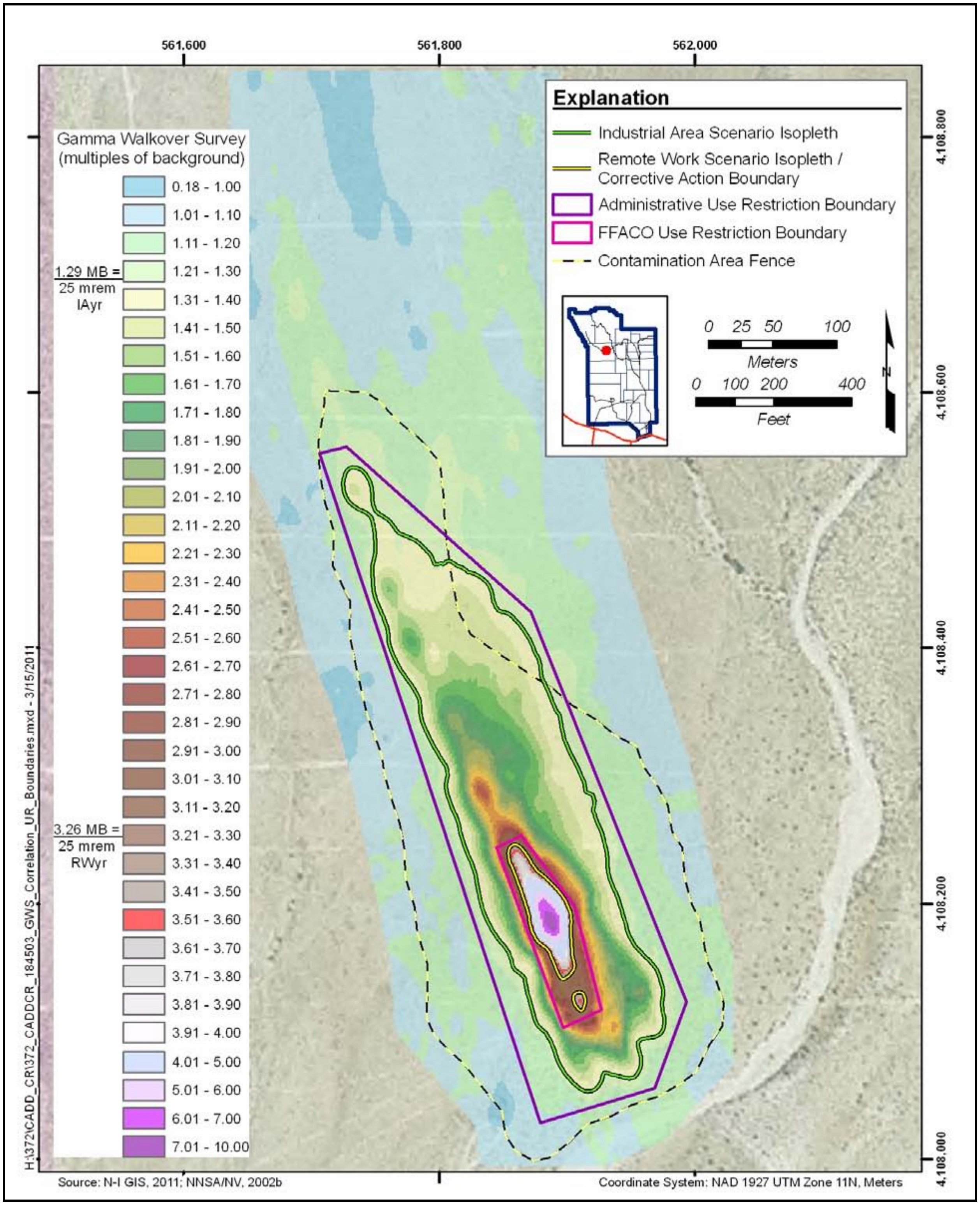

Figure A.4-4
Little Feller II Correlation of GWS Isopleth Values to 95% UCL of TED

A.4.4 Revised Conceptual Site Model

The CAU 372 CAIP requirements (NNSA/NSO, 2009) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 372. Therefore, no revisions were necessary to the CSM.

A.5.0 CAS 20-23-01, U-20k Contamination Area

Palanquin is located in Area 20 of the NNSS, south of Pahute Mesa Road. This CAS consists of a release of radionuclides to the surrounding soil surface from the underground Palanquin test conducted under the Plowshare Program (DOE/NV, 2000). Radioactive contamination at this site also includes the prompt injection of material into the crater and ejecta mounds surrounding the crater. A crater measuring approximately 24 m deep with a radius of 36 m was formed from this test (Gibson, 1965). Additional detail is provided in the CAU 372 CAIP (NNSA/NSO, 2009).

A.5.1 Corrective Action Investigation Activities

A total of 70 environmental samples (64 judgmental primary release samples and 4 FDs from 16 plots, and 2 judgmental other release samples from 2 sediment accumulation areas) were collected during investigation activities at Palanquin. All samples were analyzed for gamma spectroscopy; Sr-90; and isotopic U, Pu, and Am. The sample numbers, locations, depth, matrix, and purpose are listed in Table A.5-1. A total of 50 TLDs (representing a total of 150 sample elements) at 27 locations (4 field background locations and 23 CAS locations) were used to calculate the external dose to site workers. The TLD numbers, locations, dates placed, dates removed, and purpose are listed in Table A.5-2. The specific CAI activities conducted to satisfy the CAIP (NNSA/NSO, 2009) requirements at this CAS are described in the following sections.

A.5.1.1 Visual Inspections

Various inspections were conducted over the course of the field investigation. Scattered debris such as batteries were identified. The batteries were removed and sent for recycling; samples were not collected because the batteries were intact and no visible signs of a release were present. In addition to the batteries, drainages were identified as potential migration pathways for contaminated sediments. Within the major drainage, sediment accumulation areas were identified, and those sampled sediment accumulation areas are shown on Figure A.5-1. No other biasing factors indicating the release of contamination were identified.

Table A.5-1
Samples Collected at Palanquin
(Page 1 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
CA	372CA01	0 - 5	Soil	Environmental
	372CA02	0 - 5	Soil	Environmental
	372CA03	0 - 5	Soil	Environmental
	372CA04	0 - 5	Soil	Environmental
CB	372CB01	0 - 5	Soil	Environmental
	372CB02	0 - 5	Soil	Environmental
	372CB03	0 - 5	Soil	Environmental
	372CB04	0 - 5	Soil	Environmental
CC	372CC01	0 - 5	Soil	Environmental, Full Lab QC
	372CC02	0 - 5	Soil	Environmental
	372CC03	0 - 5	Soil	FD of #372CC02
	372CC04	0 - 5	Soil	Environmental
	372CC05	0 - 5	Soil	Environmental
CD	372CD01	0 - 5	Soil	Environmental
	372CD02	0 - 5	Soil	Environmental
	372CD03	0 - 5	Soil	Environmental
	372CD04	0 - 5	Soil	Environmental
CE	372CE01	0 - 5	Soil	Environmental, Full Lab QC
	372CE02	0 - 5	Soil	Environmental
	372CE03	0 - 5	Soil	FD of #372CE02
	372CE04	0 - 5	Soil	Environmental
	372CE05	0 - 5	Soil	Environmental
CF	372CF01	0 - 5	Soil	Environmental
	372CF02	0 - 5	Soil	Environmental
	372CF03	0 - 5	Soil	Environmental
	372CF04	0 - 5	Soil	Environmental

Table A.5-1
Samples Collected at Palanquin
(Page 2 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
CG	372CG01	0 - 5	Soil	Environmental
	372CG02	0 - 5	Soil	Environmental
	372CG03	0 - 5	Soil	Environmental
	372CG04	0 - 5	Soil	Environmental
CH	372CH01	0 - 5	Soil	Environmental
	372CH02	0 - 5	Soil	Environmental
	372CH03	0 - 5	Soil	Environmental
	372CH04	0 - 5	Soil	Environmental
CJ	372CJ01	0 - 5	Soil	Environmental
	372CJ02	0 - 5	Soil	Environmental
	372CJ03	0 - 5	Soil	Environmental
	372CJ04	0 - 5	Soil	Environmental
CK	372CK01	0 - 5	Soil	Environmental
	372CK02	0 - 5	Soil	Environmental
	372CK03	0 - 5	Soil	Environmental
	372CK04	0 - 5	Soil	Environmental
CL	372CL01	0 - 5	Soil	Environmental
	372CL02	0 - 5	Soil	FD of #372CL01
	372CL03	0 - 5	Soil	Environmental, Full Lab QC
	372CL04	0 - 5	Soil	Environmental
	372CL05	0 - 5	Soil	Environmental
CM	372CM01	0 - 5	Soil	Environmental
	372CM02	0 - 5	Soil	Environmental
	372CM03	0 - 5	Soil	Environmental, Full Lab QC
	372CM04	0 - 5	Soil	Environmental
	372CM05	0 - 5	Soil	FD of #372CM04

Table A.5-1
Samples Collected at Palanquin
(Page 3 of 3)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
CN	372CN01	0 - 5	Soil	Environmental
	372CN02	0 - 5	Soil	Environmental
	372CN03	0 - 5	Soil	Environmental
	372CN04	0 - 5	Soil	Environmental
CP	372CP01	0 - 5	Soil	Environmental
	372CP02	0 - 5	Soil	Environmental
	372CP03	0 - 5	Soil	Environmental
	372CP04	0 - 5	Soil	Environmental
CQ	372CQ01	0 - 5	Soil	Environmental
	372CQ02	0 - 5	Soil	Environmental
	372CQ03	0 - 5	Soil	Environmental
	372CQ04	0 - 5	Soil	Environmental
CR	372CR01	0 - 5	Soil	Environmental
	372CR02	0 - 5	Soil	Environmental
	372CR03	0 - 5	Soil	Environmental
	372CR04	0 - 5	Soil	Environmental
CX01	372CX01	0 - 5	Soil	Environmental
CX02	372CX02	0 - 5	Soil	Environmental

A.5.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were performed at Palanquin during the CAI. The GWSs were conducted at the site to identify the spatial distribution of radiological readings and to locate the area of highest radiological readings. The location of highest radiological readings was detected at the southwest side of the crater area. A sample plot and TLD were placed in the area of highest radiological readings outside the crater area (plot CP).

Gamma walkover surveys were also conducted at Palanquin to inspect the major drainages exiting the site for evidence of contaminant migration (readings above background were not detected within

Table A.5-2
TLDs at Palanquin
(Page 1 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
CT01 (Plot CC)	4394	11/11/2009	04/26/2010	Sample plot
	5029	05/24/2010	09/08/2010	Sample plot
CT02 (Plot CH)	4444	11/11/2009	04/26/2010	Sample plot
	4659	05/24/2010	09/08/2010	Sample plot
CT03 (Plot CJ)	4446	11/11/2009	04/26/2010	Sample plot
	4456	05/24/2010	09/08/2010	Sample plot
CT04 (Plot CA)	4499	11/11/2009	04/26/2010	Sample plot
	4446	05/24/2010	09/09/2010	Sample plot
CT05 (Plot CF)	5079	11/11/2009	04/26/2010	Sample plot
	5275	05/24/2010	09/09/2010	Sample plot
CT06 (Plot CG)	5023	11/11/2009	04/26/2010	Sample plot
	4520	05/24/2010	09/09/2010	Sample plot
CT07 (Plot CB)	4456	11/11/2009	04/26/2010	Sample plot
	4829	05/24/2010	09/09/2010	Sample plot
CT08 (Plot CD)	4829	11/11/2009	04/26/2010	Sample plot
	5015	05/24/2010	09/09/2010	Sample plot
CT09 (Plot CE)	4434	11/11/2009	04/26/2010	Sample plot
	5079	05/24/2010	09/09/2010	Sample plot
CT10[a]	4804	11/12/2009	04/26/2010	Background TLD location
	5129	05/24/2010	09/09/2010	Background TLD location
CT11[a]	5029	11/11/2009	04/26/2010	Background TLD location
	4444	05/24/2010	09/08/2010	Background TLD location
CT12[a]	5015	11/10/2009	04/26/2010	Background TLD location
	5023	05/24/2010	09/08/2010	Background TLD location
CT13[a]	5275	11/11/2009	04/26/2010	Background TLD location
	4635	05/24/2010	09/08/2010	Background TLD location
CT14 (Plot CL)	1166	08/04/2010	11/09/2010	Sample plot

Table A.5-2
TLDs at Palanquin
(Page 2 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
CT15 (Plot CK)	1854	08/04/2010	11/09/2010	Sample plot
CT16	2025	08/04/2010	11/09/2010	TLD only
CT17	1241	08/04/2010	11/09/2010	TLD only
CT18 (sample location CX01)	3830	08/05/2010	11/09/2010	Sediment sample location
CT19 (sample location CX02)	3907	08/05/2010	11/09/2010	Sediment sample location
CT20	3913	08/12/2010	11/09/2010	TLD only
CT21	3931	08/12/2010	11/09/2010	TLD only
CT22	3608	08/12/2010	11/09/2010	TLD only
CT23 (Plot CR)	4367	09/23/2010	12/10/2010	Sample plot
	4746	09/23/2010	12/10/2010	Sample plot
	4655	09/23/2010	12/10/2010	Sample plot
CT24 (Plot CQ)	4402	09/23/2010	12/10/2010	Sample plot
	4319	09/23/2010	12/10/2010	Sample plot
	5008	09/23/2010	12/10/2010	Sample plot
CT25 (Plot CP)	4998	09/23/2010	12/10/2010	Sample plot
	4378	09/23/2010	12/10/2010	Sample plot
	4838	09/23/2010	12/10/2010	Sample plot
CT26 (Plot CN)	4441	09/23/2010	12/10/2010	Sample plot
	4678	09/23/2010	12/10/2010	Sample plot
	4673	09/23/2010	12/10/2010	Sample plot
CT27 (Plot CM)	5163	09/23/2010	12/10/2010	Sample plot
	5185	09/23/2010	12/10/2010	Sample plot
	4752	09/23/2010	12/10/2010	Sample plot

[a]These background TLD locations were used for both Palanquin and Cabriolet

the drainages). Data were post-processed, loaded into a geographical information system, color-coded, and displayed on a map of Palanquin. Figure A.5-1 provides the results of the GWSs. To confirm the lack of contamination migrating off site, biased samples were collected at two sediment accumulation areas within the major drainage exiting the site (Figure A.5-2).

In addition to the GWSs, the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a) were used to determine the locations of the soil sample plots at the Palanquin site. The aerial radiological survey covered the area of the plume, which extends north outside the contamination area. Sample plot locations were placed along the plume (Figure A.5-2).

A.5.1.3 Sample Collection

A.5.1.3.1 TLD Samples

The 50 TLDs listed in Table A.5-2 and shown at the locations on Figure A.5-2 were placed at the Palanquin site to measure external doses. The TLDs at locations CT10 through CT13 were placed at field background locations. Thermoluminescent dosimeters CT12 and CT13 are shown on Figure A.6-2 because they are located east of Cabriolet. Sample plots were associated with TLD locations CT01 through CT09, CT14, CT15, and CT23 through CT27. Sediment samples were collected in the same location as TLD locations CT18 and CT19. The TLDs were also placed at locations CT16, CT17, and CT20 through CT22 to measure external dose.

The TLDs were originally placed at Palanquin in November 2009. These TLDs were scheduled to be collected in February 2010 (to meet the 2,250-hour exposure time); however, due to inclement weather (snow), the TLDs were not collected until the snow melted and the site was accessible in April 2010. Due to the uncertainty of the effect of the snow on the TLD results, a second set of TLDs was placed at the same locations in May 2010 and retrieved in September 2010. A comparison was conducted between the two sets of TLD data (with background subtracted and normalized to 2,250 hours) showed an average difference in dose of less than 1 percent (Figure A.5-3). Therefore, both rounds of TLDs were used in calculation of the external dose.

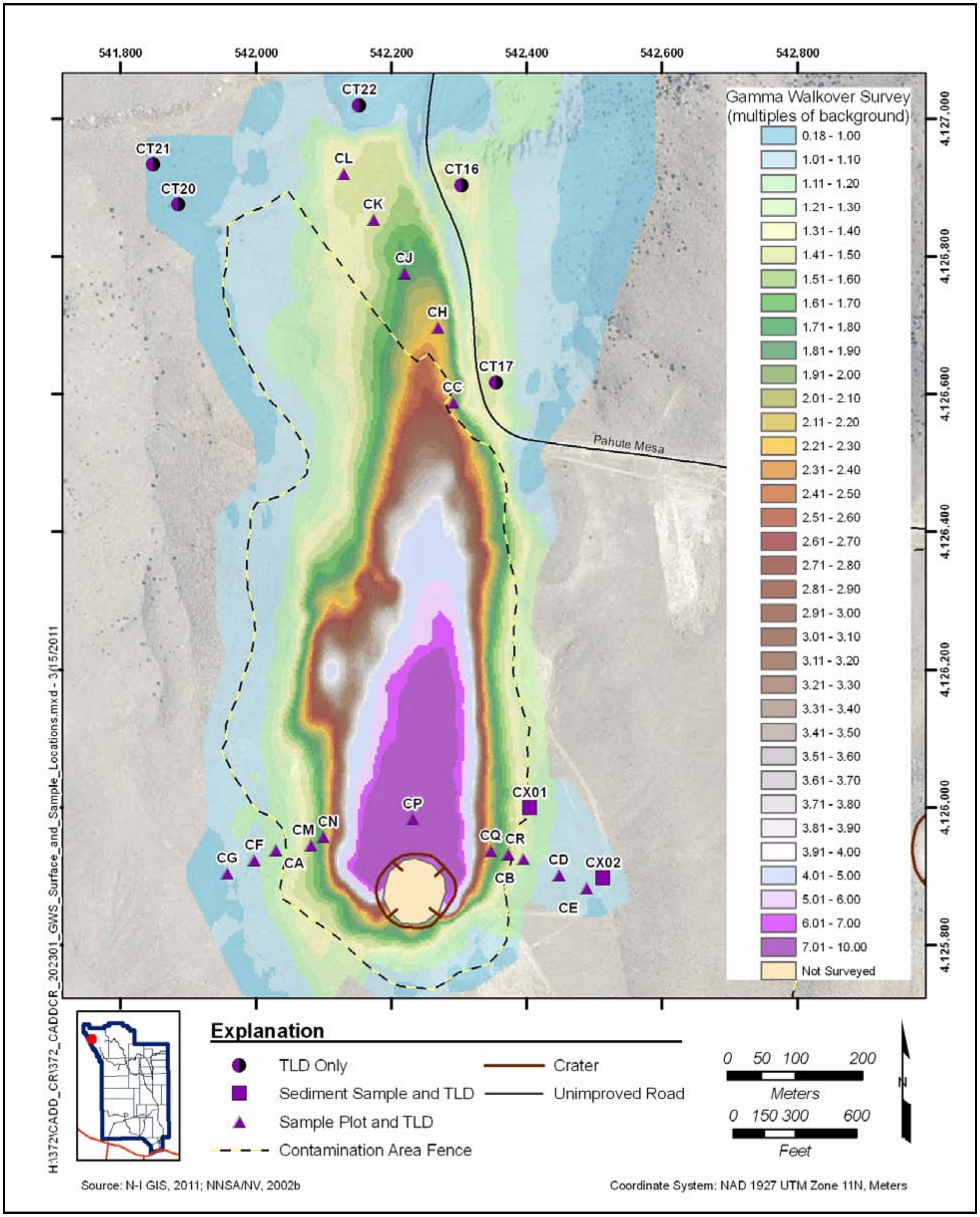

Figure A.5-1
Gamma Walkover Surveys of Selected Locations at Palanquin

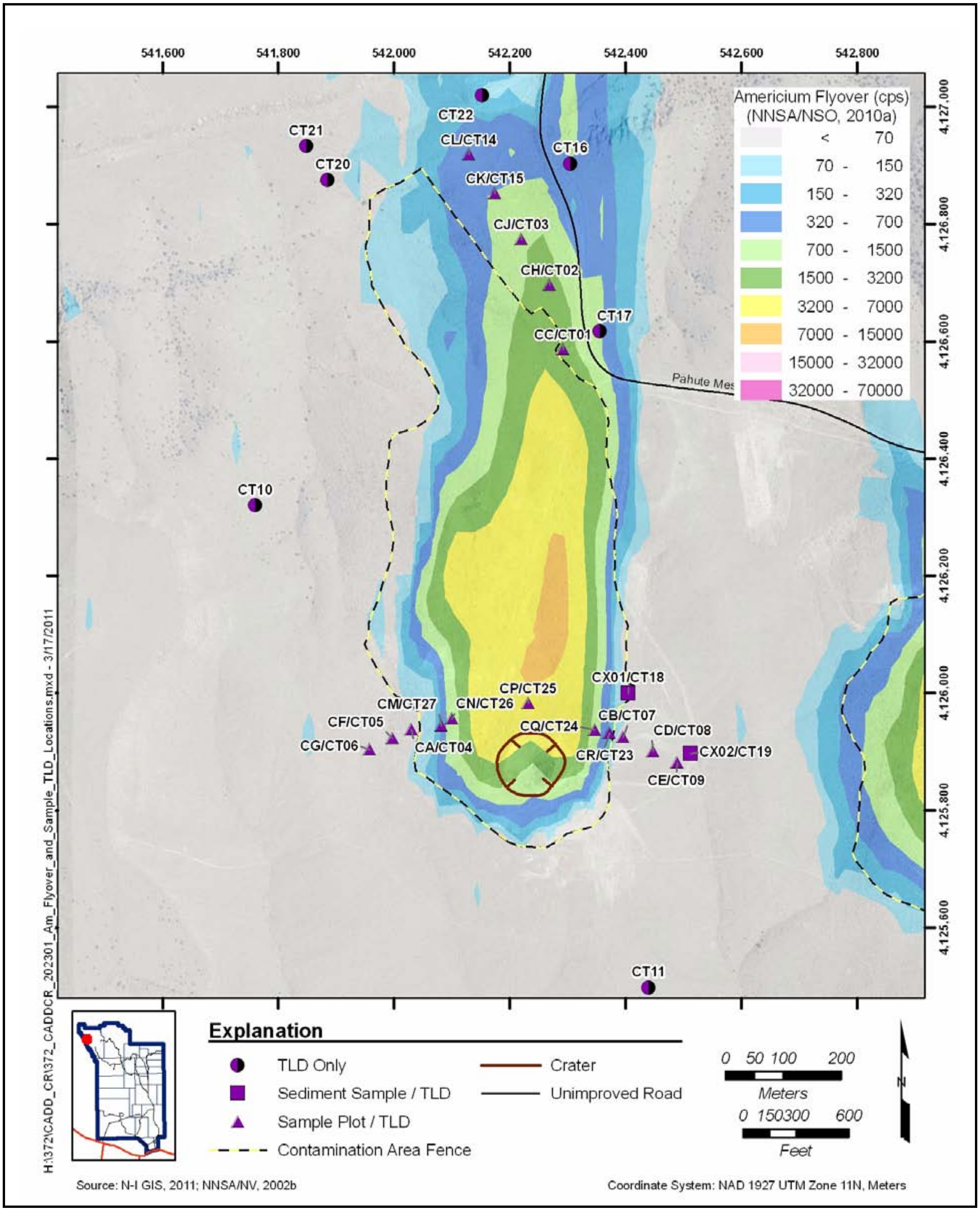

Figure A.5-2
Palanquin Sample and TLD Locations

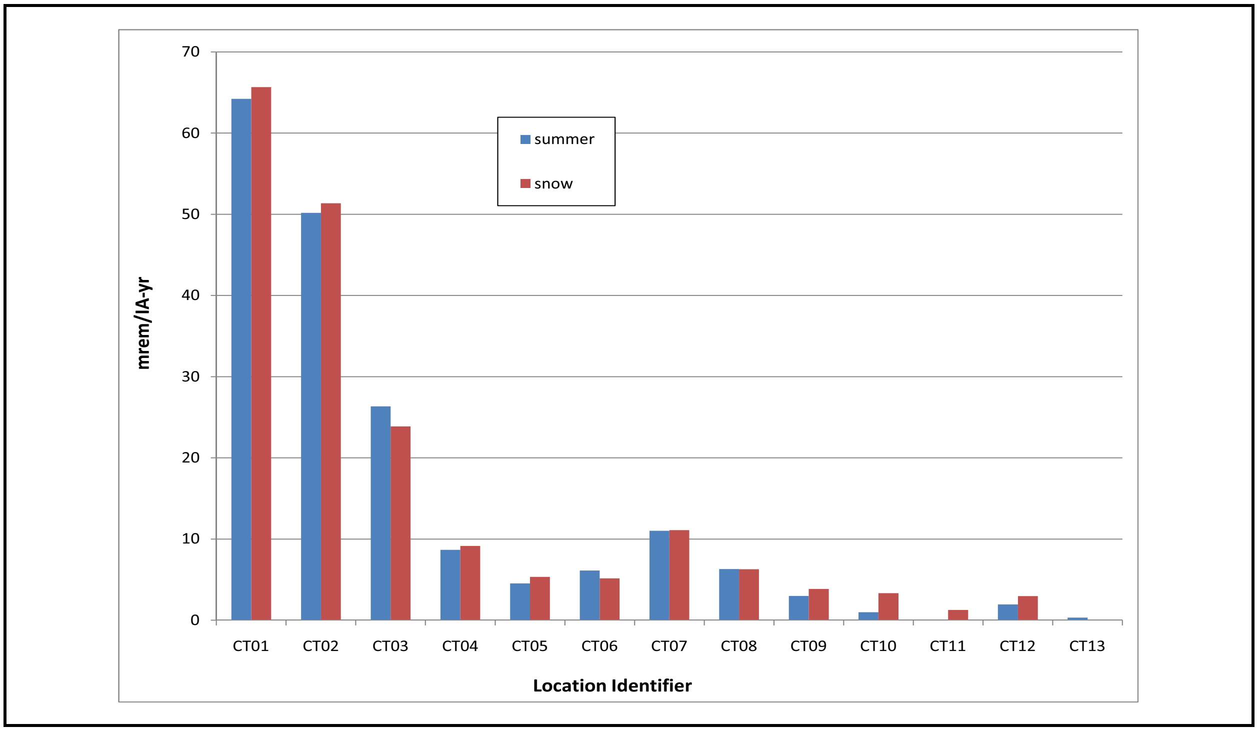

Figure A.5-3
Comparison of Snow TLDs to Non-snow TLDs at Palanquin

A.5.1.3.2 Soil Samples

For the determination of the internal dose, 68 composite surface soil samples (including 4 duplicates) were collected from 16 plots within the Palanquin area. Sample plots were established along each of three sampling vectors originating from outside the contamination area extended outward in (generally) the north, southeast, and southwest directions (based on the isopleths from the 1994 aerial radiological survey [BN, 1999]). Upon review of the TLDs, GWS data, and 2009 aerial radiological survey (NNSA/NSO, 2010), additional plots were established at Palanquin, within the area of highest radiological readings (plot CA), and further north outside the contamination area along the north vector. Ultimately, five sample plots (CC, CH, CJ, CK, and CL) were established along the north vector; five sample plots (CA, CF, CG, CM, and CN) were established along the southwest vector; and six sample plots (CB, CD, CE, CP, CQ, and CR) were established along the southeast vector. Sample plot locations are shown on Figure A.5-2.

For the other releases at Palanquin, one sample (0 to 5 cm bgs) was collected from each of two sediment accumulation areas (locations CX01 and CX02) within the major drainage exiting the contamination area to determine whether migration away from the test area has occurred. The first two sediment areas anticipated to be outside the 25-mrem/yr boundary were sampled. The sediment sample locations are shown on Figure A.5-2.

A.5.1.4 Field Screening

The FSRs were used for selection of the vertical samples collected from the sediment accumulation areas. For these samples (collected between 0 and 25 cm bgs from each of two locations), the 0- to 5-cm depth at locations CX01 and CX02 exhibited the highest field-screening values for beta. They did not exhibit the highest values for alpha; however, the alpha and beta FSL values were not exceeded for any of the intervals collected at locations CX01 or CX02. Because the samples collected at 0 to 5 cm exhibited the highest values for beta, the 0- to 5-cm interval samples were submitted to the laboratory for analysis for both sediment accumulation area locations (CX01 and CX02). These field-screening data were recorded on SCLs, which are retained in the project files.

A.5.1.5 Deviations

The CAU 372 CAIP (NNSA/NSO, 2009) states that the corrective action boundary will be established based on the distance along each vector that corresponds to the 25-mrem/yr FAL and the radiation survey isopleth that encompasses these locations. However, it was determined that the corrective action boundary could be better defined by performing the following:

- Directly correlating TED from all sample locations to the radiation survey values at each location.
- Using the radiation survey isopleth value correlating to the 25-mrem/yr FAL as the corrective action boundary with the stipulation that the boundary encompasses all locations with a TED that exceeds the FAL.

Although this is a minor deviation to the method described in the CAIP, it provides an improvement in the process in that the TED values are directly correlated to radiation survey values rather than correlating them to distance along vectors (which has no direct relationship to dose). This deviation is not expected to have any significant impact on the resulting corrective action boundary while providing a more robust and defensible process.

A.5.2 Investigation Results

The following sections provide the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2009). The radiological and sediment accumulation area results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2009), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location. External doses for TLD locations are summarized in Section A.5.2.1. Internal doses for each sampled location are summarized in Section A.5.2.2. The TEDs for each sampled location are summarized in Section A.5.2.3.

A.5.2.1 External Radiological Dose Measurements

The external dose estimates at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use Area exposure scenarios. The minimum sample size was met for all TLD locations. The standard deviation, number of elements, minimum sample size, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table A.5-3.

A.5.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Palanquin were determined as described in Section A.2.2.4. For TLD locations where soil samples were not collected, the internal to external dose ratio from the plot with the maximum amount of internal dose

Table A.5-3
Palanquin 95% UCL External Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot CA	0.278	6	1.4	9.0	1.3	0.3
Plot CB	0.371	6	1.4	11.7	1.7	0.4
Plot CC	0.933	6	1.4	**68.7**	10.3	2.4
Plot CD	0.323	6	1.4	6.7	1.0	0.2
Plot CE	0.286	6	1.4	3.6	0.5	0.1
Plot CF	0.358	6	1.4	5.5	0.8	0.2
Plot CG	0.430	6	1.4	6.6	1.0	0.2
Plot CH	0.886	6	1.4	**54.3**	8.1	1.9
Plot CJ	0.727	6	1.4	**27.8**	4.1	1.0
Plot CK	0.128	3	1.4	18.1	2.7	0.6
Plot CL	0.253	3	1.4	20.9	3.1	0.7
Plot CM	0.374	9	1.4	13.2	2.0	0.5
Plot CN	0.424	9	1.4	**32.7**	4.9	1.2
Plot CP	9.133	9	4.7	**766.3**	**114.4**	**27.2**
Plot CQ	0.697	9	1.4	**33.0**	4.9	1.2
Plot CR	0.441	9	1.4	18.3	2.7	0.7
TLD Location CT16	0.406	3	1.4	19.4	2.9	0.7
TLD Location CT17	0.660	3	1.4	**28.5**	4.3	1.0
TLD Location CT20	0.297	3	1.4	7.4	1.1	0.3
TLD Location CT21	0.387	3	1.4	5.2	0.8	0.2
TLD Location CT22	0.255	3	1.4	0[a]	0[a]	0[a]
Location CX01	0.434	3	1.4	14.0	2.1	0.5
Location CX02	0.240	3	1.4	8.8	1.3	0.3

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

was used to estimate internal dose. As shown in Table A.5-4, the maximum internal dose was at plot CP, and the resulting internal to external dose ratio at this site was 0.192.

Table A.5-4
Palanquin Ratio of Calculated Internal Dose to External Dose at Each Location (mrem/RW-yr)

Plot or Location	Average Internal Dose	Average External Dose	Average TED	Internal to External Dose Ratio
Plot CA	0.05	1.12	1.17	0.045
Plot CB	0.03	1.44	1.47	0.021
Plot CC	1.38	9.5	10.88	0.15
Plot CD	0.01	0.73	0.74	0.014
Plot CE	0.01	0.30	0.32	0.033
Plot CF	0.04	0.53	0.57	0.075
Plot CG	0.01	0.63	0.64	0.016
Plot CH	1.07	7.38	8.45	0.14
Plot CJ	0.72	3.55	4.27	0.2
Plot CK	0.46	2.49	2.96	0.18
Plot CL	0.51	2.69	3.20	0.19
Plot CM	0.13	1.73	1.87	0.075
Plot CN	0.30	4.62	4.92	0.065
Plot CP	20.90	**108.78**	**129.68**	0.192
Plot CQ	0.23	4.49	4.72	0.051
Plot CR	0.11	2.47	2.58	0.045
Location CX01	0.02	1.36	1.38	0.015
Location CX02	0.04	0.90	0.94	0.044
CT16	0.31	2.21	2.53	0.14
CT17	0.44	3.15	3.59	0.14
CT20	0.09	0.60	0.69	0.15
CT21	0.02	0.13	0.15	0.15
CT22	0[a]	0[a]	0[a]	0.14

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

As shown in Table A.5-5, the minimum sample size was met for all plots at Palanquin. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for each exposure scenario are presented in Table A.5-5. The analytical results for the individual radionuclides in each composite sample and the corresponding calculated internal dose are presented in Appendix F.

Table A.5-5
Palanquin 95% UCL Internal Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Samples	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot CA	0.0057	4	1.4	0.3	0.1	0.02
Plot CB	0.0010	4	1.4	0.2	0.03	0.01
Plot CC	0.36	5	1.4	9.9	1.7	0.6
Plot CD	0.0028	4	1.4	0.1	0.02	0.01
Plot CE	0.0029	5	1.4	0.1	0.02	0.01
Plot CF	0.0045	4	1.4	0.3	0.04	0.02
Plot CG	0.0012	4	1.4	0.05	0.01	0.003
Plot CH	0.22	4	1.4	7.6	1.3	0.5
Plot CJ	0.22	4	1.4	5.6	1.0	0.3
Plot CK	0.039	4	1.4	2.9	0.5	0.2
Plot CL	0.11	5	1.4	3.5	0.6	0.2
Plot CM	0.016	5	1.4	0.9	0.1	0.1
Plot CN	0.16	4	1.4	2.8	0.5	0.2
Plot CP	6.95	4	3.3	**166.6**	**29.1**	10.3
Plot CQ	0.07	4	1.4	1.8	0.3	0.1
Plot CR	0.033	4	1.4	0.8	0.1	0.1

Bold indicates the values exceeding 25 mrem/yr.

A.5.2.3 Total Effective Dose

The TED for each sample plot, sediment sample location, or TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for each exposure scenario are presented in Table A.5-6. The TED for sample locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at plot CP (Figure A.5-4).

Table A.5-6
Palanquin TED at Sample Locations (mrem/yr)
(Page 1 of 2)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Plot CA	7.8	9.4	1.2	1.4	0.3	0.3
Plot CB	9.8	11.9	1.5	1.8	0.4	0.4
Plot CC	**71.5**	**78.6**	10.9	12.0	2.8	3.1
Plot CD	5.0	6.8	0.7	1.0	0.2	0.2
Plot CE	2.1	3.7	0.3	0.6	0.1	0.1
Plot CF	3.8	5.8	0.6	0.9	0.1	0.2
Plot CG	4.3	6.7	0.6	1.0	0.2	0.2
Plot CH	**55.5**	**61.9**	8.4	9.4	2.1	2.4
Plot CJ	**27.9**	**33.4**	4.3	5.1	1.1	1.3
Plot CK	19.3	21.1	3.0	3.2	0.8	0.8
Plot CL	20.9	24.4	3.2	3.7	0.8	1.0
Plot CM	12.4	14.0	1.9	2.1	0.5	0.5
Plot CN	**32.6**	**35.5**	4.9	5.4	1.2	1.3
Plot CP	**848.2**	**932.9**	**129.7**	**143.5**	**33.3**	**37.5**
Plot CQ	**31.4**	**34.8**	4.7	5.2	1.2	1.3
Plot CR	17.1	19.2	2.6	2.9	0.6	0.7
TLD Location CT16	16.9	22.1	2.5	3.3	0.6	0.8
TLD Location CT17	24.0	**32.5**	3.6	4.9	0.9	1.2
TLD Location CT20	4.6	8.4	0.7	1.3	0.2	0.3
TLD Location CT21	1.0	6.0	0.2	0.9	0.0	0.2

Table A.5-6
Palanquin TED at Sample Locations (mrem/yr)
(Page 2 of 2)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
TLD Location CT22	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
Location CX01	9.2	14.1	1.4	2.1	0.3	0.5
Location CX02	6.3	9.0	0.9	1.3	0.2	0.3

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

A conservative estimate of future dose at this site (considering radioactive decay mechanisms only with no consideration of dispersion [erosion and transport mechanisms]) is that dose will continually decrease and the area exceeding the FAL will continually decrease. At the sampled location with the maximum TED (plot CP), TED will decay from 933 mrem/IA-yr (95 percent UCL) to 25 mrem/IA-yr in about 110 years. The effective half-life is about 21.0 years and is being driven by cobalt (Co)-60, cesium (Cs)-137, and europium (Eu)-152.

A.5.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, COCs were identified at this CAS at sample location CP, and it is assumed that subsurface contamination present in the crater (due to direct injection of radionuclides into the subsurface soil from the nuclear test) exceeds the FALs. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR.

To determine the extent of the area where the remote work area TED exceeds the FAL (Remote Work Area scenario), a correlation of radiation survey values to the 95 percent UCL of Remote Work Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010] and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The isopleth of 4.08 multiples of background corresponds to the 25-mrem/RW-yr FAL and was identified as the corrective action

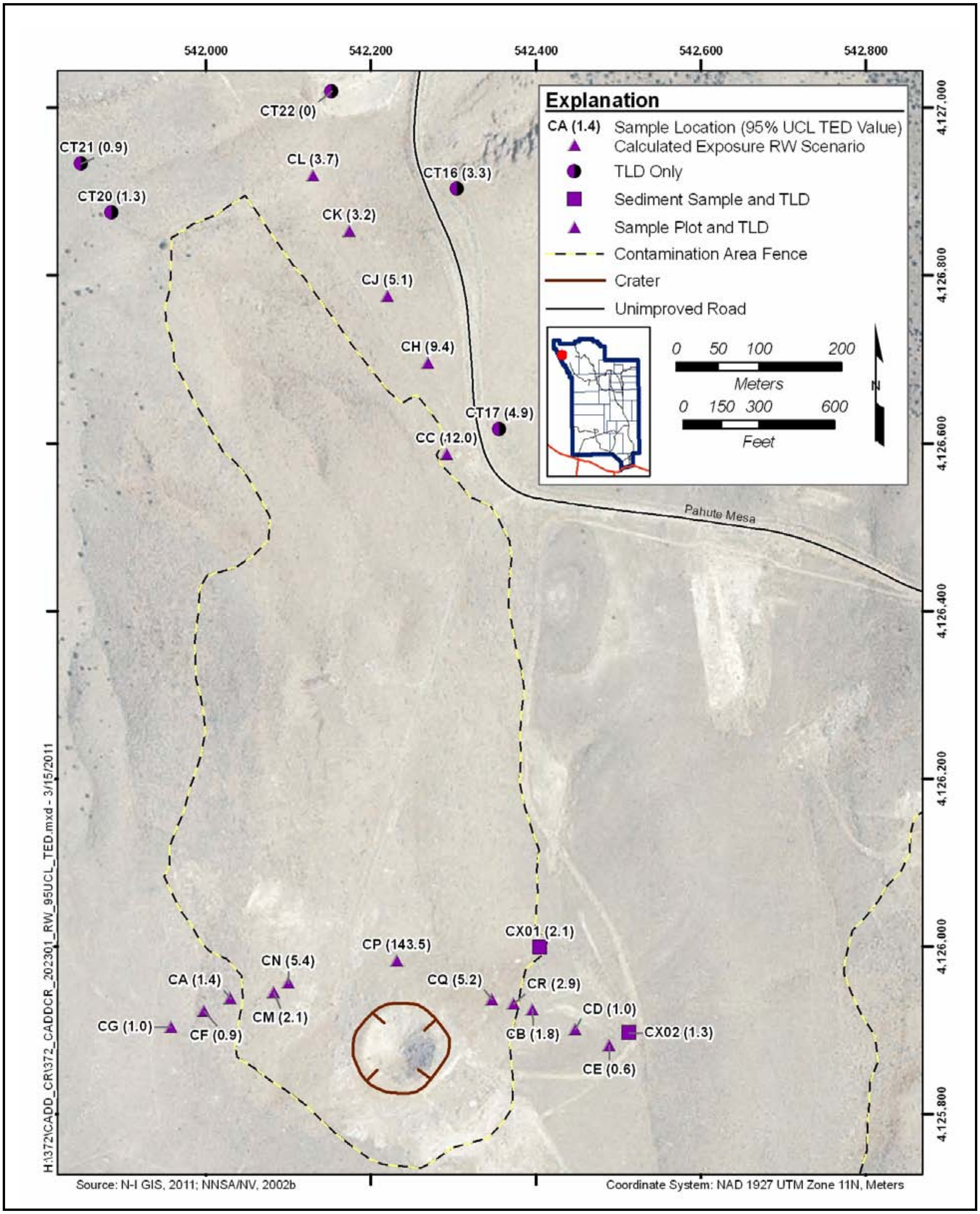

Figure A.5-4
Values for the 95% UCL of the TED at Palanquin

boundary. This corrective action boundary encompassed the other areas where contamination was assumed to exceed the FALs (i.e., the crater area and ejecta mounds surrounding the crater) as shown in Figure A.5-5. An FFACO UR was established to encompass this area and was defined as the final corrective action boundary. The UR is presented in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,250 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of the area where the Industrial Area TED exceeds the FAL (Industrial Area scenario), a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys, and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr FAL is 1.45 multiples of background (Figure A.5-5). The administrative UR boundary established to encompass this area is presented in Attachment D-2 of Appendix D.

A.5.4 Revised Conceptual Site Model

The CAU 372 CAIP requirements (NNSA/NSO, 2009) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 372. Therefore, no revisions were necessary to the CSM.

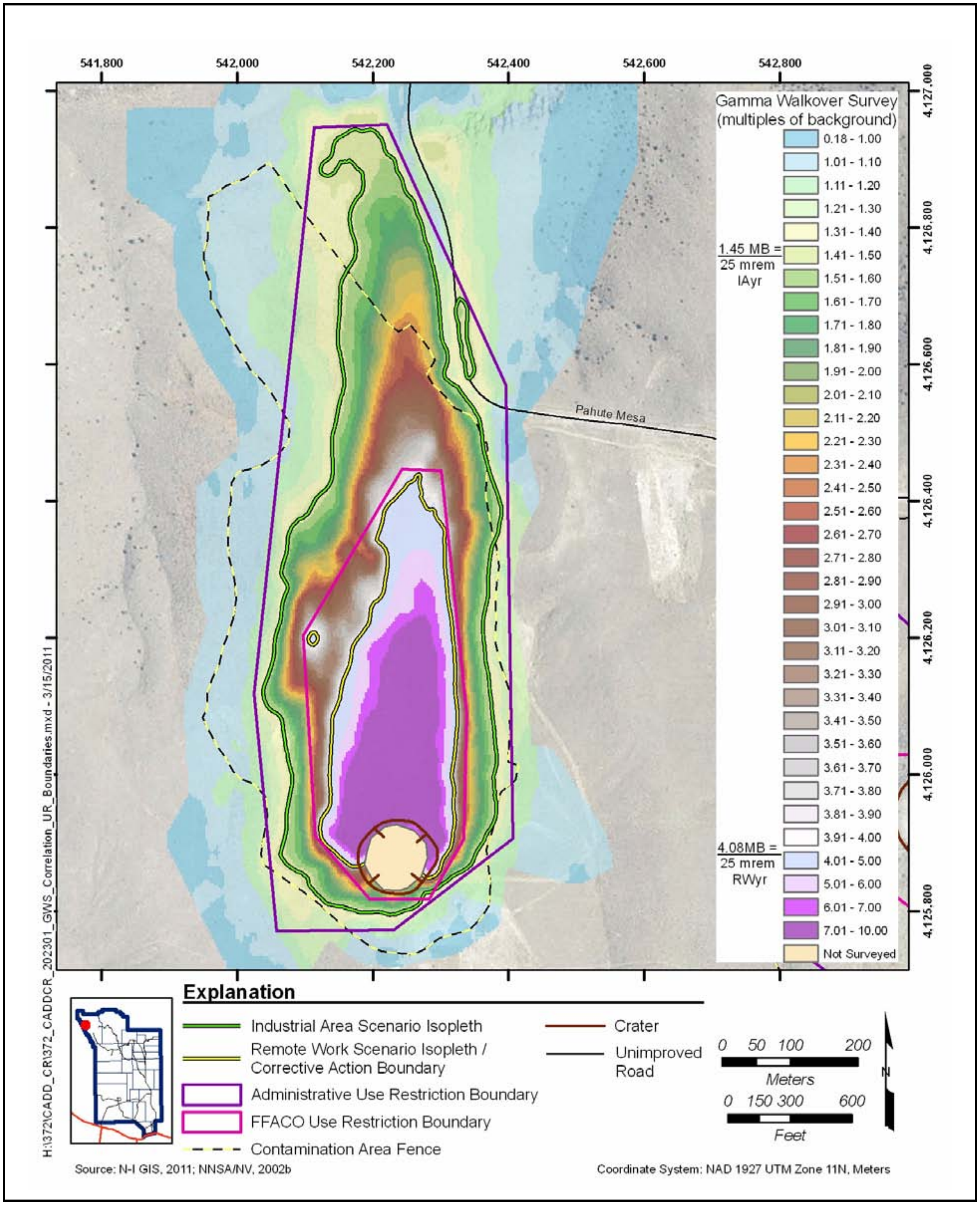

Figure A.5-5
Palanquin Correlation of GWS Isopleth Values to 95% UCL of TED

A.6.0 CAS 20-45-01, U-20L Crater (Cabriolet)

Cabriolet is located in Area 20 of the NNSS, south of Pahute Mesa Road. Cabriolet consists of a release of radionuclides to the soil surface from the underground Cabriolet test conducted under the Plowshare Program (DOE/NV, 2000). Radioactive contamination at this site also includes the prompt injection of material into the crater and ejecta mounds surrounding the crater. A large crater is present within the contamination area fence line that surrounds the site. Additional detail is provided in the CAU 372 CAIP (NNSA/NSO, 2009).

A.6.1 Corrective Action Investigation Activities

A total of 45 characterization samples (40 primary release samples and 2 FDs from 10 plots, and 3 other release samples [including 1 FD] from 2 sediment accumulation areas) were collected during investigation activities at Cabriolet. All samples were analyzed for gamma spectroscopy; Sr-90; and isotopic U, Pu, and Am. The sample numbers, locations, depth, matrix, and purpose are listed in Table A.6-1. A total of 27 TLDs (representing a total of 81 sample elements) at 16 locations (4 field background locations and 12 CAS locations) were used to calculate the external dose to site workers. The TLD numbers, locations, dates placed, dates removed, and purpose are listed in Table A.6-2. The field background TLDs were placed at four locations surrounding both Palanquin and Cabriolet. These TLDs were used as background measurements for both CASs. The four field background TLDs are listed in Table A.5-2 because they are labeled with a "CT" in their location designation. The specific CAI activities conducted to satisfy the CAIP (NNSA/NSO, 2009) requirements at this CAS are described in the following sections.

A.6.1.1 Visual Inspections

Visual inspections were conducted over the course of the field investigation. Scattered debris including batteries were identified. The batteries were removed and sent for recycling; samples were not collected because the batteries were intact and no visible signs of a release were present. In addition to the batteries, drainages were identified as potential migration pathways for contaminated sediments. Within the major drainage, sediment accumulation areas were identified and those sampled sediment accumulation areas are shown on Figure A.5-1. No other biasing factors indicating the release of contamination were identified.

Table A.6-1
Samples Collected at Cabriolet
(Page 1 of 2)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
DA	372DA01	0 - 5	Soil	Environmental
	372DA02	0 - 5	Soil	Environmental
	372DA03	0 - 5	Soil	Environmental
	372DA04	0 - 5	Soil	Environmental
DB	372DB01	0 - 5	Soil	Environmental
	372DB02	0 - 5	Soil	Environmental
	372DB03	0 - 5	Soil	FD of #372DB02
	372DB04	0 - 5	Soil	Environmental
	372DB05	0 - 5	Soil	Environmental
DC	372DC01	0 - 5	Soil	Environmental
	372DC02	0 - 5	Soil	Environmental
	372DC03	0 - 5	Soil	Environmental
	372DC04	0 - 5	Soil	Environmental
DD	372DD01	0 - 5	Soil	Environmental
	372DD02	0 - 5	Soil	Environmental
	372DD03	0 - 5	Soil	Environmental
	372DD04	0 - 5	Soil	Environmental
DE	372DE01	0 - 5	Soil	Environmental
	372DE02	0 - 5	Soil	Environmental
	372DE03	0 - 5	Soil	Environmental
	372DE04	0 - 5	Soil	Environmental
DF	372DF01	0 - 5	Soil	Environmental
	372DF02	0 - 5	Soil	Environmental
	372DF03	0 - 5	Soil	Environmental
	372DF04	0 - 5	Soil	Environmental

Table A.6-1
Samples Collected at Cabriolet
(Page 2 of 2)

Sample/ Plot Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
DG	372DG01	0 - 5	Soil	Environmental
	372DG02	0 - 5	Soil	Environmental
	372DG03	0 - 5	Soil	Environmental
	372DG04	0 - 5	Soil	Environmental
DH	372DH01	0 - 5	Soil	Environmental, Full Lab QC
	372DH02	0 - 5	Soil	Environmental
	372DH03	0 - 5	Soil	Environmental
	372DH04	0 - 5	Soil	Environmental
DJ	372DJ01	0 - 5	Soil	Environmental
	372DJ02	0 - 5	Soil	FD of #372DJ01
	372DJ03	0 - 5	Soil	Environmental
	372DJ04	0 - 5	Soil	Environmental
	372DJ05	0 - 5	Soil	Environmental
DK	372DK01	0 - 5	Soil	Environmental
	372DK02	0 - 5	Soil	Environmental, Full Lab QC
	372DK03	0 - 5	Soil	Environmental
	372DK04	0 - 5	Soil	Environmental
DX01	372DX01	0 - 5	Soil	Environmental, Full Lab QC
DX02	372DX02	5 - 10	Soil	Environmental
DX02	372DX03	5 - 10	Soil	FD of #372DX02

Table A.6-2
TLDs at Cabriolet

Location	TLD No.	Date Placed	Date Removed	Purpose
DT01 (Plot DF)	4329	11/10/2009	04/26/2010	Sample plot
	4804	05/25/2010	09/09/2010	Sample plot
DT02 (Plot DG)	4520	11/10/2009	04/26/2010	Sample plot
	4771	05/25/2010	09/09/2010	Sample plot
DT03 (Plot DH)	5020	11/10/2009	04/26/2010	Sample plot
	4329	05/25/2010	09/09/2010	Sample plot
DT04 (Plot DC)	4605	11/10/2009	04/26/2010	Sample plot
	4809	05/25/2010	09/09/2010	Sample plot
DT05 (Plot DD)	5110	11/10/2009	04/26/2010	Sample plot
	5020	05/24/2010	09/08/2010	Sample plot
DT06 (Plot DE)	4809	11/10/2009	04/26/2010	Sample plot
	4394	05/24/2010	09/08/2010	Sample plot
DT07 (Plot DA)	4771	11/10/2009	04/26/2010	Sample plot
	5110	05/25/2010	09/09/2010	Sample plot
DT08 (Plot DB)	4635	11/10/2009	04/26/2010	Sample plot
	4434	05/25/2010	09/09/2010	Sample plot
DT09 (Plot DJ)	5129	11/10/2009	04/26/2010	Sample plot
	4499	05/24/2010	09/08/2010	Sample plot
DT12 (Plot DK)	4604	09/23/2010	12/10/2010	Sample plot
	4792	09/23/2010	12/10/2010	Sample plot
	4538	09/23/2010	12/10/2010	Sample plot
DT10 (sample location DX01)	1275	08/04/2010	11/09/2010	Sediment sample location
DT11 (sample location DX02)	3945	08/04/2010	11/09/2010	Sediment sample location

A.6.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were conducted at Cabriolet during the CAI. The GWSs were conducted at the site to identify the spatial distribution of radiological readings and to locate the area of highest radiological readings. The location of highest radiological readings was detected southwest of the crater area. A sample plot (plot DK) was established at this location. Gamma walkover surveys were also conducted at Cabriolet to inspect the major drainages exiting the site for evidence of contaminant migration (readings above background were not detected within the drainages). Figure A.6-1 presents a graphic representation of the data from the GWSs.

In addition to the GWSs, the 1994 and 2009 aerial radiological surveys (BN, 1999; NNSA/NSO, 2010a) were used to determine the locations of the vector soil sample plots at the Cabriolet site. The aerial radiological surveys covered the area of the plume, which extends north outside the contamination area. Sample plots along three vectors were established (Figure A.6-2).

A.6.1.3 Sample Collection

A.6.1.3.1 TLD Samples

The 23 TLDs listed in Table A.6-2 and shown at the locations on Figure A.6-2 were placed at the Cabriolet site to measure external doses. Sample plots were associated with TLD locations DT01 through DT09 and DT12. Sediment samples were collected in the same location as TLD locations DT10 and DT11. The four field background TLDs discussed in Section A.5.1.3.1 at locations CT10 through CT13 were also used as the background TLDs for Cabriolet because the sites are located adjacent to one another and these background TLDs surround both CASs.

The TLDs were originally placed at Cabriolet in November 2009. These TLDs were scheduled to be collected in February 2010 (to meet the 2,250 hour exposure time); however, due to inclement weather (snow), the TLDs were not collected until the snow melted and the site was accessible in April 2010. Due to the uncertainty of the effect of the snow on the TLD results, a second set of TLDs was placed at the same locations in May 2010 and retrieved in September 2010. A comparison was conducted between the two sets of TLD data, which showed an average difference in dose of less than 1 percent as shown in Figure A.6-3. Therefore, both rounds of TLDs were used in calculation of the external dose.

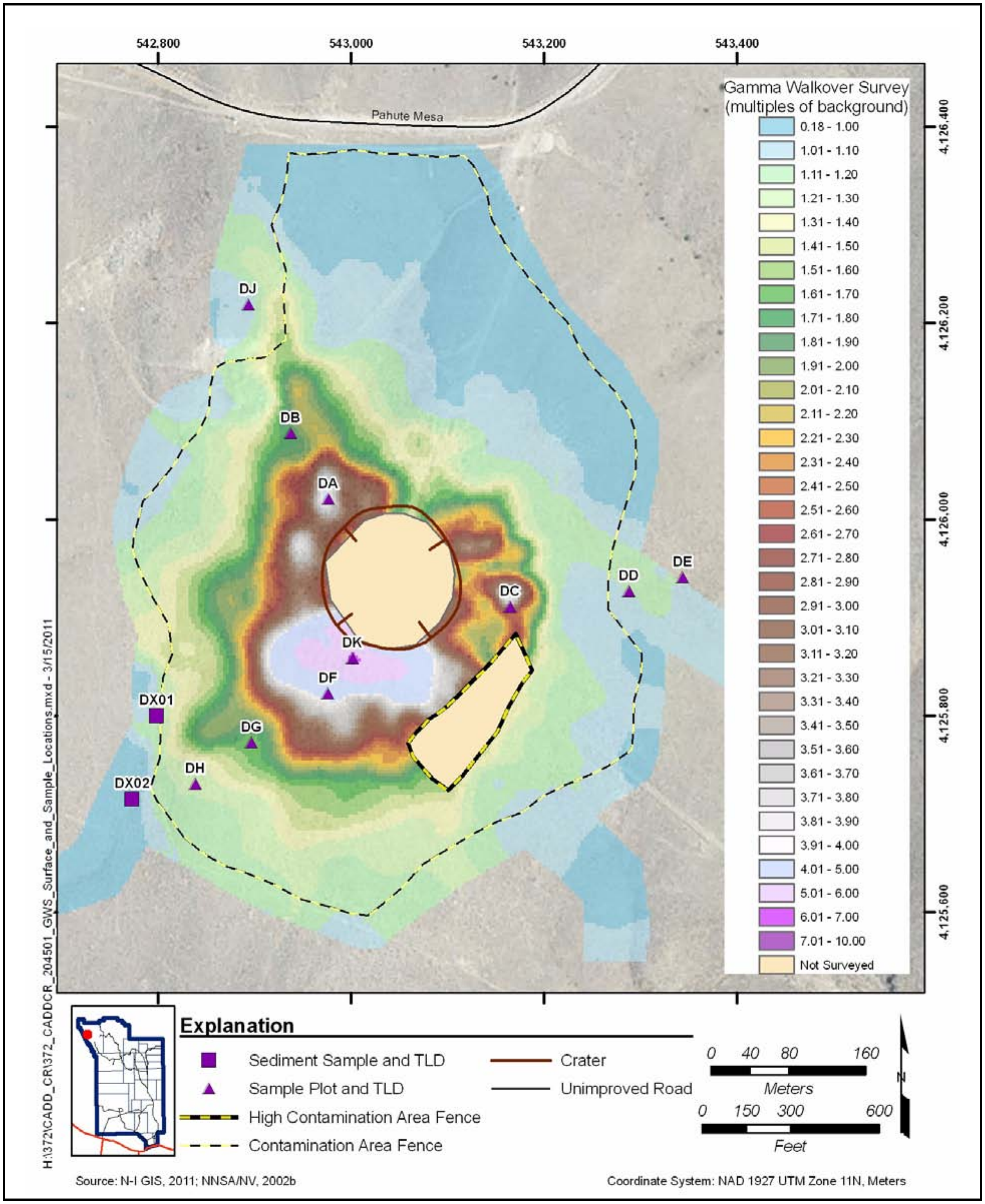

Figure A.6-1
Gamma Walkover Surveys of Selected Locations at Cabriolet

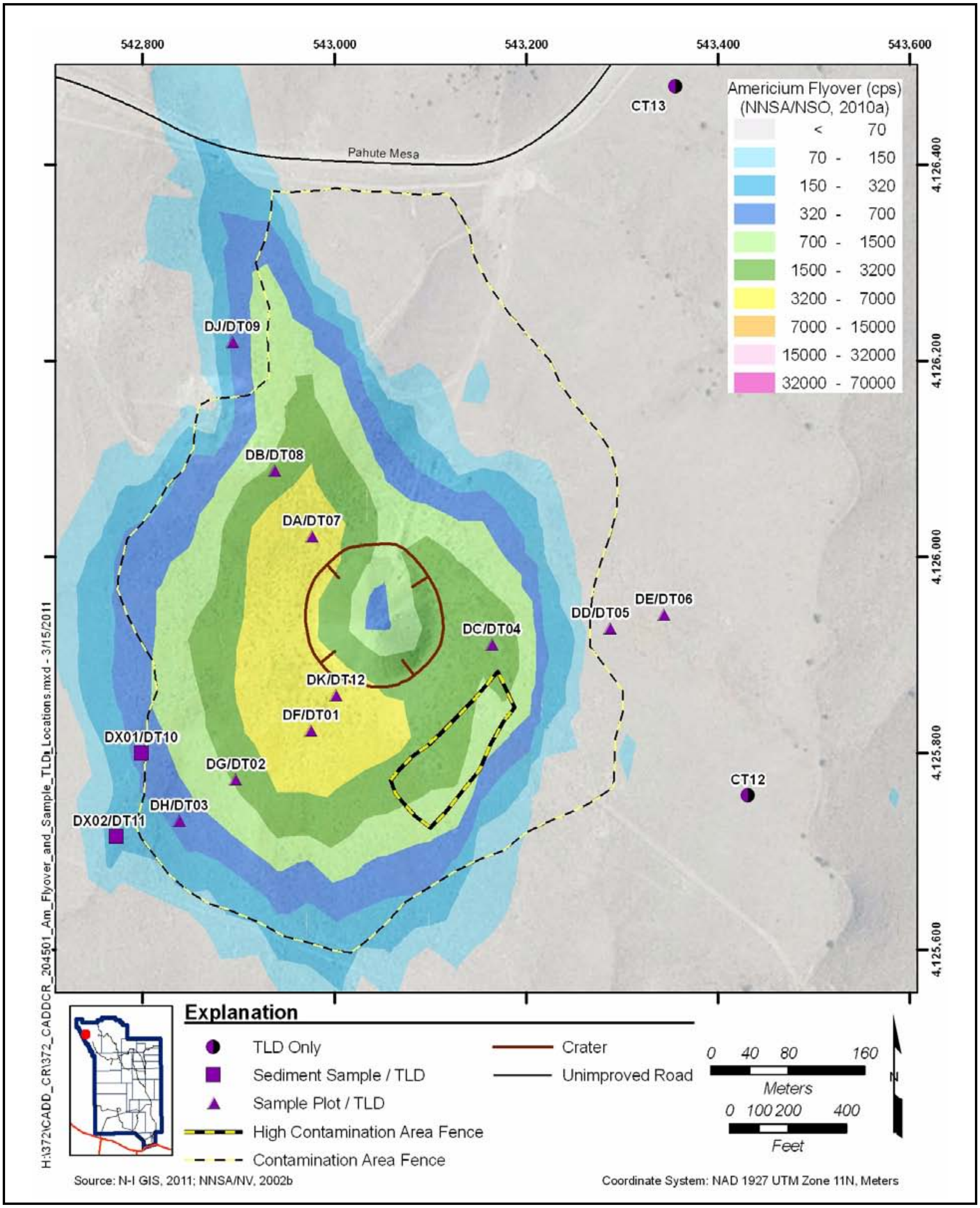

Figure A.6-2
Cabriolet Sample and TLD Locations

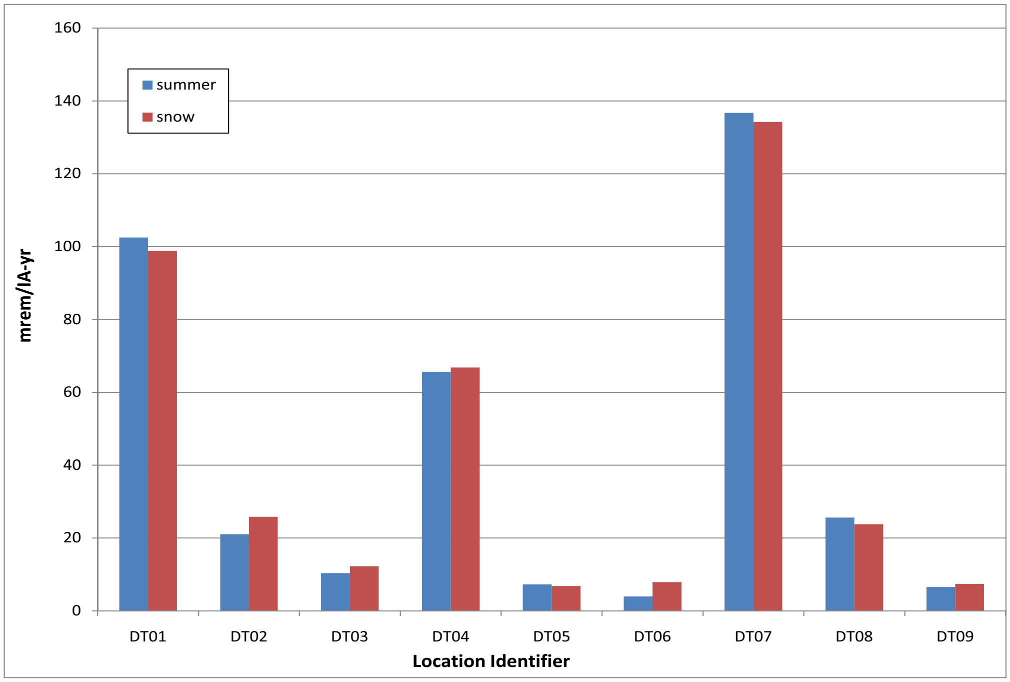

Figure A.6-3
Comparison of Snow TLDs to Non-snow TLDs at Cabriolet

A.6.1.3.2 Soil Samples

For the determination of internal dose, 42 composite surface soil samples (including 2 FDs) were collected from 10 plots within the Cabriolet area. Sample plots were established along each of three sample vectors extending outward in (generally) the northwest, east, and southwest directions. Three sample plots (DA, DB, and DJ) were established along the northwest vector; three sample plots (DF, DG, and DH) were established along the southwest vector; and three sample plots (DC, DD, and DE) were established along the east vector. After review of the GWS and TLD data, one additional sample plot (DK) was established southwest of the crater within the area of highest readings as detected during the GWS. Sample plot locations are shown on Figure A.6-2.

For the other releases at Cabriolet, sediment accumulation area samples were collected from within the major drainage exiting the site to determine whether migration away from the test area has occurred. The first two sediment areas anticipated to be outside the 25-mrem/yr boundary were sampled. One sample (0 to 5 cm bgs) was collected from location DX01, and two samples

(5 to 10 cm bgs) were collected from location DX02 (including 1 FD). The sediment sample locations are shown on Figure A.6-2.

A.6.1.4 Field Screening

The FSRs were used for selection of the vertical samples collected from the sediment accumulation areas. For these samples (collected between 0 and 30 cm bgs from each of two locations) the 0- to 5-cm depth interval at location DX01 exhibited the highest field-screening value for beta. It did not exhibit the highest value for alpha; however, the alpha FSL value was not exceeded for any of the intervals collected at location DX01. For location DX02, the 5- to 10-cm depth interval exhibited the highest field-screening value for beta. However, it did not exhibit the highest value for alpha. Therefore, the 0- to 5-cm interval sample from location DX01 and 5- to 10-cm interval samples from location DX02 were submitted to the laboratory for analysis. These field-screening data were recorded on SCLs, which are retained in the project files.

A.6.1.5 Deviations

The CAU 372 CAIP (NNSA/NSO, 2009) states that the corrective action boundary will be established based on the distance along each vector that corresponds to the 25-mrem/yr FAL and the radiation survey isopleth that encompasses these locations. However, it was determined that the corrective action boundary could be better defined by performing the following:

- Directly correlating TED from all sample locations to the radiation survey values at each location.
- Using the radiation survey isopleth value correlating to the 25-mrem/yr FAL as the corrective action boundary with the stipulation that the boundary encompasses all locations with a TED that exceeds the FAL.

Although this is a minor deviation to the method described in the CAIP, it provides an improvement in the process in that the TED values are directly correlated to radiation survey values rather than correlating them to distance along vectors (which has no direct relationship to dose). This deviation is not expected to have any significant impact on the resulting corrective action boundary while providing a more robust and defensible process.

A.6.2 Investigation Results

The following sections provide the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2009). The radiological and sediment accumulation area results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2009), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location. External doses for TLD locations are summarized in Section A.6.2.1. Internal doses for each sampled location are summarized in Section A.6.2.2. The TEDs for each sampled location are summarized in Section A.6.2.3.

A.6.2.1 External Radiological Dose Measurements

The external dose estimates at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use Area exposure scenarios. The minimum sample size was met for all TLD locations. The standard deviation, number of elements, minimum sample size, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table A.6-3.

A.6.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Cabriolet were determined as described in Section A.2.2.4. For TLD locations where soil samples were not collected, the internal to external dose ratio from the plot with the maximum amount of internal dose

Table A.6-3
Cabriolet 95% UCL External Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot DA	1.069	6	1.4	**139.2**	20.8	4.9
Plot DB	0.591	6	1.4	**26.3**	3.9	0.9
Plot DC	0.841	6	1.4	**69.0**	10.3	2.5
Plot DD	0.570	6	1.4	8.8	1.3	0.3
Plot DE	0.239	6	1.4	5.9	0.9	0.2
Plot DF	1.855	6	1.5	**108.9**	16.3	3.9
Plot DG	0.403	6	1.4	24.0	3.6	0.9
Plot DH	0.330	6	1.4	11.5	1.7	0.4
Plot DJ	0.314	6	1.4	7.3	1.1	0.3
Plot DK	2.818	9	1.7	**180.0**	**26.9**	6.4
Location DX01	0.481	3	1.4	18.3	2.7	0.7
Location DX02	0.328	3	1.4	12.6	1.9	0.4

Bold indicates the values exceeding 25 mrem/yr.

was used to estimate internal dose. As shown in Table A.6-4, the maximum average internal dose was at plot DA, and the resulting internal to external dose ratio at this site was 0.38.

As shown in Table A.6-5, the minimum sample size was met for all plots at Cabriolet. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the average internal dose for each exposure scenario are presented in Table A.6-5. The detailed analytical results for the individual radionuclides in each composite sample and the corresponding calculated internal dose are presented in Appendix F.

A.6.2.3 Total Effective Dose

The TED for each sample plot, sediment sample location, or TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for each exposure scenario are presented in Table A.6-6. The TED for sample locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at plots DA and DK (Figure A.6-4).

Table A.6-4
Cabriolet Ratio of Calculated Internal Dose to External Dose at Each Location (mrem/RW-yr)

Plot	Average Internal Dose	Average External Dose	Average TED	Internal to External Dose Ratio
Plot DA	7.62	19.90	**27.52**	0.38
Plot DB	1.16	3.44	4.6	0.34
Plot DC	1.40	9.62	11.02	0.15
Plot DD	0.02	0.85	0.87	0.024
Plot DE	0.01	0.68	0.7	0.015
Plot DF	3.09	14.73	17.82	0.21
Plot DG	0.85	3.26	4.10	0.26
Plot DH	0.22	1.45	1.67	0.15
Plot DJ	0.11	0.84	0.95	0.13
Plot DK	5.37	**25.14**	**30.51**	0.21
Location DX01	0.13	1.92	2.06	0.068
Location DX02	0.16	1.32	1.48	0.12

Bold indicates the values exceeding 25 mrem/yr.

Table A.6-5
Cabriolet 95% UCL Internal Dose for Each Exposure Scenario

Plot or Location	Standard Deviation	Number of Samples	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Plot DA	1.20	4	1.4	**51.8**	9.0	3.2
Plot DB	0.27	5	1.4	8.1	1.4	0.5
Plot DC	0.26	4	1.4	9.8	1.7	0.6
Plot DD	0.0024	4	1.4	0.1	0.03	0.01
Plot DE	0.0062	4	1.4	0.1	0.02	0.01
Plot DF	0.34	4	1.4	20.0	3.5	1.2
Plot DG	0.27	4	1.4	6.7	1.2	0.4
Plot DH	0.016	4	1.4	1.4	0.2	0.08
Plot DJ	0.030	5	1.4	0.8	0.1	0.05
Plot DK	0.89	4	1.4	**36.8**	6.4	2.3

Bold indicates the values exceeding 25 mrem/yr.

Table A.6-6
Cabriolet TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Plot DA	**176.9**	**190.9**	**27.5**	**29.8**	7.4	8.1
Plot DB	**29.7**	**34.4**	4.6	5.3	1.2	1.4
Plot DC	**72.4**	**78.9**	11.0	12.0	2.8	3.1
Plot DD	5.8	9.0	0.9	1.3	0.2	0.3
Plot DE	4.7	6.0	0.7	0.9	0.2	0.2
Plot DF	**116.3**	**128.8**	17.8	19.7	4.6	5.1
Plot DG	**26.7**	**30.7**	4.1	4.8	1.1	1.3
Plot DH	11.0	12.9	1.7	2.0	0.4	0.5
Plot DJ	6.2	8.1	0.9	1.2	0.2	0.3
Plot DK	**199.1**	**216.8**	**30.5**	**33.3**	7.9	8.7
Location DX01	13.6	19.1	2.1	2.9	0.5	0.7
Location DX02	9.8	13.5	1.5	2.0	0.4	0.5

Bold indicates the values exceeding 25 mrem/yr.

A conservative estimate of future dose at this site (considering radioactive decay mechanisms only with no consideration of dispersion [erosion and transport mechanisms]) is that dose will continually decrease and the area exceeding the FAL will continually decrease. At the sampled location with the maximum TED (plot DK), TED will decay from 217 mrem/IA-yr (95 percent UCL) to 25 mrem/IA-yr in about 94 years. The effective half-life is about 30.1 years and is being driven by Co-60, Cs-137, Eu-152, and Am-241 (to a small degree).

A.6.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, COCs were identified at this CAS at sample plots DA and DK, and it is assumed that subsurface contamination present in the crater (due to direct injection of radionuclides into the subsurface soil from the nuclear test) exceeds the FALs. Also, based on the GWS and site visits, the area within the HCA is also assumed to contain radioactivity exceeding the FALs. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR.

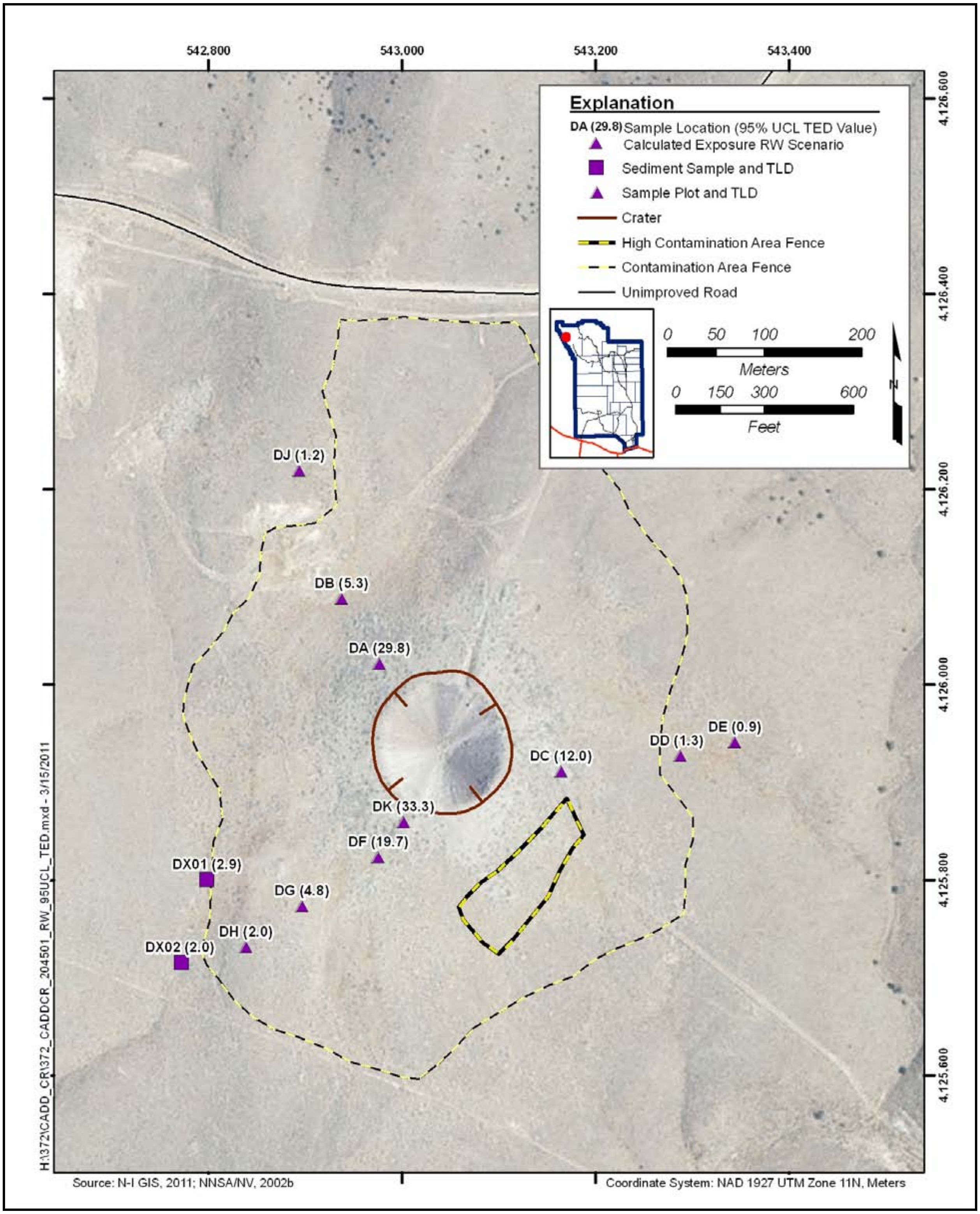

Figure A.6-4
Values for the 95% UCL of the TED at Cabriolet

To determine the extent of the area where the Remote Work Area TED exceeds the FAL (Remote Work Area scenario), a correlation of radiation survey values to the 95 percent UCL of Remote Work Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys [BN, 1999; NNSA/NSO, 2010a] and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The isopleth of 4.87 multiples of background corresponds to the 25-mrem/RW-yr FAL and was identified as the corrective action boundary. This corrective action boundary encompassed the other areas where contamination was assumed to exceed the FALs (i.e., the HCA, the crater area, and ejecta mounds surrounding the crater) as shown in Figure A.6-5. An FFACO UR was established to encompass this area and was defined as the final corrective action boundary. The UR is presented in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,250 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of the area where the Industrial Area TED exceeds the FAL (Industrial Area scenario), a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted for each radiation survey (1994 and 2009 aerial radiation surveys, and site-specific GWS). The radiation survey with the best correlation was the GWS (Section 3.0). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr FAL is 1.36 multiples of background (Figure A.6-5). The administrative UR boundary established to encompass this area is presented in Attachment D-2 of Appendix D.

A.6.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2009) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 372. Therefore, no revisions were necessary to the CSM.

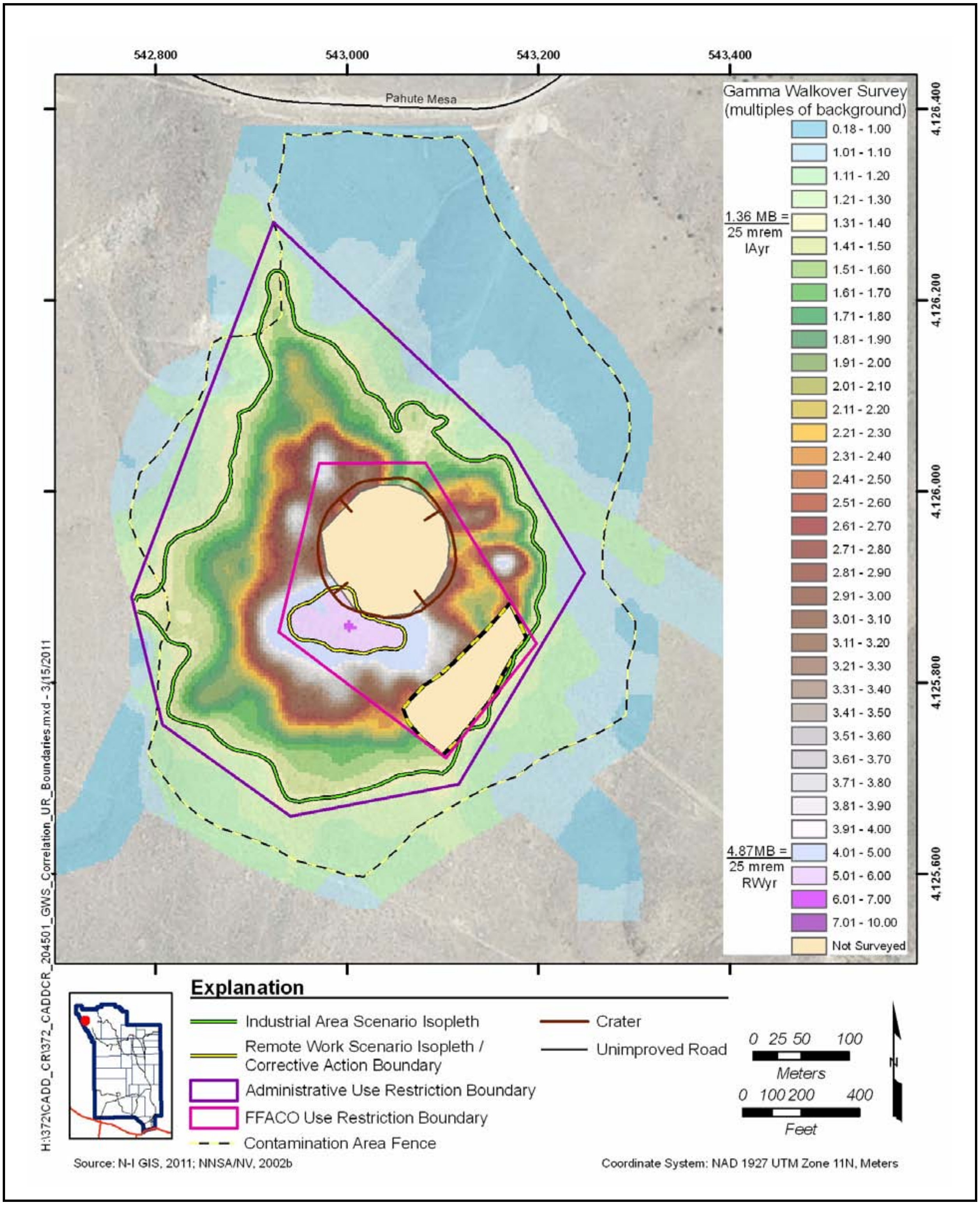

Figure A.6-5
Cabriolet Correlation of GWS Isopleth Values to 95% UCL of TED

A.7.0 Waste Management

Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2009). Investigation-derived waste (IDW) generated during the CAI was characterized based on process knowledge and FSRs. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste.

A.7.1 Waste Streams

The waste streams discussed below and in Table A.7-1 were generated at CAU 372.

A.7.1.1 Investigation-Derived Waste

Investigation-derived waste generated during the field activities for CAU 372 included disposable personal protective equipment (PPE), disposable sampling equipment, and empty sample containers. The IDW, which was collected daily, was bagged, labeled, and field screened as generated to comply with the radiological release limits of Table 4-2 of the NTS Radiological Control Manual (NNSA/NSO, 2010b) to verify that removable contamination was not present at the site. The waste, depending on FSRs, was either placed in a roll-off container at Building 23-153 (as industrial waste) or placed in a radioactive material area at Building 23-153 (as low-level waste [LLW]). The industrial waste was disposed of at the NNSS Area 9 U10c landfill on December 8, 2010. The LLW is being accumulated with other LLW from the NNSS and will be disposed of at the Area 5 Radioactive Waste Management Site (RWMS).

A.7.1.2 Batteries

Eighteen lead-acid batteries were removed from the Palanquin and Cabriolet areas and are currently staged at Building 23-153 for future recycling at TOXCO, Inc. All of the batteries were dry (i.e., no longer contained the electrolyte fluid), and there were no indications of a release of the fluid to the environment. The batteries were found outdoors, so it is presumed that the liquid evaporated over time from exposure to the desert climate. The lead plates in these batteries are considered scrap metal and will be recycled (i.e., the material is not considered waste, and will not be disposed). Under the scrap metal exemption at 40 CFR 261.4(a)(13), the lead plates are not considered solid waste

Table A.7-1
Waste Summary Table

CAS	Waste/Recycle Items	Waste Characterization				Waste Disposition			
		Hazardous	Hydrocarbon	PCBs	Radioactive	Disposal Facility	Waste Volume	Disposal Date	Disposal Doc
18-45-02, 18-45-03, 20-23-01, 20-45-01	Industrial Waste (IDW)	No	No	No	No	Area 9 U10c Landfill	6.6 yd^3	12/08/2010	NTS Landfill Load Verification Form[a]
18-45-02, 18-45-03, 20-23-01, 20-45-01	LLW (IDW)	No	No	No	Yes (LLW)	Area 5 RWMS	5 yd^3	See Attachment D-1 of Appendix D	CD[a]
18-45-02	Lead bricks[b]	No	No	No	No	Recycled at TOXCO, Inc.	31 bricks	N/A[c]	N/A[c]
20-23-01, 20-45-01	Lead-acid batteries[b]	No	No	No	No	Recycled at TOXCO, Inc.	18 batteries	N/A[c]	N/A[c]

[a]See Attachment D-1 of Appendix D.
[b]These materials are excluded from being solid wastes when they are being recycled in accordance with 40 CFR 261.4 (CFR, 2010).
[c]These materials are not being disposed, they are being recycled. Therefore, there is no disposal date or disposal documentation.

CD = Certificate of Disposal
N/A = Not applicable
TBD = To be determined
yd^3 = Cubic yard

(or hazardous waste) when recycled (CFR, 2010). These batteries will be shipped off site when enough recyclable material is accumulated to make offsite shipment economical. It is anticipated that this material will be shipped off site by the end of fiscal year (FY) 2011. A photograph of a typical battery is depicted in Figure A.7-1.

A.7.1.3 Lead Bricks

A total of 31 lead bricks were removed from within the contamination area at Little Feller I and are currently staged at Building 23-153 for future recycling at TOXCO, Inc. The lead bricks are considered scrap metal and will be recycled (i.e., the material is not considered waste and will not be disposed). Under the scrap metal exemption at 40 CFR 261.4(a)(13), the lead bricks are not considered solid waste (or hazardous waste) when recycled (CFR, 2010). The bricks will be shipped off site when enough recyclable material is accumulated to make offsite shipment economical. It is anticipated that this material will be shipped off site by the end of FY 2011. A photograph of some of the lead bricks that were removed from Little Feller I is depicted in Figure A.7-1

A.7.2 Waste Characterization

All waste dispositions were based on process knowledge, radiological surveys, and direct samples of the waste, when necessary. Waste characterization and disposition was based on federal and state regulations, permit limitations, and disposal facility acceptance criteria.

Figure A.7-1
Photograph of Typical Batteries (top) and Lead Bricks (bottom) at CAU 372

A.8.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 372 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 any contaminants 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, 2002a).

A.8.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002a) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 372 were evaluated for data quality in a tiered process and are presented in Sections A.8.1.1 through A.8.1.3. 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 7 percent of the data analyzed.

A.8.1.1 Tier I Evaluation

Tier I evaluation for radiochemical analysis examines, but is not limited to, the following items:

- Sample count/type consistent with chain of custody.
- Analysis count/type consistent with chain of custody.
- Correct sample matrix.

- Significant problems and/or nonconformances 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.8.1.2 Tier II Evaluation

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

- 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, laboratory control samples [LCSs], laboratory blanks) evaluated and used to determine laboratory result qualifiers.

- Sample results, uncertainty, and MDC evaluated.

- Detector system calibrated with National Institute of 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.8.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 7.2 percent of the sample radiological data was performed by Analytical Quality Associates. 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, matrix spikes) 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.8.2 Field QC Samples

Field QC consisted of 14 samples collected for full laboratory QC that were submitted for analysis by the laboratory analytical methods shown in Table A.2-1. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." Full laboratory QC samples are used to measure accuracy and precision associated with the matrix (see Appendix B for further discussion).

During the CAI, 14 FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-1. For these samples, the duplicate results precision (i.e., relative percent differences [RPDs] between the environmental sample results and their corresponding FD sample results) were evaluated.

A.8.2.1 Laboratory QC Samples

Analysis of QC preparation blanks, LCSs, and laboratory duplicate samples was performed on each sample delivery group (SDG) for radionuclides. 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.

A.8.3 Field Nonconformances

No field nonconformances were identified for the CAI.

A.8.4 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. A data review was conducted by reviewing QA reports and inspecting the data. A nonconformance report (NCR 0.452) was issued because original sample preparation did not meet contractual requirements. The laboratory's corrective action was to reprepare and reanalyze the samples in accordance with the statement of work. The data packages were resubmitted, and the dataset quality was found to be satisfactory. In addition to the resubmitted dataset, all other data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified.

A.8.5 TLD Data Validation

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 not available. Specifically, 10 CFR Part 835.402 (CFR, 2011) indicates that personal dosimeters shall be provided to monitor individual exposures and that the monitoring program that uses the dosimeters shall be accredited in accordance with a DOE Laboratory Accreditation Program, as was the case for the TLDs used at CAU 372.

The TLDs were exposed at the CAU 372 sample locations for exposure durations ranging from 1,704 hours to 4,008 hours. The measured dose from each TLD was then scaled based on the exposure durations defined for the Industrial Area and Remote Work Area exposure scenarios.

A.9.0 Summary

Radionuclide contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 372. Assessment of the data generated from surface soil samples indicates that surface radiological contamination exceed the FAL (based on the Remote Work Area exposure scenario) at locations at all four CASs.

Little Feller I

Based on analytical results of soil samples, radiological contamination at the Little Feller I site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at four sample locations. It is also assumed that radioactivity within the HCA and lead contamination within the location of the lead bricks exceed FALs. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead bricks and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (Section A.3.3), the HCA, and the area of the lead bricks as shown on Figure A.3-4 and in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the industrial area TED values was conducted for the CAS. The GWS values were then interpolated using a kriging technique and isopleths established for the CAS. Based on this correlation, the radiation survey value that corresponds to 25 mrem/IA-yr is 1.14 multiples of background. Therefore, as a BMP, an administrative UR boundary was established around the area exceeding this value as shown on Figure A.3-4. The administrative UR is presented in Attachment D-2 of Appendix D.

Little Feller II

Based on analytical results of soil samples, radiological contamination at the Little Feller II site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at three sample locations. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (Section A.4.3) as shown on Figure A.4-4 and in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the industrial area TED values was conducted for the CAS. The GWS values were then interpolated using a kriging technique and isopleths established for the CAS. Based on this correlation, the radiation survey value that corresponds to 25 mrem/IA-yr is 1.29 multiples of background. Therefore, as a BMP, an administrative UR boundary was established around the area exceeding this value as shown on Figure A.4-4. The administrative UR is presented in Attachment D-2 of Appendix D.

Palanquin

Based on analytical results of soil samples, radiological contamination at the Palanquin site exceed the FAL for the radiological dose (25 mrem/RW-yr) at one sample location. It is also assumed that radioactivity within the crater and in ejecta piles around the crater exceed the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead-acid batteries and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (Section A.5.3), the crater area, and ejecta mounds surrounding the crater as shown on Figure A.5-5 and in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the industrial area TED values was conducted for the CAS. The GWS values were then interpolated using a kriging technique and isopleths established for the CAS. Based on this correlation, the radiation survey value that corresponds to 25 mrem/IA-yr is 1.45 multiples of background. Therefore, as a BMP, an administrative UR boundary was established around the area exceeding this value as shown on Figure A.5-5. The administrative UR is presented in Attachment D-2 of Appendix D.

Cabriolet

Based on analytical results of soil samples, radiological contamination at the Cabriolet site exceed the FAL for the radiological dose (25 mrem/RW-yr) at one sample location. It is also assumed that radioactivity within the crater and in ejecta piles around the crater exceed the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is limited removal of lead-acid batteries and closure in place with a UR. The FFACO UR was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/RW-yr (Section A.6.3), the crater area, and ejecta mounds surrounding the crater as shown on Figure A.6-5 and in Attachment D-2 of Appendix D.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the industrial area TED values was conducted for the CAS. The GWS values were then interpolated using a kriging technique and isopleths established for the CAS. Based on this correlation, the radiation survey value that corresponds to 25 mrem/IA-yr is 1.36 multiples of background. Therefore, as a BMP, an administrative UR boundary was established around the area exceeding this value as shown on Figure A.6-5. The administrative UR is presented in Attachment D-2 of Appendix D.

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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 372 CAIP (NNSA/NSO, 2009) 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 372 CAIP (NNSA/NSO, 2009). 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 372 CAIP for the primary releases (referred to as "test releases" in the CAU 372 CAIP) is as follows: "'Is radioactivity associated with the CAS present in environmental media that could result in a dose exceeding 25 mrem/yr?' Any plot for which the 95 percent UCL of the mean TED exceeds 25 mrem/yr will be defined as containing a COC. If a COC is not present, the investigation for that release is complete." The Decision I statement for the other releases (referred to as non-test releases in the CAU 372 CAIP) is as follows: "'Is any COC associated with the CAS present in environmental media?' Any analytical result for a COPC above a FAL will result in that COPC being designated as a COC." (NNSA/NSO, 2009). Contamination at levels exceeding FALs is assumed to be present within the craters or HCAs at the Little Feller I, Palanquin, and Cabriolet CASs. Decision I for these CASs applies to contamination beyond the boundaries of the craters or HCAs.

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 372 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 COC exists at any CAS, then a corrective action will be determined, else no further action will be necessary.

- If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be required, 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 (determining that contamination above FALs is not present when it actually is) was controlled by meeting the following criteria:

1a. For Decision I, having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the CAS.

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.

Criteria 1b, 2, and 3, were assessed based on the entire dataset. Therefore, these assessments apply to both Decision I and Decision II.

Criterion 1a

To resolve Decision I for the primary releases at CAU 372 (as stipulated in the DQOs), sample plot locations were chosen based on the highest GWS values at the Palanquin and Cabriolet CASs. At the Little Feller I and Little Feller II CASs, however, the locations of the highest GWS values could not be sampled due to the presence of removable contamination above HCA criteria. For the purposes of Decision I, it was assumed that these locations are HCAs and that contamination at these locations is present at levels exceeding FALs. Therefore, sample plots were established at the Little Feller I and Little Feller II CASs at the locations of the highest radiological readings outside of the posted or assumed HCAs (Sections A.3.1.2 and A.4.1.2).

The locations for sampling the drainage areas at Little Feller II, Palanquin, and Cabriolet were selected as the first two downgradient sediment accumulation areas outside the craters or HCA areas in the major drainages (Sections A.4.1.3.2, A.5.1.3.2, and A.6.1.3.2). No drainages were identified at the Little Feller I CAS.

Criterion 1b

Control of the false negative decision error for the probabilistic samples was accomplished by ensuring the following:

- The samples are collected from random locations.
- A sufficient sample size was collected.
- A false rejection rate of 0.05 and the 95 percent UCL was used in making DQO decisions for probabilistic sampling

Selection of the sample aliquot locations within a sample plot (Sections A.5.2.1.1 and A.9.1 of the CAU 372 CAIP) was accomplished through use of the VSP software (PNNL, 2007). Each set of sample aliquot locations was 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 minimum number of samples required for each sample plot was calculated from the internal dose results for each sample as presented in Tables A.3-5, A.4-5, A.5-5, and A.6-5. The minimum number of TLD samples (elements) required for each location was calculated from the external dose results for each TLD element as presented in Tables A.3-3, A.4-3, A.5-3, and A.6-3.

The minimum sample size was calculated using the following EPA sample size formula (EPA, 2006):

$$n \geq \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z^2_{.95}}{2}$$

where:

s = standard deviation
$z_{.95}$ = z score associated with the false negative rate of 5 percent
$z_{.80}$ = z score associated with the false positive rate of 20 percent
μ = average
C = FAL

The minimum number of samples criterion was met for all soil and TLD samples except for the soil samples at plots AN and AQ, and the TLD samples at location BT19. As discussed in Section A.9.1.1

of the CAIP (NNSA/NSO, 2009) for those locations where the minimum sample size criterion is not met, it was conservatively assumed that the TED for these locations exceed the FAL.

The 95 percent UCL was calculated for both internal and external dose at each sample location and added together for each location to represent the 95 percent UCL of the TED. These calculations were conducted as stipulated in the CAU 372 CAIP based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20
- The maximum acceptable gray region set to one half the FAL (12.5 mrem/yr)
- The calculated standard deviation of each plot

Criterion 2

All samples were analyzed using the analytical methods listed in Tables 3-2 and 3-3 of the CAU 372 CAIP (NNSA/NSO, 2009) and for the following radiological analytes as listed in Section 3.2 of the CAIP: gamma spectroscopy; Sr-90; and isotopic Am, U, and Pu.

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 372 CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2009). Therefore, the criteria is that all detection limits are less than their corresponding remote work area internal dose RRMGs (see Appendix C, Attachment C-1). As all of the analytical result detection limits for every radionuclide were less than their corresponding RRMGs, the DQI for sensitivity has been met, and no data were rejected due to sensitivity.

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 CAIP (NNSA/NSO, 2009). As presented in the following subsections, these criteria were met for each of the DQIs.

Precision

Precision was evaluated as described in Section 6.2.3 of the CAIP (NNSA/NSO, 2009). Table B.1-1 provides the radiological results for all constituents that were qualified for precision. The precision rate for the isotopic analyses of Am-241, U-234, Pu-238, and Pu-239/240 did not meet the criterion of 80 percent specified in the CAIP. The precision evaluations were based on differences in laboratory duplicate sample results (RPD) or normalized differences. High variability in the sample matrix suggests that discrete particles of contamination are present within the samples. Therefore, mixing will not produce homogeneity. This variability does not mean the precision of the measurement is poor, but that activities are variable within the samples. This is commonly observed in samples containing these four radionuclides because a single particle of these isotopes within a sample can result in detectable activity attributed to the entire sample. However, the isotopic analyses of Am-241, Pu-238, and Pu-239/240 were used only to estimate plutonium to americium ratios and not used to calculate internal dose. Of the radionuclides used to calculate internal dose, U-234 was the only analyte that did not meet the criterion for precision. This radionuclide had a 79.7 percent precision rate was only slightly less than the criterion of 80 percent. There is a negligible potential for a U-234 precision error to affect a dose estimate because the reported activities for U-234 that were qualified for precision represent very little internal dose (the highest U-234 activity of 77 pCi/g equates to 0.00056 mrem/RW-yr). Therefore, the U-234 results that were qualified for precision can be confidently used to calculate TED. As the precision rates for all other constituents meet the acceptance criteria for precision, the database is determined to be acceptable for the DQI of precision.

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2009). There were 13 Sr-90 and U-234 sample results qualified for accuracy out of a total of 236 samples. This resulted in an accuracy rate of 94.5 percent for each of these analytes. Therefore, the CAIP criterion of 80 percent accuracy was met. As the accuracy rates for all contaminants meet the acceptance criterion for accuracy, the dataset is determined to be acceptable for the DQI of accuracy.

Table B.1-1
Precision Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Am-241	Gamma	3	191	98.4
Sr-90	Strontium	5	236	97.9
Eu-155	Gamma	15	236	93.6
U-238	Uranium	23	235	90.2
U-234	Uranium	48	236	**79.7**
Pu-238	Plutonium	69	236	**70.8**
Pu-239/240	Plutonium	95	236	**59.7**
Am-241	Americium	59	101	**41.6**

[a]SW-846 methods (EPA, 2004 and 2008)

Bold indicates precision rate did not meet criterion of 80 percent.

Representativeness

The DQO process as identified in Appendix A of the CAU 372 CAIP (NNSA/NSO, 2009) was used to address sampling and analytical requirements for CAU 372. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO. The identified population parameters are the most likely locations to contain contamination (judgmental sampling), that represent contamination of the sample plot (probabilistic sampling), and locations that bound COCs. The sampling locations identified in the Criterion 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 372 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAU 372 CAIP (NNSA/NSO, 2009), 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 NNSS.

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 CAIP.

Completeness

The CAU 372 CAIP (NNSA/NSO, 2009) 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 CAIP having valid results. No analytical results were rejected (either qualified as rejected or data that failed the criterion of sensitivity). Therefore, the CAU 372 analytical dataset is considered to be complete.

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 method blanks were used to determine whether a false positive analytical result may have occurred. No false positive analytical results were reported.

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

B.1.1.2 Decision II

Decision II as presented in the CAU 372 CAIP is as follows: "Is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is defined to include the following:

- Lateral and vertical extent of COC contamination.
- Information needed to determine potential remediation waste types.
- Information needed to evaluate the feasibility of remediation alternatives.

Decision II extent of contamination was needed at all four CASs because TEDs above the 25 mrem/RW-yr FAL were detected in surface soils outside of the HCAs and craters that were assumed to exceed the FAL.

Decision Rules

The decision rule for Decision II (other releases) is:

- If a flyover survey isopleth exists that bounds all locations determined to exceed the 25-mrem/yr TED, then the isopleth will be established as the corrective action boundary, else the radiation survey area will be increased until that boundary is defined.

The decision rule for Decision II (other releases) is:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL in any bounding direction or potential remediation waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2009) made the following commitments for sampling:

1. Judgmental sampling will be conducted at other releases and at locations of potential contamination identified during the CAI.

   Result: Judgmental sampling was conducted at sediment accumulation areas within the major drainages at Little Feller II, Palanquin, and Cabriolet to determine whether migration from the site has occurred.

2. Sampling of primary releases will be conducted by a combination of judgmental and probabilistic sampling approaches.

   Result: The location of the plots were selected judgmentally and samples were collected within each plot at all CASs within CAU 372 probabilistically as described in Section A.2.1.

B.1.2 Conduct a Preliminary Data Review

A data review was conducted by reviewing QA reports and inspecting the data. A nonconformance report (NCR 0.452) was issued because original sample preparation did not meet contractual requirements. The laboratory's corrective action was to reanalyze the samples in accordance with the analytical services statement of work. The data packages were resubmitted, and the dataset quality was found to be satisfactory. In addition to the resubmitted dataset, all other data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions for the primary release was the comparison of the TED to the FAL of 25 mrem/RW-yr. For other releases, the test for making DQO Decisions was the comparison of the maximum analyte concentration to the corresponding FAL. All FALs were based on an exposure duration to a site worker using the Remote Work Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-2.

Table B.1-2
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 concern through oral ingestion or inhalation of soil and/or debris due to inadvertent disturbance of these materials, or irradiation by radioactive materials.
Affected Media	Surface and shallow subsurface soil; debris such as metal, vehicles, wood, and concrete.
Location of Contamination/Release Points	Surface soil (to 5 cm depth). Refer to Section 2.1.
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside of the boundaries of the CASs. Infiltration of precipitation through subsurface media serves as a minor intermittent driving force for vertical 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 assumed to be within the spatial boundaries of each CAS.
Groundwater Impacts	None.
Future Land Use	Reserved Zone (Little Feller I and Little Feller II) and Nuclear Test (Palanquin and Cabriolet).
Other DQO Assumptions	Subsurface contamination is present at Palanquin and Cabriolet due to the prompt injection of material into each crater. Release at Little Feller I and Little Feller II is due to atmospheric deposition during testing. The DQIs were satisfactorily met as discussed in Section B.1.1.1.1. The rejected data because of sensitivity was due to the particulate nature of the rejected radionuclides and is not considered to adversely impact the ability for the data to support the DQO decisions. The data collected during the CAI are considered to accurately support the CSM and support the DQO decision; therefore, no revisions to the CSM were necessary.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 372 DQOs and Table B.1-2. All data collected during the CAI supported CSMs, and no revisions to the CSMs were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2009) made the following commitments for sampling:

1. A Decision I plot will be established in an area most likely to exceed a 25-mrem/yr dose (Section A.5.1.1 of the CAU 372 CAIP).

   Result: The location with the highest detected reading from the GWS was not sampled at Little Feller I and Little Feller II due to removable contamination levels at those locations. The locations with removable contamination exceeding HCA criteria were assumed to be part of the HCAs and were assumed to exceed the FAL. There is no potential for a false negative DQO decision error as these areas are well within the corrective action boundaries.

2. If a predetermined location cannot be feasibly sampled, the Site Supervisor will determine an alternate location (Section A.9.1.1 of the CAU 372 CAIP).

   Result: The modification of aliquot locations from planned positions was due to field conditions and observations (obstruction from a rock, vegetation, or animal burrows). The distances of the new aliquot locations from the planned locations ranged from approximately 5 in. to approximately 24 in. These changes in the planned locations did not impact the DQO decisions because the samples were collected from the nearest possible locations and were not subject to any judgment or biasing factors. Therefore, these samples are considered to be randomly located.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 372 CASs.

B.1.5.1 Decision Rules for Decision I

Decision Rule: If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then that contaminant is identified as a COC and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.

Result: The TEDs above the 25-mrem/RW-yr FAL were detected in surface soils (outside of the HCAs and craters that were assumed to exceed the FALs) at all CASs. Also, COCs (i.e., PSM) in the form of lead bricks were identified at Little Feller I and in the form of lead-acid batteries at the Palanquin and Cabriolet CASs. Therefore, Decision I was resolved that COCs exist, and Decision II was required for all CAU 372 CASs.

Decision Rule: If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.6.2 of the CAU 372 CAIP (NNSA/NSO, 2009), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Result: The COC contamination was not found to be inconsistent with the CSM or extend beyond the spatial boundaries; therefore, work was not suspended.

Decision Rule: If a COC exists at any CAS, then a corrective action will be determined, else no further action will be necessary.

Result: Because COCs were identified for all CASs, corrective actions are required.

Decision Rule: If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, else no further action will be necessary.

Result: Lead bricks were identified at Little Feller I, and lead-acid batteries were identified at the Palanquin and Cabriolet CASs. These wastes require corrective action.

B.1.5.2 Decision Rules for Decision II

Decision Rule: If a flyover survey isopleth exists that bounds all locations determined to exceed the 25-mrem/yr TED, then the isopleth will be established as the corrective action boundary, else the radiation survey area will be increased until that boundary is defined.

Result: A GWS isopleth with a value correlating to a TED of 25 mrem/RW-yr was determined at each CAS that bounds all locations exceeding the 95 percent UCL of the 25-mrem/yr TED. These isopleths were established as the corrective action boundaries.

Decision Rule: If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL in any bounding direction, or potential remediation waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

Result: For the primary releases, additional sample plots were not needed at any CAS as the GWS isopleths contained all sample locations exceeding the FAL. At the other releases, the extent of the lead bricks at Little Feller I was readily identifiable by the lead bricks lying on the surface. Although the lead bricks were removed as part of the corrective action, this area was also included in the closure in place corrective action because it could not be assured that all pieces of lead were completely removed.

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.

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

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Appendix C

Risk Assessment

C.1.0 Risk Assessment

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) and summarized in Figure C.1-1. This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2008a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2008b) requires the use of ASTM Method E1739 (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 ASTM Method E1739 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 372 CAIP [NNSA/NSO, 2009]). 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 concentrations of total petroleum hydrocarbons 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 E1739 that consider site-, pathway-, and receptor-specific parameters.

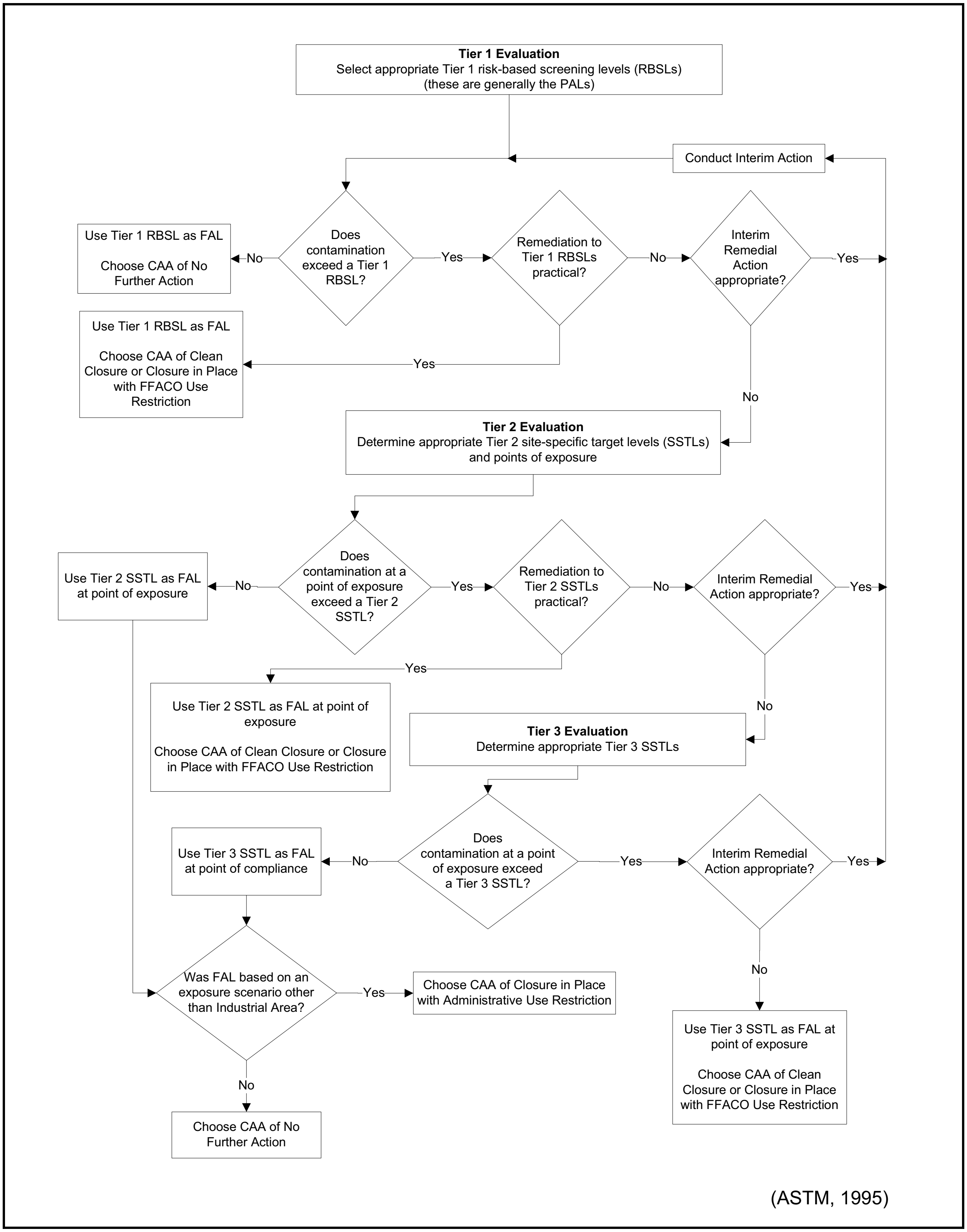

Figure C.1-1
Risk-Based Corrective Action Decision Process

C.1.1 A. Scenario

Corrective Action Unit 372, Area 20 Cabriolet/Palanquin Unit Craters, comprises the following four CASs within Areas 18 and 20 of the NNSS:

- 18-45-02, Little Feller I Surface Crater
- 18-45-03, Little Feller II Surface Crater
- 20-23-01, U-20k Contamination Area
- 20-45-01, U-20L Crater (Cabriolet)

Corrective Action Site 18-45-02, Little Feller I Surface Crater (referred to as Little Feller I in this document), is an inactive site located in Area 18 of the NNSS, west of Airport Road. Little Feller I consists of a release of radionuclides to the surrounding soil surface from the Little Feller I surface weapons-effects test. The Little Feller I test was conducted on July 17, 1962 at a height of approximately 1 m above ground surface (DOE/NV, 2000). Little Feller I was the last atmospheric test conducted at the NTS, and was a warhead fired from the Davy Crockett weapons system (Schoengold et al., 1996).

Corrective Action Site 18-45-03, Little Feller II Surface Crater (referred to as Little Feller II in this document), is an inactive site located in Area 18 of the NNSS, east of Airport Road. Little Feller II consists of a release of radionuclides to the surrounding soil surface from the Little Feller II surface weapons-effects test. The Little Feller II test was conducted on July 7, 1962, at a height of approximately 1 m above ground surface. Little Feller II was a test of the Davy Crockett weapons system (DOE/NV, 2000).

Corrective Action Site 20-23-01, U-20k Contamination Area (referred to as Palanquin in this document), is an inactive site located in Area 20 of the NNSS, south of Pahute Mesa Road. Palanquin consists of a release of radionuclides to the surrounding soil from the Palanquin Plowshare test. The Palanquin test was conducted on April 14, 1965, at a depth of approximately 85 m (DOE/NV, 1996b and 2000). A crater measuring approximately 24 m in depth and 36 m in radius resulted from this test (Gibson, 1965).

Corrective Action Site 20-45-01, U-20L Crater (Cabriolet) (referred to as Cabriolet in this document), is an inactive site located in Area 20 of the NNSS, south of Pahute Mesa Road. Cabriolet consists of a release of radionuclides to the surrounding soil from the Cabriolet Plowshare test. The Cabriolet test was conducted on January 26, 1968, at a depth of approximately 52 m (Schoengold et al., 1996; DOE/NV, 2000). A crater resulted from this test.

C.1.2 B. Site Assessment

The Little Feller I site includes the area affected by the surface release of radioactivity associated with the surface Little Feller I nuclear test. An HCA is present within the contamination area that is assumed to exceed FALs and has the potential for significant dose exposure. Outside the HCA, TED from four sample locations (Plots AM, AN, AQ, and AR) at Little Feller I exceed the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr) at four locations. The maximum potential TED to an industrial worker (based on a continuous industrial work site) at a sampled location was calculated to be 524.7 mrem/IA-yr.

The Little Feller II site includes the area affected by the surface release of radioactivity associated with the Little Feller II surface nuclear test. An area identified to have the highest radiological readings during the GWS contained removable contamination exceeding HCA criteria. Because of worker safety concerns, sampling was not conducted within this area. Rather, it was assumed that this area exceeds FALs and has the potential for significant dose exposure. Outside this area, TED from three sample locations (locations BT10 and BT19, and plot BE) at Little Feller II exceed the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr) at three locations. The maximum potential TED to an industrial worker (based on a continuous industrial work site) at a sampled location was calculated to be 463.5 mrem/IA-yr.

The Palanquin site includes the area affected by the surface release of radioactivity associated with the Palanquin subsurface Plowshare test. A crater is present at the site surrounded by mounds of ejected soil that is assumed to exceed FALs and has the potential for significant dose exposure. Outside the crater, TED from one sampled location (Plot CP) at Palanquin exceeded the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr). The maximum potential TED to an industrial worker (based on a continuous industrial work site) at a sampled location was calculated to be 932.9 mrem/IA-yr.

The Cabriolet site includes the area affected by the surface release of radioactivity associated with the Cabriolet subsurface Plowshare test. A crater is present at the site surrounded by mounds of ejected soil. The area is posted as a contamination area with an interior HCA southeast of the crater. The crater and HCA is assumed to exceed FALs and has the potential for significant dose exposure. Outside the crater, TED from two sample locations (Plots DA and DK) at Cabriolet exceed the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr). The maximum potential TED to an industrial worker (based on a continuous industrial work site) at a sampled location was calculated to be 216.8 mrem/IA-yr.

C.1.3 C. Site Classification and Initial Response Action

The four major site classifications listed in Table 1 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, site conditions at any CAS do not present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. However, corrective actions are required at all four CASs due to the presence of contamination exceeding the 25-mrem/RW-yr FAL. Contamination in the HCAs at Little Feller I, Little Feller II, or Cabriolet could pose a short-term threat to human health, safety, or the environment to industrial workers. However, each of these areas is posted and fenced to prevent inadvertent exposure. Thus, all CASs have been determined to be Classification 2 sites as defined by ASTM Method E1739 (ASTM, 1995).

C.1.4 D. Development of Tier 1 Lookup Table of RBSLs

Tier 1 risk-based screening levels (RBSLs) are defined as the PALs listed in the CAIP (NNSA/NSO, 2009) as established during the DQO process. The PALs for radionuclides are based on a dose of 25 mrem/yr using the Industrial Area exposure scenario. This represents a very conservative estimate of risk, is preliminary in nature, and is used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 RBSL (i.e., PAL) value if implementing a corrective action based on the Tier 1 RBSL would be appropriate.

The Industrial Area scenario assumes that a full-time industrial worker is present at a particular location for his entire career (225 day/yr, 10 hr/day for 25 years). The 25-mrem/yr dose-based Tier 1 RBSL for the primary release is implemented by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 2,250 hours.

The Tier 1 RBSLs for the other releases are the following PALs as defined in the CAIP:

- EPA Region 9 Risk-Based Preliminary Remediation Goals (PRGs) for Industrial Soils (EPA, 2010).
- 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).
- 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 for radioactive contaminants are the RRMGs based on the National Council on Radiation Protection and Measurements Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25-mrem/yr dose constraint (Appenzeller-Wing, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

Note: The EPA Region 9 PRGs have changed to screening levels.

The PALs were developed based on an industrial scenario. Because the CAU 372 CASs in Areas 18 and 20 are not assigned work stations and are considered to be in remote or occasional use areas, the use of industrial scenario based PALs is conservative.

C.1.5 E. Exposure Pathway Evaluation

For all CASs, the DQOs stated that site workers would only be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials at the CASs. The potential exposure pathways would be through worker contact with the contaminated soil or various debris currently present within the site boundaries. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater supports the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 RBSLs

The crater areas at Cabriolet and Palanquin and the HCAs at Little Feller I, Little Feller II, and Cabriolet are assumed to contain significant contamination and require corrective action. Therefore, these areas are not included in the RBCA evaluations. Rather, these evaluations will be limited to the CAS areas outside the HCAs and crater areas. An exposure time based on the Industrial Area scenario (2,250 hr/yr) was used to calculate site radiological doses (TED). These values were compared to the Tier 1 RBSL (25-mrem/IA-yr dose) that is also based on an exposure time of 2,250 hr/yr.

The Industrial Area scenario based TED for all sample locations at each CAU 372 CAS that exceed the Tier 1 RBSL (i.e., PAL) are listed in Table C.1-1. Based on the conservative assumption that a site worker would be exposed to the maximum dose measured at any sampled location outside of any crater area or HCA, this site worker would receive a 25-millirem (mrem) dose at each of these CAS locations in the exposure times listed in Table C.1-2.

Table C.1-1
Locations Where TED Exceeds the Tier 1 RBSL at CAU 372 (mrem/IA-yr)
(Page 1 of 2)

CAS	Location	Average TED	95% UCL TED
Little Feller I	AA	23.0	**30.6**
	AH	**42.0**	**57.9**
	AJ	**39.2**	**57.1**
	AK	**35.6**	**44.8**
	AM	**185.2**	**223.1**
	AN	**231.9**	**294.0**
	AQ	**380.8**	**524.7**
	AR	**152.6**	**199.8**

Table C.1-1
Locations Where TED Exceeds the Tier 1 RBSL at CAU 372 (mrem/IA-yr)
(Page 2 of 2)

CAS	Location	Average TED	95% UCL TED
Little Feller II	BD	**54.3**	**61.2**
	BE	**226.1**	**264.9**
	BH	24.8	**31.4**
	BL	17.7	**31.7**
	BM	**48.0**	**68.7**
	BT10	**195.9**	**225.5**
	BT19	**393.5**	**463.5**
Palanquin	CC	**71.5**	**78.6**
	CH	**55.5**	**61.9**
	CJ	**27.9**	**33.4**
	CN	**32.6**	**35.5**
	CP	**848.2**	**932.9**
	CQ	**31.4**	**34.8**
	CT17	24.0	**32.5**
Cabriolet	DA	**176.9**	**190.9**
	DB	**29.7**	**34.4**
	DC	**72.4**	**78.9**
	DF	**116.3**	**128.8**
	DG	**26.7**	**30.7**
	DK	**199.1**	**216.8**

Bold indicates the values exceeding 25 mrem/yr.

In addition, lead bricks were present at Little Feller I, and lead-acid batteries were present at the Cabriolet and Palanquin CASs. These waste items are considered to be PSM as they are assumed to contain sufficient quantities of lead to cause the underlying soil to exceed the FAL for lead when the lead is eventually released to the soil.

Table C.1-2
Minimum Exposure Time to Receive a 25-mrem/yr Dose

CAS	Location of Maximum Dose	Maximum 95% UCL TED (mrem/RW-yr)	Minimum Exposure Time (hours)
Little Feller I	Plot AQ	524.7	107
Little Feller II	BT19	463.5	121
Palanquin	Plot CP	932.9	60
Cabriolet	Plot DK	216.8	259

C.1.7 G. Evaluation of Tier 1 Results

For the primary releases at the CASs listed in Table C.1-1, NNSA/NSO determined that remediation to the RBSL is not appropriate. The risk to receptors from contaminants at CAU 372 is due to chronic exposure to radionuclides (i.e., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use at all sites in CAU 372 determined that workers may only be present at these sites for a few hours per year (see Section C.1.10), and it is not reasonable to assume that any worker would be present at this site for 2,250 hr/yr (DOE/NV, 1996). Therefore, it was determined to conduct a Tier 2 evaluation for the primary releases.

For the other releases at CAU 372, it was assumed that the lead bricks at Little Feller I and the lead-acid batteries at Cabriolet and Palanquin exceed the RBSL for lead.

C.1.8 H. Tier 1 Remedial Action Evaluation

For the lead bricks at Little Feller I, it was determined that remediation of the lead bricks was feasible and appropriate. The lead bricks were removed under a corrective action. However, it was not possible to assure that lead concentrations exceeding the FAL do not remain in the soil. Therefore, the area where the lead bricks were found is assumed to exceed the FAL for lead. The lead-acid batteries at the Cabriolet and Palanquin CASs were removed under a corrective action. As the batteries were intact, this removal was considered a complete removal of the PSM, and additional corrective action is not necessary.

C.1.9 I. Tier 2 Evaluation

No additional data were needed to complete a Tier 2 evaluation.

C.1.10 J. Development of Tier 2 Table of SSTLs

The Tier 2 action levels are typically compared to contaminant values that are representative of areas at which an individual or population may come in contact with a COC originating from a CAS. This concept is illustrated in the EPA's Human Health Evaluation Manual (EPA, 1989). This document states that "the area over which the activity is expected to occur should be considered when averaging the monitoring data for a hot spot. For example, averaging soil data over an area the size of a residential backyard (e.g., an eighth of an acre) may be most appropriate for evaluating residential soil pathways." When evaluating industrial receptors, the area over which an industrial worker is exposed may be much larger than for residential receptors. For a site that is limited to industrial uses, the receptor would be a site worker, and patterns of employee activity would be used to estimate the area over which the receptor is exposed. This can be very complicated to calculate, as industrial workers may perform routine activities at many locations where only a portion of these locations may be contaminated. A more practical measure of integrated risk to radiological dose for an industrial worker is to calculate the portion of total work time that the worker is in proximity to elevated radioactivity—and, therefore, able to receive a dose. For example, a site worker may have routine activities that require him or her to be exposed to a radioactive location for 225 hours out of each year. If the worker's industrial work schedule was 10 hr/day for 225 day/yr—or 2,250 hr/yr (as is used for the Industrial Area exposure scenario)—the site worker would receive 10 percent of the potential annual dose that he or she would otherwise receive if exposed to the radioactive location for the entire work year.

For the development of radiological Tier 2 SSTLs, the annual dose limit for a site worker is 25 mrem/yr (the same as was used for the Tier 1 evaluation). The Tier 2 evaluation is based on a receptor exposure time that is more specific to actual site conditions. The maximum potential exposure time for the most exposed worker at any CAS 372 CAS was determined based on an evaluation of current and reasonable future activities that may be conducted at the site. Activities on the NNSS are strictly controlled through a formal work control process. This process requires facility managers to authorize all work activities that take place on the land or at the facilities within their purview. As such, these facility managers are aware of all activities conducted at the site. The facility managers responsible for the area of CAU 372 identified the general types of work activities that are currently conducted at the site, to include fencing/posting inspection and maintenance workers, and military trainees. Site activities that may occur in the future were identified by assessing tasks related to maintenance of existing infrastructure and long-term stewardship of the site (e.g., inspection and maintenance of UR signs, trespasser). In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NSO and/or M&O contractor departments responsible for these activities were consulted. Under the current land use at each of the CAU 372 CASs, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker –** Workers sent to conduct the annual inspection of the postings and fencing around the four CASs. The UR requires a periodic inspection to ensure that the fencing is intact and the signs are legible. This will require two people to spend up to 10 hr/yr at each CAS.
- **Military Trainee –** Periodic military training activities conducted within Areas 18 and 20. These workers typically spend 1 to 2 weeks per year training in the general area that includes these CASs. Although they are routinely advised to avoid areas containing radiological contamination and the sites will be posted with warning signs, there is a potential that they might inadvertently enter into these CAS areas. It was conservatively assumed that this type of worker would spend up to 1 week per year (40 hours) in one or more of these CASs.
- **Trespasser –** This would include workers or individuals who do not have a specific work assignment at one of the CASs. Although the sites will be posted with warning signs, there is a potential that they might inadvertently enter into these CAS areas and come in contact with site contamination. This is assumed to be an infrequent occurrence (i.e., once per year) that would result in a potential exposure of less than a day (8 hours).

Under the current land use at each of the CAU 372 CASs, the most exposed worker would be the Military Trainee, who would not be exposed to site contamination for more than 40 hr/yr. Based on the conservative assumption that the most exposed worker would be exposed to the maximum dose measured at any sampled location outside of any crater area or HCA for the entire 40 hours, this worker would receive a maximum potential dose at each CAS as listed in Table C.1-3.

Table C.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 372 CASs

CAS	Most Exposed Worker	Exposure Time	Maximum Potential Dose
Little Feller I	Military Trainee	40 hr/yr	9.3 mrem/yr
Little Feller II	Military Trainee	40 hr/yr	8.3 mrem/yr
Palanquin	Military Trainee	40 hr/yr	16.7 mrem/yr
Cabriolet	Military Trainee	40 hr/yr	3.9 mrem/yr

In the CAU 372 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAU 372 CAIP [NNSA/NSO, 2009]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 372 CASs. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr.

However, as the corrective action requirements at each of the CAU 372 CASs would not be significantly different if based on the Remote Work Area exposure scenario, it was conservatively determined to use the Remote Work Area exposure scenario. Therefore, the radiological FAL determined under this exposure scenario was based on the assumption that a worker would be exposed to site contamination for 336 hr/yr.

C.1.11 K. Comparison of Site Conditions with Tier 2 Table SSTLs

The 25-mrem/yr dose-based Tier 2 SSTL for the primary releases based on the Remote Work Area exposure scenario was accomplished by calculating dose (i.e., TED) at the site over an exposure period of 336 hr/yr (8 hr/day, 42 day/yr). The TEDs calculated using the Remote Work Area exposure scenario were then compared to the 25-mrem/RW-yr Tier 2 SSTL. Table C.1-4 shows the 95 percent UCL TED values that exceeded the 25-mrem/RW-yr Tier 2 SSTL at each of the CAU 372 CASs. Therefore, corrective actions will be required for surface contamination at all four CASs.

Table C.1-4
Remote Work Area Scenario TED Exceedances at Each CAS (mrem/RW-yr)

CAS	Plot/Location	Average TED	95% UCL TED
Little Feller I	AM	30.4	36.8
	AN	38.7	49.4
	AQ	63.8	88.6
	AR	25.8	33.9
Little Feller II	BE	34.7	40.9
	BT10	29.3	33.7
	BT19	58.8	69.2
Palanquin	CP	129.7	143.5
Cabriolet	DA	27.5	29.8
	DK	30.5	33.3

C.1.12 L. Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, the surface soils at each of the CAU 372 CASs pose an unacceptable risk to human health and the environment and require corrective action. Any corrective action would also need to address the contamination in the crater areas and HCAs that were assumed to exceed FALs. A corrective action of clean closure at these CASs would require extensive excavations (the corrective action areas at each CAS are presented in Table C.1-5) of up to 25 ft in depth. This corrective action would not remove deeper contamination in the area of the craters at the Palanquin and Cabriolet CASs and a UR may still be required. Based on the extent of the corrective action boundaries, the infeasibility of removing deep contamination in the craters, and the presence of HCAs that would expose remediation workers to high levels of removable contamination, the Tier 2 remedial action evaluation recommends implementing a corrective action of closure in place with URs for the areas encompassed by the Tier 2 SSTL corrective action boundaries. As this corrective action is practical for the contamination at these CASs, the Tier 2 SSTL is established as the FAL for the primary releases, and corrective action will be implemented.

As the radiological FAL was established as the Tier 2 SSTL, a Tier 3 evaluation was not necessary.

Table C.1-5
Corrective Action Boundary Areas at CAU 372 CASs

CAS	Area (acres)
Little Feller I	5.05
Little Feller II	1.28
Palanquin	28.7
Cabriolet	12.6

C.2.0 Recommendations

Because the TED values for surface soils at locations at all four CASs exceed the corresponding FALs (using the Remote Work Area exposure scenario), it was determined that surface soil contamination at these locations warrant corrective actions. Surface contamination is assumed to exist within the HCAs at Little Feller I and Cabriolet that exceeds the Remote Work Area exposure scenario based FAL of 25 mrem/RW-yr. Additionally, subsurface contamination is assumed to exist within the craters and ejecta mounds at Palanquin and Cabriolet that exceeds the Remote Work Area exposure scenario based FAL or 25 mrem/RW-yr. Also, lead bricks present at Little Feller I and lead-acid batteries present at Palanquin and Cabriolet exceed PSM criteria. Therefore, corrective actions are necessary for contamination at all CAU 372 CASs.

The corrective action of closure in place with URs was implemented at each of the CAU 372 CASs that encompasses the individual CAS corrective action boundaries. These boundaries include the areas identified as exceeding the 25-mrem/RW-yr FAL as well as the crater areas at Palanquin and Cabriolet. The boundaries also include the HCAs at Little Feller I and Cabriolet. As part of the corrective action, the lead bricks at Little Feller I and the lead-acid batteries at Palanquin and Cabriolet were removed from the sites. As it cannot be assured that lead contamination exceeding the FAL does not remain at the Little Feller I lead brick location, it will be assumed that lead is a COC at this location. This area is encompassed by the Little Feller I corrective action boundary and is included in the corrective action of closure in place for Little Feller I. The FFACO UR areas around the corrective action boundaries will be posted with signs and fenced to prevent worker access.

The FAL was based on an exposure time of 336 hr/yr of site worker exposure to CAS surface soils. Should the land use at any CAU 372 CASs change such that industrial land use activities are proposed to be conducted at any of these CASs, a site worker could be potentially exposed to a dose exceeding 25 mrem/yr. Therefore, an administrative UR was implemented at all CAU 372 CASs as a BMP that would restrict future industrial land use without NDEP notification. The areas at the CAU 372 CASs that provide sufficient dose to potentially cause a full-time industrial worker to receive an annual dose exceeding 25 mrem were conservatively defined in Sections D.1.1 through D.1.4.

The corrective actions for CAU 372 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions no longer are valid, additional evaluation may be necessary.

The FFACO URs and administrative URs for all CAU 372 CASs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. These URs are included in Appendix D, Attachment D-2.

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Attachment C-1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 372 Area 20 Cabriolet/Palanquin Unit Craters Nevada National Security Site, Nevada

(10 Pages)

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 372, Area 20 Cabriolet/Palanquin Unit Craters Nevada National Security Site, Nevada

Introduction

This appendix promulgates tables of Residual Radioactive Material Guidelines (RRMGs) for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios, for use in the evaluation of Soils Project sites. These exposure scenarios are described in the document *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). Two sets of RRMGs were calculated for each of the three exposure scenarios: one set using only the inhalation and ingestion pathways (e.g., internal dose), and one set that added the external gamma pathway (e.g., internal and external dose). The second set is needed to evaluate "other release" soil samples where thermoluminescent dosimeters (TLDs) were not emplaced to measure the external dose.

Background

The *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006), provides a Nevada Department of Environmental Protection (NDEP)-approved process for the derivation of soil sampling final action levels that are congruent with the risk-based corrective action process. This document is used by the Navarro-Intera, LLC (N-I), Soils Project as well.

The Residual Radioactive (RESRAD) computer code, version 6.5 (Yu et al., 2001), and the guidance provided in NNSA/NSO (2006) were used to derive RRMGs for use in the Soils Project. The RRMGs are radionuclide-specific values for radioactivity in surface soils, expressed in units of picocuries per gram (pCi/g). A soil sample with a radionuclide concentration that is equal to the RRMG value for that radionuclide would present a potential dose of 25 millirem per year (mrem/yr) to a receptor under the conditions described in the exposure scenario. When more than one radionuclide is present, the potential dose must be evaluated by summing the fractions for each radionuclide (i.e., the measured concentration divided by the RRMG for the radionuclide). The resultant sum of the fractions value is then multiplied by 25.0 to obtain an estimate of the dose.

The RRMGs are specific to a particular exposure scenario. The dose estimates obtained from the use of RRMGs are valid only when the assumptions provided in the exposure scenario for the intended land-use hold true. In most cases at the Nevada National Security Site (NNSS), the Industrial Area exposure scenario is quite conservative and is bounding for most anticipated future land uses.

A recent revision to 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2011) had adopted new, more sophisticated, dosimetric models and new dosimetric terms. Internal dose is now to be expressed in terms of the Committed Effective Dose (CED), and International Commission on Radiological Protection (ICRP) 72 dose conversion factors are to be used.

Methods

Calculations were performed using the RESRAD code, version 6.5 (Yu et al., 2001). The ICRP 72 dose conversion factors were used. The RESRAD input parameters were verified and checkprinted.

The radionuclide niobium (Nb)-94 was previously added to the RRMGs to accommodate work in Area 25 that is related to the Nuclear Rocket Development Station (NRDS). The radionuclides silver (Ag)-108m, curium (Cm)-243, and Cm-244 were recently detected on one or more Soils Project sites, and RRMGs were calculated to demonstrate that their contribution to the total effective dose (TED) is negligible.

The RESRAD calculations have identified that for all radionuclides evaluated, with one exception: The maximum potential dose occurs at time-zero. The RRMGs provided in this memorandum do reflect those for time-zero. The exception previously mentioned is the radionuclide thorium (Th)-232, which has several daughters with short half-lives. Because the daughter activity "grows in," and because RRMGs include the contributions from daughters, the maximum potential dose for Th-232 actually occurs at 10.21 years. A RRMG for Th-232 at 10.21 years was not selected, and the RRMG for time-zero was used, for the following reasons:

- RESRAD suggests a set of RRMGs for use when the overall total dose is at its maximum. Considering the contributions from all radionuclide contaminants of potential concern (COPCs), this would be at time-zero.
- The additional dose from the in-growth of Th-232 daughters is offset by the radioactive decay of other radionuclides that would be present (e.g., cesium [Cs]-137).
- The additional dose from the in-growth of Th-232 daughters is very small when compared to the basic dose limit of 25 mrem/yr. For example, if Th-232 were found at a concentration of 100 pCi/g, the increase in potential dose from time-zero to 10.21 years would only be 0.52 millirem (mrem). To date, Th-232 has only been seen on Soils Project sites at environmental levels of about 1.5 to 3 pCi/g.

Assumptions and Default Parameters

Appendix B to DOE/NV--1107 (NNSA/NSO, 2006) lists the RESRAD code variables (i.e., input parameters) for the three exposure scenarios. These pre-determined values were used to calculate the RRMGs, with a few exceptions as described in Table 1.

Results

The RRMGs are presented in Tables 2 to 7. The abbreviation "RRMG" in each of the six tables includes a subscript to indicate the scenario and the exposure pathways that are activated. When referencing a set of RRMGs, the subscripts should be included to avoid confusion and a potential misapplication of the RRMGs.

Table 1: RESRAD Input Parameters

Item #	RESRAD Parameter	Industrial Area	Remote Work Area	Occasional Use Area	Explanation
1	Area of CZ (m^2)	1,000			Appendix B states "Site Specific." Previously, 100 m^2 was selected to conform to the maximum area of contamination limitation in DOE Order 5400.5 (DOE, 1993). Going forward, 1,000 m^2 has been selected to add conservativism and realism to the RRMGs. The 1,000 m^2 RRMGs will be applied to 100 m^2 evaluation areas.
2	Thickness of CZ (m)	0.05			Appendix B states "Site Specific." This depth encompasses the bulk of the potential contamination and includes the maximum concentration.
3	Cover Depth	0.00			Appendix B states "Site Specific." Cover depth only affects the time delay before contamination becomes available for erosion and airborne suspension. Increasing the cover depth, in some cases, may lead to lower dose estimates.
4	Precipitation (m/yr)	0.144			Appendix B states "Site Specific." The selected value is the average annual rainfall as recorded at Camp Desert Rock.
5	Indoor Time Fraction	**[0.1712]**	**[0.0256]**	0	The stated value was 0, conservatively assuming no time is spent indoors. The new value more accurately reflects the Industrial Area scenario in which 66% of the time is spent indoors. $\left(\frac{2250\ hrs\ on-site}{8760\ hrs\ in\ a\ year}\right) 0.6666\ indoors = 0.1712$ The same correction was made for the Remote Work Area scenario.
6	Soil Ingestion Rate (g/yr)	**[43.43]**	20.2	4.8	The stated value was 108, assuming that all time is spent outdoors under a 480 mg/day soil ingestion rate. The new value more accurately reflects the soil ingestion rate of 193 mg/day when both indoor and outdoor time fractions are considered. Refer to page 14 of DOE/NV--1107 (NNSA/NSO, 2006).
7	Indoor Dust Filtration Factor	**[0.4]**	**[0.4]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
8	Shielding Factor External Gamma	**[0.7]**	**[0.7]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
9	Pathway 1 – External Gamma	Suppressed	Suppressed	Suppressed	In general, external dose at Soils Projects will be evaluated via TLDs or direct measurement with a dose-rate meter. Soil samples and RRMGs are used to determine the internal dose component only. The pathway was activated for the second set of RRMGs for each scenario to allow the evaluation of biased sample locations where TLDs were not emplaced.

Note 1: Items 1–4 above are site-specific default values that were selected for the Soils Project.
Note 2: Table B.1-1 in Appendix B contains several errors. The bold and bracketed values are corrections to those values.

CZ = Contamination zone
g/yr = Grams per year
m^2 = Square meter
m/yr = Meters per year
mg/day = Milligrams per day

Table 2: Soils Project - Industrial Area Exposure Scenario - Internal Dose Only

Radionuclide	**$RRMG_{(IA-I)}$** (pCi/g)
Ag-108m	2.737E+06
Am-241	2.816E+03
Cm-243	3.852E+03
Cm-244	4.735E+03
Co-60	5.513E+05
Cs-137	1.409E+05
Eu-152	1.177E+06
Eu-154	8.469E+05
Eu-155	5.588E+06
Nb-94	3.499E+06
Pu-238	2.423E+03
Pu-239/240	2.215E+03
Sr-90	5.947E+04
Th-232	2.274E+03
U-234	1.960E+04
U-235	2.089E+04
U-238	2.120E+04

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Industrial Area exposure scenario.

Table 3: Soils Project - Industrial Area Exposure Scenario - Internal & External Dose

Radionuclide	**RRMG$_{(IA-IE)}$** (pCi/g)
Ag-108m	9.281E+01
Am-241	1.503E+03
Cm-243	3.155E+02
Cm-244	4.713E+03
Co-60	1.833E+01
Cs-137	7.290E+01
Eu-152	3.826E+01
Eu-154	3.571E+01
Eu-155	9.583E+02
Nb-94	9.653E+01
Pu-238	2.416E+03
Pu-239/240	2.207E+03
Sr-90	7.714E+03
Th-232	5.067E+02
U-234	1.865E+04
U-235	2.555E+02
U-238	1.423E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Industrial Area exposure scenario.

Table 4: Soils Project – Remote Work Area Exposure Scenario - Internal Dose Only

Radionuclide	**RRMG$_{(RWA-I)}$** (pCi/g)
Ag-108m	3.389E+07
Am-241	1.612E+04
Cm-243	2.223E+04
Cm-244	2.716E+04
Co-60	7.229E+06
Cs-137	1.955E+06
Eu-152	1.324E+07
Eu-154	9.741E+06
Eu-155	6.645E+07
Nb-94	3.966E+07
Pu-238	1.388E+04
Pu-239/240	1.268E+04
Sr-90	8.075E+05
Th-232	1.341E+04
U-234	1.379E+05
U-235	1.496E+05
U-238	1.554E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Remote Work Area exposure scenario.

Table 5: Soils Project - Remote Work Area Exposure Scenario - Internal & External Dose

Radionuclide	**RRMG$_{(RWA-IE)}$** (pCi/g)
Ag-108m	6.204E+02
Am-241	9.239E+03
Cm-243	2.083E+03
Cm-244	2.715E+04
Co-60	1.225E+02
Cs-137	4.874E+02
Eu-152	2.557E+02
Eu-154	2.387E+02
Eu-155	6.406E+03
Nb-94	6.452E+02
Pu-238	1.390E+04
Pu-239/240	1.269E+04
Sr-90	5.522E+04
Th-232	3.292E+03
U-234	1.314E+05
U-235	1.709E+03
U-238	9.572E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Remote Work Area exposure scenario.

Table 6: Soils Project – Occasional Use Area Exposure Scenario - Internal Dose Only

Radionuclide	**RRMG$_{(OUA-I)}$** (pCi/g)
Ag-108m	2.762E+08
Am-241	4.555E+04
Cm-243	6.307E+04
Cm-244	7.68E+04
Co-60	7.421E+07
Cs-137	2.756E+07
Eu-152	8.174E+07
Eu-154	6.353E+07
Eu-155	4.751E+08
Nb-94	2.492E+08
Pu-238	3.922E+04
Pu-239/240	3.582E+04
Sr-90	9.949E+06
Th-232	3.852E+04
U-234	4.470E+05
U-235	4.922E+05
U-238	3.361E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Occasional Use Area exposure scenario.

Table 7: Soils Project – Occasional Use Area Exposure Scenario - Internal & External Dose

Radionuclide	**RRMG$_{(OUA-IE)}$** (pCi/g)
Ag-108m	2.087E+03
Am-241	2.797E+04
Cm-243	6.886E+03
Cm-244	7.653E+04
Co-60	4.122E+02
Cs-137	1.640E+03
Eu-152	8.604E+02
Eu-154	8.031E+02
Eu-155	2.156E+04
Nb-94	2.171E+03
Pu-238	3.915E+04
Pu-239/240	3.573E+04
Sr-90	1.955E+05
Th-232	1.062E+04
U-234	4.252E+05
U-235	5.749E+03
U-238	3.219E+04

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Occasional Use Area exposure scenario.

References

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Appendix D

Closure Activity Summary
(Use Restriction)

D.1.0 Closure Activity Summary

The following sections document closure activities completed for each of the four CASs in CAU 372. Surface soil samples, TLD measurements, and GWS measurements were collected to characterize the nature and lateral extent of radiological contamination at these sites. Potential source material was removed, where necessary, from the CASs.

D.1.1 Little Feller I Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination exceeds the FAL for the radiological dose (25 mrem/RW-yr) at four sample locations. It is assumed that lead contamination at the location of the lead bricks and the area within the HCA exceeds the FALs. As part of the corrective action, lead bricks have been removed from the site and are being recycled by TOXCO, Inc. However, because it cannot be assured that lead contamination does not remain at the site, it is assumed that lead concentrations at levels exceeding the FAL are present in the soil.

Based on the results of this investigation, a corrective action of closure in place with a UR was implemented and encompasses the area exceeding a dose of 25 mrem/RW-yr, the HCA, and the area of the lead bricks (Figure A.3-4). As the area requiring the UR posting is encompassed by the contamination area (CA) fence, the UR signs were installed on the CA fence. If the CA changes at any time in the future, the UR signs may be moved, as long as they encompass the UR area.

The established FFACO UR for Little Feller I is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-2. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), an administrative UR was established around the area containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future, as discussed in Section 3.0 and illustrated in Attachment D-2. Note: The CA boundary does not correlate with any UR boundaries, as the CA boundary is defined by removable radioactive contamination and the UR boundaries are defined by radiological dose (Figure A.3-4).

Both URs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

D.1.2 Little Feller II Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at three sample locations. Based on the results of this investigation, a corrective action of closure in place with a UR was implemented and encompasses the area exceeding the FAL of 25 mrem/RW-yr (Figure A.4-4). As the area requiring the UR posting is encompassed by the CA fence, the UR signs were installed on the CA fence. If the CA changes at any time in the future, the UR signs may be moved, as long as they encompass the UR area.

The established FFACO UR for Little Feller II is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-2. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), an administrative UR was established around the area containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future, as discussed in Section 3.0 and illustrated in Attachment D-2. Note: The CA boundary does not correlate with any UR boundaries, as the CA boundary is defined by removable radioactive contamination and the UR boundaries are defined by radiological dose (Figure A.4-4).

Both URs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

D.1.3 Palanquin Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at one location. It is assumed that subsurface contamination present in the crater and ejecta mounds surrounding the crater exceeds the FAL due to direct injection of radionuclides into the subsurface soil from the nuclear test. Based on the results of this investigation, a corrective action of closure in place with a UR was implemented and encompasses the area that exceeds the FAL of 25 mrem/RW-yr, the crater area, and ejecta mounds surrounding the crater (Figure A.5-5). In addition, six lead-acid batteries were identified. As part of the corrective action all six batteries have been removed and are scheduled for recycling by TOXCO, Inc. Disposal documentation for the removed batteries is pending and will be included within Attachment D-1.

As the area requiring the UR posting is encompassed by the CA fence, the UR signs were installed on the CA fence. If the CA changes at any time in the future, the UR signs may be moved, as long as they encompass the UR area.

The established FFACO UR for Palanquin is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-2. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), an administrative UR was established around the area of the site containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future, as discussed in Section 3.0 and illustrated in Attachment D-2. Note: The CA boundary does not correlate with any UR boundaries, as the CA boundary is defined by removable radioactive contamination and the UR boundaries are defined by radiological dose (Figure A.5-5).

Both URs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

D.1.4 Cabriolet Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at two sample locations. It is assumed that contamination within the HCA exceeds the FAL. Additionally, it is assumed that subsurface contamination present in the crater and ejecta mounds surrounding the crater exceeds the FAL due to direct injection of radionuclides into the subsurface soil from the nuclear test. Based on the results of this investigation, a corrective action of closure in place with a UR was implemented and encompasses the area exceeding the FAL of 25 mrem/RW-yr, the posted HCA, the crater area, and ejecta mounds surrounding the crater (Figure A.6-5). In addition to the radioactivity, 12 lead-acid batteries were identified outside the posted CA. As part of the corrective action, all 12 batteries have been removed and are scheduled for recycling by TOXCO, Inc. Disposal documentation for the removed batteries is pending and will be included within Attachment D-1.

As the area requiring the UR posting is encompassed by the CA fence, the UR signs were installed on the CA fence. If the CA changes at any time in the future, the UR signs may be moved, as long as they encompass the UR area.

The established FFACO UR for Cabriolet is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-2. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), an administrative UR was established around the area of the site containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future, as discussed in Section 3.0 and illustrated in Attachment D-2. Note: The CA boundary does not correlate with any UR boundaries, as the CA boundary is defined by removable radioactive contamination and the UR boundaries are defined by radiological dose (Figure A.6-5).

Both URs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

Attachment D-1

Waste Disposition Documentation

(2 Pages)

NSTec
Form
FRM-0918

08/23/06
Rev. 0
Page 1 of 2

NTS LANDFILL LOAD VERIFICATION

SWO USE (Select One) AREA ☐ 23 ☐ 6 ☒ 9 ☒ LANDFILL

For waste characterization, approval, and/or assistance, contact Solid Waste Operation (SWO) at 5-7898.

REQUIRED: WASTE GENERATOR INFORMATION

(This form is for rolloffs, dump trucks, and other onsite disposal of materials.) Fax 5-2241

Waste Generator: Mark Heser (NI, WO) (M/S - NSF 176) (Fax 5-2241) Phone Number: (o)5-2124; (c)498-0150

Location / Origin: NTS - Mercury, Building 23-153 - Bulk debris collected in 20 yd3 roll-off (Container ID 153R10).

Waste Category: (check one) ☐ Commercial ☒ Industrial

Waste Type: (check one) ☐ NTS ☐ Non-Putrescible ☐ Putrescible ☐ Asbestos Containing Material ☒ FFACO-onsite ☐ FFACO-offsite ☐ WAC Exception ☐ Historic DOE/NV

Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP

Pollution Prevention Category: (check one) ☐ Clean-Up ☒ Routine

Method of Characterization: (check one) ☒ Sampling & Analysis ☒ Process Knowledge ☐ Contents

Prohibited Waste at all three NTS landfills: Radioactive waste; RCRA waste; Hazardous waste; Free liquids, PCBs above TSCA regulatory levels, and Medical wastes (needles, sharps, bloody clothing).

Additional Prohibited Waste at the Area 9 U10C Landfill: Sewage Sludge, Animal carcasses, Wet garbage (food waste); and Friable asbestos

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES

Check all allowable wastes that are contained within this load:

NOTE: Waste disposal at the Area 6 Hydrocarbon Landfill must have come into contact with petroleum hydrocarbons or coolants, such as: gasoline (no benzene, lead); jet fuel; diesel fuel; lubricants and hydraulics; kerosene; asphaltic petroleum hydrocarbon; and ethylene glycol.

Acceptable waste at any NTS landfill: ☒ Paper ☐ Rocks / unaltered geologic materials ☒ Empty containers ☐ Asphalt ☒ Metal ☒ Wood ☐ Soil ☐ Rubber (excluding tires) ☐ Demolition debris ☒ Plastic ☐ Wire ☐ Cable ☐ Cloth ☐ Insulation (non-Asbestosform) ☐ Cement & concrete
☒ Manufactured items: (swamp coolers, furniture, rugs, carpet, electronic components, PPE, etc.)

Additional waste accepted at the Area 23 Mercury Landfill: ☐ Office Waste ☐ Food Waste ☐ Animal Carcasses ☐ Asbestos ☐ Friable ☐ Non-Friable (contact SWO if regulated load) Quantity: ______

Additional waste accepted at the Area 9 U10c Landfill:
☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water
☐ Light ballasts (contact SWO) ☐ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above Ground Tanks
☐ Hydrocarbons (contact SWO) ☐ Other ______

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐
☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☐ Crushed non-terne plated oil filters
☐ Plants ☐ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: ______ **(If initialed, no radiological clearance is necessary.)**

The above mentioned waste was generated outside of a Controlled Waste Managemei knowledge, does not contain radiological materials.

To the best of my knowledge, the waste described above contains only those materia site. I have verified this through the waste characterization method identified above a prohibited and allowable waste items. I have contacted Property Management and ha is approved for disposal in the landfill.

Radiological Survey Release for Waste Disposal
RCT initials
____ This container/load meets the criteria for no added man-made radioactive material
____ This container/load meets the criteria for Radcon Manual Table 4.2 release limits.
[initials] This container/load is exempt from survey due to process knowledge and origin.
SIGNATURE: /s/Chao-Hsiung Tung **DATE:** 4/24/10
DN-0846 (10/05)

12-8-2010

Print Name: Mark Heser

Signature: /s/ Mark Heser Date: 11/4/10

Note: "Food waste, office trash and animal carcasses do not require a radiological clearance. Freon-containing appliances must have signed removal certification statement with Load Verification."

SWO USE ONLY

Load Weight (net from scale or estimate): 4,080 12/8/10 Signature of Certifier: /s/ Don Bickford

The Certificate of Disposal for LLW will be provided in an addendum.

Attachment D-2

Use Restrictions

(24 Pages)

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 18-45-02, Little Feller I Surface Crater

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

Physical Description:

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

Easting	Northing
560,470.2	4,107,289.3
560,483.7	4,107,289.3
560,502.7	4,107,254.0
560,513.0	4,107,242.3
560,522.3	4,107,231.1
560,638.5	4,107,107.3
560,672.7	4,107,097.2
560,669.5	4,106,990.6
560,600.9	4,106,990.7
560,573.4	4,107,057.3
560,569.0	4,107,070.3
560,470.2	4,107,255.7

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 107 hours of exposure to the surface location with the maximum detected radioactivity outside of the high contamination area (HCA). Also, surface contamination is assumed to be present at higher levels within the HCA. This site was also contains lead bricks that present a chemical exposure hazard. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 18-45-02, Little Feller I Surface Crater			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	88.6	25	mrem/336 hours
Pb	Lead metal	800	mg/kg

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the FAL of 25 mrem in 336 hours (the Remote Work Area annual exposure scenario). It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed around the use-restricted area and where access roads are present.

UR Maintenance Requirements:

Description: **The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.**

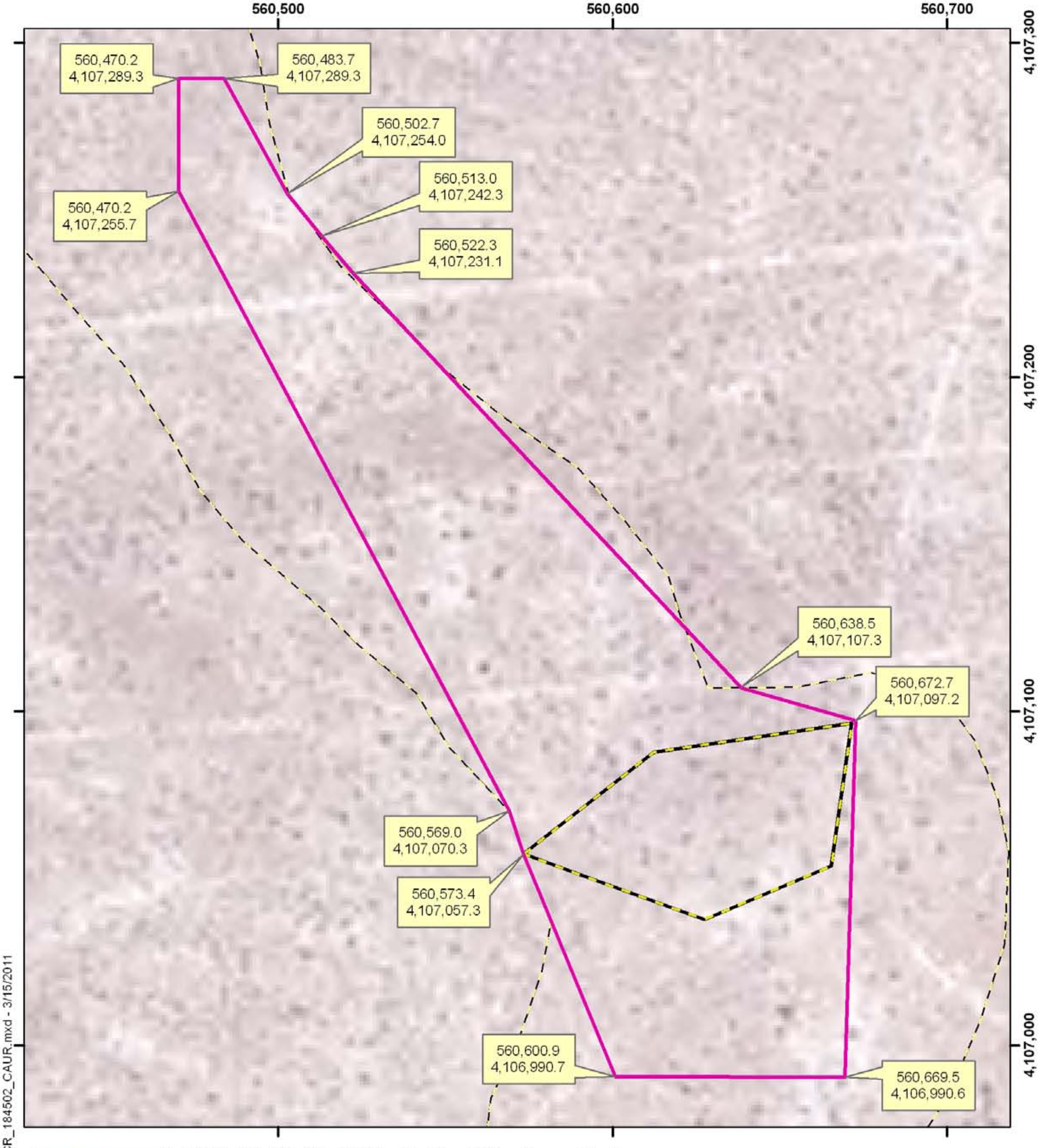
Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure postings are in place, intact, and legible.

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require entry into the HCA or that would require personnel to be present for other than short term activitites (less than approximately one week per year). This would ensure that any worker would not approach the 107 hours of exposure needed to receive a 25 mrem dose. Permissible activities include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



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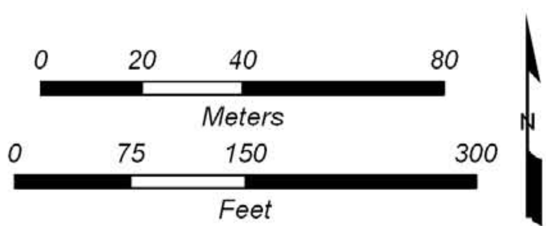
CAS 18-45-02, Little Feller I Surface Crater

Explanation

- FFACO Use Restriction Boundary
- Contamination Area Fence
- HCA Boundary



UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 18-45-02, Little Feller I Surface Crater

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

Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Administrative Use Restriction Coordinates:

Easting	Northing
560,267.8	4,107,669.7
560,324.1	4,107,685.6
560,506.7	4,107,294.9
560,628.5	4,107,171.3
560,716.6	4,107,016.7
560,687.6	4,106,958.6
560,643.5	4,106,956.7
560,592.0	4,106,991.4
560,485.2	4,107,147.8
560,434.6	4,107,243.4

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 972 hours of exposure to the surface location with the maximum detected radioactivity not included in the FFACO UR. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 18-45-02, Little Feller I Surface Crater			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	57.9	25	mrem/2250 hours

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

UR Maintenance Requirements:
Note: Effective upon acceptance of closure documents by NDEP.

NNSA/NSO CAU/CAS files.

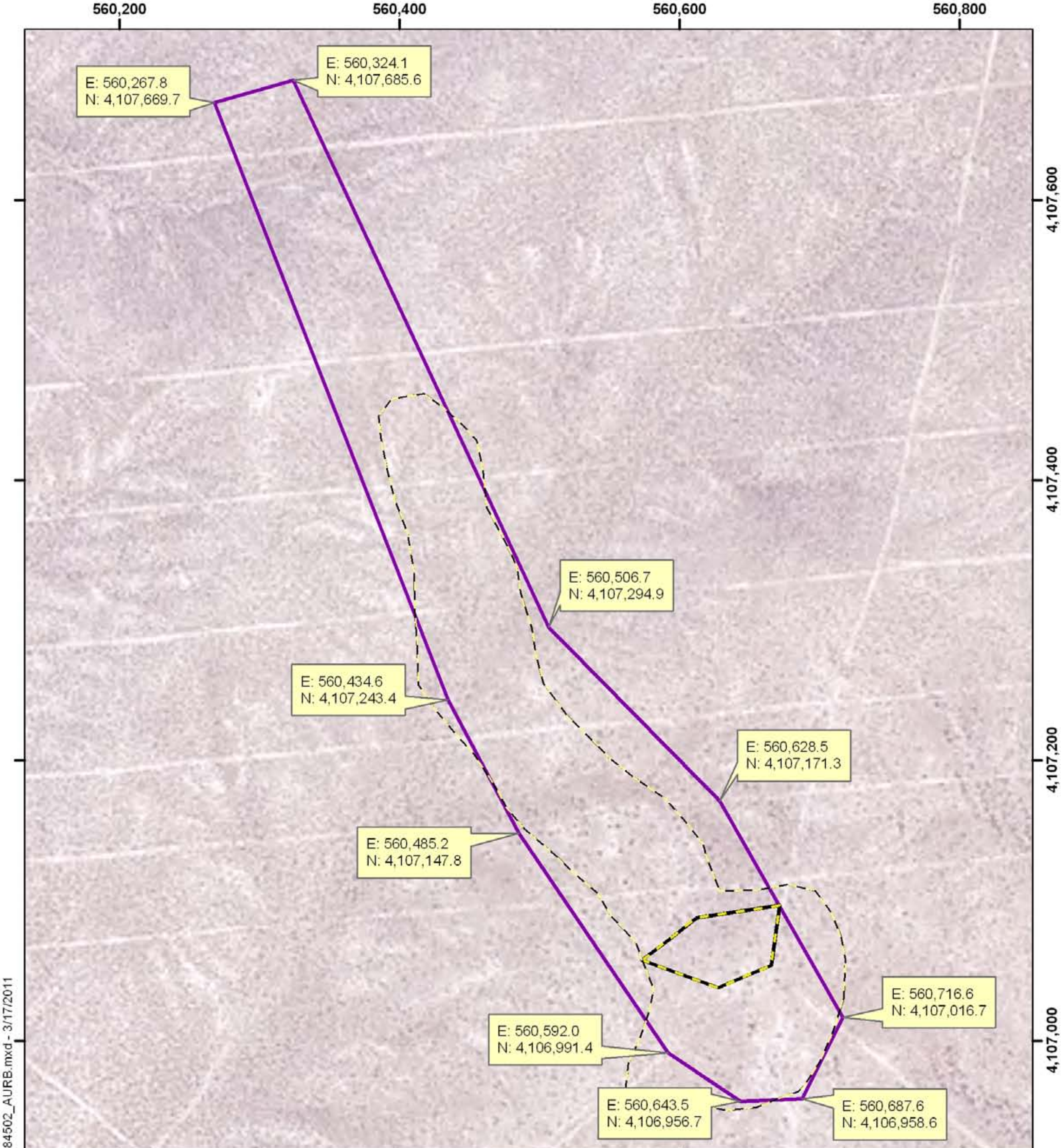
Inspection/Maintenance Frequency: N/A

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



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CAS 18-45-02, Little Feller I Surface Crater

Explanation

Administrative Use Restriction Boundary

HCA Boundary

Contamination Area Fence

0 50 100 200 Meters

0 150 300 600 Feet

N

UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 18-45-03, Little Feller II Surface Crater

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

Physical Description:

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

Easting	Northing
561,844.9	4,108,244.0
561,864.3	4,108,253.3
561,905.7	4,108,198.1
561,926.6	4,108,117.1
561,896.8	4,108,102.7

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 121 hours of exposure to the surface location with the maximum detected radioactivity. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 18-45-03, Little Feller II Surface Crater			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	69.2	25	mrem/336 hours

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the FAL of 25 mrem in 336 hours (the Remote Work Area annual exposure scenario). It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed around the use-restricted area and where access roads are present.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

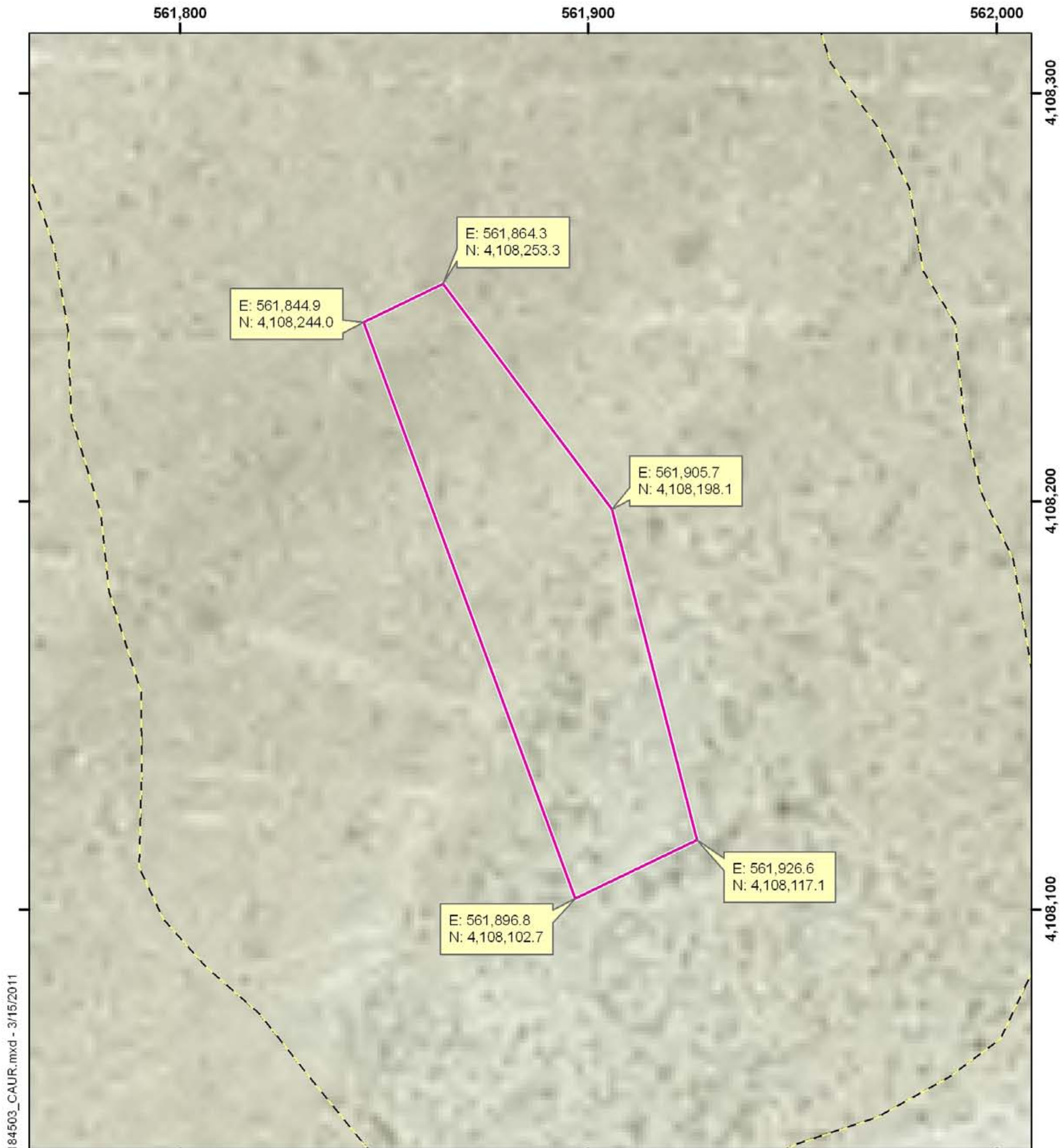
Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure postings are in place, intact, and legible.

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require personnel to be present for other than short term activitites (less than approximately one week per year). This would ensure that any worker would not approach the 121 hours of exposure needed to receive a 25 mrem dose. Permissible activities include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



CAS 18-45-03, Little Feller II Surface Crater

Explanation

FFACO Use Restriction Boundary

Contamination Area Fence

0 10 20 40
Meters

0 25 50 100
Feet

N

UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 18-45-03, Little Feller II Surface Crater

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

Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Administrative Use Restriction Coordinates:

Easting	Northing
561,968.6	4,108,055.4
561,879.1	4,108,028.2
561,706.4	4,108,552.3
561,727.6	4,108,557.4
561,871.5	4,108,428.4
561,993.2	4,108,122.8

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 919 hours of exposure to the surface location with the maximum detected radioactivity not included in the FFACO UR. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 18-45-03, Little Feller II Surface Crater			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	61.2	25	mrem/2250 hours

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

Inspection/Maintenance Frequency: N/A

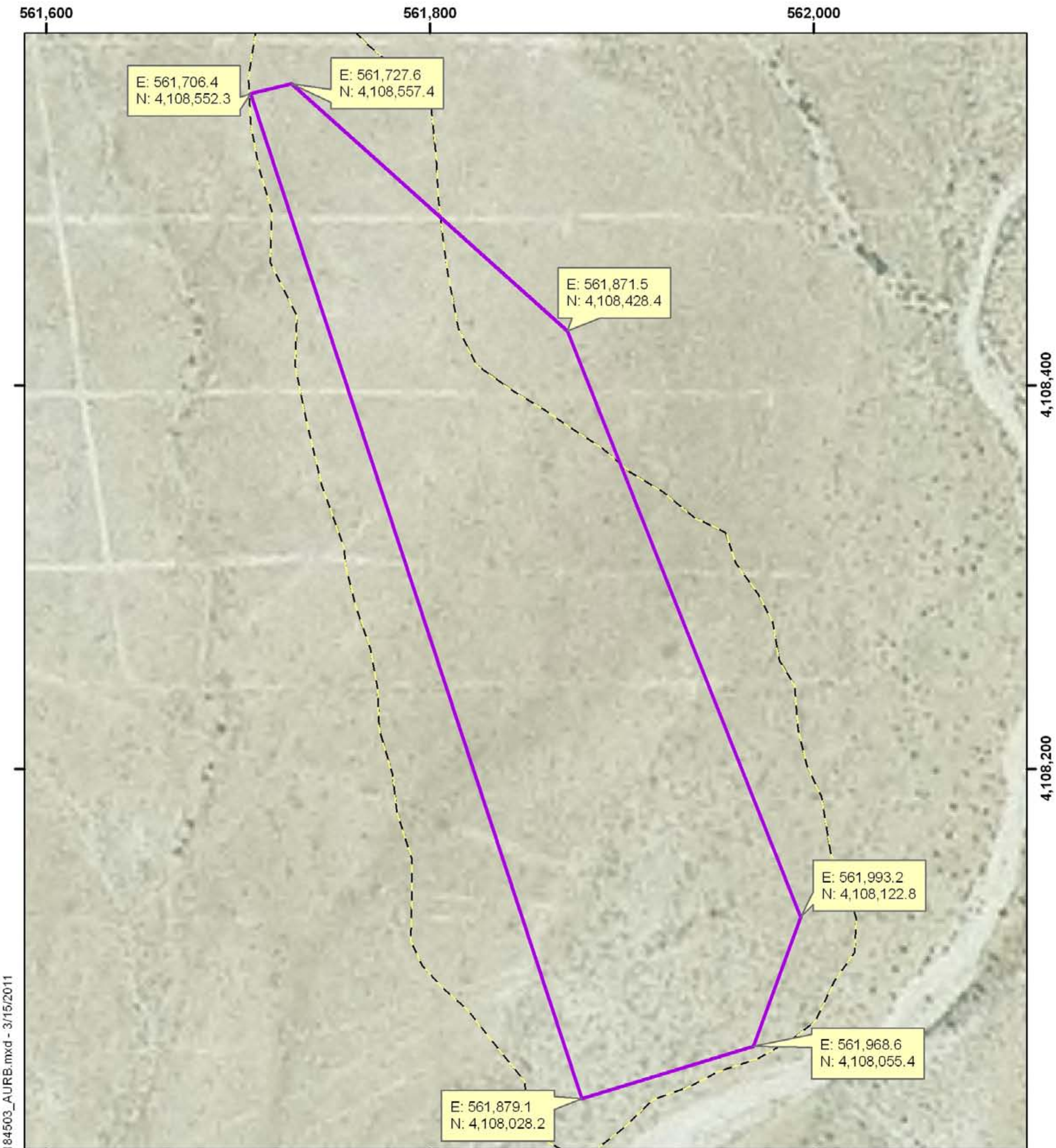
Note:

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



CAS 18-45-03, Little Feller II Surface Crater

Explanation

Administrative Use Restriction Boundary

Contamination Area Fence

0 25 50 100
Meters

0 100 200 400
Feet

N

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UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 20-23-01, U-20k Contamination Area

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

Physical Description:

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

Easting	Northing
542,195.5	4,125,817.9
542,115.2	4,125,909.4
542,097.2	4,126,203.2
542,243.1	4,126,447.0
542,301.1	4,126,444.0
542,338.6	4,126,089.2
542,334.4	4,125,905.4
542,283.3	4,125,817.9

Depth: No depth limitation within the crater, to 5 cm below native soil surface within the remaining area

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 60 hours of exposure to the surface location with the maximum detected radioactivity. Also, subsurface contamination is assumed to be present within the crater area from the direct injection of radionuclides into the soil from the nuclear test. This contamination, if exposed through excavation, could cause a site worker to receive a dose exceeding 25 mrem/yr. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 20-23-01, U-20k Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	143.5	25	mrem/336 hours

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the FAL of 25 mrem in 336 hours (the Remote Work Area annual exposure scenario). It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed around the use-restricted area and where access roads are present.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

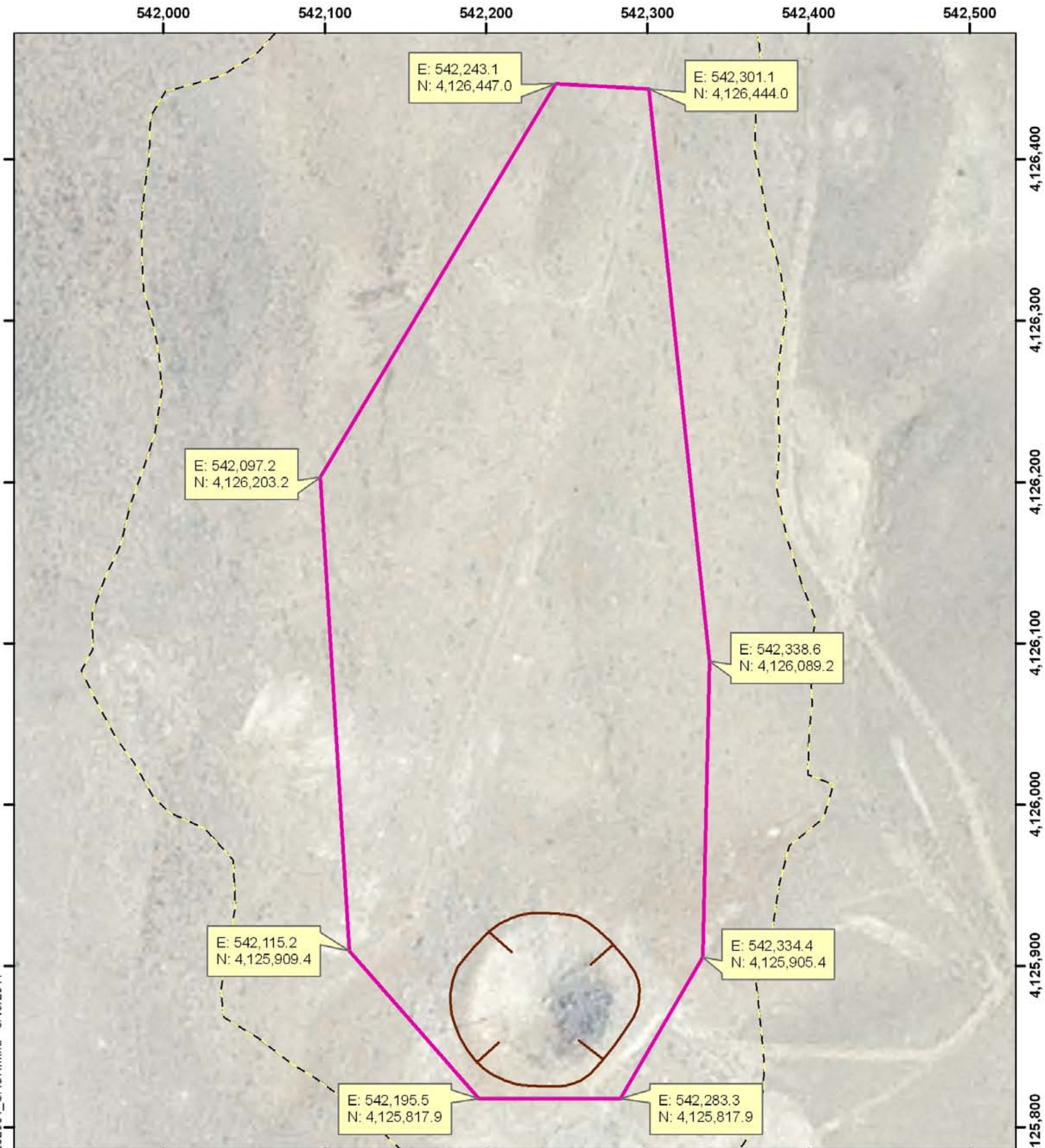
Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure postings are in place, intact, and legible.

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require entry into the crater or that would require personnel to be present for other than short term activitites (less than approximately 2 days per year). This would ensure that any worker would not approach the 60 hours of exposure needed to receive a 25 mrem dose. Permissible activities include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



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CAS 20-23-01, U-20k Contamination Area

Explanation

FFACO Use Restriction Boundary

Crater

Contamination Area Fence

0 25 50 100
Meters

0 100 200 400
Feet

N

UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 20-23-01, U-20k Contamination Area

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

Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Administrative Use Restriction Coordinates:

Easting	Northing
542,113.8	4,126,946.9
542,220.6	4,126,950.8
542,396.0	4,126,569.4
542,406.2	4,125,905.8
542,230.8	4,125,772.3
542,057.9	4,125,771.1
542,024.8	4,126,118.1

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 715 hours of exposure to the surface location with the maximum detected radioactivity not included in the FFACO UR. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 20-23-01, U-20k Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	78.6	25	mrem/2250 hours

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

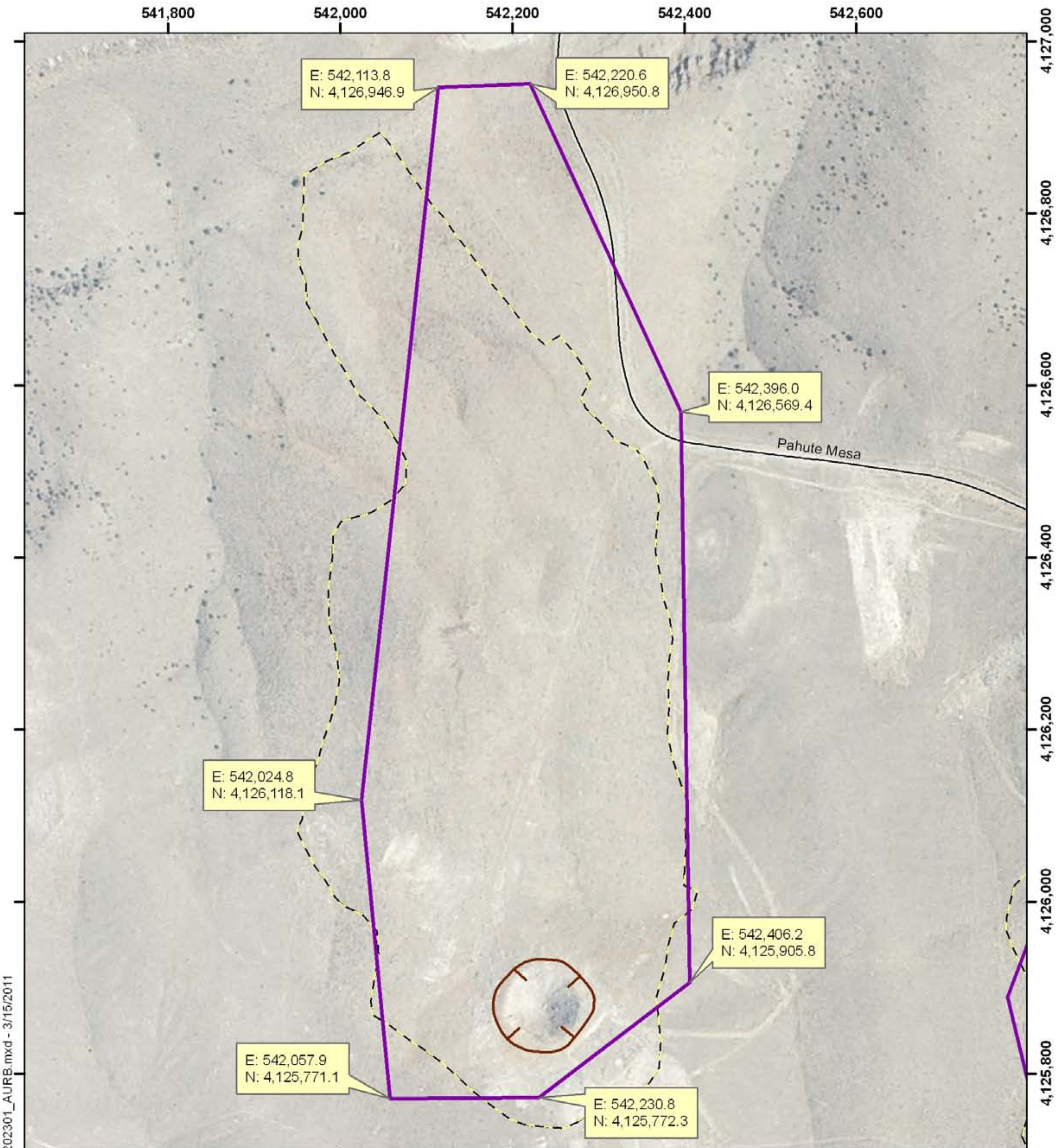
Inspection/Maintenance Frequency: N/A

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



CAS 20-23-01, U-20k Contamination Area

Explanation

Administrative Use Restriction Boundary

Crater

Contamination Area Fence

Unimproved Road

UNCONTROLLED When Printed

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Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 20-45-01, U-20L Crater (Cabriolet)

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

Physical Description:

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

Easting	Northing
543,103.3	4,125,721.3
542,929.1	4,125,852.6
542,971.2	4,126,029.1
543,081.9	4,126,029.6
543,198.0	4,125,840.9

Depth: No depth limitation within the crater, to 5 cm below native soil surface within the remaining area

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 259 hours of exposure to the surface location with the maximum detected radioactivity. Surface contamination is also assumed to be present within the high contamination area (HCA) which could cause a site worker to receive a 25 mrem dose in less than 259 hours of exposure to the surface soils. Subsurface contamination is assumed to be present within the crater area from the direct injection of radionuclides into the soil from the nuclear test. This contamination, if exposed through excavation, could cause a site worker to receive a dose exceeding 25 mrem/yr. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 20-45-01, U-20L Crater (Cabriolet)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	33.3	25	mrem/336 hours

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the FAL of 25 mrem in 336 hours (the Remote Work Area annual exposure scenario). It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed around the use-restricted area and where access roads are present.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

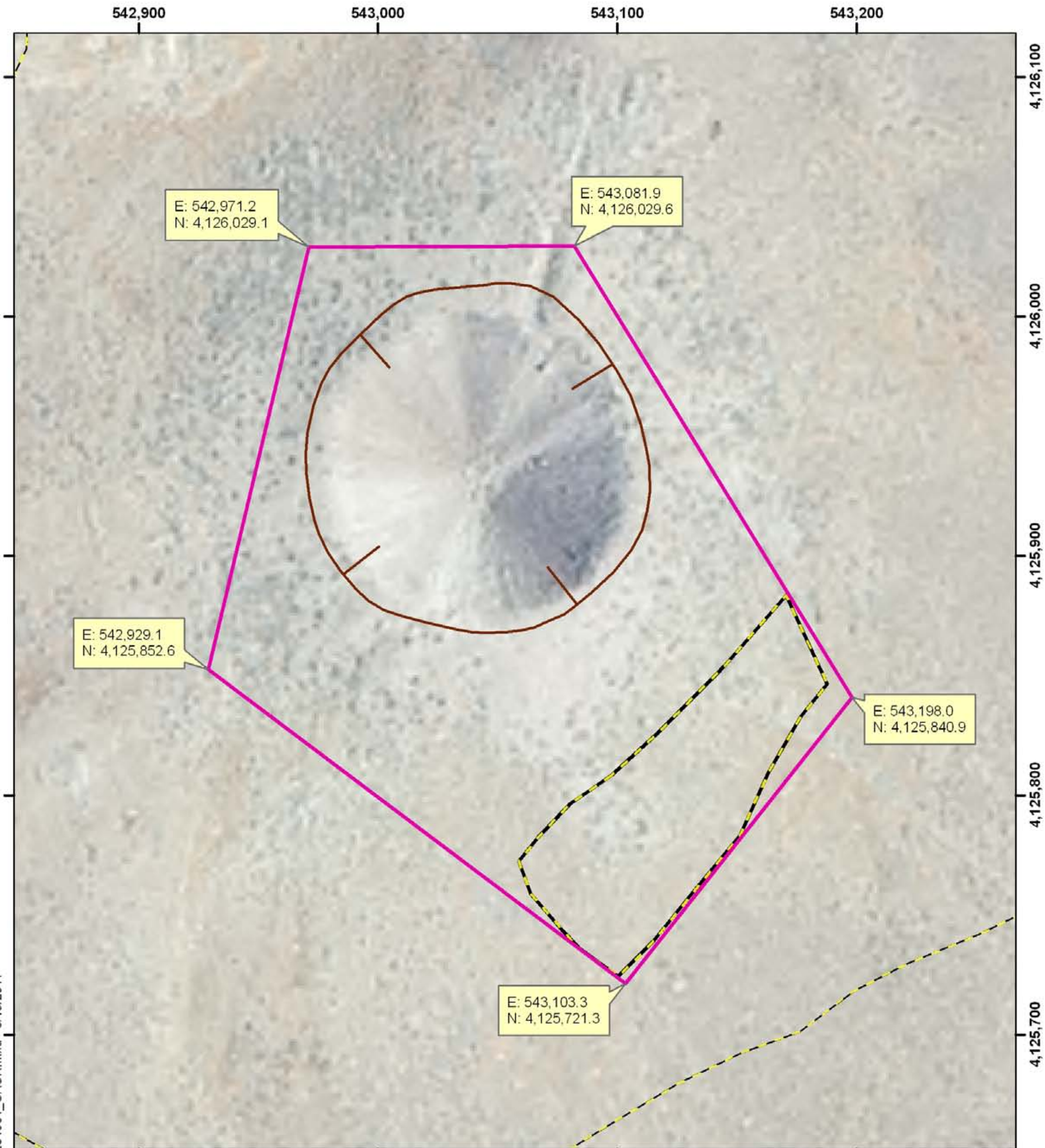
Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure postings are in place, intact, and legible.

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 CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require entry into the crater or that would require personnel to be present for other than short term activitites (less than approximately one week per year). This would ensure that any worker would not approach the 259 hours of exposure needed to receive a 25 mrem dose. Permissible activities include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



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CAS 20-45-01, U-20L Crater (Cabriolet)

Explanation

- FFACO Use Restriction Boundary
- Contamination Area Fence
- High Contamination Area Fence
- Crater
- Unimproved Road

UNCONTROLLED When Printed

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

CAU Use Restriction Information

CAU Number/Description: CAU 372, Area 20 Cabriolet/Palanquin Unit Craters

Applicable CAS Number/Description: CAS 20-45-01, U-20L Crater (Cabriolet)

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

Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Administrative Use Restriction Coordinates:

Easting	Northing
542,941.1	4,125,660.2
542,807.8	4,125,755.7
542,775.5	4,125,889.1
542,923.3	4,126,281.4
543,169.0	4,126,049.2
543,247.9	4,125,914.7
543,116.7	4,125,693.5

Depth: To 5 cm below native soil surface

Survey Method (GPS, etc): Heads-up digitizing

Basis for UR:

Summary Statement: This use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 437 hours of exposure to the surface location with the maximum detected radioactivity not included in the FFACO UR. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 372.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 372 CAS 20-45-01, U-20L Crater (Cabriolet)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	128.8	25	mrem/2250 hours

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

UR Maintenance Requirements:

Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

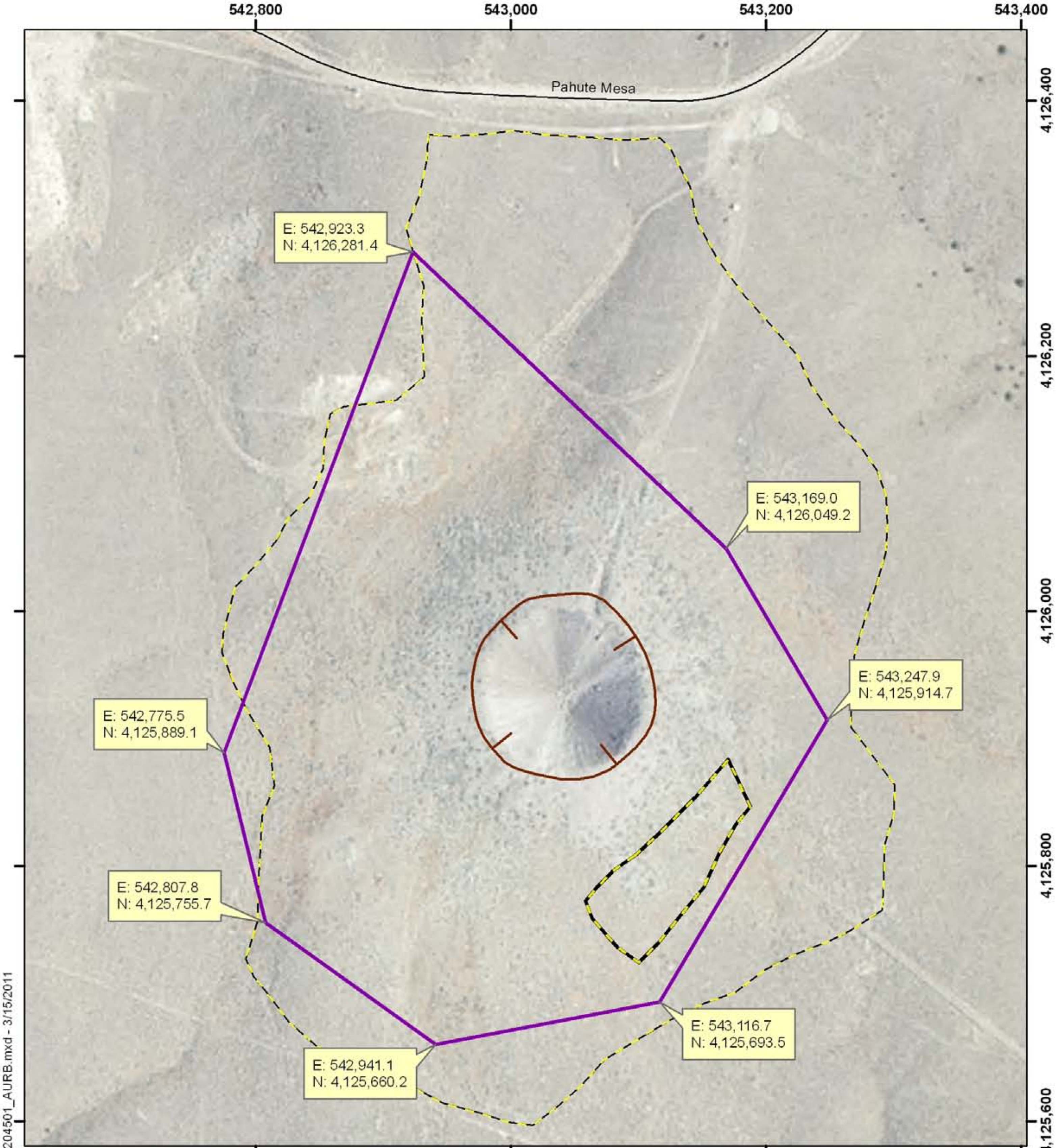
Inspection/Maintenance Frequency: N/A

Note: Effective upon acceptance of closure documents by NDEP.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/Kevin Cabble **Date:** 4-20-11

Note: Effective upon acceptance of closure documents by NDEP.



CAS 20-45-01, U-20L Crater (Cabriolet)

Explanation

- Administrative Use Restriction Boundary
- Crater
- Contamination Area Fence
- Unimproved Road
- High Contamination Area Fence

0 25 50 100
Meters

0 100 200 400
Feet

N

UNCONTROLLED When Printed

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Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 372, 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.

Corrective action alternatives for CAU 372 are based on the presumption that all areas within the current NNSS boundary will be controlled in perpetuity and restricted from release to the public. As such, only industrial activities are permitted, and risks to receptors under residential scenarios will not be considered. Should the control of the NNSS change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.1.1 Corrective Action Objectives

On May 1, 1996, EPA issued an Advance Notice of Proposed Rulemaking (ANPR) for corrective action for releases from solid waste management units at hazardous waste management facilities (EPA, 1996). The EPA states that the ANPR should be considered the primary corrective action implementation guidance (Laws and Herman, 1997). The ANPR states that a basic operating principle for remedy selection is that corrective action decisions should be based on risk. It emphasizes that current and reasonably expected future land use should be considered when selecting corrective action remedies and encourages use of innovative site characterization techniques to expedite site investigations.

The ANPR provides the following EPA expectations for corrective action remedies (EPA, 1996):

- Treatment should be used to address principle threats wherever practicable and cost effective.
- Engineering controls, such as containment, should be used where wastes and contaminated media can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.
- A combination of methods (e.g., treatment, engineering, and institutional controls) should be used, as appropriate, to protect human health and the environment.
- Institutional controls should be used primarily to supplement engineering controls as appropriate for short- or long-term management to prevent or limit exposure.

- Innovative technologies should be considered where such technologies offer potential for comparable or superior performance or implementability, less adverse impacts, or lower costs.

- Usable groundwater should be returned to maximum beneficial use wherever practicable.

- Contaminated soils should be remediated as necessary to prevent or limit direct exposure and to prevent the transfer of unacceptable concentrations of contaminants from soils to other media

Implementation of the corrective action will ensure that contaminants remaining at 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 *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. Corrective action alternatives 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 protective measures necessary to ensure the requirements are met. 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 to 282, "Hazardous Waste Management" [CFR, 2010a]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2010b]; and NAC 444.842 to 98, "Management of Hazardous Waste" [NAC, 2008]).

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
- Adverse 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, URs, public acceptance, rights of way, offsite 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 costs, 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 – Costs that 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 – 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 Little Feller I, Little Feller II, Palanquin, and Cabriolet. Contamination providing a dose exceeding the 25 mrem/RW-yr FAL was present in surface soils at all four CASs within CAU 372. Contamination is assumed to be present within the HCA at Little Feller I and Cabriolet, and in subsurface soils in the Palanquin and Cabriolet craters.

Based on the review of existing data, future use, and current operations at the NNSS, the following alternatives have been developed for consideration at CAU 372:

- Alternative 1 – No Further Action
- Alternative 2 – Clean Closure
- Alternative 3 – Closure 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 impacted soil and debris containing COCs, including PSM (e.g., lead bricks) and soil presenting a dose exceeding the 25-mrem/RW-yr FAL to a depth of 25 ft bgs within the crater areas and 1 ft bgs within the other surface soil contamination areas. A visual inspection would be conducted to ensure that contaminated surface debris have been removed before the completion of the corrective action. Verification soil samples would be collected and analyzed for the presence of COCs from PSM (lead soil samples). Verification soil samples would also be collected and analyzed for the presence of a dose exceeding the 25-mrem/RW-yr FAL after removal of contaminated soil.

Contaminated materials removed would 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 – Closure in Place

For radiological contamination, Alternative 3 includes the implementation of a UR where a radiological dose is present at levels that exceed the 25-mrem/RW-yr FAL. This UR would restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to a dose exceeding 25 mrem/yr. Under this alternative, debris within the 25-mrem/RW-yr FAL area would not be removed. Additionally, under this alternative, the UR would include the area where lead bricks may be present. Administrative controls would 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 was evaluated based on the general corrective action standards listed in Section E.1.2. This evaluation is presented in Table E.1-1. Any CAA that did not meet the general corrective action standards was removed from consideration.

Only CAAs 2 and 3 met the corrective action standard and were 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 one another.

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

CAS 18-45-02, Little Feller I Surface Crater, CAS 18-45-03, Little Feller II Surface Crater, CAS 20-23-01, U-20k Contamination Area, and CAS 20-45-01, U-20L Crater (Cabriolet)		
CAA 1, No Further Action		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	No	Would not protect a worker from receiving a dose exceeding the 25-mrem/RW-yr FAL.
Compliance with Media Cleanup Standards	No	Would not protect a worker from receiving a dose exceeding the 25-mrem/RW-yr FAL.
Control the Source(s) of the Release	Yes	The source of the release at each site was a one-time event. There are no ongoing releases.
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	The source of the release at each site was a one-time event. There are no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste can be managed in compliance with all standards.
CAA 3, Closure in Place with Administrative Controls		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	Although COCs will not be removed, site access will be controlled to prevent workers from receiving a dose exceeding the 25-mrem/RW-yr FAL.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site access will be controlled to prevent workers from receiving a dose exceeding the 25-mrem/RW-yr FAL.
Control the Source(s) of the Release	Yes	The source of the release at each site was a one-time event. There are no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

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.

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 long-term, this alternative involves increased, short-term exposure of site workers to radiological contamination during soil and debris removal. In contrast, closure in place does not require removal of soil, and there is no short-term exposure of site workers; signs are posted, 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 (to a depth of 25 ft bgs within the craters and 1 ft bgs within the other surface contamination areas) would be removed from the area, thereby eliminating both mobility and the onsite volume of contaminated media. In contrast, closure 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 after site closure, and into the future. Removal of contaminated media for clean closure provides long-term reliability and effectiveness, whereas closure 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 closure in place alternative, no construction is required other than the installation of postings. Some maintenance and administrative requirements would be onging. For the clean closure alternative, substantial

Table E.1-2
Evaluation of Remedy Selection Decision Factors for Little Feller I and II

CAS 18-45-02, Little Feller I Surface Crater; CAS 18-45-03, Little Feller II Surface Crater		
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 within the HCA.
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 the contaminated media will eliminate future exposure of site workers to COCs.
Feasibility	1	Involves the removal of large quantities soil (more than 6.5 acres combined) with more than 5 acres on steep slopes.
Cost	1	Cost to remove and dispose of contaminated soil is estimated to exceed $2 million (combined).
Score	7	
CAA 3, Closure 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 protection of human health by preventing inadvertent contact with COCs.
Feasibility	2	This alternative requires maintenance and long-term monitoring because no soil is removed.
Cost	2	The installation costs are estimated at $20,000. Ongoing maintenance costs for this alternative are estimated at $2,000 annually.
Score	8	

Table E.1-3
Evaluation of Remedy Selection Decision Factors for Palanquin and Cabriolet

CAS 20-23-01, U-20k Contamination Area (Palanquin); CAS 20-45-01, U-20L Crater (Cabriolet)		
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 the contaminated media will eliminate future exposure of site workers to COCs.
Feasibility	1	Involves the removal of large quantities soil (more than 30 acres combined). Removal of contamination within the craters is not feasible.
Cost	1	Cost to remove and dispose of contaminated soil is estimated to exceed $108 million.
Score	7	
CAA 3, Closure 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 protection of human health by preventing inadvertent contact with COCs.
Feasibility	2	This alternative requires maintenance and long-term monitoring.
Cost	2	The installation costs are estimated at $20,000. Ongoing maintenance costs for this alternative are estimated at $2,000 annually.
Score	8	

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 Tables E.1-2 and E.1-3, the total estimated cost for clean closure of CAU 372 would be approximately $110 million, while the costs for closure in place are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing, UR signs (estimated to be $40,000 for the first year and $4,000 for each year thereafter).

E.2.0 Recommended Alternative

Three CAAs were evaluated for Little Feller I, Little Feller II, Palanquin, and Cabriolet: no further action (CAA 1), clean closure (CAA 2), and closure 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, soils within the crater areas would be removed from the sites to a depth of 25 ft bgs and soil within the surface-contaminated areas would be removed from the sites to a depth of 1 ft bgs. For the closure in place alternative, potential worker exposure to radiological contamination would be controlled through the implementation of URs. 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 closure in place as the preferred CAA for the four CASs in CAU 372.

Based upon the five remedy selection decision factors, clean closure received an overall score of 7 (less desirable), whereas closure 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 NNSS administrative controls (e.g., NNSS access restrictions and control of site activities), the remoteness of the sites, no nearby structures or activities, no current or planned use of the sites, the present-day stability of the contaminated soil at the sites through the evolution of a mature plant community, and the development of soil surface durability (i.e., soil crust).

CASs Little Feller I, Little Feller II, and Cabriolet contain high levels of removable contamination (exceeding HCA criteria). Working in these areas of high removable contamination (e.g., removing soil under a corrective action of clean closure) is a high-risk activity involving extensive radiological controls to protect workers from inhaling or ingesting airborne radioactive particles. A corrective action of clean closure at these CASs would require extensive excavations (the corrective action areas at each CAS are presented in Table E.1-4) of up to 25 ft in depth. This corrective action would not remove deeper contamination in the area of the craters at the Palanquin and Cabriolet CASs, and a UR may still be required. Based on the extent of the corrective action boundaries, the infeasibility of removing deep contamination in the craters, and the presence of HCAs that would expose

Table E.1-4
Corrective Action Boundary Areas at CAU 372 CASs

CAS	Area (acres)
Little Feller I	5.5
Little Feller II	1.3
Palanquin	28.7
Cabriolet	11.8

remediation workers to high levels of removable contamination, the corrective action of closure in place with URs is recommended for the areas encompassed by the corrective action boundaries.

Selection of the CAA of closure in place for Little Feller I, Little Feller II, Palanquin, and Cabriolet 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 cleanup activities. However, if the control of the NNSS should change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.3.0 Cost Estimates

The cost estimate for clean closure is estimated to exceed $110 million to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavate, load, and dispose contaminated soil (approximately 6,707,000 cubic feet)
- Dispose of debris
- Remove and dispose of PSM appropriately
- Equipment decontamination

The estimated costs for clean closure of CAU 372 was based on removing contaminated soil within the 25-mrem/yr boundary. Specifically, soil within HCA at Little Feller I would be removed. The cost for clean closure of Little Feller I was estimated to be approximately $750,000. For Little Feller II, soil within the 3.26 multiples of background isopleth from the GWS (25-mrem/yr boundary) would be removed. The cost for clean closure of Little Feller II was estimated to be approximately $1.25 million. For Palanquin, soil within the crater, ejecta mounds surrounding the crater, and area containing a dose of 25 mrem/RW-yr would be removed. The cost for clean closure of Palanquin was estimated to be approximately $37 million. For Cabriolet, soil within the crater, ejecta mounds surrounding the crater, HCA, and area containing a dose of 25 mrem/RW-yr would be removed would be removed. The cost for clean closure of Cabriolet was estimated to be approximately $71 million. This includes excavation, loading and processing, transportation, disposal, site restoration, and site support.

The costs for closure in place, however, are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs, and are estimated to be approximately $40,000 for the first year and $4,000 for each year thereafter for all four CASs.

E.4.0 References

CFR, see *Code of Federal Regulations*.

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Code of Federal Regulations. 2010b. Title 40 CFR 761, “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Prohibitions.” Washington, DC: U.S. Government Printing Office.

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Appendix F

Sample Data

F.1.0 Sample Data for Little Feller I

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Little Feller I that were detected above MDCs are presented in Tables F.1-1 and F.1-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimations (mrem/IA-yr) for individual samples within each sample plot at Little Feller I are presented in Table F.1-3.

Results for TLDs staged at the sample plots at Little Feller I are presented in Table F.1-4. Results for TLDs staged field background locations at Little Feller I are presented in Table F.1-5.

Table F.1-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller I
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
AA1	372AA01	0 - 5	1.695	207.5	1.304	0.413	0.359 (J)	--
	372AA02	0 - 5	1.69	201.1	1.233	--	--	--
AA2	372AA03	0 - 5	1.749	215.5	1.306	--	--	--
AA3	372AA04	0 - 5	1.808	104.5	1.06	0.238	--	--
AA4	372AA05	0 - 5	1.752	161.9	1.338	--	--	--
AB1	372AB01	0 - 5	1.735	11.13	0.876	--	0.409 (J)	--
AB2	372AB02	0 - 5	1.534	6.527	0.807	--	--	2.5
AB3	372AB03	0 - 5	1.709	11.58	0.823	0.394	--	--
AB4	372AB04	0 - 5	1.607	10.06	1.143	--	--	1.887
AC1	372AC01	0 - 5	1.605	18.19	0.831	--	--	--
AC2	372AC02	0 - 5	1.542	5.945	0.914	--	--	--
AC3	372AC03	0 - 5	1.437	4.4	0.932	--	0.403 (J)	--
AC4	372AC04	0 - 5	1.594	3.463	0.861	--	0.412	--
AD1	372AD01	0 - 5	1.764	1.504	0.741	--	--	--
AD2	372AD02	0 - 5	1.742	1.447	0.736	--	0.401	1.574

Table F.1-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller I
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
AD3	372AD03	0 - 5	1.784	1.2	0.826	--	--	--
AD4	372AD04	0 - 5	1.723	1.625	0.72	--	0.383	1.423
AE1	372AE01	0 - 5	1.494	0.573	0.76	--	0.412	1.819
AE2	372AE02	0 - 5	1.796	0.306	0.757	--	--	1.421
AE3	372AE03	0 - 5	1.809	0.427	0.918	--	0.431	1.917
AE4	372AE04	0 - 5	1.752	0.291	0.728	--	0.337	1.401
AF1	372AF01	0 - 5	1.832	0.648	0.548	--	0.401	1.85
AF2	372AF02	0 - 5	1.764	2.427	0.558	--	--	1.53
AF3	372AF03	0 - 5	1.752	0.76	0.871	--	--	2.402
AF4	372AF04	0 - 5	1.691	1.635	0.657	0.322	0.325	1.264
AG1	372AG01	0 - 5	1.798	5.426	0.876	--	--	1.792
AG2	372AG02	0 - 5	1.75	1.956	0.62	--	--	--
AG3	372AG03	0 - 5	1.681	3.202	0.769	--	--	--
AG4	372AG04	0 - 5	1.508	7.649	0.538	--	--	--
	372AG05	0 - 5	1.151	1.717	0.469	0.173	--	--
AH1	372AH01	0 - 5	2	402.6	1.913	--	--	--
AH2	372AH02	0 - 5	1.934	596.8	2.422	--	--	--
AH3	372AH03	0 - 5	1.929	211.5	1.21	--	0.411	--
AH4	372AH04	0 - 5	1.913	438.3	2.194	--	--	--
AH4	372AH05	0 - 5	1.885	469.1	2.339	--	--	--
AJ1	372AJ01	0 - 5	1.784	429.1	2.149	--	--	--
AJ2	372AJ02	0 - 5	1.875	478.6	2.156	--	--	--
AJ3	372AJ03	0 - 5	1.764	243	1.393	--	0.495	--
AJ4	372AJ04	0 - 5	1.786	345.3	1.782	--	--	--
AK1	372AK01	0 - 5	2.016	462.1	2.162	--	--	--
AK2	372AK02	0 - 5	1.854	422.8	2.48	--	--	--
AK3	372AK03	0 - 5	1.679	403.6	1.832	--	--	--
AK4	372AK04	0 - 5	1.808	308.3	1.607	--	--	--

Table F.1-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller I
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
AL1	372AL01	0 - 5	1.798	165	1.173	--	--	--
AL2	372AL02	0 - 5	1.98	125.5	1.247	--	0.351 (J)	--
AL3	372AL03	0 - 5	2.48	137	1.13	--	--	3.7 (J)
AL4	372AL04	0 - 5	1.816	86.29 (J)	0.701	--	--	--
AM1	372AM01	0 - 5	1.715	1,244	4.833	1.131	--	--
AM2	372AM02	0 - 5	1.242	1,314	5.298	0.898	--	--
AM3	372AM03	0 - 5	1.661	1,981	7.193	1.193	--	--
AM4	372AM04	0 - 5	1.546	1,805	7.583	1.125	--	--
AN1	372AN01	0 - 5	1.681	3,147	9.811	--	--	--
AN2	372AN02	0 - 5	1.756	2,153	7.519	--	--	--
AN3	372AN03	0 - 5	1.512	1,545	5.58	--	--	--
AN4	372AN04	0 - 5	1.809	2,746	8.983	0.821	--	--
AP1	372AP01	0 - 5	2.16	241	1.37	--	--	2.07
	372AP02	0 - 5	2.21	114	0.82	--	--	1.73
AP2	372AP03	0 - 5	2.2	157	1.03	--	--	1.98
AP3	372AP04	0 - 5	2.13	138	1.04	--	--	2.88
AP4	372AP05	0 - 5	2.21	139	1.02	--	--	1.9
AQ1	372AQ01	0 - 5	2.33	3,440	10.5	0.47	--	--
AQ2	372AQ02	0 - 5	2.2	2,620	7.05	0.439	--	--
AQ3	372AQ03	0 - 5	2.28	3,760	10.2	0.53	--	--
AQ4	372AQ04	0 - 5	2.35	6,430	16.4	0.95	--	--
AR1	372AR01	0 - 5	2.26	1,900	4.01	0.51	--	--
AR2	372AR02	0 - 5	2.13	1,920	4.33	0.393	--	--
AR3	372AR03	0 - 5	2.07	920	1.99	0.364	--	2.45
AR4	372AR04	0 - 5	2.11	2,210	5.3	0.56	--	--

Ac = Actinium
Th = Thorium

J = Estimated value
-- = Not detected above MDCs.

Table F.1-2
Isotopic Sample Results Detected above MDCs at Little Feller I
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
AA1	372AA01	0 - 5	17.1	1.256	82.76	0.944	1.058	--	0.815
AA1	372AA02	0 - 5	0.029	3.06	165.6	--	0.898(J)	--	0.762(J)
AA2	372AA03	0 - 5	20.53	1.229 (J)	84.51 (J)	--	0.725 (J)	--	0.663 (J)
AA3	372AA04	0 - 5	21.1	1.671	99.59	--	0.989 (J)	--	0.832 (J)
AA4	372AA05	0 - 5	50.71	4.492	279.8	--	1.359	--	0.922
AB1	372AB01	0 - 5	3.588	0.593	21.64	--	0.829	--	1.147
AB2	372AB02	0 - 5	3.813	0.307 (J)	21.75 (J)	--	0.984 (J)	--	0.532 (J)
AB3	372AB03	0 - 5	5.367	0.389	27	--	0.741 (J)	--	0.645 (J)
AB4	372AB04	0 - 5	5.203	0.621	27.28	--	0.912	--	0.671
AC1	372AC01	0 - 5	1.813	0.445	11.1	--	0.794 (J)	--	0.799 (J)
AC2	372AC02	0 - 5	--	0.44	12.17	--	1.071 (J)	--	0.849 (J)
AC3	372AC03	0 - 5	9.797	1.24 (J)	50.53 (J)	--	0.976 (J)	--	0.665 (J)
AC4	372AC04	0 - 5	0.933	--	6.049	--	0.891 (J)	--	0.688 (J)
AD1	372AD01	0 - 5	0.626	--	3.829	--	0.824 (J)	--	0.628 (J)
AD2	372AD02	0 - 5	0.433	--	3.716	--	0.626 (J)	--	0.613
AD3	372AD03	0 - 5	0.549	--	2.515	--	0.797 (J)	--	0.695
AD4	372AD04	0 - 5	2.529	0.486	17.03	--	0.783 (J)	--	0.623 (J)
AE1	372AE01	0 - 5	--	0.343	1.189	--	0.843 (J)	--	0.923 (J)
AE2	372AE02	0 - 5	--	--	0.616	--	0.839 (J)	--	0.755
AE3	372AE03	0 - 5	--	--	1.328	--	0.625 (J)	--	0.667
AE4	372AE04	0 - 5	--	--	0.591	--	0.636 (J)	--	0.71
AF1	372AF01	0 - 5	--	0.394	1.905	--	0.787 (J)	--	0.864 (J)
AF2	372AF02	0 - 5	0.273	--	1.437	--	0.76 (J)	--	0.798 (J)
AF3	372AF03	0 - 5	0.407	--	2.174	--	0.807 (J)	--	0.746 (J)
AF4	372AF04	0 - 5	0.24	--	1.419	--	0.787 (J)	--	0.824
AG1	372AG01	0 - 5	0.508	--	2.71	--	0.887 (J)	--	0.85 (J)
AG2	372AG02	0 - 5	2.113	0.294	10.08	--	1.018 (J)	--	0.9 (J)
AG3	372AG03	0 - 5	1.026	0.275	4.915	--	0.936 (J)	0.185 (J)	0.618 (J)

Table F.1-2
Isotopic Sample Results Detected above MDCs at Little Feller I
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
AG4	372AG04	0 - 5	7.339 (J)	0.57	34.84	--	1.108	--	0.919 (J)
	372AG05	0 - 5	1.391	0.401	10.42	--	0.775(J)	--	0.655(J)
AH1	372AH01	0 - 5	790	69.87	5,139	1.271 (J)	4.147 (J)	0.292 (J)	0.545 (J)
AH2	372AH02	0 - 5	112.5	6.453 (J)	396.3 (J)	--	1.575 (J)	--	1.088 (J)
AH3	372AH03	0 - 5	5.291	0.508	23.1	--	1.034	--	0.874
AH4	372AH04	0 - 5	492.1	37.1	2,562	--	1.593 (J)	--	0.754 (J)
	372AH05	0 - 5	293.5 (J)	40.54	2,391	--	--	--	--
AJ1	372AJ01	0 - 5	64.43	7.371	452	--	1.221 (J)	--	0.738 (J)
AJ2	372AJ02	0 - 5	249.9 (J)	19.21 (J)	1,314 (J)	--	1.585 (J)	--	1.068 (J)
AJ3	372AJ03	0 - 5	5.527 (J)	0.85	31.96	--	0.964 (J)	--	0.875 (J)
AJ4	372AJ04	0 - 5	213.5	15.44	1,029	--	1.354	--	--
AK1	372AK01	0 - 5	116.4 (J)	7.488 (J)	593.2 (J)	--	--	--	--
AK2	372AK02	0 - 5	1,447 (J)	123.8	8,055	1.037 (J)	7.288	--	--
AK3	372AK03	0 - 5	270.8 (J)	12.5 (J)	983.7 (J)	--	2.394	--	0.609
AK4	372AK04	0 - 5	109.8	6.634	446.6	1.035 (J)	--	--	--
AL1	372AL01	0 - 5	144	12.91	739.7	--	--	--	--
AL2	372AL02	0 - 5	8.08	0.82	34.5	--	0.54 (J)	--	0.616 (J)
AL3	372AL03	0 - 5	406	27.4	1,840	--	3	--	--
AL4	372AL04	0 - 5	2.907	0.328	15.13	--	0.658 (J)	--	0.67 (J)
AM1	372AM01	0 - 5	546.5	23.62 (J)	1,506 (J)	--	5.673 (J)	--	--
AM2	372AM02	0 - 5	972.2	60.46	4,096	--	6.828 (J)	--	0.853 (J)
AM3	372AM03	0 - 5	502.3	30.18	1,982	--	--	--	--
AM4	372AM04	0 - 5	813.7	57.13	4,009	--	5.78 (J)	0.307 (J)	0.751 (J)
AN1	372AN01	0 - 5	1,029	87.65	6,498	--	--	--	--
AN2	372AN02	0 - 5	80.28	5.782	370.3	--	1.548 (J)	--	0.772 (J)
AN3	372AN03	0 - 5	2,252	167.8	11,300	--	--	--	--
AN4	372AN04	0 - 5	92.96 (J)	8.753	566.2	--	1.143 (J)	0.191 (J)	0.885 (J)

Table F.1-2
Isotopic Sample Results Detected above MDCs at Little Feller I
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
AP1	372AP01	0 - 5	222 (J)	22.8 (J)	1,670 (J)	--	--	--	--
	372AP02	0 - 5	890 (J)	42.3 (J)	3,030 (J)	--	4	--	--
AP2	372AP03	0 - 5	202 (J)	16.1 (J)	970 (J)	--	2.3	--	--
AP3	372AP04	0 - 5	157 (J)	12.7 (J)	840 (J)	--	1.59	--	--
AP4	372AP05	0 - 5	54.6 (J)	4.2 (J)	284 (J)	--	2.34	--	1.54
AQ1	372AQ01	0 - 5	103 (J)	7.5 (J)	506 (J)	--	1.65	--	--
AQ2	372AQ02	0 - 5	241 (J)	21.1 (J)	1,350 (J)	--	3.4	--	--
AQ3	372AQ03	0 - 5	3,300 (J)	285 (J)	17,200 (J)	--	--	--	--
AQ4	372AQ04	0 - 5	1,170 (J)	96 (J)	6,140 (J)	--	--	--	--
AR1	372AR01	0 - 5	226 (J)	23.5 (J)	1,200 (J)	--	--	--	--
AR2	372AR02	0 - 5	466 (J)	37.2 (J)	2,530 (J)	--	--	--	--
AR3	372AR03	0 - 5	303 (J)	22.8 (J)	1,660 (J)	--	--	--	--
AR4	372AR04	0 - 5	1,590 (J)	109 (J)	7,600 (J)	--	--	--	--

J = Estimated value
-- = Not detected above MDCs.

Table F.1-3
Internal Dose Estimations at Little Feller I Sample Plots (mrem/IA-yr)

Plot	Sample					Average for Sample Plot	95% UCL for Sample Plot
	1	2	3	4	5		
Plot AA	14.01	13.58	14.55	7.07	10.94	12.0	15.0
Plot AB	0.77	0.46	0.80	0.70	--	0.7	0.9
Plot AC	1.25	0.42	0.31	0.25	--	0.6	1.1
Plot AD	0.12	0.12	0.10	0.13	--	0.1	0.1
Plot AE	0.058	0.043	0.052	0.042	--	0.05	0.1
Plot AF	0.067	0.19	0.075	0.13	--	0.1	0.2
Plot AG	0.39	0.15	0.24	0.53	0.13	0.3	0.5
Plot AH	27.17	40.26	14.28	29.57	31.64	**28.6**	**37.5**
Plot AJ	28.95	32.29	16.41	23.30	--	**25.2**	**33.4**
Plot AK	31.17	28.53	27.23	20.80	--	**26.9**	**32.1**
Plot AL	11.14	8.48	9.27	5.84	--	8.7	11.3
Plot AM	83.88	88.60	133.55	121.70	--	**106.9**	**135.7**
Plot AN	212.15	145.15	104.17	185.13	--	**161.6**	**217.2**
Plot AP	16.27	7.72	10.61	9.33	9.40	10.7	13.8
Plot AQ	231.91	176.64	253.48	433.46	--	**273.9**	**404.7**
Plot AR	128.10	129.45	62.04	148.99	--	**117.1**	**161.8**

-- = Duplicate not taken for this plot.

Bold indicates the values exceeding 25 mrem/yr.

Table F.1-4
TLD Results for Little Feller I Plots (mrem/IA-yr)

Plot	Location ID	Element											
		2	3	4	2	3	4	2	3	4	2	3	4
		TLD 1			TLD 2			TLD 3			TLD 4		
AA	AT01	48.7	45.5	43.2	--	--	--	--	--	--	--	--	--
AB	AT02	37.9	38.2	40.1	--	--	--	--	--	--	--	--	--
AC	AT03	38.5	36.2	35.1	--	--	--	--	--	--	--	--	--
AD	AT04	38.7	36.8	34.5	--	--	--	--	--	--	--	--	--
AE	AT07	35.8	35.3	33.2	--	--	--	--	--	--	--	--	--
AF	AT06	36.9	36.7	35.1	--	--	--	--	--	--	--	--	--
AG	AT05	41.9	38.9	39.7	--	--	--	--	--	--	--	--	--
AH	AT08	52.4	48.1	44.2	--	--	--	--	--	--	--	--	--
AJ	AT09	55.4	46.4	44.7	--	--	--	--	--	--	--	--	--
AK	AT10	50.5	42.7	37.3	46.7	44.8	39.3	--	--	--	--	--	--
AL	AT11	44.1	39.8	38.4	--	--	--	--	--	--	--	--	--
AM	AT12	123.9	97	101.6	146	114.1	112.9	139.4	97.7	107.9	126.9	95.1	95.3
AN	AT13	116.2	90.9	87.8	125.3	106.4	105.1	120.9	92.3	101.4	119	100.1	96.1
AP	AT19	43.1	37.7	39	39.9	37.5	37	44.8	38.5	38.5	39	37.9	35.6
AQ	AT17	173.8	131.5	131.5	175.1	131.5	123.4	185.6	130.2	136.8	159.2	111.4	111.2
AR	AT18	75.8	70.8	68.8	72.3	66.4	70.5	78	64.8	69	78	65.5	64.4

-- = No result

Table F.1-5
Background TLD Results for Little Feller I (mrem/IA-yr)

Location ID	Element		
	2	3	4
	TLD 1		
AT14	35.3	33.9	32.1
AT15	37.2	34.1	33.1
AT16	35.4	35.2	32.7
BT13	36.2	35.7	33.9
BT14	39	35.4	35.9
BT15	35.4	35	32.2

F.2.0 Sample Data for Little Feller II

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Little Feller II that were detected above MDCs are presented in Tables F.2-1 and F.2-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimations (mrem/IA-yr) for individual samples within each sample plot and sediment sample location at Little Feller II are presented in Table F.2-3.

Results for TLDs staged at the sample plots at Little Feller II are presented in Table F.2-4. Results for TLDs staged at field background locations at Little Feller II are presented in Table F.2-5.

Table F.2-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller II
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
BA1	372BA01	0 - 5	1.873	82.98 (J)	1.413	--	0.359 (J)	--
BA2	372BA02	0 - 5	2.012	112.9 (J)	1.739	--	--	--
BA3	372BA03	0 - 5	1.903	92.73 (J)	1.369	--	0.506 (J)	--
BA4	372BA04	0 - 5	1.844	111.5 (J)	1.721	--	0.402 (J)	--
BB1	372BB01	0 - 5	2.108	222.5 (J)	1.707	0.34 (J)	0.35	--
BB2	372BB02	0 - 5	1.919	248.4 (J)	1.818	--	--	--
BB3	372BB03	0 - 5	2.04	172.6 (J)	1.508	--	0.401 (J)	--
BB4	372BB04	0 - 5	1.957	293.3 (J)	2.254	--	0.338 (J)	--
BC1	372BC01	0 - 5	2.011	209 (J)	1.834	--	--	--
BC2	372BC02	0 - 5	2.173	232.8 (J)	2.419	--	--	--
BC3	372BC03	0 - 5	1.99	194.9 (J)	2.162	--	0.425 (J)	--
	372BC04	0 - 5	2.043	202.6 (J)	2.119	--	--	--
BC4	372BC05	0 - 5	1.935	195.8 (J)	1.756	--	0.547 (J)	--
BD1	372BD01	0 - 5	2.085	1,032 (J)	5.218	--	--	--
BD2	372BD02	0 - 5	1.965	1,188 (J)	5.331	0.458 (J)	--	--

Table F.2-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller II
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
BD3	372BD03	0 - 5	1.758	1,414 (J)	6.593	0.531	--	--
BD4	372BD04	0 - 5	2.06	1,056 (J)	4.857	0.437 (J)	--	--
BE1	372BE01	0 - 5	2.112	2,604 (J)	10.69	0.863 (J)	--	--
BE2	372BE02	0 - 5	2.475	5,989 (J)	22.71	1.498 (J)	--	--
BE3	372BE03	0 - 5	2.048	3,315 (J)	13.98	1.399 (J)	--	--
BE4	372BE04	0 - 5	2.505	3,468 (J)	13.8	1.294 (J)	--	--
BF1	372BF01	0 - 5	2	88.42 (J)	1.286	--	--	--
BF2	372BF02	0 - 5	1.911	113.8 (J)	1.552	--	0.463 (J)	--
BF3	372BF03	0 - 5	1.883	99.29 (J)	1.393	--	0.373 (J)	--
BF4	372BF04	0 - 5	1.877	237.4 (J)	2.117	--	0.336 (J)	--
BG1	372BG01	0 - 5	1.867	170.5 (J)	1.879	--	0.276	--
BG2	372BG02	0 - 5	1.923	261.3 (J)	2.238	--	--	--
BG3	372BG03	0 - 5	1.952	427.6 (J)	3.386	--	--	--
BG4	372BG04	0 - 5	2.188	441.6 (J)	3.093	--	--	--
BH1	372BH01	0 - 5	1.905	391.5 (J)	2.294	--	--	--
BH2	372BH02	0 - 5	1.889	513.1 (J)	2.911	0.391	--	--
BH3	372BH03	0 - 5	1.875	539 (J)	3.212	--	--	--
BH4	372BH04	0 - 5	1.874	455.3 (J)	2.931	--	--	--
BJ1	372BJ01	0 - 5	2.052	60.38 (J)	1.12	--	0.444 (J)	--
BJ2	372BJ02	0 - 5	2.14	17.1 (J)	1.062	--	--	--
BJ3	372BJ03	0 - 5	2.218	15.52 (J)	0.934	0.334	--	--
BJ3	372BJ04	0 - 5	2.298	73.5 (J)	1.05	--	--	--
BJ4	372BJ05	0 - 5	2.015	10.53 (J)	0.942	--	--	--
BK1	372BK01	0 - 5	2.66	146	1.78	--	--	--
	372BK02	0 - 5	2.02	123.7 (J)	1.485	--	--	--
BK2	372BK03	0 - 5	1.953	135.4 (J)	1.604	--	--	14.26 (J)
BK3	372BK04	0 - 5	1.973	95.46 (J)	1.514	--	--	--

Table F.2-1
Gamma Spectroscopy Sample Results Detected above MDCs at Little Feller II
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Cs-137	Eu-152	Eu-155	Th-234
BK4	372BK05	0 - 5	1.946	90.95 (J)	1.098	--	--	--
BL1	372BL01	0 - 5	2.097	247.9 (J)	1.478	--	0.522 (J)	--
BL2	372BL02	0 - 5	2.4 (J)	224 (J)	1.82 (J)	--	--	--
BL3	372BL03	0 - 5	1.977	398.5 (J)	2.116	--	--	--
BL4	372BL04	0 - 5	1.998	230.4 (J)	1.561	--	--	--
BM1	372BM01	0 - 5	2.57	471	2.88	--	--	1.82
BM2	372BM02	0 - 5	2.55	667 (J)	3.95	--	--	2.85 (J)
BM3	372BM03	0 - 5	2.59	703 (J)	3.53	--	--	2.86 (J)
BM4	372BM04	0 - 5	2.46	714 (J)	3.85	--	--	1.92 (J)
BX01	372BX02	5 - 10	2.1	0.06	--	--	--	--
BX02	372BX01	5 - 10	2.9	1.34	--	--	--	--

J = Estimated value
-- = Not detected above MDCs.

Table F.2-2
Isotopic Sample Results Detected above MDCs at Little Feller II
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
BA1	372BA01	0 - 5	36.95	--	9.253	--	1.568	--	1.379
BA2	372BA02	0 - 5	61.43	--	64.65	0.864	3.979 (J)	--	3.177 (J)
BA3	372BA03	0 - 5	19.75 (J)	--	12.15	--	1.223	--	1.012
BA4	372BA04	0 - 5	136.8	--	--	--	1.447	--	1.223
BB1	372BB01	0 - 5	221 (J)	--	17.96	--	1.191 (J)	0.219	1.048
BB2	372BB02	0 - 5	186 (J)	--	21.5	--	0.439 (J)	--	0.275
BB3	372BB03	0 - 5	2,556 (J)	--	918.7	--	0.983 (J)	--	0.616 (J)
BB4	372BB04	0 - 5	60.39	0.808 (J)	24.25 (J)	1.048	1.129 (J)	--	0.676 (J)

Table F.2-2
Isotopic Sample Results Detected above MDCs at Little Feller II
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
BC1	372BC01	0 - 5	217.6	--	15.21	--	0.78 (J)	--	0.877
BC2	372BC02	0 - 5	8.076 (J)	--	20.53	--	1.706 (J)	--	0.933
BC3	372BC03	0 - 5	509.1 (J)	1.169	39.74	--	1.117 (J)	--	0.979
	372BC04	0 - 5	62.5 (J)	0.489	20.93	--	1.121 (J)	--	0.967
BC4	372BC05	0 - 5	186.5	0.561	22.32	--	1.169 (J)	--	0.959
BD1	372BD01	0 - 5	3,118 (J)	1.872	112	--	--	--	--
BD2	372BD02	0 - 5	108.9 (J)	--	104.4	--	2.267 (J)	--	0.919
BD3	372BD03	0 - 5	174.3	--	26.14	--	--	--	--
BD4	372BD04	0 - 5	17.69	1.798 (J)	109.7 (J)	1.57	20.85 (J)	1.044	1.079
BE1	372BE01	0 - 5	677.6 (J)	--	225.8	--	3.903 (J)	--	--
BE2	372BE02	0 - 5	633.3 (J)	--	212.4	--	--	--	--
BE3	372BE03	0 - 5	299.5 (J)	--	483	--	--	--	--
BE4	372BE04	0 - 5	1,618 (J)	--	276	--	--	--	--
BF1	372BF01	0 - 5	2.329	--	9.451	0.908	2.589	--	2.867
BF2	372BF02	0 - 5	45.57	--	20.64	--	1.298	--	1.185
BF3	372BF03	0 - 5	5.936	--	21	--	1.06	0.089	1.247
BF4	372BF04	0 - 5	6.536 (J)	--	13.01	--	1.206	--	1.018
BG1	372BG01	0 - 5	88.7 (J)	--	9.643	--	1.965	--	1.2 (J)
BG2	372BG02	0 - 5	13.73 (J)	--	15.08	--	--	--	--
BG3	372BG03	0 - 5	120 (J)	0.67 (J)	35.89 (J)	--	4.003	--	1.524 (J)
BG4	372BG04	0 - 5	350 (J)	--	49.18	--	--	--	--
BH1	372BH01	0 - 5	206.8 (J)	--	196.8	--	4.738	0.299	1.778 (J)
BH2	372BH02	0 - 5	155.1 (J)	--	19.82	--	7.533 (J)	1.111 (J)	2.299 (J)
BH3	372BH03	0 - 5	3,907 (J)	--	34.68	--	2.06 (J)	--	1.189 (J)
BH4	372BH04	0 - 5	1.744 (J)	--	29.6	--	--	--	--
BJ1	372BJ01	0 - 5	0.852	0.995	6.033	--	1.03 (J)	--	1.118
BJ2	372BJ02	0 - 5	1.111	--	4.953	--	1.052 (J)	--	0.862

Table F.2-2
Isotopic Sample Results Detected above MDCs at Little Feller II
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
BJ3	372BJ03	0 - 5	5.27 (J)	0.28	7.235	--	1.008 (J)	--	1.038 (J)
	372BJ04	0 - 5	4.328 (J)	--	55.46	--	1.745	--	1.288 (J)
BJ4	372BJ05	0 - 5	0.674 (J)	0.222	2.339	--	2.246	--	1.316 (J)
BK1	372BK01	0 - 5	2.48	0.53	12.1	--	0.85	--	0.88
	372BK02	0 - 5	2.911	0.465 (J)	17.18	--	0.789 (J)	--	0.811
BK2	372BK03	0 - 5	2.164	0.474 (J)	13.91 (J)	--	0.777	--	0.688
BK3	372BK04	0 - 5	2.174	0.85 (J)	11.15 (J)	--	0.565 (J)	--	0.739 (J)
BK4	372BK05	0 - 5	27.26 (J)	0.265 (J)	7.936 (J)	--	1.032 (J)	--	0.738 (J)
BL1	372BL01	0 - 5	91.45 (J)	0.624 (J)	21.02 (J)	--	1.542 (J)	--	--
BL2	372BL02	0 - 5	149 (J)	12.6 (J)	770 (J)	--	2.31 (J)	--	0.9 (J)
BL3	372BL03	0 - 5	397.8 (J)	0.435 (J)	20.03 (J)	--	1.824 (J)	--	0.694 (J)
BL4	372BL04	0 - 5	2.863	0.269 (J)	15.39 (J)	--	0.766	--	0.553
BM1	372BM01	0 - 5	572 (J)	46 (J)	2,710 (J)	--	--	--	--
BM2	372BM02	0 - 5	93 (J)	8.2 (J)	437 (J)	--	1.92	--	--
BM3	372BM03	0 - 5	167 (J)	13.4 (J)	830 (J)	--	--	--	--
BM4	372BM04	0 - 5	592 (J)	50 (J)	2,920 (J)	--	--	--	--
BX01	372BX02	5 - 10	--	--	0.257	--	1.3	--	1.14
BX02	372BX01	5 - 10	0.055	--	--	--	1	0.088	0.98

J = Estimated value
-- = Not detected above MDCs.

Table F.2-3
Internal Dose Estimations at Little Feller II Sample Locations (mrem/IA-yr)

Location	Sample					Average for Sample Plot	95% UCL for Sample Plot
	1	2	3	4	5		
Plot BA	0.87	1.76	0.98	1.01	--	1.2	1.6
Plot BB	2.21	2.47	11.93	2.91	--	4.9	10.4
Plot BC	2.05	2.33	2.22	2.07	2.02	2.1	2.3
Plot BD	10.47	11.75	12.87	10.69	--	11.4	12.7
Plot BE	25.70	55.60	34.91	33.93	--	**37.5**	**52.5**
Plot BF	0.92	1.27	1.14	2.28	--	1.4	2.1
Plot BG	1.65	2.51	4.24	4.50	--	3.2	4.8
Plot BH	5.73	4.81	5.20	4.40	--	5.0	5.7
Plot BJ	0.64	0.23	0.25	1.31	0.15	0.5	1.0
Plot BK	1.47	1.32	1.40	1.01	0.92	1.2	1.5
Plot BL	2.47	10.84	3.79	2.25	--	4.8	9.6
Plot BM	35.27	10.97	15.78	39.84	--	**25.5**	**42.2**
BX01	0.035	N/A	N/A	N/A	N/A	0.035	N/A
BX02	0.041	N/A	N/A	N/A	N/A	0.041	N/A

-- = Duplicate not taken for this plot.

Bold indicates the values exceeding 25 mrem/yr.

Table F.2-4
TLD Results for Little Feller II Locations (mrem/IA-yr)

Location	Location ID	Element											
		2	3	4	2	3	4	2	3	4	2	3	4
		TLD 1			TLD 2			TLD 3			TLD 4		
BA	BT09	38.3	38.4	34.9	--	--	--	--	--	--	--	--	--
BB	BT08	44.7	41	40.9	--	--	--	--	--	--	--	--	--
BC	BT07	44.4	40	39.2	--	--	--	--	--	--	--	--	--
BD	BT12	77.9	64.4	62.8	95.9	72.2	73.3	83.5	74.6	75.1	98.6	76.1	78.7
BE	BT11	230.6	183.7	201.5	279.7	189.5	188.3	267.6	196.7	167.9	320.5	213.6	241.2
BF	BT03	42.1	37.2	37.6	--	--	--	--	--	--	--	--	--
BG	BT02	41.6	40.5	35.5	--	--	--	--	--	--	--	--	--
BH	BT01	58	50.9	54.9	--	--	--	--	--	--	--	--	--
BJ	BT06	39.6	38.7	38.8	--	--	--	--	--	--	--	--	--
BK	BT05	43.4	41.3	42.1	--	--	--	--	--	--	--	--	--
BL	BT04	54	44.6	44.5	--	--	--	--	--	--	--	--	--
None	BT10	316.8	184.6	184.6	202.7	157.1	175.1	247.2	189.5	193.1	229.2	155.9	142.6
BX01	BT16	39.7	41.4	37.4	--	--	--	--	--	--	--	--	--
BX02	BT17	41.6	37.6	38.8	--	--	--	--	--	--	--	--	--

Table F.2-5
Background TLD Results for Little Feller II (mrem/IA-yr)

Location ID	Element		
	2	3	4
	TLD 1		
AT14	35.3	33.9	32.1
AT15	37.2	34.1	33.1
AT16	35.4	35.2	32.7
BT13	36.2	35.7	33.9
BT14	39	35.4	35.9
BT15	35.4	35	32.2

F.3.0 Sample Data for Palanquin

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Palanquin that were detected above MDCs are presented in Tables F.3-1 and F.3-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimations (mrem/IA-yr) for individual samples within each sample plot and sediment sample location at Palanquin are presented in Table F.3-3.

Results for TLDs staged at the sample plots at Palanquin are presented in Table F.3-4. Results for TLDs staged at field background locations at Palanquin are presented in Table F.3-5.

Table F.3-1
Gamma Spectroscopy Sample Results Detected above MDCs at Palanquin
(Page 1 of 4)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
CA1	372CA01	0 - 5	2.28	7.5 (J)	0.215	4.51	0.53 (J)	--	3.6 (J)
CA2	372CA02	0 - 5	2.02	8.8 (J)	0.256	4.7	0.63 (J)	--	--
CA3	372CA03	0 - 5	2.35	10.3 (J)	0.278	5.24	0.78 (J)	--	1.77 (J)
CA4	372CA04	0 - 5	2.26	9.2 (J)	0.245	5.2	0.65 (J)	--	3.4 (J)
CB1	372CB01	0 - 5	2.25	4.46 (J)	--	2.57	0.299 (J)	--	1.73 (J)
CB2	372CB02	0 - 5	2.23	4.86	--	2.94	--	--	3.3 (J)
CB3	372CB03	0 - 5	2.22	4.83	0.118	3.38	0.346 (J)	--	--
CB4	372CB04	0 - 5	2.28	4.59	--	2.27	0.314	--	1.6
CC1	372CC01	0 - 5	2.05	299	5.34	43.3	15.7 (J)	2.62	--
CC2	372CC02	0 - 5	2.31	232	3.82	36.6	12.6 (J)	1.82	--
	372CC03	0 - 5	2.22	207	3.34	29	10.1 (J)	1.51	--
CC3	372CC04	0 - 5	1.94	393	5.71	54.2	18.6 (J)	3.12	--
CC4	372CC05	0 - 5	2.07	257	4.21	40	13.9 (J)	2.5	--
CD1	372CD01	0 - 5	2.12	1.39	--	2.22	--	--	--
CD2	372CD02	0 - 5	2.21	2.55	--	2.46	--	--	2.88

Table F.3-1
Gamma Spectroscopy Sample Results Detected above MDCs at Palanquin
(Page 2 of 4)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
CD3	372CD03	0 - 5	2.21	1.7	--	2.15	--	--	2.13
CD4	372CD04	0 - 5	2.17	1.58	--	1.73	--	--	--
CE1	372CE01	0 - 5	2.18	1.77	--	2	--	--	--
CE2	372CE02	0 - 5	2.07	1.59	--	1.98	--	--	2.81
	372CE03	0 - 5	2.12	1.26	--	1.51	--	--	--
CE3	372CE04	0 - 5	2.19	2.48	--	2.26	0.32	--	2.22
CE4	372CE05	0 - 5	2.41	2.4 (J)	--	2.06	--	--	2.54 (J)
CF1	372CF01	0 - 5	2.14	7.4 (J)	0.209	4.04	0.49 (J)	--	--
CF2	372CF02	0 - 5	2.21	7.7	0.235	3.61	0.56 (J)	--	--
CF3	372CF03	0 - 5	2.19	7.3	0.235	4	0.56 (J)	--	3.6 (J)
CF4	372CF04	0 - 5	2.1	5.64	0.154	2.91	0.43	--	3.9
CG1	372CG01	0 - 5	2.39	0.5	--	0.93	--	--	--
CG2	372CG02	0 - 5	2.07	0.56	--	0.89	--	--	2.94
CG3	372CG03	0 - 5	2.22	0.44	--	0.84	--	--	--
CG4	372CG04	0 - 5	2.28	0.02	--	0.632	--	--	--
CH1	372CH01	0 - 5	1.97	174 (J)	3.11	28.8	9.9 (J)	1.26	--
CH2	372CH02	0 - 5	2.05	241 (J)	3.77	33.7	11.4 (J)	1.54	--
CH3	372CH03	0 - 5	2.26	263	4.91	45.5	15.5	2.35	--
CH4	372CH04	0 - 5	2.1	178	3.3	30.8	10.8	1.49	--
CJ1	372CJ01	0 - 5	1.88	190 (J)	2.97	28.7	9.8 (J)	1.49	--
CJ2	372CJ02	0 - 5	1.99	89	1.59	16.9	5.51	1.01	--
CJ3	372CJ03	0 - 5	2.21	169	2.69	24.6	8.11 (J)	1.09	3 (J)
CJ4	372CJ04	0 - 5	1.83	130	2.25	21.9	7.28 (J)	1.06	--
CK1	372CK01	0 - 5	2.33	88.9 (J)	1.25	12.3	3.9 (J)	0.54 (J)	1.9 (J)
CK2	372CK02	0 - 5	2.08	89.1	1.33	12.6	4.2	0.61	--
CK3	372CK03	0 - 5	2.39	104 (J)	1.42	14.1	4.73 (J)	--	2.82 (J)
CK4	372CK04	0 - 5	2.26	87.6 (J)	1.21	11.9	3.98 (J)	0.54 (J)	1.82 (J)

Table F.3-1
Gamma Spectroscopy Sample Results Detected above MDCs at Palanquin
(Page 3 of 4)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	**Am-241**	**Co-60**	**Cs-137**	**Eu-152**	**Eu-154**	**Th-234**
CL1	372CL01	0 - 5	2.39	89.1	1.32	13.5	4.25	--	--
	372CL02	0 - 5	2.27	126 (J)	1.93	18.2	5.8 (J)	0.98 (J)	2.4 (J)
CL2	372CL03	0 - 5	2.39	115	1.53	16.1	5.05	0.58	3.07
CL3	372CL04	0 - 5	2.28	109	1.62	16.1	5.34	0.75	2.72
CL4	372CL05	0 - 5	2.38	70.7	1.1	10	3.17	--	2.92
CM1	372CM01	0 - 5	2.3	26.2	0.663	5.75	1.63	--	2.43
CM2	372CM02	0 - 5	2.22	31.5 (J)	0.675	6.62	1.98 (J)	--	2.11 (J)
CM3	372CM03	0 - 5	2.07	24.9	0.584	5.22	1.72	--	2.7
CM4	372CM04	0 - 5	2.15	23.4 (J)	0.553	5.07	1.62 (J)	--	2.66 (J)
	372CM05	0 - 5	2.17	23.8 (J)	0.547	5.36	1.49 (J)	--	1.86 (J)
CN1	372CN01	0 - 5	2.11	50	1.06	7.25	3.31	0.59	2.12
CN2	372CN02	0 - 5	2.06	106	2.49	13.6	7.18	1.37	2.37
CN3	372CN03	0 - 5	2.17	33.7 (J)	0.718	5.17	2.29 (J)	--	1.92 (J)
CN4	372CN04	0 - 5	2.21	50.4 (J)	1.11	6.84	3.1 (J)	0.61 (J)	2.92 (J)
CP1	372CP01	0 - 5	--	6,210 (J)	79.5	425	195 (J)	50.3 (J)	--
CP2	372CP02	0 - 5	--	3,030 (J)	69	347	173 (J)	41 (J)	--
CP3	372CP03	0 - 5	--	4,120 (J)	65.9	346	169 (J)	38.8 (J)	--
CP4	372CP04	0 - 5	--	3,500 (J)	81	408	209 (J)	48.5 (J)	--
CQ1	372CQ01	0 - 5	2.61	40.5	0.76	7.84	2.05	--	2.37
CQ2	372CQ02	0 - 5	2.55	67 (J)	1.25	11.8	3.68 (J)	0.68 (J)	1.81 (J)
CQ3	372CQ03	0 - 5	2.6	38.2 (J)	0.663	6.71	1.94 (J)	--	2.92 (J)
CQ4	372CQ04	0 - 5	2.56	37.9	0.77	7	1.96	0.82	2.69
CR1	372CR01	0 - 5	2.4	14.4 (J)	0.302	5.6	0.77 (J)	--	2.67 (J)
CR2	372CR02	0 - 5	2.14	19 (J)	0.427	6.12	0.82 (J)	--	2.08 (J)

Table F.3-1
Gamma Spectroscopy Sample Results Detected above MDCs at Palanquin
(Page 4 of 4)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
CR3	372CR03	0 - 5	2.38	20.4 (J)	0.443	6.32	1.01 (J)	--	2.38 (J)
CR4	372CR04	0 - 5	2.27	30.1 (J)	0.634	6.44	1.29 (J)	--	2.46 (J)
CX01	372CX01	0 - 5	2.56	3.12 (J)	--	2.48	--	--	--
CX02	372CX02	0 - 5	2.02	7.6 (J)	--	8	--	--	--

J = Estimated value
-- = Not detected above MDCs.

Table F.3-2
Isotopic Sample Results Detected above MDCs at Palanquin
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
CA1	372CA01	0 - 5	6.6	28.1	14.8 (J)	1.52	1.14	--	1.1
CA2	372CA02	0 - 5	6.4	24	15.4 (J)	1.41	1.25	--	1.18
CA3	372CA03	0 - 5	8.7	45.8	19.9 (J)	1.85	1.23	--	1.1
CA4	372CA04	0 - 5	8.6	32.8	26.9 (J)	1.81	1.2	--	1.02
CB1	372CB01	0 - 5	2.03	8.1	5.37 (J)	1.1	1.03	--	0.99
CB2	372CB02	0 - 5	7.3	14.5	20.9 (J)	0.75	1.2	--	1.05
CB3	372CB03	0 - 5	5	12.9	11.9 (J)	0.99	1.1	0.056	0.98
CB4	372CB04	0 - 5	1.81	5.83	6.5 (J)	0.95	1.08	--	1.17
CC1	372CC01	0 - 5	233	274 (J)	516	1.44 (J+)	4.3	--	2.1
CC2	372CC02	0 - 5	396	91 (J)	545	1.09 (J+)	5.3	--	--
	372CC03	0 - 5	123	72 (J)	197	1.01 (J+)	2.27	--	1.16
CC3	372CC04	0 - 5	188	223 (J)	574	1.11 (J+)	4.7	--	1.4
CC4	372CC05	0 - 5	372	96 (J)	513	3.2 (J+)	6.1	--	--
CD1	372CD01	0 - 5	1.33	2.53	4.53 (J)	1.01	1.04	--	0.97
CD2	372CD02	0 - 5	1.69	3	1.76 (J)	1.46	1.19	--	0.77
CD3	372CD03	0 - 5	1.81	3.27	2.01 (J)	1.05	0.93	--	0.75

Table F.3-2
Isotopic Sample Results Detected above MDCs at Palanquin
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
CD4	372CD04	0 - 5	1.81	2.72	4.36	0.93	0.88	--	0.8
CE1	372CE01	0 - 5	1.63	2.59	1.97	--	1.06	--	0.94
CE2	372CE02	0 - 5	1.55	2.48	1.55	0.88	1.15	--	1.19
	372CE03	0 - 5	0.84	1.58	1.19	--	1.14	--	1.06
CE3	372CE04	0 - 5	2.18	4.53	2.55	1.13	1.09	0.119	0.96
CE4	372CE05	0 - 5	1.49	2.89 (J)	1.51 (J)	1.15	1.15 (J)	--	1.09
CF1	372CF01	0 - 5	6.7	24.8	16 (J)	1.27	1.17	--	1.16
CF2	372CF02	0 - 5	8.1	33.2	16 (J)	1.25	1.03	--	1.04
CF3	372CF03	0 - 5	10.2	20.5	21.6 (J)	1.13	1.4	--	1.13
CF4	372CF04	0 - 5	4.64	17	8.6 (J)	0.99	1.16	--	1.08
CG1	372CG01	0 - 5	0.62	1.29	1.82 (J)	--	0.94	--	0.95
CG2	372CG02	0 - 5	0.81	1.11	1.34 (J)	--	0.9	--	0.87
CG3	372CG03	0 - 5	0.39	2.62	1.21 (J)	--	0.9	--	0.94
CG4	372CG04	0 - 5	0.32	1.58	0.88 (J)	--	1.06	0.066	0.9
CH1	372CH01	0 - 5	72	36.335	164.642 (J)	1.25	2.61	--	1.08
CH2	372CH02	0 - 5	142	91	392 (J)	1.13	3.7	--	1.15
CH3	372CH03	0 - 5	850	581	1,300 (J)	1.25	7.2	--	--
CH4	372CH04	0 - 5	545	96	421 (J)	0.97	3.6	--	1.47
CJ1	372CJ01	0 - 5	174	76	240 (J)	1.2	2.15	--	1.25
CJ2	372CJ02	0 - 5	120	104	280 (J)	1.06	2.54	--	1.6
CJ3	372CJ03	0 - 5	186	97	534 (J)	1	7.5	--	--
CJ4	372CJ04	0 - 5	163	78	346 (J)	1	2.86	--	1.2
CK1	372CK01	0 - 5	64 (J)	93	184 (J)	--	2.02 (J)	--	--
CK2	372CK02	0 - 5	35.5 (J)	17.1	101 (J)	--	1.39 (J)	--	1.01
CK3	372CK03	0 - 5	114 (J)	45.9	323 (J)	--	2.89 (J)	--	--
CK4	372CK04	0 - 5	85 (J)	69	178 (J)	--	1.39 (J)	--	1.13
CL1	372CL01	0 - 5	84 (J)	34.7	206 (J)	1.14	2.09 (J)	--	1.37
	372CL02	0 - 5	133 (J)	148	290 (J)	0.87	3.1 (J)	--	1.75

Table F.3-2
Isotopic Sample Results Detected above MDCs at Palanquin
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
CL2	372CL03	0 - 5	56.7 (J)	43.9	169 (J)	0.82	1.85 (J)	--	1.15
CL3	372CL04	0 - 5	186 (J)	93	401 (J)	--	2.8 (J)	--	1.37
CL4	372CL05	0 - 5	92 (J)	108	215 (J)	0.9	1.83 (J)	--	--
CM1	372CM01	0 - 5	12.7 (J)	38.9	36.7	--	1.3	--	1.27
CM2	372CM02	0 - 5	44.7 (J)	62	92	--	1.36	--	1.37
CM3	372CM03	0 - 5	15.5 (J)	33	39.8	--	1.29	0.083	1.07
CM4	372CM04	0 - 5	19.1 (J)	49.6	40.4	--	1.42	--	1.19
	372CM05	0 - 5	14.5 (J)	54	31.8	3.7 (J+)	1.25	--	1.11
CN1	372CN01	0 - 5	29.5 (J)	51.7	70	--	1.41	--	1.13
CN2	372CN02	0 - 5	62.2 (J)	126	133	--	1.4	--	1.11
CN3	372CN03	0 - 5	23.5 (J)	35.4	49.5	1.93 (J+)	1.38	--	1.28
CN4	372CN04	0 - 5	33.9 (J)	53.8	93	2.4 (J+)	1.71	--	1.09
CP1	372CP01	0 - 5	11,100 (J)	4,650	14,000	1.67 (J)	36	--	1.09
CP2	372CP02	0 - 5	5,510 (J)	3,970	7,400	2.34 (J+)	27.7	0.2	1.05
CP3	372CP03	0 - 5	8,600 (J)	3,550	9,800	2.97 (J)	37.8	0.2	0.92
CP4	372CP04	0 - 5	5,000 (J)	3,870	8,500	5.8 (J+)	30 (J)	--	1.04 (J)
CQ1	372CQ01	0 - 5	20.9 (J)	52.6	49.2 (J)	1.28	1.22 (J)	--	0.97
CQ2	372CQ02	0 - 5	40 (J)	83	105 (J)	0.99	1.11 (J)	--	1.06
CQ3	372CQ03	0 - 5	60.3 (J)	81	140 (J)	1.02	1.04 (J)	--	0.9
CQ4	372CQ04	0 - 5	29.9 (J)	89	76 (J)	0.9	1.32 (J)	--	1.04
CR1	372CR01	0 - 5	12.2 (J)	31.2	28 (J)	2.02	0.85 (J)	--	1.09
CR2	372CR02	0 - 5	22.1 (J)	44.4	56 (J)	1.61	1.33 (J)	--	1.19
CR3	372CR03	0 - 5	14.8 (J)	24.3	36.4 (J)	0.91	1.18 (J)	--	0.76
CR4	372CR04	0 - 5	21.4 (J)	28	47.7 (J)	1.69	1.13 (J)	--	1.09
CX01	372CX01	0 - 5	4.38 (J)	6.3	8	1.55 (J)	1.2	0.064	1.14
CX02	372CX02	0 - 5	5.3 (J)	8.5	4.07	3.2 (J)	1.41	0.069	0.97

J = Estimated value
J+ = Result is an estimated quantity, but may be biased high.
-- = Not detected above MDCs.

Table F.3-3
Internal Dose Estimations at Palanquin Sample Locations (mrem/IA-yr)

Plot	Sample					Average for Sample Plot	95% UCL for Sample Plot
	1	2	3	4	5		
Plot CA	0.25	0.28	0.32	0.29	--	0.3	0.3
Plot CB	0.16	0.17	0.17	0.16	--	0.2	0.2
Plot CC	8.52	6.62	5.91	11.19	7.33	7.9	9.9
Plot CD	0.07	0.10	0.08	0.07	--	0.1	0.1
Plot CE	0.08	0.07	0.06	0.10	0.10	0.1	0.1
Plot CF	0.24	0.25	0.24	0.19	--	0.23	0.3
Plot CG	0.04	0.04	0.04	0.03	--	0.04	0.05
Plot CH	4.97	6.87	7.51	5.09	--	6.1	7.6
Plot CJ	5.42	2.56	4.84	3.72	--	4.1	5.6
Plot CK	2.56	2.56	2.99	2.52	--	2.7	2.9
Plot CL	2.56	3.61	3.30	3.13	2.04	2.9	3.5
Plot CM	0.77	0.92	0.74	0.69	0.71	0.8	0.9
Plot CN	1.45	3.04	1.00	1.46	--	1.7	2.8
Plot CP	176.35	86.09	117.03	99.44	--	**119.7**	**166.6**
Plot CQ	1.18	1.94	1.12	1.11	--	1.3	1.8
Plot CR	0.44	0.57	0.61	0.89	--	0.6	0.8
CX01	0.12	N/A	N/A	N/A	N/A	0.12	N/A
CX02	0.24	N/A	N/A	N/A	N/A	0.24	N/A

-- = Sample not taken for this location.

Bold indicates the values exceeding 25 mrem/yr.

Table F.3-4
TLD Results for Palanquin Locations (mrem/IA-yr)

Location	Location ID	Element								
		2	3	4	2	3	4	2	3	4
		TLD 1			TLD 2			TLD 3		
CA	CT04	47.4	46.6	45.4	50.1	49.9	48.5	--	--	--
CB	CT07	50.7	46.1	48.5	53.1	50.9	51.5	--	--	--
CC	CT01	112.8	99.2	96.9	110.4	102.6	102.6	--	--	--
CD	CT08	43.2	43.6	44	45.7	48.7	47	--	--	--
CE	CT09	41.4	40.2	41.9	44.1	45.4	42	--	--	--
CF	CT05	42.4	45.4	40.2	44	46.8	45.3	--	--	--
CG	CT06	42.7	41.8	42.8	48.7	47.9	44.3	--	--	--
CH	CT02	91.9	87.9	86.2	100.8	88.5	84.1	--	--	--
CJ	CT03	64.2	56.8	62.5	71.6	66.6	63.7	--	--	--
CK	CT15	57.8	57.4	56.2	--	--	--	--	--	--
CL	CT14	60.3	58.3	56.9	--	--	--	--	--	--
CM	CT27	56.1	51.9	49.8	54.9	48.3	50	53.2	52.6	51.7
CN	CT26	75.5	67.9	70.7	74.9	69.4	73.4	72.6	68	70.1
CP	CT25	790.3	753	744.6	807.1	748.2	661.7	890	778.2	747
CQ	CT24	79.9	72.4	73.4	68.4	66.5	64.1	72.5	69.8	67.9
CR	CT23	58.3	54.6	53.8	56.5	58.9	52.6	62.3	58.1	57.8
None	CT16	58.4	54	53.5	--	--	--	--	--	--
None	CT17	66.5	60	58.1	--	--	--	--	--	--
CX01	CT18	52.2	50	46.5	--	--	--	--	--	--
CX02	CT19	48.3	45.3	45.9	--	--	--	--	--	--
None	CT20	46.1	45.2	42.3	--	--	--	--	--	--
None	CT21	42.7	43	38.4	--	--	--	--	--	--
None	CT22	38.2	35.3	35.1	--	--	--	--	--	--

Table F.3-5
Background TLD Results for Palanquin (mrem/IA-yr)

Location ID	Element					
	2	3	4	2	3	4
	TLD 1			TLD 2		
CT10	41.9	41.6	38.9	41.5	41.7	42.1
CT11	40.6	38.6	36.6	43.8	39.2	39.9
CT12	42.1	40.8	37.5	44	42.9	41.8
CT13	37.5	39.1	35.4	43.7	40.7	39.5

F.4.0 Sample Data for Cabriolet

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Cabriolet that were detected above MDCs are presented in Tables F.4-1 and F.4-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimations (mrem/IA-yr) for individual samples within each sample plot and sediment sample location at Cabriolet are presented in Table F.4-3.

Results for TLDs staged at the sample plots at Cabriolet are presented in Table F.4-4. Results for TLDs staged at field background locations at Cabriolet are presented in Table F.4-5.

Table F.4-1
Gamma Spectroscopy Sample Results Detected above MDCs at Cabriolet
(Page 1 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
DA1	372DA01	0 - 5	2.31	1,780 (J)	7.64	65.1	17.1 (J)	6.6	--
DA2	372DA02	0 - 5	2.28	1,400	7.89	69.9	20.2	7.01	--
DA3	372DA03	0 - 5	2.81	1,260	7.82	66.7	19.2	6.78	--
DA4	372DA04	0 - 5	2.44	1,350	8.6	63.8	20.9	7.31	--
DB1	372DB01	0 - 5	2.57	284 (J)	1.64	15.5	3.77 (J)	1.34	--
DB2	372DB02	0 - 5	2.24	218	1.29	12.6	2.85 (J)	1.03	3.17 (J)
	372DB03	0 - 5	2.13	149	0.9	9.1	1.92	0.63	2.15
DB3	372DB04	0 - 5	2.29	250	1.45	13.9	3.71 (J)	1.4	--
DB4	372DB05	0 - 5	2.11	194	1.28	12.5	3.15 (J)	1.25	--
DC1	372DC01	0 - 5	2.63	311	1.46	58.7	0.97	--	--
DC2	372DC02	0 - 5	2.51	194	0.95	48.5	0.7	--	--
DC3	372DC03	0 - 5	2.65	275	1.4	52.9	0.71	--	--
DC4	372DC04	0 - 5	2.57	281	1.35	52	0.95	--	--
DD1	372DD01	0 - 5	2.24	3.3	--	3.93	--	--	1.7 (J)
DD2	372DD02	0 - 5	2.23	3.05	--	4.49	--	--	2.8 (J)

Table F.4-1
Gamma Spectroscopy Sample Results Detected above MDCs at Cabriolet
(Page 2 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
DD3	372DD03	0 - 5	2.23	3.01 (J)	--	4.57	--	--	--
DD4	372DD04	0 - 5	2.57	3.86 (J)	--	4.2	--	--	2.05 (J)
DE1	372DE01	0 - 5	2.37	--	--	2.06	--	--	3.1 (J)
DE2	372DE02	0 - 5	2.26	1.88 (J)	--	2.11	--	--	2.54 (J)
DE3	372DE03	0 - 5	2.31	2.88 (J)	--	3.86	--	--	2.69 (J)
DE4	372DE04	0 - 5	2.2	1.5 (J)	--	2.49	--	--	3.1
DF1	372DF01	0 - 5	2.48	553	2.97	35.2	14.6 (J)	3.43	--
DF2	372DF02	0 - 5	2.52	640	3.59	38.6	18.2 (J)	4.24	--
DF3	372DF03	0 - 5	2.86	638	3.04	35.8	14.9 (J)	3.43	--
DF4	372DF04	0 - 5	2.35	510 (J)	2.78	32.8	13.1 (J)	2.98	--
DG1	372DG01	0 - 5	2.24	132	0.702	15.8	2.15	--	3
DG2	372DG02	0 - 5	2.31	104	0.653	15.6	2.19	--	--
DG3	372DG03	0 - 5	2.32	216	1.09	18.2	3.14	0.88	--
DG4	372DG04	0 - 5	2.4	188	0.96	15.3	2.91	--	3.26
DH1	372DH01	0 - 5	2.34	41	0.224	9.7	1.07	--	--
DH2	372DH02	0 - 5	2.39	44.2 (J)	0.224	9.5	1.09 (J)	--	--
DH3	372DH03	0 - 5	2.22	39.2 (J)	0.216	8.5	0.94 (J)	--	--
DH4	372DH04	0 - 5	2.29	36.9	0.2	8.5	0.97	--	1.78
DJ1	372DJ01	0 - 5	2.25	13.5	--	2.79	--	--	--
	372DJ02	0 - 5	2.21	19.5	0.118	3.23	0.367	--	2.19
DJ2	372DJ03	0 - 5	2.3	29 (J)	0.188	4.77	0.52 (J)	--	--
DJ3	372DJ04	0 - 5	2.38	16.9	--	3.06	0.241 (J)	--	2.8 (J)
DJ4	372DJ05	0 - 5	2.18	20.7	0.155	3.73	0.4	--	--
DK1	372DK01	0 - 5	2.16	960 (J)	5.2	44.8	33 (J)	7.51 (J)	--
DK2	372DK02	0 - 5	2.66	1,090	5.03	40.2	28.4	6.33	--
DK3	372DK03	0 - 5	2.54	1,210 (J)	5.38	43.8	29.5 (J)	7.46 (J)	--
DK4	372DK04	0 - 5	2.57	818 (J)	3.92	38.6	24.6 (J)	5.58 (J)	--
DX01	372DX01	0 - 5	2.38	24 (J)	--	9	--	--	--

Table F.4-1
Gamma Spectroscopy Sample Results Detected above MDCs at Cabriolet
(Page 3 of 3)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Th-234
DX02	372DX02	5 - 10	2.26	25.5 (J)	--	6.47	0.68	--	--
	372DX03	5 - 10	2.04	32.1 (J)	--	7.26	0.79	--	--

J = Estimated value
-- = Not detected above MDCs.

Table F.4-2
Isotopic Sample Results Detected above MDCs at Cabriolet
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
DA1	372DA01	0 - 5	980	1,480 (J)	670 (J)	6.7	43.6	0.42	1.14
DA2	372DA02	0 - 5	960	1,410 (J)	620 (J)	9.1	48.6 (J)	0.316 (J)	1.24 (J)
DA3	372DA03	0 - 5	1,380 (J)	1,820 (J)	760 (J)	10.7	77 (J)	0.38 (J)	1.29 (J)
DA4	372DA04	0 - 5	1,010	1,680 (J)	720 (J)	20.4	54.9 (J)	0.31 (J)	1.12 (J)
DB1	372DB01	0 - 5	168	404 (J)	172 (J)	1.59	11.4 (J)	--	--
DB2	372DB02	0 - 5	249	487 (J)	205	2.72 (J+)	21.8	--	1.85
	372DB03	0 - 5	170	205 (J)	86	1.69 (J+)	13.1	--	--
DB3	372DB04	0 - 5	380	710 (J)	285	1.95 (J+)	18.7	--	--
DB4	372DB05	0 - 5	536	609 (J)	261	4.4 (J+)	25.7	--	--
DC1	372DC01	0 - 5	165	333 (J)	152	5.4 (J+)	13.2	--	1.28
DC2	372DC02	0 - 5	175	291 (J)	133	4.8 (J+)	11.9	--	--
DC3	372DC03	0 - 5	273	345 (J)	159	5.1 (J+)	22.9	--	2.3
DC4	372DC04	0 - 5	136	270 (J)	122	4.7 (J+)	8	--	--
DD1	372DD01	0 - 5	3.89	7.7	3.64 (J)	2.32	1.26	--	0.92
DD2	372DD02	0 - 5	4.89	7.6	3.55 (J)	1.98	1.3	--	0.98
DD3	372DD03	0 - 5	1.49	3.37	1.8 (J)	2.28	1.03	--	1
DD4	372DD04	0 - 5	2.5	5.24	2.59 (J)	2.79	1.16	0.066	1.19
DE1	372DE01	0 - 5	1.16	2.54	1.57 (J)	1.09	1.33	--	1.09
DE2	372DE02	0 - 5	0.85	1.37	2.08 (J)	1.53	1.29	0.083	1.26

Table F.4-2
Isotopic Sample Results Detected above MDCs at Cabriolet
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)						
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-235	U-238
DE3	372DE03	0 - 5	1.59	3.68	2.14 (J)	1.74	1.33	0.045	1.13
DE4	372DE04	0 - 5	1.37	2.05	3.3 (J)	1.49	1.15	--	0.95
DF1	372DF01	0 - 5	1,020 (J)	1,530 (J)	680 (J)	2.78	44.9 (J)	0.244 (J)	1 (J)
DF2	372DF02	0 - 5	660 (J)	840 (J)	379 (J)	14.2	33.4 (J)	--	--
DF3	372DF03	0 - 5	780 (J)	1,010 (J)	487 (J)	6.7	29.7 (J)	--	--
DF4	372DF04	0 - 5	297	527 (J)	240 (J)	5.2	19.9 (J)	--	2.1
DG1	372DG01	0 - 5	69	114 (J)	50.6	6.1 (J+)	5.1	--	1.82
DG2	372DG02	0 - 5	136	204 (J)	90	5.2 (J+)	7.6	--	1.1
DG3	372DG03	0 - 5	67	112 (J)	53.6	6.1 (J+)	5.2	--	1.39
DG4	372DG04	0 - 5	326	537 (J)	246	5 (J+)	18	--	1.49
DH1	372DH01	0 - 5	37.4	66 (J)	34.9 (J)	4.3	3.93 (J)	--	1.18
DH2	372DH02	0 - 5	31.6	53.1 (J)	23.5 (J)	2.6	3.08 (J)	--	1.12
DH3	372DH03	0 - 5	29	65 (J)	32.3 (J)	2.36	3.01 (J)	--	1.18
DH4	372DH04	0 - 5	31.5	58.5 (J)	27.7 (J)	2.98	2.47 (J)	--	1.18
DJ1	372DJ01	0 - 5	3.67	5.88 (J)	3.19 (J)	1.03	1.22 (J)	--	1.04
	372DJ02	0 - 5	7.1	10.6 (J)	5.1 (J)	0.87	1.4 (J)	--	0.99
DJ2	372DJ03	0 - 5	6.7	12.3 (J)	5.18 (J)	1.28	1.6 (J)	0.074	1.16
DJ3	372DJ04	0 - 5	26 (J)	35.8 (J)	18.1 (J)	1.98	2.83 (J)	--	1.38
DJ4	372DJ05	0 - 5	30.5 (J)	52 (J)	23.9 (J)	1.44	2.97 (J)	--	1.52
DK1	372DK01	0 - 5	670 (J)	1,130	501	19.6 (J+)	33.9	--	1.12
DK2	372DK02	0 - 5	1,400 (J)	1,190	554	6.6 (J+)	50.7	--	--
DK3	372DK03	0 - 5	1,040 (J)	1,760	820	7 (J+)	62.8	--	1.89
DK4	372DK04	0 - 5	730 (J)	1,050	465	7.5 (J+)	41.7	--	2.3
DX01	372DX01	0 - 5	23.7	36.8	17.4	1.01	2.53	--	1.15
DX02	372DX02	5 - 10	46.6	73	37.8	2.19	3.42	--	0.88
	372DX03	5 - 10	93	124	57.3	1.61	5.78	--	0.9

J = Estimated value
J+ = Result is an estimated quantity, but may be biased high.
-- = Not detected above MDCs.

Table F.4-3
Internal Dose Estimations at Cabriolet Sample Locations (mrem/IA-yr)

Plot	Sample					Average for Sample Plot	95% UCL for Sample Plot
	1	2	3	4	5		
Plot DA	53.65	42.22	38.05	40.73	--	**43.7**	**51.8**
Plot DB	8.59	6.62	4.53	7.57	5.90	6.6	8.1
Plot DC	9.42	5.89	8.35	8.50	--	8.0	9.8
Plot DD	0.13	0.12	0.12	0.15	--	0.1	0.1
Plot DE	0.03	0.09	0.12	0.08	--	0.08	0.1
Plot DF	16.73	19.34	19.27	15.41	--	17.7	20.0
Plot DG	4.01	3.17	6.54	5.71	--	4.9	6.7
Plot DH	1.27	1.36	1.21	1.14	--	1.2	1.4
Plot DJ	0.43	0.62	0.90	0.54	0.65	0.6	0.8
Plot DK	28.97	32.90	36.52	24.70	--	**30.8**	**36.8**
DX01	0.75	N/A	N/A	N/A	N/A	0.76	N/A
DX02	0.8	1.0	N/A	N/A	N/A	0.9	N/A

-- = Duplicate not taken for this plot.

Bold indicates the values exceeding 25 mrem/yr.

Table F.4-4
TLD Results for Cabriolet Locations (mrem/IA-yr)

Location	Location ID	Element								
		2	3	4	2	3	4	2	3	4
		TLD 1			TLD 2			TLD 3		
DA	DT07	180.1	171.7	162.7	179.5	179.5	169	--	--	--
DB	DT08	65.6	60	57.7	63.4	67.8	66.6	--	--	--
DC	DT04	109.4	101.5	101.5	113.8	104.2	98.9	--	--	--
DD	DT05	44.9	46.5	40.9	52.1	48.3	44.2	--	--	--
DE	DT06	46.4	45	44.1	47.4	44.4	43	--	--	--
DF	DT01	151.5	126.8	130.1	156.7	139.2	130.5	--	--	--
DG	DT02	66.1	61.1	62.2	64.3	58.3	61.6	--	--	--
DH	DT03	52.9	48.1	47.6	50.5	52.6	49.5	--	--	--
DJ	DT09	46.3	45.4	42.4	48.7	46.7	47	--	--	--
DK	DT12	223	210.9	192.9	243.4	198.9	195.3	227.8	200.1	186.9
DX01	DT10	57	52.3	50.8	--	--	--	--	--	--
DX02	DT11	50.9	50.3	46.8	--	--	--	--	--	--

Table F.4-5
Background TLD Results for Cabriolet (mrem/IA-yr)

Location ID	Element					
	2	3	4	2	3	4
	TLD 1			TLD 2		
CT10	41.9	41.6	38.9	41.5	41.7	42.1
CT11	40.6	38.6	36.6	43.8	39.2	39.9
CT12	42.1	40.8	37.5	44	42.9	41.8
CT13	37.5	39.1	35.4	43.7	40.7	39.5

Appendix G

Sample Location Coordinates

G.1.0 Sample Location Coordinates

The TLD location within each sample plot and the locations of individual (judgmental) sample locations for the CAU 372 CASs were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Tables G.1-1 through G.1-4.

Nine aliquot sample locations were established at each plot for each composite sample (4 composite samples, 36 aliquot sample locations). The VSP software (PNNL, 2007) was used to derive coordinates for a systematic triangular grid pattern based on a randomly generated origin or starting point. The sample aliquot locations for each composite sample were provided to the field crew in tabular format in terms of east and north distances from the southwest corner stake at each plot. In some cases, aliquot locations were moved due to surface/subsurface obstructions or conditions (e.g., rocks, vegetation, and animal burrows). These offsets (distance and direction) of each aliquot location were recorded in the project files. It is important to note that if an offset was less than the nominal 4-in. width of core sampler, the original coordinate was not modified.

Table G.1-1
Sample Plot/Location Coordinates for Little Feller I[a]
(Page 1 of 2)

Easting[b]	Northing[b]	Sample Plot/Location
560645	4107117	AA
560647	4107139	AB
560650	4107160	AC
560657	4107202	AD
560540	4106999	AE
560563	4107033	AF
560573	4107043	AG
560376	4107470	AH
560358	4107550	AJ
560305	4107656	AK
560239	4108097	AL
560643	4107038	AM
560559	4107147	AN

Table G.1-1
Sample Plot/Location Coordinates for Little Feller I[a]
(Page 2 of 2)

Easting[b]	Northing[b]	Sample Plot/Location
560224	4107968	AP
560581	4107099	AQ
560616	4107112	AR

[a]All coordinates listed are for the TLD location within the sample plot or 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 Coordinates for Little Feller II[a]

Easting[b]	Northing[b]	Sample Plot/Location
561645	4108817	BA
561685	4108670	BB
561697	4108611	BC
561828	4108328	BD
561878	4108192	BE
561824	4108657	BF
561829	4108520	BG
561831	4108422	BH
561918	4108455	BJ
561895	4108421	BK
561876	4108390	BL
561729	4108530	BM
561896	4107979	BX01
561969	4108027	BX02

[a]All coordinates listed are for the TLD location within the sample plot or sample location
[b]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Table G.1-3
Sample Plot/Location Coordinates for Palanquin[a]

Easting[b]	Northing[b]	Sample Plot/Location
542030	4125938	CA
542396	4125925	CB
542292	4126587	CC
542448	4125901	CD
542489	4125882	CE
541998	4125923	CF
541958	4125904	CG
542269	4126696	CH
542220	4126775	CJ
542174	4126853	CK
542130	4126919	CL
542082	4125945	CM
542100	4125957	CN
542232	4125983	CP
542347	4125937	CQ
542373	4125932	CR
542405	4125999	CX01
542513	4125897	CX02

[a]All coordinates listed are for the TLD location within the sample plot or sample location
[b]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Table G.1-4
Sample Plot/Location Coordinates for Cabriolet[a]

Easting[b]	Northing[b]	Sample Plot/Location
542977	4126021	DA
542938	4126088	DB
543165	4125911	DC
543288	4125927	DD
543344	4125941	DE
542976	4125823	DF
542897	4125773	DG
542839	4125731	DH
542894	4126219	DJ
543002	4125859	DK
542799	4125800	DX01
542773	4125715	DX02

[a]All coordinates listed are for the TLD location within the sample plot or sample location
[b]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

G.2.0 References

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

Appendix H

Nevada Division of Environmental Protection Comments

(1 Page)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 372: Area 20 Cabriolet/Palanquin Unit Craters	**2. Document Date:**	3/18/2011
3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NSO Federal Sub-Project Director:	Kevin J. Cabble	**6. Date Comments Due:**	4/18/2011
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	John Wong, NDEP, 486-2850, ext. 245	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
1.) Section 3.0, page 26; Appendix A, Section A.9.0, page A-93; and Appendix D	Mandatory	**Section 3.0, page 26; Appendix A, Section A.9.0, page A-93, and Appendix D:** With respect to FFACO scope and objectives, clarify/explain why it is necessary or appropriate to define and establish both an "FFACO" UR and "Administrative" UR at each CAS...it is stated throughout the document that the contamination area boundary is defined by removable radioactive contamination, while the use restriction boundary is defined by radiological dose – if the contamination area does not encompass the administrative UR and does not correlate with UR boundaries, at each CAS, would it not be logical to establish and define one area to be use-restricted, and require that area to meet both contamination and dose criteria?	To clarify, Section 3.0, page 26 (second paragraph) has been revised as follows: "The administrative URs at all four CAU 372 CASs are not part of the corrective action but were implemented as BMPs. In accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), if the Remote Work Area or Occasional Use Area scenarios are used for any site to calculate a FAL, an administrative UR will be recorded to protect workers from future work activities that would cause an exposure exceeding the 25 mrem/yr. An administrative UR will be controlled in the same manner as the FFACO URs, but will not require postings or inspections. Any proposed activity within this use restricted area that would potentially change the land-use scenario and cause an exposure exceeding the exposure limits would require NDEP approval. The administrative URs are discussed and shown in Attachment D-2 of Appendix D." Additionally, reference to the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006), Section 3.3 of the CAU 372 CAIP (NNSA/NSO, 2009), and Section 3.0 (of this CADD/CR) has been added to the paragraphs in Sections D.1.1, D.1.2, D.1.3, and D.1.4 which discuss the establishment of an administrative use restriction at each of the four CASs within CAU 372.	

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