RECORD OF TECHNICAL CHANGE

Technical Change No. DOE/NV--1503-ROTC-1 Page 1 of 1

Activity Name Corrective Action Decision Document/Closure Report for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada Date May 16, 2013

The following technical changes (including justification) are requested by:

Christina Sloop	CAU Lead
(Name)	(Title)

Description of Change:

Replace the use restriction form and the Bandicoot Crater use restriction figure in Attachment D-1for CAS 03-23-21with the attached pages.

Replace the use restriction form and figure in Attachment D-1 for CAS 03-23-09 with the attached pages.

Justification:

Some of the coordinates presented in the original forms and figures are incorrect and have been updated.

The task time will be (Increased) (Decreased) (Unchanged) by approximately 0 days.

Applicable Activity-Specific Document(s):

Corrective Action Decision Document/Closure Report for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites Nevada National Security Site, Nevada (DOE/NV--1503)

Approved By: /s/ Tiffany A. Lantow Date 5/21/2013
Activity Lead

/s/ Robert F. Boehlecke Date 5/22/13
EM Operations Manager

/s/ Jeff MacDougall Date 5/23/13
NDEP

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-21/Pike Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area 1 - Pike (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,826	587,873
	4,100,833	587,768
	4,100,917	587,719
	4,101,000	587,753
	4,100,997	587,893
	4,100,917	587,925

Surveyed Area 2 - Bandicoot (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,099,641	587,054
	4,099,597	586,996
	4,099,617	586,891
	4,099,688	586,857
	4,099,784	586,891
	4,099,819	586,960
	4,099,798	587,042
	4,099,722	587,089

Depth: No depth limitation

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Subsurface contamination is assumed to be present within the Pike (U-3cy) crater and covered fissure area, and also within the Bandicoot (U-3bj) crater. The contamination, if exposed through excavation, could cause a site worker to receive a dose exceeding 25 mrem/yr.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-21, Pike Contamination Area			
Constituent	**Maximum Concentration***	**Action Level****	**Units**
Cesium-137	166	81.45	pCi/g
Plutonium-239/240	1,849.7	7,645	pCi/g

*Highest measured value. Higher concentrations may be present within the crater or fissure areas
**Action level based on 25 mrem/yr under the industrial scenario

Site Controls: The use restricted areas encompass Bandicoot crater and the Pike crater and covered fissure where subsurface soil contamination is assumed to exceed the FAL of 25 mrem in 80 hours (the Occasional Use Area annual exposure scenario). They are established at the boundaries identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed on the use restriction boundaries.

UR Maintenance Requirements:

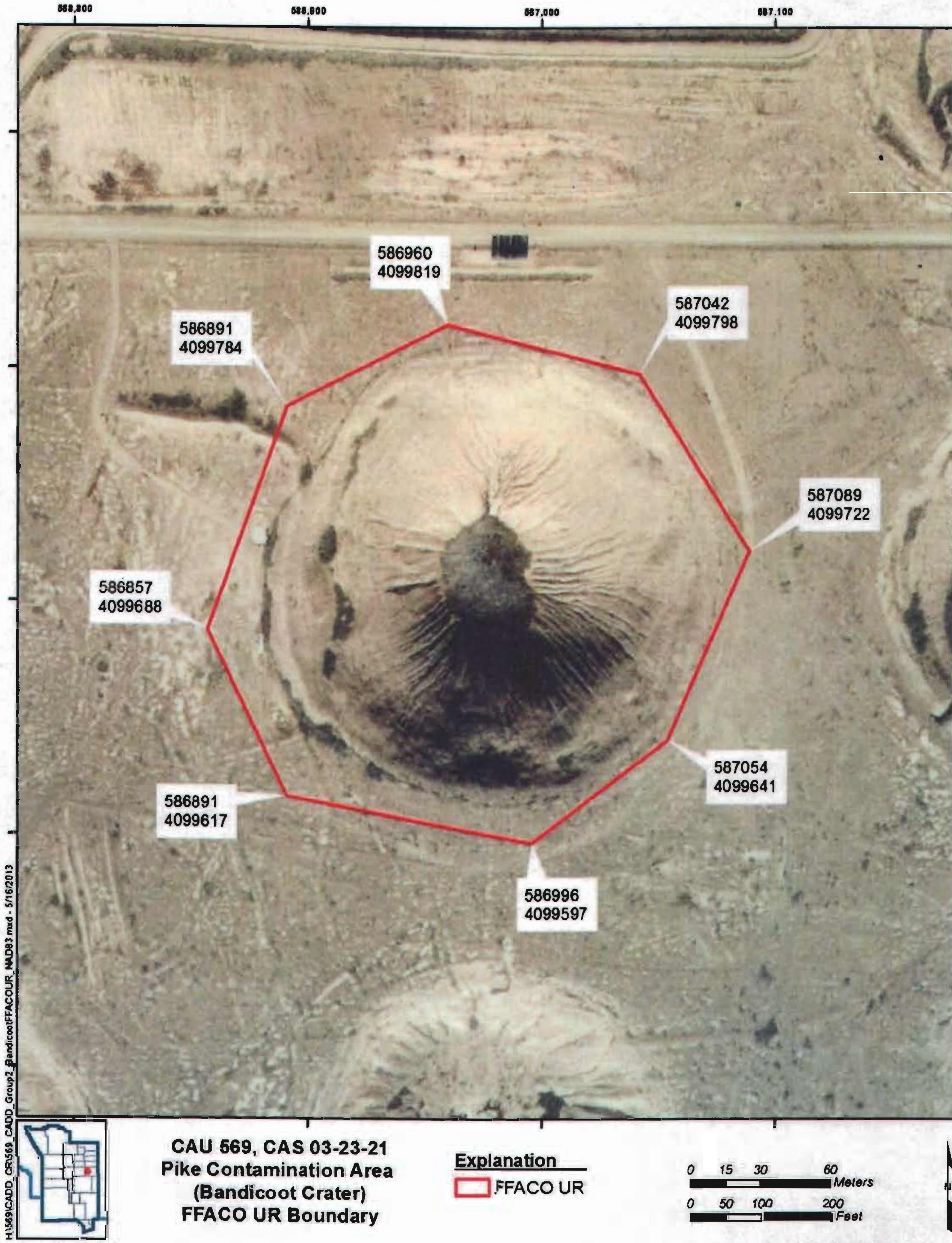
Description: The FFACO UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. FFACO UR signs are posted at the site.

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 5/21/2013



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Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-09/T-3 Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

Administrative Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,507	587,313
	4,100,426	586,876
	4,100,513	586,791
	4,100,690	586,748
	4,100,817	586,820
	4,100,849	587,096
	4,100,692	587,296

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 299 hours of exposure to the surface location with the maximum detected radioactivity. 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 569.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-09, T-3 Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Cesium-137	6.7	81.45	pCi/g
Europium-152	57.4	42.75	pCi/g
Th-232	1.8	22.34	pCi/g

*Action level based on 25 mrem/yr under the industrial scenario

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

UR Maintenance Requirements:

Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

Inspection/Maintenance Frequency: N/A

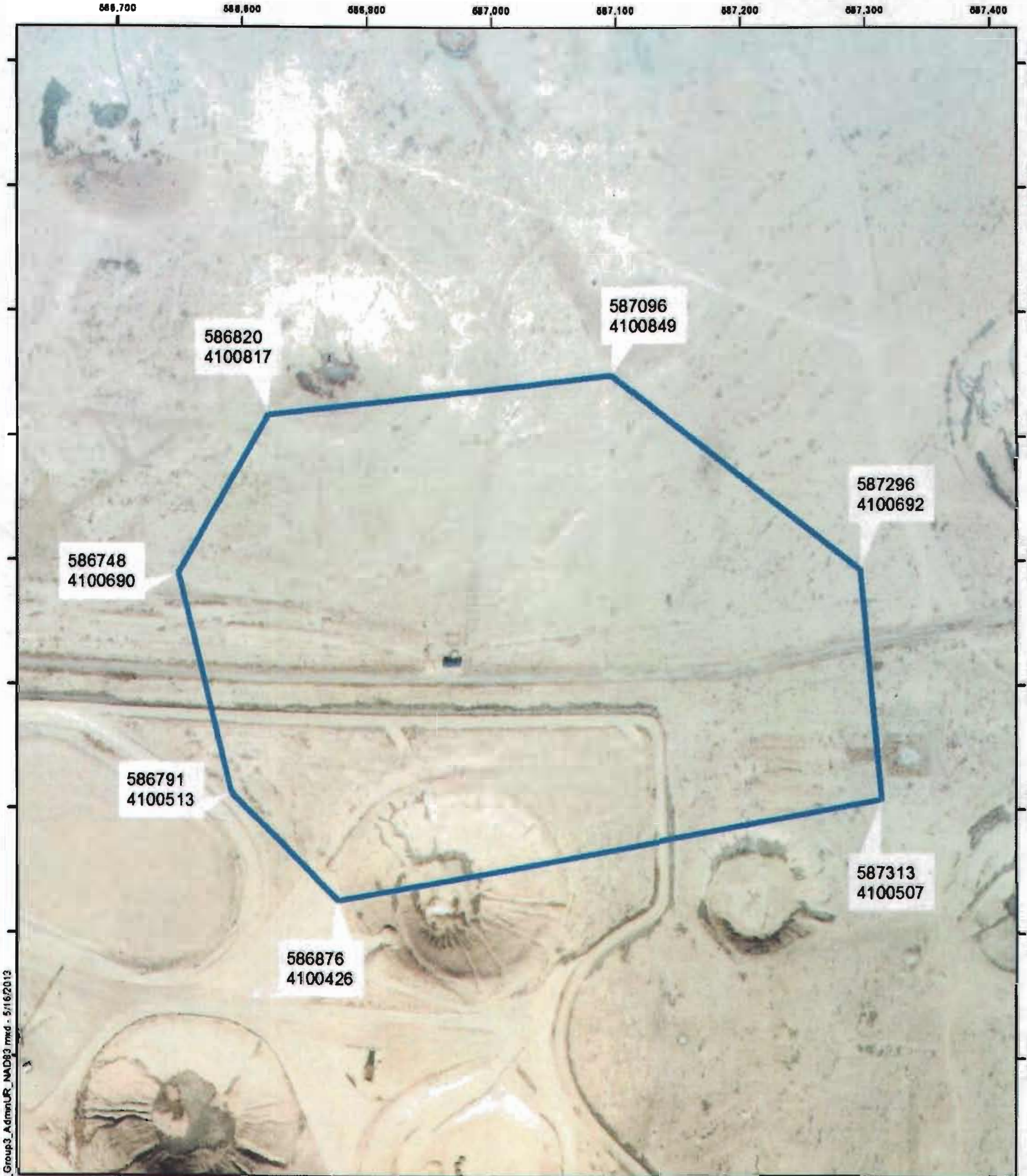
Note: Effective upon acceptance of closure documents by NDEP

Use Restriction Information

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 5/21/2013



CAU 569, CAS 03-23-09
T-3 Contamination Area
(Annie, Franklin, George, and Moth)
Administrative UR Boundary

Explanation

Administrative UR

0 25 50 100 150 Meters
0 125 250 500 Feet

Source: N-I GIS 2013

Coordinate System: NAD 1983 UTM Zone 11N Meters

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Nevada
Environmental
Management
Operations Activity

DOE/NV--1503

National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

April 2013

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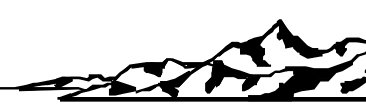
/s/ Joseph P. Johnston, N-I CO 04/18/2013



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DOE/NV--1503

CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 569: AREA 3 YUCCA FLAT ATMOSPHERIC TEST SITES NEVADA NATIONAL SECURITY SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 0

April 2013

CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 569: AREA 3 YUCCA FLAT ATMOSPHERIC TEST SITES NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 4/15/2013

Tiffany A. Lantow
Soils Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 4/15/2013

Robert F. Boehlecke
Environmental Management Operations Manager

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List of Acronyms and Abbreviations

Ac	Actinium
ALM	Adult Lead Methodology
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
BOL	Bill of Lading
CA	Contamination area
CAA	Corrective action alternative
CAB	Corrective action boundary
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
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
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
day/yr	Days per year
DCB	Default contamination boundary
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
g/day	Grams per day
GIS	Geographic Information System
GPS	Global Positioning System
GZ	Ground zero
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
IA	Industrial Area

List of Acronyms and Abbreviations *(Continued)*

IDW	Investigation-derived waste
in.	Inch
kt	Kiloton
LCS	Laboratory control sample
LLW	Low-level radioactive waste
LVF	Load Verification Form
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MLLW	Mixed low-level radioactive waste
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
NA	Not analyzed
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site

List of Acronyms and Abbreviations *(Continued)*

NSTec	National Security Technologies, LLC
OU	Occasional Use
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
QAP	Quality Assurance Plan
QC	Quality control
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual Radioactive
RMA	Radioactive material area
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SAA	Satellite accumulation area
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SVOC	Semivolatile organic compound
TBD	To be determined

List of Acronyms and Abbreviations (Continued)

Tc	Technetium
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
TRS	Terrestrial radiological survey
TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UGTA	Underground Test Area
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
yd^3	Cubic yard

Executive Summary

This Corrective Action Decision Document/Closure Report presents information supporting the closure of Corrective Action Unit (CAU) 569: Area 3 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada. This complies with the requirements of 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. CAU 569 comprises the nine corrective action sites (CASs) listed in Table ES-1. During a historical review, Waste Consolidation Site 3A was identified north of CAS 03-23-21 and was included in the scope of that CAS.

Table ES-1
CAU 569 CASs

CAS Number	CAS Name
03-23-09	T-3 Contamination Area
03-23-10	T-3A Contamination Area
03-23-11	T-3B Contamination Area
03-23-12	T-3S Contamination Area
03-23-13	T-3T Contamination Area
03-23-14	T-3V Contamination Area
03-23-15	S-3G Contamination Area
03-23-16	S-3H Contamination Area
03-23-21	Pike Contamination Area

The purpose of this Corrective Action Decision Document/Closure Report is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 569 based on the implementation of the corrective actions listed in Table ES-2.

Corrective action investigation (CAI) activities were performed from April 23 through November 8, 2012, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites*; and in accordance with the *Soils Activity Quality Assurance Plan*, which establishes requirements, technical planning, and general quality practices.

The approach for the CAI was to investigate and make data quality objective (DQO) decisions based on the locations and types of releases present. To facilitate site investigation and DQO decisions, the CASs were organized into study groups. The reporting of investigation results and the evaluation of DQO decisions are at the study group level. The need for corrective action and the corrective action alternatives (CAAs) were evaluated at the FFACO CAS level.

The purpose of the CAI was to fulfill data needs as defined during the DQO process. The CAU 569 dataset of investigation results was evaluated based on a data quality assessment. This assessment demonstrated the dataset is complete and 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 of 25 millirem per year was established based on the Occasional Use Area exposure scenario (80 hours of annual exposure). Although CAI measurements did not result in radiological doses exceeding the FAL, some areas could not be sampled and were assumed to exceed FALs and require corrective action. These corrective actions are listed in Table ES-2. This table lists the CASs where potential source material (PSM) was identified and the corrective actions that were completed during the CAI. The final FFACO corrective actions and the rationale for those corrective action decisions are also listed in Table ES-2.

Table ES-2
CAU 569 Corrective Actions
(Page 1 of 2)

CAS Number	CAS Name	Corrective Action Required?	Rationale	Corrective Action
03-23-09	T-3 Contamination Area	Yes	Removed PSM (4 batteries) - No other contamination present that exceeds FALs	No Further Action
03-23-10	T-3A Contamination Area	Yes	Removed PSM (1 battery and 1 lead brick) - No other contamination present that exceeds FALs	No Further Action
03-23-11	T-3B Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-12	T-3S Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-13	T-3T Contamination Area	Yes	Subsurface radiological contamination assumed to exceed FALs	Closure in Place with FFACO UR
03-23-14	T-3V Contamination Area	No	No contamination present that exceeds FALs	No Further Action

Table ES-2
CAU 569 Corrective Actions
(Page 2 of 2)

CAS Number	CAS Name	Corrective Action Required?	Rationale	Corrective Action
03-23-15	S-3G Contamination Area	Yes	Subsurface radiological contamination assumed to exceed FALs	Closure in Place with FFACO UR
03-23-16	S-3H Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-21	Pike Contamination Area	Yes	Removed PSM (1 battery) - Radiological contamination remains that is assumed to exceed FALs	Closure in Place with FFACO UR

UR = Use restriction

The FFACO URs are posted with warning signs and recorded as required by the FFACO. Warning signs are posted along each boundary and are annually inspected and maintained. The corrective actions meet all requirements for the technical components evaluated, and meet all applicable federal and state regulations for closure of the site. Based on the implementation of these corrective actions, the DOE, National Nuclear Security Administration Nevada Field Office provides the following recommendations:

- No further corrective actions are necessary for CAU 569.
- A Notice of Completion to the DOE, National Nuclear Security Administration Nevada Field Office is requested from the Nevada Division of Environmental Protection for closure of CAU 569.
- CAU 569 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) 569, Area 3 Yucca Flat Atmospheric Test Sites, 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) (1996, as amended) 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.

CAU 569 comprises the following nine corrective action sites (CASs):

- 03-23-09, T-3 Contamination Area
- 03-23-10, T-3A Contamination Area
- 03-23-11, T-3B Contamination Area
- 03-23-12, T-3S Contamination Area
- 03-23-13, T-3T Contamination Area
- 03-23-14, T-3V Contamination Area
- 03-23-15, S-3G Contamination Area
- 03-23-16, S-3H Contamination Area
- 03-23-21, Pike Contamination Area

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites* (NNSA/NSO, 2012a).

1.1 Purpose

This CADD/CR provides documentation and justification for the closure of CAU 569. This includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The CAIP (NNSA/NSO, 2012a) provides information relating to the scope and planning of the investigation. Therefore, that information will not be repeated in this document.

1.2 Scope

The scope of CAU 569 includes nine CASs and one waste consolidation site located in Area 3 of the NNSS, listed in Section 1.0 and shown on Figure 1-1. To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for different releases were organized into study groups. The study groups and the CASs associated with each study group are described in Table 1-1 and shown on Figure 1-2.

Study Group 1 consists of CASs 03-23-13 and 03-23-15, located within the Area 3 Radioactive Waste Management Site (RWMS). CAS 03-23-13, T-3T Contamination Area (referred to as Catron in this document), consists of a deposition of radioactive contamination as a result of the Catron atmospheric safety experiment. Catron had a yield of 21 tons and was detonated from a 72.5-foot (ft)-tall tower (DOE/NV, 2000; GE, 1979). CAS 03-23-15, S-3G Contamination Area (referred to as Coulomb-B in this document), consists of a deposition of radioactive contamination as a result of the Coulomb-B atmospheric safety experiment. Coulomb-B had a yield of 300 tons and was detonated at a height of 3 ft above ground surface (DOE/NV, 2000; GE, 1979). A small americium plume is present surrounding the ground zero (GZ) area for these tests (BN, 1999).

Study Group 2 consists of CAS 03-23-21, Pike Contamination Area (referred to as Pike in this document), located northeast of the Area 3 RWMS. This CAS consists of a release of surface and near-surface radioactive contamination as a result of the venting of radioactive gases from a fissure formed during the Pike weapons-related underground test. Pike had a yield of less than 20 kilotons (kt) and was detonated below ground surface (bgs) at a depth of 374 ft (Shoengold et al., 1996; DOE/NV, 2000). This test resulted in a fallout plume originating south of the Pike GZ (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 fissure located north of the crater.

Study Group 3 consists of CAS 03-23-09, T-3 Contamination Area (referred to as Annie, Franklin, Moth, and George in this document), located within and north of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Annie, Franklin, George, and Moth atmospheric weapons-related tests. Annie (yield of 16 kt), Franklin (yield of 140 tons), George

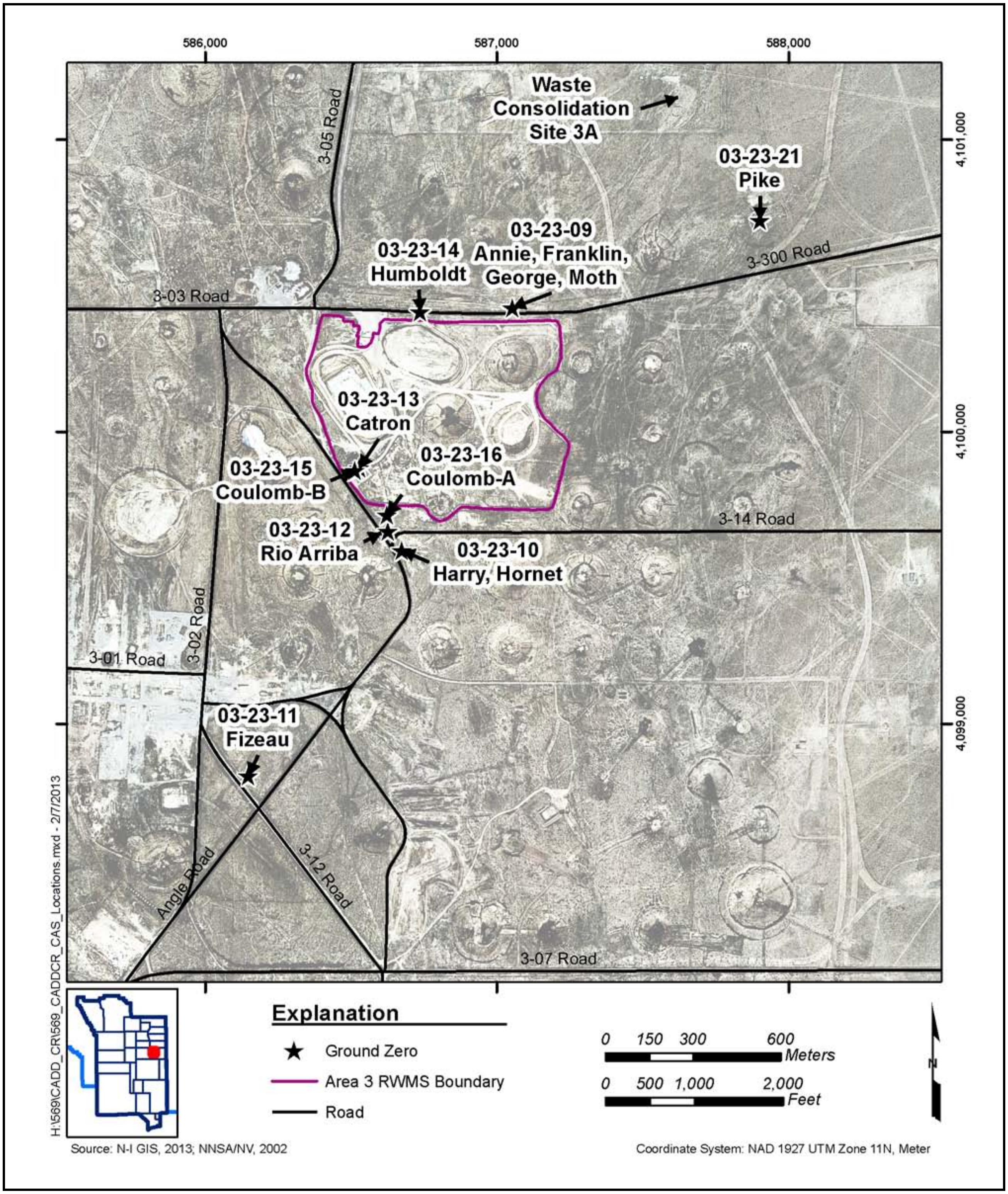

Figure 1-1
CAU 569 CAS Location Map

Table 1-1
CAU 569 Study Groups

FFACO CASs	Test	Study Group
03-23-13	Catron	1
03-23-15	Coulomb-B	
03-23-21	Pike	2
	Waste Consolidation Site 3A	7
03-23-09	Annie, Franklin, George, and Moth	3
03-23-14	Humboldt	4
03-23-10	Harry and Hornet	5
03-23-12	Rio Arriba	
03-23-16	Coulomb-A	
03-23-11	Fizeau	6

(yield of 15 kt), and Moth (yield of 2 kt) were detonated from a 300-ft-tall tower (DOE/NV, 2000; GE, 1979). These four tests resulted in a concentric fallout plume originating from a GZ that was common to the Annie, Franklin, George, and Moth tests (BN, 1999).

Study Group 4 consists of CAS 03-23-14, T-3V Contamination Area (referred to as Humboldt in this document), located adjacent to the northern boundary of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Humboldt atmospheric weapons-related test. Humboldt had a yield of 7.8 tons and was detonated from a 25-ft-tall tower (DOE/NV, 2000; GE, 1979). This test resulted in an americium fallout plume originating from the Humboldt GZ area (BN, 1999).

Study Group 5 consists of CASs 03-23-10, 03-23-12, and 03-23-16, located adjacent to the southern boundary of the Area 3 RWMS. CAS 03-23-10, T-3A Contamination Area (referred to as Harry and Hornet in this document), consists of a deposition of radioactive contamination as a result of the Harry and Hornet atmospheric weapons-related tests. Harry (yield of 32 kt) and Hornet (yield of 4 kt) were detonated from a 300-ft-tall tower (DOE/NV, 2000; GE, 1979). CAS 03-23-12, T-3S Contamination Area (referred to as Rio Arriba in this document), consists of a deposition of radioactive contamination as a result of the Rio Arriba atmospheric weapons-related test. Rio Arriba had a yield of 90 tons and was detonated from a 72.5 ft-tall tower (DOE/NV, 2000; GE, 1979).

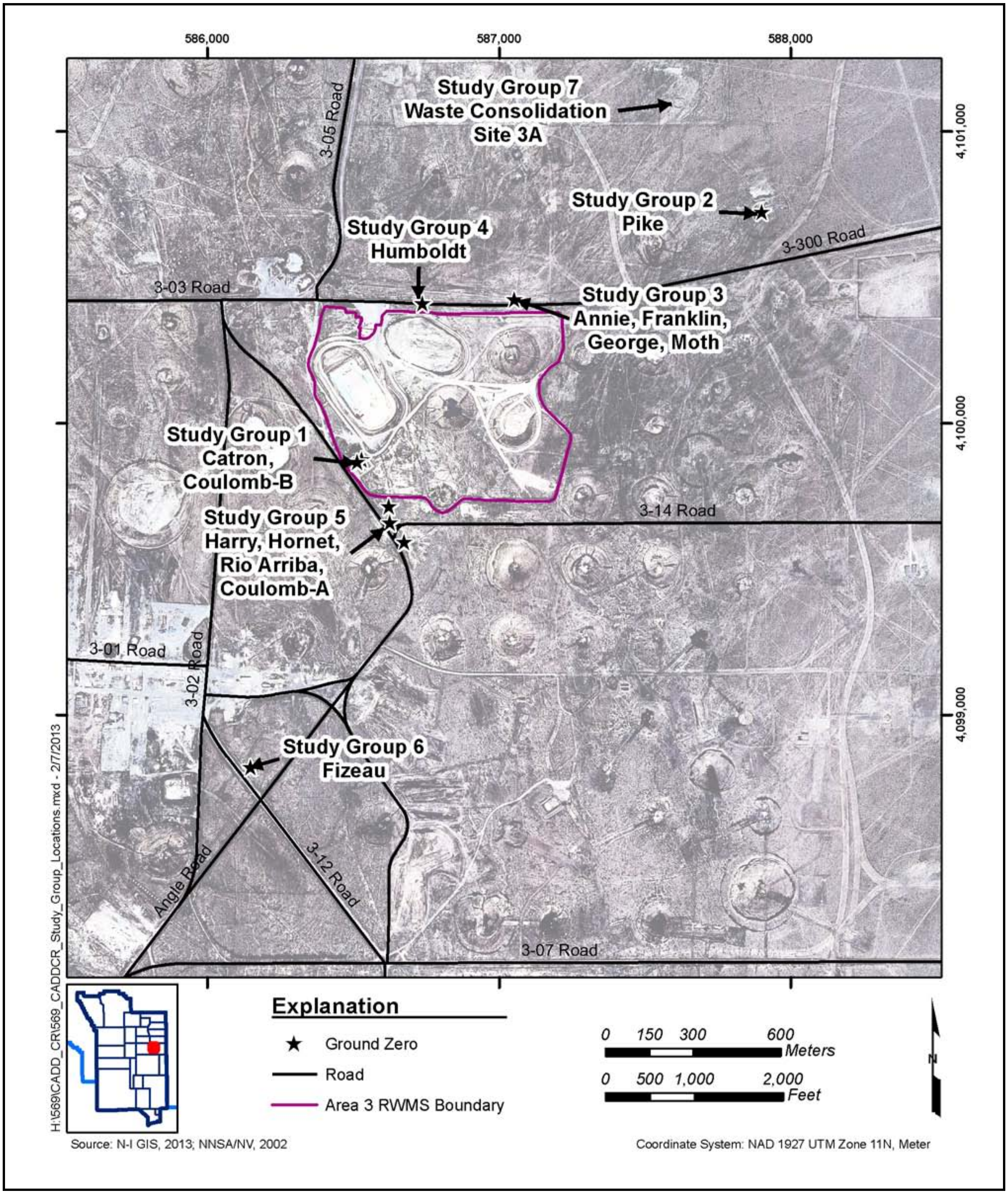

Figure 1-2
CAU 569 Study Group Location Map

CAS 03-23-16, S-3H Contamination Area (referred to as Coulomb-A in this document), consists of a deposition of radioactive contamination as a result of the Coulomb-A atmospheric safety experiment. Coulomb-A had a zero yield and was detonated at the ground surface (DOE/NV, 2000; GE, 1979). These four tests (Harry, Horner, Rio Arriba, and Coulomb-A) resulted in a radially distributed fallout plume originating from a GZ common to the Harry and Hornet tests (BN, 1999).

Study Group 6 consists of CAS 03-23-11, T-3B Contamination Area (referred to as Fizeau in this document), located southwest of the Area 3 RWMS. Fizeau consists of a deposition of radioactive contamination as a result of the Fizeau atmospheric weapons-related test. Fizeau had a yield of 11 kt and was detonated from a 500-ft-tall tower (DOE/NV, 2000; GE, 1979). This test resulted in a radially distributed fallout plume originating from the Fizeau GZ area (BN, 1999).

Study Group 7 consists of Waste Consolidation Site 3A, which was identified north of Pike during a historical document review. This area consists of the potential release of contaminants associated with the consolidation of soil and debris from atmospheric testing operations. Due to its geographic proximity to CAS 03-23-21 (Pike), Waste Consolidation Site 3A has been included in the scope of this CAS.

Also included in the CAU 569 scope were potential releases to the soil from debris (e.g., batteries, former transformer areas) present as a result of other CAU 569 activities.

In addition, releases from the following underground tests in the vicinity of CAU 569 were included in the scope of the investigation: Anchovy, Bandicoot, Barracuda, Barsac, Brush, Carp, Cerise, Cinnamon, Cormorant, Finfoot, Fisher, Merlin, Moa, Mushroom, Pampas, Parrot, Pipefish, Pliers, Ringtail, Sardine, Scissors, Screamer, Sevilla, Sidecar, Snubber, Tapper, Tern, Truchas-Chacon, Truchas-Rodarte, and Umber. These tests had documented releases to the environment and were not previously investigated as CASs.

The corrective action investigation (CAI) for CAU 569 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs) at all study groups (defined in the CAIP [NNSA/NSO, 2012a] and Section 2.1). For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding a final action level (FAL) of 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding FAL.

The CAI activities were completed in accordance with the CAU 569 CAIP (NNSA/NSO, 2012a) (except as noted in Appendix A) and the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012b), which establishes requirements, technical planning, and general quality practices. The evaluation of investigation results and the risk associated with site contamination was conducted in accordance with the *Soils Risk-Based Corrective Action* (RBCA) *Evaluation Process* (NNSA/NSO, 2012c).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), the quality required of a dataset will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions. As presented in Appendix C, the radiological and chemical FALs are based on the appropriate site-specific exposure scenario (Occasional Use Area).

The collection of samples was not feasible within the bermed GZ area at Catron and Coulomb-B and within the crater and fissure at Pike. Therefore, an assumption was made that corrective action is required within these areas. For the remainder of the site, the scope of activities used to identify, evaluate, and recommend preferred corrective action alternatives (CAAs) for CAU 569 included the following:

- Performing visual and terrestrial radiological surveys (TRSs)
- Conducting geophysical surveys
- Collecting environmental samples from sample plot and biased sample locations
- Collecting step-out samples to define the lateral and vertical extent of contamination
- Collecting quality control (QC) soil samples
- Staging and collecting TLDs at environmental sample locations, background locations, and other locations of interest
- Collecting waste management samples to determine the proper disposal of waste

- Collecting Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest
- Performing limited removal of potential source material (PSM)
- Evaluating corrective action objectives based on the results of the CAI and the CAA screening criteria
- Recommending and justifying preferred CAAs

1.3 CADD/CR Contents

This document is divided into the following sections and appendices:

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

Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities and the results of the investigation, and justifies that, following the implementation of needed corrective actions, 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 CAU 569 objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA).

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*, provides documentation of the chemical and radiological RBCA processes as applied to CAU 569.

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

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

Appendix F, *Data Tables*, 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 CAI sample location coordinates.

Appendix H, *Nevada Division of Environmental Protection* (NDEP) *Summary of Changes to the CAU 569 Sampling Approach*, presents the revisions to the CSM.

Appendix I, *Nevada Division of Environmental Protection Comments*, contains responses to 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 569, Area 3 Yucca Flat Atmospheric Test Sites (NNSA/NSO, 2012a)
- Soils QAP (NNSA/NSO, 2012b)
- Soils RBCA document (NNSA/NSO, 2012c)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP (NNSA/NSO, 2012a) contains the DQOs as agreed to by decision makers before the field investigation. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions with an appropriate level of confidence. A DQA was conducted that evaluated the degree of acceptability and usability of the reported data in the decision-making process. This DQA is presented in Appendix B and summarized in Section 2.2.2. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

Based on this evaluation, the nature and extent of COCs at CAU 569 have been adequately identified to implement the corrective actions. Information generated during the investigation supports 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 subsections summarize the investigation activities, investigation results, and corrective actions; and justify why no further corrective action is required at CAU 569. Detailed investigation activities and results for individual CAU 569 study groups are presented in Appendix A.

2.1 Investigation Activities

CAI activities were conducted as set forth in the CAIP (NNSA/NSO, 2012a) from April 23 through November 8, 2012. The purpose of the CAU 569 CAI was to provide the additional information needed to resolve the following CAU 569-specific DQOs:

- Determining whether COCs are present in the soils associated with CAU 569.
- Determining the extent of identified COCs.
- Ensuring adequate data have been collected to evaluate closure alternatives under the FFACO.

To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for different releases were organized into study groups. The study groups and the CASs associated with each study group are described in Table 1-1 and shown on Figure 1-2. Although the need for corrective action is evaluated separately for each study group, CAAs are evaluated for each FFACO CAS.

The study groups were generally investigated by collecting TLD samples for external radiological dose measurements and collecting soil samples for the calculation of internal radiological dose and chemical risk. The field investigation was completed as specified in the CAIP with minor deviations. The investigation is described in Sections A.2.1 through A.2.5, which provide the general investigation and evaluation methodologies.

For Study Groups 2, 3, 4, 5, 6, and 7, sample locations were established judgmentally based on aerial radiological surveys and the results of the TRSs. For Study Group 1, grab sample locations were determined based on a random-start triangular pattern.

Confidence in judgmental sampling scheme decisions was established qualitatively through validation of the CSM and verification that the selected sample locations meet the DQO criteria (see Appendix B).

Soil samples within sample plots were collected and evaluated based on a probabilistic sampling scheme. 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 external dose at each TLD location was determined from the results of a TLD placed at a height of 1 meter (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 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 potential internal dose at each soil sample location was determined based on the laboratory analytical results of soil samples and residual radioactivity material guidelines (RRMGs) that were calculated using the Residual Radioactive (RESRAD) computer code, version 6.5 (Yu et al., 2001) (NNSA/NSO, 2012c). 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 are 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 sample location with the maximum internal dose. This was done under the conservative assumption that the internal dose at any CAU 569 location would constitute the same percentage of the total dose as at the location where the maximum internal dose was observed. Therefore, the ratio of the internal to external dose was determined at the sample location with the highest internal dose by dividing the internal dose by the external dose. This study-group-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 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, 2013) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

Because a calculated TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the calculated TED were significantly different than the true TED, a decision based on the calculated TED could result in a decision error. To reduce the probability of making a false negative decision error at probabilistic sample locations, a conservative estimate of the true TED is used to compare to the FAL instead of the calculated TED. This conservative estimate (overestimation) of the true TED was calculated as the 95 percent UCL of the average TED. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated 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 (250 days per year [day/yr], 8 hours per day [hr/day] for 25 years). The TED values calculated using this exposure scenario are the TED an industrial worker receives during 2,000 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 subsections describe specific investigation activities conducted at each study group. Additional information regarding the investigation is presented in Appendix A.

2.1.1 Study Group 1 (Catron and Coulomb-B)

Investigation activities at Study Group 1 included performing visual inspections, conducting TRSs, staging TLDs, and collecting probabilistic surface grab samples.

Information obtained after the CAIP was approved identified that the area of the Catron and Coulomb-B GZs was enclosed in a soil berm and covered with a layer of clean soil of unknown thickness. A default contamination boundary (DCB) was established surrounding the bermed GZ area (Sloop, 2013). A TLD was placed within the DCB (Location A02) to measure external dose, as a verification that the GZ area was covered with clean soil.

It was also discussed that the surface area within the southwestern portion of the Area 3 RWMS (outside the DCB) was scraped to lower contamination levels to RWMS site workers. This scraped surface soil was deposited in an area just outside the southeastern boundary of the RWMS (within Study Group 5) (Sloop, 2013). Because there is no longer the concern for buried horizons of soil contamination within the southwestern portion of the Area 3 RWMS, the CSM and sampling approach for Study Group 1 were modified to collect only surface grab samples within this area (see Appendix H). TLDs were installed at 10 sample locations within this scraped area to measure external radiological doses. Sampling activities to determine internal dose at these 10 locations consisted of the collection of surface grab samples.

TRSs (PRM-470 and KIWI) were conducted within the scraped area to identify locations of elevated radiological readings. The results of the PRM-470 TRS showed that the highest radiation readings were detected adjacent to the southern boundary of the RWMS (see Figure A.3-1). A TLD was placed at this location to measure external dose (Location A11). A TLD was also placed at the location of highest readings (Location A13) from the KIWI TRS, which was conducted in 1996 (see Figure A.3-2).

The results for the 10 sample locations established within the scraped area, as well as the two locations identified during the TRSs (Locations A11 and A13), were averaged together (presented as Location A14) to obtain an average dose for the area. See Figure A.3-3 for sample locations and Section A.3.1 for additional information on investigation activities at Study Group 1. Results of the sampling effort are reported in Section 2.2.

There is no assumed radiological contamination pattern at Study Group 1, which is consistent with the revised CSM. The surface radiological contamination is low throughout the Study Group 1 area, due to the surface area being scraped and the GZ area being covered with clean fill. Information gathered during the CAI supports and validates the revised CSM.

2.1.2 Study Group 2 (Pike)

Investigation activities at Study Group 2 included performing visual inspections, conducting TRSs, staging TLDs, and collecting both probabilistic and judgmental surface soil samples. The TRSs were conducted within the area surrounding the crater and the soil-covered fissure (established as a DCB) to identify locations of elevated radiological readings. The results of the TRSs showed that the highest radiation readings were detected adjacent to the southern edge of the Pike crater and confirmed that the fallout plume was positioned as expected (see Figures A.4-1 and A.4-2). TLDs were placed in this area to measure external dose (Locations B04 and B05), and one 100-square-meter (m^2) probabilistic sample plot was established at each of the two locations (see Figure A.4-3).

TLDs were also installed at six grid pattern locations to measure external radiological doses. See Section A.4.1 for additional information on investigation activities at Study Group 2. Results of the sampling effort are reported in Section 2.2.

During the visual inspections, a “FRAM” filter, intact lead-acid battery, and a potential mud pit were identified. A soil sample was collected from below the filter for waste management purposes as described in Section A.10.2.1. A sample (and duplicate) from the potential mud pit was collected from the center of the area. See Section 2.2 for the results of the sampling at the potential mud pit. Because there was no indication of a release, no samples were collected from below the lead-acid battery. However, the battery was removed from the site as a corrective action.

CAIs for Study Group 2 also included evaluation of the need for corrective action for the 30 underground tests in the vicinity of CAU 569 that had documented releases to the environment (Section 1.2). Aerial and ground-based radiological surveys were reviewed to determine whether any identifiable releases are present at any of these sites. The locations of these tests are shown on Figure 2-1.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 2 is consistent with the CSM in that the radiological contamination is greatest near the release point and generally decreases with distance from the release point. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.3 Study Group 3 (Annie, Franklin, George, and Moth)

Investigation activities at Study Group 3 included performing visual inspections, conducting TRSs, staging TLDs, and collecting probabilistic and judgmental surface soil samples. The TRSs were conducted within the area to identify locations of elevated radiological readings. The results of the TRS showed that the highest gamma radiation readings are present near GZ and confirmed that the fallout plume was positioned as expected (see Figure A.5-1). A TLD was placed in this area of elevated readings to measure external dose (Location C03), and one 100-m^2 probabilistic sample plot was established (see Figure A.5-2).

TLDs were installed at 17 grid pattern locations to measure external radiological doses. See Section A.5.1 for additional information on investigation activities at Study Group 3. Results of the sampling effort are reported in Section 2.2.

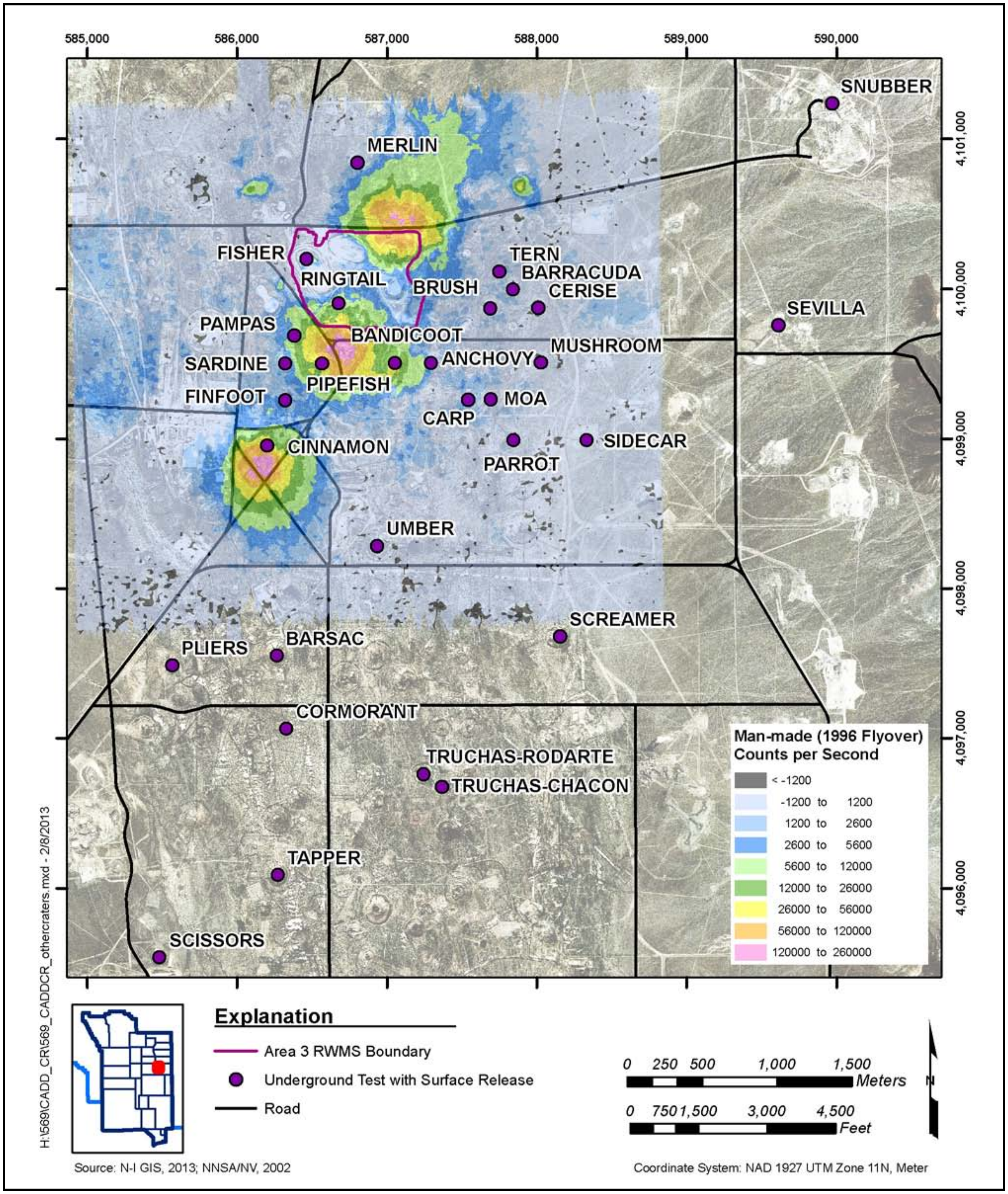

Figure 2-1
Other Test Areas Investigated in Study Group 2

During the visual inspections, a potential transformer area, a gear box, and two intact lead-acid batteries were identified. A sample was collected from the soil/pea gravel within the transformer area. See Section 2.2 for the results of the sampling at these locations. Waste management samples were collected from the gear box location and are discussed in Section A.10.2.1. Because there was no indication of a release, no samples were collected from below the lead-acid batteries. However, the batteries were removed from the site as a corrective action.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 3 is consistent with the CSM in that the radiological contamination is greatest at the release point, generally decreases with distance from the release point, and is biased in the northerly (downwind) direction. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.4 Study Group 4 (Humboldt)

Investigation activities at Study Group 4 included performing visual inspections, conducting TRSs, staging TLDs, and collecting probabilistic surface soil samples. The TRSs were conducted within the area to identify locations of elevated radiological readings. The results of the TRSs showed that the highest gamma radiation readings were identified within both the northern and southern contamination areas (CAs) and confirmed that the fallout plume was positioned as expected (see Figures A.6-1 and A.6-2). TLDs and 100-m^2 probabilistic sample plots were placed in the areas of most elevated readings to measure dose (Locations D01 and D02). Three additional sample plots with TLDs (Locations D04, D05, and D06) were established within isopleths generated from the KIWI TRS. See Figure A.6-3 for sample locations and Section A.6.1 for additional information on investigation activities at Study Group 4. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 4 is consistent with the CSM in that the radiological contamination is greatest at the release point and generally decreases with distance from the release point. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.5 Study Group 5 (Harry, Hornet, Rio Arriba, and Coulomb-A)

Investigation activities at Study Group 5 included performing visual inspections, conducting TRSs, geophysical surveys, staging TLDs, and collecting probabilistic and judgmental surface and shallow subsurface soil samples within the atmospheric depositional area and within an area where soil from within the RWMS was dumped. The TRSs were conducted within Study Group 5 to identify locations of elevated radiological readings. Within the atmospheric depositional area, the results of the PRM-470 TRS showed that the highest radiation readings were detected northeast of the Harry and Hornet GZ (Location E14) (see Figure A.7-1). The results of the KIWI TRS, conducted in this area in 1996, showed two areas of elevated readings (see Figure A.7-2). TLDs and 100-m^2 probabilistic sample plots were placed in these three areas of most elevated readings from the PRM-470 and KIWI surveys (Locations E01, E14, and E18) (see Figure A.7-3). Additionally, three Decision II sample plots with TLDs (Locations E26, E28, and E30) were established within decreasing isopleths identified in the 1996 aerial radiological survey (BN, 1999). TLDs were also installed at 25 grid pattern locations to measure external radiological doses, as established in the CAIP (NNSA/NSO, 2012a).

Information obtained after the CAIP was approved identified that the surface soil within the southwest portion of the RWMS (within Study Group 1) was removed and dumped within Study Group 5 (see Section 2.1.1 and Appendix H). The revised CSM includes the possibility for contamination within this soil dump area to be present down to native soil, which is approximately 4 ft deep. Because soil within this area was mixed together, and the entire 4 ft of soil is assumed to be contaminated, four grab sample locations in this area were chosen and investigated for buried soil contamination down to native soil.

TRSs were conducted within this RWMS soil dump area, and results showed two areas of elevated readings (see Figure A.7-2) based on the 1996 KIWI TRS. TLDs and 100-m^2 probabilistic sample plots were placed at these two locations (E07 and E09) (see Figure A.7-3).

A geophysical survey was conducted in RWMS soil dump area to identify potential buried metallic debris. Results of the geophysical survey indicate distinct pieces of metallic debris generally separated by meters and are not indicative of a landfill containing significant amounts of metal.

See Section A.7.1 for additional information on investigation activities at Study Group 5. Results of the sampling effort are reported in Section 2.2.

During the visual inspections conducted within the entire Study Group 5 area, a decontamination pad, two potential transformer areas, a lead brick, and a cracked lead-acid battery were identified. Samples were collected from each of two transformer areas, a decontamination area, from below a lead-acid battery, and from below a lead brick. The battery and lead brick were removed for disposal as PSM. See Section 2.2 for the results of the sampling at these locations. Waste management samples were collected from the containerized soil which was removed from the lead brick location. See Section A.10.2 for additional details on the sampling of the containerized soil waste.

The contamination pattern of the radionuclides at Study Group 5 is consistent with the revised CSM in that there are elevated surface radiological readings within RWMS soil dump area. Additionally, the radiological contamination within the fallout plume at Study Group 5 is greatest at the release point and generally decreases with distance from the release point. Information gathered during the CAI supports and validates the revised CSM.

2.1.6 Study Group 6 (Fizeau)

Investigation activities at Study Group 6 included performing visual inspections, conducting TRSs, staging TLDs, and collecting judgmental and probabilistic surface soil samples. The TRSs were conducted within the area to identify locations of elevated radiological readings. The results of the PRM-470 TRS showed that the highest radiation readings were detected east of GZ (Location F15) (see Figure A.8-1). A KIWI survey was also conducted in 1996, and the highest radiological readings were detected northeast of GZ (Location F14) (see Figure A.8-2). A TLD and one 100-m^2 probabilistic sample plot were established within each of these locations (see Figure A.8-3). Four Decision II sample plots with TLDs (Locations F18, F19, F21, and F27) were established within decreasing isopleths identified in the 1996 aerial radiological survey (BN, 1999).

TLDs were installed at 15 grid pattern locations to measure external radiological doses. See Section A.8.1 for additional information on investigation activities at Study Group 6. Results of the sampling effort are reported in Section 2.2.

During the visual inspections, a pile of white gravelly material; a layer of fine black material on a soil pile; a rusty petroleum naphtha drum; and three areas of crushed, scattered lead-acid batteries were identified. Samples were collected from the pile of white gravelly material, the pile of soil covered with fine black material, and from the soil under a closed rusty drum labeled as containing "140 Solvent-66 Petroleum Naphtha." See Section 2.2 for the results of the sampling at these locations.

Three areas (Locations F31 through F33) of scattered, crushed lead-acid batteries were identified within Study Group 6. A sample plot was established within each of these three areas. Four composite samples were collected from each of the three sample plots in the same manner as described in Section A.2.2.3. See Section 2.2 for the results of the sampling at these locations.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 6 is consistent with the CSM in that the radiological contamination is greatest at the release point and generally decreases with distance from the release point. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.7 Study Group 7 (Waste Consolidation Site 3A)

Investigation activities at Study Group 7 included performing visual inspections, conducting TRSs and geophysical surveys, staging TLDs, and collecting surface and shallow subsurface judgmental soil samples. The TRSs were conducted within the area of the former waste consolidation site and current fenced area to identify locations of elevated radiological readings. The results of the TRS showed that the highest radiation readings were detected west of the fenced area (see Figures A.9-1 and A.9-2). A TLD was placed in the area of most elevated readings to measure external dose (see Figure A.9-3). It is stated in the CAU 569 CAIP (NNSA/NSO, 2012a) that a ground-based radiological survey would be conducted to identify any elevated levels of radioactivity. If levels are greater than two times background levels, then a sample plot would be established within the area of highest values. Within this plot, four screening locations would be investigated to determine whether buried soil contamination exists. Results of the TRSs (both PRM-470 and FIDLER) show that the areas of elevated radiological readings are much smaller than the area of a sample plot. Therefore, in lieu of a sample plot being established in that location, two grab samples locations were established in the locations of the highest readings (see Figure A.9-3). To investigate the potential for the presence of buried soil contamination, samples were screened at 5-centimeter (cm) intervals down to 1 ft bgs, as discussed in Section A.2.2.2. Results of the sampling effort are reported in Section 2.2.

Results of the geophysical survey indicate distinct pieces of metallic debris generally separated by meters and are not indicative of a landfill containing significant amounts of metal.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 7 is consistent with the CSM in that there is limited surface radiological contamination. The geophysical survey showed that subsurface contamination is not present. Information gathered during the CAI supports and 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 569. Section 2.2.2 summarizes the assessment made in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

The preliminary action levels (PALs) and FALs for radioactivity 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 569 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs for radioactivity were established in the CAIP (NNSA/NSO, 2012a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 250 day/yr and 8 hr/day). The FALs for radioactivity were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario defines that a site worker would be exposed to site contamination for 10 day/yr and 8 hr/day). The CAU 569 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.

The chemical PALs are based on the U.S. Environmental Protection Agency (EPA) Region 9 Regional Screening Levels for chemical contaminants in industrial soils (EPA, 2012) except where natural background concentrations of *Resource Conservation and Recovery Act* (RCRA) metal exceed the screening level (e.g., arsenic on the NNSS). The chemical contaminant FALs, except for lead, were established in Appendix C at the PAL concentrations. The FAL for lead was established in Appendix C based on EPA's Adult Lead Methodology (ALM) (EPA, 2009).

2.2.1 Summary of Analytical Data

Chemical and radiological results for environmental samples collected at each of the study groups are summarized in the following subsections. Chemical results are reported as individual analytical results compared to their individual FALs. PSM samples are evaluated against the PSM criteria listed in Section A.2.5 and assumptions defined in Section 2.3 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. For radioactivity, results are reported as TED comparable to the radiological FAL as established in Appendix C. 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, A.6.2.3, A.7.2.3, A.8.2.3, and A.9.2.3.

Judgmental sample results are reported as individual analytical results and as multiple contaminant analyses where the combined effect of contaminants are compared to FALs. Probabilistic sample results are reported as the average and the 95 percent UCL of the average results.

Soil samples are evaluated against FALs to determine the presence of COCs and the extent of COC contamination, if present. PSM samples are evaluated against the PSM criteria listed in Section A.2.5 and assumptions defined in Section 2.3 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. Discussions of the results for samples collected at CAU 569 are grouped geographically (i.e., study group).

2.2.1.1 Study Group 1

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected from the scraped area at Study Group 1, surface radiological contamination does not exceed the FAL for the radiological dose

(25 mrem/OU-yr). Because this area was characterized probabilistically, an average dose for the soil samples and TLDs was calculated. This TED is presented as Location A14.

For the DCB established for the bermed GZ area, it is assumed that subsurface radiological contamination exceeds the FALs. Therefore, a corrective action is required for this area. One TLD was placed within this area (Location A02). The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-1.

Table 2-1
Study Group 1 TED at Sample Locations (mrem/yr)

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
A02[a]	2.4	7.4	0.4	1.2	0.1	0.4
A14[b]	9.9	12.0	1.7	2.0	0.5	0.6

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (see Section A.2.2.4).
[b] Probabilistic sample - average and UCL based on 10 grab samples and TLD elements from 12 TLDs.

2.2.1.2 Study Group 2

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Study Group 2, surface radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-2). However, within the DCB, at locations where it was not feasible to collect samples (Pike crater and fissure area), it is assumed that radiological contamination exceeds the FALs. Therefore, a corrective action is required. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-2.

For the underground tests in the vicinity of CAU 569 that had documented releases to the environment (Section 1.2), aerial and ground-based radiological surveys were reviewed to determine whether any identifiable releases are present. At Bandicoot, elevated readings above background were identified in the aerial and ground-based surveys. Reading above background were not

Table 2-2
Study Group 2 TED at Sample Locations (mrem/yr)

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
B01[a]	1.5	3.9	0.3	0.6	0.1	0.2
B02[a]	2.7	6.6	0.4	1.1	0.1	0.3
B03[a]	**29.6**	**36.8**	5.0	6.2	1.5	1.9
B04[b]	**61.1**	**69.7**	10.3	11.7	3.2	3.6
B05[b]	**68.8**	**79.0**	11.6	13.3	3.6	4.1
B06[a]	3.0	5.8	0.5	1.0	0.2	0.3
B07[a]	4.9	8.2	0.8	1.4	0.3	0.4
B08[a]	6.4	10.3	1.1	1.7	0.3	0.5

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (see Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

identified at any of the other tests in either aerial or ground-based surveys. As measurements to determine dose could not be made within the crater area at Bandicoot, it is assumed that radiological contamination within the crater area exceeds FALs. Therefore, a corrective action is required for the Bandicoot crater.

PSM consisting of an intact lead-acid battery was identified at Study Group 2. No indications of a release were identified; therefore, no soil samples were collected below this PSM. The presence of this PSM requires corrective action.

An area resembling a mud pit (with no bermed sides) was identified north of Pike GZ and sampled; however, no sample results exceeded FALs. See Section A.4.2.4 for the results above MDCs.

2.2.1.3 Study Group 3

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Study Group 3, surface radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-3). Therefore, a corrective action is not required.

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

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

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
C01[a]	16.4	18.3	2.8	3.1	0.8	0.9
C02[a]	**28.8**	**33.1**	4.8	5.6	1.4	1.7
C03[b]	**124.0**	**133.7**	20.8	22.5	6.2	6.7
C04[a]	**41.6**	**47.7**	7.0	8.0	2.1	2.4
C05[a]	**53.2**	**59.1**	8.9	9.9	2.7	3.0
C06[a]	**29.0**	**36.7**	4.9	6.2	1.5	1.8
C07[a]	15.4	18.2	2.6	3.1	0.8	0.9
C08[a]	**25.6**	**31.7**	4.3	5.3	1.3	1.6
C09[a]	10.1	13.6	1.7	2.3	0.5	0.7
C10[a]	**46.0**	**53.4**	7.7	9.0	2.3	2.7
C11[a]	**62.3**	**71.5**	10.5	12.0	3.1	3.6
C12[a]	**58.9**	**65.6**	9.9	11.0	2.9	3.3
C13[a]	**47.5**	**53.6**	8.0	9.0	2.4	2.7
C14[a]	8.8	10.3	1.5	1.7	0.4	0.5
C15[a]	18.7	19.9	3.1	3.3	0.9	1.0
C16[a]	13.8	17.8	2.3	3.0	0.7	0.9
C18[a]	**26.0**	**28.9**	4.4	4.8	1.3	1.4
C19[a]	**78.2**	**90.3**	13.1	15.2	3.9	4.5

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (see Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

Four intact lead-acid batteries were identified at Study Group 3. No indications of a release were identified; therefore, no soil samples were collected below this PSM. The presence of this PSM requires corrective action.

Samples were collected from a potential former transformer area and from the soil underneath a gear box. No sample results exceeded FALs. See Section A.5.2.4 for the analytical results above MDCs.

2.2.1.4 Study Group 4

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Study Group 4, surface radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-4). Therefore, a corrective action is not required.

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

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
D01[a]	**25.9**	**31.6**	4.4	5.3	1.4	1.7
D02[a]	**48.2**	**67.6**	8.1	11.4	2.7	3.7
D04[a]	10.7	14.2	1.8	2.4	0.6	0.7
D05[a]	7.0	8.7	1.2	1.5	0.4	0.5
D06[a]	7.5	10.7	1.3	1.8	0.4	0.6

[a]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

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

2.2.1.5 Study Group 5

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected within the atmospheric depositional area at Study Group 5, surface radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-5). Therefore, a corrective action is not required.

Based on analytical results for soil (0 to 5 cm bgs or 0 to 1 ft bgs) samples collected within the RWMS soil dump area at Study Group 5, radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-5). Therefore, a corrective action is not required. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-5.

Table 2-5
Study Group 5 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

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
Atmospheric Depositional Area						
E01[a]	20.9	24.2	3.5	4.1	1.1	1.2
E02[b]	**32.1**	**37.6**	5.4	6.3	1.7	2.0
E03[b]	**43.3**	**48.2**	7.3	8.1	2.3	2.5
E04[b]	**124.8**	**132.3**	21.0	22.2	6.5	6.9
E05[b]	**98.4**	**114.9**	16.5	19.3	5.1	6.0
E10[b]	18.3	22.6	3.1	3.8	1.0	1.2
E11[b]	**35.5**	**41.2**	6.0	6.9	1.9	2.1
E12[b]	**91.9**	**96.8**	15.5	16.3	4.8	5.0
E13[b]	**163.6**	**169.7**	**27.5**	**28.5**	8.6	8.9
E14[a]	**160.8**	**170.2**	**27.0**	**28.6**	8.0	8.5
E15[b]	**129.7**	**134.9**	21.8	22.7	6.8	7.0
E16[b]	**28.2**	**29.5**	4.7	5.0	1.5	1.5
E17[b]	**26.8**	**28.8**	4.5	4.8	1.4	1.5
E18[a]	**116.8**	**123.6**	19.6	20.8	5.8	6.2
E19[a]	**96.1**	**99.9**	16.1	16.8	5.0	5.2
E20[b]	**112.4**	**117.5**	18.9	19.7	5.9	6.1
E21[b]	**46.5**	**51.4**	7.8	8.6	2.4	2.7
E22[b]	4.7	6.9	0.8	1.2	0.2	0.4
E23[b]	20.9	24.0	3.5	4.0	1.1	1.2
E24[b]	**42.5**	**48.3**	7.1	8.1	2.2	2.5
E25[b]	**62.0**	**66.2**	10.4	11.1	3.2	3.5
E26[a]	**49.1**	**54.7**	8.3	9.2	2.5	2.7
E27[b]	**58.8**	**65.2**	9.9	11.0	3.1	3.4

Table 2-5
Study Group 5 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

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
E28[a]	**30.3**	**35.0**	5.1	5.9	1.5	1.8
E29[b]	**25.6**	**29.6**	4.3	5.0	1.3	1.5
E30[a]	13.3	16.7	2.2	2.8	0.7	0.8
E31[b]	**27.9**	**32.9**	4.7	5.5	1.5	1.7
E32[b]	**29.3**	**36.3**	4.9	6.1	1.5	1.9
E33[b]	--	--	--	--	--	--
RWMS Soil Dump Area						
E06[b]	**34.8**	**37.5**	5.8	6.3	1.8	2.0
E07 (plot)[a]	**27.6**	**33.4**	4.6	5.6	1.4	1.8
E07 (grab)[c]	23.9	**27.9**	4.0	4.7	1.2	1.4
E08[a]	**34.8**	**42.7**	5.9	7.2	1.8	2.2
E09 (plot)[a]	11.8	16.3	2.0	2.7	0.6	0.9
E09 (grab)[c]	8.7	11.9	1.5	2.0	0.4	0.6
E39[d]	7.5	NC	1.3	NC	0.3	NC
E40[d]	2.0	NC	0.3	NC	0.1	NC

[a]Judgmental sample - results from TLD elements and 4 composite (plot) samples.
[b]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (see Section A.2.2.4).
[c]Judgmental sample - results from TLD elements and 1 grab sample.
[d]Judgmental sample - results from 1 grab sample using total dose RRMGs (see Section A.7.2.1).

-- = Data not available.
NC = 95% UCL not able to be calculated for this sample.

Bold indicates the values equal to or greater than 25 mrem/yr.

Samples were collected from two potential former transformer areas and a decontamination pad. Soil samples were also collected from beneath a lead-acid battery and a lead brick. No sample results exceeded FALs. However, the presence of this PSM requires corrective action. See Section A.7.2.4 for the analytical results above MDCs.

2.2.1.6 Study Group 6

Based on analytical results for surface soil (0 to 5 cm bgs) samples collected at Study Group 6, surface radiological contamination does not exceed the FAL for radiological dose (25 mrem/OU-yr) at any sample location (Table 2-6). Therefore, a corrective action is not required. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-6.

Table 2-6
Study Group 6 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

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
F05[a]	12.1	13.5	2.0	2.3	0.6	0.7
F06[a]	19.5	23.4	3.3	3.9	1.0	1.2
F07[a]	18.5	22.1	3.1	3.7	0.9	1.1
F08[a]	8.8	11.8	1.5	2.0	0.4	0.6
F09[a]	11.3	12.9	1.9	2.2	0.6	0.6
F10[a]	**25.5**	**32.1**	4.3	5.4	1.3	1.6
F11[a]	**41.9**	**50.5**	7.0	8.5	2.1	2.5
F12[a]	**47.1**	**59.7**	7.9	10.0	2.4	3.0
F13[a]	4.4	5.2	0.7	0.9	0.2	0.3
F14[b]	**124.7**	**133.4**	21.0	22.4	6.3	6.7
F15[b]	**183.6**	**196.4**	**30.8**	**32.9**	9.2	9.9
F16[a]	**141.3**	**147.0**	23.7	24.7	7.1	7.4
F17[a]	**118.3**	**125.6**	19.9	21.1	5.9	6.3
F18[b]	**39.3**	**47.8**	6.6	8.0	2.0	2.4
F19[b]	20.4	24.2	3.4	4.1	1.0	1.2
F20[a]	22.3	**25.4**	3.7	4.3	1.1	1.3
F21[b]	12.2	15.7	2.1	2.6	0.6	0.8
F22[a]	**25.6**	**29.4**	4.3	4.9	1.3	1.5
F23[a]	**97.3**	**101.4**	16.3	17.0	4.9	5.1
F24[a]	15.3	18.4	2.6	3.1	0.8	0.9

Table 2-6
Study Group 6 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

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
F25[a]	**190.3**	**214.7**	**32.0**	**36.1**	9.6	10.8
F26[a]	**215.0**	**288.7**	**36.1**	**48.5**	10.8	14.5
F27[b]	**84.4**	**91.9**	14.2	15.4	4.2	4.6

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (see Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

Soil samples were collected from a pile of white gravelly material; a pile of sand covered with fine black material; from beneath and surrounding a closed rusty drum labeled as containing "140 Solvent-66 Petroleum Naphtha"; and within three areas of scattered debris. No sample results exceeded FALs. The crushed lead-acid batteries were not removed from site, because the small size of the lead pieces were not amenable to removal. See Section A.8.2.4 for the analytical results above MDCs.

2.2.1.7 Study Group 7

Based on analytical results for surface and shallow subsurface soil (0 to 5 cm bgs and 10 to 15 cm bgs) samples collected at Study Group 7, radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sample location (Table 2-7). Therefore, a corrective action is not required. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-7.

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 defines the type, quality, and quantity of data needed to support the

Table 2-7
Study Group 7 TED at Sample Locations (mrem/yr)

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
G01[a]	10.6	10.8	1.8	1.8	0.5	0.5
G01 (subsurface)[b]	14.2	14.5	2.4	2.4	0.7	0.8
G02[a]	9.8	10.1	1.7	1.7	0.5	0.5

[a]Judgmental sample - results from TLD elements and grab 2 samples.
[b]Judgmental sample - results from grab sample only. TLD-equivalent external dose was calculated using the subsurface sample results.

resolution of DQO 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:

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

The results of the DQI evaluation show that criteria were not met in the areas of accuracy and precision. However, as presented in Appendix B, these deficiencies do not affect the decision-making process.

Sample locations that support the presence and/or extent of contamination at each study group are shown in Appendix B. Based on the results of the DQA presented in Appendix B, the nature and extent of COCs at CAU 569 have been adequately identified to develop and evaluate CAAs. The DQA also determined that information generated during the investigation supports the CSM assumptions, and the data collected met the DQOs and support their intended use in the decision-making process.

2.2.2.1 Study Group 1 Resolution of DQO Decisions

Decision I

The DQO decision on the presence of COCs was resolved for the bermed area at the Catron and Coulomb-B GZs based on the assumption of COCs by the established DCB. Corrective action and the resolution of Decision II is required for this area.

No COCs were identified at the scraped area in the southwestern portion of the Area 3 RWMS. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

Decision II

The DQO decision on the extent of COCs was resolved for the bermed area at the Catron and Coulomb-B GZs based on the physical dimensions of the bermed area (the DCB).

The DQO decision on the sufficiency of information to determine potential remediation waste types and evaluate the feasibility of remediation alternatives was resolved. Sufficient information was available to evaluate the CAAs presented in Appendix E.

2.2.2.2 Study Group 2 Resolution of DQO Decisions

Decision I

The DQO decision on the presence of COCs was resolved for the Pike crater and covered fissure based on the assumption of COCs by the established DCB, and for the Bandicoot crater based on the assumption of COCs within the crater area, as indicated on the radiological surveys. Corrective action and the resolution of Decision II is required for these areas.

No COCs were identified at any sampled location within Study Group 2 outside the DCB. Therefore, no additional corrective action is needed, and Decision II does not need to be resolved for this area.

PSM in the form of one intact lead-acid battery was identified at Study Group 2. Corrective action is required for the PSM. The PSM was removed from the site as a corrective action, and no indications of a release to the soil were identified. Therefore, no further corrective action is needed, and Decision II does not need to be resolved for the PSM.

Decision II

The DQO decision on the extent of COCs was resolved for the Pike crater and bermed fissure, based on the physical dimensions of the crater and bermed fissure (the DCB), the area exceeding 25 mrem/IA-yr, and the area exceeding CA criteria.

The DQO decision on the extent of COCs was resolved for the Bandicoot crater based on the physical dimensions of the Bandicoot crater.

The DQO decision on the sufficiency of information to determine potential remediation waste types and evaluate the feasibility of remediation alternatives was resolved. Sufficient information was available to evaluate the CAAs presented in Appendix E.

2.2.2.3 Study Group 3 Resolution of DQO Decisions

Decision I

No COCs were identified at any sampled location within Study Group 3. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

PSM in the form of four intact lead-acid batteries were identified at Study Group 3. Corrective action is required for the PSM. The PSM was removed from the site as a corrective action, and no indications of a release to the soil were identified. Therefore, no further corrective action is needed, and Decision II does not need to be resolved for the PSM.

2.2.2.4 Study Group 4 Resolution of DQO Decisions

Decision I

No COCs were identified at any sampled location within Study Group 4. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

2.2.2.5 Study Group 5 Resolution of DQO Decisions

Decision I

No COCs were identified at any sampled location within the atmospheric depositional area at Study Group 5. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

No COCs were identified at any sampled location within the RWMS soil dump area at Study Group 5. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

PSM in the form of one lead brick and one cracked lead-acid battery were identified at Study Group 5. Corrective action is required for the PSM. The PSM and associated soil were removed as a corrective action, and verification samples confirmed that COCs are not present in the remaining soil. Therefore, no further corrective action is needed, and Decision II does not need to be resolved for the PSM.

2.2.2.6 Study Group 6 Resolution of DQO Decisions

Decision I

No COCs were identified at any sampled location within Study Group 6. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

2.2.2.7 Study Group 7 Resolution of DQO Decisions

Decision I

No COCs were identified at any sampled location within Study Group 7. Therefore, no corrective action is needed, and Decision II does not need to be resolved for this area.

2.3 Justification for No Further Action

No further corrective action is needed for the CASs within CAU 569 based on the implementation of corrective actions or the absence of contamination exceeding risk-based levels (presented in Section 2.3.1). Some corrective actions were completed during the CAI by removing PSM. For every site where contamination exceeds a FAL after the CAI, an FFACO use restriction (UR) was implemented under an FFACO corrective action of closure in place. All FFACO URs are recorded in the FFACO database; the DOE, National Nuclear Security Administration (NNSA) Nevada Field Office Management and Operating (M&O) Geographic Information System (GIS); and the NNSA Nevada Field Office CAU/CAS files. These FFACO URs require warning signs and annual inspections to certify that postings are in place, intact, and readable.

If an exposure scenario other than the Industrial Work Area scenario is used to calculate a FAL for any site, an administrative UR will be required if contamination exceeds a PAL (the PALs are based on the Industrial Work Area exposure scenario). An administrative UR will not be used to satisfy corrective action requirements but will be implemented as a best management practice (BMP) to warn potential future site workers if a change in site use could cause increased exposure to site contamination. Administrative URs are recorded and tracked identically to FFACO URs but do not require site warning signs.

The need for further corrective action is evaluated for each study group in Sections 2.3.2 through 2.3.8.

2.3.1 Final Action Levels

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NSO, 2012b). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012c) requires the use of ASTM International (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 or to establish that corrective action is not necessary.” For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses. These tiers are defined in Appendix C.

A Tier 1 evaluation was conducted to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. For chemical contaminants, this was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP [NNSA/NSO, 2012a]). For radiological contaminants, this was accomplished by comparing the radiological PAL of 25 mrem/IA-yr to the TED at each sample location calculated using the Industrial Area exposure scenario.

The only contaminant detected at CAU 569 that exceeded Tier 1 action levels was radionuclides at Study Groups 1, 2, 3, 4, 5, and 6.

The FALs for all non-radiological contaminants except lead were established as the Tier 1 action levels. The FALs for lead and radiological contaminants were passed on to a Tier 2 evaluation.

The Tier 2 evaluation was conducted in accordance with the Soils RBCA document (NNSA/NSO, 2012c). This evaluation (presented in Appendix C) was based on risk to receptors. The risk to receptors from contaminants at CAU 569 is due to chronic exposure to contaminants (e.g., 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 CAU 569 sites determined that workers may be present at these sites for only 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).

Based on current site usage, it was determined in the CAU 569 DQOs that the Occasional Use Area exposure scenario would be appropriate in calculating receptor exposure time. In order to quantify the maximum number of hours a site worker may be present at CAU 569, current and anticipated future site activities were evaluated in Appendix C. This evaluation concluded that the most exposed worker under current land usage is the Area 3 RWMS Worker, who has the potential to be present at the site for up to 40 hr/yr. As a result, it was determined that the most exposed worker could not be exposed to site contamination for more time than is assumed under the Occasional Use Area exposure scenario (80 hr/yr). Therefore, the Tier 2 action level and the TEDs at each location were calculated using a more conservative exposure time of 80 hr/yr. The 95 percent UCL of the TED measured at each location was used to compare to the FAL. Additional details of the Tier 2 evaluation for radionuclides are provided in Appendix C.

Using the 95 percent UCL of the TED at the location of maximum measured dose at any study group, a receptor would have to be exposed to this location for 233 hours to receive a dose of 25 millirem (mrem). Thus, a receptor exposed to CAU 569 contamination for 80 hr/yr (Occasional Use Area exposure scenario) would not exceed the 25-mrem/yr dose limit.

The Tier 2 evaluation for lead compared the analytical results to the Tier 2 action levels. The Tier 2 action level was calculated using EPA's ALM to estimate the concentration of lead in the blood of pregnant women and their developing fetuses who might be exposed to lead-contaminated soils (EPA, 2009). This calculation used a site-specific soil ingestion rate (of 0.067 grams/day [g/day]) and an exposure frequency of 44 day/yr. The FAL for lead established in Appendix C using this methodology is 8,356 milligrams per kilogram (mg/kg).

2.3.2 Study Group 1 (Catron and Coulomb-B)

Based on analytical results for environmental samples collected from within the scraped area at this study group, no COCs have been identified. Therefore, corrective action is not required for the scraped area.

It is assumed that soil buried within the bermed GZ area (DCB) contains COCs. Therefore, corrective action is required for this area (corrective action boundary [CAB]). Based on the completed implementation of the corrective action of closure in place with an FFACO UR, no additional corrective action is required for this study group, and no potential receptors will be subjected to an unacceptable risk from remaining contamination at this site.

2.3.3 Study Group 2 (Pike)

PSM consisting of one lead-acid battery was removed from the site under a corrective action. Therefore, no additional corrective action is required for this PSM.

Based on analytical results for environmental samples collected at this study group outside the DCB, no COCs have been identified. Therefore, corrective action is not required for this area.

It is assumed that soil within the Pike crater and covered fissure, and within the Bandicoot crater contains COCs. Therefore, corrective action is required for these areas (CABs). Based on the completed implementation of the corrective action of closure in place with an FFACO UR, no additional corrective action is required for this study group, and no potential receptors will be subjected to an unacceptable risk from remaining contamination at this site.

2.3.4 Study Group 3 (Annie, Franklin, George, and Moth)

PSM consisting of four intact lead-acid batteries was removed from the site under corrective actions. Therefore, no additional corrective action is required for this PSM.

Based on analytical results for environmental samples collected at this study group, no COCs are present, and no corrective actions are required. Therefore, no further action is required for this site, because potential receptors will not be subjected to an unacceptable risk from remaining contamination at this site.

2.3.5 Study Group 4 (Humboldt)

Based on analytical results for environmental samples collected at this study group, no COCs are present, and no corrective actions are required. Therefore, no further action is required for this site, because potential receptors will not be subjected to an unacceptable risk from remaining contamination at this site.

2.3.6 Study Group 5 (Harry, Hornet, Rio Arriba, and Coulomb-A)

PSM consisting of one lead-acid battery and one lead brick was removed from the site under corrective actions. Therefore, no additional corrective action is required for this PSM.

Based on analytical results for environmental samples collected at this study group, no COCs are present within the atmospheric depositional area or the RWMS soil dump area, and no corrective actions are required. Therefore, no further action is required for this site, because potential receptors will not be subjected to an unacceptable risk from remaining contamination at this site.

2.3.7 Study Group 6 (Fizeau)

Based on analytical results for environmental samples collected at this study group, no COCs are present, and no corrective actions are required. Therefore, no further action is required for this site, because potential receptors will not be subjected to an unacceptable risk from remaining contamination at this site.

2.3.8 Study Group 7 (Waste Consolidation Site 3A)

Based on analytical results for environmental samples collected at this study group, no COCs are present, and no corrective actions are required. Therefore, no further action is required for this site, because potential receptors will not be subjected to an unacceptable risk from remaining contamination at this site.

3.0 Recommendation

Corrective actions at all nine 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 Occasional Use Area exposure scenario (with an exposure duration of 80 hr/yr of site worker exposure) to determine FALs (except for lead, which used the Remote Work Area exposure scenario).

For sampled locations at all nine CASs, radiological contamination does not exceed the FAL of 25 mrem/OU-yr. However, it is assumed that radioactivity exceeds FALs within the bermed GZ at CASs 03-23-13 (Catron) and 03-23-15 (Coulomb-B), within the crater and fissure area at CAS 03-23-21 (Pike), and within the nearby Bandicoot crater. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with FFACO URs. FFACO URs were established to encompass these areas (see Sections A.3.3 and A.4.3) as shown on Figures A.3-5 and A.4-5.

The FFACO URs implemented at CASs 03-23-13, 03-23-15, and 03-23-21 will protect site workers from inadvertent exposure. The FFACO URs are presented in Attachment D-1 and contain the applicable boundaries, site controls, conditions of use, and maintenance requirements.

No further corrective action is required at CAU 569 based upon implementation of corrective actions at the CAU 569 CASs. The corrective actions for CAU 569 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.

In accordance with the Soils RBCA document (NNSA/NSO, 2012c) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), an administrative UR was implemented as a BMP for any area where an industrial land use of the area could cause a future site worker to receive an annual dose exceeding 25 mrem/yr. This assumes the worker would be exposed to site contamination for a period of 2,000 hr/yr). Administrative URs (implemented as BMPs) are not part of any FFACO corrective action. The administrative UR boundaries at Study Groups 3, 4, 5, and 6 were established to encompass the TRS isopleth corresponding to a dose of 25 mrem/IA-yr and any area exceeding CA criteria for removable contamination (see Sections A.5.4, A.6.4, A.7.4, and A.8.4). Also included within the administrative UR for Study Group 5 is the entire RWMS soil dump area (see Section A.7.4 for justification). This will prevent any inadvertent exposure of workers to site radioactivity if a more intensive use of the site were to be considered in the future.

The administrative URs will be recorded and controlled in the same manner as the FFACO URs, but will not require posting or inspections. The administrative URs are presented in Attachment D-1.

All URs are recorded in the FFACO database, the NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. The development of URs for CAU 569 are based on current land use. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

The DOE, NNSA Nevada Field Office 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. The DOE, under its regulatory authority for management of radioactive waste materials associated with environmental remediation activities, approves these actions (USC, 2012).

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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 569. CAU 569 consists of the following nine CASs located in Area 3 of the NNSS:

- 03-23-09, T-3 Contamination Area
- 03-23-10, T-3A Contamination Area
- 03-23-11, T-3B Contamination Area
- 03-23-12, T-3S Contamination Area
- 03-23-13, T-3T Contamination Area
- 03-23-14, T-3V Contamination Area
- 03-23-15, S-3G Contamination Area
- 03-23-16, S-3H Contamination Area
- 03-23-21, Pike Contamination Area

CAS 03-23-09, T-3 Contamination Area (referred to as Annie, Franklin, Moth, and George in this document), is located within and north of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Annie, Franklin, George, and Moth atmospheric weapons-related tests. Annie (yield of 16 kt), Franklin (yield of 140 tons), George (yield of 15 kt), and Moth (yield of 2 kt) were detonated from a 300-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-10, T-3A Contamination Area (referred to as Harry and Hornet in this document), is located south of the Area 3 Radioactive RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Harry and Hornet atmospheric weapons-related tests. Harry (yield of 32 kt) and Hornet (yield of 4 kt) were detonated from a 300-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-11, T-3B Contamination Area (referred to as Fizeau in this document), is located southwest of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Fizeau atmospheric weapons-related test. Fizeau had a yield of 11 kt and was detonated from a 500-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-12, T-3S Contamination Area (referred to as Rio Arriba in this document), is located south of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Rio Arriba atmospheric weapons-related test. Rio Arriba had a yield of 90 tons and was detonated from a 72.5-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-13, T-3T Contamination Area (referred to as Catron in this document), is located within the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Catron atmospheric safety experiment. Catron had a yield of 21 tons and was detonated from a 72.5-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-14, T-3V Contamination Area (referred to as Humboldt in this document), is located adjacent to the northern boundary of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Humboldt atmospheric weapons-related test. Humboldt had a yield of 7.8 tons and was detonated from a 25-ft-tall tower (DOE/NV, 2000; GE, 1979).

CAS 03-23-15, S-3G Contamination Area (referred to as Coulomb-B in this document), is located within the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Coulomb-B atmospheric safety experiment. Coulomb-B had a yield of 300 tons and was detonated at a height of 3 ft above ground surface (DOE/NV, 2000; GE, 1979).

CAS 03-23-16, S-3H Contamination Area (referred to as Coulomb-A in this document) is located south of the Area 3 RWMS. This CAS consists of a deposition of radioactive contamination as a result of the Coulomb-A atmospheric safety experiment. Coulomb-A had a zero yield and was detonated at the ground surface (DOE/NV, 2000; GE, 1979).

CAS 03-23-21, Pike Contamination Area (referred to as Pike in this document), is located northeast of the Area 3 RWMS. This CAS consists of a release of surface and near-surface radioactive contamination as a result of the venting of radioactive gases from a fissure formed during the Pike weapons-related underground test. Pike had a yield of less than 20 kt and was detonated below ground surface at a depth of 374 ft (Shoengold et al., 1996; DOE/NV, 2000).

Waste Consolidation Site 3A was identified during a historical document review and is located north of CAS 03-23-21 (Pike). It consists of the potential release of contaminants associated with the consolidation of soil and debris from atmospheric testing operations. Due to its geographic proximity to CAS 03-23-21 (Pike), Waste Consolidation Site 3A has been included in the scope of this CAS.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAIP (NNSA/NSO, 2012a).

A.1.1 Investigation 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 569. This objective was achieved by identifying the nature and extent of COCs; and by evaluating, selecting, and implementing acceptable CAAs.

For radiological contamination, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding the FAL of 25 mrem/yr. For chemical contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.5).

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 the contents of this document.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.9.0 provide study-group-specific (see Section A.2.0) information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.10.0 summarizes waste management activities.
- Section A.11.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.12.0 provides a summary of the investigation results.
- Section A.13.0 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 CAU 569 files as hard copy files or electronic media.

A.2.0 Investigation Overview

The following CAU 569 CAI activities were conducted from April 23 through November 8, 2012:

- Performed visual and radiological surveys.
- Conducted geophysical surveys.
- Established sample plot and biased sample locations.
- Collected soil samples at sample plot and biased sampling locations.
- Collected QC soil samples.
- Submitted soil samples for analysis.
- Staged TLDs at environmental sample and background locations.
- Collected and submitted TLDs for analysis.
- Collected GPS coordinates of sample locations, TLD locations, and points of interest.
- Performed limited removal of PSM wastes.
- Conducted waste management activities (e.g., sampling, disposal).

The investigation and sampling program adhered to the requirements set forth in the CAU 569 CAIP (NNSA/NSO, 2012a) (except any deviations described herein) and in accordance with the Soils QAP (NNSA/NSO, 2012b), which establishes requirements, technical planning, and general quality practices. The evaluation of investigation results and the risk associated with site contamination was conducted in accordance with the Soils RBCA document (NNSA/NSO, 2012c).

To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for different releases were organized into study groups. The study groups and the CASs associated with each study group are described in Table A.2-1 and shown on Figure A.2-1. Although the need for corrective action is evaluated separately for each study group, CAAs are evaluated for each FFACO CAS.

The study groups 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 (NNSA/NSO, 2012a) with minor deviations. Sections A.2.1 through A.2.5 provide the general investigation and evaluation methodologies.

Table A.2-1
CAU 569 Study Groups

FFACO CASs	Test	Study Group
03-23-13	Catron	1
03-23-15	Coulomb-B	
03-23-21	Pike	2
	Waste Consolidation Site 3A	7
03-23-09	Annie, Franklin, George, and Moth	3
03-23-14	Humboldt	4
03-23-10	Harry and Hornet	5
03-23-12	Rio Arriba	
03-23-16	Coulomb-A	
03-23-11	Fizeau	6

A.2.1 Sample Locations

All sample plot and grab sample locations within Study Groups 2 through 7 were selected judgmentally based on biasing factors such as site-specific TRS values, the 1996 KIWI radiological survey americium (Am)-241 values (Hendricks, 2011), the 1996 aerial radiological survey isopleths (BN, 1999b), potential releases identified during site visits, visual identification of sedimentation areas in drainages, and site physical features as described in the CAIP (NNSA/NSO, 2012a). The grab sample locations within Study Group 1 were selected probabilistically based on a random-start triangular pattern, because the areas were disturbed with significant mixing of soil such that there is no discernible spatial pattern of contamination. For this area, any DQO decision will be applied to the entire disturbed area.

Soil sample aliquot locations within the sample plots were determined using a probabilistic sampling approach. Composite soil samples were collected using an unbiased, predetermined random-start, triangular grid pattern.

Sample plot locations, grab sample locations, TLD sample locations, and points of interest were surveyed with a GPS instrument. Appendix G presents these data in a tabular format. Specific sample locations and the rationale for selecting sample locations are shown in the study group-specific sections (see Sections A.3.0 through A.9.0).

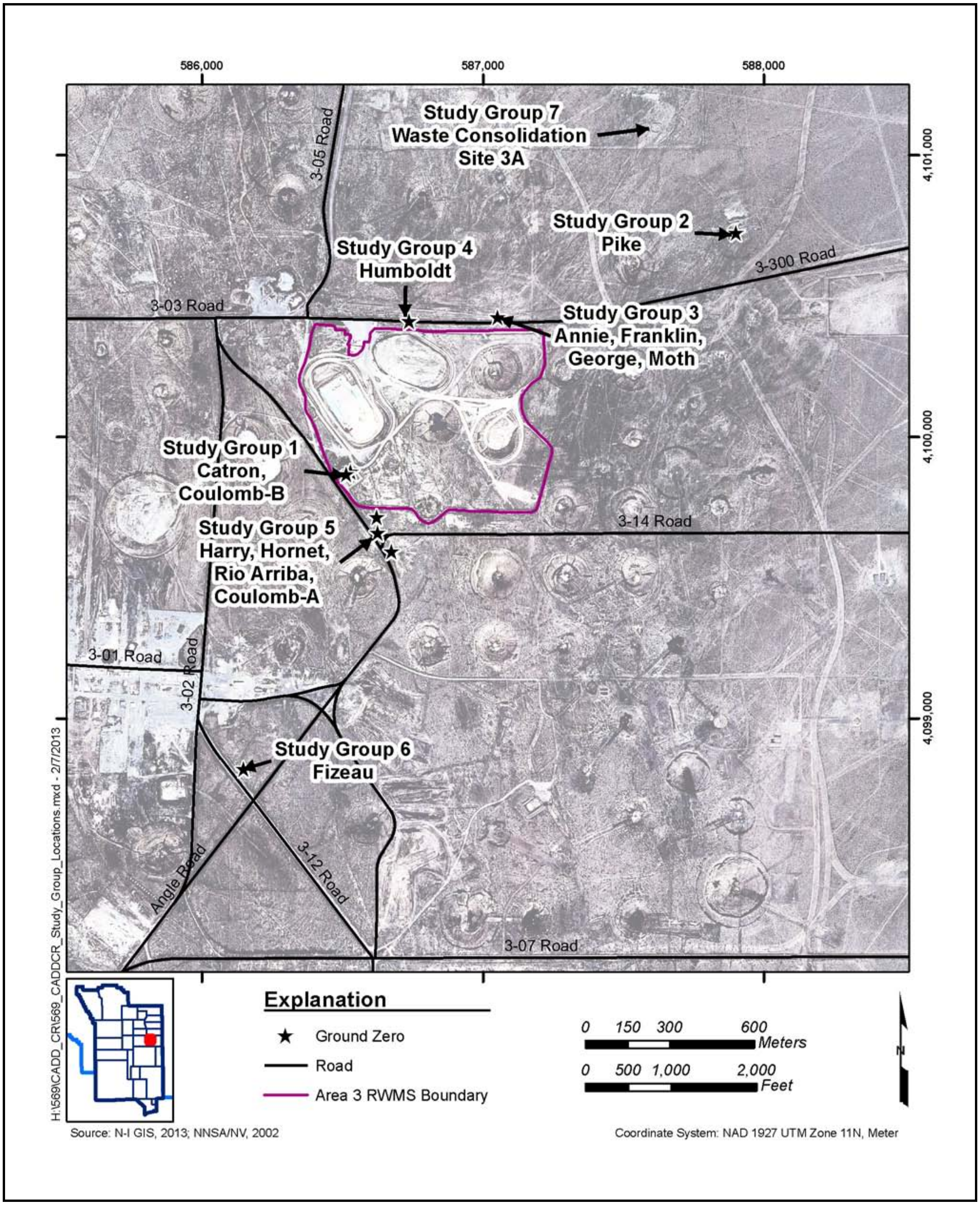

Figure A.2-1
CAU 569 Study Group Location Map

A.2.2 Investigation Activities

The investigation activities as listed in Section A.2.0 performed at CAU 569 were consistent with the field investigation activities specified in the CAIP (NNSA/NSO, 2012a). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each study group. The following subsections describe the specific investigation activities that took place at CAU 569.

A.2.2.1 Radiological Surveys

Aerial radiological surveys and TRSs were conducted at the CAU 569 CASs. Aerial surveys were performed at the sites in 1994 at an altitude of 200 ft with 500-ft flight-line spacing (BN, 1999a). Another aerial survey was conducted in Area 3 in 1996 at an altitude of 50 ft with 75-ft flight line spacing (BN, 1999b). This later survey provides better resolution of the distribution of site radioactivity and was used in selecting sampling locations.

TRSs were performed in 2012 to identify specific locations for sample plots, TLD placement, and biased sample locations. Count-rate data were collected using two radiological instruments: the TSA Systems PRM-470 model plastic scintillator and a field instrument for the detection of low-energy radiation (FIDLER). The FIDLER was used at Study Groups 2, 4, 5, and 6 where plutonium was identified as a potential contaminant. The PRM-470 instrument was used at all study groups. Count-rate and position data were collected and recorded at 1-second intervals, via a Trimble Systems GeoXT GPS unit. The travel speed was approximately 1 to 2 m per second with the radiation detector held at a height of approximately 0.5 m above ground surface. Count rates for the PRM-470 and FIDLER are expressed in units of counts per second (cps) and evaluated qualitatively as comparative relative spatial distributions in units of multiples of background.

A KIWI survey was conducted in 1996 within Area 3 to measure gamma radiation within the area. The KIWI is an array of sodium-iodide detectors mounted on a vehicle approximately 2.5 ft above the ground surface with line spacings of approximately 2 m. The count rate data from the KIWI survey were post-processed in October 2011 to extract the Am-241 component (Hendricks, 2011). Count rates for the KIWI are expressed in units of cps and presented as net cps (with background cps levels subtracted).

A.2.2.2 Field Screening

The study group-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. Field-screening results (FSRs) are recorded on SCLs that are retained in project files.

Field screening was used at CAU 569 to evaluate the presence of buried contamination at Study Groups 5 and 7 and to aid in the selection of biased samples for laboratory analyses. Field screening was limited to radiological parameters and was conducted using an NE Electra instrument. Field screening was used to determine whether there is a potential for buried contamination to be present at concentrations higher than that of the surface soil (that could result in a higher dose to a future receptor than the dose from the current soil surface). This was accomplished at Study Groups 5 and 7 by removing separate 1-ft-depth increments of soil at the sample location to a total depth of 3 to 4 ft; and by removing 5-cm-depth increments of soil at the sample location to a total depth of 30 cm bgs, respectively. Each of these depth increments of soil were screened for radioactivity (see Sections A.7.1.4.1 and A.9.1.4.1). Buried contamination is considered to be present if the depth interval reading exceeds the FSL (described below) and if there is a greater than 20 percent difference between the depth interval reading and the surface soil reading. For locations where it was determined that buried contamination was present, a sample from the depth interval with the highest reading was submitted for offsite laboratory analyses.

Field screening was also used at CAU 569 to determine which plot samples would be analyzed for the additional analytes strontium (Sr)-90, plutonium (Pu)-241, and technetium (Tc)-99. These analyses were determined based on highest FSRs among the plot samples for each study group. Refer to the study-group specific sampling locations for additional information.

Site-specific FSLs are determined daily before investigational soil sampling begins. An area is selected in the vicinity of the site that has a minimal probability of being impacted from releases or site operations. Ten or more surface soil aliquots, from the top 5 cm of soil, are collected at grid locations within the selected area. The aliquots are then mixed, and 10 one-minute static counts are obtained for both alpha and beta/gamma measurements. The FSLs for both alpha and beta/gamma are calculated by multiplying the sample standard deviation by 2 and adding that value to the sample average (roughly equivalent to the 95 percent UCL).

A.2.2.3 Soil Sampling

Soil sampling at CAU 569 consisted of the collection of surface soil and shallow subsurface samples within sample plots and at grab sample locations. Within each sample 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 the 3.5-inch (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.

At grab sample locations collected for radiological purposes, samples were collected from the surface 5-cm interval using the "vertical-slice cylinder and bottom-trowel" method as described above. Where there was the potential for subsurface contamination, additional depth intervals were collected and field screened as described in Section A.2.2.2. For grab sample locations collected for chemical purposes, samples were collected from the soil surface using a disposable scoop.

After collection, each aliquot from a plot sample or each grab sample (collected for radiological purposes) 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). Oversized material that did not pass through the sieve was returned to the original sample location. Each sample was then transferred to a sample container, which was then sealed.

A.2.2.4 Internal Dose Estimates

The analytical results used to calculate dose were the detected values reported by the analytical laboratories with special consideration for Am-241, uranium (U)-235, and the reported plutonium isotopes. Am-241 is reported by the gamma spectrometry method and by the isotopic americium method. As the distribution of Am-241 in soil can be heterogeneous (see Section B.1.1.1.1) and the gamma spectrometry measurement is based on a much larger soil sample (usually 1 liter) than the isotopic americium measurement (usually 1 to 2 grams), the gamma spectrometry result was used to calculate dose. Because U-235 generally has a homogeneous distribution in soil, the more precise isotopic results were used instead of the corresponding result reported from gamma spectrometry when an isotopic U-235 result was available. Soil concentrations of plutonium isotopes are inferred from gamma spectroscopy results as described in Section B.1.1.1.1.

Internal dose was estimated using the radionuclide analytical results from soil samples and the corresponding RRMG (NNSA/NSO, 2012c). 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 (assuming 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 RESRAD computer code (Yu et al., 2001) under the appropriate exposure scenario (NNSA/NSO, 2012c).

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 (NNSA/NSO, 2012c) to yield a fraction of the 25-mrem/yr dose and then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. The internal doses for all radionuclides detected in a soil sample were then summed to yield an internal dose for that sample. For probabilistic 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 (NNSA/NSO, 2012c). For judgmental sample locations 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 soil sample with the maximum internal dose within the same study group. The internal dose for each of these locations was calculated by multiplying this ratio by the external dose value specific to each TLD location using the following formula:

$$\textit{Internal dose}_{est} = \textit{External dose}_{est} \times [\textit{Internal dose} / \textit{External dose}]_{max}$$

where

est = location for the estimate of internal dose
max = location of maximum internal dose

Use of this method to estimate internal dose will overestimate the internal dose (and therefore TED), as the internal to external dose ratio generally decreases with decreasing TED values.

A.2.2.5 External Dose Measurements

TLDs (Panasonic UD-814) were staged at CAU 569 with the objective of collecting *in situ* measurements to determine the external radiological dose. TLDs were placed in background areas (beyond the influence of study group releases), at the approximate center of each sample plot, at specific grab sample locations, and at other biased locations. Each TLD was placed at a height of 1 m above the ground surface, which is consistent with TLD placement in the NNSS routine environmental monitoring program (see Section A.11.5). Once retrieved from the field locations, the TLDs were analyzed by automated TLD readers that are calibrated and maintained by the NNSS 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.11.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location. The TLD results are discussed in each study group-specific section.

The TLDs used at CAU 569 contain four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4. Each of these elements is considered to ba a separate independent measurement of external dose. A 95 percent UCL of the average of these measurements was calculated for each TLD location. 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.

Estimates of external dose at the CAU 569 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result). The background TLDs measure (1) the dose the TLDs were exposed to while not deployed in the field and (2) dose from natural sources in areas unaffected by the CAU-related releases during field deployment.

To aid in the determination of the proper background dose to use in TED calculation, a background isopleth map generated from the 1994 aerial radiological survey was used to verify that background TLDs represent the background dose estimated at CAU 569 TLD locations (Figure A.2-2). The background TLDs were placed in areas beyond the influence of study group releases. It was determined that the background TLD locations are representative of the general area and can be used as a good estimate of true average background dose for all of the environmental TLDs. Because there was no significant variance in background TLD values at any location, an average of the six background TLDs (28.9 mrem/IA-yr) (Locations C17, D03, F01, F02, F03, and F04) was used for all study groups.

A.2.3 Total Effective Dose

The measured 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 measured TED calculated from sample results is an estimate of the true (unknown) TED. It is uncertain how well the measured TED represents the true TED. If a measured TED were directly compared to the FAL, any significant difference between the true TED and the measured TED could lead to decision errors. To reduce the probability of a false negative decision error for probabilistic sampling results, 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 measured TED. The probabilistic sampling design as described in the CAIP (NNSA/NSO, 2012a) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The 95 percent UCL of the TED at each sample location was calculated as the sum of the 95 percent UCLs of the internal and external doses, where available.

A minimum number of samples is required to assure sufficient confidence in dose statistics for probabilistic sampling such as the average and 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2012a), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of the minimum sample size is described in Section B.1.1.1.1.

To reduce the probability of a false negative decision error for judgmental sampling results, samples were biased to locations of higher radioactivity. Samples from these locations will produce TED

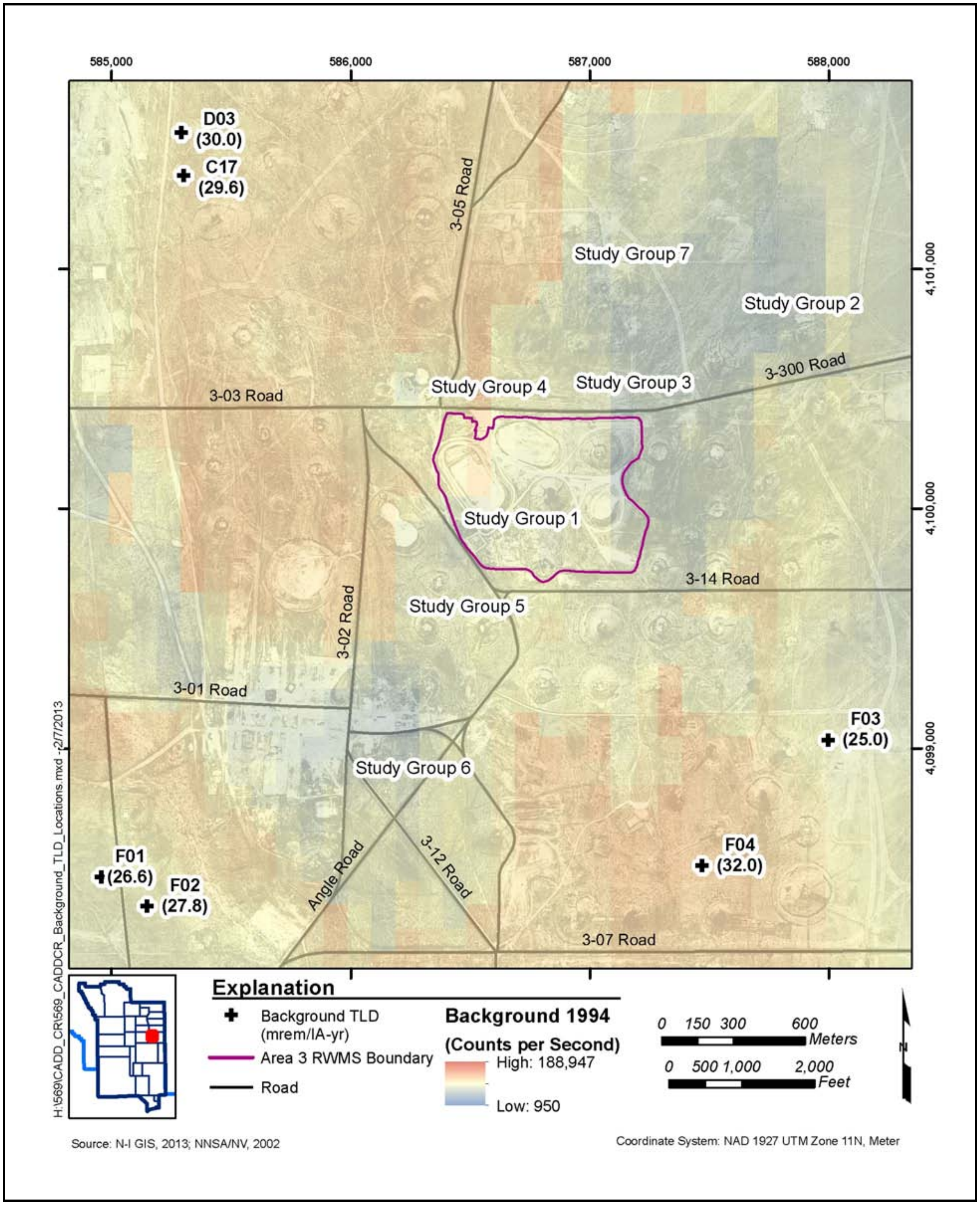

Figure A.2-2
CAU 569 Background TLD Locations

results that are higher than from adjacent locations of lower radioactivity within the exposure area that is being characterized for dose. This will conservatively overestimate the true TED of the exposure area and protect against false negative decision errors.

A.2.4 Laboratory Analytical Information

Radiological and chemical analyses of the collected soil samples were performed by General Engineering Laboratories, LLC, of Charleston, South Carolina. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in the CAIP (NNSA/NSO, 2012a). 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.

Validated analytical data for CAU 569 investigation samples have been compiled and evaluated to determine the presence of COCs and to define the extent of COC contamination if present. The analytical results for each study group are presented in Sections A.3.0 through A.9.0.

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

A.2.5 Comparison to Action Levels

The radiological 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 569 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, 2012a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario in which a site worker is exposed to site contamination for 250 day/yr and 8 hr/day). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario in which a site worker is exposed to site contamination for 10 day/yr and 8 hr/day).

Results for each of the study groups are presented in Sections A.3.2, A.4.2, A.5.2. A.6.2, A.7.2, A.8.2, and A.9.2. Radiological results are reported as doses that are comparable to the dose-based

FAL as established in Appendix C. Chemical results are reported as individual concentrations that are comparable to the individual chemical FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the study group-specific results tables.

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, 2012c). If COCs are present, corrective action must be considered for the study group.

A corrective action may also be required if a waste present within a study group 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 release the contaminants 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 divided by the mass of the potentially contaminated soil. 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 divided by the mass of the potentially

contaminated soil (for each radioactive contaminant) and calculating the combined dose using the appropriate RRMGs. If the resulting dose 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.2.6 Correlation of Dose to Radiation Survey Isopleths

A boundary for a corrective action or an administrative UR for a particular release site may be established by using radiation survey isopleths if it can be shown that a sufficient correlation exists between TED and radiation survey values. This is accomplished by pairing each TED value with a radiation survey value from the corresponding geographic location. Correlation statistics are then used to establish the relationship between the paired values as well as an indicator of the strength of the relationship (i.e., the coefficient of determination, or r^2). The minimum strength of the relationship for a valid correlation was defined as an r^2 of 0.8.

The TED values used in the correlation were the 95 percent UCL of the TED for probabilistic samples or the calculated TED for judgmental samples from biased sample locations. The values from the radiation surveys were based on interpolated values at the TED location. These interpolated values were generated from a continuous spatial distribution (i.e., interpolated surface) that was estimated using an inverse distance weighted interpolation technique.

A correlation for each radiation survey was established to identify the radiation survey that has the best correlation to the Occasion Use Area exposure scenario TED values. This correlation was used to establish a radiation survey value corresponding to the FAL when establishing CABs. A similar correlation of radiation survey values to the Industrial Area exposure scenario TED values was used to establish administrative UR boundaries.

A.3.0 Study Group 1, Catron, Coulomb-B

Study Group 1, Catron and Coulomb-B, is located in Area 3 of the NNSS, within the southwestern portion of the Area 3 RWMS. The study group consists of a release of radionuclides to the soil surface from the Catron and Coulomb-B surface safety experiments. Catron had a yield of 21 tons and was detonated from a 72.5-ft-tall tower. Coulomb-B had a yield of 300 tons and was detonated at a height of 3 ft above ground surface. The GZ area of Catron and Coulomb-B is covered by a layer of clean fill and surrounded by a soil berm. A DCB was established for this bermed GZ area.

The surface soil within the southwest portion of the Area 3 RWMS (outside the bermed GZ area) was scraped to lower the contamination levels for RWMS workers. This scraped soil was dumped within the boundary of Study Group 5 (Sloop, 2013). Additional detail on the history of Study Group 1 is provided in the CAIP (NNSA/NSO, 2012a) and Section A.3.1.4.

A.3.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.3.1.1 Visual Inspections

Visual inspections of Study Group 1 were conducted during site walks, sampling efforts, and radiological surveys over the course of the field investigation within the bermed GZ area and scraped area. The presence of scattered debris was identified and noted. However, no biasing factors (indicating the potential release of contamination) were identified, and no additional samples were collected as a result of the visual inspections. Visual inspections also included looking for drainages; however, no visible drainages were identified.

A.3.1.2 Radiological Surveys

TRSs were performed using a PRM-470 instrument at Study Group 1 during the CAI. The TRSs were conducted within the bermed GZ area and scraped area within the southwest portion of the Area 3 RWMS to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest PRM-470 radiological readings was detected within the scraped area, adjacent to the southern berm of the RWMS. A TLD was placed at this location (A11) to measure external dose. A KIWI TRS was also conducted within the bermed GZ area and scraped area in 1996, and a TLD was placed within the scraped area at the location of highest KIWI readings (Location A13). Figures A.3-1 and A.3-2 present a graphic representation of the data from the PRM-470 and KIWI TRSs, respectively.

A.3.1.3 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.3.1.3.1 Soil Samples

No soil samples were collected from the bermed GZ area.

Soil samples from within the boundary of the scraped area were collected under a probabilistic design to represent the area as a whole. A total of 11 environmental grab samples (including 1 field duplicate [FD]) were collected at Locations A01, A03 through A10, and A12 (as shown on Figure A.3-3). These sample locations were established based on a random start, triangular pattern. All samples were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Sample A004 from Location A05 and Sample A011 from Location A12 were also analyzed for Sr-90, Pu-241, and Tc-99, based on highest alpha or beta FSRs among the 11 samples collected at Study Group 1. Information including depth and purpose for each soil sample collected for Study Group 1 is provided in Table A.3-1.

A.3.1.3.2 TLD Samples

One TLD (Location A02) was placed to measure the external dose within the bermed GZ area.

For the scraped area, TLDs were installed at the 10 grab sample locations described in Section A.3.1.3.1 and at Locations A11 and A13 TLDs. The TLDs placed at Locations A11 and A13 were based on the highest readings as detected during the PRM-470 and KIWI TRSs (Figures A.3-1 and A.3-2).

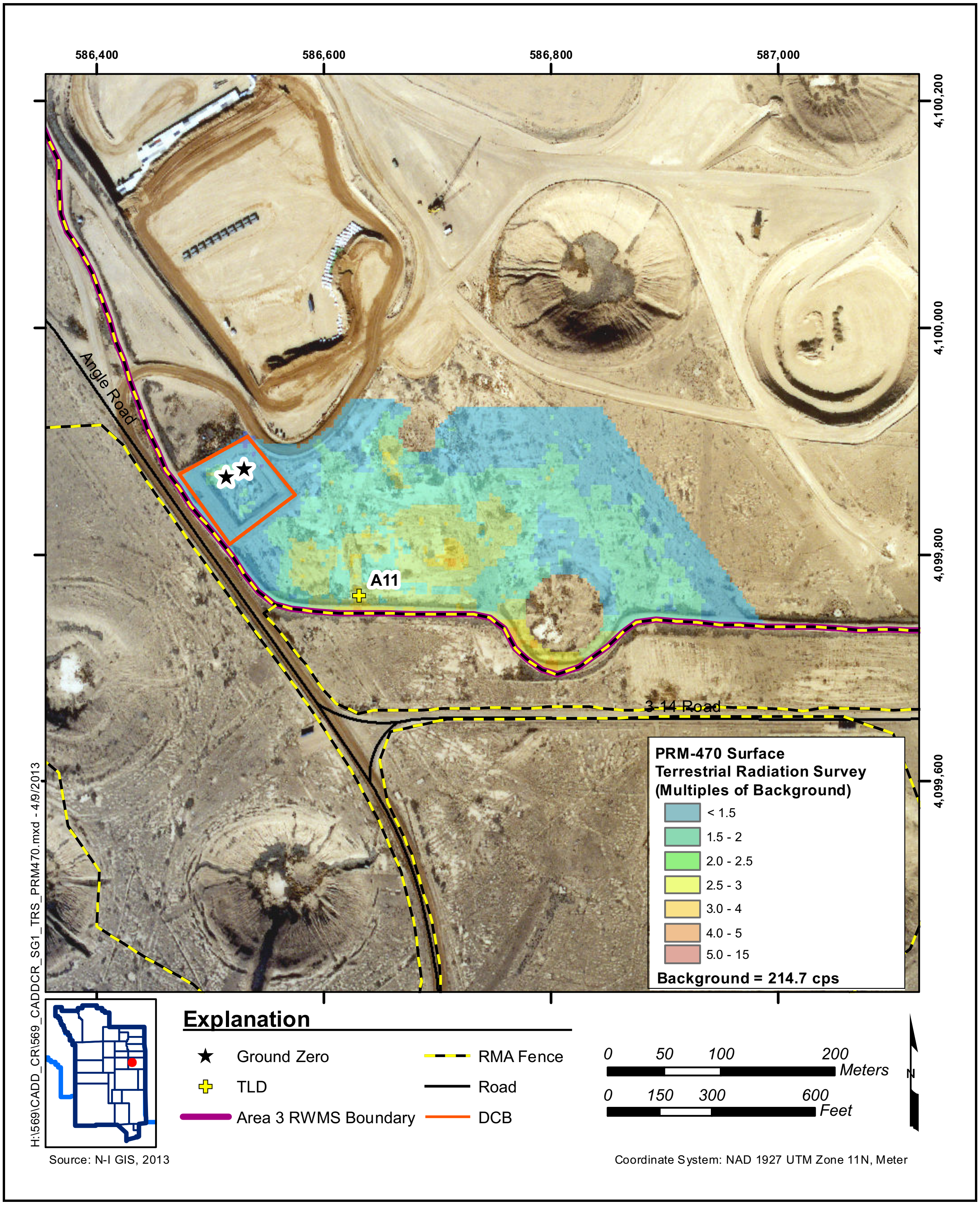

Figure A.3-1
PRM-470 TRS Results for Study Group 1

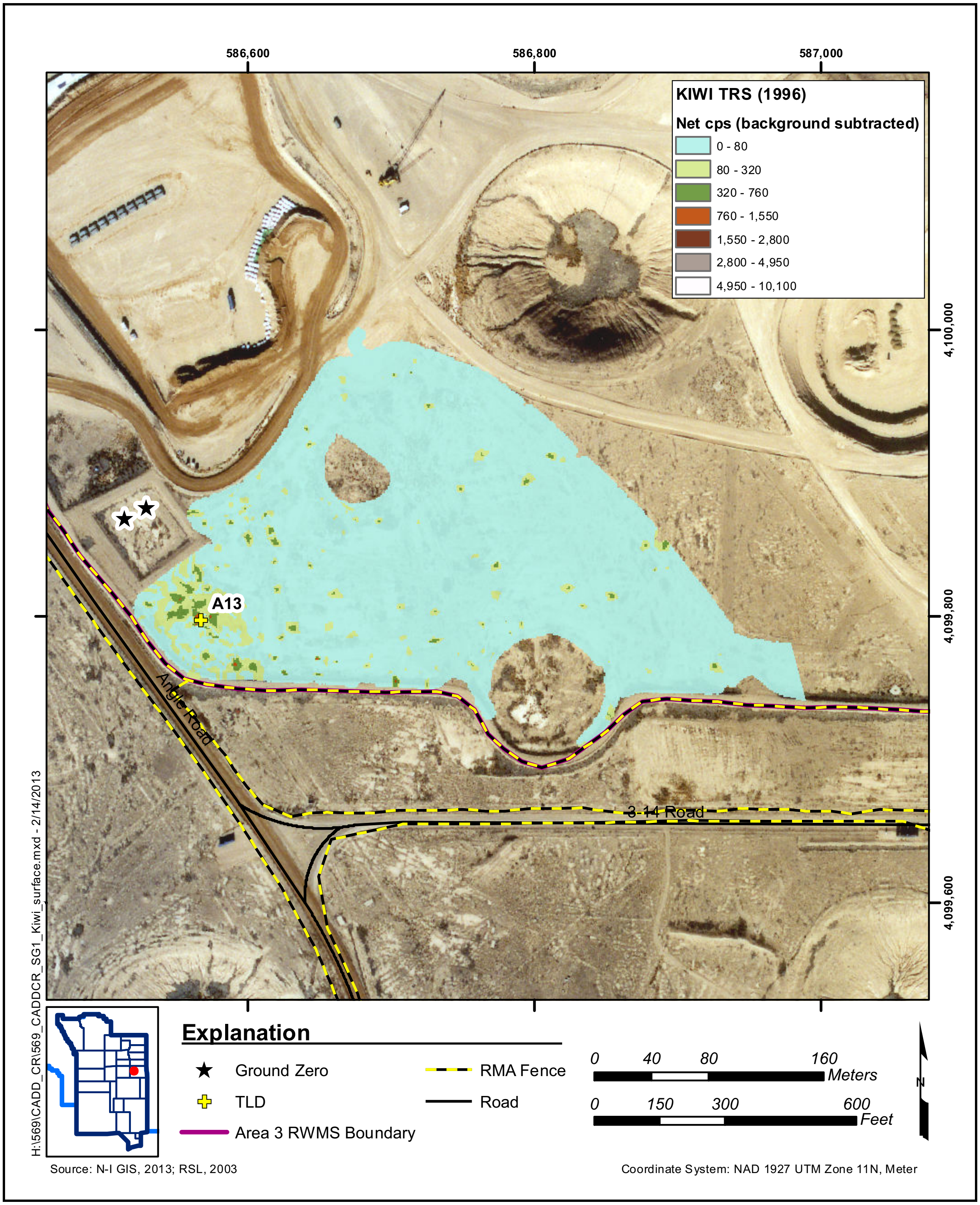

Figure A.3-2
KIWI TRS Results for Study Group 1

Table A.3-1
Soil Samples Collected at Study Group 1

Location	Sample Number	Depth (cm bgs)	Purpose
A01	A001	0.0 - 5.0	Grab
A03	A002	0.0 - 5.0	Grab
A04	A003	0.0 - 5.0	Grab
A05	A004	0.0 - 5.0	Grab, Lab QC
	A005	0.0 - 5.0	FD of A004
A06	A006	0.0 - 5.0	Grab, Lab QC
A07	A007	0.0 - 5.0	Grab
A08	A008	0.0 - 5.0	Grab
A09	A009	0.0 - 5.0	Grab
A10	A010	0.0 - 5.0	Grab
A12	A011	0.0 - 5.0	Grab

All TLDs are listed in Table A.3-2. The TLDs were analyzed by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.3-3 for TLD locations.

A.3.1.4 Deviations

In e-mail correspondence dated May 31, 2012 (see Appendix H), the CSM for Study Group 1 was revised (Section 2.1.1). No deviations to the revised CSM were noted.

A.3.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a) with the exceptions noted in Section A.3.1.4. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

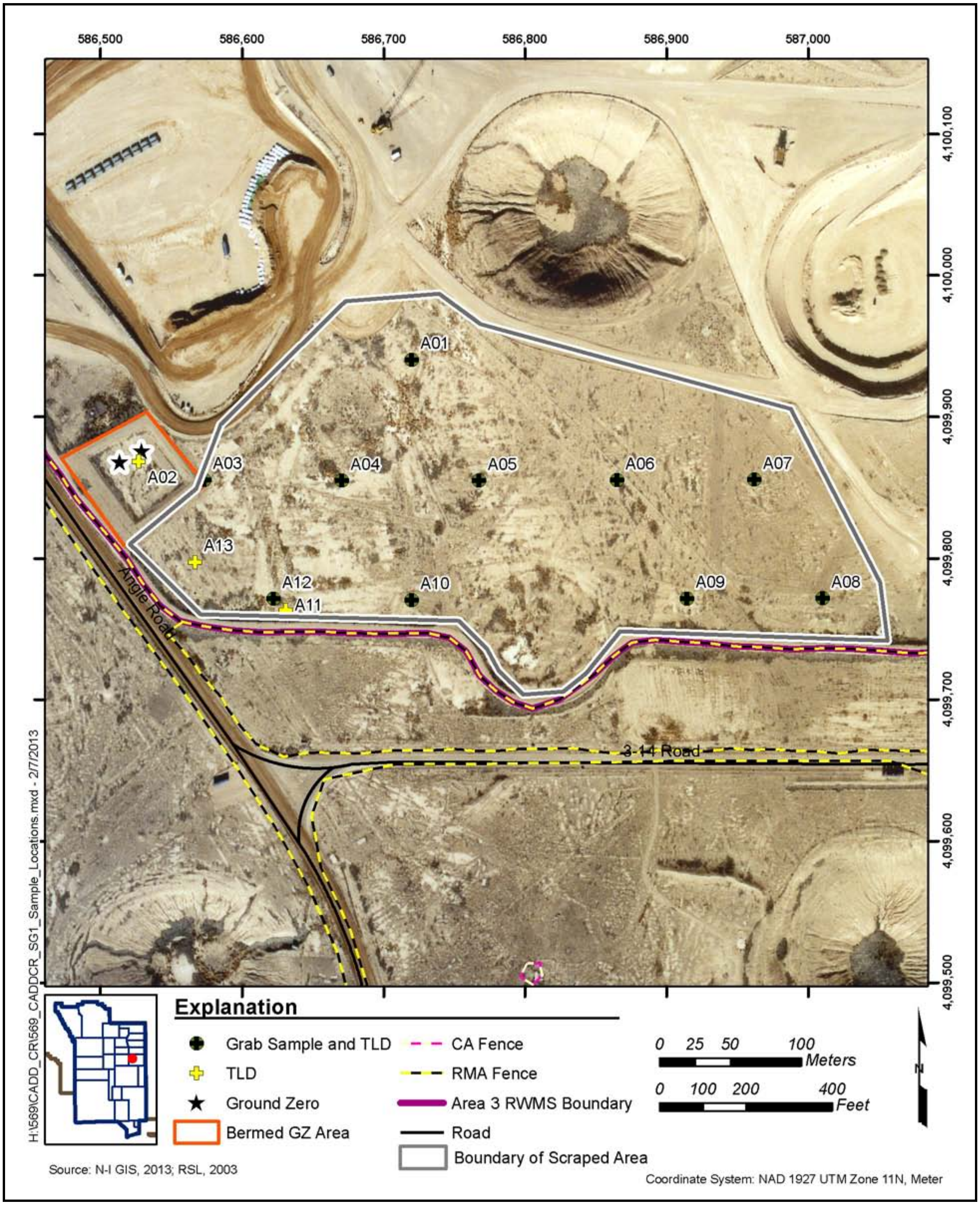

Figure A.3-3
Study Group 1 Sample and TLD Locations

Table A.3-2
TLDs at Study Group 1

Location	TLD No.	Date Placed	Date Removed	Purpose
A01	4358	04/24/2012	07/30/2012	Grab Sample
A02	4432	04/24/2012	07/30/2012	TLD Only (GZ Area)
A03	4910	04/24/2012	07/30/2012	Grab Sample
A04	5262	04/24/2012	07/30/2012	Grab Sample
A05	4436	04/24/2012	07/30/2012	Grab Sample
A06	4614	04/24/2012	07/30/2012	Grab Sample
A07	4367	04/24/2012	07/30/2012	Grab Sample
A08	4926	04/24/2012	07/30/2012	Grab Sample
A09	4721	04/24/2012	07/30/2012	Grab Sample
A10	4679	04/24/2012	07/30/2012	Grab Sample
A11	4402	04/24/2012	07/30/2012	TLD Only (KIWI Highest Reading)
A12	4832	04/24/2012	07/30/2012	Grab Sample
A13	5088	04/24/2012	07/30/2012	TLD Only (PRM-470 Highest Reading)

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

As specified in the CAIP (NNSA/NSO, 2012a), the samples from the scraped area would be collected based on a probabilistic sampling scheme, and any corrective action decision would apply to the entire scraped area. This is because no pattern of contaminant distribution was identified for the scraped area within Study Group 1. Therefore, the dose results from the scraped area are presented as a single location (A14).

A.3.2.1 External Radiological Dose Measurements

For the bermed GZ area, external dose was calculated from one TLD location (A02).

For the scraped area, external dose was calculated probabilistically to represent the dose of the entire area based on an average of 12 TLD locations and reported as a single location (A14). Measurements for the external dose were 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.3-3. The minimum sample size criterion was met for both the scraped area and the bermed GZ area within Study Group 1.

Table A.3-3
Study Group 1 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A02	0.1	3	3	7.4	1.2	0.4
A14	0.4	36	3	12.0	2.0	0.6

The external dose that a receptor would receive at each Study Group 1 TLD sample location was determined as described in Section A.2.2.5.

A.3.2.2 Internal Radiological Dose Estimations

Internal dose was not calculated for the bermed GZ area. An inferred internal dose was calculated at the bermed area location (A02) where soil samples were not collected (as described in Section A.2.2.4) for each exposure scenario.

For the scraped area, internal dose was calculated probabilistically to represent the dose of the entire area based on an average of 11 sample results from 10 grab sample locations and reported as a single location (A14). 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.3-4. Table A.3-5 presents a comparison of the internal and external doses at the probabilistic sample location. This demonstrates that internal dose at Study Group 1 comprises less than 1 percent of the TED. The analytical results for the individual radionuclides in each sample are presented in Appendix F. The internal doses were determined as described in Section A.2.2.4.

Table A.3-4
Study Group 1 95% UCL Internal Dose at Probabilistic Sample Location for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A14	0.0	11	3	0.1	0.0	0.0

Table A.3-5
Study Group 1 Ratio of Calculated Internal Dose to External Dose at Probabilistic Soil Sample Location (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
A14	0.0	0.5	0.5	0.005

The internal doses for the bermed and scraped areas were less than 0.1 mrem for all exposure scenarios.

A.3.2.3 Total Effective Dose

The TED reported for the bermed GZ area (Location A02) does not represent the subsurface contamination beneath the cover material. Subsurface contamination is assumed to be present that exceeds the FAL. The dose of 0.4 mrem/OU-yr reported for Location A02 does represent dose from the surface cover and supports the CSM that the site was covered with clean fill.

The average and 95 percent UCL of TED for the scraped area (Location A14) was calculated as the combined internal and external doses as described in Sections A.3.2.1 and A.3.2.2.

Values for both the average TED 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 A.3-6. The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location within Study Group 1, as shown on Figure A.3-4.

Table A.3-6
Study Group 1 TED at Sample Locations (mrem/yr)

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
A02[a]	2.4	7.4	0.4	1.2	0.1	0.4
A14[b]	9.9	12.0	1.7	2.0	0.5	0.6

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (Section A.2.2.4). This dose only represents surface material, not subsurface material that is assumed to exceed the FAL.
[b] Probabilistic sample - average and UCL based on 10 grab samples and TLD elements from12 TLDs.

A.3.3 Corrective Actions

No COCs were identified at any sampled location within the scraped area at Study Group 1. Therefore, no corrective action is required for this area.

It is assumed that the bermed area at the Catron and Coulomb-B GZs (DCB) contains COCs. This assumed presence of a COC requires a corrective action.

CAAs were identified and evaluated in Appendix E. CAAs were not evaluated for the scraped area.

The extent of the COC contamination (CAB) within the bermed Catron and Coulomb-B GZs is defined by the physical dimensions of the bermed area (DCB). The affected volume of contaminated material is estimated to be 341,000 cubic feet (ft^3). No radiological contamination associated with Study Group 1 was identified on the surface of the bermed area or outside the DCB that exceeded the FAL of 25 mrem/OU-yr. Based on the assumed presence of COCs in the subsurface soil in the bermed area (CAB), the CAA of closure in place with an FFACO UR was selected for this area (see Appendix E). This area is shown on Figure A.3-5. The FFACO UR is presented in Attachment D-1.

In the more than 50 years since the Catron and Coulomb-B tests, radionuclides at levels detectable by radiation surveys (either the aerial radiological survey or TRSs) have not migrated from the bermed area. Any migration at detectable levels would appear as elongations of the contaminant plume in the downgradient drainages. Migration at these levels (which are much lower than the FALs) was not apparent in any of the radiation survey plumes.

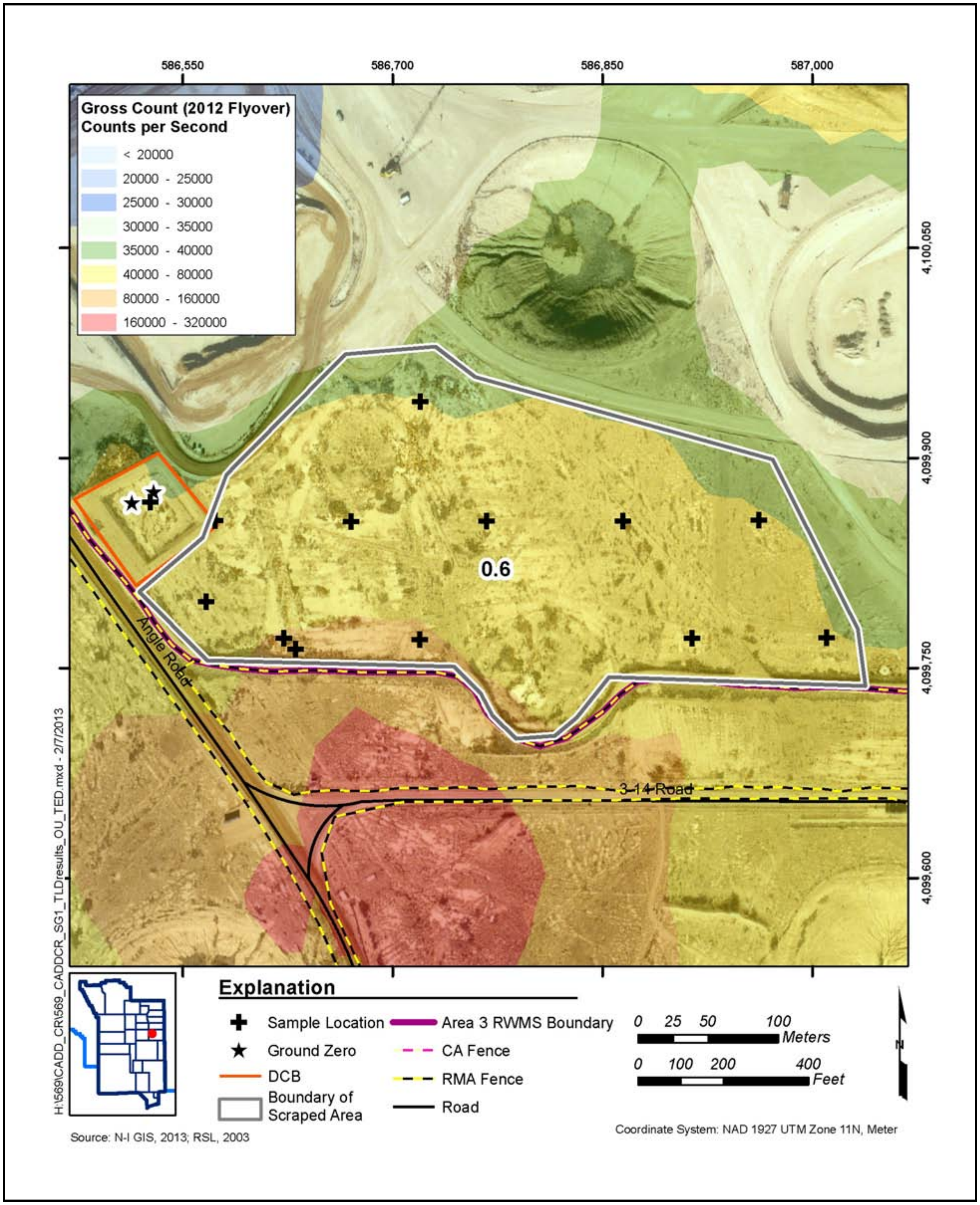

Figure A.3-4
95% of the TED at Study Group 1

Figure A.3-5
Study Group 1 FFACO UR Boundary

The relatively flat topography and the physical characteristics of the geologic material in the vicinity of Study Group 1 are indicative of a low migration potential. Physical characteristics include medium to high adsorptive capacities, low moisture content, and a long distance to groundwater (approximately 1,600 ft bgs). Based on these physical factors and the absence of significant migration in the past 50 years, the defined extent of contamination is not expected to increase in the future.

Based on the implementation of the corrective action at Study Group 1 (establishment of an FFACO UR), no further corrective action is necessary.

A.3.4 Best Management Practices

No BMPs were conducted for the CASs within Study Group 1.

A.3.5 Revised CSM

The CSM for Study Group 1 was revised based on historical information that was identified after completion of the CAIP (NNSA/NSO, 2012a). The revised CSM is discussed in Section A.3.1.4. The information gathered during the CAI supports the revised CSM.

A.4.0 Study Group 2, Pike

Study Group 2, Pike, is located in Area 3 of the NNSS, northeast of the Area 3 RWMS. The study group consists of a release of radioactive material to the soil surface as a result of the venting of radiological gases from a fissure formed during the Pike weapons-related underground test. The fissure was covered with a soil mound to protect site workers during post-test drilling operations. The Pike crater area and covered fissure were established as a DCB. Additional detail on the history of Study Group 2 is provided in the CAIP (NNSA/NSO, 2012a).

CAIs for Study Group 2 also included evaluation of the need for corrective action for any craters in the vicinity of CAU 569 that had documented releases to the environment and were not previously investigated as CASs. This comprised the following tests: Anchovy, Bandicoot, Barracuda, Barsac, Brush, Carp, Cerise, Cinnamon, Cormorant, Finfoot, Fisher, Merlin, Moa, Mushroom, Pampas, Parrot, Pipefish, Pliers, Ringtail, Sardine, Scissors, Screamer, Sevilla, Sidecar, Snubber, Tapper, Tern, Truchas-Chacon, Truchas-Rodarte, and Umber. Existing aerial and ground-based radiological surveys were reviewed to determine whether any identifiable releases are present at any of these sites. No releases were identified on radiological surveys from any of these tests, other than Bandicoot.

A.4.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.4.1.1 Visual Inspections

Visual inspections of Study Group 2 were conducted around Pike and Bandicoot during site walks, sampling efforts, and radiological surveys over the course of the field investigation. Visual inspections included looking for drainages; however, no visible drainages were identified. Limited ephemeral streams that were identified north of Pike flow into craters. Scattered debris including an empty FRAM oil filter and closed pipe dope can were identified near Pike and removed from the site. No environmental samples were collected at these locations because there was no indication of a release. A potential mud pit was identified north of the Pike crater, and samples were collected. PSM was also identified near Pike during visual surveys, consisting of a lead-acid battery.

See Section A.4.2.5 for additional details regarding this PSM. No debris or PSM was identified during visual surveys at Bandicoot.

A.4.1.2 Radiological Surveys

TRSs were performed using a PRM-470 and FIDLER instrument around the Pike DCB at Study Group 2 during the CAI. The TRSs were conducted at the site within the fenced and posted radioactive material area (RMA) and CA (outside the established DCB) to verify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The locations of highest radiological readings for both the PRM-470 and FIDLER TRSs were detected near the southwest edge of the Pike crater. A sample plot with TLD was placed at each of these locations (Locations B04 and B05) to measure dose. Figures A.4-1 and A.4-2 present a graphic representation of the data from the PRM-470 and FIDLER TRSs, respectively.

For Bandicoot, TRSs were performed using a PRM-470 and KIWI instrument during the CAI. This survey is included within the TRS for Study Group 5. No sample locations or TLDs were added as a result of the TRS conducted around the Bandicoot crater. See Figures A.7-1 and A.7-2 for a graphic representation of the data from the Bandicoot PRM-470 and KIWI TRSs, respectively.

A.4.1.3 Sample Collection

Soil and TLD samples were collected near Pike to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at Pike are described in the following subsections. No soil or TLD samples were collected at Bandicoot.

A.4.1.3.1 Soil Samples

A total of 10 environmental samples (9 environmental samples and 1 FD) were collected during investigation activities at Study Group 2. Four composite samples, collected from each of two soil sample plots (Locations B04 and B05), were established based on elevated readings from the TRSs for the determination of internal dose (Figures A.4-1 and A.4-2). These samples were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Sample B605 at Location B05 was also analyzed for Sr-90, Pu-241, and Tc-99, based on highest alpha FSRs among the eight composite samples collected from the sample plots.

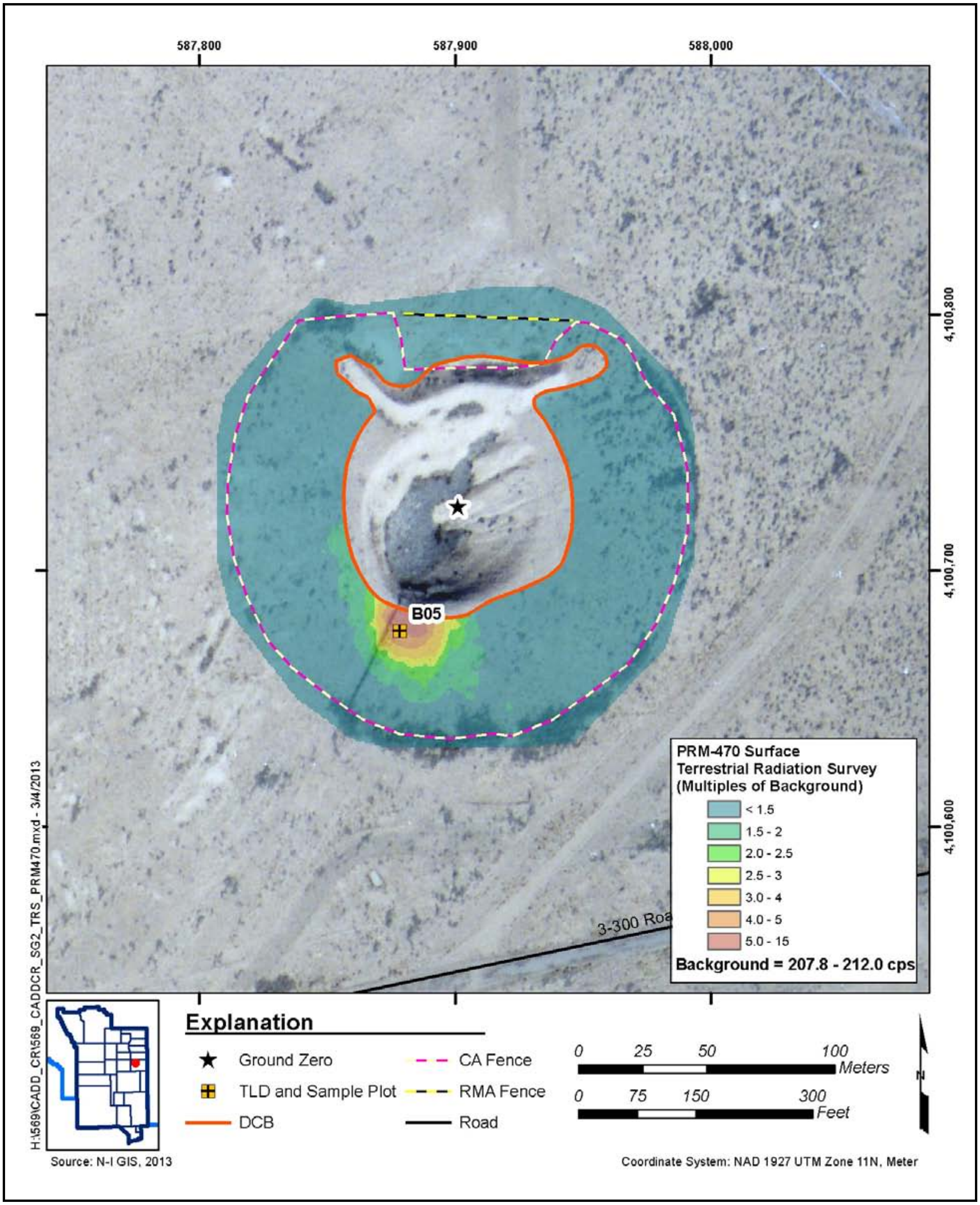

Figure A.4-1
PRM-470 TRS Results for Study Group 2

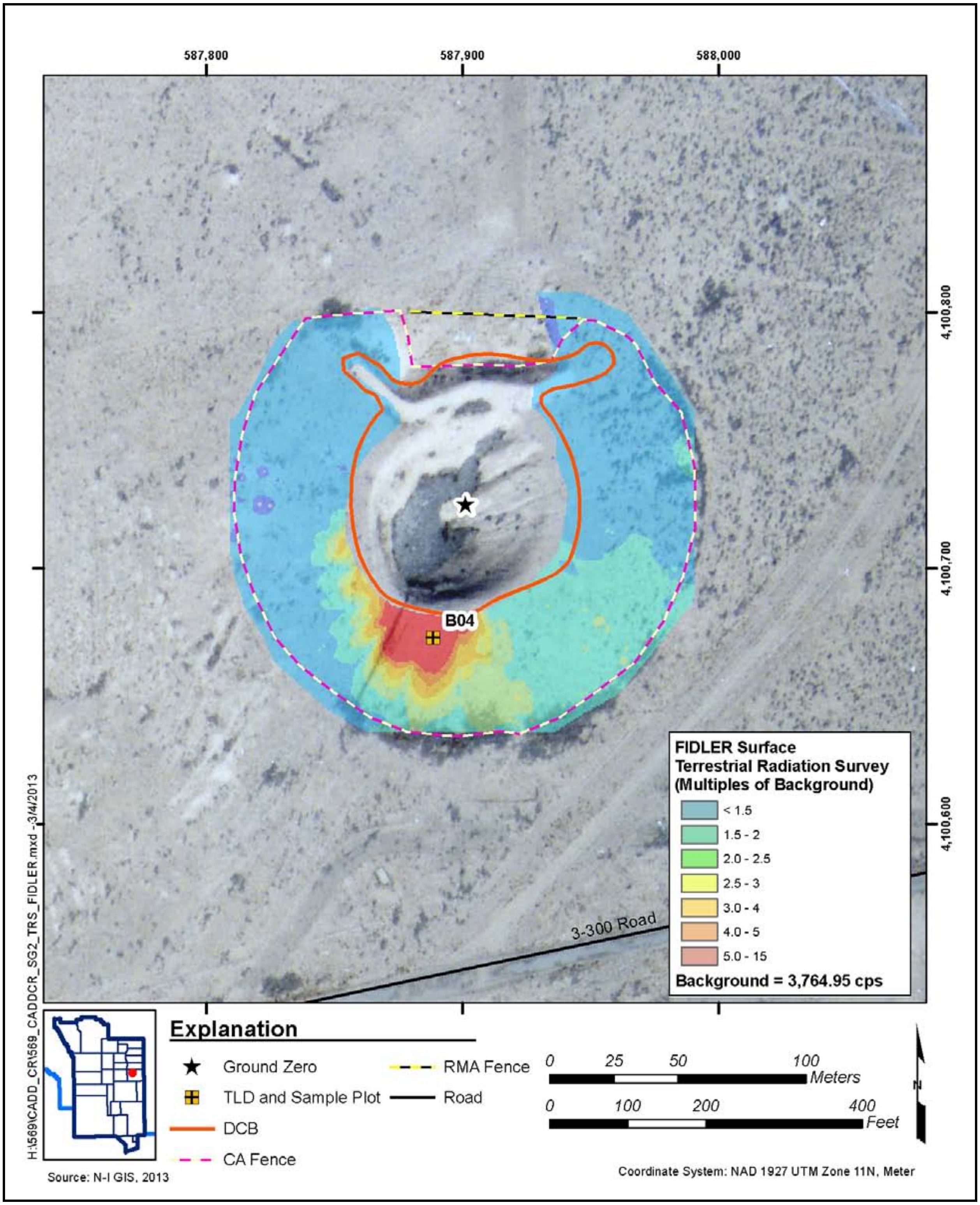

Figure A.4-2
FIDLER TRS Results for Study Group 2

One grab sample and one FD (from Location B09) were collected from the center of a suspected mud pit and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), RCRA metals, and chromium VI to determine whether a release occurred. Information including matrix, depth, and purpose for each soil sample collected from Study Group 2 is provided in Table A.4-1, and the sample locations are shown on Figure A.4-3.

Table A.4-1
Soil Samples Collected at Study Group 2

Location	Sample Number	Depth (cm bgs)	Purpose
B04	B601	0.0 - 5.0	Plot Composite
	B602	0.0 - 5.0	Plot Composite
	B603	0.0 - 5.0	Plot Composite
	B604	0.0 - 5.0	Plot Composite
B05	B605	0.0 - 5.0	Plot Composite, Lab QC
	B606	0.0 - 5.0	Plot Composite
	B607	0.0 - 5.0	Plot Composite
	B608	0.0 - 5.0	Plot Composite, Lab QC
B09	B001	0.0 - 5.0	Mud Pit Grab
	B002	0.0 - 5.0	FD of B001

A.4.1.3.2 TLD Samples

TLDs were installed at eight locations (B01 through B08) to measure external doses to site workers. As shown in Table A.4-2, six of the TLD locations (B01 through B03 and B06 through B08) were placed at grid locations within the TLD grid area as shown on Figure A.4-3. The TLD grid area was established in an area of elevated radiological survey values, and sample locations were selected using a random start, triangular pattern. One TLD and plot (Location B04) was placed at the location of highest readings as detected during the PRM-470 TRS, and one TLD and plot (Location B05) was established at the location of highest readings detected during the FIDLER TRS (Figures A.4-1 and A.4-2). All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.4-3 for TLD locations.

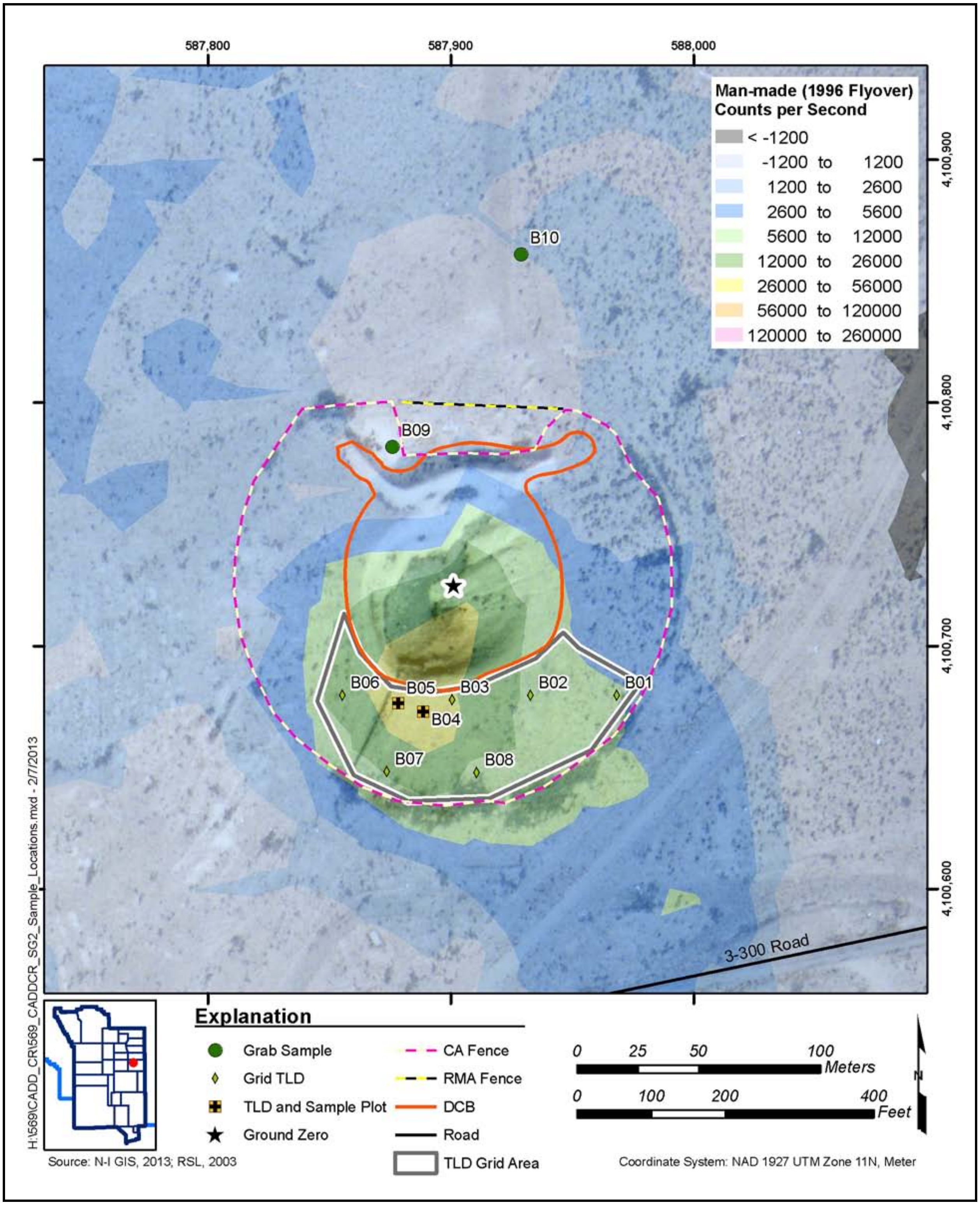

Figure A.4-3
Study Group 2 Sample and TLD Locations

Table A.4-2
TLDs at Study Group 2

Location	TLD No.	Date Placed	Date Removed	Purpose
B01	4943	04/23/2012	07/31/2012	TLD Only (Grid)
B02	4373	04/23/2012	07/31/2012	TLD Only (Grid)
B03	4349	04/23/2012	07/31/2012	TLD Only (Grid)
B04	4528	04/23/2012	07/31/2012	Sample plot
B05	5118	04/23/2012	07/31/2012	Sample plot
B06	4622	04/23/2012	07/31/2012	TLD Only (Grid)
B07	4894	04/23/2012	07/31/2012	TLD Only (Grid)
B08	4319	04/23/2012	07/31/2012	TLD Only (Grid)

A.4.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.4.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples collected from the Pike area at Study Group 2. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses from judgmental sample locations that individually are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

The internal dose calculated from soil sample results, and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.4.2.1. Internal doses for each sample location are summarized in Section A.4.2.2. The TEDs for each sampled location are summarized in Section A.4.2.3. Additional sample results (i.e., potential mud pit) are summarized in Section A.4.2.4.

A.4.2.1 External Radiological Dose Measurements

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in Section A.2.2.5. Measurements for the external dose were 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.4-3. The minimum sample size criterion was met for all locations within Study Group 2.

Table A.4-3
Study Group 2 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.1	3	3	3.6	0.6	0.2
B02	0.1	3	3	6.1	1.0	0.3
B03	0.2	3	3	**31.6**	5.3	1.6
B04	0.2	3	3	**56.2**	9.4	2.8
B05	0.3	3	3	**65.8**	11.1	3.3
B06	0.1	3	3	5.2	0.9	0.3
B07	0.1	3	3	7.3	1.2	0.4
B08	0.1	3	3	9.2	1.5	0.5

Bold indicates the values equal to or greater than 25 mrem/yr.

A.4.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot (Locations B04 and B05) were determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at sample plots for each exposure scenario are presented in Table A.4-4. As shown in Table A.4-4, the minimum sample size was met for all sample locations. An inferred internal dose was calculated at TLD grid locations where soil samples were not collected (Locations B01, B02, B03, B06, B07, and B08) as described in Section A.2.2.4 and shown on Table A.4-5 for each exposure scenario. The analytical results for the individual radionuclides in each composite sample are presented in Appendix F.

Table A.4-4
Study Group 2 95% UCL Internal Dose at Sample Plots for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B04	0.1	4	3	13.5	2.3	0.8
B05	0.1	4	3	13.2	2.2	0.8

Table A.4-5
Study Group 2 Inferred Internal Dose at Grid TLD Locations for Each Exposure Scenario

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.3	0.0	0.0
B02	0.5	0.1	0.0
B03	5.2	0.9	0.3
B06	0.5	0.1	0.0
B07	0.9	0.1	0.1
B08	1.1	0.2	0.1

Table A.4-6 presents a comparison of the internal and external doses at each sample plot. Based on the internal and TED doses in this table, internal dose at Study Group 2 comprises a maximum of 21 percent of TED.

Table A.4-6
Study Group 2 Ratio of Calculated Internal Dose to External Dose at Each Sample Plot (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
B04	0.7	2.5	3.2	0.26
B05	0.7	2.8	3.6	0.26

A.4.2.3 Total Effective Dose

The TED for each sample location was calculated by adding the external dose values and the internal dose values. Values for both the average TED 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 A.4-7. The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location at Study Group 2, as shown on Figure A.4-4.

Table A.4-7
Study Group 2 TED at Sample Locations (mrem/yr)

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
B01[a]	1.5	3.9	0.3	0.6	0.1	0.2
B02[a]	2.7	6.6	0.4	1.1	0.1	0.3
B03[a]	**29.6**	**36.8**	5.0	6.2	1.5	1.9
B04[b]	**61.1**	**69.7**	10.3	11.7	3.2	3.6
B05[b]	**68.8**	**79.0**	11.6	13.3	3.6	4.1
B06[a]	3.0	5.8	0.5	1.0	0.2	0.3
B07[a]	4.9	8.2	0.8	1.4	0.3	0.4
B08[a]	6.4	10.3	1.1	1.7	0.3	0.5

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

A.4.2.4 Chemical Contaminants

A suspected mud pit was sampled and analyzed for VOCs, SVOCs, RCRA metals, and chromium VI. The analytical results exceeding MDCs from the samples collected at the suspected mud pit (Location B09) are presented in Table A.4-8. No sample result exceeded FALs.

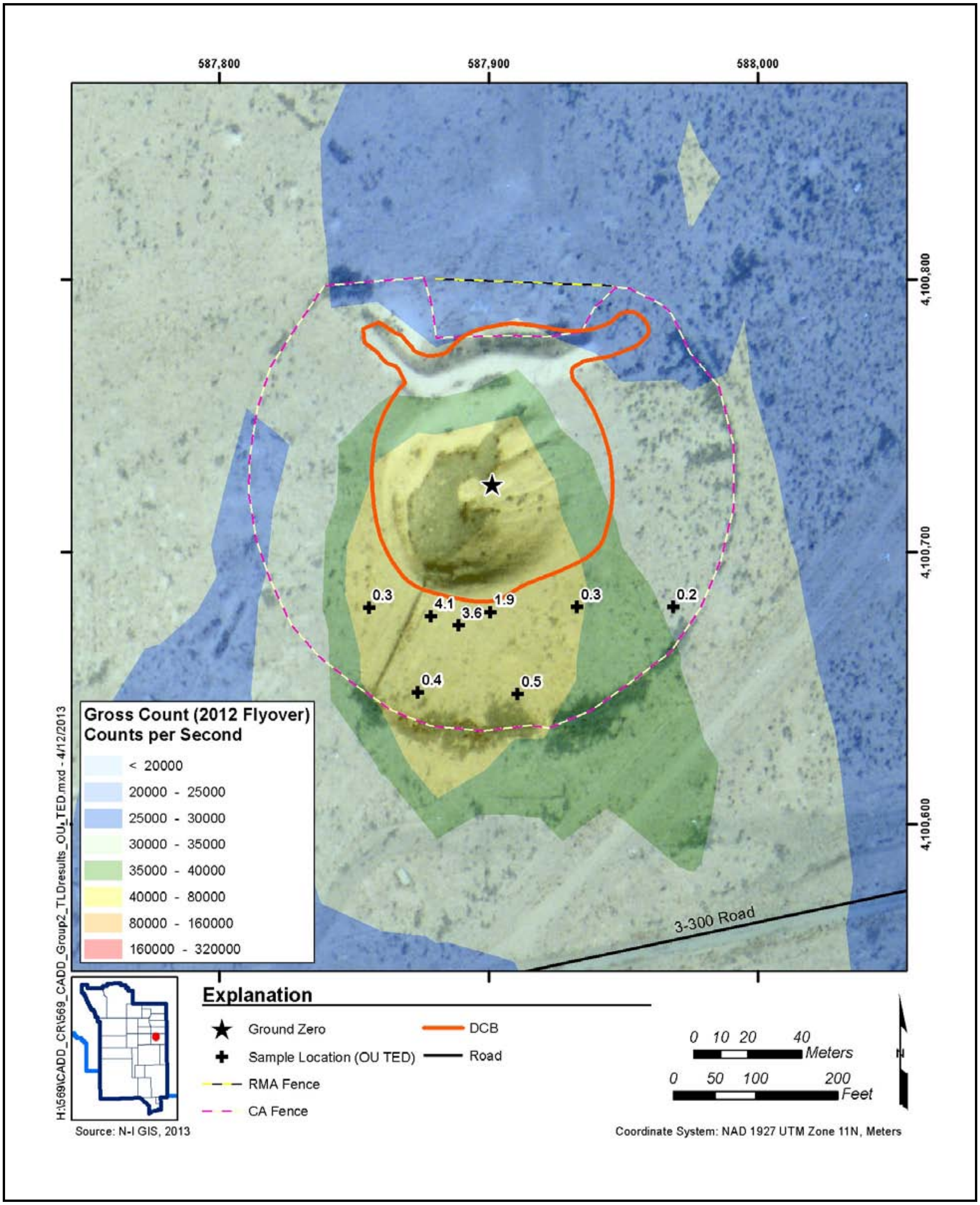

Figure A.4-4
95% of the TED at Study Group 2

Table A.4-8
Study Group 2 Sample Results above MDCs

Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)						
			Arsenic	Barium	Cadmium	Chromium VI	Lead	Mercury	Silver
FALs			**23**	**190,000**	**9,300**	**5.6**	**8,356**	**43**	**5,100**
B09	B001	0 - 5	6.78	134 (J)	0.151 (J)	0.241 (J)	14.9 (J)	0.0485 (J)	0.288 (J)
	B002	0 - 5	6.26	129 (J)	0.142 (J)	0.495 (J)	15.2 (J)	0.0439 (J)	0.223 (J)

COPC = Contaminant of potential concern

J = Estimated value

A.4.2.5 PSM at Study Group 2

A lead-acid battery was identified as PSM at Study Group 2. The battery was removed as a corrective action and sent for recycling. No indications of a release were identified. See Section A.10.0 for information on the disposition of this PSM.

A.4.3 Corrective Actions

No COCs were identified at any sampled location within the boundaries of Study Group 2. However, it is assumed that the Pike crater and fissure, and the Bandicoot crater contain COCs. This assumed presence of a COC requires a corrective action. A corrective action was also necessary for the PSM present at the site.

CAAs were identified and evaluated in Appendix E. CAAs were not evaluated for corrective actions that were completed during the CAI.

The extent of the COC contamination (CAB) within the Pike crater and fissure is defined by the physical dimensions of the Pike crater and fissure. The extent of COC contamination (CAB) within the Bandicoot crater is defined by the physical dimensions of the Bandicoot crater. The affected volume of contaminated material at both Pike and Bandicoot is estimated to be 5,076,000 ft^3. No radiological contamination associated with Study Group 2 was identified outside the DCB that exceeded the FAL of 25 mrem/OU-yr. Based on the assumed presence of COCs in the soil in the Pike and Bandicoot craters, and Pike fissure (CABs), the CAA of closure in place with an FFACO UR was selected for these areas (see Appendix E). For logistical purposes, the area exceeding CA criteria at Pike was included within the UR. These FFACO UR areas are shown on Figure A.4-5. The FFACO UR is presented in Attachment D-1.

Based on the presence of PSM (one intact lead-acid battery) at this study group, corrective action is required. A corrective action of removal of the PSM was completed. The battery had physical integrity, and there was no indication of a release to the soil.

In the more than 50 years since the Pike and Bandicoot tests, radionuclides at levels detectable by radiation surveys (either the aerial radiological surveys or TRSs) have not migrated from the areas of original deposition. Any migration at detectable levels would appear as elongations of the contaminant plume in the downgradient drainages. Migration at these levels (which are much lower than the FALs) was not apparent in any of the radiation survey plumes.

The relatively flat topography and the physical characteristics of the geologic material in the vicinity of Study Group 2 are indicative of a low migration potential. Physical characteristics include medium to high adsorptive capacities, low moisture content, and a long distance to groundwater (approximately 1,600 ft bgs). Based on these physical factors and the absence of significant migration in the past 50 years, the defined extent of contamination is not expected to increase in the future.

Based on the implementation of corrective actions at Study Group 2 (removal of PSM and establishment of an FFACO UR), no further corrective action is necessary.

A.4.4 Best Management Practices

BMPs are voluntary protective measures and are not part of any corrective action. As a BMP, any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr was evaluated for inclusion in an administrative UR. To determine the extent of the area where the industrial area TED exceeds 25 mrem/IA-yr (Industrial Area exposure scenario), correlations of radiation survey values to the 95 percent UCL of industrial area TED values were conducted for the radiation surveys listed in Table A.4-9 (as discussed in Section 3.0). The

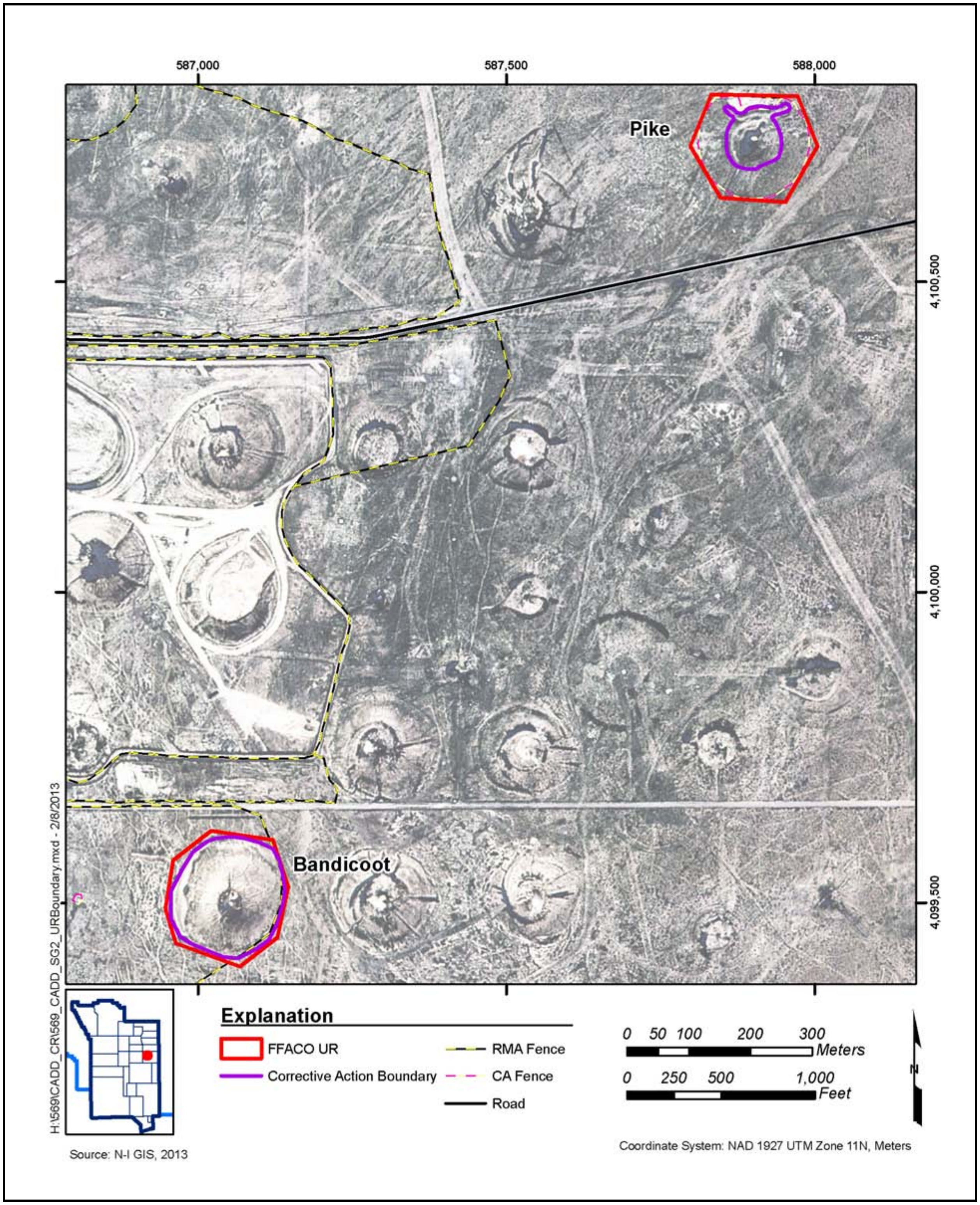

Figure A.4-5
Study Group 2 FFACO UR Boundary

Table A.4-9
Study Group 2 Correlations of 95% UCL TED with Gamma Surveys

Dataset	Correlation Coefficient (R^2)
2012 N-I FIDLER TRS	0.99
2012 N-I PRM-470 TRS	0.95
1994 Gamma Flyover - Gross Count	--
1994 Gamma Flyover - Man Made	0.10
1994 Gamma Flyover - Americium	--
1996 Gamma Flyover - Man Made	0.86
1996 Gamma Flyover - Americium	0.84
2012 Gamma Flyover - Gross Count	0.07
2012 Gamma Flyover - Man Made	0.74
2012 Gamma Flyover - Europium	0.18
2012 Gamma Flyover - Americium	0.41

-- = Not enough co-located data available to provide a correlation.

radiation survey that exhibited the best correlation is the FIDLER TRS, with a correlation of 0.99. This correlation exceeds the minimum criteria of 0.8 as set in the CAIP (NNSA/NSO, 2012a). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 3.97 multiples of background. The TRS isopleth of 3.97 multiples of background is located within the FFACO UR area (as shown on Figure A.4-6). Therefore, no administrative UR was established for Study Group 2.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sampled location with the maximum TED (Location B05) will decay to less than 25 mrem/IA-yr in approximately 90 years.

A.4.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions to the CSM were necessary.

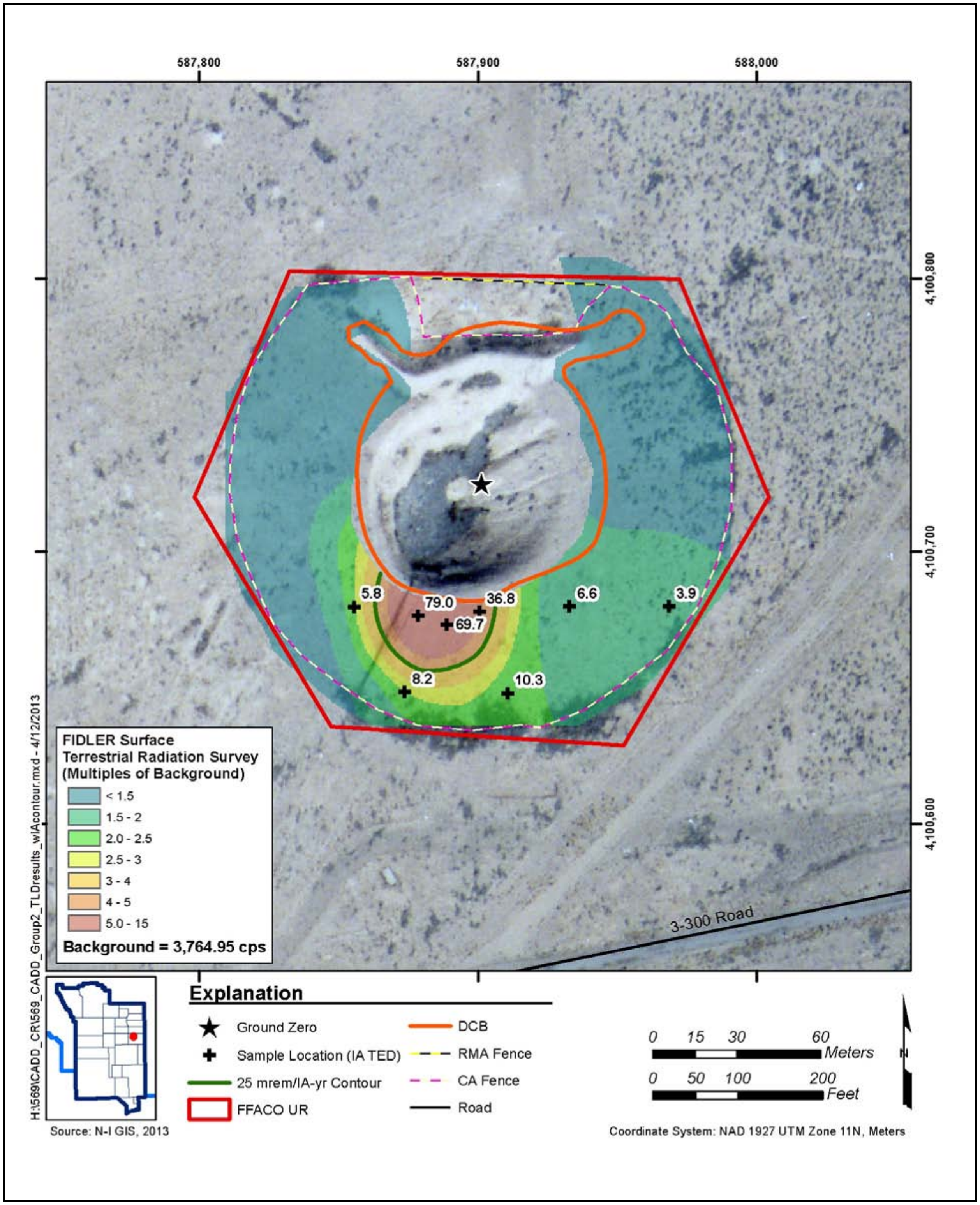

Figure A.4-6
Study Group 2 25-mrem/IA-yr Contour and Administrative UR Boundary

A.5.0 Study Group 3, Annie, Franklin, George, and Moth

Study Group 3, Annie, Franklin, George, Moth, is located in Area 3 of the NNSS, within and north of the Area 3 RWMS. The study group consists of a release of radionuclides to the soil surface from the Annie, Franklin, George, and Moth weapons-related tests. Additional detail on the history of Study Group 3 is provided in the CAIP (NNSA/NSO, 2012a).

A.5.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.5.1.1 Visual Inspections

Visual inspections of Study Group 3 were conducted during site walks, sampling efforts, and radiological surveys over the course of the field investigation. Visual inspections included looking for drainages; however, no visible drainages were identified. A gear box and potential former transformer area were identified. Soil samples were collected from these features as described in Section A.5.1.3.1. PSM including four lead-acid batteries were also identified during the visual inspections.

A.5.1.2 Radiological Surveys

TRSs were performed using a PRM-470 instrument at Study Group 3 during the CAI. The TRSs were conducted at the site within the fenced and posted RMA to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest radiological readings for the PRM-470 was detected west of GZ. A sample plot and TLD were placed at this location to measure dose (Location C03). Figure A.5-1 presents a graphic representation of the data from the PRM-470 TRS.

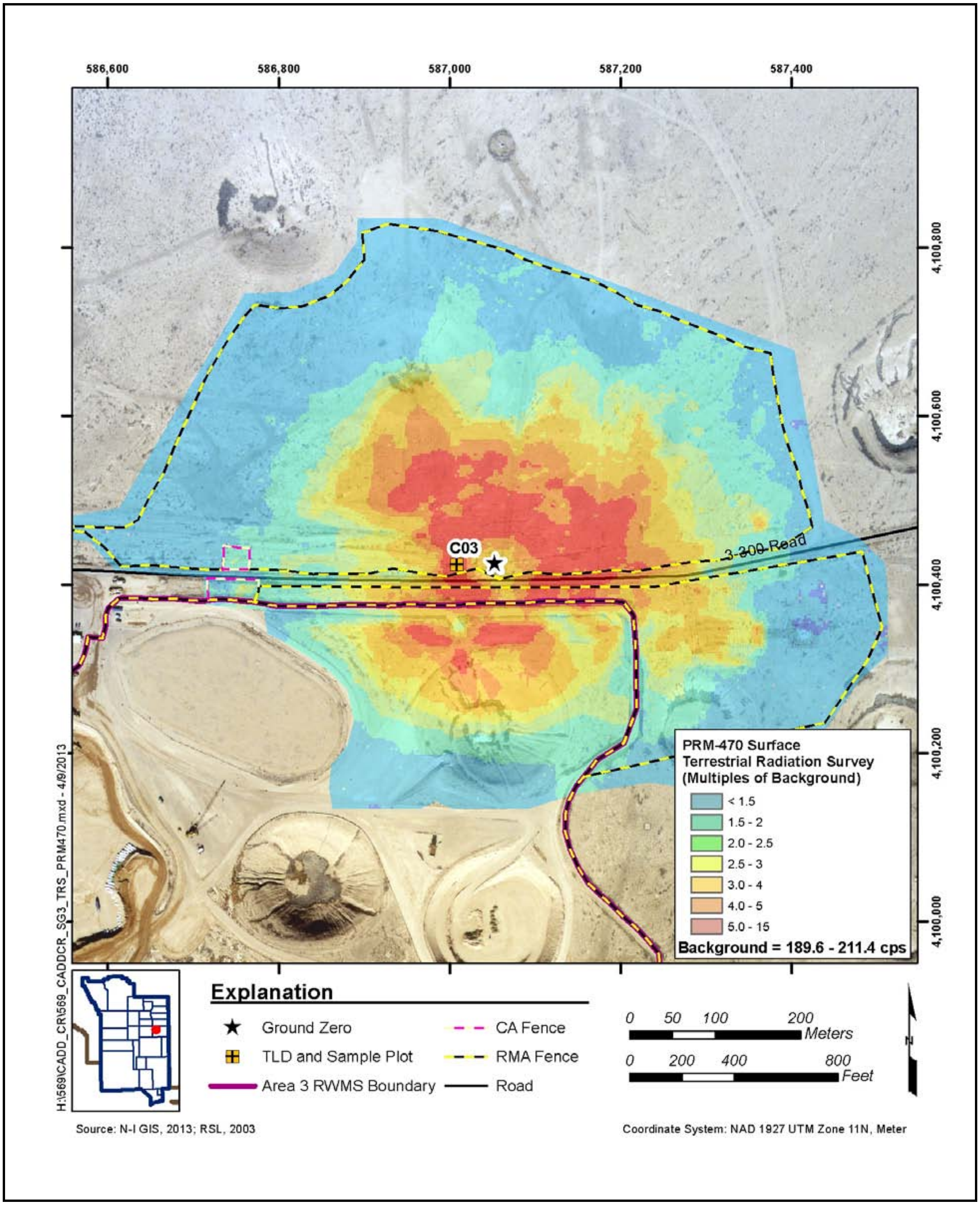

Figure A.5-1
PRM-470 TRS Results for Study Group 3

A.5.1.3 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.5.1.3.1 Soil Samples

A total of seven environmental samples (six environmental samples and one FD) were collected during investigation activities at Study Group 3. Four composite samples were collected from one sample plot (Location C03) to determine internal dose. This sample plot was established based on elevated radiological readings identified during the TRS (Figure A.5-1), and samples collected within the plot were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Sample C601 at Location C03 was also analyzed for Sr-90, Pu-241, and Tc-99, based on highest alpha FSRs of the four composite samples collected from the sample plot.

One of the seven samples (Location C20) collected at Study Group 3 was from the center of a former transformer area and was analyzed for SVOCs, RCRA metals, polychlorinated biphenyls (PCBs), and chromium VI. One sample (Location C21) and one FD were from the soil underneath a gear box that was removed from the site (see Section A.10.0 for disposal information on the gear box) and were analyzed for VOCs, SVOCs, RCRA metals, PCBs, and chromium VI. Information including matrix, depth, and purpose for each soil sample collected from Study Group 3 is provided in Table A.5-1, and the sample locations are shown on Figure A.5-2.

Table A.5-1
Soil Samples Collected at Study Group 3

Location	Sample Number	Depth (cm bgs)	Purpose
C03	C601	0.0 - 5.0	Plot Composite, Lab QC
	C602	0.0 - 5.0	Plot Composite
	C603	0.0 - 5.0	Plot Composite, Lab QC
	C604	0.0 - 5.0	Plot Composite
C20	C001	0.0 - 15.0	Transformer Grab
C21	C002	0.0 - 5.0	Gear Box Grab, Lab QC
	C003	0.0 - 5.0	FD of C002

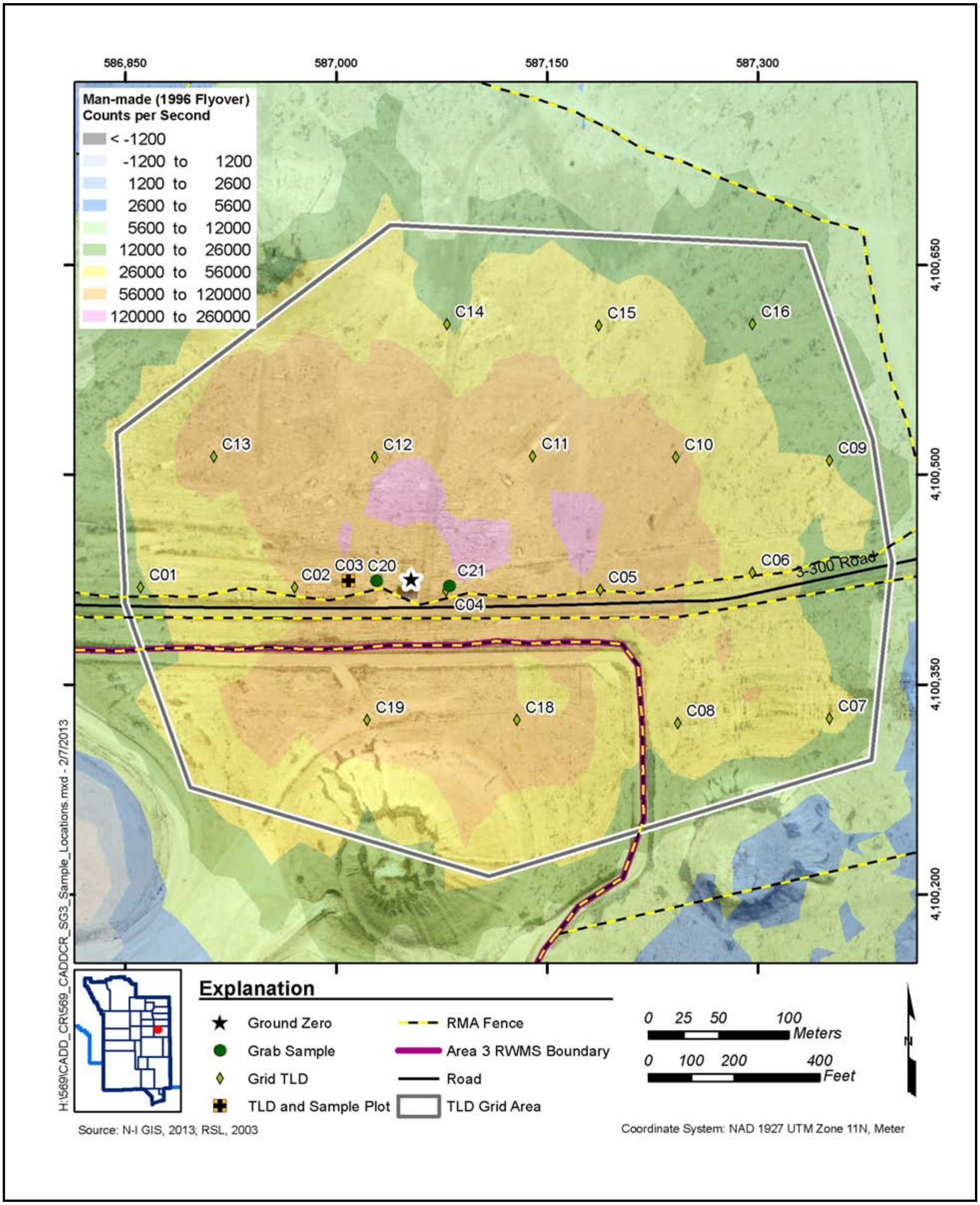

Figure A.5-2
Study Group 3 Sample and TLD Locations

A.5.1.3.2 TLD Samples

TLDs were installed at 18 locations (C01 through C16, C18, and C19) to measure external doses to site workers as listed in Table A.5-2. Seventeen of the TLDs (Locations C01, C02, C04 through C16, C18, and C19) were placed at grid locations within the TLD grid area as shown on Figure A.5-2. The TLD grid area was established in an area of elevated radiological survey values (Figure A.5-1), and sample locations were selected using a random start, triangular pattern. One TLD (Location C03) was placed within the sample plot. All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.5-2 for TLD locations.

Table A.5-2
TLDs at Study Group 3

Location	TLD No.	Date Placed	Date Removed	Purpose
C01	2025	04/23/2012	07/30/2012	TLD Only (Grid)
C02	4573	04/23/2012	07/30/2012	TLD Only (Grid)
C03	4957	04/23/2012	07/30/2012	Sample Plot
C04	4538	04/23/2012	07/30/2012	TLD Only (Grid)
C05	4949	04/23/2012	07/30/2012	TLD Only (Grid)
C06	5056	04/23/2012	07/30/2012	TLD Only (Grid)
C07	4568	04/23/2012	07/30/2012	TLD Only (Grid)
C08	4638	04/23/2012	07/30/2012	TLD Only (Grid)
C09	4458	04/23/2012	07/30/2012	TLD Only (Grid)
C10	4808	04/23/2012	07/30/2012	TLD Only (Grid)
C11	4785	04/23/2012	07/30/2012	TLD Only (Grid)
C12	5053	04/23/2012	07/30/2012	TLD Only (Grid)
C13	4449	04/23/2012	07/30/2012	TLD Only (Grid)
C14	4451	04/23/2012	07/30/2012	TLD Only (Grid)
C15	4313	04/23/2012	07/30/2012	TLD Only (Grid)
C16	4346	04/23/2012	07/30/2012	TLD Only (Grid)
C18	4558	04/24/2012	07/30/2012	TLD Only (Grid)
C19	4880	04/24/2012	07/30/2012	TLD Only (Grid)

A.5.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.5.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses for judgmental sample locations that individually are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

The internal dose calculated from soil sample results, and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.5.2.1. Internal doses for each sample location are summarized in Section A.5.2.2. The TEDs for each sampled location are summarized in Section A.5.2.3. Additional sample results (i.e., former transformer area and gear box) are summarized in Section A.5.2.4.

A.5.2.1 External Radiological Dose Measurements

Estimates for the external dose that a receptor would receive at each Study Group 3 TLD sample location were determined as described in Section A.2.2.5. Measurements for the external dose were 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.5-3. The minimum sample size criterion was met for all locations within Study Group 3.

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

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	0.1	3	3	18.3	3.1	0.9
C02	0.1	3	3	**33.0**	5.5	1.7
C03	0.3	3	3	**133.4**	22.4	6.7
C04	0.2	3	3	**47.6**	8.0	2.4
C05	0.2	3	3	**59.0**	9.9	2.9
C06	0.2	3	3	**36.7**	6.2	1.8
C07	0.1	3	3	18.2	3.1	0.9
C08	0.2	3	3	**31.6**	5.3	1.6
C09	0.1	3	3	13.6	2.3	0.7
C10	0.2	3	3	**53.4**	9.0	2.7
C11	0.3	3	3	**71.4**	12.0	3.6
C12	0.2	3	3	**65.5**	11.0	3.3
C13	0.2	3	3	**53.5**	9.0	2.7
C14	0.0	3	3	10.2	1.7	0.5
C15	0.0	3	3	19.9	3.3	1.0
C16	0.1	3	3	17.8	3.0	0.9
C18	0.1	3	3	**28.8**	4.8	1.4
C19	0.4	3	3	**90.2**	15.2	4.5

Bold indicates the values equal to or greater than 25 mrem/yr.

A.5.2.2 Internal Radiological Dose Estimations

The estimate for the internal dose that a receptor would receive at the Study Group 3 sample plot (Location C03) was determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plot for each exposure scenario are presented in Table A.5-4. An inferred internal dose was calculated at TLD grid locations where soil samples were not collected (Locations C01, C02, C04 through C16, C18, and C19) as described in Section A.2.2.4 and shown on Table A.5-5 for each exposure scenario. The analytical results for the individual radionuclides in each composite sample are presented in Appendix F. As shown in Table A.5-4, the minimum sample size was met for all sample locations.

Table A.5-4
Study Group 3 95% UCL Internal Dose at Sample Plot for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C03	0.0	4	3	0.3	0.0	0.0

Table A.5-5
Study Group 3 Inferred Internal Dose at Grid TLD Locations for Each Exposure Scenario

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	0.0	0.0	0.0
C02	0.1	0.0	0.0
C04	0.1	0.0	0.0
C05	0.1	0.0	0.0
C06	0.1	0.0	0.0
C07	0.0	0.0	0.0
C08	0.0	0.0	0.0
C09	0.0	0.0	0.0
C10	0.1	0.0	0.0
C11	0.1	0.0	0.0
C12	0.1	0.0	0.0
C13	0.1	0.0	0.0
C14	0.0	0.0	0.0
C15	0.0	0.0	0.0
C16	0.0	0.0	0.0
C18	0.0	0.0	0.0
C19	0.1	0.0	0.0

Table A.5-6 presents a comparison of the internal and external doses at the sample plot. Based on the internal and TED doses in this table, internal dose at Study Group 3 comprises less than 1 percent of TED.

Table A.5-6
Study Group 3 Ratio of Calculated Internal Dose to External Dose at the Sample Plot (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
C03	0.0	6.2	6.2	0.002

A.5.2.3 Total Effective Dose

The TED for each sample plot or TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED 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 A.5-7. The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location within Study Group 3, as shown on Figure A.5-3.

Table A.5-7
Study Group 3 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

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
C01[a]	16.4	18.3	2.8	3.1	0.8	0.9
C02[a]	**28.8**	**33.1**	4.8	5.6	1.4	1.7
C03[b]	**124.0**	**133.7**	20.8	22.5	6.2	6.7
C04[a]	**41.6**	**47.7**	7.0	8.0	2.1	2.4
C05[a]	**53.2**	**59.1**	8.9	9.9	2.7	3.0
C06[a]	**29.0**	**36.7**	4.9	6.2	1.5	1.8
C07[a]	15.4	18.2	2.6	3.1	0.8	0.9
C08[a]	**25.6**	**31.7**	4.3	5.3	1.3	1.6
C09[a]	10.1	13.6	1.7	2.3	0.5	0.7
C10[a]	**46.0**	**53.4**	7.7	9.0	2.3	2.7
C11[a]	**62.3**	**71.5**	10.5	12.0	3.1	3.6
C12[a]	**58.9**	**65.6**	9.9	11.0	2.9	3.3
C13[a]	**47.5**	**53.6**	8.0	9.0	2.4	2.7

Table A.5-7
Study Group 3 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

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
C14[a]	8.8	10.3	1.5	1.7	0.4	0.5
C15[a]	18.7	19.9	3.1	3.3	0.9	1.0
C16[a]	13.8	17.8	2.3	3.0	0.7	0.9
C18[a]	**26.0**	**28.9**	4.4	4.8	1.3	1.4
C19[a]	**78.2**	**90.3**	13.1	15.2	3.9	4.5

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

A.5.2.4 Chemical Contaminants

One sample collected from the center of a former transformer area (Location C20) was analyzed for SVOCs, RCRA metals, PCBs, and chromium VI. One sample and one FD collected from the soil underneath a gear box (Location C21) was analyzed for VOCs, SVOCs, RCRA metals, PCBs, and chromium VI. The analytical results exceeding MDCs from the samples collected at the former transformer area and gear box are presented in Table A.5-8. No sample result exceeded FALs.

A.5.2.5 PSM at Study Group 3

Four intact lead-acid batteries were identified as PSM at Study Group 3. The batteries were removed from the site as a corrective action and sent for recycling. No indications of a release were identified. See Section A.10.0 for information on the disposition of these batteries.

A.5.3 Corrective Actions

No COCs were identified at any sampled location within the boundaries of Study Group 3. Therefore, no corrective action is required for this area. However, a corrective action was necessary for the PSM present at the site.

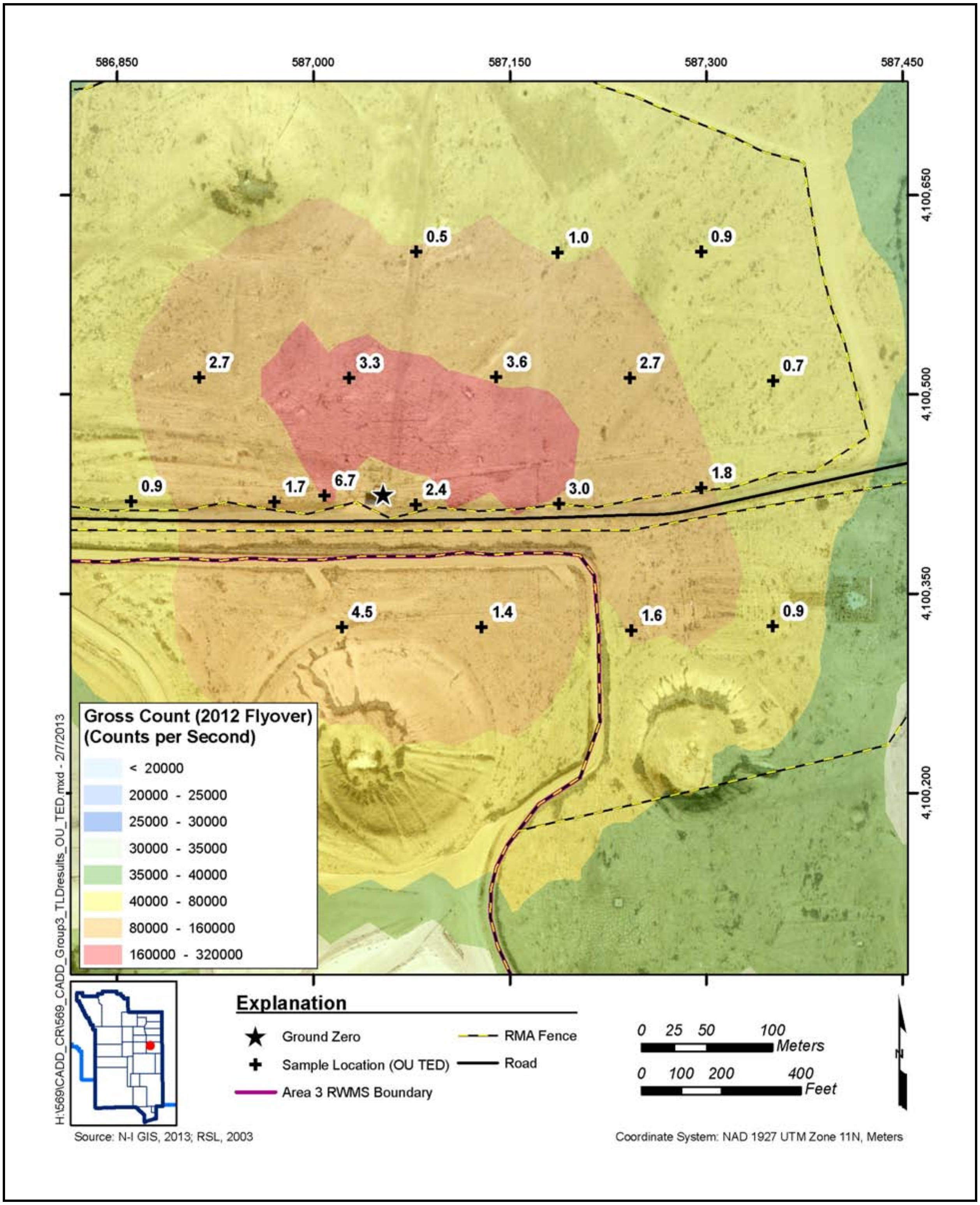

Figure A.5-3
95% of the TED at Study Group 3

Table A.5-8
Study Group 3 Sample Results above MDCs

Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)									
			Aroclor 1254	Aroclor 1260	Arsenic	Barium	Cadmium	Chromium VI	Lead	Mercury	Silver	Toluene
FALs			0.74	0.74	23	190,000	9,300	5.6	8,356	43	5,100	45,000
C20	C001	0 - 15	0.00191 (J)	0.00326 (J)	2.8	181 (J)	--	0.297 (J)	10.1 (J)	0.00787 (J)	0.102 (J)	--
C21	C002	0 - 5	--	--	2.78	157 (J)	7.96	--	9.43 (J)	0.00588 (J)	0.366 (J)	0.000514 (J)
	C003	0 - 5	--	--	2.55	140 (J)	9.4	0.192 (J)	8.78 (J)	0.00755 (J)	0.38 (J)	--

J = Estimated value
-- = No result

CAAs were not evaluated for corrective actions that were completed during the CAI.

Based on the presence of PSM (four intact lead-acid batteries) at this study group, corrective action is required. A corrective action of removal of the PSM was completed. The battery had physical integrity, and there was no indication of a release to the soil. Therefore, no further corrective action is needed.

A.5.4 Best Management Practices

BMPs are voluntary protective measures and are not part of any corrective action. As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,000 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 25 mrem/IA-yr (Industrial Area exposure scenario), correlations of radiation survey values to the 95 percent UCL of industrial area TED values were conducted for the radiation surveys listed in Table A.5-9 (as discussed in Section 3.0). The radiation survey that exhibited the best correlation is the PRM-470 TRS, with a correlation of 0.84. This correlation exceeds the minimum criteria of 0.8 as set in the CAIP (NNSA/NSO, 2012a). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 2.71 multiples of background. The administrative UR boundary was established to encompass the TRS isopleth of 2.71 multiples of background. This area is shown on Figure A.5-4.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sampled location with the maximum TED (Location C03) will decay to less than 25 mrem/IA-yr in approximately 45 years.

The administrative UR boundary is presented in Attachment D-1.

A.5.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions to the CSM were necessary.

Table A.5-9
Study Group 3 Correlations of 95% UCL TED with Gamma Surveys

Dataset	Correlation Coefficient (R^2)
2012 N-I PRM-470 TRS	0.84
1996 KIWI TRS	--
1994 Gamma Flyover - Gross Count	0.39
1994 Gamma Flyover - Man Made	0.42
1994 Gamma Flyover - Americium	0.67
1996 Gamma Flyover - Man Made	0.63
1996 Gamma Flyover - Americium	0.12
2012 Gamma Flyover - Gross Count	0.03
2012 Gamma Flyover - Man Made	0.57
2012 Gamma Flyover - Europium	0.55
2012 Gamma Flyover - Americium	0.08

-- = Not enough co-located data available to provide a correlation.

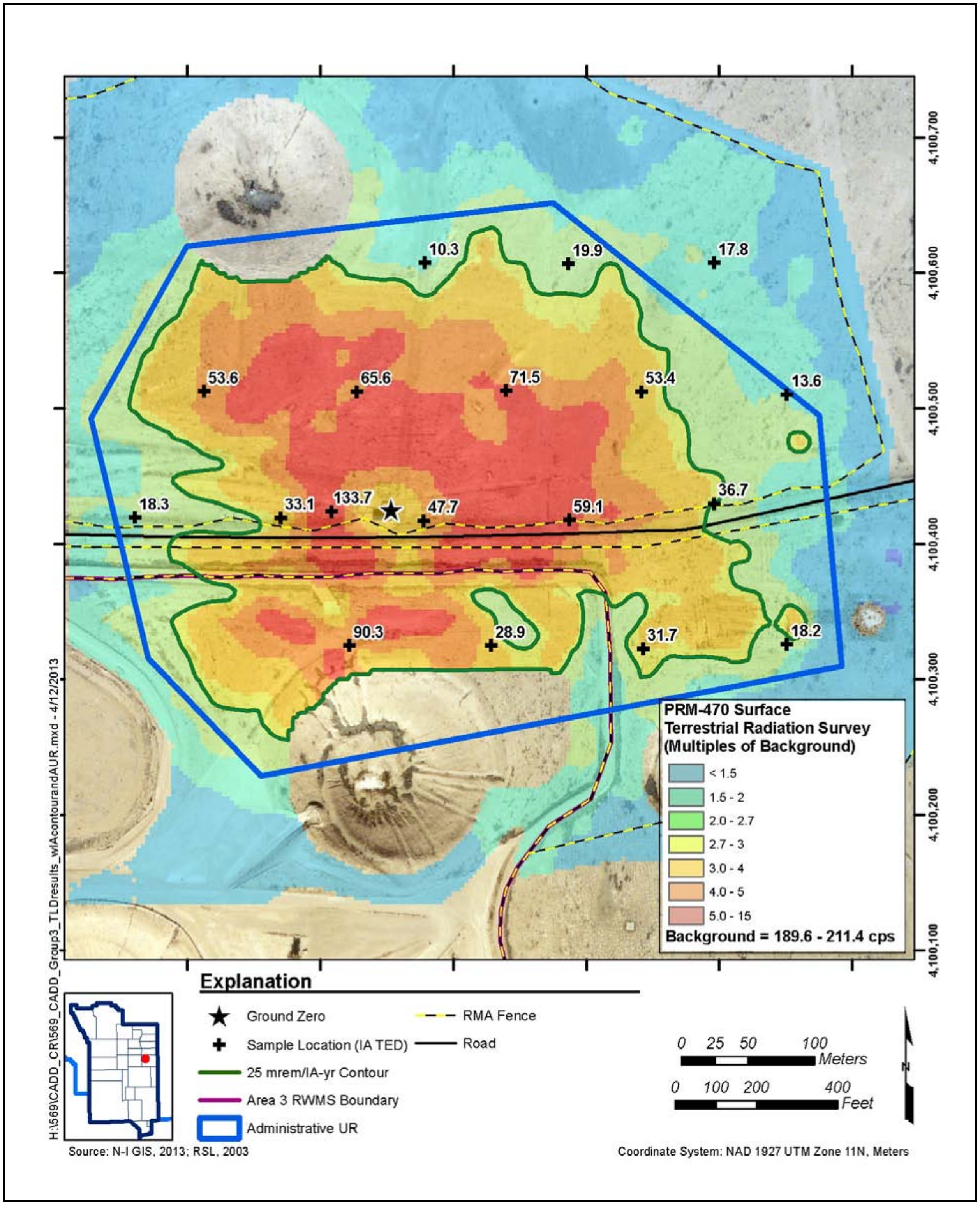

Figure A.5-4
Study Group 3 25-mrem/IA-yr Contour and Administrative UR Boundary

A.6.0 Study Group 4, Humboldt

Study Group 4, Humboldt, is located in Area 3 of the NNSS, just north of and adjacent to the Area 3 RWMS. The study group consists of a release of radionuclides to the soil surface from the Humboldt weapons-related test. Additional detail on the history of Study Group 4 is provided in the CAIP (NNSA/NSO, 2012a).

A.6.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.6.1.1 Visual Inspections

Visual inspections of Study Group 4 were conducted during site walks, sampling efforts, and radiological surveys over the course of the field investigation. Visual inspections included looking for drainages; however, no visible drainages were identified. No biasing factors (indicating the potential release of contamination) or PSM were identified, and no additional samples were collected as a result of the visual inspections.

A.6.1.2 Radiological Surveys

TRSs were performed using a PRM-470 and FIDLER instrument at Study Group 4 during the CAI. The TRSs were conducted within the CA on both sides of 3-300 Road to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest radiological readings as detected during the PRM-470 TRS was identified within the southern CA. A sample plot with TLD was placed at this location (D02) to measure dose. A KIWI TRS was also conducted in this area in 1996. Two areas of elevated readings were detected with the KIWI; one within the southern CA that coincides with the results of the PRM-470 TRS and one in the northern CA. A sample plot with TLD was placed at the location of highest readings in the northern CA (Location D01), as detected with the KIWI. Sample plot Locations D04 through D06 were also established based on the KIWI TRS, within isopleths of decreasing value.

Figures A.6-1 and A.6-2 present a graphic representation of the data from the PRM-470 and KIWI TRSs, respectively.

A.6.1.3 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.6.1.3.1 Soil Samples

A total of 20 environmental samples were collected from 5 sample plots (Locations D01, D02, D04, D05, and D06) during investigation activities of Study Group 4. Sample plot Location D01 was established based on elevated radiological readings from the KIWI TRS. Location D02 was established based on elevated readings from the PRM-470 TRS. Locations D04 through D06 were established within isopleths of decreasing value generated from the KIWI TRS (Figures A.6-1 and A.6-2). All 20 of the composite samples were collected to determine the internal dose at the sample plots and were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Sample D608 at Location D02 was also analyzed for Sr-90, Pu-241, and Tc-99, based on highest alpha FSRs among the 20 samples. Information including matrix, depth, and purpose for each soil sample collected from Study Group 4 is provided in Table A.6-1, and the sample locations are shown on Figure A.6-3.

A.6.1.3.2 TLD Samples

TLDs were installed at the five sample plot locations at Study Group 4 to measure external doses to site workers as listed in Table A.6-2. All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.6-3 for TLD locations.

A.6.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

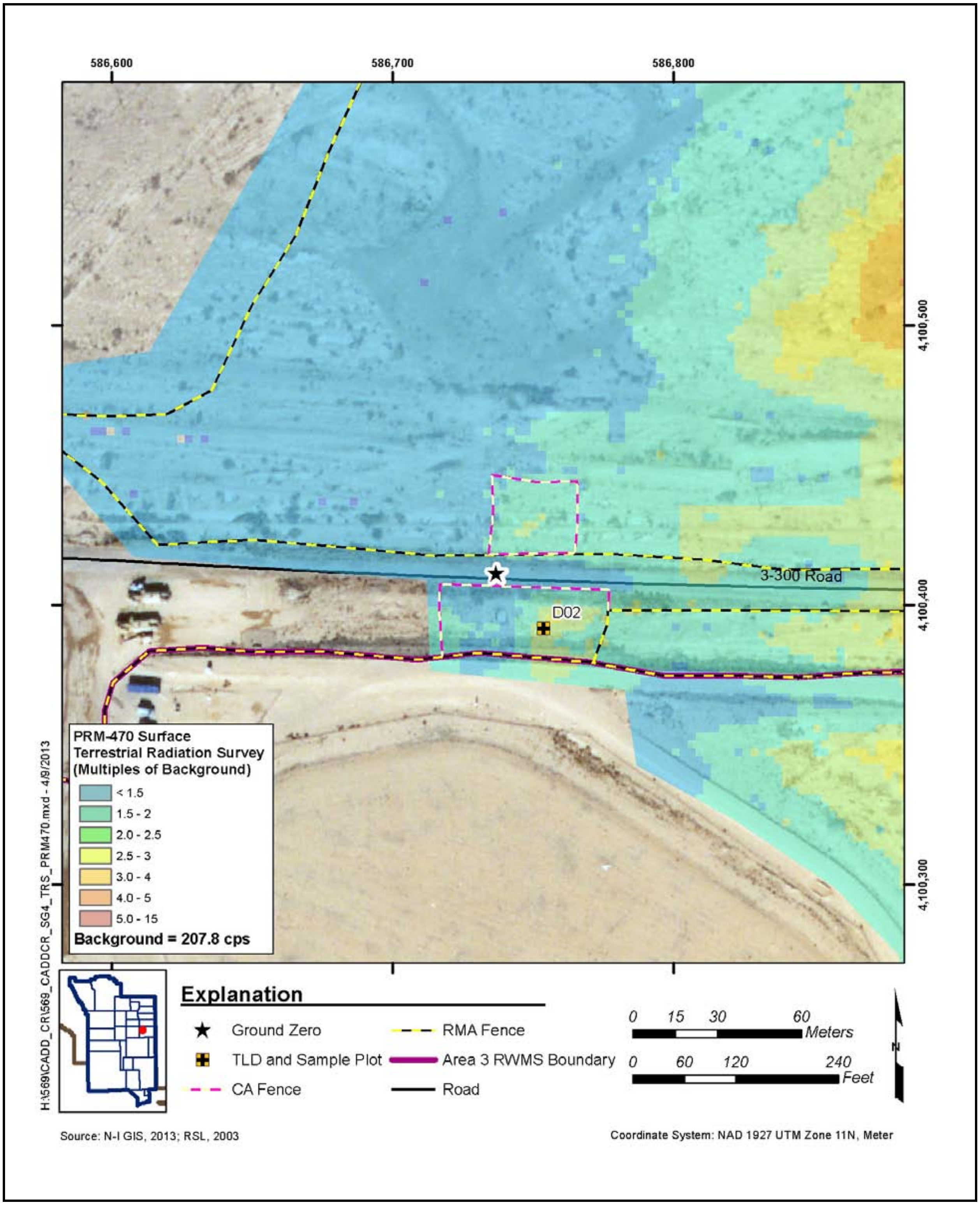

Figure A.6-1
PRM-470 TRS Results for Study Group 4

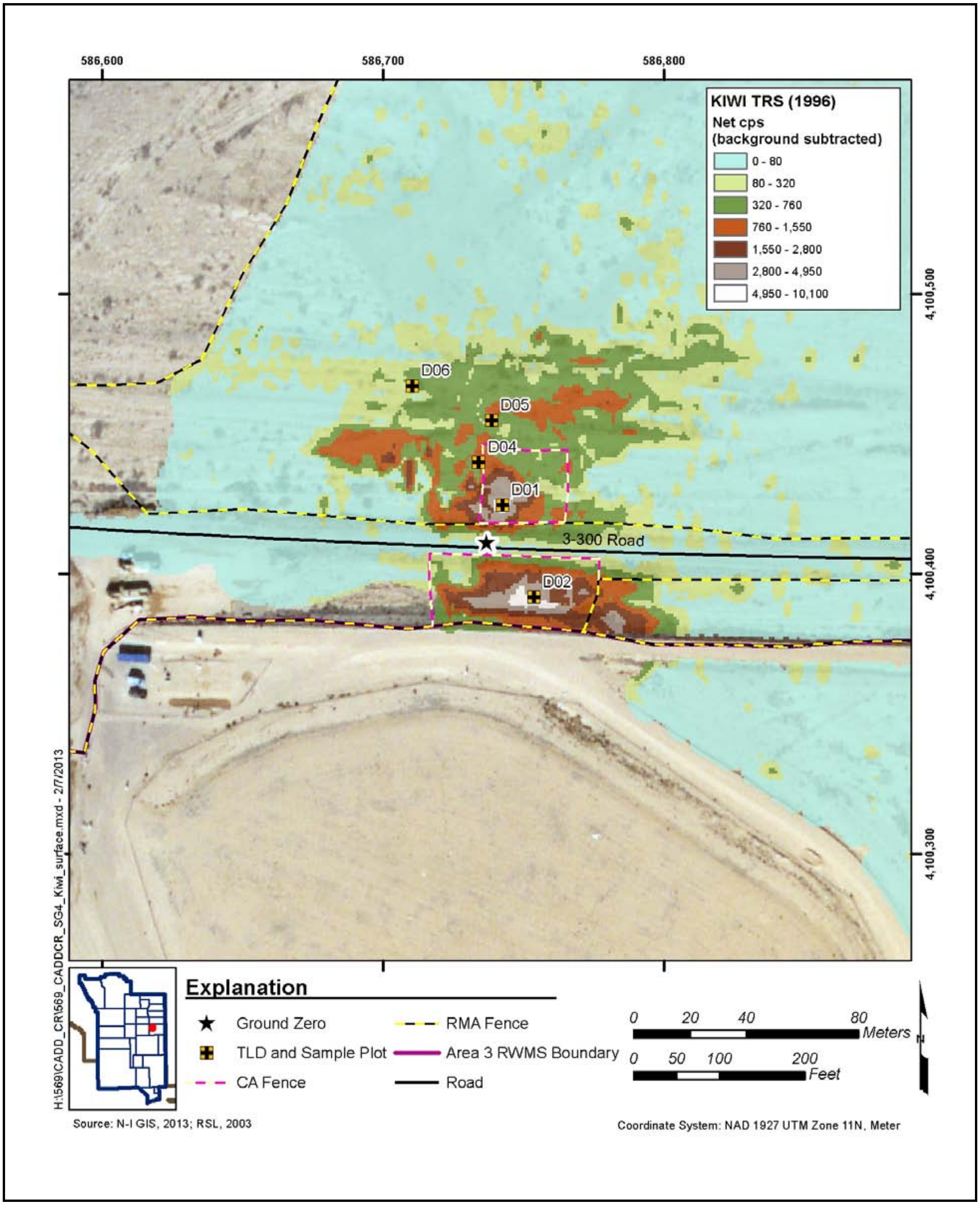

Figure A.6-2
KIWI TRS Results for Study Group 4

Table A.6-1
Samples Collected at Study Group 4

Location	Sample Number	Depth (cm bgs)	Purpose
D01	D601	0.0 - 5.0	Plot Composite
	D602	0.0 - 5.0	Plot Composite
	D603	0.0 - 5.0	Plot Composite
	D604	0.0 - 5.0	Plot Composite
D02	D605	0.0 - 5.0	Plot Composite
	D606	0.0 - 5.0	Plot Composite
	D607	0.0 - 5.0	Plot Composite
	D608	0.0 - 5.0	Plot Composite, Lab QC
D04	D617	0.0 - 5.0	Plot Composite
	D618	0.0 - 5.0	Plot Composite
	D619	0.0 - 5.0	Plot Composite
	D620	0.0 - 5.0	Plot Composite
D05	D613	0.0 - 5.0	Plot Composite
	D614	0.0 - 5.0	Plot Composite
	D615	0.0 - 5.0	Plot Composite
	D616	0.0 - 5.0	Plot Composite
D06	D609	0.0 - 5.0	Plot Composite, Lab QC
	D610	0.0 - 5.0	Plot Composite, Lab QC
	D611	0.0 - 5.0	Plot Composite
	D612	0.0 - 5.0	Plot Composite

A.6.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses for judgmental sample locations that individually are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

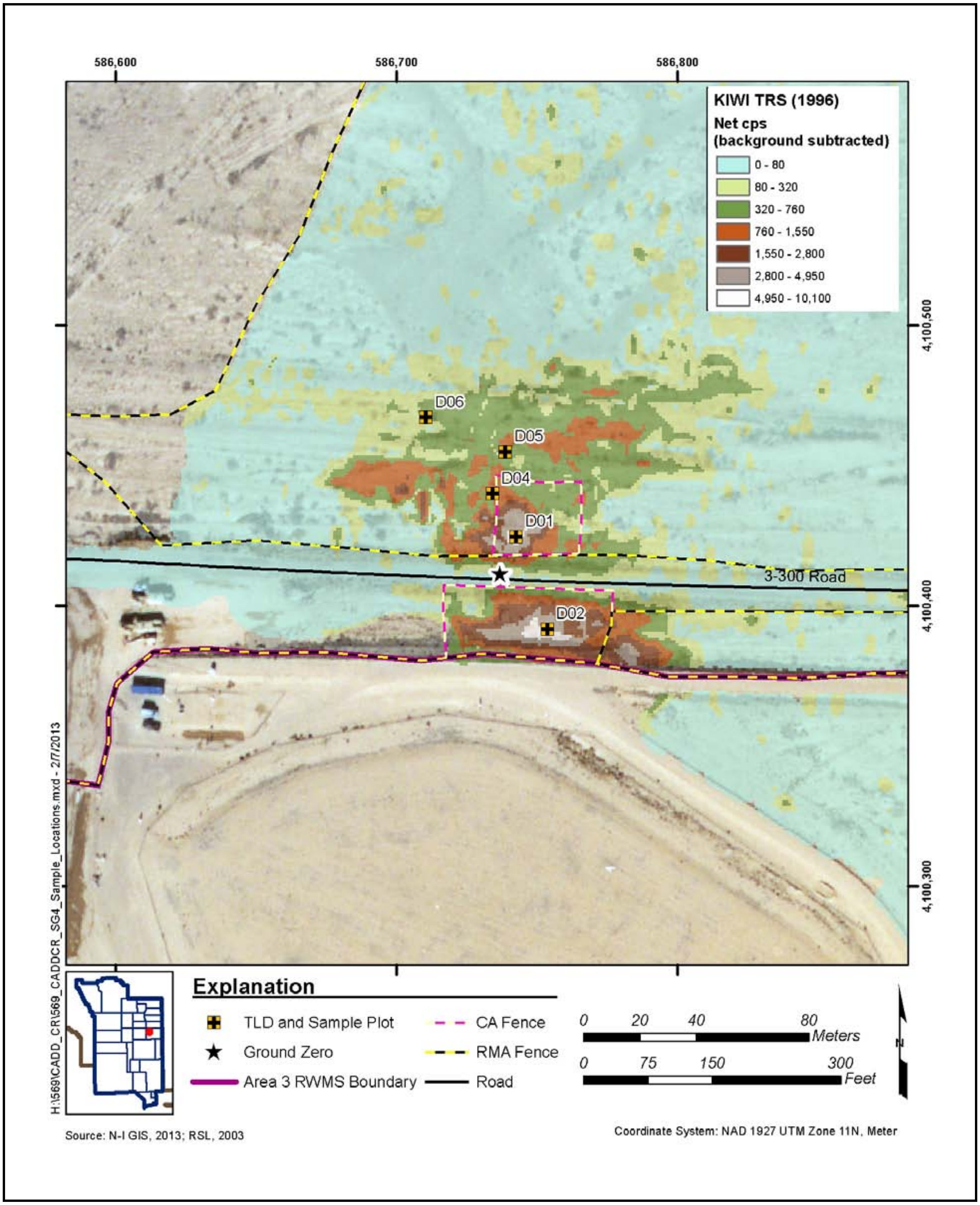

Figure A.6-3
Study Group 4 Sample and TLD Locations

Table A.6-2
TLDs at Study Group 4

Location	TLD No.	Date Placed	Date Removed	Purpose
D01	4479	04/23/2012	07/31/2012	Sample Plot
D02	5099	04/23/2012	07/31/2012	Sample Plot
D04	4319	09/12/2012	11/08/2012	Sample Plot
D05	4894	09/12/2012	11/08/2012	Sample Plot
D06	4492	09/12/2012	11/08/2012	Sample Plot

The internal dose calculated from soil sample results, and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.6.2.1. Internal doses for each sample location are summarized in Section A.6.2.2. The TEDs for each sampled location are summarized in Section A.6.2.3. Radiological results for Study Group 4 are summarized in Section A.6.3.

A.6.2.1 External Radiological Dose Measurements

Estimates for the external dose that a receptor would receive at each Study Group 4 TLD sample location were determined as described in Section A.2.2.5. Measurements for the external dose were 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.6-3. The minimum sample size criterion was met for all locations within Study Group 4.

Table A.6-3
Study Group 4 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 2)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
D01	0.1	3	3	17.9	3.0	0.9
D02	0.2	3	3	**31.2**	5.2	1.6
D04	0.1	3	3	11.5	1.9	0.6

Table A.6-3
Study Group 4 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 2)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
D05	0.0	3	3	7.0	1.2	0.3
D06	0.1	3	3	8.9	1.5	0.4

Bold indicates the values equal to or greater than 25 mrem/yr.

A.6.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 4 sample location were determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plot for each exposure scenario are presented in Table A.6-4. The analytical results for the individual radionuclides in each sample are presented in Appendix F.

Table A.6-4
Study Group 4 95% UCL Internal Dose at Sample Plots for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
D01	0.1	4	3	13.8	2.3	0.8
D02	0.6	4	3	**36.3**	6.1	2.2
D04	0.0	4	3	2.7	0.5	0.2
D05	0.0	4	3	1.7	0.3	0.1
D06	0.0	4	3	1.8	0.3	0.1

Bold indicates the values equal to or greater than 25 mrem/yr.

Table A.6-5 presents a comparison of the internal and external doses at each sample plot. Based on the internal and TED doses in this table, internal dose comprises between 24 and 55 percent of TED.

Table A.6-5
Study Group 4 Ratio of Calculated Internal Dose to External Dose at Each Sample Plot (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
D01	0.7	0.7	1.4	1.04
D02	1.5	1.2	2.7	1.21
D04	0.1	0.4	0.6	0.34
D05	0.1	0.3	0.4	0.34
D06	0.1	0.3	0.4	0.31

A.6.2.3 Total Effective Dose

The TED for each sample plot location or TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED 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 A.6-6.

Table A.6-6
Study Group 4 TED at Sample Locations (mrem/yr)

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
D01[a]	**25.9**	**31.6**	4.4	5.3	1.4	1.7
D02[a]	**48.2**	**67.6**	8.1	11.4	2.7	3.7
D04[a]	10.7	14.2	1.8	2.4	0.6	0.7
D05[a]	7.0	8.7	1.2	1.5	0.4	0.5
D06[a]	7.5	10.7	1.3	1.8	0.4	0.6

[a]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location within Study Group 4, as shown on Figure A.6-4.

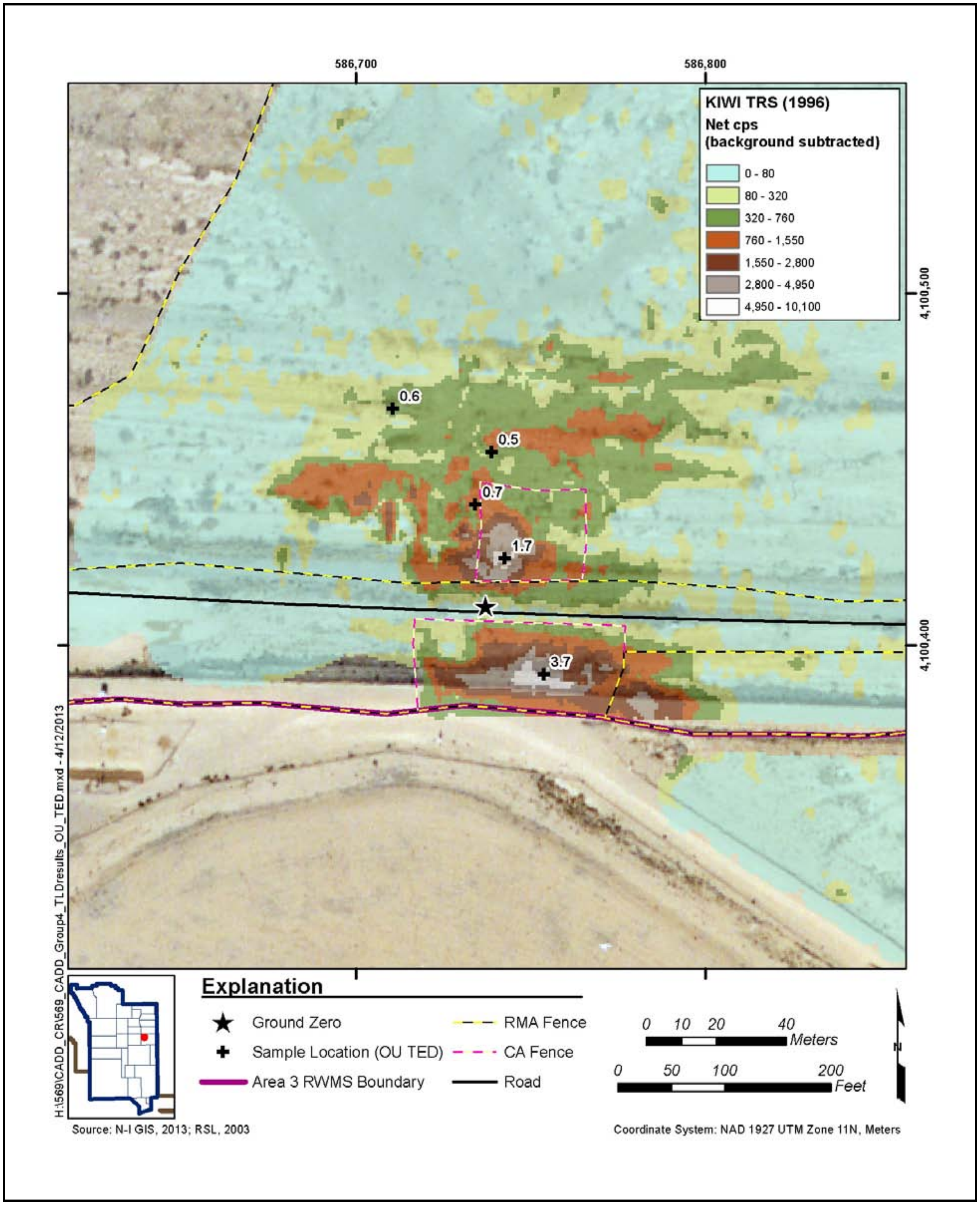

Figure A.6-4
95% of the TED at Study Group 4

A.6.3 Corrective Actions

No COCs were identified at any sampled location within the boundaries of Study Group 4. Therefore, no corrective action is required for this area. No PSM was identified at this study group.

A.6.4 Best Management Practices

BMPs are voluntary protective measures and are not part of any corrective action. As a BMP, an administrative UR was established to include any area exceeding CA criteria as shown on Figure A.6-5. The administrative UR boundary is presented in Attachment D-1.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sampled location with the maximum TED (Location D02) will decay to less than 25 mrem/IA-yr in greater than 12,000 years.

A.6.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

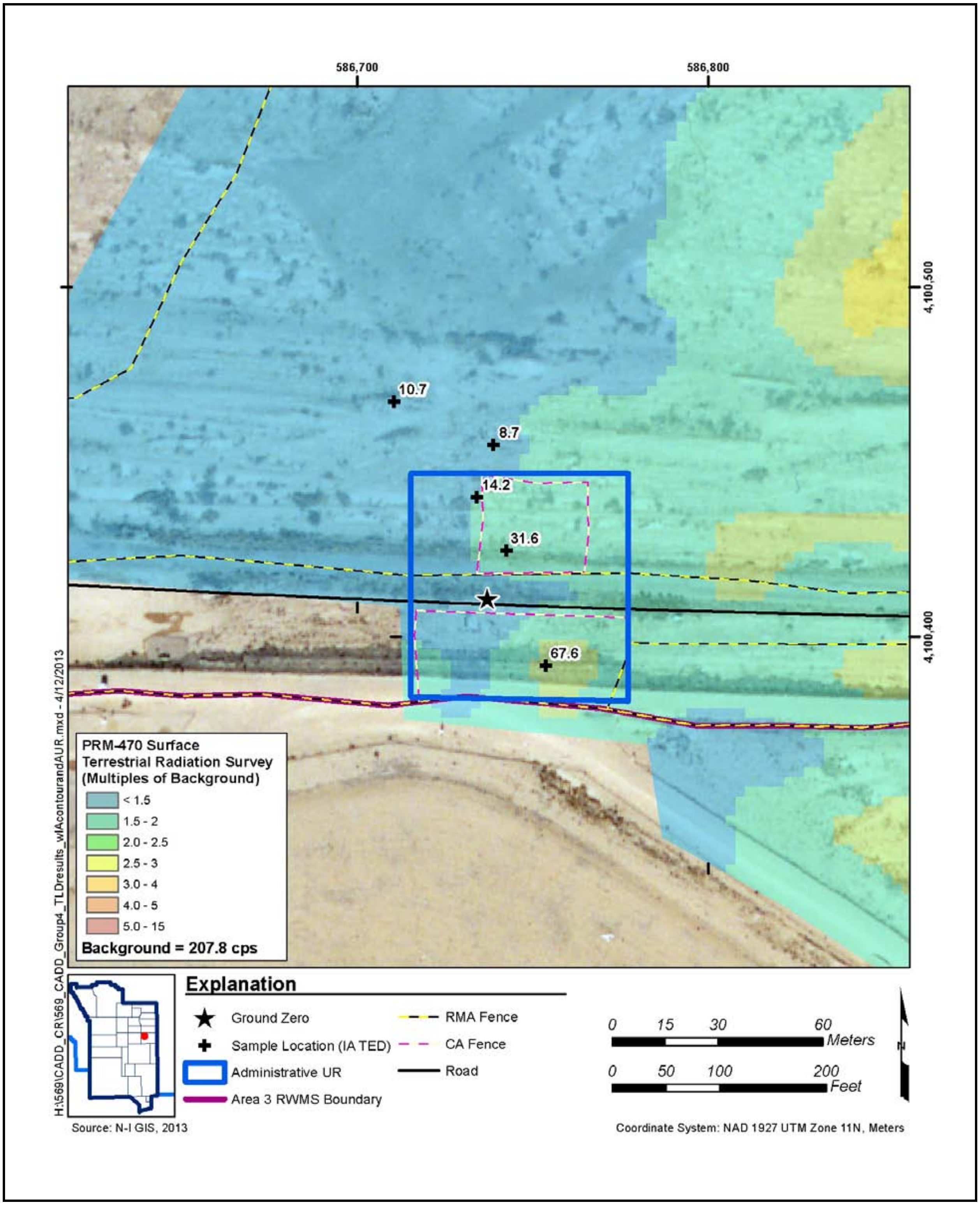

Figure A.6-5
Study Group 4 Administrative UR Boundary

A.7.0 Study Group 5, Harry, Hornet, Rio Arriba, Coulomb-A

Study Group 5, Harry, Hornet, Rio Arriba, Coulomb-A, is located in Area 3 of the NNSS, south of the Area 3 RWMS. The study group consists of a release of radionuclides to the soil surface from the Harry, Hornet, and Rio Arriba weapons-related tests, and the Coulomb-A surface safety experiment (atmospheric depositional area).

The surface soil within the southwest portion of the Area 3 RWMS was scraped to lower the contamination levels for RWMS workers. This scraped soil was dumped within the boundary of Study Group 5 (Sloop, 2013) (RWMS soil dump area). Therefore, Study Group 5 also includes any contamination situated outside the Area 3 RWMS associated with the Coulomb-B and Catron safety experiments. Additional detail on the history of Study Group 5 is provided in the CAIP (NNSA/NSO, 2012a) and Section A.7.1.5.

A.7.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following sections.

A.7.1.1 Visual Inspections

Visual inspections of Study Group 5 were conducted during site walks, sampling efforts, radiological surveys, and geophysical surveys over the course of the field investigation within the atmospheric depositional area and RWMS soil dump area. Visual inspections included looking for drainages; however, no visible drainages were identified. Two possible former transformer areas, a potential vehicle decontamination area, and PSM including a cracked lead-acid battery and a lead brick were identified within the atmospheric depositional area, and samples were collected. Soil samples were collected from these features as described in Section A.7.1.4.1.

A.7.1.2 Radiological Surveys

TRSs were performed using a PRM-470 and FIDLER instrument at Study Group 5, within the atmospheric depositional area and RWMS soil dump area during the CAI. The TRSs were conducted at the site to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings.

For the atmospheric depositional area, the location of highest radiological readings from the PRM-470 was detected northeast of GZ (Location E14). A plot and TLD were placed at this location to measure dose. A KIWI TRS was conducted in this area in 1996. Two areas of elevated readings were detected with the KIWI within the atmospheric depositional area (Locations E01 and E18). A plot and TLD were placed at each of these locations.

For the RWMS soil dump area, two grab sample locations (Locations E39 and E40) were established based on elevated radiological readings from the PRM-470 TRS. For the KIWI TRS, two areas of elevated readings were detected within the RWMS soil dump area (Locations E07 and E09). A plot, grab sample, and TLD were established at each of these locations. Figures A.7-1 and A.7-2 present a graphic representation of the data from the PRM-470 and KIWI TRSs, respectively.

A.7.1.3 Geophysical Surveys

A geophysical survey was conducted during the CAI within the RWMS soil dump area. The survey was conducted to identify whether buried metallic debris indicative of a landfill is present. Results of the geophysical survey indicate distinct pieces of metallic debris generally separated by meters and are not indicative of a solid waste landfill containing significant amounts of metal (Londergan, 2012).

A.7.1.4 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.7.1.4.1 Soil Samples

A total of 32 environmental samples were collected from sample plots during investigation activities at Study Group 5. Within the atmospheric depositional area, four composite samples were collected from each of six sample plots (Locations E01, E14, E18, E26, E28, and E30) to determine internal dose. Sample plots at Locations E01, E14, and E18 were established based on the highest readings as

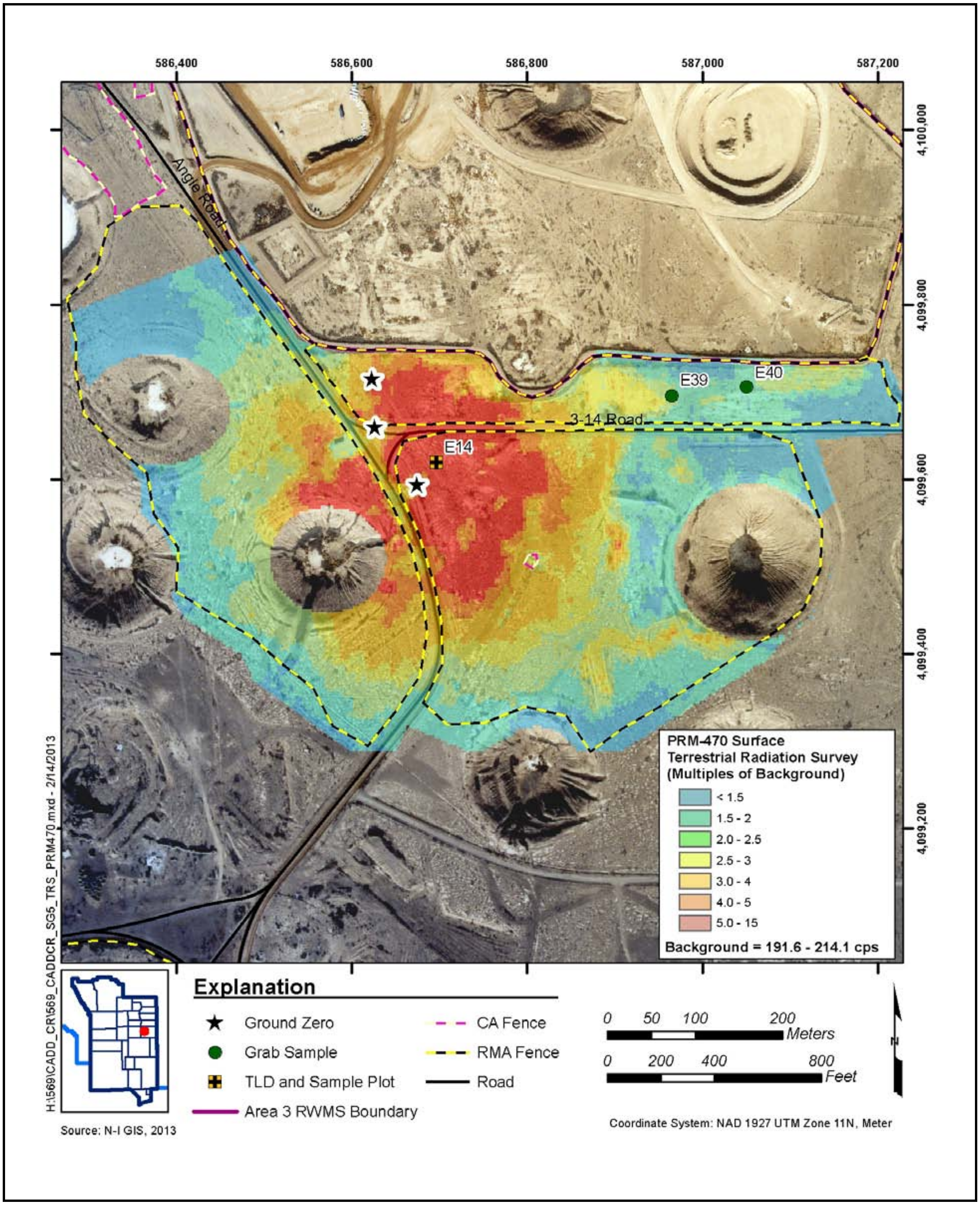

Figure A.7-1
PRM-470 TRS Results for Study Group 5

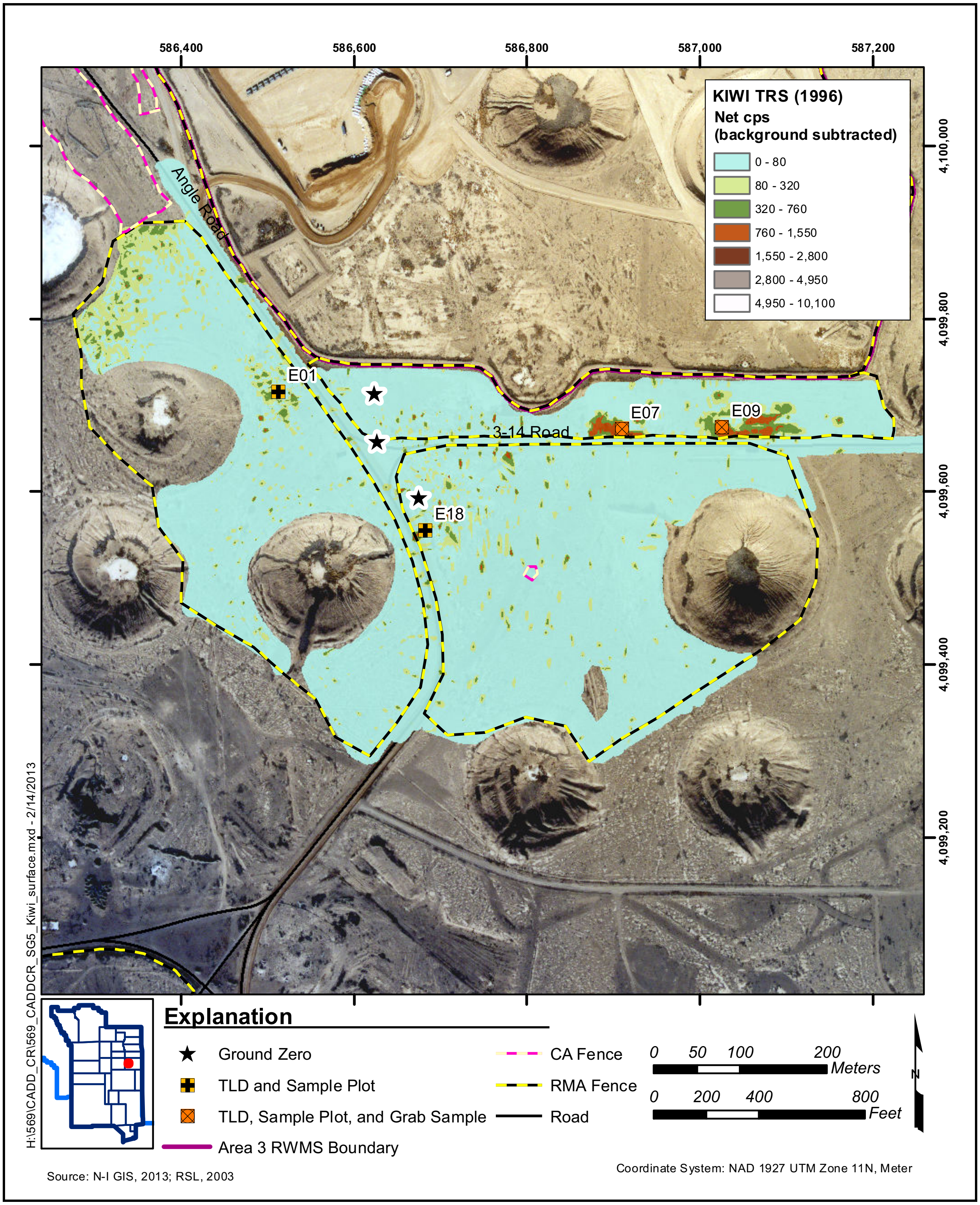

Figure A.7-2
KIWI TRS Results for Study Group 5

detected during the TRSs (Figures A.7-1 and A.7-2). Sample plots at Locations E26, E28, and E30 were established based on aerial radiological survey isopleths. Each composite sample was submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Composite Sample E603 at Location E01 and composite Sample E608 at Location E14 were also analyzed for Sr-90, Pu-241, and Tc-99, because Sample E603 had the highest alpha FSR and Sample E608 had the highest beta FSR among the samples collected from the sample plots.

Within the RWMS soil dump area, four composite samples were collected from each of two sample plots (Locations E07 and E09). These sample plots were established based on the results of the TRSs, and each composite sample was submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses.

Ten environmental samples (including one FD) collected at Study Group 5 were grab samples and are described below.

Within the RWMS soil dump area, four locations (Locations E07, E09, E39, and E40) were established based on the highest results of the KIWI or PRM-470 TRS and investigated for the presence of buried soil contamination. One-foot intervals were screened down to native soil (3 to 4 ft depending on the location). No subsurface samples met the criteria for sample collection (i.e., FSRs at least 20 percent greater than the corresponding surface sample) as stipulated in the CAIP (NNSA/NSO, 2012a). Therefore, only surface (0 to 1 ft) grab samples from each of the four locations were submitted for analysis. All four samples were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses.

Samples were collected from various potential release areas within the atmospheric depositional area. Two samples were collected from potential former transformer areas (Locations E35 and E36) and analyzed for SVOCs, RCRA metals, PCBs, and chromium VI. One sample collected (and one FD) were from a low spot within a rectangular bermed area (Location E37), which is believed to be a decontamination pad. These samples were analyzed for VOCs, SVOCs, RCRA metals, and chromium VI.

Samples were collected from soil beneath two PSM items identified within the atmospheric depositional area to determine whether a release occurred. One sample was collected from the soil underneath a cracked lead-acid battery (Location E34). The battery was removed for disposal (see Section A.10.0 for information on the disposition of the battery). The sample was analyzed for RCRA metals and chromium VI. A lead brick (Location E38) and 15 cm of soil underneath the brick were removed from the site (see Section A.10.0 for information on the disposition of the lead brick and soil). A verification sample was collected from the soil left in place once the brick and soil were removed. This sample was analyzed for RCRA metals. Table A.7-1 shows the number of soil samples collected by type. Additional information including depth and purpose for each soil sample collected for Study Group 5 is provided in Table A.7-1, and the sample locations are shown on Figure A.7-3.

Table A.7-1
Soil Samples Collected at Study Group 5
(Page 1 of 2)

Location	Sample Number	Depth (cm bgs)	Purpose
Atmospheric Depositional Area			
E01	E601	0.0 - 5.0	Plot Composite
	E602	0.0 - 5.0	Plot Composite
	E603	0.0 - 5.0	Plot Composite, Lab QC
	E604	0.0 - 5.0	Plot Composite
E14	E605	0.0 - 5.0	Plot Composite
	E606	0.0 - 5.0	Plot Composite
	E607	0.0 - 5.0	Plot Composite
	E608	0.0 - 5.0	Plot Composite
E18	E609	0.0 - 5.0	Plot Composite
	E610	0.0 - 5.0	Plot Composite
	E611	0.0 - 5.0	Plot Composite
	E612	0.0 - 5.0	Plot Composite
E26	E613	0.0 - 5.0	Plot Composite
	E614	0.0 - 5.0	Plot Composite
	E615	0.0 - 5.0	Plot Composite
	E616	0.0 - 5.0	Plot Composite

Table A.7-1
Soil Samples Collected at Study Group 5
(Page 2 of 2)

Location	Sample Number	Depth (cm bgs)	Purpose
E28	E617	0.0 - 5.0	Plot Composite
	E618	0.0 - 5.0	Plot Composite
	E619	0.0 - 5.0	Plot Composite
	E620	0.0 - 5.0	Plot Composite
E30	E629	0.0 - 5.0	Plot Composite, Lab QC
	E630	0.0 - 5.0	Plot Composite
	E631	0.0 - 5.0	Plot Composite
	E632	0.0 - 5.0	Plot Composite, Lab QC
E34	E001	0.0 - 15.0	Battery Grab, Lab QC
E35	E002	0.0 - 15.0	Transformer Grab, Lab QC
E36	E003	0.0 - 15.0	Transformer Grab
E37	E004	0.0 - 5.0	Decontamination Area Grab
	E005	0.0 - 5.0	FD of E004
E38	E006	0.0 - 5.0	Lead Brick Grab
RWMS Soil Dump Area			
E07	E621	0.0 - 5.0	Plot Composite
	E622	0.0 - 5.0	Plot Composite
	E623	0.0 - 5.0	Plot Composite
	E624	0.0 - 5.0	Plot Composite
	E007	0.0 - 30.0	Grab
E09	E625	0.0 - 5.0	Plot Composite
	E626	0.0 - 5.0	Plot Composite
	E627	0.0 - 5.0	Plot Composite
	E628	0.0 - 5.0	Plot Composite
	E008	0.0 - 30.0	Grab
E39	E009	0.0 - 30.0	Grab
E40	E010	0.0 - 30.0	Grab

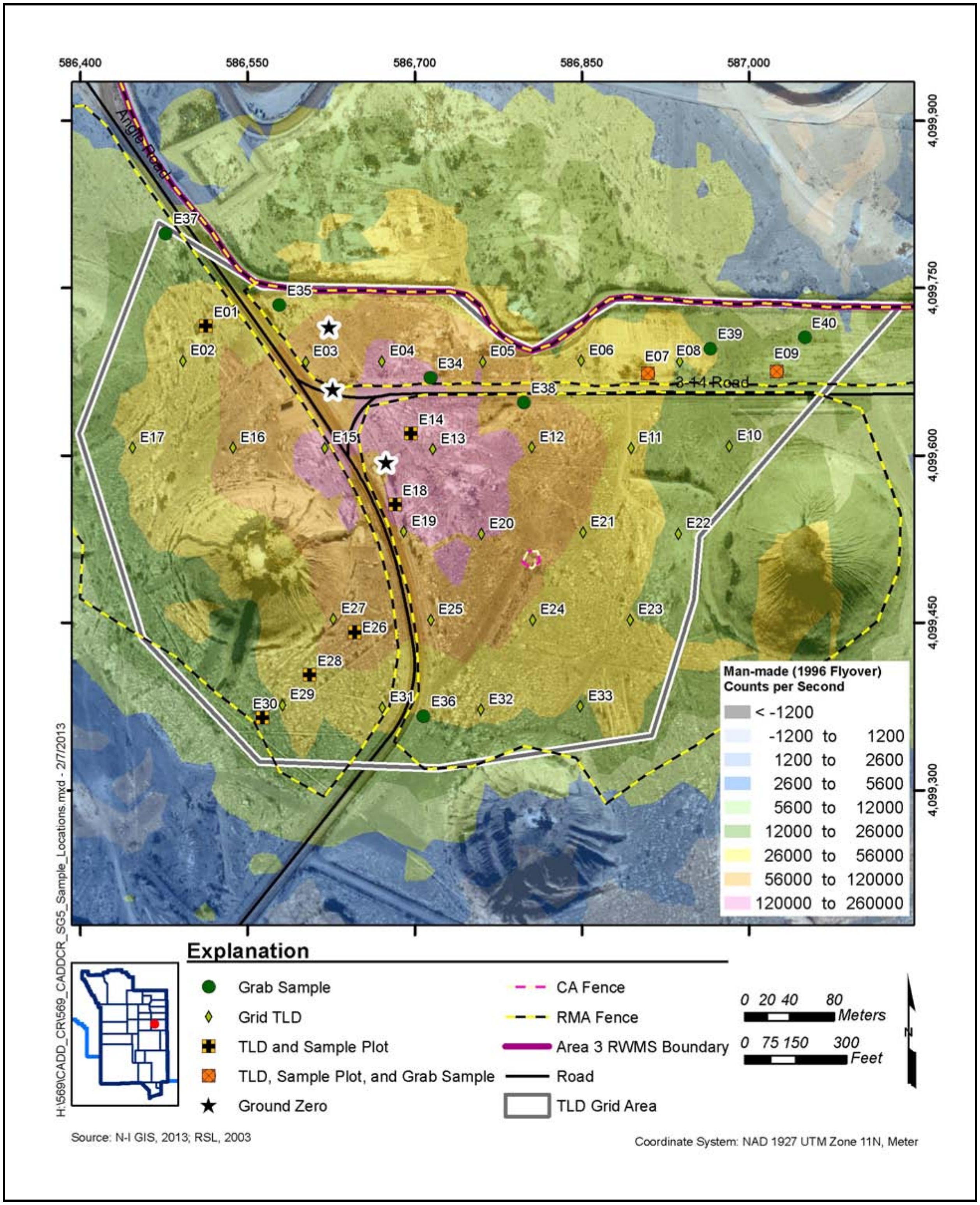

Figure A.7-3
Study Group 5 Sample and TLD Locations

A.7.1.4.2 TLD Samples

Within the atmospheric depositional area, 38 TLDs were installed at 31 locations (E01 through E06, E08, and E10 through E33) to measure external doses to site workers as listed in Table A.7-2. Thirty of the TLDs (Locations E02 through E06, E08, E10 through E13, E15 through E17, E19 through E25, E27, E29, and E31 through E33) were placed at 25 grid locations within the TLD grid area as shown on Figure A.7-3. The TLD grid area was established in an area of elevated radiological survey values, and sample locations were selected using a random start, triangular pattern. Although TLD Locations E06 and E08 were placed within the TLD grid area, their results were used in evaluating contamination in the RWMS soil dump area. Eight TLDs (Locations E01, E14, E18, E26, E28, and E30) were placed at six sample plots within the atmospheric depositional area. The six sample plots were established based on the highest readings as detected during the TRSs.

Table A.7-2
TLDs at Study Group 5
(Page 1 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
Atmospheric Depositional Area				
E01	4663	04/24/2012	07/30/2012	Sample Plot
E02	5103	04/24/2012	07/30/2012	TLD Only (Grid)
E03	4374	04/24/2012	07/30/2012	TLD Only (Grid)
E04	5059	04/24/2012	07/30/2012	TLD Only (Grid)
	4935	04/24/2012	07/30/2012	TLD Only (Grid)
E05	4342	04/24/2012	07/30/2012	TLD Only (Grid)
E10	4443	04/24/2012	07/30/2012	TLD Only (Grid)
E11	4441	04/24/2012	07/30/2012	TLD Only (Grid)
E12	4742	04/24/2012	07/30/2012	TLD Only (Grid)
E13	4737	04/24/2012	07/30/2012	TLD Only (Grid)
	4998	04/24/2012	07/30/2012	TLD Only (Grid)
E14	4615	04/24/2012	07/30/2012	Sample Plot
	4331	04/24/2012	07/30/2012	Sample Plot
E15	4315	04/24/2012	07/30/2012	TLD Only (Grid)
	4895	04/24/2012	07/30/2012	TLD Only (Grid)
E16	5024	04/24/2012	07/30/2012	TLD Only (Grid)

Table A.7-2
TLDs at Study Group 5
(Page 2 of 2)

Location	TLD No.	Date Placed	Date Removed	Purpose
E17	4481	04/24/2012	07/30/2012	TLD Only (Grid)
E18	4404	04/24/2012	07/30/2012	Sample Plot
	5266	04/24/2012	07/30/2012	Sample Plot
E19	4363	04/24/2012	07/30/2012	TLD Only (Grid)
	4536	04/24/2012	07/30/2012	TLD Only (Grid)
E20	4438	04/24/2012	07/30/2012	TLD Only (Grid)
	4641	04/24/2012	07/30/2012	TLD Only (Grid)
E21	4284	04/24/2012	07/30/2012	TLD Only (Grid)
E22	4487	04/24/2012	07/30/2012	TLD Only (Grid)
E23	4323	04/24/2012	07/30/2012	TLD Only (Grid)
E24	4368	04/24/2012	07/30/2012	TLD Only (Grid)
E25	4362	04/24/2012	07/30/2012	TLD Only (Grid)
E26	4901	04/24/2012	07/30/2012	Sample Plot
E27	4953	04/24/2012	07/30/2012	TLD Only (Grid)
E28	4535	04/24/2012	07/30/2012	Sample Plot
E29	5152	04/24/2012	07/30/2012	TLD Only (Grid)
E30	4934	04/24/2012	07/30/2012	Sample Plot
E31	4494	04/24/2012	07/30/2012	TLD Only (Grid)
E32	4459	04/24/2012	07/30/2012	TLD Only (Grid)
E33	4465	04/24/2012	--	TLD Only (Grid)
RWMS Soil Dump Area				
E06	5004	04/24/2012	07/30/2012	TLD Only (Grid)
E07	4637	04/24/2012	07/30/2012	Sample Plot/Grab Sample
E08	4350	04/24/2012	07/30/2012	TLD Only (Grid)
E09	5284	04/24/2012	07/30/2012	Sample Plot/Grab Sample

-- = TLD not processed

Within the RWMS soil dump area, two TLDs were placed at two sample plot/grab sample locations (E07 and E09) to measure external doses to site workers as listed in Table A.7-2. These locations were established based on the highest readings as detected during the KIWI TRS.

All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.7-3 for TLD locations. Table A.7-2 shows the number of TLD samples collected by type.

A.7.1.5 Deviations

In email correspondence dated May 31, 2012 (see Appendix H), the CSM and sampling approach for the soil waste pile area was revised (Section 2.1.5). No deviations to the revised CSM were noted.

A.7.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples collected from within the atmospheric depositional area and RWMS soil dump area at Study Group 5. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a) with the exceptions noted in Section A.7.1.5. The radiological results are reported as doses from judgmental sample locations that individually are comparable to the dose-based FAL of 25 mrem/OU-yr. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.7.2.1. Internal doses for each sample location are summarized in Section A.7.2.2. The TEDs for each sampled location are summarized in Section A.7.2.3. Additional sample results (i.e., soil from within the former transformer and decontamination areas, and soil beneath a lead brick and cracked lead-acid battery) are summarized in Section A.7.2.4.

A.7.2.1 External Radiological Dose Measurements

Estimates for the external dose that a receptor would receive at each Study Group 5 TLD sample location were determined as described in Section A.2.2.5. The external dose 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.7-3. The minimum sample size criterion was met for all locations within Study Group 5.

Table A.7-3
Study Group 5 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 2)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Depositional Area						
E01	0.1	3	3	20.9	3.5	1.0
E02	0.2	3	3	**30.3**	5.1	1.5
E03	0.1	3	3	**38.5**	6.5	1.9
E04	0.5	6	3	**104.2**	17.5	5.2
E05	0.5	3	3	**92.6**	15.6	4.6
E10	0.1	3	3	18.5	3.1	0.9
E11	0.2	3	3	**33.1**	5.6	1.7
E12	0.1	3	3	**76.0**	12.8	3.8
E13	0.4	6	3	**132.8**	22.3	6.6
E14	0.6	6	3	**169.9**	**28.5**	8.5
E15	0.3	6	3	**105.6**	17.7	5.3
E16	0.0	3	3	23.2	3.9	1.2
E17	0.1	3	3	22.8	3.8	1.1
E18	0.4	6	3	**123.4**	20.7	6.2
E19	0.2	6	3	**78.2**	13.1	3.9
E20	0.3	6	3	**92.1**	15.5	4.6
E21	0.1	3	3	**40.9**	6.9	2.0
E22	0.1	3	3	5.8	1.0	0.3

Table A.7-3
Study Group 5 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 2)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
E23	0.1	3	3	19.3	3.2	1.0
E24	0.2	3	3	**38.7**	6.5	1.9
E25	0.1	3	3	**52.2**	8.8	2.6
E26	0.2	3	3	**54.4**	9.1	2.7
E27	0.2	3	3	**51.9**	8.7	2.6
E28	0.1	3	3	**34.1**	5.7	1.7
E29	0.1	3	3	23.8	4.0	1.2
E30	0.1	3	3	16.2	2.7	0.8
E31	0.1	3	3	**26.6**	4.5	1.3
E32	0.2	3	3	**29.7**	5.0	1.5
E33	--	--	--	--	--	--
RWMS Soil Dump Area						
E06	0.1	3	3	**29.6**	5.0	1.5
E07	0.1	3	3	**25.4**	4.3	1.3
E08	0.2	3	3	**34.8**	5.8	1.7
E09	0.1	3	3	11.6	2.0	0.6

-- TLD not processed.

Bold indicates the values equal to or greater than 25 mrem/yr.

For sample locations where external dose measurements were not available (Locations E39 and E40 within the RWMS soil dump area), the TED was calculated using the process discussed in Section A.2.2.4, except the RRMGs for total dose were used instead of those for internal dose.

A.7.2.2 Internal Radiological Dose Estimations

The estimates for the internal dose that a receptor would receive at the Study Group 5 sample plots within the atmospheric depositional area and sample plots and at grab sample locations within the RWMS soil dump area were determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plots (atmospheric depositional area and RWMS dump area) for each exposure scenario are presented in Table A.7-4. The average internal dose for each grab sample location (Locations E07, E09, E39, and E40 within the RWMS dump area) and the inferred internal dose (which was calculated where soil samples were not collected, as described in Section A.2.2.4) at TLD grid locations for each exposure scenario are presented in Table A.7-5. The analytical results for the individual radionuclides in each composite sample are presented in Appendix F. As shown in Table A.7-4, the minimum sample size was met for all sample locations.

Table A.7-4
Study Group 5 95% UCL Internal Dose at Sample Plots for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Depositional Area						
E01	0.0	4	3	3.2	0.5	0.2
E14	0.0	4	3	0.4	0.1	0.0
E18	0.0	4	3	0.2	0.0	0.0
E26	0.0	4	3	0.2	0.0	0.0
E28	0.0	4	3	0.8	0.1	0.1
E30	0.0	4	3	0.5	0.1	0.0
RWMS Soil Dump Area						
E07	0.1	4	3	8.0	1.3	0.5
E09	0.1	4	3	4.7	0.8	0.3

Table A.7-6 presents a comparison of the internal and external doses at each sample plot and grab sample location. Based on the internal and TED doses in this table, internal dose at the atmospheric depositional area comprises a maximum of 14 percent of TED, and internal dose at the RWMS soil dump area comprises a maximum of 32 percent of TED.

Table A.7-5
Study Group 5 Internal Dose at Grid TLD and Grab Sample Locations for Each Exposure Scenario
(Page 1 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Depositional Area			
E02	7.2	1.2	0.4
E03	9.8	1.6	0.6
E04	**28.2**	4.7	1.7
E05	22.2	3.7	1.3
E10	4.1	0.7	0.2
E11	8.0	1.4	0.5
E12	20.8	3.5	1.2
E13	**36.9**	6.2	2.2
E15	**29.3**	4.9	1.8
E16	6.4	1.1	0.4
E17	6.0	1.0	0.4
E19	21.7	3.7	1.3
E20	**25.4**	4.3	1.5
E21	10.5	1.8	0.6
E22	1.1	0.2	0.1
E23	4.7	0.8	0.3
E24	9.6	1.6	0.6
E25	14.0	2.4	0.8
E27	13.3	2.2	0.8
E29	5.8	1.0	0.3
E31	6.3	1.1	0.4
E32	6.6	1.1	0.4
E33	--	--	--

Table A.7-5
Study Group 5 Internal Dose at Grid TLD and Grab Sample Locations for Each Exposure Scenario
(Page 2 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
RWMS Soil Dump Area			
E06	7.9	1.3	0.5
E07	2.5	0.4	0.2
E08	7.9	1.3	0.5
E09	0.2	0.0	0.0
E39	0.2	0.0	0.0
E40	0.0	0.0	0.0

-- = TLD not processed

Table A.7-6
Study Group 5 Ratio of Calculated Internal Dose to External Dose at Each Soil Sample Location (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
Atmospheric Depositional Area				
E01	0.2	0.9	1.1	0.17
E14	0.0	8.0	8.0	0.001
E18	0.0	5.8	5.8	0.002
E26	0.0	2.4	2.5	0.005
E28	0.0	1.5	1.5	0.02
E30	0.0	0.6	0.7	0.03
RWMS Soil Dump Area				
E07 (plot)	0.4	1.1	1.4	0.35
E07 (grab)	0.2	1.1	1.2	0.14
E09 (plot)	0.2	0.4	0.6	0.47
E09 (grab)	0.0	0.4	0.4	0.03

A.7.2.3 Total Effective Dose

The TED for each sample plot, grab sample location, or TLD location within the atmospheric depositional area and RWMS soil dump area was calculated by adding the external dose values and the internal dose values. For sample locations where soil samples were collected but no TLD was staged (Locations E39 and E40 within the RWMS soil dump area), the TED at these locations was calculated using the RRMGs for TED. Values for both the average TED 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 A.7-7. The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location within the atmospheric depositional area or RWMS soil dump area at Study Group 5, as shown on Figure A.7-4.

Table A.7-7
Study Group 5 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

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
Atmospheric Depositional Area						
E01[a]	20.9	24.2	3.5	4.1	1.1	1.2
E02[b]	**32.1**	**37.6**	5.4	6.3	1.7	2.0
E03[b]	**43.3**	**48.2**	7.3	8.1	2.3	2.5
E04[b]	**124.8**	**132.3**	21.0	22.2	6.5	6.9
E05[b]	**98.4**	**114.9**	16.5	19.3	5.1	6.0
E10[b]	18.3	22.6	3.1	3.8	1.0	1.2
E11[b]	**35.5**	**41.2**	6.0	6.9	1.9	2.1
E12[b]	**91.9**	**96.8**	15.5	16.3	4.8	5.0
E13[b]	**163.6**	**169.7**	**27.5**	**28.5**	8.6	8.9
E14[a]	**160.8**	**170.2**	**27.0**	**28.6**	8.0	8.5
E15[b]	**129.7**	**134.9**	21.8	22.7	6.8	7.0
E16[b]	**28.2**	**29.5**	4.7	5.0	1.5	1.5
E17[b]	**26.8**	**28.8**	4.5	4.8	1.4	1.5
E18[a]	**116.8**	**123.6**	19.6	20.8	5.8	6.2
E19[b]	**96.1**	**99.9**	16.1	16.8	5.0	5.2
E20[b]	**112.4**	**117.5**	18.9	19.7	5.9	6.1

Table A.7-7
Study Group 5 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

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
E21[b]	**46.5**	**51.4**	7.8	8.6	2.4	2.7
E22[b]	4.7	6.9	0.8	1.2	0.2	0.4
E23[b]	20.9	24.0	3.5	4.0	1.1	1.2
E24[b]	**42.5**	**48.3**	7.1	8.1	2.2	2.5
E25[b]	**62.0**	**66.2**	10.4	11.1	3.2	3.5
E26[a]	**49.1**	**54.7**	8.3	9.2	2.5	2.7
E27[b]	**58.8**	**65.2**	9.9	11.0	3.1	3.4
E28[a]	**30.3**	**35.0**	5.1	5.9	1.5	1.8
E29[b]	**25.6**	**29.6**	4.3	5.0	1.3	1.5
E30[a]	13.3	16.7	2.2	2.8	0.7	0.8
E31[b]	**27.9**	**32.9**	4.7	5.5	1.5	1.7
E32[b]	**29.3**	**36.3**	4.9	6.1	1.5	1.9
E33	--	--	--	--	--	--
RWMS Soil Dump Area						
E06[b]	**34.8**	**37.5**	5.8	6.3	1.8	2.0
E07 (plot)[a]	**27.6**	**33.4**	4.6	5.6	1.4	1.8
E07 (grab)[c]	23.9	**27.9**	4.0	4.7	1.2	1.4
E08[b]	**34.8**	**42.7**	5.9	7.2	1.8	2.2
E09 (plot)[a]	11.8	16.3	2.0	2.7	0.6	0.9
E09 (grab)[c]	8.7	11.9	1.5	2.0	0.4	0.6
E39[d]	7.5	NC	1.3	NC	0.3	NC
E40[d]	2.0	NC	0.3	NC	0.1	NC

[a]Judgmental sample - results from TLD elements and 4 composite (plot) samples.
[b]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (Section A.2.2.4).
[c]Judgmental sample - results from TLD elements and 1 grab sample.
[d]Judgmental sample - results from 1 grab sample using total dose RRMGs (Section A.7.2.1).

-- = TLD not processed.
NC = 95% UCL not able to be calculated for this sample.

Bold indicates the values equal to or greater than 25 mrem/yr.

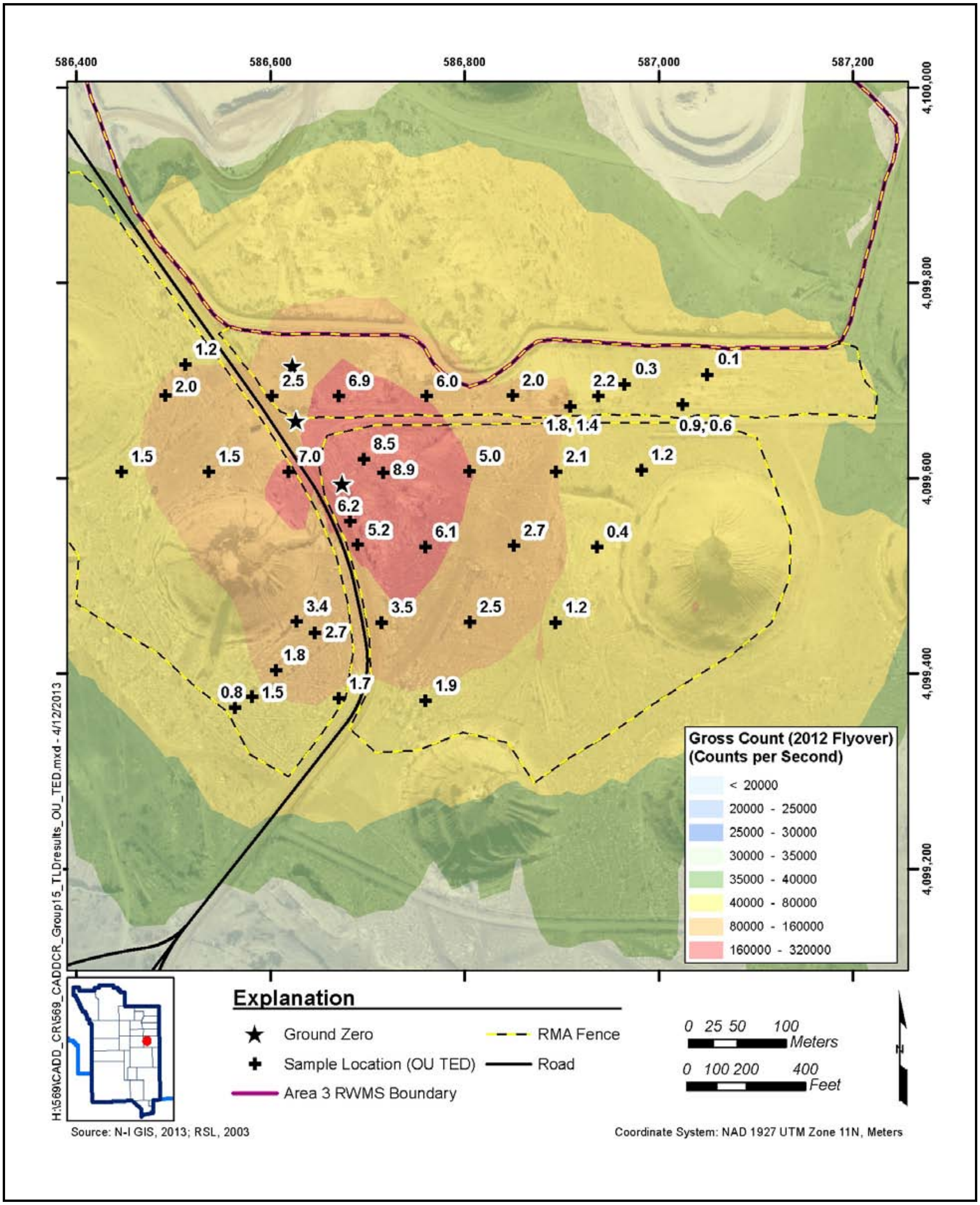

Figure A.7-4
95% of the TED at Study Group 5

A.7.2.4 Chemical Contaminants

Samples collected from two potential former transformer areas (Locations E35 and E36) were analyzed for SVOCs, RCRA metals, PCBs, and chromium VI. One sample collected (and one FD) from a low spot within a rectangular bermed area (Location E37) were analyzed for VOCs, SVOCs, RCRA metals, and chromium VI. The analytical results exceeding MDCs from the samples collected at the former transformer areas and decontamination area are presented in Table A.7-8. No sample result exceeded FALs.

A.7.2.5 PSM at Study Group 5

One cracked lead-acid battery and one lead brick were identified as PSM at Study Group 5. One sample collected from the soil underneath the lead-acid battery (Location E34) was analyzed for RCRA metals and chromium VI. One sample collected from the soil left in place once the lead brick and soil were removed was analyzed for RCRA metals. The analytical results exceeding MDCs from the samples collected from the soil under the lead brick and battery are presented in Table A.7-8. No sample result exceeded FALs. The lead brick and battery were removed from the site as a corrective action. See Section A.10.0 for information on the disposition of these items.

A.7.3 Corrective Actions

No COCs were identified at any sampled location within the atmospheric depositional area or RWMS soil dump area at Study Group 5. Therefore, no corrective action is required for these areas. However, a corrective action was necessary for the PSM present at the site.

CAAs were not evaluated for corrective actions that were completed during the CAI.

Based on the presence of PSM (one lead brick and one cracked lead-acid battery) at this study group, corrective action is required. A corrective action of removal of the PSM and associated soil was completed. Verification sample results confirmed that COCs are not present in the remaining soil. Therefore, no further corrective action is needed.

Table A.7-8
Study Group 5 Sample Results above MDCs

Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)											
			Aroclor 1248	Aroclor 1254	Aroclor 1260	Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Silver	Toluene
FALs			0.74	0.74	0.74	23	190,000	9,300	33.6	5.6	8,356	43	5,100	45,000
E34	E001	0 - 15	--	--	--	2.61	140 (J)	--	--[a]	--	15.7 (J)	0.0085 (J)	0.351 (J)	--
E35	E002	0 - 15	0.0072 (J)	0.0133 (J)	0.00564 (J)	2.5	161 (J)	0.179 (J)	--[a]	--	12 (J)	0.0107 (J)	0.409 (J)	--
E36	E003	0 - 15	--	0.00494 (J)	0.00421 (J)	2.7	148 (J)	0.815	--[a]	0.138 (J)	11.8 (J)	0.0101 (J)	0.487 (J)	--
E37	E004	0 - 5	--	--	--	2.62	152 (J)	--	--[a]	--	10.6 (J)	0.0131 (J)	0.427 (J)	0.000318 (J)
	E005	0 - 5	--	--	--	3.08	175 (J)	--	--[a]	--	11.6 (J)	0.013 (J)	0.512	--
E38	E006	0 - 5	--	--	--	5.1	156 (J)	0.144 (J)	7.34	NA	14.5 (J)	0.0127 (J)	0.378 (J)	--

[a]Total chromium reported only when chromium VI results are not available.

NA = Not analyzed

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

A.7.4 Best Management Practices

BMPs are voluntary protective measures and are not part of any corrective action. As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr within the atmospheric depositional area. To determine the extent of the area where the industrial area TED exceeds 25 mrem/IA-yr (Industrial Area exposure scenario), correlations of radiation survey values to the 95 percent UCL of industrial area TED values were conducted for the radiation surveys listed in Table A.7-9 (as discussed in Section 3.0). The radiation survey that exhibited the best correlation is the PRM-470 TRS, with a correlation of 0.96. This correlation exceeds the minimum criteria of 0.8 as set in the CAIP (NNSA/NSO, 2012a). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 2.18 multiples of background. The administrative UR boundary was established to encompass the TRS isopleth of 2.18 multiples of background. For the RWMS soil dump area, sample Locations E06, E07, and E08 exceed the TED of 25 mrem/IA-yr. The revised CSM is that this disturbed soil does not have a discernible spatial contaminant distribution pattern. Therefore, a contaminant concentration detected at any sample location could also be present at any location within the RWMS soil dump area. The entire RWMS soil dump area was added to the administrative UR boundary for the atmospheric depositional area. The combined administrative UR area is shown on Figure A.7-5.

Table A.7-9
Study Group 5 Correlations of 95% UCL TED with Gamma Surveys
(Page 1 of 2)

Dataset	Correlation Coefficient (R^2)
2012 N-I FIDLER TRS	--
2012 N-I PRM-470 TRS	0.96
1996 KIWI TRS	--
1994 Gamma Flyover - Gross Count	0.63
1994 Gamma Flyover - Man Made	0.63
1994 Gamma Flyover - Americium	--
1996 Gamma Flyover - Man Made	0.94
1996 Gamma Flyover - Americium	0.85
2012 Gamma Flyover - Gross Count	0.11

Table A.7-9
Study Group 5 Correlations of 95% UCL TED with Gamma Surveys
(Page 2 of 2)

Dataset	Correlation Coefficient (R^2)
2012 Gamma Flyover - Man Made	0.94
2012 Gamma Flyover - Europium	0.94
2012 Gamma Flyover - Americium	0.22

-- = Not enough co-located data available to provide a correlation.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sampled location with the maximum TED (Location E14 within the atmospheric depositional area) at Study Group 5 will decay to less than 25 mrem/IA-yr in approximately 45 years.

The administrative UR boundary is presented in Attachment D-1.

A.7.5 Revised Conceptual Site Model

The CSM for Study Group 5 was revised based on historical information that was identified after completion of the CAIP (NNSA/NSO, 2012a). The revised CSM is discussed in Section A.7.1.5. The information gathered during the CAI supports the revised CSM.

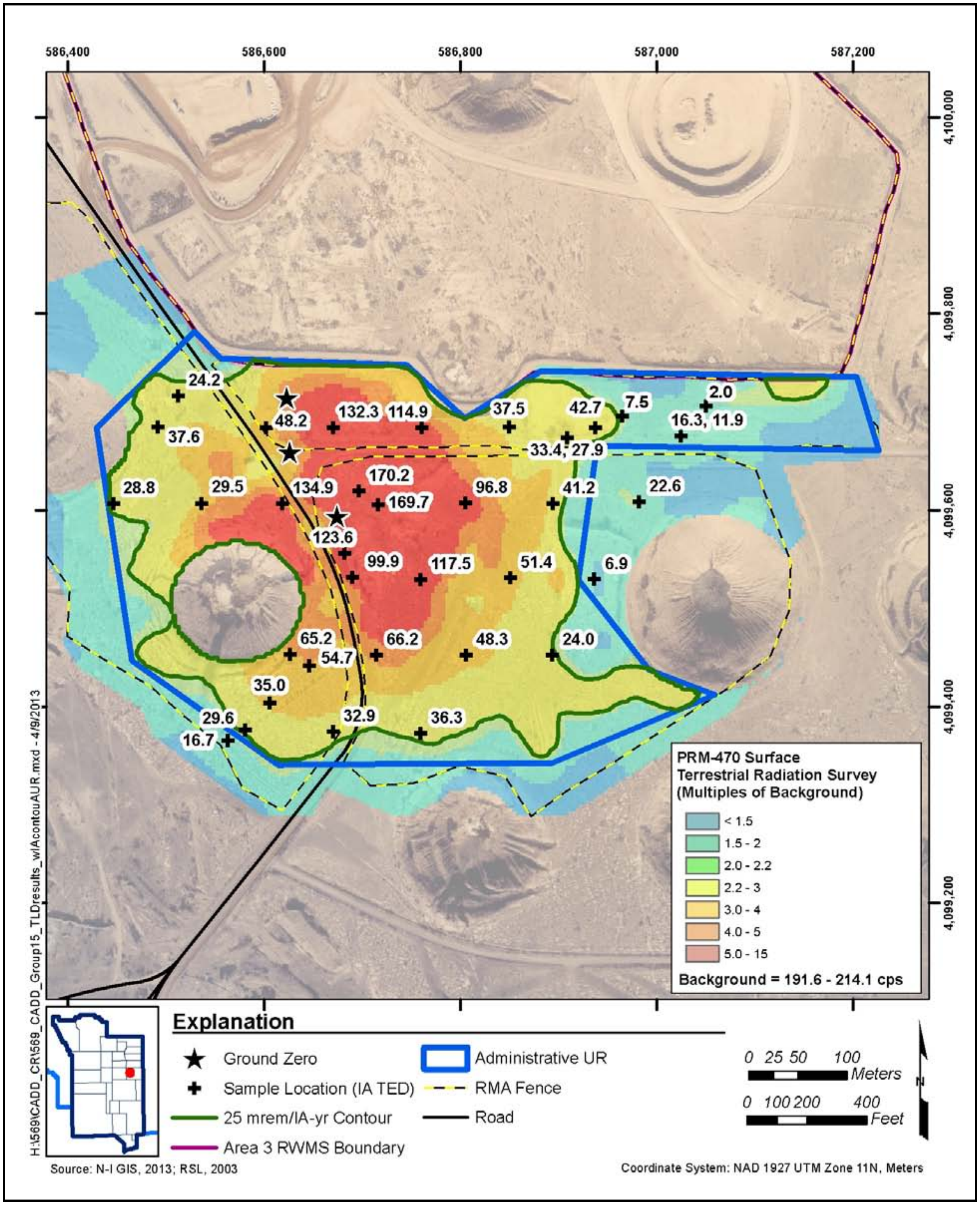

Figure A.7-5
Study Group 5 25-mrem/IA-yr Contour and Administrative UR Boundary

A.8.0 Study Group 6, Fizeau

Study Group 6, Fizeau, is located in Area 3 of the NNSS, southwest of the Area 3 RWMS, near the intersection of 3-12 Road and Angle Road. The study group consists of a release of radionuclides to the soil surface from the Fizeau weapons-related test. Additional detail on the history of Study Group 6 is provided in the CAIP (NNSA/NSO, 2012a).

A.8.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.8.1.1 Visual Inspections

Visual inspections of Study Group 6 were conducted during site walks, sampling efforts, and radiological surveys over the course of the field investigation. Visual inspections included looking for drainages; however, no visible drainages were identified. A pile of white gravelly material, fine silty black material on the surface of a soil pile, crushed lead-acid batteries, a closed drum labeled “petroleum naphtha,” and concrete debris coated with Trinity glass were identified. Soil samples were collected from selected features as described in Section A.8.1.3.1.

A.8.1.2 Radiological Surveys

TRSs were performed using a PRM-470 and FIDLER instrument at Study Group 6 during the CAI. The TRSs were conducted at the site within the fenced and posted RMA to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. The location of highest radiological readings for the PRM-470 was detected east of GZ (Location F15). A sample plot and TLD were placed at this location to measure dose. A KIWI TRS was also conducted at Study Group 6 in 1996. The location of highest radiological readings detected with the KIWI was located northeast of GZ (Location F14). A sample plot and TLD were placed at this location. Figures A.8-1 and A.8-2 present a graphic representation of the data from the PRM-470 and KIWI TRSs, respectively.

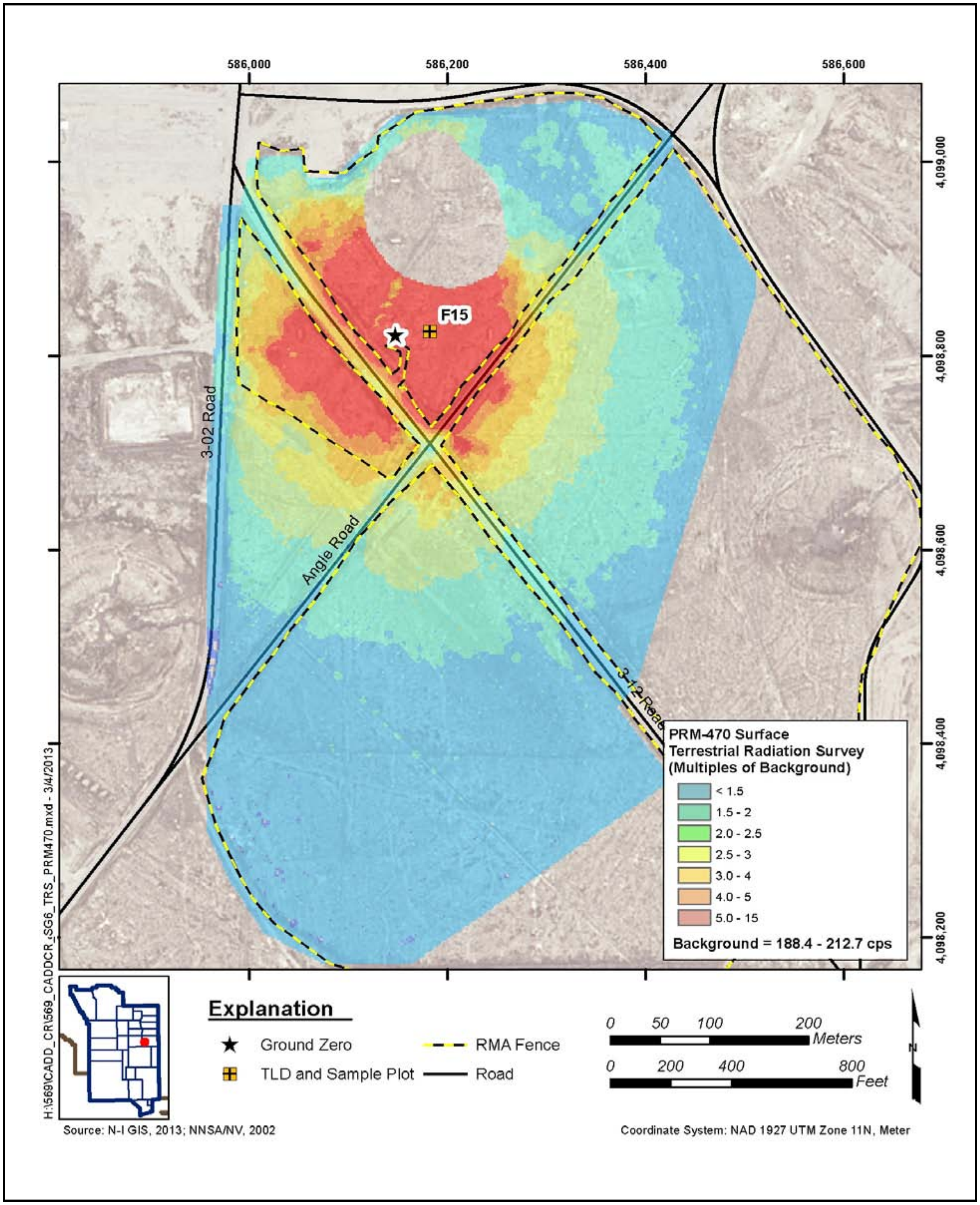

Figure A.8-1
PRM-470 TRS Results for Study Group 6

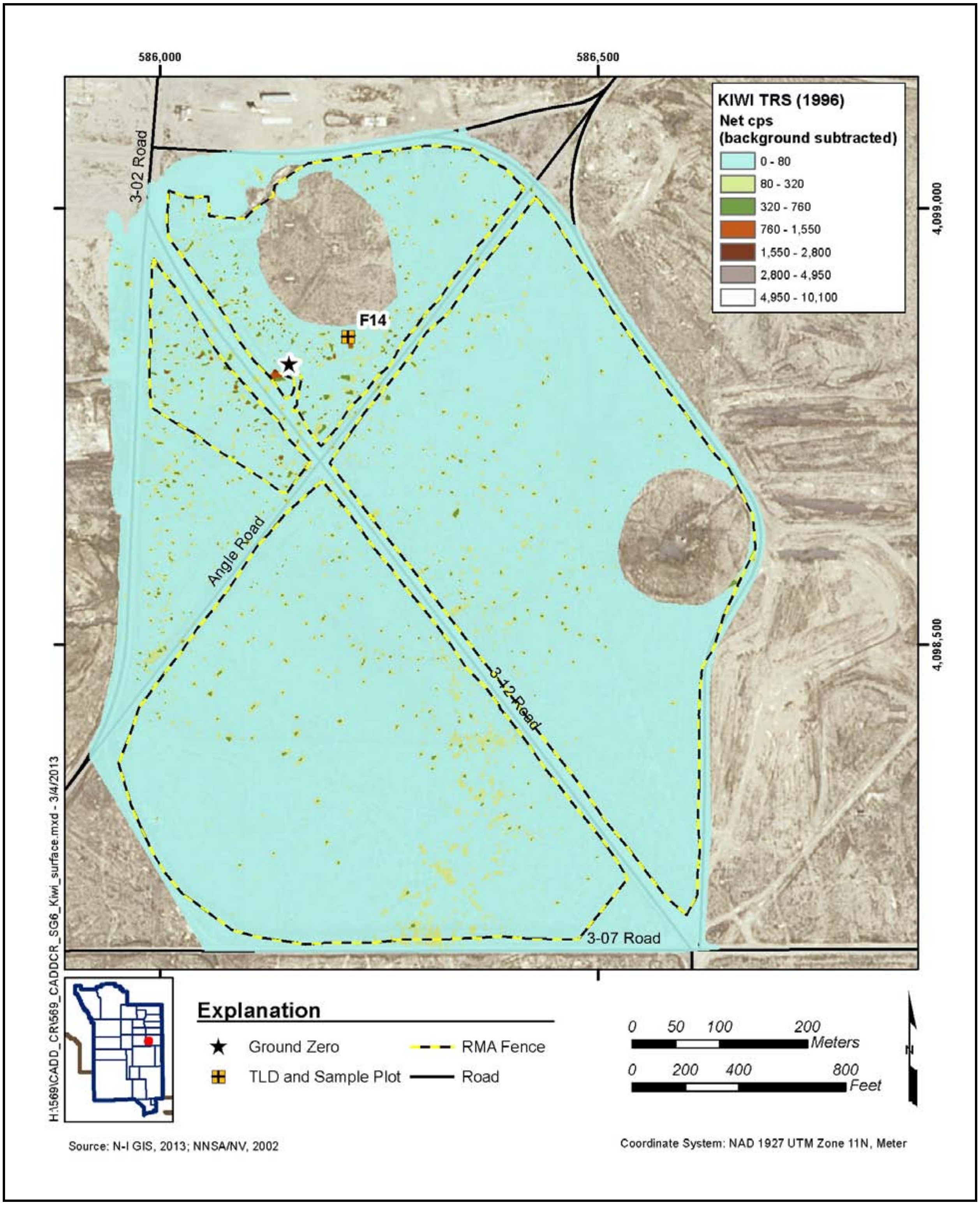

Figure A.8-2
KIWI TRS Results for Study Group 6

A.8.1.3 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.8.1.3.1 Soil Samples

A total of 40 environmental samples (39 environmental samples and 1 FD) were collected during investigation activities at Study Group 6 (24 samples from 6 sample plots, 12 samples from areas of scattered debris, and 4 samples from other potential releases). Four composite samples were collected from each of 6 sample plots (Locations F14, F15, F18, F19, F21, and F27) to determine the internal dose at sample plots. Locations F14 and F15 were established based on the results of the TRSs (Figures A.8-1 and A.8-2), while Locations F18, F19, and F21 were established based on aerial radiological survey isopleths. Because the sample plot at Location F18 was covered with gravel, the sample plot at Location F27 was established as a step-out. All plot composite samples were submitted for gamma spectroscopy; and isotopic U, Pu, and Am analyses. Composite Samples F605 and F608 at Location F15 were also analyzed for Sr-90, Pu-241, and Tc-99, because Sample F605 had the highest alpha FSR and Sample F608 had the highest beta FSR among the 24 samples collected from the sample plots.

Three areas of scattered, crushed, lead-acid batteries were identified within Study Group 6. Because lead was scattered across a large area, to obtain a representative sample and determine whether the lead had leached into the soil, sample plots (Locations F31 through F33) were established within these three areas, and four composite samples were collected from each of the three areas in the same manner as described in Section A.2.2.3. These 12 samples were analyzed for RCRA metals.

To determine the presence of chemical contamination, samples were collected from various potential release areas. One sample and one FD were collected from the surface of a pile of white gravelly material (Location F28); and one sample was collected from an area of fine black material on a soil pile (Location F29). One sample was collected from the soil surrounding a closed rusty drum (Location F30) labeled “140 Solvent-66 Petroleum Naphtha” to verify that the contents had not leaked. These samples were analyzed for VOCs, SVOCs, RCRA metals, and chromium VI.

Table A.8-1 shows the number of soil samples collected by type (plot, grab). Additional information including depth and purpose for each soil sample is provided in Table A.8-1, and the sample locations are shown on Figure A.8-3.

Table A.8-1
Soil Samples Collected at Study Group 6
(Page 1 of 2)

Location	Sample Number	Depth (cm bgs)	Purpose
F14	F601	0.0 - 5.0	Plot Composite
	F602	0.0 - 5.0	Plot Composite, Lab QC
	F603	0.0 - 5.0	Plot Composite
	F604	0.0 - 5.0	Plot Composite
F15	F605	0.0 - 5.0	Plot Composite, Lab QC
	F606	0.0 - 5.0	Plot Composite
	F607	0.0 - 5.0	Plot Composite
	F608	0.0 - 5.0	Plot Composite
F18	F609	0.0 - 5.0	Plot Composite
	F610	0.0 - 5.0	Plot Composite
	F611	0.0 - 5.0	Plot Composite
	F612	0.0 - 5.0	Plot Composite
F19	F613	0.0 - 5.0	Plot Composite
	F614	0.0 - 5.0	Plot Composite
	F615	0.0 - 5.0	Plot Composite
	F616	0.0 - 5.0	Plot Composite
F21	F617	0.0 - 5.0	Plot Composite
	F618	0.0 - 5.0	Plot Composite
	F619	0.0 - 5.0	Plot Composite
	F620	0.0 - 5.0	Plot Composite
F27	F621	0.0 - 5.0	Plot Composite, Lab QC
	F622	0.0 - 5.0	Plot Composite, Lab QC
	F623	0.0 - 5.0	Plot Composite
	F624	0.0 - 5.0	Plot Composite
F28	F001	0.0 - 5.0	White Gravelly Material Pile Grab
	F002	0.0 - 5.0	FD of F001

Table A.8-1
Soil Samples Collected at Study Group 6
(Page 2 of 2)

Location	Sample Number	Depth (cm bgs)	Purpose
F29	F003	0.0 - 5.0	Black Material Soil Pile Grab
F30	F004	0.0 - 5.0	Soil Under Rusty Drum Grab
F31	F625	0.0 - 5.0	Composite Plot (Lead)
	F626	0.0 - 5.0	Composite Plot (Lead), Lab QC
	F627	0.0 - 5.0	Composite Plot (Lead)
	F628	0.0 - 5.0	Composite Plot (Lead)
F32	F629	0.0 - 5.0	Composite Plot (Lead)
	F630	0.0 - 5.0	Composite Plot (Lead)
	F631	0.0 - 5.0	Composite Plot (Lead)
	F632	0.0 - 5.0	Composite Plot (Lead)
F33	F633	0.0 - 5.0	Composite Plot (Lead)
	F634	0.0 - 5.0	Composite Plot (Lead)
	F635	0.0 - 5.0	Composite Plot (Lead)
	F636	0.0 - 5.0	Composite Plot (Lead)

A.8.1.3.2 TLD Samples

Table A.8-2 shows the number of TLD samples collected by type. Twenty-seven TLDs were installed at 23 locations (F05 through F27) at Study Group 6 to measure external doses to site workers as listed in Table A.8-2. Seventeen of the TLDs (Locations F05 through F13, F16, F17, F20, and F22 through F24) were placed at 15 grid locations within the TLD grid area as shown on Figure A.8-3. The TLD grid area was established in an area of elevated radiological survey values, and sample locations were selected using a random start, triangular pattern. Eight of the TLDs (Locations F14, F15, F18, F19, F21, and F27) were placed at six sample plot locations, established based on the results of the TRSs. To evaluate external dose on concrete debris coated with Trinity glass, one TLD was placed near a cable anchor/stanchion and one was placed at the GZ elevator shaft. All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5. See Figure A.8-3 for TLD locations.

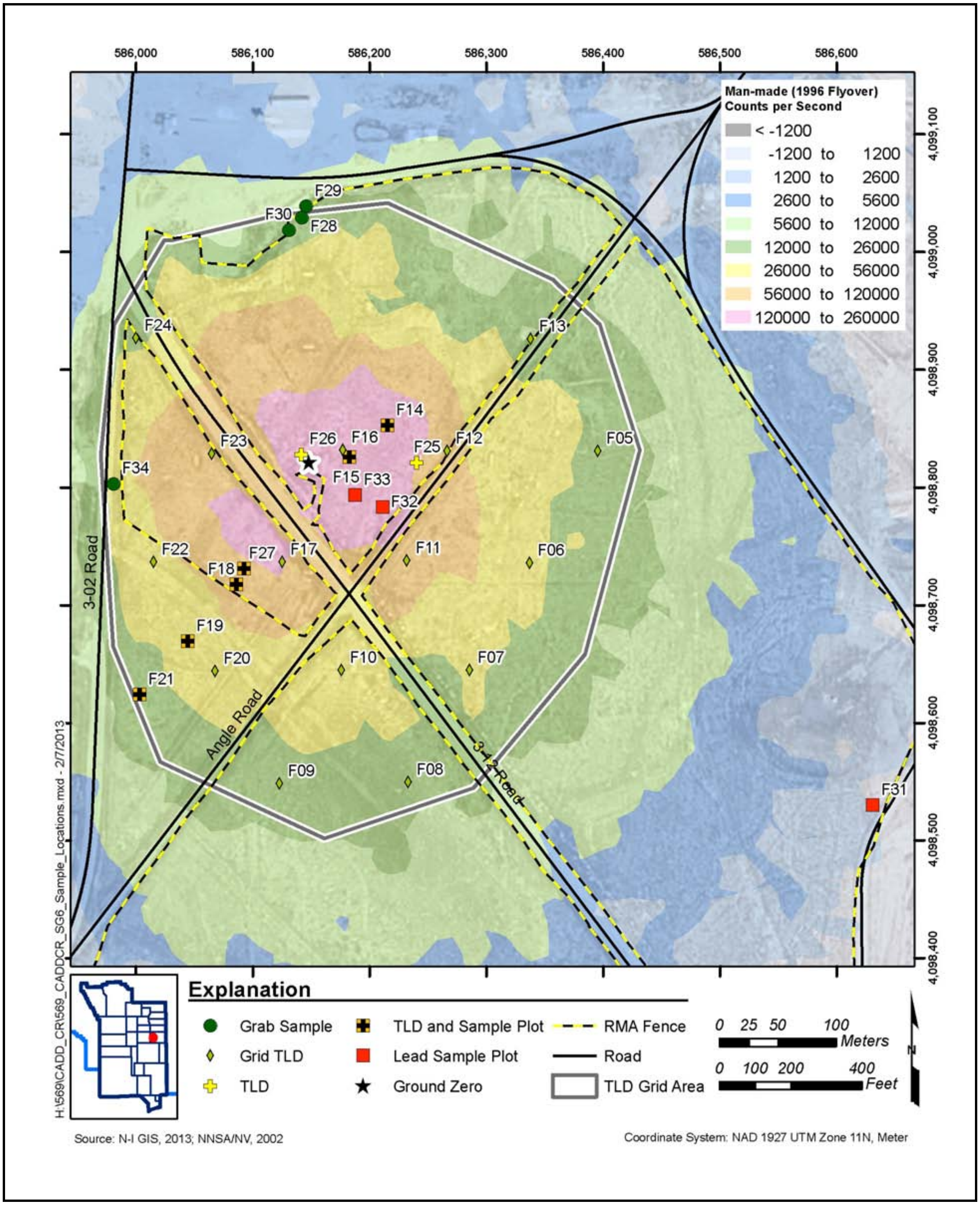

Figure A.8-3
Study Group 6 Sample and TLD Locations

Table A.8-2
TLDs at Study Group 6

Location	TLD No.	Date Placed	Date Removed	Purpose
F05	4753	04/25/2012	07/30/2012	TLD Only (Grid)
F06	4592	04/25/2012	07/30/2012	TLD Only (Grid)
F07	4308	04/25/2012	07/30/2012	TLD Only (Grid)
F08	4676	04/25/2012	07/30/2012	TLD Only (Grid)
F09	4483	04/25/2012	07/30/2012	TLD Only (Grid)
F10	4343	04/25/2012	07/30/2012	TLD Only (Grid)
F11	5082	04/25/2012	07/30/2012	TLD Only (Grid)
F12	4447	04/25/2012	07/30/2012	TLD Only (Grid)
F13	5115	04/25/2012	07/30/2012	TLD Only (Grid)
F14	5172	04/25/2012	07/30/2012	Sample Plot
	4689	04/25/2012	07/30/2012	Sample Plot
F15	4399	04/25/2012	07/30/2012	Sample Plot
	5130	04/25/2012	07/30/2012	Sample Plot
F16	4360	04/25/2012	07/30/2012	TLD Only (Grid)
	4597	04/25/2012	07/30/2012	TLD Only (Grid)
F17	4398	04/25/2012	07/30/2012	TLD Only (Grid)
	4838	04/25/2012	07/30/2012	TLD Only (Grid)
F18	4351	04/25/2012	07/30/2012	Sample Plot
F19	5279	04/25/2012	07/30/2012	Sample Plot
F20	4490	04/25/2012	07/30/2012	TLD Only (Grid)
F21	5251	04/25/2012	07/30/2012	Sample Plot
F22	5163	04/25/2012	07/30/2012	TLD Only (Grid)
F23	4963	04/25/2012	07/30/2012	TLD Only (Grid)
F24	4457	04/25/2012	07/30/2012	TLD Only (Grid)
F25	4873	07/12/2012	10/10/2012	TLD Only (Trinity Glass on Cable Anchor)
F26	4694	07/12/2012	10/10/2012	TLD Only (Trinity Glass on Elevator Shaft Near GZ)
F27	4433	07/12/2012	10/10/2012	Sample Plot

A.8.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.8.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses from judgmental sample locations that individually are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

The internal dose calculated from soil sample results, and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.8.2.1. Internal doses for each sample location are summarized in Section A.8.2.2. The TEDs for each sampled location are summarized in Section A.8.2.3. Additional sample results (i.e., potential former transformer areas, soil under lead brick and cracked lead-acid battery, and potential decontamination area) are summarized in Section A.8.2.4.

A.8.2.1 External Radiological Dose Measurements

Estimates for the external dose that a receptor would receive at each Study Group 6 TLD sample location were determined as described in Section A.2.2.5. Measurements for the external dose were 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 for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.8-3. The minimum sample size criterion was met for all locations within Study Group 6.

Table A.8-3
Study Group 6 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
F05	0.0	3	3	13.2	2.2	0.7
F06	0.1	3	3	22.8	3.8	1.1
F07	0.1	3	3	21.5	3.6	1.1
F08	0.1	3	3	11.6	1.9	0.6
F09	0.0	3	3	12.6	2.1	0.6
F10	0.2	3	3	**31.4**	5.3	1.6
F11	0.3	3	3	**49.3**	8.3	2.5
F12	0.4	3	3	**58.3**	9.8	2.9
F13	0.0	3	3	5.0	0.8	0.3
F14	0.5	6	3	**129.2**	21.7	6.5
F15	0.7	6	3	**190.3**	**32.0**	9.5
F16	0.3	6	3	**142.9**	24.0	7.1
F17	0.4	6	3	**122.2**	20.5	6.1
F18	0.2	3	3	**47.2**	7.9	2.4
F19	0.1	3	3	23.8	4.0	1.2
F20	0.1	3	3	**24.7**	4.2	1.2
F21	0.1	3	3	15.6	2.6	0.8
F22	0.1	3	3	**28.6**	4.8	1.4
F23	0.1	3	3	**98.5**	16.6	4.9
F24	0.1	3	3	17.9	3.0	0.9
F25	0.7	3	3	**209.2**	**35.1**	10.5
F26	2.2	3	3	**282.5**	**47.5**	14.1
F27	0.2	3	3	**89.9**	15.1	4.5

Bold indicates the values equal to or greater than 25 mrem/yr.

A.8.2.2 Internal Radiological Dose Estimations

The estimates for the internal dose that a receptor would receive at the Study Group 6 sample plots were determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plots for each exposure scenario are presented in Table A.8-4. An inferred dose was calculated at TLD grid locations (where soil samples were not collected) as described in Section A.2.2.4 for each exposure scenario (presented in Table A.8-5). The analytical results for the individual radionuclides in each composite sample are presented in Appendix F. As shown in Table A.8-4, the minimum sample size was met for all sample locations.

Table A.8-4
Study Group 6 95% UCL Internal Dose at Sample Plots for Each Exposure Scenario

Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
F14	0.0	4	3	4.2	0.7	0.3
F15	0.0	4	3	6.1	1.0	0.4
F18	0.0	4	3	0.6	0.1	0.0
F19	0.0	4	3	0.4	0.1	0.0
F21	0.0	4	3	0.1	0.0	0.0
F27	0.0	4	3	2.0	0.3	0.1

Table A.8-5
Study Group 6 Inferred Internal Dose at TLD Locations for Each Exposure Scenario
(Page 1 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
F05	0.3	0.1	0.0
F06	0.6	0.1	0.0
F07	0.5	0.1	0.0
F08	0.3	0.0	0.0
F09	0.3	0.1	0.0
F10	0.7	0.1	0.0
F11	1.2	0.2	0.1
F12	1.4	0.2	0.1
F13	0.1	0.0	0.0
F16	4.1	0.7	0.2
F17	3.4	0.6	0.2
F20	0.6	0.1	0.0

Table A.8-5
Study Group 6 Inferred Internal Dose at TLD Locations for Each Exposure Scenario
(Page 2 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
F22	0.7	0.1	0.0
F23	2.8	0.5	0.2
F24	0.4	0.1	0.0
F25	5.5	0.9	0.3
F26	6.2	1.0	0.4

Table A.8-6 presents a comparison of the internal and external doses at each sample plot. Based on the internal and TED doses in this table, internal dose at Study Group 6 comprises a maximum of 3 percent of TED.

Table A.8-6
Study Group 6 Ratio of Calculated Internal Dose to External Dose at Each Sample Plot (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
F14	0.2	6.1	6.3	0.04
F15	0.3	8.9	9.2	0.04
F18	0.0	1.9	2.0	0.01
F19	0.0	1.0	1.0	0.02
F21	0.0	0.6	0.6	0.01
F27	0.1	4.1	4.2	0.03

A.8.2.3 Total Effective Dose

The TED for each sample plot or TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED 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 A.8-7. The TED 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location at Study Group 6, as shown on Figure A.8-4.

Table A.8-7
Study Group 6 TED at Sample Locations (mrem/yr)

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
F05[a]	12.1	13.5	2.0	2.3	0.6	0.7
F06[a]	19.5	23.4	3.3	3.9	1.0	1.2
F07[a]	18.5	22.1	3.1	3.7	0.9	1.1
F08[a]	8.8	11.8	1.5	2.0	0.4	0.6
F09[a]	11.3	12.9	1.9	2.2	0.6	0.6
F10[a]	**25.5**	**32.1**	4.3	5.4	1.3	1.6
F11[a]	**41.9**	**50.5**	7.0	8.5	2.1	2.5
F12[a]	**47.1**	**59.7**	7.9	10.0	2.4	3.0
F13[a]	4.4	5.2	0.7	0.9	0.2	0.3
F14[b]	**124.7**	**133.4**	21.0	22.4	6.3	6.7
F15[b]	**183.6**	**196.4**	**30.8**	**32.9**	9.2	9.9
F16[a]	**141.3**	**147.0**	23.7	24.7	7.1	7.4
F17[a]	**118.3**	**125.6**	19.9	21.1	5.9	6.3
F18[b]	**39.3**	**47.8**	6.6	8.0	2.0	2.4
F19[b]	20.4	24.2	3.4	4.1	1.0	1.2
F20[a]	22.3	**25.4**	3.7	4.3	1.1	1.3
F21[b]	12.2	15.7	2.1	2.6	0.6	0.8
F22[a]	**25.6**	**29.4**	4.3	4.9	1.3	1.5
F23[a]	**97.3**	**101.4**	16.3	17.0	4.9	5.1
F24[a]	15.3	18.4	2.6	3.1	0.8	0.9
F25[a]	**190.3**	**214.7**	**32.0**	**36.1**	9.6	10.8
F26[a]	**215.0**	**288.7**	**36.1**	**48.5**	10.8	14.5
F27[b]	**84.4**	**91.9**	14.2	15.4	4.2	4.6

[a]Judgmental sample - average and UCL based on TLD elements. Internal dose inferred from internal/external dose ratios (Section A.2.2.4).
[b]Judgmental sample - results from TLD elements and 4 composite (plot) samples.

Bold indicates the values equal to or greater than 25 mrem/yr.

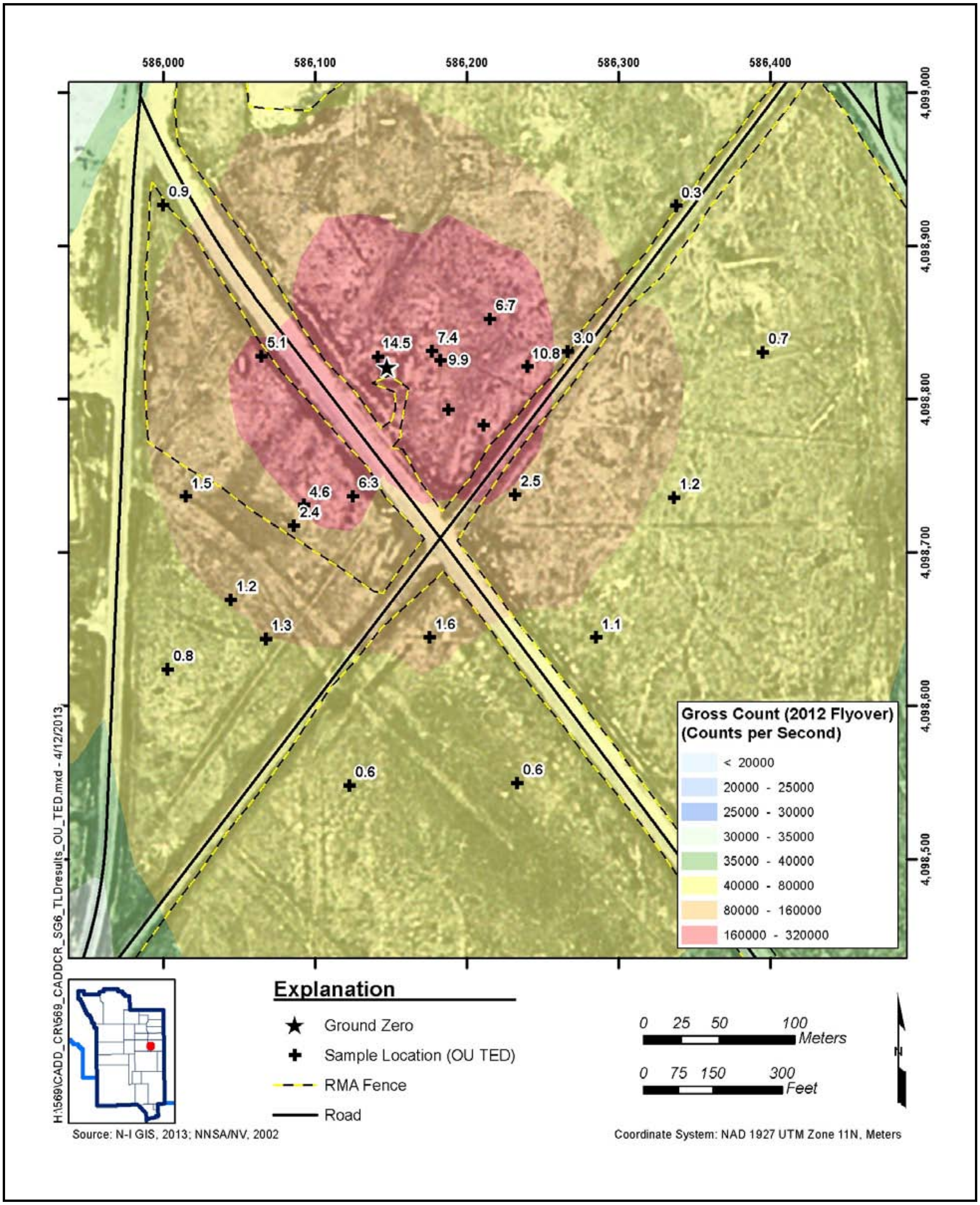

Figure A.8-4
95% of the TED at Study Group 6

A.8.2.4 Chemical Contaminants

One sample and one FD collected from the surface of a pile of white gravelly material (Location F28); one sample collected from an area of fine black material on a soil pile (Location F29); and one sample collected from the soil surrounding a closed rusty drum (Location F30) were all analyzed for VOCs, SVOCs, RCRA metals, and chromium VI. The analytical results exceeding MDCs from the samples collected at the white and black material piles and rusty drum are presented in Table A.8-8. No sample result exceeded FALs.

Three areas of crushed lead-acid batteries were sampled probabilistically using sample plots. The samples collected from the three areas of scattered, crushed, lead-acid batteries (Locations F31 through F33) were analyzed for RCRA metals (see Appendix F for analytical sample results) of the analyte concentrations reported, only lead was determined to be a site contaminant. The 95 percent UCL of the lead was compared to the PAL and FAL as shown on Table A.8-9. No results exceeded the PAL or FAL.

A.8.3 Corrective Actions

No COCs were identified at any sampled location within the boundaries of Study Group 6. Therefore, no corrective action is required for this area. No PSM was identified at this study group.

A.8.4 Best Management Practices

BMPs are voluntary protective measures and are not part of any corrective action. As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,000 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 25 mrem/IA-yr (Industrial Area exposure scenario), correlations of radiation survey values to the 95 percent UCL of industrial area TED values were conducted for the radiation surveys listed in Table A.8-10 (as discussed in Section 3.0). The radiation survey that exhibited the best correlation is the PRM-470 TRS, with a correlation of 0.98. This correlation exceeds the minimum criteria of 0.8 as set in the CAIP (NNSA/NSO, 2012a). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 2.44 multiples of background. The administrative UR boundary was established to encompass the TRS isopleth of 2.44 multiples of background. This area is shown on Figure A.8-5.

Table A.8-8
Study Group 6 Sample Results above MDCs

Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)									
			Arsenic	Barium	Cadmium	Chromium VI	Lead	Mercury	Methylene Chloride	Selenium	Silver	Toluene
FALs			23	190,000	9,300	5.6	8,356	43	960	5,100	5,100	45,000
F28	F001	0 - 5	1.12	57.3 (J)	--	0.143 (J)	6.22 (J)	0.00608 (J)	--	--	0.327 (J)	0.000345 (J)
	F002	0 - 5	1.02	73.1 (J)	0.104 (J)	--	5.26 (J)	0.00492 (J)	--	--	0.55	0.000314 (J)
F29	F003	0 - 5	1.74	58.8 (J)	--	--	8.6 (J)	0.00603 (J)	0.00285 (J)	0.511 (J)	8.44	0.00224 (J)
F30	F004	0 - 5	4.38	185 (J)	0.139 (J)	--	7.63 (J)	0.0205 (J)	--	--	0.563	--

J = Estimated value
J+ = The result is an estimated quantity, but the result may be biased high.
-- = Not detected above MDCs

Table A.8-9
Study Group 6 95% UCL for Lead Sample Plots

Location	Standard Deviation	Number of Samples	Minimum Sample Size	Average	95% UCL	PAL (IA)	FAL (RW)
F31	9.2	4	3	18.7	29.5	800	8,356
F32	85.7	4	3	95.8	196.6	800	8,356
F33	236.3	4	4	179.8	457.8	800	8,356

Table A.8-10
Study Group 6 Correlations of 95% UCL TED with Gamma Surveys

Dataset	Correlation Coefficient (R^2)
2012 N-I FIDLER TRS	0.96
2012 N-I PRM-470 TRS	0.98
1996 KIWI TRS	--
1994 Gamma Flyover - Gross Count	0.69
1994 Gamma Flyover - Man Made	0.64
1994 Gamma Flyover - Americium	--
1996 Gamma Flyover - Man Made	0.94
1996 Gamma Flyover - Americium	0.00
2012 Gamma Flyover - Gross Count	0.04
2012 Gamma Flyover - Man Made	0.94
2012 Gamma Flyover - Europium	0.87
2012 Gamma Flyover - Americium	0.89

-- = Not enough co-located data available to provide a correlation.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sampled location with the maximum TED (Location F15) will decay to less than 25 mrem/IA-yr in approximately 105 years.

The administrative UR boundary is presented in Attachment D-1.

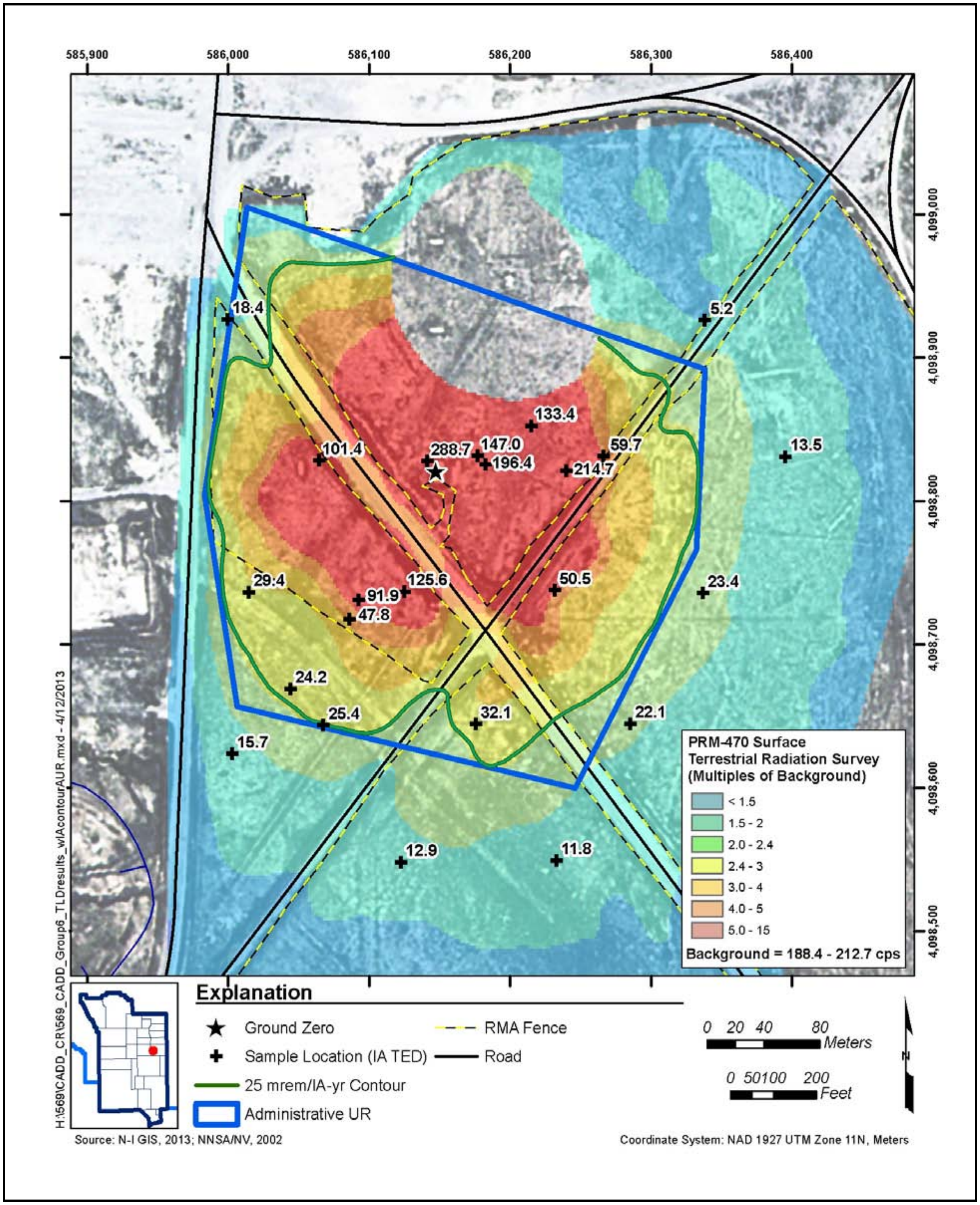

Figure A.8-5
Study Group 6 25-mrem/IA-yr Contour and Administrative UR Boundary

A.8.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.9.0 Study Group 7, Waste Consolidation Site 3A

Study Group 7, Waste Consolidation Site 3A, is located in Area 3 of the NNSS, northwest of Study Group 2 (Pike). The study group consists of a release of radionuclides to the soil surface or subsurface from waste consolidation operations associated with atmospheric testing. Additional detail on the history of Study Group 7 is provided in the CAIP (NNSA/NSO, 2012a).

A.9.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a) are described in the following subsections.

A.9.1.1 Visual Inspections

Visual inspections of Study Group 7 were conducted during site walks, sampling efforts, and geophysical and radiological surveys over the course of the field investigation. Visual inspections included looking for drainages; however, no visible drainages were identified. The presence of scattered debris was identified and noted. However, no biasing factors (indicating the potential release of contamination) were identified, and no additional samples were collected as a result of the visual inspection.

A.9.1.2 Radiological Surveys

TRSs were performed using a PRM-470 and FIDLER instrument at Study Group 7 during the CAI. The TRSs were conducted within the approximate area of the former waste consolidation site, including the currently fenced area, to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings. A small area of elevated radiological readings, coincident with surface Trinity glass, was detected during the PRM-470 TRS at the southeastern side of the former waste consolidation area. Two grab samples were collected in this area (Locations G01 and G02), and one TLD was placed at Location G01 to measure dose. A FIDLER TRS was also conducted in this area. The location of highest readings as detected during the FIDLER TRS coincides with the area detected during the PRM-470 TRS. Figures A.9-1 and A.9-2 present a graphic representation of the data from the PRM-470 and FIDLER TRSs, respectively.

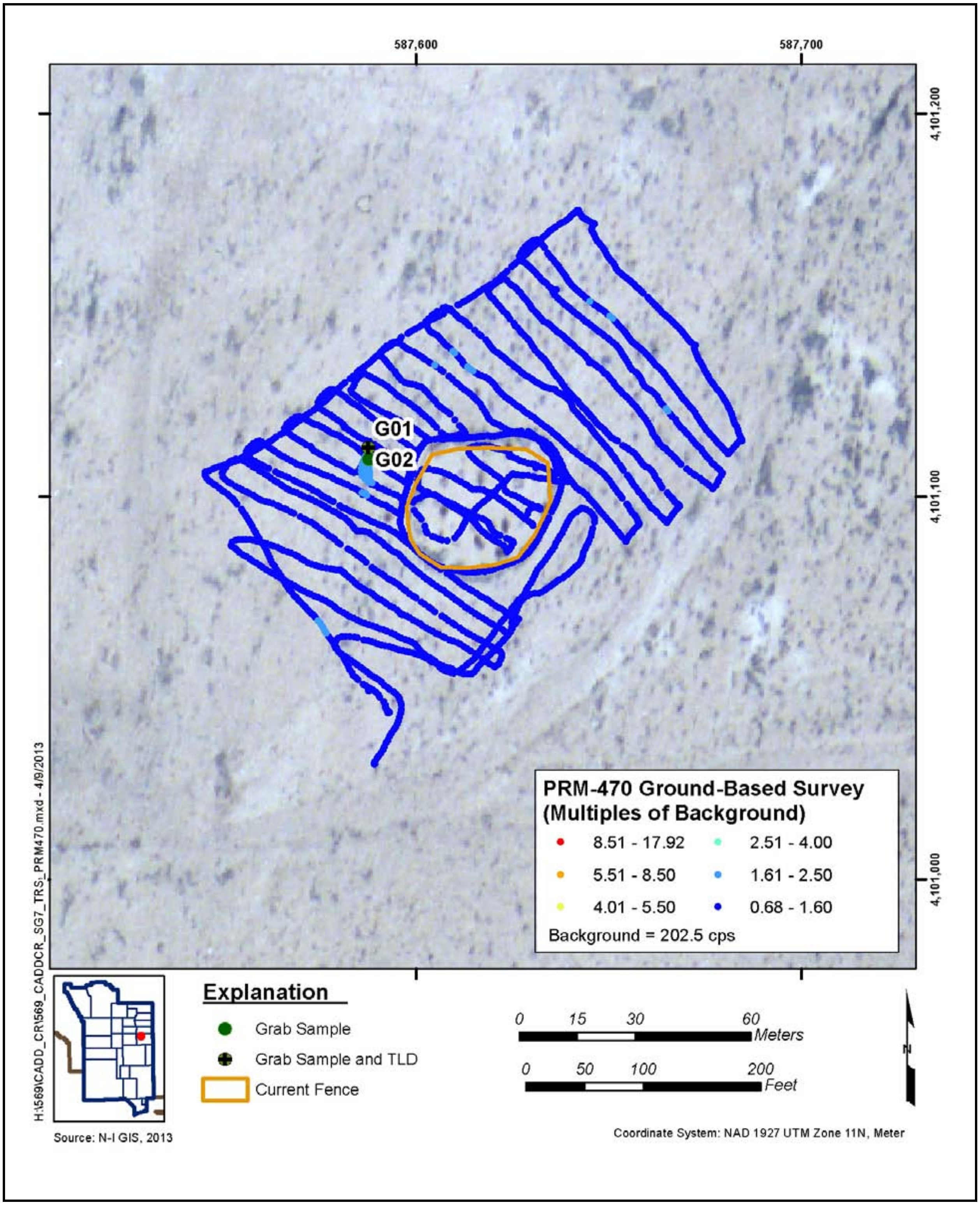

Figure A.9-1
PRM-470 TRS Results for Study Group 7

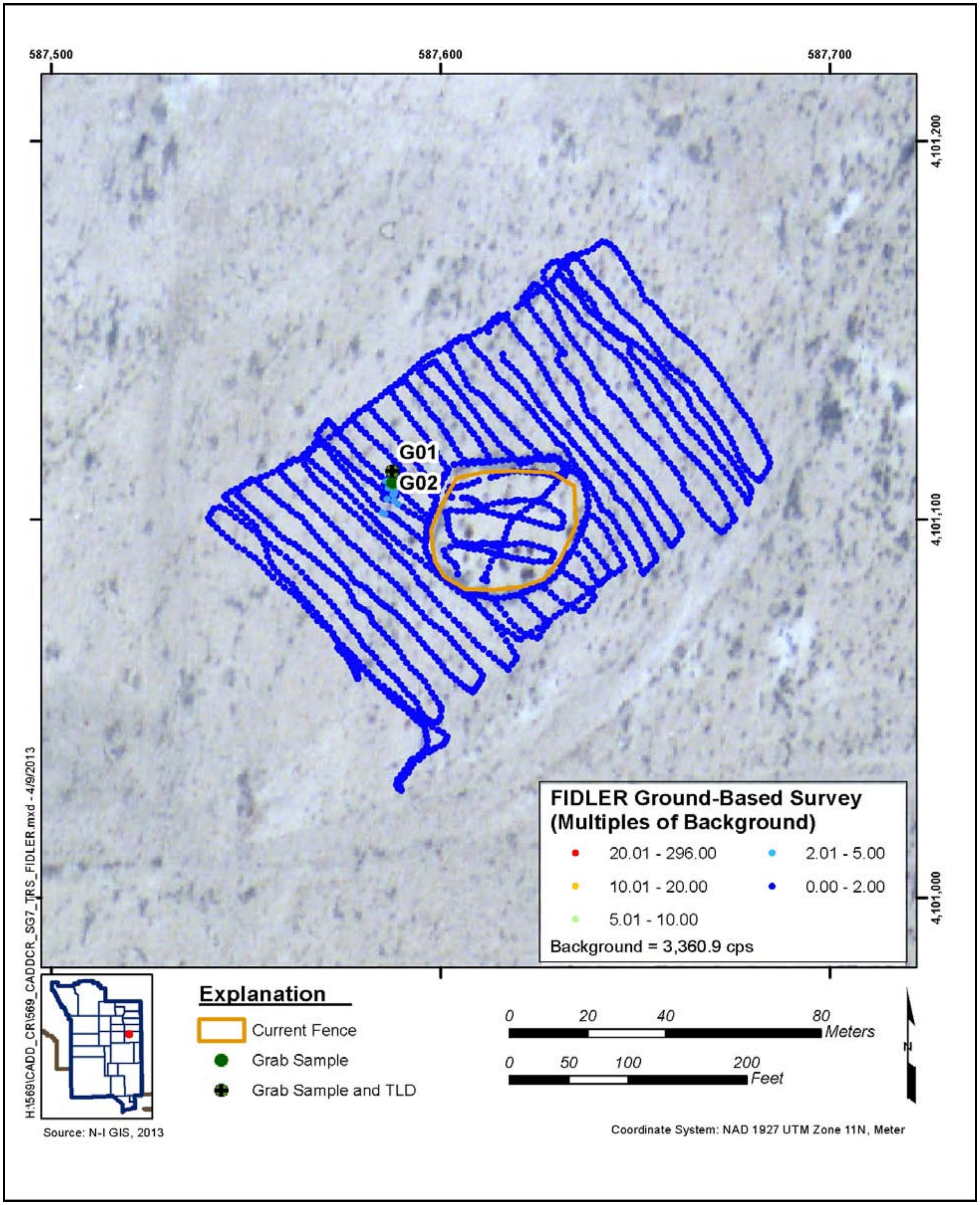

Figure A.9-2
FIDLER TRS Results for Study Group 7

A.9.1.3 Geophysical Surveys

A geophysical survey was conducted during the CAI within the area where soil and debris were historically stored in the waste consolidation site. The survey was conducted to identify whether buried metallic debris indicative of a landfill is present. Results of the geophysical survey indicate distinct pieces of metallic debris generally separated by meters and are not indicative of a solid waste landfill containing significant amounts of metal (Londergan, 2012).

A.9.1.4 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements at this study group (NNSA/NSO, 2012a). The specific CAI activities conducted at this study group are described in the following subsections.

A.9.1.4.1 Soil Samples

A total of four environmental samples (three environmental samples and one FD) were collected during investigation activities of Study Group 7 (Locations G01 and G02). One sample and one FD were collected from the soil surface (0 to 5 cm bgs) at Location G01. An additional sample was collected from 5 to 10 cm bgs at Location G01 to investigate the potential for buried contamination at the site. The final sample collected at Study Group 7 was from Location G02 (0 to 5 cm bgs), located approximately 3 m south of Location G01. All sample locations were established within the small area of elevated radiological readings detected during the TRSs. They were collected for the determination of internal dose and were submitted for gamma spectroscopy; and isotopic U, Pu, and Am analyses. Additional information including depth and purpose for each soil sample collected for Study Group 7 is provided in Table A.9-1, and the sample locations are shown on Figures A.9-1 and A.9-2.

A.9.1.4.2 TLD Samples

One TLD was installed at Location G01 at Study Group 7 to measure external doses to site workers. This TLD was placed at the location of highest readings as detected during the PRM-470 and FIDLER TRSs. The TLD was measured by the NNSS environmental TLD monitoring program

Table A.9-1
Samples Collected at Study Group 7

Location	Sample Number	Depth (cm bgs)	Purpose
G01	G001	0.0 - 5.0	Grab, Lab QC
	G002	0.0 - 5.0	FD of G001
	G004	5.0 - 10.0	Grab
G02	G003	0.0 - 5.0	Grab

according to the *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.5.

A.9.1.5 Deviations

It is stated in the CAIP (NNSA/NSO, 2012a) that a TRS would be conducted to identify any elevated levels of radioactivity. If levels are greater than two times background levels, then a sample plot would be established within the area of highest values. Within this plot, four screening locations would be investigated to determine whether buried soil contamination exists.

Results of the radiological surveys (PRM-470 and FIDLER TRS) showed only a small isolated area of elevated radiological readings (approximately 360 ft^2 [33.4 m^2]) associated with surface Trinity glass. Therefore, because the area of elevated radiological readings was smaller than a standard sample plot, it was more conservative to collect grab samples within that area. Two grab sample locations were established to investigate the potential for the presence of surface and buried soil contamination.

A.9.2 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 CAIP (NNSA/NSO, 2012a) with the exception of the deviation noted above. The radiological results are reported as doses from judgmental sample locations that are individually comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than 25 mrem/yr are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

The internal dose calculated from soil sample results, and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.9.2.1. Internal doses for each sample location are summarized in Section A.9.2.2. The TEDs for each sampled location are summarized in Section A.9.2.3. Radiological results for Study Group 7 are summarized in Section A.9.3.

A.9.2.1 External Radiological Dose Measurements

The estimate for the external dose that a receptor would receive at the Study Group 7 TLD sample location was determined as described in Section A.2.2.5. Measurements for the external dose were 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 for the TLD location. Although a TLD was not placed at sample Location G02, it was located in close proximity to sample Location G01 at which a TLD was placed. Therefore, the TLD external dose value for Location G01 was also used as the external dose value for Location G02. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.9-2. The minimum sample size criterion was met for all locations within Study Group 7.

Table A.9-2
Study Group 7 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
G01	0.0	3	3	9.8	1.6	0.5

For the subsurface soil sample location where external dose measurements were not available (Location G01), a TLD-equivalent external dose was calculated using the subsurface sample results. This was accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The RESRAD-calculated external dose from the subsurface samples was then adjusted to TLD-equivalent values using the following formula:

$$Equivalent\ Subsurface_{TLD} = Subsurface_{RR}\ x\ (Surface_{TLD} / Surface_{RR})$$

where

TLD = external dose based on TLD readings
RR = external dose based on RESRAD calculation from analytical soil concentrations

A.9.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 7 sample location were determined as described in Section A.2.2.4. The average internal dose for the sample locations for each exposure scenario is presented in Table A.9-3. The analytical results for the individual radionuclides in each sample are presented in Appendix F.

Table A.9-3
Study Group 7 Internal Dose for Each Exposure Scenario

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
G01	1.0	0.2	0.1
G01 (subsurface)	2.7	0.5	0.2
G02	0.3	0.0	0.0

Table A.9-4 presents a comparison of the internal and external doses at each sample location. Based on the internal and TED doses in this table, internal dose at Study Group 7 comprises a maximum of 22 percent of TED.

A.9.2.3 Total Effective Dose

The TED for each sample location was calculated by adding the external dose values and the internal dose values. Values for both the average TED 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 A.9-5.

Table A.9-4
Study Group 7 Ratio of Calculated Internal Dose to External Dose at Each Sample Location (mrem/OU-yr)

Location	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
G01	0.1	0.5	0.5	0.13
G01 (subsurface)	0.2	0.6	0.7	0.28
G02	0.0	0.5	0.5	0.04

Table A.9-5
Study Group 7 TED at Sample Locations (mrem/yr)

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
G01[a]	10.6	10.8	1.8	1.8	0.5	0.5
G01 (subsurface)[b]	14.2	14.5	2.4	2.4	0.7	0.8
G02[a]	9.8	10.1	1.7	1.7	0.5	0.5

[a]Judgmental sample - results from TLD elements and grab 2 samples.
[b]Judgmental sample - results from grab sample only. TLD-equivalent external dose was calculated using the subsurface sample results.

The 95 percent UCL of the average TED does not exceed the FAL of 25 mrem/OU-yr at any sampled location within Study Group 7, as shown on Figure A.9-3.

A.9.3 Corrective Actions

No COCs were identified at any sampled location within the boundaries of Study Group 7. Therefore, no corrective action is required for this area. No PSM was identified at this study group.

A.9.4 Best Management Practices

BMPs were not conducted for this study group.

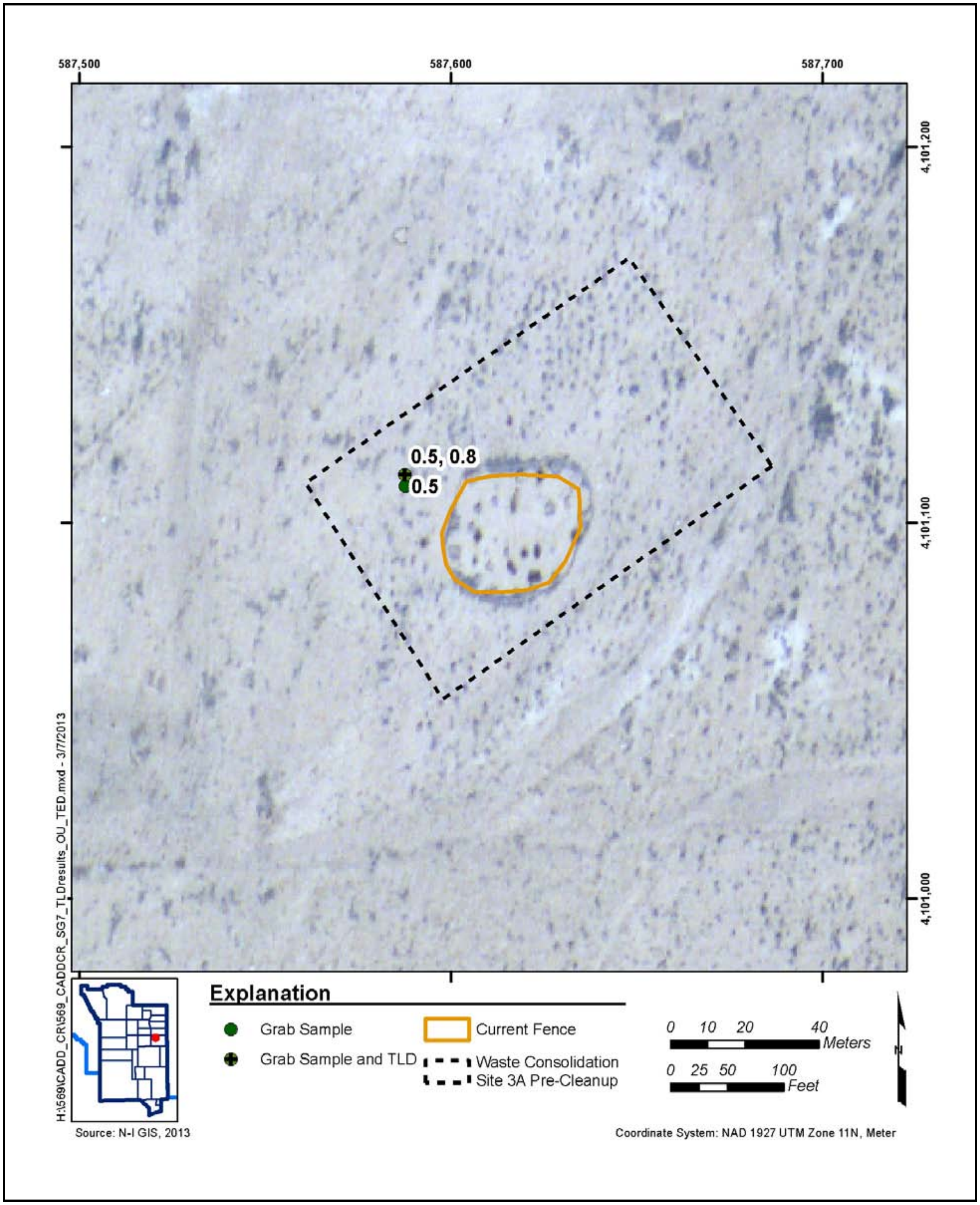

Figure A.9-3
95% of the TED at Study Group 7

A.9.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.10.0 Waste Management

Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2012a). Investigation-derived waste (IDW) generated during the CAI was characterized based on process knowledge, FSRs, and analytical data.

A.10.1 Generated Wastes

The IDW listed in Table A.10-1 was generated during the field investigation activities of CAU 569. The IDW was segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. Waste shipping and disposal documentation for CAU 569 are in Attachment D-2.

One satellite accumulation area (SAA) was established to manage hazardous and potentially hazardous waste at volumes less than 55 gallons (gal) generated during the CAI. The amount, type, and source of waste placed into each drum was recorded in waste management logbooks that are maintained in the CAU 569 file.

IDW generated during the investigation was segregated into the following waste streams:

- Disposable personal protective equipment (PPE) and sampling equipment
- Soil removed from underneath a lead brick
- Debris
- Lead for recycling
- Lead waste

A.10.2 Waste Characterization

The generated waste streams were characterized as Industrial Solid Waste, Low-Level Radioactive Waste (LLW), Mixed Low-Level Radioactive Waste (MLLW), and Recyclable Materials. In addition to these waste types, soil was removed from a location directly below a lead brick and placed in container 569E01. A sample of the soil (E501) was collected and analyzed for Toxicity Characteristic Leaching Procedure (TCLP) metals and radionuclides, and the analytical results (Table A.10-2) were

Table A.10-1
Waste Summary Table

Study Group	Waste Items	Waste Type	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc[a]
Various	Debris	Industrial Solid Waste	Area 9 – U10C	2 yd^3	March 2013	N/A
Study Group 5	Lead Brick (recyclable material, not waste)	Recyclable Material	Offsite Recycler (Energy Solutions)	1 brick	N/A Recycled	N/A
Various	Lead-Acid Batteries (recyclable material, not waste)	Recyclable Material	NSTec, Motor Services	5 batteries	N/A Recycled	N/A
Study Group 5	Lead-Acid Battery (cracked)	Mixed Low-Level Waste	Area 5 RWMC	10 gal	April 2013	Onsite Hazardous Material Transfer
All	PPE, Disposable Sampling Equipment	Low-Level Waste	Area 5 RWMC	55-gal	April 2013	CD

[a]Copies of waste disposal documents are located in Attachment D-2.

CD = Certificate of Disposal
N/A = Not applicable
NSTec = National Security Technologies, LLC
RWMC = Radioactive Waste Management Complex
yd^3 = Cubic yard

Table A.10-2
Waste Management Results Detected above MDCs at CAU 569

Sample Location	Sample Number	Sample Matrix	Parameter	Result	Criteria	Units
C21	C501	Solid	Barium	0.091 (J)	100[a]	mg/L
			Cadmium	0.108 (J)	1[a]	mg/L
			TPH-DRO	2,990 (J)	N/A	mg/kg
Drum 569E01	E501	Soil	Am-241	0.447	10[b]	pCi/g
			Am-241	1.73	10[b]	pCi/g
			Cs-137	3.98	100[b]	pCi/g
			Pu-238	0.409	10[b]	pCi/g
			Pu-239/240	3.93 (J)	10[b]	pCi/g
			U-234	1.62	100[b]	pCi/g
			Co-60	0.103	100[b]	pCi/g
			Eu-152	21.4	100[b]	pCi/g
			Eu-154	0.462	100[b]	pCi/g
			Sr-90	0.418	100[b]	pCi/g
			U-238	0.831	100[b]	pCi/g
			Barium	0.372	100[a]	mg/L

[a]TCLP limit (CFR, 2012)
[b]Radionuclide limits in NNSS U10c landfill permit (NNSA/NSO, 2010)

Cs = Cesium
Co = Cobalt
DRO = Diesel-range organics
Eu = Europium
mg/L = Milligrams per liter
TPH = Total petroleum hydrocarbons

J = Estimated value.

below regulatory levels. The soil in container 569E01 was characterized as nonhazardous and nonradioactive, and was returned to the original sample location.

A.10.2.1 Industrial Solid Waste

Approximately 2 yd^3 of debris consisting of metal (i.e., empty metal drums, steel pipe plug), an abandoned oil filter, and two hydrocarbon-burdened solid waste items were generated and characterized as industrial solid waste that meets the chemical and radiological waste acceptance criteria of the Area 9 U10c solid waste landfill. The bags of debris are pending transfer to the industrial waste roll-off located at Building 23-153 for ultimate disposal at the Area 9 U10c landfill.

Three samples were collected to support the waste characterization of this debris. Tar adhering to a metal gear box was sampled (Samples C501 and C502). Sample C501 was analyzed for TPH-DRO, PCBs, TCLP VOCs, TCLP SVOCs, and TCLP metals; and Sample C502 was analyzed for TCLP SVOCs due to rejected data from Sample C501. The validated analytical results identified the presence of TPH-DRO; however, no hazardous constituents were detected above criteria (Table A.10-2). The total volume of hydrocarbon material is minor and meets the waste acceptance criteria of the Area 9 U10c solid waste landfill. Soil that accumulated in the void space of the gear box was also sampled (Sample C005) and analyzed for radionuclides to support potential waste disposal in the event that the soil could not be removed from the box. The data are reported in Table F.3-1; however, the data were not used for waste characterization because the soil was successfully removed from the box, and the item was field screened for radiological contamination and found to meet the waste acceptance criteria of the Area 9 U10c landfill.

An abandoned oil filter contained accumulated soil that could not be completely removed; therefore, a representative soil sample (Sample B003) was collected from below the filter and analyzed for radiological constituents. Based on the validated analytical results (see Tables F.2-1 and F.2-2), the activity concentrations meet the waste acceptance criteria of the Area 9 U10c solid waste landfill.

A.10.2.2 LLW

One 55-gal drum (Container 569A01) of PPE and disposable sampling equipment was generated and characterized as LLW that meets the waste acceptance criteria for disposal at the Area 5 RWMC.

A.10.2.3 MLLW

One 10-gal drum (Container 569E02) containing an abandoned and breached lead-acid battery was generated and characterized as MLLW. The waste will be transferred to NSTec Waste Generator Services for treatment and disposal either on site, or at an offsite TSDF. The only source of chemical contamination is lead in the form of plates inside the battery casing; therefore, the waste is characterized as RCRA regulated. The battery was located in a posted RMA near various historical atmospheric test sites. The battery had no caps, and a small breach in the casing allowed soil to accumulate in the void space. Analytical data reported in Appendix F for soil Samples E609, E610, E611, and E612 were evaluated to support the radiological characterization of the waste. These samples are from plot E18 located in an area that is representative of the background activity of the soil at the battery location. Based on the analytical results, the maximum activity concentrations of Am-241, Pu-238, Pu-239/240, Cs-137, U-234, and U-235/236 in the waste container exceed the *Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995); therefore the waste is characterized as MLLW.

A.10.2.4 Recyclable Materials

Recyclable materials were generated, including one lead brick that was released from the site and is pending recycling through an offsite recycler, and five lead-acid batteries that were transferred to NSTec Motor Services for recycling.

A.11.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 569 CAI. The following subsections 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 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 Soils QAP (NNSA/NSO, 2012b).

A.11.1 Data Validation

Data validation was performed in accordance with the Soils QAP (NNSA/NSO, 2012b) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 569 were evaluated for data quality in a tiered process. 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 CAU 569 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 6 percent of the data analyzed.

A.11.1.1Tier I Evaluation

Tier I evaluation for chemical and 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.

A.11.1.2Tier II Evaluation

Tier II evaluation for chemical and 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.
- QC 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.11.1.3Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 6 percent of the sample radiological data was performed by TLI Solutions, Inc., in Golden, Colorado. No Tier II data qualifications were changed as a result of Tier III validation. 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; and
  - 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; and
- 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; and
  - 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.11.2 Field QC Samples

Twenty-four laboratory QC samples were analyzed by the laboratory for the analytical methods discussed in Sections A.3.0 through A.9.0. Full laboratory QC samples are used to measure accuracy and precision associated with the matrix (see Appendix B for further discussion). Analysis of QC preparation blanks, LCSs, and laboratory duplicate samples was performed on each sample delivery group (SDG) for radionuclides and chemicals. 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 CAU 569 files as both hard copy and electronic media.

During the CAI, six FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters discussed in the CAIP (NNSA/NSO, 2012a). 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.11.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.11.4 Laboratory Nonconformances

A nonconformance was initiated because the laboratory reported data for waste characterization Sample C501 with an associated LCS that failed control criteria for pyridine and hexachloroethane. As a result of the failed LCS, the data for these analytes were not usable. An additional sample (Sample C502) was collected to replace Sample C501. Results for this sample met all QC requirements.

A.11.5 TLD Data Validation

The data from the TLD measurements met rigorous data quality requirements. TLDs were obtained from, and measured by, the Environmental Technical Services group at the NNSS. This group is responsible for a routine environmental monitoring program at the NNSS. TLDs were submitted to the Environmental Technical Services group for analysis using automated TLD readers that are calibrated and maintained by the NSTec Radiological Control Department in accordance with existing QC procedures for TLD processing. A summary of the routine environmental monitoring TLD QC program can be found in the *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

The determination of the external dose component of the TED by TLDs was determined to be the most accurate method because of the following factors:

1. *TLDs are exposed at the sample plots for an extended time period that approximates the 2,000 hours of exposure time used for the Industrial Area exposure scenario.* This eliminates errors in reading dose-rate meter scale graduations and needle fluctuations that would be magnified when as-read meter values are multiplied from units of “per-hour” to 2,000 hours.

2. *The use of a TLD to determine an individual’s external dose is the standard in radiation safety and serves as the “legal dose of record” when other measurements are available.* Specifically, 10 CFR Part 835.402 (CFR, 2013) indicates that personal dosimeters must be provided to monitor individual exposures and that the monitoring program that uses the dosimeters must be accredited in accordance with a DOE Laboratory Accreditation Program.

A.12.0 Summary

Radionuclide and chemical contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 569. Assessment of the data generated from the CAI indicates that COCs were not identified for any sampled location at CAU 569. However, COCs were assumed to be present at some study groups based on process knowledge and the inability to collect samples. A summary of the investigation results as well as corrective actions and BMPs that were implemented during the CAI are presented in Table A.12-1.

Table A.12-1
Summary of Investigation Results at CAU 569
(Page 1 of 2)

Study Group	CAS Number	Release	COCs	Corrective Action	BMP
1	03-23-13, 03-23-15	Buried contamination in bermed GZ area	Assumed presence of radioactive COCs	Closure in Place with FFACO UR	None
		Scraped portion of Area 3 RWMS	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	None
2	03-23-21	Atmospheric release from Pike crater	Assumed presence of radioactive COCs	Closure in Place with FFACO UR	None
		Atmospheric release from Bandicoot crater	Assumed presence of radioactive COCs	Closure in Place with FFACO UR	None
		PSM (lead-acid battery)	Lead	Removal of PSM	None
3	03-23-09	Atmospheric release from tests	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		PSM (lead-acid batteries)	Lead	Removal of PSM	None
4	03-23-14	Atmospheric release from test	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established

Table A.12-1
Summary of Investigation Results at CAU 569
(Page 2 of 2)

Study Group	CAS Number	Release	COCs	Corrective Action	BMP
5	03-23-10, 03-23-12, 03-23-16	Soil waste pile from Area 3 RWMS	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		Atmospheric release from tests	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		PSM (lead-acid battery and lead brick)	Lead	Removal of PSM	None
6	03-23-11	Atmospheric release from test	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
7	03-23-21	Waste Consolidation Site 3A	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	None

The FFACO URs are presented in Attachment D-1 and contain the applicable boundaries, site controls, conditions of use, and maintenance requirements. The corrective actions meet all requirements for the technical components evaluated, and meet all applicable federal and state regulations for closure of the site. Based on the implementation of these corrective actions, no further corrective action is necessary for CAU 569.

The administrative URs are presented in Attachment D-1 as voluntary protective measures and contain the applicable boundaries and conditions of use. An administrative UR will not be used to satisfy corrective action requirements but will be implemented as a BMP to warn potential future site workers if a change in site use could cause increased exposure to site contamination. Administrative URs are recorded and tracked identically to FFACO URs but do not require site warning signs.

A.13.0 References

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 569 CAIP (NNSA/NSO, 2012a) 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. These steps are briefly summarized as follows:

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.

2. *Conduct a Preliminary Data Review.* Review QA reports and inspect 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.

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.

4. *Verify the Assumptions.* Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.

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 CAIP (NNSA/NSO, 2012a). 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 CAIP (NNSA/NSO, 2012a) is as follows: “Is any COC present in environmental media within the study group?” For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. 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 contaminant analysis (NNSA/NSO, 2012c). If a COC is detected, then Decision II must be resolved.

B.1.1.1.1 DQO Provisions To Limit False Negative Decision Error

A false negative decision error (when it is concluded that contamination exceeding 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 study group (judgmental sampling).

1b) Maintaining 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 (Confidence Judgmental Sample Locations Identify COCs)

Decision I for Study Groups 1 and 2 (as stipulated in the DQOs) was already resolved for the areas within the DCBs because those areas were already identified as requiring corrective action. Therefore, Decision I sampling only applied to those areas outside the DCBs. To resolve Decision I (determine whether a COC is present at a study group), samples were collected in areas most likely to contain a COC. The following activities were conducted to ensure that this criterion was met:

Study Group 1

Judgmental sampling was not conducted at this study group.

Study Group 2

Sample plot locations were selected judgmentally outside the DCB at the highest radiological readings as detected during the FIDLER and PRM-470 TRSs.

Judgmental samples were collected within the center of a potential mud pit, consistent with the mud pit sampling approach (NNSA/NSO, 2004).

Study Group 3

The sample plot location was selected judgmentally at the highest radiological readings as detected during the PRM-470 TRS.

Judgmental samples were collected at the center of a former transformer area and from the soil under a gear box.

Study Group 4

Sample plot locations were selected judgmentally at the highest radiological readings as detected during the KIWI and PRM-470 TRSs.

Study Group 5

Sample plot locations were selected judgmentally at the highest radiological readings as detected during the KIWI and PRM-470 TRSs.

Judgmental grab sampling was conducted within an area of soil deposited from within the Area 3 RWMS. These locations were identified based on the highest radiological readings detected from the KIWI and PRM-470 TRSs.

Judgmental samples were collected from two former transformer areas (selected from the low spot at the edge of each pad) and from the low spot within a potential decontamination pad. Verification samples were collected from the soil below PSM (battery and lead brick).

Study Group 6

Sample plot locations were selected judgmentally at the highest radiological readings as detected during the KIWI and PRM-470 TRSs.

Judgmental samples were collected from the surface of a pile of white gravelly material (where the largest visual accumulation of the white material was present), a soil pile covered in fine black material (where the largest visual accumulation of the black material was present), and from the soil around a "petroleum naphtha" drum.

Sample plot locations were selected within the center of each crushed lead-acid battery area.

Study Group 7

Judgmental grab sampling was conducted within the area of highest radiological readings as detected during the FIDLER and PRM-470 TRSs.

Criterion 1b (Confidence in Probabilistic False Negative Decision Error Rate)

Protection of the 0.05 false negative decision error rate for the probabilistic samples was accomplished by ensuring the following:

- The samples are collected from unbiased locations.
- A sufficient sample size was collected.
- A false rejection rate of 0.05 was used in calculating the 95 percent UCLs and minimum sample size.

Within Study Group 1 and within all judgmental sample plots, probabilistic surface grab sample locations were selected based on a random start, triangular pattern.

This permitted an unbiased, equal-weighted chance that any given location within the boundaries of the sample plot would be chosen. Although the TLD locations were not established at random locations (i.e., they were placed at the center of the sample plot), they provided three independent measurements of dose (per TLD) that integrate unbiased measurements from the plot area.

The minimum number of samples required for each probabilistic sample group was calculated. A minimum sample size was calculated for internal (soil samples) and external (TLD elements) dose samples. The minimum sample size (*n*) was calculated using the following EPA sample size formula (EPA, 2006):

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

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 = dose level where false positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples are required to calculate these statistical values and, as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required. For sample plots, four samples were collected. For TLDs, a minimum of three samples were collected. As shown in the results presented in Appendix A, the minimum number of sample plot and TLD samples was met or exceeded for all probabilistic samples. The minimum sample size calculations were conducted as stipulated in the CAIP (NNSA/NSO, 2012a) 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

Criterion 2 (Confidence in Detecting COCs Present in Samples)

All samples were analyzed using the analytical methods specified in the CAIP (NNSA/NSO, 2012a) with the following exceptions:

- Historical information identified Tc-99, Pu-241, and Sr-90 as being used as tracers in nuclear testing on the NNSS. Because it is not known at which test locations these tracers were used, Tc-99, Pu-241, and Sr-90 were included in the analysis request for the sample(s) at each study group with the highest FSRs (Samples A004, A011, B605, C601, D608, E603, E608, F605, and F608).
- Analyses for isotopic Am, isotopic Pu, and isotopic U were added to the analysis request for the plot samples collected from Location C03, to verify whether plutonium is present and to be consistent with the sampling approach for the other study groups.
- In addition to the radiological analyses, samples were collected from potential former transformer areas, a potential mud pit, a decontamination pad, from a pile of white gravelly material, from a pile of soil covered in fine black material, from underneath a gear box, underneath a battery, underneath a lead brick, underneath a "petroleum naphtha" drum, and from areas of crushed lead-acid batteries. Samples in these areas were analyzed for VOCs, SVOCs, PCBs, RCRA metals, and/or hexavalent chromium depending on the nature of the release.

The analytical methods were chosen during the DQO process as the analyses required to detect any of the COPCs listed in the CAIP that were defined as the contaminants that could reasonably be expected at the site that could contribute to a dose or risk exceeding FALs. The COPCs were identified based on operational histories, waste inventories, release information, investigative background, contaminant sources, release mechanisms, and migration pathways as presented in the CAIP. This provides assurance that the analyses conducted for each sample has the capability of identifying any COPC present in the sample.

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils QAP (NNSA/NSO, 2012b). The sensitivity acceptance criterion defined in the CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2012a). All of the chemical analyses met this criterion. For all radionuclides, the criterion is that all detection limits are less than their corresponding Occasional Use Area internal dose RRMGs. All of the analytical result detection limits for every radionuclide were less than their corresponding RRMGs. Therefore, the DQI for sensitivity has been met for all contaminants, and no data were rejected due to sensitivity.

Criterion 3 (Confidence that the Dataset is of Sufficient Quality and Complete)

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 Soils QAP (NNSA/NSO, 2012b). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NSO, 2012a). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 6.2.3 of the CAIP (NNSA/NSO, 2012a). Precision was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2012a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012b). As stipulated in Section 4.3 of the Soils QAP, when analyses of a particular contaminant does not meet the DQI criteria and the highest reported activity for that contaminant exceeds one-half its corresponding FAL, the data assessment must include explanations or justifications for their use or rejection. There were no analytical data qualified for precision that exceeded one-half the FAL. Therefore, the CAIP criterion of 80 percent precision was met for contaminants. The potential for a false negative DQO decision error is negligible, and use of the results that were qualified for precision can be confidently used.

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2012a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012b). As stipulated in Section 4.3 of the Soils QAP, when analyses of a particular contaminant does not meet the DQI criteria and the highest reported activity for that contaminant exceeds one-half its corresponding FAL, the data assessment must include explanations or justifications for their use or rejection.

There were no analytical data qualified for accuracy that exceeded one-half the FAL. Therefore, the CAIP criterion of 80 percent accuracy was met for contaminants. The potential for a false negative DQO decision error is negligible, and use of the results that were qualified for accuracy can be confidently used. As the accuracy rates for all other constituents meet the acceptance criteria for accuracy, the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NSO, 2012a) was used to address sampling and analytical requirements for CAU 569. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1a discussion meet this criterion.

Special consideration is needed for americium and plutonium isotope concentrations related to representativeness. This is due to the nature of these contaminants in soil. These isotopes may be present in soil in the form of small particles that may or may not be captured in a small soil sample of 1 to 2 grams. As individual particles of these radionuclides can make a significant impact on analytical results, small soil samples taken from the same site can produce analytical results that are very different (i.e., poor accuracy). However, the americium and plutonium isotopes are co-located (e.g., Am-241 is a daughter product of Pu-241), and the relative concentrations between different samples from the same site (i.e., the ratio of americium to plutonium isotope concentrations) should be equal. Based on process knowledge and demonstrated by analytical results from previously sampled Soils sites, the ratios between americium and plutonium isotopes in soil contamination from any given source is expected to be the same throughout the contaminant plume at any given time. Therefore, if the ratios are known and one of these isotopic concentrations is known, the concentrations of the other isotopes can be estimated.

Am-241 is reported by the gamma spectrometry method as well as the isotopic americium method. As the gamma spectrometry measurement is based on a much larger soil sample (usually 1 liter), the particle distribution problem discussed above is greatly diminished and the probability of the result being representative of the sampled site is much improved. Therefore, the ratios between the americium and plutonium isotopes will be established using the isotopic analytical results, and these ratios will be used to infer concentrations of plutonium isotopes using the gamma spectrometry results for Am-241. See Appendix F for inferred plutonium concentrations.

Based on the methodical selection of sample locations and the use of americium and plutonium concentrations that are more representative of the sampled area, the analytical data acquired during the CAU 569 CAI are considered to adequately represent contaminant concentrations of the sampled population.

Comparability

Field sampling, as described in the CAIP (NNSA/NSO, 2012a), 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, CAU 569 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 CAIP (NNSA/NSO, 2012a) 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 study group-specific analytes identified in the CAIP having valid results. The dataset for CAU 569 has met the completeness criteria as sufficient information is available to make the DQO decisions.

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. QA/QC samples such as method blanks were used to determine whether a false positive analytical result may have occurred. This provision is evaluated during the data validation process and appropriate qualifications are applied to the data when applicable. There were no data qualifications that would indicate a potential false positive analytical result.

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

The Decision II statement as presented in the CAIP (NNSA/NSO, 2012a) is as follows: "If a COC is present, is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

- The lateral and vertical extent of COC contamination
- The information needed to predict potential remediation waste types and volumes
- Any other information needed to evaluate the feasibility of remediation alternatives

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

For all seven study groups, there were no COCs detected outside the DCBs. Therefore, Decision II sampling was not required. Decision II was resolved for the areas defined as DCBs. Samples were collected from selected waste materials identified during the visual surveys that were determined to have a potential to be PSM. No potential remediation waste types were identified, because no results were detected above FALs. No other information was required to evaluate the feasibility of remediation alternatives.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2012a) stipulated that the following sampling processes would be implemented:

- Sampling 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 probabilistically as described in Section A.2.2.3.

- Judgmental sampling will be conducted at locations of potential contamination identified during the CAI.

  Result. Judgmental sampling was conducted at locations of former transformer areas, a potential mud pit, adjacent to a drum, underneath a cracked battery, underneath a lead brick, within piles of unknown material, under and adjacent to a gear box, and under a filter.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated. Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified in the Soils QAP (NNSA/NSO, 2012b). The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions for radiological contamination was the comparison of the TED to the FAL of 25 mrem/OU-yr. For other types of contamination, the test for making DQO decisions was the comparison of the maximum analyte result from each study group to the corresponding FAL. All FALs, except for lead, were based on an exposure duration to a site worker using the Occasional Use Area exposure scenario. The FAL for lead was 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.1-1.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 569 DQOs and Table B.1-1. The affected media consists of surface, shallow subsurface, and subsurface soil as expected.

For Study Group 1, the CAIP assumption of Industrial Area being the exposure scenario was determined to be incorrect and was changed to Occasional Use Area. This is because the most exposed individual for current or future land use within the Area 3 RWMS area was determined to be an Area 3 RWMS worker (see Section C.1.10). This individual may only be present at the site for a maximum of 40 hr/yr, which is less than the Occasional Use Area scenario of 80 hr/yr. Therefore, it is appropriate for this area to have the Occasional Use Area exposure scenario.

Table B.1-1
Key Assumptions

Exposure Scenario	Occasional Use Area for all study groups
Affected Media	Surface, shallow subsurface, and subsurface soil
Location of Contamination/Release Points	Contaminated surface soil is deposited in annular pattern surrounding GZs at Study Groups 3, 4, 5, and 6. Surface contaminated soil was removed from Study Group 1 and deposited within a portion of Study Group 5. Due to the removal of soil from Study Group 1, there is no assumption of a release pattern. For the area of Study Group 5 where the contaminated soil from Study Group 1 was deposited, the soil within this area is assumed to be contaminated to depth. Surface soil from venting at Study Group 2; subsurface soil within fissure at Study Group 2; shallow subsurface or subsurface soil at or near location of waste consolidation at Study Group 7.
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Surface water runoff may provide for the transportation of some contaminants within or outside the footprints of the study groups. Wind may cause limited resuspension and transport of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding FALs.
Preferential Pathways	Vertical transport is expected to dominate over lateral transport due to the lack of surface drainage features.
Lateral and Vertical Extent of Contamination	For Study Groups 2, 3, 4, 5, 6, and 7, contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. For Study Group 1, the contaminated surface soil from this area was removed and deposited within a portion of Study Group 5. For that portion of Study Group 5, the contamination is expected to be deposited throughout the area, down to the native soil interface. Contamination at depth at Study Group 2 (Pike) is addressed under the Underground Test Area (UGTA) Activity. Lateral and vertical extent of COC contamination is expected to be within the spatial boundaries.
Groundwater Impacts	The annual precipitation is approximately 6.34 in., and the annual potential evapotranspiration is estimated at 61.7 in. The thickness of the unsaturated zone extends to more than 600 ft bgs, while the depth to the water table is approximately 1,600 ft bgs. Percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater. Groundwater contamination is not expected.
Future Land Use	Nuclear and High Explosives Test.
Other DQO Assumptions	Not applicable.

For Study Group 7, it was assumed in the CSM that the location of contamination is shallow subsurface or subsurface soil at or near the location(s) of waste. However, a geophysical survey was conducted, and it was concluded that a landfill is not present. Additionally, the potential for buried soil contamination was addressed by screening soil samples in 5-cm intervals, down to 30 cm bgs. Samples were collected and analyzed, and no COCs were detected. Therefore, the CSM was refined to remove the presence of contamination at the subsurface or shallow subsurface at or near the location(s) of waste.

Surface water runoff was identified as potentially providing a transport mechanism for contaminants. However, there are no washes present within the area of CAU 569, and no surface water runoff pathways were identified that showed migration of contaminants.

B.1.4.1 Other DQO Commitments

The following commitments were made in the CAIP (NNSA/NSO, 2012a):

1. Decision I for Study Groups 2, 3, 4, 5, and 6, outside the DCBs will be evaluated by calculating TED in sample plots established within the areas of the highest radiological readings, as determined by the results of the TRSs.

   Result: Decision I was resolved by placing TLDs and collecting environmental samples in sample plots as required in the CAIP. Decision I sample locations outside the DCBs did not exceed the FALs.

2. At Study Group 1, 10 probabilistic sample locations will be chosen based on a random-start, triangular pattern.

   Result. The commitment to select 10 sample locations was met.

3. At Study Group 5, grab samples to depth will be collected from within the area where soil from Study Group 1 was deposited.

   Result. This commitment was met. Four grab sample locations were established and investigated for the potential presence of buried soil contamination.

4. At Study Group 7, if the results of a TRS identified levels of radioactivity greater than two times background, a judgmentally located sample plot would be established within that area. The sample plot would then be investigated to determine the potential for buried soil contamination.

   Result. The results of the TRS identified only a small area of elevated radiological readings attributable to visible Trinity glass. Because this area was smaller than the dimensions of a typical sample plot, two grab sample locations were established within this area instead.

5. At Study Groups 5 and 6, three sample plots would be judgmentally established along a vector that is approximately normal to the radiation survey isopleths with the constraint that, on each vector, at least one sample plot will present a TED less than the FAL.

   Result. This commitment was met by establishing three sample plots along a vector, with at least one plot presenting a TED less than the FAL.

6. Conduct a geophysical survey at Study Groups 5 and 7 to verify the CSM that debris is not buried in these locations.

   Result. A geophysical survey was conducted. This confirmed that the areas were not used as solid waste landfills, with significant amounts of buried debris.

7. Determine whether a potential release is present based on biasing factors such as stains, spills, or debris.

   Result. Environmental samples were collected from former transformer areas, within a potential mud pit, adjacent to a drum, within piles of unknown material, at a gear box, and under a filter. One lead brick and one battery were located and were assumed to be PSM. The PSM were removed, and verification samples of underlying soil were collected.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 569 study groups.

B.1.5.1 Decision Rules for Both Decision I and II

Decision rule. If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.5.2 of the CAIP (NNSA/NSO, 2012a), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

- **Result.** The COC contamination was found to be consistent with the CSM and to not extend beyond the spatial boundaries.

B.1.5.2 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.** Because COCs were assumed to be present within the established DCBs in Study Groups 1 and 2, Decision II needed to be resolved. No COCs were identified outside the DCBs at any study group; therefore, Decision II activities were not required for these areas.

Decision rule. If a COC exists at any study group, then a corrective action will be determined, else no further action is required.

- **Result**. Because COCs were not identified outside the DCBs at any study group, corrective actions are not required for these areas. COCs are assumed to be present within the DCBs. These areas require corrective action.

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 corrective action will be necessary.

- **Result.** Hazardous debris (e.g., lead brick, battery) was identified as PSM, and corrective actions of debris and soil removal were completed.

B.1.5.3 Decision Rules for Decision II

Decision rule. If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL or potential remediation wastes 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.** Decision II samples were not required because COCs were not detected outside DCBs.

Decision rule. If valid analytical results are available for the waste characterization samples (see Section A.8.0 of the CAIP), then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

- **Result.** Valid analytical data were obtained to adequately characterize the material associated with the lead brick and battery. Data were determined to be adequate to determine waste types and evaluate alternatives.

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.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2004. *Mud Pit Risk-Based Closure Strategy Report, Nevada Test Site, Nevada*, DOE/NV--991. Las Vegas, NV

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit* 569*: Area 3 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1474. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012c. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

Appendix C

Risk Assessment

C.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NSO, 2012b). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2012b) 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 or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

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 Tier 1 action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 569 CAIP [NNSA/NSO, 2012a]). 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 action levels using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 action levels 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.

- **Tier 3 evaluation.** Conducted by calculating Tier 3 action levels on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The RBCA decision process stipulated in the Soils RBCA document (NNSA/NSO, 2012b) is summarized in Figure C.1-1.

A risk evaluation was not conducted for any DCB because it is assumed that contamination exceeding the FAL and requires corrective action. The DCBs at CAU 569 include the bermed Catron and Coulomb-B GZ area, and the Pike crater and fissure. A risk evaluation was not conducted for the Bandicoot crater because COCs were assumed to be present, or for PSM at CAU 569 (lead batteries and lead brick) because the PSM was removed as a corrective action.

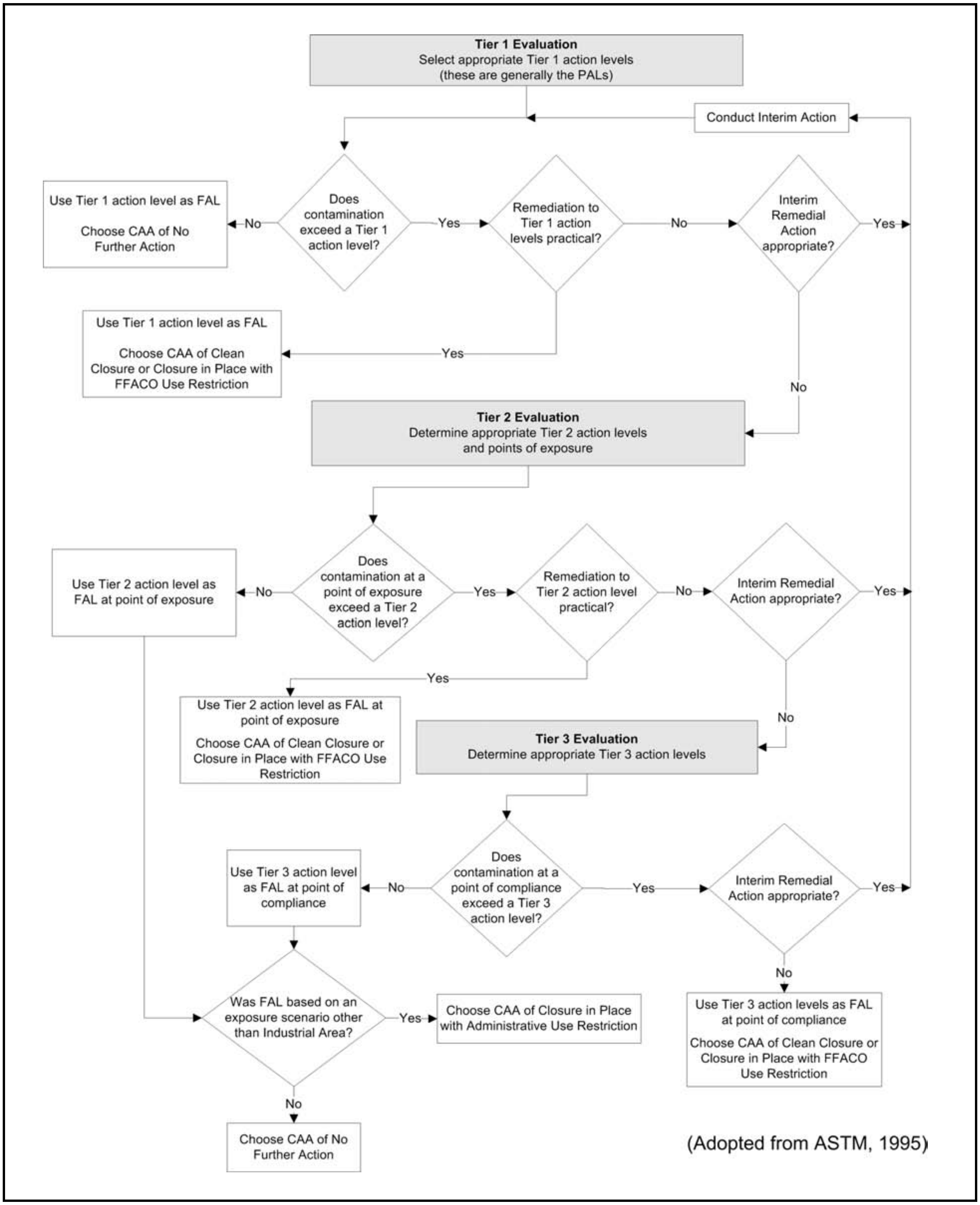

Figure C.1-1
RBCA Decision Process

C.1.1 Scenario

CAU 569, Area 3 Yucca Flat Atmospheric Test Sites, comprises the following nine CASs within Area 3 of the NNSS that were consolidated into study groups as shown on Table C.1-1:

- 03-23-09, T-3 Contamination Area
- 03-23-10, T-3A Contamination Area
- 03-23-11, T-3B Contamination Area
- 03-23-12, T-3S Contamination Area
- 03-23-13, T-3T Contamination Area
- 03-23-14, T-3V Contamination Area
- 03-23-15, S-3G Contamination Area
- 03-23-16, S-3H Contamination Area
- 03-23-21, Pike Contamination Area

Table C.1-1
CAU 569 Study Groups

Study Group	Description	FFACO CASs
1	Catron, Coulomb-B	03-23-13, 03-23-15
2	Pike	03-23-21
3	Annie, Franklin, George, Moth	03-23-09
4	Humboldt	03-23-14
5	Harry, Hornet, Rio Arriba, Coulomb-A	03-23-10, 03-23-12, 03-23-16
6	Fizeau	03-23-11
7	Waste Consolidation Site 3A	03-23-21

CASs 03-23-09 (Annie, Franklin, George, and Moth), 03-23-10 (Harry and Hornet), 03-23-11 (Fizeau), 03-23-12 (Rio Arriba), and 03-23-14 (Humboldt) consist of a release of radioactive contaminants to the environment from eight weapons-related experiments conducted at four separate, close-proximity tower test areas. The tests were conducted between June 1, 1952, and October 29, 1958, atop towers ranging in height from 25 ft to 500 ft. The yields of the tests ranged from 7.8 tons (Humboldt) to 32 kt (Harry) (GE, 1979; DOE/NV, 2000).

CASs 03-23-13 (Catron), 03-23-15 (Coulomb-B), and 03-23-16 (Coulomb-A) consist of a release of radioactive contaminants to the environment from three surface safety experiments conducted at three separate, close-proximity test areas. The tests were conducted between July 1, 1957, and October 24, 1958, at heights ranging from ground surface to 72.5 ft. The yields of the tests ranged from zero (Coulomb-A) to 300 tons (Coulomb-B) (GE, 1979; DOE/NV, 2000).

CAS 03-23-21 (Pike) consists of a release of radioactive material to the soil surface from venting during the Pike underground weapons-related test. The Pike test was conducted on March 13, 1964, at a depth of 374 ft bgs (Schoengold et al., 1996; DOE/NV, 2000). A crater was formed from this test, and a surface crack measuring 8- to 10-ft long formed northeast of the crater approximately 30 ft beyond the crater lip (AEC, 1964).

Also included in the CAU 569 scope were the Area 3 Waste Consolidation Site 3A, Bandicoot crater, and potential releases to the soil from debris generated as a result of the atmospheric testing activities.

C.1.2 Site Assessment

The CASs in CAU 569 were investigated to identify the sources of release, both chemical and radiological. During the investigation, historical records and photographs were reviewed to determine the potential significant transport and exposure pathways, the regional hydrogeologic and geologic characteristics for the CAU, and the current or potential future use of the site. Visual surveys and TRSs were conducted to determine the appropriate locations for the collection of soil samples. Samples were collected and the results were reviewed to determine whether COCs are present. Major contaminants at CAU 569 consist of radioisotopes from nuclear testing at levels less than FALs, within areas outside the DCBs. Inside DCBs, significant contaminant levels may exist.

Migration pathways for contamination include windborne material and materials displaced from maintenance activities (such as operations within the Area 3 RWMS). The area of CAU 569 is relatively flat, and gently sloping to the southeast. No significant drainages were identified in the area of CAU 569; therefore, no wash samples were collected. Subsurface migration pathways at CAU 569 are expected to be predominately vertical. The average annual precipitation at the nearest rain gauge station to CAU 569 is 15.9 cm (6.25 in.), and the depth to groundwater in this area is approximately 1,600 ft bgs (NNSA/NSO, 2012a).

During the historical records review, no past releases were identified other than the tests. However, during the visual surveys, PSM was identified and removed. This PSM included intact lead-acid batteries, a cracked lead-acid battery, and a lead brick. Additionally, other potential releases were identified, such as potential former transformer areas, a mud pit, and locations of piles of unknown material.

C.1.3 Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) immediate threat to human health, safety, and the environment; (2) short-term (0 to 2 years) threat to human health, safety, and the environment; (3) long-term (greater than 2 years) threat to human health, safety, or the environment; and (4) no demonstrated long-term threats.

Based on the CAI, the 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 Study Group 1 (CASs 03-23-13, 03-23-15), and Study Group 2 (03-23-21 [which includes Bandicoot]) due to the presence or assumed presence of subsurface contamination exceeding the 25 mrem/OU-yr FAL. Contamination is present that could pose a short-term threat to human health, safety, or the environment if any excavation was done in the bermed GZ area at Study Group 1 or in the craters or fissure at Study Group 2. However, some of these areas were covered with a layer of (unknown depth) clean fill, and the craters are posted and fenced to prevent inadvertent exposure. Thus, these areas have been determined to be Classification 3 sites as defined by ASTM Method E1739.

For all other release sites, no contamination was detected exceeding a FAL. These release sites have been determined to be Classification 4 sites as defined by ASTM Method E1739.

C.1.4 Development of Tier 1 Action Level Lookup Table

Tier 1 action levels are defined as the PALs listed in the CAIP (NNSA/NSO, 2012a) as established during the DQO process. The PALs represent a very conservative estimate of risk, are preliminary in nature, and are generally used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 action level (i.e., PAL) value if implementing a corrective action based on the Tier 1 action level would be appropriate.

The PALs are based on the Industrial Area exposure scenario, which assumes that a full-time industrial worker is present at a particular location for his or her entire career (250 day/yr, 8 hr/day for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 action level for radiological contaminants is implemented by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 2,000 hours.

The Tier 1 action levels for chemical contaminants are the following PALs as defined in the CAIP (NNSA/NSO, 2012a):

- EPA Region 9 Regional Screening Levels (EPA, 2012).
- Background concentrations for RCRA metals will be evaluated when natural background exceeds the PAL, as is often the case with arsenic at the NNSS. 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 Regional Screening Levels, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established value from another source may be chosen.

Although the PALs are based on an Industrial Area exposure scenario, no industrial activities are conducted at this site, and there are no assigned work stations in the surrounding area. Therefore, the use of an industrial scenario is overly conservative and is not representative of current land use.

C.1.5 Exposure Pathway Evaluation

For all study groups, the DQOs stated that site workers could 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 study groups. 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 releases, and depth to groundwater support 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 Comparison of Site Conditions with Tier 1 Action Levels

Results from environmental samples were compared to Tier 1 action levels. The contaminants that exceed the Tier 1 action level (i.e., PAL) are listed in Table C.1-2. The only contaminants that exceeded the Tier 1 action level were radionuclides. The doses listed in Table C.1-2 are based on the assumption that the site worker would be present at the sampled location for the entire work year. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose measured at any sampled location outside any crater area or high contamination area (HCA), this site worker would receive a 25-mrem dose at each of these CAS locations in the exposure times listed in Table C.1-3.

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 569 (mrem/IA-yr)
(Page 1 of 3)

Study Group	Location	Average TED	95% UCL TED
Study Group 2	B03	**29.6**	**36.8**
	B04	**61.1**	**69.7**
	B05	**68.8**	**79.0**
Study Group 3	C02	**28.8**	**33.1**
	C03	**124.0**	**133.7**
	C04	**41.6**	**47.7**
	C05	**53.2**	**59.1**
	C06	**29.0**	**36.7**
	C08	**25.6**	**31.7**
	C10	**46.0**	**53.4**
	C11	**62.3**	**71.5**
	C12	**58.9**	**65.6**
	C13	**47.5**	**53.6**
	C18	**26.0**	**28.9**
	C19	**78.2**	**90.3**
Study Group 4	D01	**25.9**	**31.6**
	D02	**48.2**	**67.6**

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 569 (mrem/IA-yr)
(Page 2 of 3)

Study Group	Location	Average TED	95% UCL TED
Study Group 5	E02	**32.1**	**37.6**
	E03	**43.3**	**48.2**
	E04	**124.8**	**132.3**
	E05	**98.4**	**114.9**
	E06	**34.8**	**37.5**
	E07	**27.6**	**33.4**
	E07g	23.9	**27.9**
	E08	**34.8**	**42.7**
	E11	**35.5**	**41.2**
	E12	**91.9**	**96.8**
	E13	**163.6**	**169.7**
	E14	**160.8**	**170.2**
	E15	**129.7**	**134.9**
	E16	**28.2**	**29.5**
	E17	**26.8**	**28.8**
	E18	**116.8**	**123.6**
	E19	**96.1**	**99.9**
	E20	**112.4**	**117.5**
	E21	**46.5**	**51.4**
	E24	**42.5**	**48.3**
	E25	**62.0**	**66.2**
	E26	**49.1**	**54.7**
	E27	**58.8**	**65.2**
	E28	**30.3**	**35.0**
	E29	**25.6**	**29.6**
	E31	**27.9**	**32.9**
	E32	**29.3**	**36.3**

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 569 (mrem/IA-yr)
(Page 3 of 3)

Study Group	Location	Average TED	95% UCL TED
Study Group 6	F10	**25.5**	**32.1**
	F11	**41.9**	**50.5**
	F12	**47.1**	**59.7**
	F14	**124.7**	**133.4**
	F15	**183.6**	**196.4**
	F16	**141.3**	**147.0**
	F17	**118.3**	**125.6**
	F18	**39.3**	**47.8**
	F20	22.3	**25.4**
	F22	**25.6**	**29.4**
	F23	**97.3**	**101.4**
	F25	**190.3**	**214.7**
	F26	**215.0**	**288.7**
	F27	**84.4**	**91.9**

Bold indicates the values equal to or greater than 25 mrem/yr.

Table C.1-3
Minimum Exposure Time to Receive a 25-mrem/yr Dose

Study Group	Location of Maximum Dose	Maximum 95% UCL TED (mrem/OU-yr)	Minimum Exposure Time (hours)
Study Group 1	A14	0.6	5,053
Study Group 2	B05	4.1	727
Study Group 3	C03	6.7	403
Study Group 4	D02	3.7	1,038
Study Group 5	E14	8.5	311
Study Group 6	F26	14.5	233
Study Group 7	G01b	0.8	3,521

C.1.7 Evaluation of Tier 1 Results

For the locations exceeding Tier 1 action levels for radionuclide contamination listed in Table C.1-2, the NNSA Nevada Field Office determined that remediation to the Tier 1 action level is not appropriate. The risk to receptors from contaminants at CAU 569 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 569 determined that workers may be present at these sites for only 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 2,000 hr/yr (DOE/NV, 1996). Therefore, it was determined to conduct a Tier 2 evaluation.

The analyses for lead failed precision and accuracy criteria (Appendix B). To better evaluate the potential impacts of this DQI issue, it was determined to calculate a Tier 2 action level for lead.

For all other contaminants that did not exceed Tier 1 action levels, the FALs were established as the Tier 1 action levels.

C.1.8 Tier 1 Remedial Action Evaluation

No additional remedial actions were implemented based on exceedences of Tier 1 action levels.

C.1.9 Tier 2 Evaluation

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

C.1.10 Development of Tier 2 Action Levels

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 contaminant levels. For example, workers may be present at a site for the entire work year but only spend 10 percent of their time at the location of elevated contamination. If the worker's industrial work schedule was 8 hr/day for 250 day/yr resulting in 2,000 hr/yr (as is used for the Industrial Area exposure scenario), the appropriate annual exposure time for that worker would be 200 hr/yr.

For the development of radiological Tier 2 action levels, 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 CAU 569 study group 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 569 identified the general types of work activities that are currently conducted at the site, to include fencing/posting inspection and maintenance workers, and Area 3 RWMS workers. 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, Area 3 RWMS operations, trespasser). In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA Nevada Field Office and/or M&O contractor departments responsible for these activities were consulted. Under the current and projected future land use at each of the CAU 569 study groups, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker**. This includes workers sent to conduct the annual inspection of the postings and fencing around the UR areas. The URs require periodic inspections 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 FFACO UR.

- **Area 3 RWMS Worker**. This includes several types of workers. Radiological control technicians make periodic visits to the Area 3 RWMS to verify the postings and radiological conditions for 1 day per year (8 hr/yr). Waste specialists conduct monthly inspections to verify the waste remains covered (2 hours per month). Occasionally, laborers clear tumbleweeds within the Area 3 RWMS (20 hr/yr). Also, fire extinguisher inspections are conducted annually (2 hr/yr). In the future, if waste disposal operations are resumed, a worker may spend up to 4 days per year supporting the off-loading (40 hr/yr).

- **Trespasser**. This includes workers or individuals who do not have a specific work assignment at one of the study groups. Although the sites will be posted with warning signs, workers could potentially inadvertently enter these study group 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 hr/yr).

Under the current land use at each of the CAU 569 study groups, the most exposed worker for Study Group 1 would be the Area 3 RWMS Worker, who would not be exposed to site contamination for more than 40 hr/yr. For the other study groups, the most exposed worker would be the Inspection and Maintenance Worker, who would not be exposed to site contamination for more than 10 hr/yr. Based on the conservative assumption that the most exposed worker would be exposed to the maximum dose measured at any sampled location for the entire time, this worker would receive a maximum potential dose at each study group as listed in Table C.1-4.

In the CAU 569 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAIP [NNSA/NSO, 2012a]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 569 study groups except Study Group 1. Based on the potential for the Area 3 RWMS to be used in the future, the Industrial Area exposure scenario was chosen for Study Group 1. However, based on information obtained on the most exposed individual, a site worker at Study Group 1 would not be present at the site for more than 40 hr/yr. Even if the Area 3 RWMS becomes active, the facility would not be manned continuously, but only when waste is accepted at the facility. Therefore, the CSM exposure scenario for Study Group 1 was changed to an Occasional Use Area, to more accurately reflect the amount of time for the most exposed individual. 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

Table C.1-4
Maximum Potential Dose to Most Exposed Worker at CAU 569 CASs

Study Group	Most Exposed Worker	Exposure Time	Maximum Potential Dose
Study Group 1	Area 3 RWMS Worker	40 hr/yr	<1 mrem/yr
Study Group 2	Inspection and Maintenance Worker	10 hr/yr	<1 mrem/yr
Study Group 3	Inspection and Maintenance Worker	10 hr/yr	<1 mrem/yr
Study Group 4	Inspection and Maintenance Worker	10 hr/yr	<1 mrem/yr
Study Group 5	Inspection and Maintenance Worker	10 hr/yr	1.1 mrem/yr
Study Group 6	Inspection and Maintenance Worker	10 hr/yr	1.8 mrem/yr
Study Group 7	Inspection and Maintenance Worker	10 hr/yr	<1 mrem/yr

of 80 hr/yr. As the use of this scenario provides a more conservative (longer) exposure time to site contaminants than the most exposed workers (based on current and projected future land use), the development and evaluation of Tier 2 action levels other than lead were conservatively based on the Occasional Use Area exposure scenario.

Therefore, RRMGs developed using the Occasional Use Area exposure scenario were used to calculate internal doses. The external doses were calculated using the exposure time of 80 hr/yr and the shielding factor of 1.0 associated with the Occasional Use Area exposure scenario as listed in the Soils RBCA document (NNSA/NSO, 2012b).

The EPA's risk assessment tool for lead (the ALM) was used to calculate a Tier 2 action level for lead. This methodology is recommended by EPA because a reference dose value for lead is not available. In the commercial/industrial setting, the most sensitive receptor is the fetus of a worker who has a non-residential exposure to lead. Based on the available scientific data, a fetus is more sensitive to the adverse effects of lead than an adult is (National Academy of Sciences, 1993). The EPA assumes that cleanup levels that are protective of a fetus will also afford protection for male or female adult workers. An outdoor industrial soil Tier 2 action level was calculated for lead at CAU 569 using EPA's ALM to estimate the concentration of lead in the blood of pregnant women and developing fetuses who might be exposed to lead-contaminated soils (EPA, 2009). The ALM is a series of equations for calculation of fetal risks from adult exposures to specified levels of soil lead contamination. These equations conservatively estimate lead concentrations in blood based on the ingestion of lead in soil. The equations are a relationship between soil lead concentration, soil ingestion rate, and a correlation of lead ingested and blood lead concentrations from numerous studies. While the soil ingestion rate includes direct ingestion and ingestion of inhaled dust, dermal absorption is not included because dermal absorption is generally not a significant route of exposure for inorganic lead and quantifying uptake from dermal exposure to soil-borne lead is not currently recommended by EPA (EPA, 2009). This approach supports EPA's goal of limiting the risk of elevated fetal blood concentrations due to lead exposures to women of child-bearing age. The ALM model is used to estimate blood lead concentrations, which can then be correlated to estimate possible adverse health effects in persons who have been exposed.

Although the Tier 2 action level for other contaminants were developed using the Occasional Use Area exposure scenario, the Tier 2 action level for lead was developed using the Remote Work Area exposure scenario. The Remote Work Area exposure scenario was used to calculate the Tier 2 action level for lead because EPA states that the minimum frequency of exposure of 1 day per week is recommended for short-term exposures. The recommended full-time exposure frequency of 219 day/yr equates to approximately 44 weeks per year. At 1 day per week, this minimum exposure frequency of 44 day/yr is equivalent to the Remote Work Area exposure scenario.

Therefore, the Remote Work Area exposure scenario soil ingestion rate (0.067 g/day) and the exposure frequency of 44 day/yr were used to calculate a Tier 2 action level for lead of 8,356 mg/kg.

C.1.11 Comparison of Site Conditions with Tier 2 Action Levels

Results from environmental samples for lead were compared to Tier 2 action levels. The maximum detected lead result of 534 mg/kg was less than the action level of 8,356 mg/kg. Therefore, no corrective action is required for lead.

The average and 95 percent UCL TEDs calculated using the Occasional Use Area exposure scenario were compared to the 25-mrem/OU-yr Tier 2 action level. As shown in Table C.1-5, none of the TED values exceeded the 25-mrem/OU-yr Tier 2 action level at any of the locations that exceeded the Tier 1 action level.

Table C.1-5
Occasional Use Area Scenario TED (mrem/OU-yr)
(Page 1 of 3)

Study Group	Plot/Location	Average TED	95% UCL TED
Study Group 2	B03	1.5	1.9
	B04	3.2	3.6
	B05	3.6	4.1
Study Group 3	C02	1.4	1.7
	C03	6.2	6.7
	C04	2.1	2.4
	C05	2.7	3.0
	C06	1.5	1.8
	C08	1.3	1.6
	C10	2.3	2.7
	C11	3.1	3.6
	C12	2.9	3.3
	C13	2.4	2.7
	C18	1.3	1.4
	C19	3.9	4.5
Study Group 4	D01	1.4	1.7
	D02	2.7	3.7

Table C.1-5
Occasional Use Area Scenario TED (mrem/OU-yr)
(Page 2 of 3)

Study Group	Plot/Location	Average TED	95% UCL TED
Study Group 5	E02	1.7	2.0
	E03	2.3	2.5
	E04	6.5	6.9
	E05	5.1	6.0
	E06	1.8	2.0
	E07	1.4	1.8
	E07g	1.2	1.4
	E08	1.8	2.2
	E11	1.9	2.1
	E12	4.8	5.0
	E13	8.6	8.9
	E14	8.0	8.5
	E15	6.8	7.0
	E16	1.5	1.5
	E17	1.4	1.5
	E18	5.8	6.2
	E19	5.0	5.2
	E20	5.9	6.1
	E21	2.4	2.7
	E24	2.2	2.5
	E25	3.2	3.5
	E26	2.5	2.7
	E27	3.1	3.4
	E28	1.5	1.8
	E29	1.3	1.5
	E31	1.5	1.7
	E32	1.5	1.9

Table C.1-5
Occasional Use Area Scenario TED (mrem/OU-yr)
(Page 3 of 3)

Study Group	Plot/Location	Average TED	95% UCL TED
Study Group 6	F10	1.3	1.6
	F11	2.1	2.5
	F12	2.4	3.0
	F14	6.3	6.7
	F15	9.2	9.9
	F16	7.1	7.4
	F17	5.9	6.3
	F18	2.0	2.4
	F20	1.1	1.3
	F22	1.3	1.5
	F23	4.9	5.1
	F25	9.6	10.8
	F26	10.8	14.5
	F27	4.2	4.6

The Tier 2 action levels are typically 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. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a CAS. However, for CAU 569, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from a single point location.

C.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, soil contamination at CAU 569 does not pose an unacceptable risk to human health and the environment.

As the FALs for all contaminants that were passed on to a Tier 2 evaluation were established as the Tier 2 action levels, a Tier 3 evaluation is not necessary.

C.2.0 Recommendations

The Tier 2 action levels are typically 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. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a study group. However, for CAU 569, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from a single point location.

Because the soil contaminant levels at CAU 569 CASs outside the DCBs were less than the corresponding FALs at all sampled locations (using the Occasional Use Area exposure scenario), it was determined that soil contamination at these locations do not warrant corrective actions. However, contamination is assumed to exist within the DCBs at Catron/Coulomb-B (CASs 03-23-13/03-23-15) and at the Pike and Bandicoot craters (CAS 03-23-21) that exceed the Occasional Use Area exposure scenario based FAL of 25 mrem/OU-yr. Therefore, a corrective action is necessary for both DCBs. The DCB for the Pike and Bandicoot craters is assumed to include a depth of 25 ft. The DCB for the bermed area at the Catron/Coulomb-B site is assumed to include all material overlying the native ground surface.

PSM was identified in the Tier 1 Remedial Action Evaluation as requiring corrective action. The lead bricks and batteries, as well as soil beneath them, were removed under a corrective action. Confirmation sampling was conducted on the remaining soil, and lead was not present at concentrations exceeding the FAL. No further corrective action is required for the PSM.

The corrective actions for CAU 569 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.

C.3.0 References

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Appendix D

Closure Activity Summary

D.1.0 Closure Activity Summary

The following subsections document closure activities completed for CAU 569.

D.1.1 Closure Activities for Study Group 1 (CASs 03-23-13 and 03-23-15)

No COCs were detected within sampled areas at Study Group 1 (Section A.3.0). However, it is assumed that subsurface contamination present in the bermed GZ area exceeds the FAL (Figure A.3-5). Therefore, a corrective action of closure in place with a UR was implemented for the subsurface soil contamination. The FFACO UR encompasses the area of the bermed Catron and Coulomb-B GZ area.

The established FFACO UR for CASs 03-23-13 and 03-23-15 is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. This UR is recorded in the FFACO database, the NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the UR will require NDEP notification. The FFACO UR signs posted at this site reads as follows:

WARNING

SURFACE RADIOLOGICAL CONTAMINATION

FFACO Site CAU 569

CAS 03-23-13, T-3T Contamination Area

CAS 03-23-15, S-3G Contamination Area

No activities that may alter of modify the containment control
are permitted in this area without
U.S. Government permission.
Before working in this area,
Contact Real Estate Services at 702-295-2528

D.1.2 Closure Activities for Study Groups 2 and 7 (CAS 03-23-21)

No COCs were identified within sampled locations at Pike or Bandicoot, or within Waste Consolidation Site 3A (located north of Pike). However, it is assumed that subsurface contamination present in the Pike and Bandicoot craters (due to direct injection of radionuclides into the subsurface soil from the nuclear test) exceeds the FAL. Therefore, a corrective action of closure in place with a UR was implemented for the subsurface contamination. The UR consists of two areas that encompass the Pike crater (including the soil-covered fissure north of the crater) and the Bandicoot crater.

The established FFACO UR for Pike and Bandicoot is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. The FFACO UR is recorded in the FFACO database, the NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the UR will require NDEP notification. The FFACO UR signs posted at this site reads as follows:

WARNING

SURFACE AND SUBSURFACE RADIOLOGICAL CONTAMINATION

FFACO Site CAU 569/CAS 03-23-21

Pike Contamination Area

No activities that may alter of modify the containment control are permitted in this area without U.S. Government permission.

Before working in this area,
Contact Real Estate Services at 702-295-2528

D.1.3 Closure Activities for Study Groups 3 and 5 (CASs 03-23-09, 03-23-10, 03-23-12, and 03-23-16)

No COCs were detected within sampled areas at CASs 03-23-09, 03-23-10, 03-23-12, and 03-23-16. However, PSM in the form of lead-acid batteries and lead bricks were identified that required corrective actions. All PSM and contaminated soil were removed during the CAI (Sections A.5.0 and A.7.0). A BMP of an administrative UR (as presented in Attachment D-1) was implemented for each CAS to prevent a future site worker from inadvertently receiving a dose exceeding 25 mrem/yr if a more intensive use of the site were to occur in the future.

D.1.4 Closure Activities for Study Groups 4 and 6 (CASs 03-23-11 and 03-23-14)

No COCs were detected at CASs 03-23-11 and 03-23-14. Therefore, no corrective actions were required (Sections A.6.0 and A.8.0). A BMP of an administrative UR (as presented in Attachment D-1) was implemented for each CAS to prevent a future site worker from inadvertently receiving a dose exceeding 25 mrem/yr if a more intensive use of the site were to occur in the future.

Attachment D-1

Use Restrictions

(19 Pages)

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-13/T-3T Contamination Area; 03-23-15/S-3G Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,059	586,495
Southwest	4,100,012	586,440
Northwest	4,100,077	586,388
Northeast	4,100,110	586,450

Depth: 20 ft bgs

Survey Source (GPS, GIS, etc): GPS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Subsurface contamination is assumed to be present within the bermed GZ area from atmospheric testing. The contamination, if exposed through excavation, could cause a site worker to receive a dose exceeding 25 mrem/yr.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-13, T-3T Contamination Area; CAS 03-23-15, S-3G Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Plutonium-238	Unknown	8,830	pCi/g
Plutonium-239/240	Unknown	7,645	pCi/g
Plutonium-241	Unknown	193,200	pCi/g
Uranium-234	Unknown	49,460	pCi/g
Uranium-235	Unknown	289.7	pCi/g
Uranium-238	Unknown	1,667	pCi/g

Site Controls: The use restricted area encompasses the area where subsurface soil contamination is assumed to exceed the FAL of 25 mrem in 80 hours (the Occasional Use 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 on the use restriction boundary.

UR Maintenance Requirements:

Description: The FFACO UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. FFACO UR signs are posted at the site.

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

Use Restriction Information

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires the prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013

Note: Effective upon acceptance of closure documents by NDEP

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CAU 569, CAS 03-23-13
T-3T Contamination Area (Catron)
and CAS 03-23-15
S-3G Contamination Area (Coulomb-B)
FFACO UR Boundary

Explanation

FFACO UR

0 25 50 100 Meters

0 100 200 400 Feet

N

Source: N-I GIS, 2013

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-21/Pike Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area 1 - Pike (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,826	587,873
	4,100,833	587,768
	4,100,917	587,719
	4,101,000	587,753
	4,100,997	587,893
	4,100,917	587,925

Surveyed Area 2 - Bandicoot (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,099,641	587,054
	4,099,588	586,984
	4,099,631	586,914
	4,099,687	586,867
	4,099,762	586,880
	4,099,819	586,960
	4,099,798	587,042
	4,099,722	587,089

Depth: No depth limitation

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Subsurface contamination is assumed to be present within the Pike (U-3cy) crater and covered fissure area, and also within the Bandicoot (U-3bj) crater. The contamination, if exposed through excavation, could cause a site worker to receive a dose exceeding 25 mrem/yr.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-21, Pike Contamination Area			
Constituent	**Maximum Concentration***	**Action Level****	**Units**
Cesium-137	166	81.45	pCi/g
Plutonium-239/240	1,849.7	7,645	pCi/g

*Highest measured value. Higher concentrations may be present within the crater or fissure areas
**Action level based on 25 mrem/yr under the industrial scenario

Site Controls: The use restricted areas encompass Bandicoot crater and the Pike crater and covered fissure where subsurface soil contamination is assumed to exceed the FAL of 25 mrem in 80 hours (the Occasional Use Area annual exposure scenario). They are established at the boundaries identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed on the use restriction boundaries.

UR Maintenance Requirements:

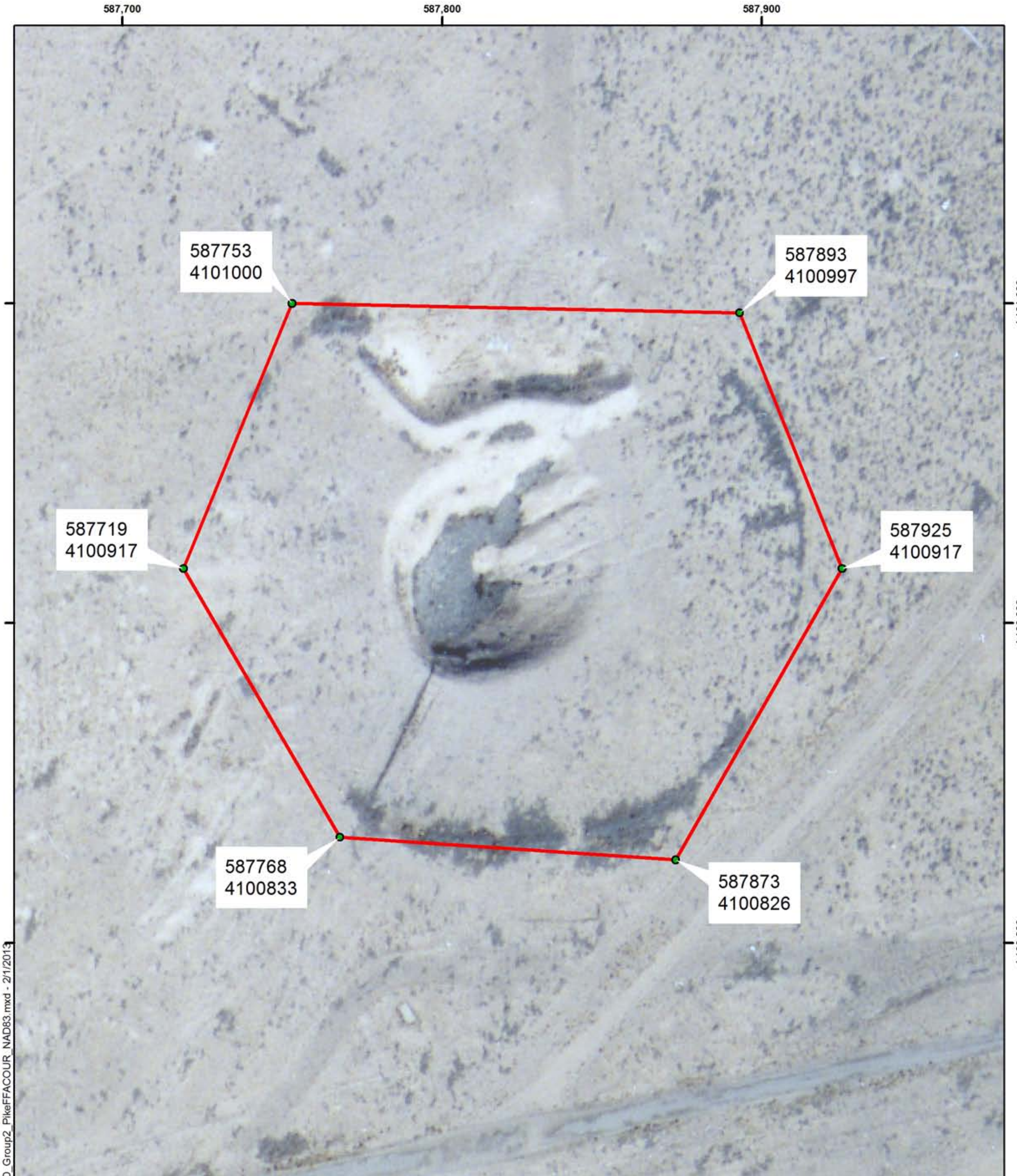
Description: The FFACO UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. FFACO UR signs are posted at the site.

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013



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CAU 569, CAS 03-23-21
Pike Contamination Area
FFACO UR Boundary

Explanation

FFACO UR

0 15 30 60 Meters

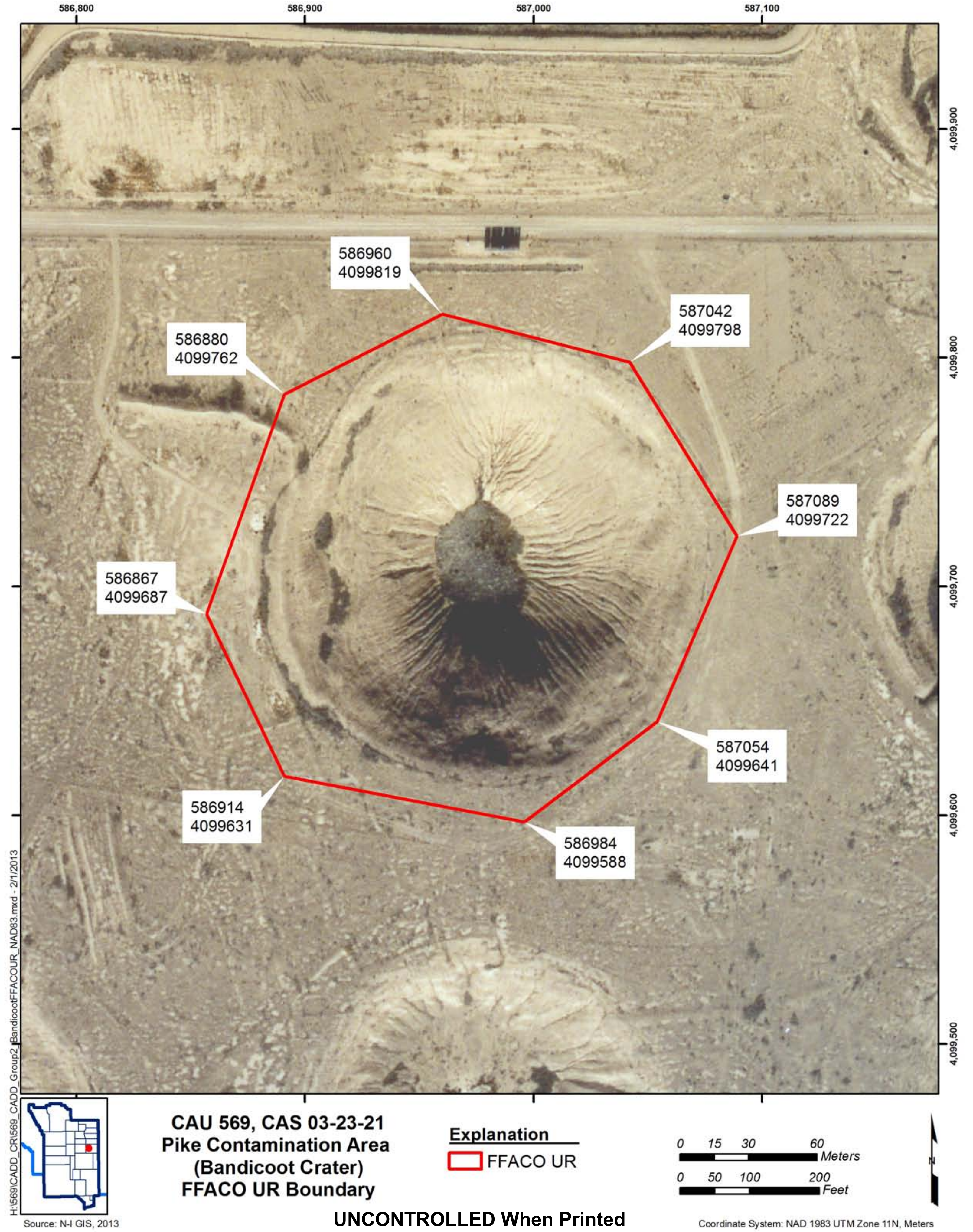
0 50 100 200 Feet

N

Source: N-I GIS, 2013

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meters



CAU 569, CAS 03-23-21
Pike Contamination Area
(Bandicoot Crater)
FFACO UR Boundary

UNCONTROLLED When Printed

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-09/T-3 Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

Administrative Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,521	587,309
	4,100,426	586,876
	4,100,513	586,791
	4,100,690	586,748
	4,100,817	586,820
	4,100,849	587,096
	4,100,677	587,302

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 299 hours of exposure to the surface location with the maximum detected radioactivity. 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 569.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-09, T-3 Contamination Area			
Constituent	**Maximum Concentration**	**Action Level***	**Units**
Cesium-137	6.7	81.45	pCi/g
Europium-152	57.4	42.75	pCi/g
Th-232	1.8	22.34	pCi/g

*Action level based on 25 mrem/yr under the industrial scenario

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

UR Maintenance Requirements:

Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

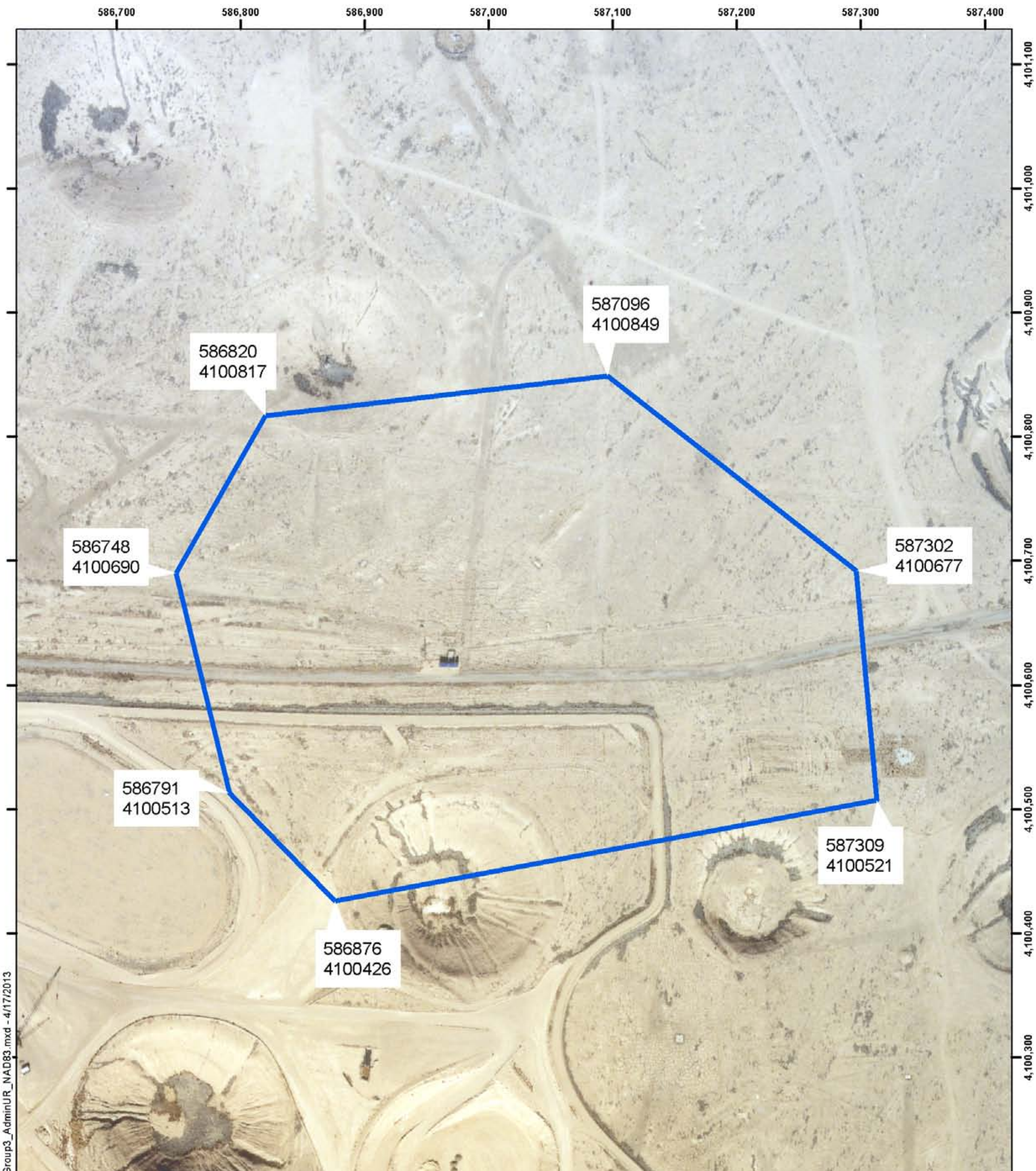
Inspection/Maintenance Frequency: N/A

Use Restriction Information

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013



H:\569\CADD_CR\569_CADD_Group3_AdminUR_NAD83.mxd - 4/17/2013

Source: N-I GIS, 2013

CAU 569, CAS 03-23-09
T-3 Contamination Area
(Annie, Franklin, George, and Moth)
Administrative UR Boundary

Explanation

Administrative UR

0 25 50 100 150 Meters

0 125 250 500 Feet

N

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-14/T-3V Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

Administrative Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,100,576	586,698
	4,100,578	586,636
	4,100,644	586,636
	4,100,644	586,698

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 514 hours of exposure to the surface location with the maximum detected radioactivity. 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 569.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-14, T-3V Contamination Area			
Constituent	**Maximum Concentration**	**Action Level***	**Units**
Americium-241	868	2,687	pCi/g
Cesium-137	5.4	81.45	pCi/g
Europium-152	5.6	42.75	pCi/g
Pu-239/240	5479.8	7,645	pCi/g
Th-232	2	22.34	pCi/g

*Action level based on 25 mrem/yr under the industrial scenario

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

UR Maintenance Requirements:

Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

Inspection/Maintenance Frequency: N/A

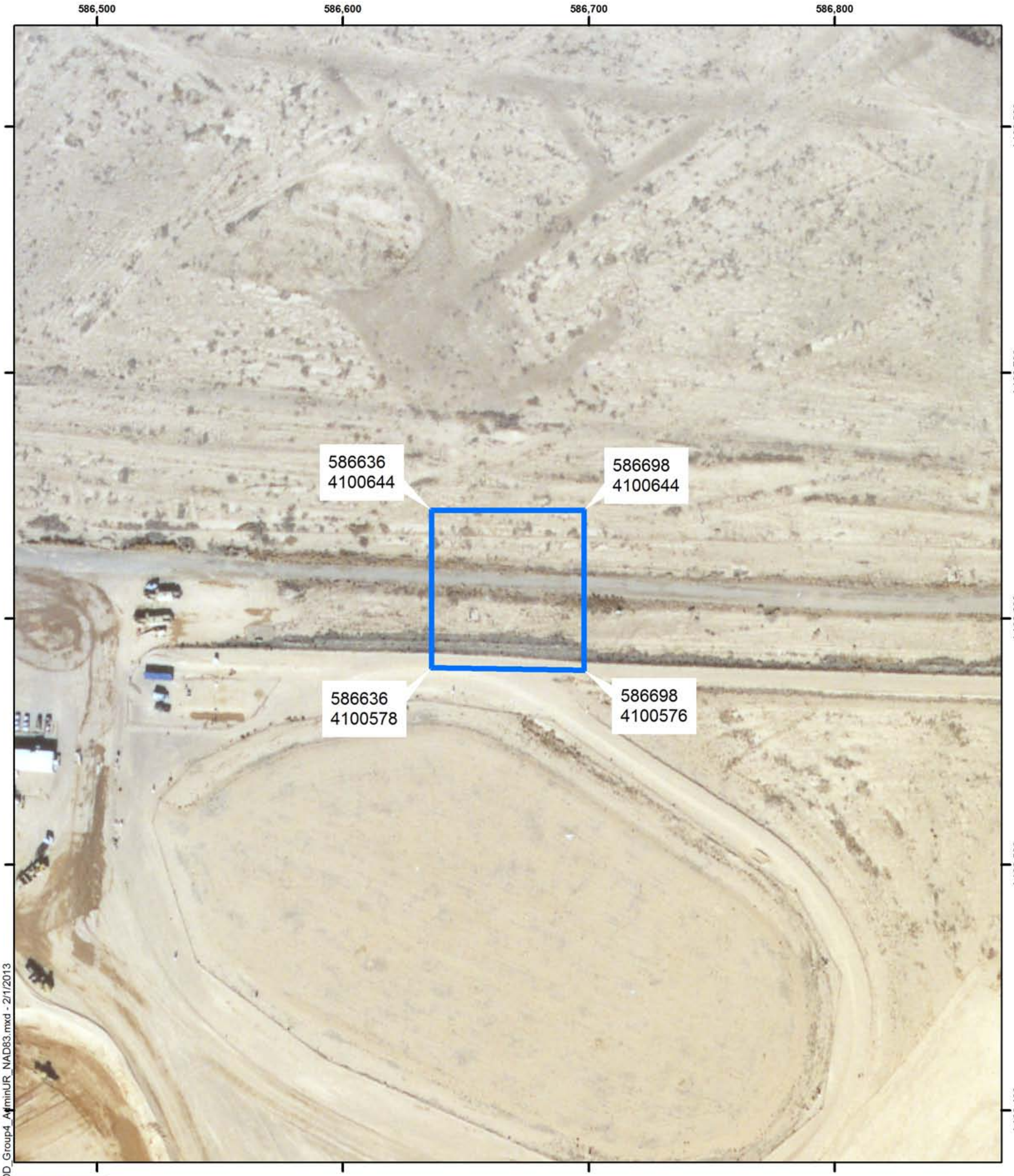
Use Restriction Information

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013

Note: Effective upon acceptance of closure documents by NDEP



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CAU 569, CAS 03-23-14
T-3V Contamination Area (Humboldt)
Administrative UR Boundary

Explanation

Administrative UR

0 15 30 60 Meters

0 50 100 200 Feet

N

Source: N-I GIS, 2013

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites

Applicable CAS Number/Description: 03-23-10/T-3A Contamination Area; 03-23-12/T-3S Contamination Area; 03-23-16/S-3H Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

Administrative Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,099,609	586,980
	4,099,540	586,814
	4,099,538	586,535
	4,099,644	586,386
	4,099,881	586,350
	4,099,979	586,450
	4,099,952	586,476
	4,099,945	586,666
	4,099,891	586,725
	4,099,939	586,803
	4,099,933	587,124
	4,099,858	587,147
	4,099,863	586,860
	4,099,726	586,841
	4,099,635	586,913

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 235 hours of exposure to the surface location with the maximum detected radioactivity. 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 569.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-10, T-3A Contamination Area; CAS 03-23-12, T-3S Contamination Area; CAS 03-23-16, S-3H Contamination Area			
Constituent	**Maximum Concentration**	**Action Level***	**Units**
Americium-241	151	2,687	pCi/g
Cesium-137	9.6	81.45	pCi/g
Europium-152	134	42.75	pCi/g
Plutonium-238	256.5	8,830	pCi/g
Plutonium-239/240	953.3	7,645	pCi/g
Thorium-232	2.2	22.34	pCi/g

*Action level based on 25 mrem/yr under the industrial scenario

Use Restriction Information

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

UR Maintenance Requirements:

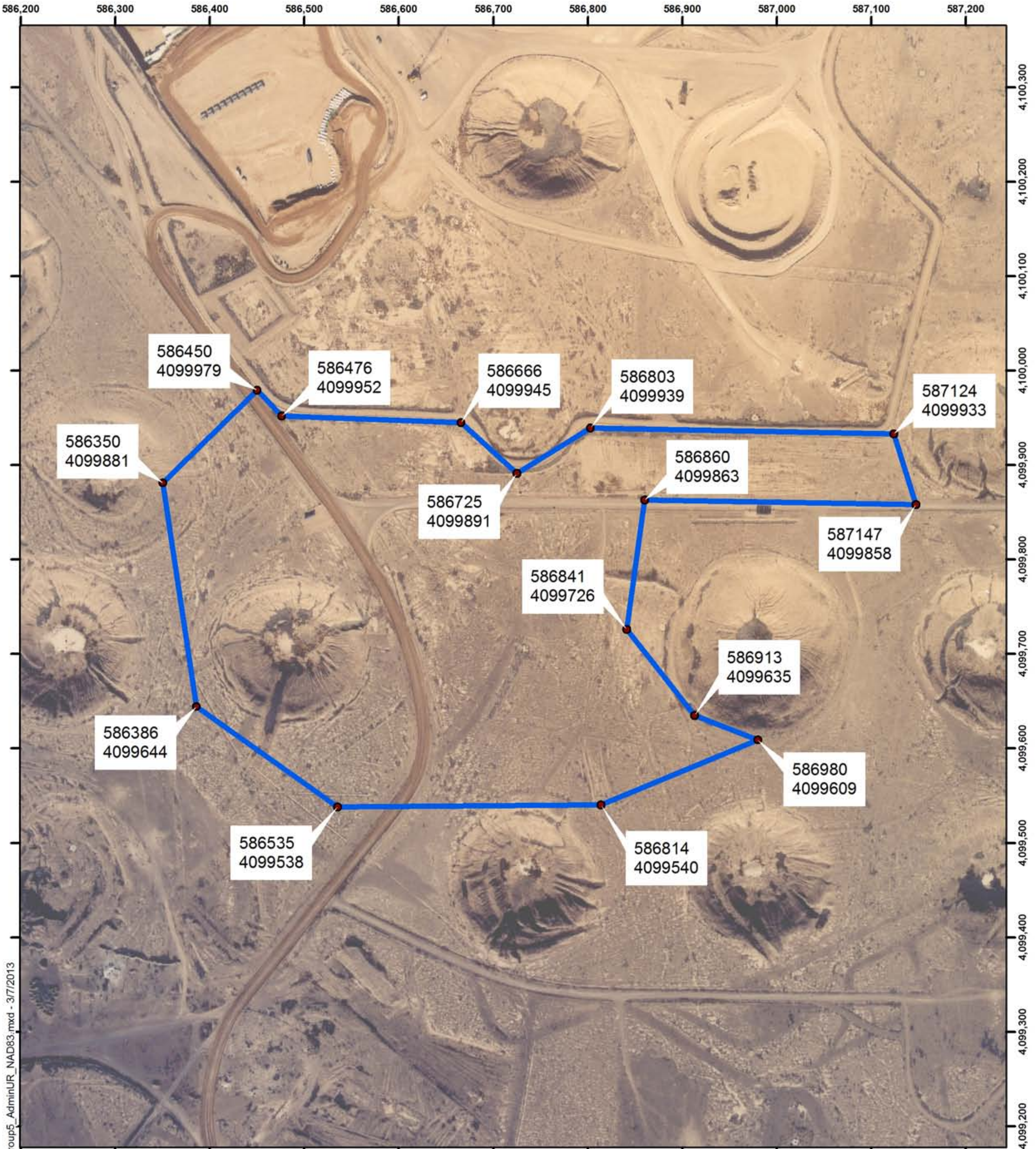
Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

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 any work in this restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013



Source: N-I GIS, 2013

CAU 569,
CAS 03-23-10 T-3A Contamination Area (Harry and Hornet),
CAS 03-23-12 T-3S Contamination Area (Rio Arriba),
CAS 03-23-16 S-3H Contamination Area (Coulomb-A),
Administrative UR Boundary

UNCONTROLLED When Printed

Explanation

Administrative UR

0 25 50 100 Meters

0 100 200 400 Feet

N

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Use Restriction Information

CAU Number/Description: 569/Area 3 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: 03-23-11/T-3B Contamination Area

Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

Administrative Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,098,797	586,167
	4,098,854	585,927
	4,099,001	585,904
	4,099,202	585,934
	4,099,089	586,259
	4,098,963	586,253

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): Heads-up digitizing

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 142 hours of exposure to the surface location with the maximum detected radioactivity. 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 569.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 569 CAS 03-23-11, T-3B Contamination Area			
Constituent	**Maximum Concentration**	**Action Level** *	**Units**
Cesium-137	229	81.45	pCi/g
Europium-152	28.3	42.75	pCi/g
Thorium-232	1.8	22.34	pCi/g

**Action level based on 25 mrem/yr under the industrial scenario

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical controls are required for this administrative use restriction.

UR Maintenance Requirements:

Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NNSS.

Inspection/Maintenance Frequency: N/A

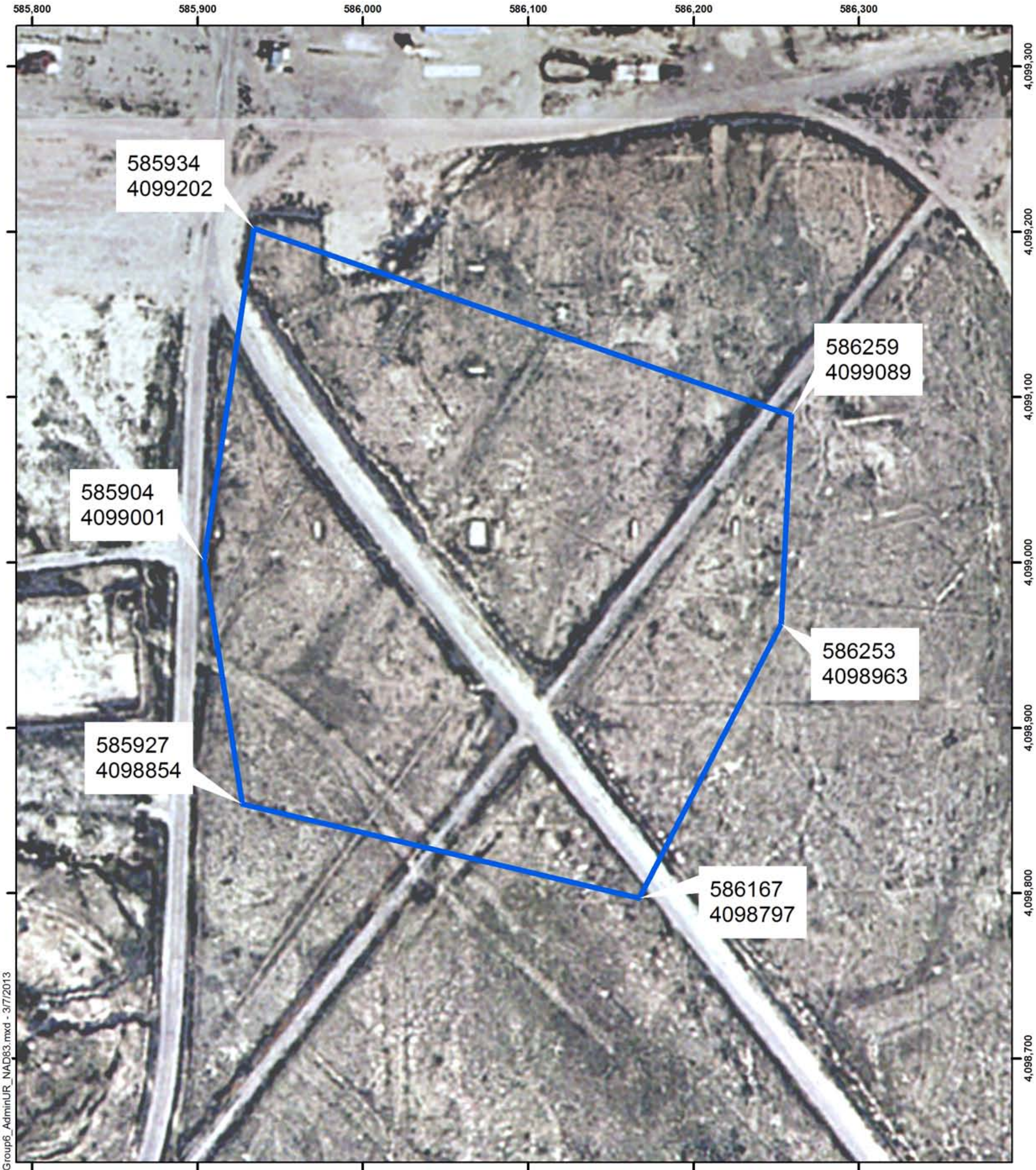
Use Restriction Information

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 restricted area that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the Occasional Use Area exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 4/15/2013

Note: Effective upon acceptance of closure documents by NDEP



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CAU 569, CAS 03-23-11
T-3B Contamination Area (Fizeau)
Administrative UR Boundary

Explanation

Administrative UR

0 25 50 100 Meters

0 100 200 400 Feet

N

Source: N-I GIS, 2013

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Attachment D-2

Waste Disposal Documentation

(2 Pages)

NTS On-Site HazMat Transfer - Published

Tracking No: DPM13T06 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G820436D
Driver: ROBERT YOUNG

Depart: 02-APR-2013 Arrival: 02-APR-2013

From: ROBERT ZION
NSTEC
BASE CAMP
MERCURY, NV 89023

Area: 03
Bldg: MUD PLANT
Phone: 702-295-4594
Mobile: 702-466-4231

To: ROBERT ZION
NSTEC
3-05
7-01
MERCURY, NV 89023
Area: 7
Bldg: N/A
Phone: 702-295-4594
Mobile: 702-466-4231

Entered By: ROBERT ZION
Modified By: ROBERT ZION

Date Entered: 01-APR-2013
Date Modified: 01-APR-2013

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 3077, HAZARDOUS WASTE, SOLID, N.O.S., 9, PG III UN/NA 3077, HAZARDOUS WASTE, SOLID, N.O.S., (LEAD, CADMIUM), 9, PG III. PACKAGE #569E02 D004, D006, D008. EXCLUSIVE USE SHIPMENT, ONSITE SHIPMENT/TRANSFER	1 DRUM	50.00 POUND(S) (GROSS)	171

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
WILLIAM NICOSIA @ 702-630-0223

In the event of an emergency on the Nevada Test Site, immediately contact the Operations Coordination Center (OCC) Duty Manager at 702/295-0311 for assistance.

EMERGENCY RESPONSE

By Phone
702-295-0311

By Radio
'MAYDAY - MAYDAY - MAYDAY'

In the event of an incident involving Hazardous Material:

1. Gather HazMat shipping papers and NAER Guidebook
2. Isolate the immediate area
3. Assess the situation:
   a. Fire, Spill, or Leak?
   b. People, Property, or the Environment at risk?
4. Contact On-site Emergency Response Personnel
5. Reference On-Site HazMat Transfer Tracking Number

This is to certify that the above-named materials are properly classified, described, packaged, marked, placarded, and labeled and are in proper condition for transportation according to the applicable regulations of the U.S Department of Transportation. As a signatory I cerfify that I have been trained and tested to the requirements of 49 CFR, Part 172-700 and is compliant with the NTS OTSD.

Authorized Signature: /s/ Signature on File Date: 4/2/13 Time: 1020

Received by: /s/ Signature on File Date: 4/2/13 Time: 11:35

Certificate of Disposal

This is to certify that the Waste Stream No. LITN000000006, Revision 15, shipment number ITL13005, with container number 569A01 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Nicole Nastanski	N-I	Waste Coordinator
Shipped by	Organization	Title
/s/ Nicole Natanski		4/17/13
Signature		Date
Jon Tanaka	NSTEC	Specialist
Received by	Organization	Title
/s/ Jon Tanaka		04-17-2013
Signature		Date

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 569, 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.

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 principal 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.

E.1.1 Corrective Action Objectives

The corrective action objectives are the FALs as defined in using Soils RBCA document (NNSA/NSO, 2012b). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012b) 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 or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

E.1.2 Screening Criteria

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

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

The general corrective action standards are as follows:

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

The remedy selection decision factors are as follows:

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

E.1.3 Corrective Action Standards

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

Protection of Human Health and the Environment

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

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs defined in Section 2.3.1.

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, 2012a]; 40 CFR 761 “Polychlorinated Biphenyls,” [CFR, 2012b]; and NAC 444.842 to 444.980, “Facilities for Management of Hazardous Waste” [NAC, 2011]).

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, such as fugitive dusts, transportation of hazardous materials, and explosion
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

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

Long-Term Reliability and Effectiveness

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

Feasibility

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

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

- **Administrative Feasibility.** The administrative activities needed to implement the CAA (e.g., permits, 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, and operation and maintenance costs, as applicable. 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 Costs.** 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 each CAU 569 CAS. The CAAs are based on the current nature of contamination at CAU 569 which does not include contamination removed as part of the corrective actions completed during the CAI (Section 2.2.1). 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 569:

- **Alternative 1.** No Further Action
- **Alternative 2.** Clean Closure
- **Alternative 3.** Closure in Place

Regardless of the CAA selected, BMPs will be conducted consisting of the implementation of an administrative UR for areas that exceed the 25-mrem/IA-yr PAL.

E.1.4.1 Alternative 1 – No Further Action

Under Alternative 1, 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 presenting a dose exceeding the 25-mrem/OU-yr FAL to a depth of 25 ft bgs (the maximum depth to which a construction activity might excavate for a building foundation or basement) within the Bandicoot crater area and Pike crater/fissure area, and excavating and disposing of the top 9 ft of soil within the bermed GZ area at Catron and Coulomb-B (including the berm). A visual inspection will be conducted to ensure that contaminated surface debris has been removed before the corrective action is completed. Verification soil samples will also be collected and analyzed for the presence of a dose exceeding the 25-mrem/OU-yr FAL after contaminated soil is removed.

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

E.1.4.3 Alternative 3 – Closure in Place

For radiological contamination, Alternative 3 includes the implementation of a UR where a radiological dose is present (or assumed to be present) at levels that exceed the 25-mrem/OU-yr FAL. This UR will 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.

E.1.5 Evaluation and Comparison of Alternatives

Each CAA presented in Section E.1.4 will be evaluated for the CASs that contain a COC 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 does not meet the general corrective action standards will be removed from consideration.

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

CAS 03-23-13 (Catron); CAS 03-23-15 (Coulomb-B); CAS 03-23-21 (Pike)		
CAA 1, No Further Action		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	No	Workers could be exposed to contamination exceeding risk-based action levels.
Compliance with Media Cleanup Standards	No	Contamination would remain that exceeds FALs.
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. The GZ area at Catron and Coulomb-B is covered over by a layer of clean fill and surrounded by a berm. The Pike fissure is covered by a mound of clean soil.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.
CAA 2, Clean Closure		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	Contamination exceeding the risk-based action levels will be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels will be removed.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event. There are no ongoing releases. The top 9 ft of soil will be removed from the bermed GZ area at Catron and Coulomb-B, and replaced with clean fill to ground surface. The top 25 ft of soil will be removed from the Bandicoot crater area and Pike crater/fissure area, and replaced with clean fill to ground surface.
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		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	URs will be implemented to protect site workers from contamination exceeding the risk-based action levels.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site access will be controlled to prevent site workers from exposure to COCs above risk-based action levels.
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. The GZ area at Catron and Coulomb-B was covered with a layer of clean fill, and the fissure at Pike was covered by a mound of clean soil.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

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

CAS 03-23-13 (Catron); CAS 03-23-15 (Coulomb-B); CAS 03-23-21 (Pike)		
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. However, the short-term exposure to site workers would increase.
Feasibility	1	This option would involve the excavation, disposal, and backfill of approximately 5,417,000 ft^3 of soil.
Cost	1	Cost is estimated to be approximately $81 million.
Score	7	
CAA 3, Closure in Place		
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 is easily implemented, but requires maintenance and long-term monitoring.
Cost	2	The installation costs are estimated at $177,000. Ongoing maintenance costs for this alternative are estimated at $1,800 annually.
Score	8	

The remaining CAAs will be further evaluated based on the remedy selection decision factors described in Section E.1.2. This evaluation is presented in Table E.1-2. For each remedy selection decision factor, the CAAs are ranked relative to one another. 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 evaluation of CAAs does not include corrective actions that have been completed during the CAI.

The five EPA remedy selection decision factors are (1) short-term reliability and effectiveness; (2) reduction of toxicity, mobility, and/or volume; (3) long-term reliability and effectiveness; (4) feasibility; and (5) cost. These factors are evaluated 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 (the top 9 ft from Catron and Coulomb-B, and soil to a depth of 25 ft bgs from Pike and Bandicoot) 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 construction, operation, and administrative actions consistent with soil removal and management of generated wastes are needed.

The fifth remedy selection decision factor—cost—includes assessment of both capital (direct) costs of implementation and costs for operation and maintenance of the corrective action. As shown in Table E.1-2, the estimated cost for clean closure would be approximately $81 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 $177,000 for the first year and $1,800 for each year thereafter).

E.2.0 Recommended Alternative

PSM was identified at Study Groups 2, 3, and 5 (CASs 03-23-09, 03-23-10, 03-23-12, 03-23-16, and 03-23-21) and removed with associated impacted soils as an interim corrective action during the CAI. Verification of the completion of these corrective actions are documented in this report. Therefore, additional corrective actions were not required nor included in the evaluation of CAAs.

Any remaining contamination at the following sites do not exceed FALs: CASs 03-23-09 (Annie, Franklin, George, and Moth), 03-23-10 (Harry and Hornet), 03-23-11 (Fizeau), 03-23-12 (Rio Arriba), 03-23-14 (Humboldt), and 03-23-16 (Coulomb-A); and Waste Consolidation Site 3A (which was included within the scope of CAS 03-23-21). Therefore, Alternative 1, no further action, was selected for these sites.

The CAAs for the sites that require additional corrective action were evaluated based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short- and long-term feasibility; and cost. The corrective action recommendations for CAU 569 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.

Three CAAs were evaluated for the areas at CAS 03-23-13 (Catron), 03-23-15 (Coulomb-B), and 03-23-21 (Pike) where contamination levels were assumed to exceed FALs: 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, near-surface soils would be removed from Pike and Bandicoot to a depth of 25 ft bgs, and the top 9 ft of soil would be removed from Catron and Coulomb-B. This corrective action would not remove deeper contamination in the area of the Pike or Bandicoot crater. For the closure in place alternative, potential worker exposure to radiological contamination would be controlled through the implementation of FFACO 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 CAS 03-23-13 (Catron), 03-23-15 (Coulomb-B), and 03-23-21 (Pike).

Alternative 3, closure in place, was the highest scoring CAA in Table E.1-2 and is selected as the preferred corrective action for CASs 03-23-13, 03-23-15, and 03-23-21.

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.2-1) of up to 25 ft in depth. This corrective action would not remove deeper contamination in the area of the Pike and Bandicoot craters, and an FFACO UR may still be required. Additionally, the soil contamination at the Catron and Coulomb-B GZ area and Pike fissure area is currently covered by a layer of clean fill. Based on the extent of the CABs, the infeasibility of removing deep contamination in the craters, and the fact that contamination in some areas is currently covered by clean soil, the corrective action of closure in place with an FFACO URs is recommended for these areas encompassed by the CABs.

Table E.2-1
CAB Areas at CAU 569 CASs

CAS	Encompassed Area	Area (acres)
03-23-13 (Catron) and 03-23-15 (Coulomb-B)	Bermed GZ area	1.3
03-23-21 (Pike)	Pike crater and fissure	6.9
	Bandicoot crater	9.1

Every site where the corrective action of closure in place is selected as the CAA, an FFACO UR is required. All FFACO URs are recorded in the FFACO database, the NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. These FFACO URs require warning signs and annual inspections to certify that postings are in place, intact, and readable.

In accordance with the Soils RBCA document (NNSA/NSO, 2012b) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), an administrative UR was implemented as a voluntary protective measure (i.e., BMP) for CASs 03-23-09, 03-23-10, 03-23-11, 03-23-12, 03-23-14, 03-23-16, and 03-23-21 (Study Groups 2 through 6). At these sites, it is assumed that a site worker could potentially receive an annual dose exceeding 25 mrem/yr under a full-time industrial use of the contaminated area (i.e., the Industrial Area exposure scenario). This administrative UR (implemented as a BMP) is not part of any FFACO corrective action. 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 as described in Section A.2.6.

Administrative URs will prevent inadvertent exposure of workers to site contamination if a more intensive use of the sites were to be considered in the future. The administrative URs will be recorded and controlled in the same manner as the FFACO URs but will not require posting or inspections. The administrative URs for each CAS are presented in Attachment D-1.

All URs are recorded in the FFACO database, the NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. The development of URs for CAU 569 are based on specific land use assumptions. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

E.3.0 Cost Estimates

The cost estimate for clean closure is estimated to exceed $81 million to conduct the following activities:

- Preparation and procurement
- Removal of soil berms and contaminated soil
- Excavation, loading, and disposal of contaminated soil (approximately 5,417,000 ft^3)
- Disposal of soil and debris as LLW
- Equipment decontamination

The estimated costs for clean closure of CAU 569 was based on removing contaminated soil within the fissure and crater area at Pike, the crater at Bandicoot, and the bermed GZ area at Catron and Coulomb-B. The cost for clean closure of Pike (including the Bandicoot crater) was estimated to be more than $76 million. The cost for clean closure of Catron and Coulomb-B was estimated to be approximately $5 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 $177,000 for the first year and $1,800 for each year thereafter.

E.4.0 References

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Appendix F

Data Tables

F.1.0 Data Tables for Study Group 1

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 1 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.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.1-3.

Table F.1-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 1

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)			
			Ac-228	Am-241	Cs-137	Eu-152
A01	A001	0.0 - 5.0	1.79	--	--	1.52
A03	A002	0.0 - 5.0	1.55	2.62	0.327	1.26
A04	A003	0.0 - 5.0	1.6	--	0.24	7.54
A05	A004	0.0 - 5.0	1.75	1.34 (J)	2.2	6.44 (J)
	A005	0.0 - 5.0	1.56	1.18	1.8	6.44
A06	A006	0.0 - 5.0	1.7	--	1.17	2.84
A07	A007	0.0 - 5.0	1.57	--	0.428	1.38
A08	A008	0.0 - 5.0	1.64	--	1.65	1.38
A09	A009	0.0 - 5.0	1.53	--	0.576	3.23
A10	A010	0.0 - 5.0	1.69	0.894	0.512	7.6
A12	A011	0.0 - 5.0	1.85	1.01 (J)	0.244	8.62 (J)

Ac = Actinium

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

Table F.1-2
Sample Results for Isotopes Detected above MDCs at Study Group 1

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Am-241	Pu-238	Pu-239/240	U-234	U-235	U-238
A01	A001	0.0 - 5.0	--	--	0.127 (J)	0.937	0.0524	0.678
A03	A002	0.0 - 5.0	0.359	--	1.39 (J)	1.07	0.074	0.93
A04	A003	0.0 - 5.0	--	--	0.25 (J)	2.11	0.0774	0.853
A05	A004	0.0 - 5.0	0.197	0.0531	0.435 (J)	0.822	--	0.835
	A005	0.0 - 5.0	0.354	--	0.499 (J)	1.01	0.0805	0.949
A06	A006	0.0 - 5.0	0.137	--	0.352 (J)	0.809	--	0.771
A07	A007	0.0 - 5.0	0.0436	--	0.156 (J)	0.773	--	0.927
A08	A008	0.0 - 5.0	0.0738	--	0.801 (J)	0.724	0.0608	0.954
A09	A009	0.0 - 5.0	0.154	--	3.29 (J)	0.811	--	0.82
A10	A010	0.0 - 5.0	--	--	0.631 (J)	1.04	--	0.897
A12	A011	0.0 - 5.0	0.75	--	--	1.01	--	0.799

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

Table F.1-3
Inferred Plutonium Concentrations at Study Group 1

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
A03	A002	0.0 - 5.0	0.19	16.54	6.10
A05	A004	0.0 - 5.0	0.10	8.46	3.12
	A005	0.0 - 5.0	0.08	7.45	2.75
A10	A010	0.0 - 5.0	0.06	5.64	2.08
A12	A011	0.0 - 5.0	0.07	6.38	2.35

F.2.0 Data Tables for Study Group 2

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 2 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.

Analytical results for RCRA metals environmental samples collected at Study Group 2 that were detected above MDCs are presented in Table F.2-3.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.2-4.

Table F.2-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
B04	B601	0.0 - 5.0	1.54	180	0.406	115	--	--
	B602	0.0 - 5.0	1.43	287	0.629	166	1.1	--
	B603	0.0 - 5.0	1.47	223	0.506	124	0.943	0.321
	B604	0.0 - 5.0	1.34	277	0.597	153	0.946	--
B05	B605	0.0 - 5.0	1.32	276	0.623	159	1.19	--
	B606	0.0 - 5.0	1.37	293	0.595	164	1.15	--
	B607	0.0 - 5.0	1.37	259	0.574	163	1.29	--
	B608	0.0 - 5.0	1.44	244	0.563	153	1.16	--
B10	B003	0.0 - 15.0	1.66	0.621 (J)	--	3.26	--	--

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

Table F.2-2
Sample Results for Isotopes Detected above MDCs at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)							
			Am-241	Pu-238	Pu-239/240	Pu-241	Sr-90	U-234	U-235	U-238
B04	B601	0.0 - 5.0	146	47.5	944	--	--	--	--	--
	B602	0.0 - 5.0	105	33.4	687	--	--	--	--	--
	B603	0.0 - 5.0	97.5	25.9	490	--	--	--	--	--
	B604	0.0 - 5.0	286 (J)	70.6	1,460	--	--	--	0.471	--
B05	B605	0.0 - 5.0	254	69.7	1,500	788	111	--	--	1.12
	B606	0.0 - 5.0	77.7	26	514	--	--	--	--	0.822
	B607	0.0 - 5.0	169	58.5	1,250	--	--	--	--	1.21
	B608	0.0 - 5.0	159	32.6	727	--	--	--	0.466	1.38
B10	B003	0.0 - 15.0	0.19 (J)	0.0965	3.77 (J)	--	0.945	0.768	--	0.853

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

Table F.2-3
Sample Results for Metals Detected above MDCs at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**5.6**	**8,356**	**43**	**5,100**
B09	B001	0.0 - 5.0	6.78	134 (J)	0.151 (J)	9.77	0.241 (J)	14.9 (J)	0.0485 (J)	0.288 (J)
	B002	0.0 - 5.0	6.26	129 (J)	0.142 (J)	9.34	0.495 (J)	15.2 (J)	0.0439 (J)	0.223 (J)

J = Estimated value.

Table F.2-4
Inferred Plutonium Concentrations at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
B04	B601	0.0 - 5.0	54.32	1,136.36	419.09
	B602	0.0 - 5.0	86.61	1,811.86	668.21
	B603	0.0 - 5.0	67.29	1,407.82	519.20
	B604	0.0 - 5.0	83.59	1,748.73	644.93
B05	B605	0.0 - 5.0	83.29	1,742.42	642.60
	B606	0.0 - 5.0	88.42	1,849.74	682.18
	B607	0.0 - 5.0	78.16	1,635.09	603.02
	B608	0.0 - 5.0	73.63	1,540.40	568.10

F.3.0 Data Tables for Study Group 3

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 3 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.

Analytical results for RCRA metals, PCBs, and VOCs chemical environmental samples collected at Study Group 3 that were detected above MDCs are presented in Tables F.3-3 through F.3-5.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.3-6.

Table F.3-1
Soil Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
C03	C601	0.0 - 5.0	1.48	2.54	0.287	2.92	53.9	1.11
	C602	0.0 - 5.0	1.6	4.77	0.236	4.88	52	1.29
	C603	0.0 - 5.0	1.55	3.59	0.222	6.65	45.2	1.08
	C604	0.0 - 5.0	1.81	4.97	0.267	3.49	57.4	1.19
C21	C005	0 - 0	1.57	4.39 (J)	--	3.48	22.5 (J)	0.968 (J)

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

Table F.3-2
Soil Sample Results for Isotopes Detected above MDCs at Study Group 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
C03	C601	0.0 - 5.0	0.287	--	2.64 (J)	0.789	0.839	--	0.972
	C602	0.0 - 5.0	1.62	0.404	8.76 (J)	--	1.75	0.129	0.893
	C603	0.0 - 5.0	0.893	--	4.66 (J)	--	0.792	--	0.786
	C604	0.0 - 5.0	7.3	1.09	32.2 (J)	--	1.25	0.12	0.839
C21	C005	0 - 0	2.99 (J)	0.414	12.8 (J)	1.25	0.858	--	0.883

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

Table F.3-3
Soil Sample Results for Metals Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**5.6**	**8,356**	**43**	**5,100**
C20	C001	0 - 6 (in. bgs)	2.8	181 (J)	--	4.81	0.297 (J)	10.1 (J)	0.00787 (J)	0.102 (J)
C21	C002	0.0 - 5.0	2.78	157 (J)	7.96	6.32	--	9.43 (J)	0.00588 (J)	0.366 (J)
	C003	0.0 - 5.0	2.55	140 (J)	9.4	6.12	0.192 (J)	8.78 (J)	0.00755 (J)	0.38 (J)

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

Table F.3-4
Soil Sample Results for PCBs Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)	
			Aroclor 1254	Aroclor 1260
FALs			**0.74**	**0.74**
C20	C001	0 - 6	0.00191 (J)	0.00326 (J)

J = Estimated value.

Table F.3-5
Soil Sample Results for VOCs Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (cm bgs)	COPC (mg/kg)
			Toluene
FAL			**45,000**
C21	C002	0.0 - 5.0	0.000514 (J)

J = Estimated value.

Table F.3-6
Inferred Plutonium Concentrations for Study Group 3

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
C03	C601	0.0 - 5.0	4.32	16.04	5.91
	C602	0.0 - 5.0	8.10	30.11	11.11
	C603	0.0 - 5.0	6.10	22.66	8.36
	C604	0.0 - 5.0	8.44	31.38	11.57

F.4.0 Data Tables for Study Group 4

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 4 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.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.4-3.

Table F.4-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)			
			Ac-228	Am-241	Cs-137	Eu-152
D01	D601	0.0 - 5.0	1.61	250	3.02	3.87
	D602	0.0 - 5.0	1.49	314	3.35	3.74
	D603	0.0 - 5.0	1.88	294 (J)	3.08	3.88 (J)
	D604	0.0 - 5.0	1.73	245	3.12	3.16
D02	D605	0.0 - 5.0	1.74	499	4.76	4.76
	D606	0.0 - 5.0	1.58	552	4.96	5.58
	D607	0.0 - 5.0	1.59	295	3.53	3.86
	D608	0.0 - 5.0	1.98	868	5.41	4.19
D04	D617	0.0 - 5.0	1.63	65.2	1.62	2.84
	D618	0.0 - 5.0	1.43	50.2	1.78	2.86
	D619	0.0 - 5.0	1.45	50.9	1.41	3.07
	D620	0.0 - 5.0	1.55	48.6	1.32	2.5
D05	D613	0.0 - 5.0	1.53	39.8	1.19	2.34
	D614	0.0 - 5.0	1.62	34.7	1.23	2.13
	D615	0.0 - 5.0	1.41	30.7	0.858	1.88
	D616	0.0 - 5.0	1.57	35.7	1.01	2.33

Table F.4-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)			
			Ac-228	Am-241	Cs-137	Eu-152
D06	D609	0.0 - 5.0	1.64	40.9	2.13	2.63
	D610	0.0 - 5.0	1.56	36.1	2.28	2.62
	D611	0.0 - 5.0	1.55	33.5	2.17	2.5
	D612	0.0 - 5.0	1.6	28.6	2.25	2.21

J = Estimated value.

Table F.4-2
Sample Results for Isotopes Detected above MDCs at Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)							
			Am-241	Pu-238	Pu-239/ 240	Pu-241	Sr-90	U-234	U-235	U-238
D01	D601	0.0 - 5.0	74.1	6.92	509	--	--	4.37	--	--
	D602	0.0 - 5.0	111	11.5	780	--	--	2.9	0.684	--
	D603	0.0 - 5.0	32.8	8.27	360	--	--	--	--	--
	D604	0.0 - 5.0	87	12.3	626	--	--	--	--	0.531
D02	D605	0.0 - 5.0	339	27.2	2,120	--	--	--	--	1.25
	D606	0.0 - 5.0	136	19.2	1,320	--	--	--	--	0.799
	D607	0.0 - 5.0	444	43.2	2,950	--	--	2.02	--	--
	D608	0.0 - 5.0	800	49.2	5,170	1,840	5	--	--	--
D04	D617	0.0 - 5.0	37.3	3.11	228	--	--	1.07	--	0.975
	D618	0.0 - 5.0	22.2	1.72	139	--	--	1.08	0.0743	0.911
	D619	0.0 - 5.0	20.5	1.63	125	--	--	1.96	--	0.892
	D620	0.0 - 5.0	17.2	1.43	114	--	--	1.7	--	0.874
D05	D613	0.0 - 5.0	4.17	0.46	27.2	--	--	3.57	0.166	0.847
	D614	0.0 - 5.0	31.7	2.59	210	--	--	0.802	--	0.85
	D615	0.0 - 5.0	41.3	3.57	259	--	--	0.889	--	0.885
	D616	0.0 - 5.0	3.63	0.324	24.6	--	--	0.829	--	0.933

Table F.4-2
Sample Results for Isotopes Detected above MDCs at Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)							
			Am-241	Pu-238	Pu-239/240	Pu-241	Sr-90	U-234	U-235	U-238
D06	D609	0.0 - 5.0	3.13	0.376	20.2	--	--	0.999	0.109	0.987
	D610	0.0 - 5.0	5.95	0.452	37.6	--	--	1.09	--	0.962
	D611	0.0 - 5.0	3.55	0.358	21.7	--	--	0.948	--	0.949
	D612	0.0 - 5.0	4.44	0.458	31.8	--	--	1.12	--	1.01

-- = Not detected above MDCs.

Table F.4-3
Inferred Plutonium Concentrations for Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
D01	D601	0.0 - 5.0	17.83	1,578.28	582.07
	D602	0.0 - 5.0	22.40	1,982.31	731.08
	D603	0.0 - 5.0	20.97	1,856.05	684.51
	D604	0.0 - 5.0	17.48	1,546.71	570.43
D02	D605	0.0 - 5.0	35.60	3,150.24	1,161.81
	D606	0.0 - 5.0	39.38	3,484.83	1,285.21
	D607	0.0 - 5.0	21.04	1,862.36	686.84
	D608	0.0 - 5.0	61.92	5,479.77	2,020.94
D04	D617	0.0 - 5.0	4.65	411.61	151.80
	D618	0.0 - 5.0	3.58	316.92	116.88
	D619	0.0 - 5.0	3.63	321.34	118.51
	D620	0.0 - 5.0	3.47	306.82	113.15
D05	D613	0.0 - 5.0	2.84	251.26	92.67
	D614	0.0 - 5.0	2.48	219.06	80.79
	D615	0.0 - 5.0	2.19	193.81	71.48
	D616	0.0 - 5.0	2.55	225.38	83.12

Table F.4-3
Inferred Plutonium Concentrations for Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
D06	D609	0.0 - 5.0	2.92	258.21	95.23
	D610	0.0 - 5.0	2.58	227.90	84.05
	D611	0.0 - 5.0	2.39	211.49	78.00
	D612	0.0 - 5.0	2.04	180.55	66.59

F.5.0 Data Tables for Study Group 5

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 5 that were detected above MDCs are presented in Tables F.5-1 and F.5-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Analytical results for RCRA metals and PCBs chemical environmental samples collected at Study Group 5 that were detected above MDCs are presented in Tables F.5-3 and F.5-4.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.5-5.

Table F.5-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 5
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
E01	E601	0.0 - 5.0	1.76	33.2	--	2.96	9.93	--
	E602	0.0 - 5.0	1.69	46.7	--	3.85	11.5	0.279
	E603	0.0 - 5.0	1.52	57.6	--	3.98	10.6	--
	E604	0.0 - 5.0	1.69	55.5	--	4.97	9.95	--
E07	E007	0.0 - 30.0	1.71	47.5	--	2.03	9.22	--
	E621	0.0 - 5.0	1.68	151 (J)	--	3.21	7.26 (J)	--
	E622	0.0 - 5.0	1.87	117 (J)	--	3.82	9.39 (J)	--
	E623	0.0 - 5.0	1.69	81.5 (J)	0.069	3.5	8.5 (J)	--
	E624	0.0 - 5.0	1.78	124 (J)	--	3.23	7.28 (J)	--
E09	E008	0.0 - 30.0	1.71	4.02	--	8.85	2.74	--
	E625	0.0 - 5.0	1.75	95.2	--	2.13	3.64	--
	E626	0.0 - 5.0	1.87	54.7 (J)	--	1.68	2.9 (J)	--
	E627	0.0 - 5.0	1.77	51.1	--	2.2	3.69 (J)	--
	E628	0.0 - 5.0	1.86	48	--	2.12	4.49	--

Table F.5-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 5
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
E14	E605	0.0 - 5.0	1.95	--	0.766	2.79	134	2.73
	E606	0.0 - 5.0	1.75	3.6	0.7	6.04	111	2.55
	E607	0.0 - 5.0	2.17	6.77 (J)	0.659	5.03	115 (J)	2.63 (J)
	E608	0.0 - 5.0	1.62	2.95 (J)	0.788	6.65	128 (J)	3.09 (J)
E18	E609	0.0 - 5.0	1.76	2.15 (J)	0.239	3.52	58.7 (J)	1.35 (J)
	E610	0.0 - 5.0	1.35	2.03 (J)	0.221	3.2	39.2 (J)	1.05 (J)
	E611	0.0 - 5.0	1.67	2.29	0.269	2.57	44.2	1.09
	E612	0.0 - 5.0	1.72	3.76	0.377	3.19	57.2	1.26
E26	E613	0.0 - 5.0	1.85	3.7	--	4.25	25.8	0.655
	E614	0.0 - 5.0	1.95	2.99	0.272	3.6	30.8	0.701
	E615	0.0 - 5.0	2.02	2.61	0.163	4.28	30.9	0.829
	E616	0.0 - 5.0	1.71	4.34	0.176	7.33	24.2	0.679
E28	E617	0.0 - 5.0	1.54	6.84	0.0761	4.56	17.3	0.431
	E618	0.0 - 5.0	1.65	11 (J)	--	9.25	14.7 (J)	0.474 (J)
	E619	0.0 - 5.0	1.75	16.2	0.0915	9.55	14.5	0.342
	E620	0.0 - 5.0	1.63	3.52	0.0982	4.3	16.7	0.448
E30	E629	0.0 - 5.0	1.75	8.52 (J)	--	2.56	7.61 (J)	--
	E630	0.0 - 5.0	1.8	2.73	--	1.9	8.24	--
	E631	0.0 - 5.0	1.88	8.17 (J)	--	2.61	8.2 (J)	--
	E632	0.0 - 5.0	1.91	3.57 (J)	--	1.85	8.85 (J)	--
E39	E009	0.0 - 30.0	1.77	2.93	--	2.66	11.1	--
E40	E010	0.0 - 30.0	1.66	--	--	1.92	2.29	--

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

Table F.5-2
Sample Results for Isotopes Detected above MDCs at Study Group 5
(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
E01	E601	0.0 - 5.0	11.7 (J)	--	14.4 (J)	--	1.48	--	0.933
	E602	0.0 - 5.0	3.69 (J)	0.784 (J)	33.8 (J)	--	1.99	--	0.842
	E603	0.0 - 5.0	3.7 (J)	2.99 (J)	42.1 (J)	--	2.71	--	0.816
	E604	0.0 - 5.0	3.22 (J)	0.807 (J)	17.1 (J)	--	1.92	0.0968	0.921
E07	E007	0.0 - 30.0	--	--	90.2	--	3.41	0.145	0.9
	E621	0.0 - 5.0	57	10.1	258	--	1.79	0.0728	1.03
	E622	0.0 - 5.0	28.8	5.37	298	--	1.79	--	0.988
	E623	0.0 - 5.0	23	6.43	452	--	2.07	0.139	1.01
	E624	0.0 - 5.0	39.4	4.06	258	--	3.11	--	0.979
E09	E008	0.0 - 30.0	0.762	0.515 (J)	4.85	--	0.883	--	0.906
	E625	0.0 - 5.0	55	2.79	186	--	1.67	0.113	1.07
	E626	0.0 - 5.0	9.76	4.35	258	--	1.43	--	1.03
	E627	0.0 - 5.0	13.1 (J)	1.63	93.1	--	2.3	--	1.01
	E628	0.0 - 5.0	8.75	0.766	55.9	--	1.93	0.0848	1.06
E14	E605	0.0 - 5.0	--	0.264	1.23 (J)	--	1.62	--	0.847
	E606	0.0 - 5.0	0.533	0.806	4.38 (J)	--	2.12	--	0.853
	E607	0.0 - 5.0	0.884	1.06	7.76 (J)	--	1.41	0.092	0.858
	E608	0.0 - 5.0	0.846	0.947	6.07 (J)	0.536	3.77	0.215	1.03
E18	E609	0.0 - 5.0	0.58	1.01	5.72 (J)	--	1.14	0.0944	0.953
	E610	0.0 - 5.0	0.344	--	2.18 (J)	--	0.834	--	0.783
	E611	0.0 - 5.0	1.72	2.52	10.6 (J)	--	1.11	0.11	0.839
	E612	0.0 - 5.0	--	0.423	2.66 (J)	--	1.33	--	0.911
E26	E613	0.0 - 5.0	1.08	0.828	3.73 (J)	--	0.964	--	0.939
	E614	0.0 - 5.0	0.456	0.515	4.18 (J)	--	2.12	0.14	0.908
	E615	0.0 - 5.0	0.871	0.724	5.51 (J)	--	0.985	--	0.99
	E616	0.0 - 5.0	0.608	0.602	5.54 (J)	--	1.07	--	0.869

Table F.5-2
Sample Results for Isotopes Detected above MDCs at Study Group 5
(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
E28	E617	0.0 - 5.0	1.07	0.864	7.66 (J)	--	1.72	--	0.838
	E618	0.0 - 5.0	3.26	0.996	18.1 (J)	--	1.07	--	0.855
	E619	0.0 - 5.0	16.3	1.46	80.8 (J)	--	1.27	0.0934	0.749
	E620	0.0 - 5.0	--	0.209	2.19 (J)	--	1.15	--	0.937
E30	E629	0.0 - 5.0	0.693	0.19	3.18	--	0.996	--	0.908
	E630	0.0 - 5.0	0.536	--	2.69	--	0.888	0.0746	0.921
	E631	0.0 - 5.0	1.06	0.779	5.17	--	0.89	0.0636	0.842
	E632	0.0 - 5.0	1	1.34 (J)	5.78 (J)	--	0.973	--	0.97
E39	E009	0.0 - 30.0	0.363	0.142 (J)	2.04	--	1.7	0.0925	0.852
E40	E010	0.0 - 30.0	0.0883	--	0.444	--	0.799	0.0526	0.835

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

Table F.5-3
Sample Results for Metals Detected above MDCs at Study Group 5
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Silver
FALs			23	190,000	9,300	33.6	5.6	8,356	43	5,100
E34	E001	0 - 6 (in. bgs)	2.61	140 (J)	--	5.33	--	15.7 (J)	0.0085 (J)	0.351 (J)
E35	E002	0 - 6 (in. bgs)	2.5	161 (J)	0.179 (J)	5.82	--	12 (J)	0.0107 (J)	0.409 (J)
E36	E003	0 - 6 (in. bgs)	2.7	148 (J)	0.815	6.06	0.138 (J)	11.8 (J)	0.0101 (J)	0.487 (J)

Table F.5-3
Sample Results for Metals Detected above MDCs at Study Group 5
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**5.6**	**8,356**	**43**	**5,100**
E37	E004	0.0 - 5.0	2.62	152 (J)	--	6.77	--	10.6 (J)	0.0131 (J)	0.427 (J)
	E005	0.0 - 5.0	3.08	175 (J)	--	7.29	--	11.6 (J)	0.013 (J)	0.512
E38	E006	15.0 - 20.0	5.1	156 (J)	0.144 (J)	7.34	--	14.5 (J)	0.0127 (J)	0.378 (J)

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

Table F.5-4
Sample Results for PCBs Detected above MDCs at Study Group 5

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)		
			Aroclor 1248	Aroclor 1254	Aroclor 1260
FALs			**0.74**	**0.74**	**0.74**
E35	E002	0 - 6	0.0072 (J)	0.0133 (J)	0.00564 (J)
E36	E003	0 - 6	--	0.00494 (J)	0.00421 (J)

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

Table F.5-5
Inferred Plutonium Concentrations for Study Group 5
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
E01	E601	0.0 - 5.0	56.40	209.59	77.30
	E602	0.0 - 5.0	79.34	294.82	108.73
	E603	0.0 - 5.0	97.85	363.63	134.11
	E604	0.0 - 5.0	94.29	350.38	129.22
E07	E007	0.0 - 30.0	80.70	299.87	110.59
	E621	0.0 - 5.0	256.53	953.28	351.57
	E622	0.0 - 5.0	198.77	738.63	272.41
	E623	0.0 - 5.0	138.46	514.52	189.75
	E624	0.0 - 5.0	210.66	782.82	288.71
E09	E008	0.0 - 30.0	6.83	25.38	9.36
	E625	0.0 - 5.0	161.73	601.01	221.65
	E626	0.0 - 5.0	92.93	345.33	127.36
	E627	0.0 - 5.0	86.81	322.60	118.97
	E628	0.0 - 5.0	81.55	303.03	111.76
E14	E606	0.0 - 5.0	6.12	22.73	8.38
	E607	0.0 - 5.0	11.50	42.74	15.76
	E608	0.0 - 5.0	5.01	18.62	6.87
E18	E609	0.0 - 5.0	3.65	13.57	5.01
	E610	0.0 - 5.0	3.45	12.82	4.73
	E611	0.0 - 5.0	3.89	14.46	5.33
	E612	0.0 - 5.0	6.39	23.74	8.75
E26	E613	0.0 - 5.0	6.29	23.36	8.61
	E614	0.0 - 5.0	5.08	18.88	6.96
	E615	0.0 - 5.0	4.43	16.48	6.08
	E616	0.0 - 5.0	7.37	27.40	10.10

Table F.5-5
Inferred Plutonium Concentrations for Study Group 5
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
E28	E617	0.0 - 5.0	11.62	43.18	15.93
	E618	0.0 - 5.0	18.69	69.44	25.61
	E619	0.0 - 5.0	27.52	102.27	37.72
	E620	0.0 - 5.0	5.98	22.22	8.20
E30	E629	0.0 - 5.0	14.47	53.79	19.84
	E630	0.0 - 5.0	4.64	17.23	6.36
	E631	0.0 - 5.0	13.88	51.58	19.02
	E632	0.0 - 5.0	6.06	22.54	8.31
E39	E009	0.0 - 30.0	4.98	18.50	6.82

F.6.0 Data Tables for Study Group 6

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 6 that were detected above MDCs are presented in Tables F.6-1 and F.6-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Analytical results for RCRA metals and PCBs chemical environmental samples collected at Study Group 6 that were detected above MDCs are presented in Tables F.6-3 and F.6-4.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.6-5.

Table F.6-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 6
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	**Am-241**	**Co-60**	**Cs-137**	**Eu-152**	**Eu-154**
F14	F601	0.0 - 5.0	1.64	71.4	0.76	150	21.7	0.652
	F602	0.0 - 5.0	1.54	78.6	0.801	167	22.1	0.849
	F603	0.0 - 5.0	1.48	55.3	0.628	136	20.4	0.706
	F604	0.0 - 5.0	1.63	64.7	0.699	138	19	0.82
F15	F605	0.0 - 5.0	1.64	87.9	0.907	180	28.1	0.982
	F606	0.0 - 5.0	1.79	95.6	0.992	209	28.3	1
	F607	0.0 - 5.0	1.57	117	1.03	229	27.1	0.876
	F608	0.0 - 5.0	1.71	98	0.887	207	25.4	0.86
F18	F609	0.0 - 5.0	1.53	11.3	0.21	19.9	13.1	0.563
	F610	0.0 - 5.0	1.53	7.81	0.154	11.5	11.4	--
	F611	0.0 - 5.0	1.54	5.55	0.148	8.73	11.9	--
	F612	0.0 - 5.0	1.63	10	0.148	14	12.8	0.462

Table F.6-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 6
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
F19	F613	0.0 - 5.0	1.53	4.5	0.0842	5.8	9.94	0.411
	F614	0.0 - 5.0	1.53	7.79	0.103	6.26	9.07	0.338
	F615	0.0 - 5.0	1.77	7.27	0.106	7.75	9.35	--
	F616	0.0 - 5.0	1.54	6.25	0.132	6.92	9.6	0.355
F21	F617	0.0 - 5.0	1.59	2.62	0.0715	1.97	5.42	--
	F618	0.0 - 5.0	1.65	1.4	--	2.43	5.47	0.23
	F619	0.0 - 5.0	1.55	1.58	--	1.47	5.71	--
	F620	0.0 - 5.0	1.64	1.71	--	1.85	6.01	--
F27	F621	0.0 - 5.0	1.63	34.1	0.475	60.2	19.8	0.685
	F622	0.0 - 5.0	1.53	34.4	0.475	58.4	18.6	0.598
	F623	0.0 - 5.0	1.68	38.5	0.494	67.9	19.3	0.646
	F624	0.0 - 5.0	1.51	32.2	0.455	59.2	19.7	0.626

-- = Not detected above MDCs.

Table F.6-2
Sample Results for Isotopes
Detected above MDCs at Study Group 6
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)							
			Am-241	Pu-238	Pu-239/ 240	Pu-241	Sr-90	U-234	U-235	U-238
F14	F601	0.0 - 5.0	36.9 (J)	174 (J)	613 (J)	--	--	1.32	--	0.854
	F602	0.0 - 5.0	17.2 (J)	31.1 (J)	110 (J)	--	--	1.18	--	0.858
	F603	0.0 - 5.0	14.6 (J)	28 (J)	98.4 (J)	--	--	1.2	--	0.997
	F604	0.0 - 5.0	85.9 (J)	26.6 (J)	96.8 (J)	--	--	1.22	0.075	0.893

Table F.6-2
Sample Results for Isotopes
Detected above MDCs at Study Group 6
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)							
			Am-241	Pu-238	Pu-239/240	Pu-241	Sr-90	U-234	U-235	U-238
F15	F605	0.0 - 5.0	37.2 (J)	114	419	139	13.6	1.35	--	0.944
	F606	0.0 - 5.0	76.5 (J)	94.9 (J)	326 (J)	--	--	1.39	--	0.999
	F607	0.0 - 5.0	92.1 (J)	91.8	334	--	--	1.25	--	0.852
	F608	0.0 - 5.0	101 (J)	62.5	222	75.8	10.7	1.17	0.0598	0.78
F18	F609	0.0 - 5.0	9.12 (J)	9.99	44.6	--	--	0.942	--	0.877
	F610	0.0 - 5.0	1.78 (J)	1.28	11	--	--	0.751	--	0.878
	F611	0.0 - 5.0	2.28 (J)	3.44 (J)	18.8 (J)	--	--	0.866	--	0.89
	F612	0.0 - 5.0	4.68 (J)	7.6	35.6	--	--	0.886	--	0.904
F19	F613	0.0 - 5.0	2.07 (J)	0.988	19.6	--	--	0.732	--	0.809
	F614	0.0 - 5.0	8.39 (J)	0.49	16.6	--	--	0.674	--	0.927
	F615	0.0 - 5.0	3.2 (J)	3.14	28.2	--	--	0.881	--	0.765
	F616	0.0 - 5.0	3.08 (J)	6.98	37	--	--	0.989	--	0.975
F21	F617	0.0 - 5.0	1.3 (J)	0.088	6.96	--	--	0.875	--	0.931
	F618	0.0 - 5.0	1.08 (J)	--	3.76	--	--	0.873	--	0.815
	F619	0.0 - 5.0	0.894 (J)	0.105	6.23	--	--	0.915	--	0.946
	F620	0.0 - 5.0	0.485 (J)	--	3.82	--	--	0.988	0.0764	0.939
F27	F621	0.0 - 5.0	15.6	17.1	84.2	--	--	0.86	0.0542	1
	F622	0.0 - 5.0	7.06	10.1	41.9	--	--	0.736	0.0753	0.805
	F623	0.0 - 5.0	4.74	6.7	30.5	--	--	0.882	--	0.859
	F624	0.0 - 5.0	6.54	10.2	42.8	--	--	0.887	--	0.944

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

Table F.6-3
Sample Results for Metals Detected above MDCs at Study Group 6
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)								
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**5.6**	**8,356**	**43**	**5,100**	**5,100**
F28	F001	0.0 - 5.0	1.12	57.3 (J)	--	3.69	0.143 (J)	6.22 (J)	0.00608 (J)	--	0.327 (J)
	F002	0.0 - 5.0	1.02	73.1 (J)	0.104 (J)	6.38	--	5.26 (J)	0.00492 (J)	--	0.55
F29	F003	0.0 - 5.0	1.74	58.8 (J)	--	**143**	--	8.6 (J)	0.00603 (J)	0.511 (J)	8.44
F30	F004	0.0 - 5.0	4.38	185 (J)	0.139 (J)	7.77	--	7.63 (J)	0.0205 (J)	--	0.563
F31	F625	0.0 - 5.0	1.76	159 (J+)	--	4.22	--	13.6 (J)	0.0105 (J)	--	--
	F626	0.0 - 5.0	1.89	153 (J+)	--	5.02	--	13.7 (J)	0.0112 (J)	--	--
	F627	0.0 - 5.0	2	161 (J+)	--	4.69	--	14.8 (J)	0.0149	--	--
	F628	0.0 - 5.0	2.36	182 (J+)	--	4.89	--	32.5 (J)	0.0191	--	--
F32	F629	0.0 - 5.0	2.99	177 (J+)	14.3	7.31	--	68.4 (J)	0.0198	--	--
	F630	0.0 - 5.0	2.93	173 (J+)	--	7.47	--	37.9 (J)	0.0226	--	--
	F631	0.0 - 5.0	2.54	193 (J+)	0.121 (J)	5.98	--	53.7 (J)	0.027	--	--
	F632	0.0 - 5.0	2.87	175 (J+)	0.278 (J)	9.6	--	223 (J)	0.022	--	0.147 (J)

Table F.6-3
Sample Results for Metals Detected above MDCs at Study Group 6
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)								
			Arsenic	Barium	Cadmium	Chromium	Chromium VI	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**5.6**	**8,356**	**43**	**5,100**	**5,100**
F33	F633	0.0 - 5.0	2.43	162 (J+)	--	5.71	--	73.8 (J)	0.0147	--	0.137 (J)
	F634	0.0 - 5.0	2.46	155 (J+)	--	6.43	--	55 (J)	0.0162	--	0.207 (J)
	F635	0.0 - 5.0	2.66	185 (J+)	--	6.33	--	534 (J)	0.0163	--	0.141 (J)
	F636	0.0 - 5.0	2.34	158 (J+)	0.442 (J)	5.65	--	56.4 (J)	0.0149	--	0.15 (J)

J = Estimated value.
J+ = The result is an estimated quantity, but the result may be biased high.
-- = Not detected above MDCs.

Bold indicates value equal to or greater than FAL.

Table F.6-4
Sample Results for VOCs
Detected above MDCs at Study Group 6

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)	
			Methylene Chloride	Toluene
FALs			**960**	**45,000**
F28	AA1F001	0.0 - 5.0	--	0.000345 (J)
	AA1F002	0.0 - 5.0	--	0.000314 (J)
F29	AA1F003	0.0 - 5.0	0.00285 (J)	0.00224 (J)

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

Table F.6-5
Inferred Plutonium Concentrations for Study Group 6

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
F14	F601	0.0 - 5.0	121.30	450.76	166.24
	F602	0.0 - 5.0	133.53	496.21	183.00
	F603	0.0 - 5.0	93.95	349.11	128.75
	F604	0.0 - 5.0	109.92	408.46	150.64
F15	F605	0.0 - 5.0	149.33	554.92	204.66
	F606	0.0 - 5.0	162.41	603.53	222.58
	F607	0.0 - 5.0	198.77	738.63	272.41
	F608	0.0 - 5.0	166.49	618.68	228.17
F18	F609	0.0 - 5.0	19.20	71.34	26.31
	F610	0.0 - 5.0	13.27	49.31	18.18
	F611	0.0 - 5.0	9.43	35.04	12.92
	F612	0.0 - 5.0	16.99	63.13	23.28
F19	F613	0.0 - 5.0	7.64	28.41	10.48
	F614	0.0 - 5.0	13.23	49.18	18.14
	F615	0.0 - 5.0	12.35	45.90	16.93
	F616	0.0 - 5.0	10.62	39.46	14.55
F21	F617	0.0 - 5.0	4.45	16.54	6.10
	F618	0.0 - 5.0	2.38	8.84	3.26
	F619	0.0 - 5.0	2.68	9.97	3.68
	F620	0.0 - 5.0	2.91	10.80	3.98
F27	F621	0.0 - 5.0	57.93	215.28	79.39
	F622	0.0 - 5.0	58.44	217.17	80.09
	F623	0.0 - 5.0	65.41	243.05	89.64
	F624	0.0 - 5.0	54.70	203.28	74.97

F.7.0 Data Tables for Study Group 7

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample locations at Study Group 7 that were detected above MDCs are presented in Tables F.7-1 and F.7-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.7-3.

Table F.7-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 7

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
G01	G001	0.0 - 5.0	1.66	25.2	0.225	16.7	17.5	0.603
	G002	0.0 - 5.0	1.63	12.8	0.383	15.2	20.1	--
	G004	5.0 - 10.0	1.48	50.5	0.223	24.3	20	0.49
G02	G003	0.0 - 5.0	1.41	5.32	--	3.28	4.3	--

-- = Not detected above MDCs.

Table F.7-2
Sample Results for Isotopes Detected above MDCs at Study Group 7

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)				
			Am-241	Pu-238	Pu-239/240	U-234	U-238
G01	G001	0.0 - 5.0	15.8	4.48 (J)	99.4	0.774	0.822
	G002	0.0 - 5.0	10.8	6.57 (J)	55.7	0.86	0.839
	G004	5.0 - 10.0	40.9	17.7 (J)	187	0.93	0.823
G02	G003	0.0 - 5.0	3.96	0.725 (J)	13.6	0.751	0.856

J = Estimated value.

Table F.7-3
Inferred Plutonium Concentrations for Study Group 7

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)		
			Pu-238	Pu-239/240	Pu-241
G01	G001	0.0 - 5.0	42.81	159.09	58.67
	G002	0.0 - 5.0	21.75	80.81	29.80
	G004	5.0 - 10.0	85.79	318.81	117.58
G02	G003	0.0 - 5.0	9.04	33.59	12.39

Appendix G

Sample Location Coordinates

G.1.0 Sample Location Coordinates

Sample location coordinates for sample plots, TLDs, judgmental samples, and background TLD locations were collected during the CAI using a GPS instrument. These coordinates identify the field sampling locations (e.g., northing, easting) of the center of the sample plots (including the TLD location), individual (judgmental) sample locations, additional TLD-only locations for specific debris items, and background TLD locations established for the features associated with CAU 569 and are listed in Table G.1-1.

Nine aliquot sample locations were established at each plot for each composite sample (4 composite samples, 36 aliquot sample locations). A systematic triangular grid pattern was based on a randomly generated origin or starting point. 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) were recorded in the project files.

Table G.1-1
Sample Location Coordinates for CAU 569
(Page 1 of 5)

Easting[a]	Northing[a]	Sample Location
Study Group 1		
586719.8	4099940.3	A01
586527.0	4099868.4	A02
586573.2	4099855.3	A03
586670.6	4099854.7	A04
586767.5	4099854.8	A05
586864.9	4099855.1	A06
586962.0	4099855.5	A07
587010.4	4099771.6	A08
586914.5	4099771.4	A09
586719.8	4099770.3	A10
586630.9	4099763.6	A11
586622.3	4099771.3	A12
586566.8	4099797.5	A13

Table G.1-1
Sample Location Coordinates for CAU 569
(Page 2 of 5)

Easting[a]	Northing[a]	Sample Location
Study Group 2		
587968.5	4100679.7	B01
587932.9	4100679.7	B02
587900.6	4100677.7	B03
587888.8	4100672.9	B04
587878.6	4100676.3	B05
587855.6	4100679.5	B06
587873.9	4100648.3	B07
587910.8	4100647.7	B08
587876.0	4100781.9	B09
587929.0	4100861.1	B10
Study Group 3		
586860.9	4100419.4	C01
586970.3	4100419.1	C02
587008.7	4100423.8	C03
587078.2	4100416.9	C04
587187.7	4100417.4	C05
587296.3	4100429.6	C06
587351.1	4100325.6	C07
587243.0	4100322.4	C08
587351.2	4100510.1	C09
587241.8	4100512.3	C10
587139.9	4100513.0	C11
587027.5	4100512.4	C12
586912.7	4100512.6	C13
587078.7	4100607.4	C14
587186.8	4100606.6	C15
587296.4	4100607.4	C16
585301.4	4101390.2	C17
587128.7	4100324.8	C18

Table G.1-1
Sample Location Coordinates for CAU 569
(Page 3 of 5)

Easting[a]	Northing[a]	Sample Location
587021.9	4100324.7	C19
587028.8	4100423.9	C20
587080.6	4100420.3	C21
Study Group 4		
586742.7	4100424.6	D01
586753.8	4100391.7	D02
585291.6	4101570.2	D03
586734.3	4100439.9	D04
586738.8	4100454.9	D05
586710.6	4100467.2	D06
Study Group 5		
586512.7	4099716.1	E01
586492.0	4099684.5	E02
586602.2	4099683.7	E03
586670.7	4099684.1	E04
586761.1	4099683.7	E05
586849.7	4099684.7	E06
586909.3	4099673.5	E07
586937.8	4099684.0	E08
587025.2	4099675.1	E09
586982.5	4099608.0	E10
586894.3	4099606.3	E11
586805.4	4099607.0	E12
586716.4	4099605.4	E13
586696.7	4099619.3	E14
586619.2	4099606.3	E15
586536.8	4099606.7	E16
586446.8	4099606.6	E17
586682.4	4099555.7	E18
586690.3	4099531.5	E19

Table G.1-1
Sample Location Coordinates for CAU 569
(Page 4 of 5)

Easting[a]	Northing[a]	Sample Location
586760.0	4099529.2	E20
586851.2	4099530.8	E21
586936.7	4099529.4	E22
586893.7	4099452.0	E23
586806.0	4099452.2	E24
586714.5	4099452.1	E25
586646.2	4099441.2	E26
586627.1	4099453.1	E27
586605.9	4099403.2	E28
586581.3	4099376.1	E29
586563.6	4099365.1	E30
586670.9	4099374.0	E31
586759.7	4099372.1	E32
586848.9	4099375.1	E33
586714.1	4099669.2	E34
586578.4	4099734.7	E35
586707.9	4099366.3	E36
586476.4	4099799.0	E37
586797.8	4099647.0	E38
586965.2	4099695.5	E39
587050.4	4099705.7	E40
Study Group 6		
584956.9	4098463.5	F01
585148.7	4098341.1	F02
587997.5	4099035.4	F03
587470.1	4098510.1	F04
586395.5	4098830.7	F05
586337.0	4098735.7	F06
586285.5	4098644.5	F07
586233.2	4098549.4	F08

Table G.1-1
Sample Location Coordinates for CAU 569
(Page 5 of 5)

Easting[a]	Northing[a]	Sample Location
586122.8	4098548.1	F09
586175.8	4098644.5	F10
586231.9	4098737.7	F11
586266.6	4098830.9	F12
586338.2	4098926.0	F13
586215.4	4098852.2	F14
586183.0	4098825.4	F15
586177.1	4098831.4	F16
586125.1	4098736.6	F17
586086.2	4098717.4	F18
586044.6	4098669.0	F19
586067.8	4098643.6	F20
586003.0	4098623.7	F21
586014.8	4098736.3	F22
586064.7	4098828.1	F23
585999.9	4098926.6	F24
586240.2	4098821.0	F25
586141.6	4098827.7	F26
586092.7	4098730.8	F27
586141.9	4099028.8	F28
586145.5	4099038.5	F29
586131.0	4099018.3	F30
586631.3	4098529.7	F31
586211.2	4098782.9	F32
586187.9	4098793.0	F33
585980.7	4098802.7	F34
Study Group 7		
587587.7	4101112.8	G01
587587.8	4101109.7	G02

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters

Appendix H

Nevada Division of Environmental Protection Summary of Changes to the CAU 569 Sampling Approach

(2 Pages)

From: Jeff MacDougall [mailto:jmacdoug@ndep.nv.gov]
Sent: Thursday, May 31, 2012 3:35 PM
To: Lantow, Tiffany (NEV)

Tiffany,

To the best of my recollection, this email accurately describes my understanding of the discussion which took place at NNSS on May 17th.

JEFF MACDOUGALL, PH.D., CPM
ENVIRONMENTAL SCIENTIST IV/OFFICE MANAGER

BUREAU OF FEDERAL FACILITIES
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
2030 E. FLAMINGO ROAD SUITE 230
LAS VEGAS, NV 89119
(702) 486-2850 EXT 233

From: Lantow, Tiffany [mailto:LantowT@nv.doe.gov]
Sent: Thursday, May 31, 2012 2:38 PM
To: Jeff MacDougall
Cc: Matthews, Patrick (N-I); Kidman, Raymond (N-I); Boehlecke, Robert
Subject: FW: Summary of changes to the CAU 569 sampling approach

Jeff,

This email documents recent discussion between NNSA and NDEP representatives during a May 17, 2012 site visit to the CAU 569 "Area 3 Yucca Flat Atmospheric Test Sites" site. The objective of this site visit was to discuss changes to the sampling approach presented in the CAU 569 CAIP due to newly-identified information affecting the conceptual site model for Study Group 1 (contamination resulting from the Coulomb-B and Catron safety experiments that is located within the Area 3 RWMS). It was agreed to update the conceptual site model (CSM) for Study Group 1 and revise the sampling approach accordingly. This email presents the newly-identified information, the current and revised CSMs for Study Group 1, and the subsequent necessary changes to the sampling approach.

During a photograph review, it was identified that the Area 3 RWMS was reworked between 1989 and 1994. Three former employees who worked at the Area 3 RWMS during those dates were interviewed with regards to actions taken that affected two areas within Study Group 1: an area inside the south border of the RWMS and an area encompassing the Coulomb-B and Catron GZs inside the center of the western boundary. It was discussed during these interviews that the surface area within the southern portion of the Area 3 RWMS was scraped to lower contamination levels to provide a staging area for trucks when they brought waste to the RWMS. This scraped surface soil and debris was deposited in an area just outside the southern boundary of the RWMS. Additionally, the area encompassing the Catron and Coulomb-B GZs was bermed and covered with a layer of soil of unknown thickness.

The current conceptual site model for Study Group 1 as stated in the CAIP includes the potential for there to be buried soil contamination inside the RWMS from unknown soil reworking operations.

Due to the newly acquired information, the following describes the revised CSM:

- For the area inside the south border of the Area 3 RWMS, the surface soil was initially contaminated from atmospheric deposition from nearby weapons and safety tests. This surface soil was removed and deposited in an area outside the southern boundary of the RWMS (currently addressed by Study Group 5).

- For the area encompassing the Coulomb-B and Catron GZs inside the center of the western boundary, the surface soil was initially contaminated from the atmospheric deposition from these safety tests. This surface contamination was not removed but was covered with clean soil and a berm of clean soil was installed around the area to prevent inadvertent intrusion. Therefore, the surface is assumed to be uncontaminated and a subsurface layer of soil is assumed to contain significant contamination.

Based on the original CSM, two surface sample plots were planned at the locations of the highest radiological readings (KIWI and PRM-470 surveys) and 10 randomly chosen locations within the southwest portion of the Area 3 RWMS were to be sampled for buried contamination.
Based on the revision to the CSM, the following changes will be made to the sampling approach.

- At the southern portion of the Areas 3 RWMS where the soil was removed, there is no longer the concern for buried soil contamination. Therefore, the surface sample plots and the 10 locations to be sampled for buried contamination are not necessary. However, surface grab samples will be collected at the 10 random grab-sample locations.

- At the Catron and Coulomb-B GZ area, due to the berm and clean soil cap being placed, no surface samples will be taken. A default contamination boundary will be established for the bermed ground zero area containing subsurface contamination.

- At the area just outside the south boundary of the RWMS, where the scraped soil from the southern portion of the Area 3 RWMS was placed, surface plot samples and grab samples to depth will be taken as currently planned for Study Group 5 in the CAIP.

Per our discussion, revision of the CAIP is not necessary. However, the changes to the sampling approach for Study Group 1 will be addressed in the deviations section of the future CAU 569 closure document. Please let me know if this email accurately documents your understanding of our discussion.
Sincerely,

Tiffany Lantow
NNSA Nevada Site Office
Environmental Management
702-295-7645

Appendix I

Nevada Division of Environmental Protection Comments

(7 Pages)

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 569: Area 3 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	3/11/2013
3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	4/10/2013
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Jeff MacDougall, NDEP, 486-2850 ext. 233	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Executive Summary, Page ES-2, 1st Bullet	Mandatory	For CASs 03-23-13, 03-23-15, and 03-23-21, Closure in Place with use restriction (whether FFACO or administrative) is the selected corrective action - this, along with any post-closure inspection requirements, should be included here and **throughout** the document when discussing these sites.	We understand from this comment that there may be some confusion about the first bullet on page ES-2 which states that "no further corrective actions are necessary" when the corrective action for 3 CASs was Closure in Place with use restriction. The statement that "no further corrective actions are necessary" was included as specific text required by the standardized FFACO outline for the CADD/CR regardless of the corrective actions actually implemented. To clarify the actual corrective actions for all CASs, a table was added that clearly lists the corrective actions that were completed during the CAI, the final FFACO corrective actions, and the rationale for those corrective action decisions (see attached table). This comment also indicates some confusion about the use of FFACO or administrative URs. Additional clarification was addressed in our response to Comment 3. Because administrative URs are voluntary protective measures that are only associated with Best Management Practices (and FFACO URs are only associated with corrective actions), only the FFACO URs are included in the added table and in the corrective action discussion. The FFACO UR post-closure inspection requirements were added as requested in the Executive Summary and in the rest of the document (some by reference to Attachment D-1). The third and fourth paragraphs on page ES-2 were edited to read: *Investigationresults were evaluated against final action levels (FALs) established in this document. A radiological dose FAL of 25 millirem per year was established based on the Occasional Use*	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
	Mandatory		*Area exposure scenario (80 hours of annual exposure). Although CAI measurements did not result in radiological doses exceeding the FAL, some areas could not be sampled and were assumed to exceed FALs and require corrective action. These corrective actions are listed in Table ES-2. This table lists the CASs where potential source material (PSM) was identified and the corrective actions that were completed during the CAI. The final FFACO corrective actions and the rationale for those corrective action decisions are also listed in Table ES-2.* *The FFACO URs are posted with warning signs and recorded as required by the FFACO. Warning signs are posted along each boundary and are annually inspected and maintained. The corrective actions meet all requirements for the technical components evaluated, and meet all applicable federal and state regulations for closure of the site. Based on the implementation of these corrective actions, the DOE, National Nuclear Security Administration Nevada Field Office provides the following recommendations:* Information was also added throughout the document (as requested) to discuss the corrective action chosen and any post-closure inspection requirements. Clarifications about corrective actions were also made to Sections 1.3, 2.0, 2.2.2.2, 2.2.2.3, 2.2.2.5, 3.0, A.3.3, A.4.3, and A.12.0. Clarifications about UR requirements were also made to Sections 2.3, 3.0, and A.12.0.	

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10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
2.) Section A.2.2.1 Radiological Surveys, Page A-7	Mandatory	In the discussion of the PRM-470 instrument, FIDLER, and KIWI survey, include a discussion that specifies the units of measure (i.e., dose in mrem/IA-yr, background concentrations, etc.) for each of the data types collected using the PRM-470 scintillator, FIDLER, and sodium iodide detector. Be certain to present these units in **all figures and tables** in the document.	We understand from this comment that the units of measure for the various radiological surveys need to be added. In Section A.2.2.1, a discussion of the units of measure was added for each type of data collected. For the PRM-470 and FIDLER surveys, a sentence was added to the end of the second paragraph which reads, "Count rates for the PRM-470 and FIDLER are expressed in units of counts per second (cps) and evaluated qualitatively as comparative relative spatial distributions in units of multiples of background." For the KIWI survey, the last sentence in the third paragraph was edited and a final sentence was added which reads, "The count rate data from the KIWI survey were post-processed in October 2011 to extract the americium (Am)-241 component (Hendricks, 2011). Count rates for the KIWI are expressed in units of counts per second (cps) and presented as net cps (with background cps levels subtracted)." It was also requested in this comment that the units are presented in all figures and tables in the document. Multiple figures present data from PRM-470 or FIDLER surveys in which the data are represented as "multiples of background." For each of these figures, the value of background in counts per second was added as a note in the figure. For the figures where KIWI data are represented as "relative response," units were added to the figures as "net cps [background subtracted]."	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
3.) Section E.2.0 Recommended Alternative, Page E-11	Mandatory	In the discussion of Use Restrictions (UR), explain clearly the difference between administrative UR and FFACO UR, and indicate why the appropriate UR was determined/implemented for the sites that are to be closed in place (CASs 03-23-13, 03-23-15, 03-23-21). This discussion should be made here and in other applicable sections within the document.	We understand from this comment that additional discussion and clarification of the difference between administrative URs and FFACO URs is needed, as well as why FFACO URs were determined/implemented for the sites which are to be closed in place. To clarify this, Section 2.3 was edited to read: *No further corrective action is needed for the CASs within CAU 569 based on the implementation of corrective actions or the absence of contamination exceeding risk-based levels (presented in Section 2.3.1). Some corrective actions were completed during the CAI by removing PSM. For every site where contamination exceeds a FAL after the CAI, an FFACO use restriction (UR) was implemented under an FFACO corrective action of closure in place. All FFACO URs are recorded in the FFACO database; the DOE, National Nuclear Security Administration (NNSA) Nevada Field Office Management and Operating (M&O) Geographic Information System (GIS); and the NNSA Nevada Field Office CAU/CAS files. These FFACO URs require warning signs and annual inspections to certify that postings are in place, intact, and readable.* *If an exposure scenario other than the Industrial Work Area scenario is used to calculate a FAL for any site, an administrative UR will be required if contamination exceeds a PAL (the PALs are based on the Industrial Work Area exposure scenario). An administrative UR will not be used to satisfy corrective action requirements but will be implemented as a best management practice (BMP) to warn potential future site workers if a change in site use*	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
	Mandatory		*could cause increased exposure to site contamination. Administrative URs are recorded and tracked identically to FFACO URs but do not require site warning signs.* *The need for further corrective action is evaluated for each study group in Sections 2.3.2 through 2.3.8.* As requested, a similar discussion was incorporated into Section E.2.0 and other applicable sections of the document. Two paragraphs were added to the end of Section A.12.0, which read: *The FFACO URs are presented in Attachment D-1 and contain the applicable boundaries, site controls, conditions of use, and maintenance requirements. The corrective actions meet all requirements for the technical components evaluated, and meet all applicable federal and state regulations for closure of the site. Based on the implementation of these corrective actions, no further corrective action is necessary for CAU 569.* *The administrative URs are presented in Attachment D-1 as voluntary protective measures and contain the applicable boundaries and conditions of use. An administrative UR will not be used to satisfy corrective action requirements but will be implemented as a BMP to warn potential future site workers if a change in site use could cause increased exposure to site contamination. Administrative URs are recorded and tracked identically to FFACO URs but do not require site warning signs.*	

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	Mandatory		A sentence was also added to the beginning of the first paragraph in Sections A.4.4, A.5.4, A.6.4, A.7.4, and A.8.4, which reads: *BMPs are voluntary protective measures and are not part of any corrective action.* Attached Table	
4.) General		Although not done in response to specific comments from NDEP, editorial changes have been addressed throughout the document which include spelling and acronym corrections. Additionally, Table A.10-1 (Waste Summary Table) was updated with the most recent waste disposal information for CAU 569. Waste disposal documentation is included in Attachment D-2.		

Table ES-2

CAU 569 Corrective Actions

CAS Number	CAS Name	Corrective Action Required?	Rationale	Corrective Action
03-23-09	T-3 Contamination Area	Yes	Removed PSM (4 batteries) - No other contamination present that exceeds FALs	No Further Action
03-23-10	T-3A Contamination Area	Yes	Removed PSM (1 battery and 1 lead brick) - No other contamination present that exceeds FALs	No Further Action
03-23-11	T-3B Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-12	T-3S Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-13	T-3T Contamination Area	Yes	Subsurface radiological contamination assumed to exceed FALs	Closure In Place with FFACO UR
03-23-14	T-3V Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-15	S-3G Contamination Area	Yes	Subsurface radiological contamination assumed to exceed FALs	Closure In Place with FFACO UR
03-23-16	S-3H Contamination Area	No	No contamination present that exceeds FALs	No Further Action
03-23-21	Pike Contamination Area	Yes	Removed PSM (1 battery) - radiological contamination remains that is assumed to exceed FALs	Closure In Place with FFACO UR

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