

Nevada
Environmental
Management
Operations Activity

DOE/NV--1529



Corrective Action Decision Document/ Closure Report for Corrective Action Unit 567: Miscellaneous Soil Sites Nevada National Security Site, Nevada

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/s/ Joseph P. Johnston 12/11/2014

Joseph P. Johnston, N-I CO

Date

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**CORRECTIVE ACTION DECISION DOCUMENT/
CLOSURE REPORT FOR
CORRECTIVE ACTION UNIT 567:
MISCELLANEOUS SOIL SITES
NEVADA NATIONAL SECURITY SITE, NEVADA**

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

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CORRECTIVE ACTION UNIT 567:
MISCELLANEOUS SOIL SITES
NEVADA NATIONAL SECURITY SITE, NEVADA**

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List of Acronyms and Abbreviations

Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of Disposal
CFR	<i>Code of Federal Regulations</i>
CLP	Contract Laboratory Program
cm	Centimeter
Cm	Curium
COC	Contaminant of concern
COPC	Contaminant of potential concern
cpm	Counts per minute
cps	Counts per second
CR	Closure report
Cr(VI)	Hexavalent chromium
Cs	Cesium
CSM	Conceptual site model
CTOS	Counter Terrorism Operation Support
CWD	Contaminated waste dump

List of Acronyms and Abbreviations (Continued)

DCB	Default contamination boundary
day/yr	Days per year
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
DU	Depleted uranium
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	<i>Federal Facility Agreement and Consent Order</i>
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
GIS	Geographic Information Systems
GPS	Global Positioning System
GZ	Ground zero
HASL	Health and Safety Laboratory
HAZMAT	Hazardous materials
hr/day	Hours per day
hr/yr	Hours per year
in.	Inch

List of Acronyms and Abbreviations (Continued)

kg/cm ³	Kilograms per cubic centimeter
kt	Kiloton
lb	Pound
LCL	Lower confidence limit
LCS	Laboratory control sample
LLW	Low-level radioactive waste
LVF	Load Verification Form
m	Meter
m ²	Square meter
m ³	Cubic 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
mV	Millivolt
N/A	Not applicable
NAC	<i>Nevada Administrative Code</i>
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology

List of Acronyms and Abbreviations (Continued)

NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NSTec	National Security Technologies, LLC
OU	Occasional Use Area
PAL	Preliminary action level
PC	Personal computer
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
ppt	Parts per thousand
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
r^2	Coefficient of determination
RBCA	Risk-based corrective action
RCRA	<i>Resource Conservation and Recovery Act</i>
RfD	Reference dose
RMA	Radioactive material area
RRMG	Residual radioactive material guideline
RSL	Regional Screening Level
RW	Remote Work Area
RWMC	Radioactive waste management complex
SCL	Sample collection log
Sr	Strontium

List of Acronyms and Abbreviations (Continued)

SVOC	Semivolatile organic compound
TBD	To be determined
Tc	Technetium
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
TRS	Terrestrial radiological survey
TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
URMA	Underground radioactive material area
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
WCL	Waste Container Log
WGS	World Geodetic System
yd ³	Cubic yard

Executive Summary

This Corrective Action Decision Document/Closure Report presents information supporting the closure of Corrective Action Unit (CAU) 567: Miscellaneous Soil 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 567 comprises the five corrective action sites (CASs) listed in [Table ES-1](#).

Table ES-1
CAU 567 CASs and Corrective Actions

CAS Number	CAS Description	Corrective Action
01-23-03	Atmospheric Test Site T-1	Closure in place
03-23-25	Seaweed E Contamination Area	No Further Action
05-23-07	A5b RMA	No Further Action
20-23-08	Colby Mud Spill	No Further Action
25-23-23	J-11 Soil RMA	No Further Action

RMA = Radioactive material 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 567 based on the implementation of the corrective actions listed in [Table ES-1](#).

Corrective action investigation (CAI) activities were performed from September 2012 through September 2014, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 567: Miscellaneous Soil 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 types of releases present. The reporting of investigation results and the evaluation of DQO decisions are at the release level. The corrective action alternatives (CAAs) were evaluated and corrective actions applied at the FFACO CAS level.

The purpose of the CAI was to fulfill data needs as defined during the DQO process. The CAU 567 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 used at all CAU 567 sites. Atmospheric Test Site T-1 is currently used as a training facility with personnel present approximately 24 days per year; therefore, the radiological FAL was established based on the Remote Work Area exposure scenario (336 hours of annual exposure). For the remaining sites where regular activities are not conducted, the radiological FAL was established based on the Occasional Use exposure scenario (80 hours of annual exposure). Soil that exceeded the radiological FAL was removed from J-11 Soil RMA as an interim corrective action during the investigation. Soil remaining at that site is below the preliminary action level (PAL). Locations that exceed the radiological FAL are present at Atmospheric Test Site T-1. Additionally, a default contamination boundary is present at Atmospheric Test Site T-1 where it is assumed buried contamination exceeds the FAL. Potential source material was removed from Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill during the CAI under a corrective action.

During the CAI, a best management practice was conducted at A5b RMA. Soil from an area where the radiological dose exceeded the PAL was removed. After the soil was removed, radiological dose was below the PAL.

The corrective actions implemented at CAU 567 were developed based on an evaluation of analytical data from the CAI, the assumed presence of COCs at specific locations, and the detailed and comparative analysis of the CAAs. The CAAs were selected on technical merit focusing on performance, reliability, feasibility, safety, and cost. The implemented corrective actions meet all requirements for the technical components evaluated. The CAAs 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 567.
- The Nevada Division of Environmental Protection issue a Notice of Completion to the DOE, National Nuclear Security Administration Nevada Field Office for closure of CAU 567.
- CAU 567 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) 567, Miscellaneous Soil Sites, located at the Nevada National Security Site (NNSS), Nevada. CAU 567 comprises the five corrective action sites (CASSs) shown on [Figure 1-1](#) and listed below:

- 01-23-03, Atmospheric Test Site T-1
- 03-23-25, Seaweed E Contamination Area
- 05-23-07, A5b RMA
- 20-23-08, Colby Mud Spill
- 25-23-23, J-11 Soil RMA

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan (CAIP) for Corrective Action Unit 567: Miscellaneous Soil Sites, Nevada National Security Site, Nevada* (NNSA/NFO, 2013).

The CASSs associated with each release are described in [Table 1-1](#). The need for corrective action and the corrective action alternatives (CAAs) are evaluated separately for each release.

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.

1.1 Purpose

The purpose of this CADD/CR is to provide documentation and justification that no further corrective action is needed for the closure of CAU 567 based on the implementation of corrective actions. This includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The CAIP provides information relating to the scope and planning of the investigation. Therefore, that information will not be repeated in this document.

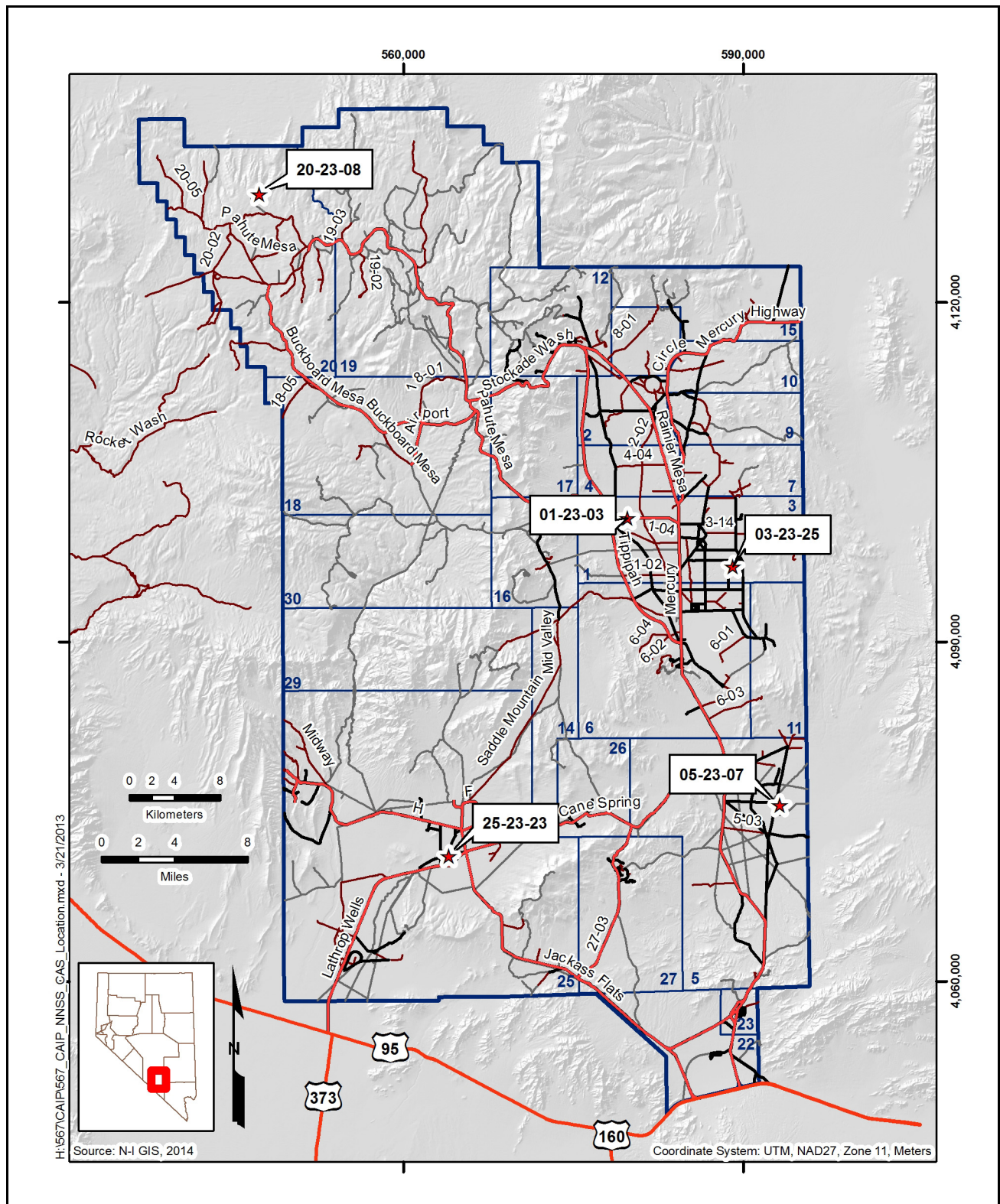


Figure 1-1
CAU 567 CAS Location Map

Table 1-1
CAU 567 Releases with Associated CASs
(Page 1 of 2)

CAS Name	CAS Number	Area	Release
Atmospheric Test Site T-1	01-23-03	1	Atmospheric Release: Surface release of radionuclides from four atmospheric tests conducted in the 1950s. Includes deposition of radionuclides from weapons testing (fission and activation products) onto the soil surface as well as undisturbed surface deposition that was later covered with asphalt. A DCB is established at the bunker area located at GZ, where contamination has been covered with clean fill.
			CWDs: Surface and subsurface release of radionuclides from the consolidation of contaminated materials after nuclear testing.
			Drainages: Migration of radionuclides released during nuclear testing in drainages.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes a broken lead-acid battery, a bucket of lead-contaminated grease, and two areas where asphalt and debris were dumped in drainages.
Seaweed E Contamination Area	03-23-25	3	Atmospheric Release: Surface release of radionuclides (xenon gas) from the underground safety experiments Seaweed C, Seaweed D, and Seaweed E conducted October 1, 1969, during Operation Mandrel (DOE/NV, 2000; Schoengold et al., 1996). Any contamination remaining at the site would be adjacent to the emplacement hole.
A5b RMA	05-23-07	5	Soil Contamination and PSM: Surface release point consistent with a non-nuclear detonation site resulting in a crater and dispersion of fragments, with vaporization of DU in a small crater and ejection of DU and metal fragments to the surface in a regular pattern surrounding the crater.
			Landfills: Subsurface release from DU and other metallic debris consolidated in landfills.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes two pieces of lead.

Table 1-1
CAU 567 Releases with Associated CASs
(Page 2 of 2)

CAS Name	CAS Number	Area	Release
Colby Mud Spill	20-23-08	20	Drainage: Surface release and migration of radionuclides in drilling mud spilled on May 16, 1976, from the post-test hole for the Colby test (Straume et al., 1977).
			URMA: Subsurface release of radionuclides in drilling mud that was buried after cleanup efforts for the mud spill.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes a lead-acid battery.
J-11 Soil RMA	25-23-23	25	Spill: Source is unknown but believed to be a surface release of radionuclides from a spill of liquid.

CWD = Contaminated waste dump
DCB = Default contamination boundary
DU = Depleted uranium
GZ = Ground zero

PSM = Potential source material
RMA = Radioactive material area
URMA = Underground radioactive material area

1.2 Scope

The corrective action investigation (CAI) for CAU 567 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs) at each CAS. 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 presence of a COC requires a corrective action. A corrective action is also required if a waste present within a release site contains a contaminant that, if released to the soil, would cause the soil to contain a COC. Such a waste is considered to be PSM as defined in the Soils Risk-Based Corrective Action (RBCA) document (NNSA/NFO, 2014).

The activities used to identify, evaluate, and recommend preferred CAAs for CAU 567 included the following:

- Performed visual surveys to identify biasing factors for selecting soil and PSM sample locations.

- Performed radiological surveys to identify biasing factors for selecting soil and PSM sample locations.
- Conducted geophysical surveys.
- Established sample plot and biased sample locations.
- Collected soil samples at sample plot and biased sampling locations.
- Submitted soil samples for analysis.
- Placed TLDs at soil sample and background locations.
- Collected and submitted TLDs for analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest.
- Performed interim corrective actions (i.e., PSM removal).
- Performed best management practices (BMP) (i.e., soil removal)
- Conducted waste management activities (e.g., sampling, disposal).
- Evaluated corrective action objectives based on the results of the CAI and the CAA screening criteria.
- Implemented and justified preferred CAAs.

The CAI activities were completed in accordance with the CAIP (NNSA/NFO, 2013) except as noted in [Appendix A](#) and in accordance with the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012), 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/NFO, 2014).

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 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 567 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 567.
- [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](#), *Sample Location Coordinates*, presents the CAI sample location coordinates.
- [Appendix G](#), *Technical Memorandum: Conduct of Geophysical Surveys at the Nevada National Security Site Corrective Action Unit 567*, contains descriptions and results of geophysical surveys conducted at three CASs in CAU 567.
- [Appendix H](#), *Nevada Division of Environmental Protection (NDEP) Comments*, contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

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

- CAIP for CAU 567, Miscellaneous Soil Sites (NNSA/NFO, 2013)
- Soils QAP (NNSA/NSO, 2012)
- Soils RBCA document (NNSA/NFO, 2014)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP (NNSA/NFO, 2013) 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 567 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 and investigation results, and justify why no further corrective action is required at CAU 567. Detailed investigation activities and results for individual CAU 567 CASs are presented in [Appendix A](#) of this document.

2.1 Investigation Activities

CAI activities were conducted from September 2012 through September 2014. The purpose of the CAI was to provide the additional information needed to resolve the following CAU 567-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 567.
- Determine the extent of identified COCs.
- Ensure that adequate data have been collected to evaluate closure alternatives under the FFACO.

The field investigation was completed as specified in the CAIP as described in [Sections A.2.1](#) through [A.2.4](#), which provide the general investigation and evaluation methodologies.

Data to calculate radiological dose were provided by the analytical results of TLD samples for external radiological dose and soil samples for the calculation of internal radiological dose. Data to evaluate chemical risk were provided by analytical results of soil samples.

The DQO Decision I (the presence of a COC) was resolved for the locations containing PSM. DQO Decision II (the extent of COC contamination) was resolved for the PSM locations by collecting soil samples adjacent to the PSM.

For DQO Decision I at other potential release sites, sample locations were established judgmentally based on the presence of biasing factors (e.g., highest radiation survey values). Using the contamination levels from the judgmental locations of highest potential contamination provides a conservative estimate of the contaminant exposure a receptor would receive from working at the release site. Where samples were collected in sample plots, an additional level of conservatism was

added by evaluating the judgmental sample results probabilistically using the 95 percent upper confidence limit (UCL) of the average sample result to resolve DQO Decision I.

Sample locations for DQO Decision II (the extent of COC contamination) for radiological COCs were selected judgmentally at locations estimated to provide a range of dose values from the highest dose to a level below the FAL. The extent of radiological COC contamination was defined as a boundary that encompasses radiation survey isopleths with a value that corresponds to a total effective dose (TED) of 25 mrem/yr. To accomplish this, the relationship between TED (the sum of internal and external dose) and radiation survey values is estimated from a simple linear regression of paired calculated TED and radiation survey values for each sample location. Then the radiation survey value that corresponds to 25 mrem/yr is calculated from the regression equation. Confidence in estimating the extent of Decision II was provided by a more conservative estimate of the radiation survey value corresponding to 25 mrem/yr. This is accomplished using the uncertainty of how well the calculated relationship between TED and radiation survey values (i.e., the regression) represents the assumed true relationship. This uncertainty includes the uncertainty of how well the calculated TED represents true TED and the uncertainty of how well the radiation survey instrument readings represent the calculated TED. This combined uncertainty was estimated using an uncertainty interval as defined in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance* (EPA, 2009). This process for using regression uncertainty in establishing a conservative estimate of the extent of COC contamination is presented in the Soils RBCA document (NNSA/NFO, 2014).

Sample locations for DQO Decision II (the extent of COC contamination) for chemical COCs were selected judgmentally at locations surrounding the estimated extent of COC contamination.

The calculated TED 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, 2014) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

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 that address the potential exposure of industrial workers to contaminants in soil:

- **Industrial Area.** Assumes continuous industrial use of a site. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (8 hours per day [hr/day], 250 days per year [day/yr] for 25 years). The industrial worker is assumed to spend one third of the workday outdoors exposed to contaminated soil. The TED values calculated using this exposure scenario are the TED an industrial area 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 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 hours per year (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 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).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012), the dataset quality 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 FALs are based on the Remote Work Area exposure scenario for Atmospheric Test Site T-1, and the Occasional Use Area exposure scenario for Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA. Chemical FALs are based on the Industrial Area exposure scenario for all CASs.

An assumption was made that corrective action is required within the DCB established at the inaccessible bunker area at the Atmospheric Test Site T-1 GZ.

The following subsections describe specific investigation activities conducted at each CAS. Additional information regarding the investigation is presented in [Appendix A](#).

2.1.1 Atmospheric Test Site T-1

Investigation activities at Atmospheric Test Site T-1 included performing visual inspections, conducting GPS-assisted terrestrial radiological surveys (TRSs), staging TLDs, performing geophysical surveys, and collecting surface and subsurface soil samples. See [Section A.3.1](#) for additional information on investigation activities at Atmospheric Test Site T-1. Results of the sampling effort are reported in [Section 2.2](#).

TLDs were placed at each sample and screening location established for the atmospheric release, CWDs, drainages, and at each of two locations where debris was dumped in drainages. TLDs were placed in a grid pattern covering the site in addition to the TLD locations that correspond with soil screening and sampling. All TLD locations are shown on [Figure A.3-3](#).

TRSs were performed, and soil screening and sampling was conducted to investigate the atmospheric release. TRSs were conducted over the area surrounding the test GZ outside the DCB. The results of the TRS showed that the highest gamma radiation readings corresponded to locations near the test GZ and confirmed that the fallout plume was positioned as expected based on the aerial survey. One 100-square-meter (m²) sample plot with a TLD was established at each of the two areas outside the DCB with the highest readings detected during the TRSs, as shown on [Figure A.3-2](#). These two sample plots and 12 additional locations laid out in three radials extending from GZ were screened for subsurface contamination. Of the subsurface locations screened, potential for buried contamination was identified at one location (A06), resulting in the collection of a surface and subsurface sample at that location. All screening and sample locations are shown on [Figure A.3-4](#).

TRSs, visual, and geophysical surveys were conducted at the three CWDs identified in historical documents. The TRSs identified elevated readings associated with CWD #2. There was no indication of subsurface debris at any location. Two samples were collected at each of the three CWDs: one from the area of highest radiological reading within each CWD, and one based on visual observation of disturbance.

Visual surveys identified sediment areas in the drainage downgradient from the test release.

Subsurface screening was performed at these two sediment areas, and one sample was collected at each location (A17 and A18); locations are shown on [Figure A.3-4](#).

Two piles of waste consisting of asphalt and small pieces of debris, dumped in drainages to the north and west (i.e., upgradient) of the GZ, were discovered as a result of unexpected radiologically elevated areas in the TRS survey area. Visual and geophysical surveys were conducted at the two drainage dumps. There was no indication of subsurface debris at either location. One surface grab sample was collected from the area of highest radioactivity in each area (locations A99 and A118). These locations are shown on [Figure A.3-4](#).

During the visual inspections, one lead-acid battery and one can containing lead-contaminated grease were identified as PSM and were removed as a corrective action. Because the grease was contained in the bucket, sampling of the adjacent soil was not required. Two composite surface grab samples were collected from the soil beneath the lead-acid battery (location A136). This sample consisted of nine aliquots in a 2-by-2-meter (m) grid encompassing the area of the battery. This location is shown on [Figure A.3-4](#).

The CSM and associated discussion for this CAS are provided in the CAIP (NNSA/NFO, 2013). The contamination pattern of the radionuclides at Atmospheric Test Site T-1 is consistent with the CSM in that the radiological contamination is greatest at the release point (GZ, CWDs, and debris dumped in drainages) 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.

2.1.2 Seaweed E Contamination Area

Investigation activities at Seaweed E Contamination Area included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, and collecting surface soil samples. See [Section A.4.1](#) for additional information on investigation activities at Seaweed E Contamination Area. Results of the sampling effort are reported in [Section 2.2](#).

During the visual inspections, no biasing factors were identified. The TRSs were conducted over the areas surrounding the three emplacement holes. The results of the TRS showed that elevated radiological conditions are not present at the site. Because TRSs showed no elevated readings, TLD and sample locations were biased to the location closest to the release, the emplacement hole of each test (B01, B02, and B03). One TLD was placed adjacent to each emplacement hole, and one grab sample was collected from this location. These locations are shown on [Figure A.4-1](#).

The CSM and associated discussion for this CAS are provided in the CAIP (NNSA/NFO, 2013). The lack of radionuclides at Seaweed E Contamination Area is consistent with the CSM in that the release consisted of short-lived radioactive gasses. 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 A5b RMA

Investigation activities at A5b RMA included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, performing geophysical surveys, removing contaminated soil as a BMP, and collecting surface and subsurface soil samples. See [Section A.5.1](#) for additional information on investigation activities at A5b RMA. Results of the sampling effort are reported in [Section 2.2](#).

TRSs were conducted over the area within and surrounding the detonation crater and showed that the highest gamma radiation readings corresponded to the detonation crater. A 10-by-10-m grid of TLDs was placed centered on the crater, and three surface grab samples and two subsurface samples were collected from the crater area (location C01). It was determined that the crater area was above the preliminary action level (PAL) for radiological dose, and 15.9 cubic yards (yd³) of contaminated soil was removed from the crater area as a BMP. Although soil contamination levels did not exceed the FAL, confirmation sampling was conducted after the BMP removal of contaminated soil. TRSs were conducted; one surface grab confirmation sample was collected; and a 10-by-10-m grid of TLDs was placed after the soil was removed to confirm the area was below the PAL. Sample locations are shown on [Figure A.5-3](#).

Field surveys using radiation detection equipment were conducted to locate pieces of DU fragments outside the detonation crater and determine extent of these across the site. As pieces were identified,

they were removed as a BMP. It was determined that the fragments were concentrated within the crater at the center of the site and decreased with distance from the crater. Two surface grab confirmation samples were collected from locations (C02 and C03) where DU pieces were removed outside the crater area. Sample locations are shown on [Figure A.5-3](#).

The locations of two potential landfills were identified based on surface disturbance observed during visual inspections. Geophysical surveys were conducted at the two potential landfills; there was no indication of subsurface debris at these locations.

During the visual inspections, two pieces of lead were identified as PSM and were removed as a corrective action. One composite grab sample was collected from the soil beneath the lead pieces. This sample consisted of nine aliquots in a 6-by-6-m grid encompassing the area of both pieces (location C04). Sample locations are shown on [Figure A.5-3](#).

The CSM and associated discussion for this CAS are provided in the CAIP (NNSA/NFO, 2013). The presence of DU fragments in and around the detonation crater at the A5b RMA is consistent with the CSM in that the radiological contamination and presence of fragments is greatest at the release point (crater) 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.

2.1.4 Colby Mud Spill

Investigation activities at Colby Mud Spill included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, performing geophysical surveys, and collecting surface and subsurface soil samples. See [Section A.6.1](#) for additional information on investigation activities at Colby Mud Spill. Results of the sampling effort are reported in [Section 2.2](#).

The TRSs were conducted over the area of the drainage, beginning at the post-test hole where the spill originated and continuing north approximately one-half mile to a dam that was constructed to block the flow of mud. The results of the TRS showed that radioactivity was slightly elevated above background; however, it was determined based on visual surveys and process knowledge that this was the result of changes in geology (i.e., potential mineral content and radiation detection instrument

geometry effects from the exposed sheer rock faces). Three sample locations (D01, D02, and D03) were selected within sediment areas: one at the base of each of two dams identified through historical documents and confirmed during visual surveys, and one at a flat sediment area in the center of the drainage identified during visual surveys. Subsurface screening was performed at these three sediment areas; subsurface contamination was not identified, and one surface sample was collected from each of these locations. TLDs were placed at all three drainage locations. Sample locations are shown on [Figure A.6-2](#).

Visual surveys were used to identify the location of the URMA, which identified the area of cap composed of clean fill. Geophysical surveys and TRSs were conducted at the URMA; there was no indication of subsurface debris or elevated radiological readings. The presence of mud in each sample location confirmed the URMA was correctly identified. Two locations (D08 and D09) were identified in the URMA where mud was disposed of for subsurface screening, and five subsurface grab samples were collected, two from each location and a field duplicate (FD). Sample locations are shown on [Figure A.6-2](#).

During the visual inspections, one lead-acid battery was identified as PSM and was removed as a corrective action. Because PSM was contained within battery samples were not required at that location. One 10-gallon (gal) container of motor oil, two paint cans, and a 5-by-4-foot (ft) pile of hydrocarbon-impacted filter were identified as waste and were removed during the investigation. One composite grab sample was collected from areas where staining was present in the soil beneath the filter pile (location D07) to confirm hazardous constituents had not been released to the soil. Sample locations are shown on [Figure A.6-2](#).

The CSM and associated discussion for this CAS are provided in the CAIP (NNSA/NFO, 2013). The lack of elevated radiological readings at Colby Mud Spill is consistent with historical documents that indicate the radionuclides in the spilled drilling mud were short-lived and that an extensive cleanup was conducted (Straume et al., 1977). Evidence of cleanup activities in the drainage and the presence of drilling mud in the URMA is consistent with the CSM. 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 J-11 Soil RMA

Investigation activities at J-11 Soil RMA included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, removing contaminated soil as a corrective action, and collecting surface and subsurface soil samples. See [Section A.7.1](#) for additional information on investigation activities at J-11 Soil RMA. Results of the sampling effort are reported in [Section 2.2](#).

TRSs were conducted within the RMA surrounding area. The results of the TRS showed that the highest gamma radiation readings were limited to one elevated location at the center of the RMA. A TLD was placed at the highest area of radioactivity (location E02), and five surface samples and three subsurface samples were collected to determine the extent of contamination in the soil. It was determined that the RMA was above the FAL for radiological dose, and 30.9 yd³ of contaminated soil was removed from this area. After the soil was removed, confirmation sampling was conducted and a 10-by-10-m grid of TLDs was placed to confirm the area was below the PAL. Sample locations are shown on [Figure A.7-4](#).

The CSM and associated discussion for this CAS are provided in the CAIP (NNSA/NFO, 2013). The contamination pattern of the radionuclides at J-11 Soil RMA is consistent with the CSM in that the radiological contamination is greatest at the release point and is also found at subsurface intervals. 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 567. [Section 2.2.2](#) summarizes the assessment made in [Appendix B](#), which demonstrates that the investigation results satisfy the DQO data requirements.

The 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 567 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/NFO, 2013) 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 8 hr/day for 250 day/yr). For all CAU 567 potential

release sites, except the Atmospheric Test Site T-1, the FAL for radiological dose was based on 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 8 hr/day for 10 day/yr). For the Atmospheric Test Site T-1, the FAL for radiological dose was established based on an annual exposure time of 336 hours (i.e., the Remote Work Area exposure scenario defines that a site worker would be exposed to site contamination 8 hr/day for 42 day/yr). To be comparable to these action levels, the CAU 567 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 (RSLs) for chemical contaminants in industrial soils (EPA, 2014) except where natural background concentrations of *Resource Conservation and Recovery Act* (RCRA) metal exceed the screening level (e.g., arsenic on the NNSS). With the exception of hexavalent chromium (Cr[VI]), the chemical FALs were established in [Appendix C](#) at the PAL concentrations.

2.2.1 Summary of Analytical Data

The following subsections present a summary of the analytical and computational results for soil and TLD samples at all CASs. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2013). Results that are equal to or greater than the FAL are identified by bold text in the data tables in [Appendix A](#).

Chemical results are reported as individual analytical results compared to their individual FALs. PSM samples are evaluated against the PSM criteria and assumptions defined in [Section A.2.4](#) to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. Radiological results are reported as doses that are comparable to the dose-based FALs of 25-mrem/OU-yr or 25-mrem/RW-yr 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.3.3.3, A.4.3.3, A.5.3.3, A.6.3.3, and A.7.3.3](#).

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.

2.2.1.1 Atmospheric Test Site T-1

Based on the results of TLD and soil samples collected at Atmospheric Test Site T-1, radiological contamination exceeds the FAL for the radiological dose (25 mrem/RW-yr) at locations A01, A02, A03, A06, and A08, which are located south of GZ. It was assumed that buried contamination at levels above the FAL could be present at the bunker area at test GZ, so a DCB was established for the area of the bunker. Sample locations are shown on [Figure A.3-4](#); the DCB and sample locations determined to exceed the FAL are shown on [Figure A.3-5](#). These areas require corrective action. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations are presented in [Table A.3-9](#). Sample locations within drainages, at the CWDs, in the drainage dumps, and at PSM locations were below the radiological and chemical FALs.

A broken lead-acid battery and bucket of lead-contaminated grease were identified as PSM and required corrective action. They were removed from the site, and samples collected from the soil adjacent to the battery did not exceed the FAL. The grease was contained within the bucket, so sampling was not required for that item. Therefore, no further action for chemical contaminants is required. The sample location (A136) associated with the broken lead-acid battery is shown on [Figure A.3-4](#), and the analytical results of soil samples collected after corrective action are presented in [Table A.3-10](#).

2.2.1.2 Seaweed E Contamination Area

Based on the results of TLD and surface soil samples collected at Seaweed E Contamination Area, radiological contamination is not present above the FAL of 25 mrem/OU-yr. Therefore, a corrective action is not required for this CAS. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations are presented in [Table A.4-5](#).

2.2.1.3 A5b RMA

Based on the results of TLDs, surface, and subsurface soil samples collected at A5b RMA, radiological contamination is not present above the FAL of 25 mrem/OU-yr. Therefore, a corrective action is not required for radiological contamination. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations are presented in [Table A.5-5](#).

Although contamination levels were below the FAL, results of TLD, surface, and subsurface soil samples showed radiological contamination was present above the PAL of 25 mrem/IA-yr at the crater where DU fragments were concentrated. As a BMP, DU fragments and 15.9 yd³ of soil were removed from the crater and surrounding area. After excavation, the TED was below the PAL of 25 mrem/IA-yr. Sample locations (C01, C02, and C03) are shown on [Figure A.5-3](#), and the results of TLD and soil samples collected before and after implementation of the BMP are presented in [Table A.5-5](#).

Two pieces of lead were identified as PSM and required corrective action. They were removed, and samples collected from the adjacent soil did not exceed the FAL. Therefore, no further action for chemical contaminants is required. The sample location (C04) is shown on [Figure A.5-3](#), and the analytical results of soil samples collected after corrective action are presented in [Table A.5-6](#).

2.2.1.4 Colby Mud Spill

Based on the results of TLD and surface and subsurface soil samples collected in the drainage URMA at Colby Mud Spill, radiological contamination is not present above the FAL of 25 mrem/OU-yr. Therefore, a corrective action is not required for radiological contamination. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations are presented in [Table A.6-6](#).

A lead-acid battery was identified as PSM and required corrective action. The battery was removed from the site. Because COCs associated with the battery were within the intact container and had not impacted soil, samples were not collected from adjacent soil. A filter pile was removed from the site, and one sample was taken from soil beneath the pile to ensure hazardous constituents had not been released to soil. Soil sample results did not exceed the FAL. Therefore, no further action for chemical

contaminants is required. The sample location (D07) is shown on [Figure A.6-2](#), and analytical results of soil samples collected after corrective action are presented in [Table A.6-7](#).

2.2.1.5 J-11 Soil RMA

Results of TLD, surface, and subsurface soil samples showed radiological contamination was present above the FAL of 25 mrem/RW-yr at the location of highest radioactivity. As an interim corrective action, 30.9 yd³ of radioactive soil was removed from the site during the investigation. After excavation, the TED within this area was below the PAL of 25 mrem/IA-yr.

Based on the results of TLD, surface, and subsurface soil samples collected after soil removal at J-11 Soil RMA, radiological contamination is not present above the FAL of 25 mrem/OU-yr. Therefore, additional 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 for all sample locations are presented in [Table A.7-5](#).

Sample locations (E01, E02, E06, and E07) are shown on [Figure A.7-4](#), and the results of TLD and soil samples collected before and after implementation of the corrective action are presented in [Table A.7-5](#).

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 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 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 in [Appendix B](#) show that all DQI criteria were met and that the CAU 567 dataset supports their intended use in the decision-making process. Based on the results of the DQA, the nature and extent of COCs at CAU 567 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.

2.3 Justification for No Further Action

No further corrective action is needed for the CASS within CAU 567 based on the absence of contamination exceeding risk-based levels (presented in [Section 2.3.1](#)) or the implementation of the corrective actions based on an evaluation of risk, feasibility, and cost-effectiveness (presented in [Appendix E](#)). The need for corrective action is evaluated for each release through the resolution of the DQO decisions as presented in [Section 2.3.2](#). The implementation of corrective actions at CAU 567 ensures protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2014a).

2.3.1 Final Action Levels

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2014c) 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 for all detected contaminants 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). 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.

Radiological dose at Atmospheric Test Site T-1 and Cr(VI) at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill exceeded Tier 1 action levels. The FALs for radiological contaminants and Cr(VI) were passed on to a Tier 2 evaluation. The FALs for all other chemical contaminants were established at the Tier 1 level.

The Tier 2 evaluation was conducted in accordance with the Soils RBCA document (NNSA/NFO, 2014). This evaluation (presented in [Appendix C](#)) was based on risk to receptors. The risk to receptors from contaminants at CAU 567 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 567 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).

For Atmospheric Test Site T-1, it was determined in the CAU 567 DQOs that the Remote Work Area exposure scenario is appropriate in calculating receptor exposure time. In order to quantify the maximum number of hours a site worker may be present at CAU 567, current and anticipated future site activities were evaluated in [Appendix C](#). This evaluation concluded that the most exposed worker under current land usage is a Counter Terrorism Operation Support (CTOS) program worker, who would be present at the site for radiological emergency response training about 240 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 Remote Work exposure scenario (336 hr/yr). Therefore, the TEDs at each location were calculated using a more conservative exposure time of 336 hr/yr, and the 95 percent UCL of the remote work area 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](#).

For the remaining CAU 567 sites (Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA), it was determined that the Occasional Use Area exposure scenario is appropriate in calculating receptor exposure time. The evaluation in [Appendix C](#) concluded that the most exposed

worker under current land usage is a military trainee, 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 TEDs at each location were calculated using a more conservative exposure time of 80 hr/yr, and 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](#).

For Cr(VI) at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill, the Industrial Area scenario was used to develop the Tier II level. The use of this scenario provides a more conservative (longer) exposure to site contaminants than the most exposed worker (based on current and projected future land use).

The FALs for all CAU 567 contaminants of potential concern (COPCs) are shown in [Table 2-1](#).

Table 2-1
Definition of FALs for CAU 567 COPCs

COPCs	Tier 1 Based FALs	Tier 2 Based FALs	Tier 3 Based FALs
VOCs	EPA Region 9 RSLs	None	N/A
SVOCs	EPA Region 9 RSLs	None	N/A
PCBs	EPA Region 9 RSLs	None	N/A
RCRA Metals	EPA Region 9 RSLs	None	N/A
Cr(VI)	None	Industrial Area Scenario for Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill	N/A
Radionuclides	None	25 mrem/RW-yr for Atmospheric Test Site T-1	N/A
		25 mrem/OU-yr for Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA	

N/A = Not applicable
PCB = Polychlorinated biphenyl

SVOC = Semivolatile organic compound
VOC = Volatile organic compound

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption is made that any physical waste

containment will fail at some point, and the contaminants will be released to the surrounding media. The criteria to be used for determining whether a waste is PSM is defined in the Soils RBCA document (NNSA/NFO, 2014).

2.3.2 Resolution of DQO Decisions

The following subsections compare the results presented in [Section 2.2](#) to the FALs presented in [Section 2.3.1](#) for the resolution of DQO decisions and the need for corrective action.

2.3.2.1 Atmospheric Test Site T-1 Resolution of DQO Decisions

Based on analytical results for TLD and soil samples collected during the investigation of Atmospheric Test Site T-1, radiological dose exceeded the FAL at sample locations A01, A02, A03, A06, and A08. Additionally, it was assumed that buried contamination at levels above the FAL is present at the bunker at test GZ, so a DCB was established at that location. Therefore, corrective action is required for radiological dose at Atmospheric Test Site T-1.

Decision II was resolved by correlating the PRM-470 walkover surveys with the Remote Work Area TED as described in [Section A.2.5](#). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/RW-yr FAL is 9.77 multiples of background. An FFACO use restriction (UR) was established encompassing this isopleth and the DCB.

PSM was present in the form of a bucket of lead-contaminated grease and a broken lead-acid battery. The PSM was assumed to contain COCs; therefore, the resolution of Decision I is that corrective action is required. The items were removed from the site as part of an interim corrective action, and a soil sample was collected to evaluate Decision I for soil at the location of the broken battery. Because the PSM items were removed and no COCs were detected in the soil, the final resolution of Decision I is that no corrective action is needed, and Decision II does not need to be resolved.

2.3.2.2 Seaweed E Contamination Area Resolution of DQO Decisions

Based on analytical results for TLD and soil samples collected at Seaweed E Contamination Area, no COCs were identified. Therefore, the resolution of Decision I is that no corrective action is needed, and Decision II does not need to be resolved.

2.3.2.3 A5b RMA Resolution of DQO Decisions

Based on geophysical surveys and analytical results for TLD and soil samples collected at A5b RMA, no COCs were identified resulting from the release that occurred at the detonation crater.

PSM in the form of two lead pieces was identified at A5b RMA. For PSM, the resolution of Decision I is that corrective action is required. The lead was removed from the site as part of an interim corrective action. Because the PSM items were removed and no COCs were detected in soil, the final resolution of Decision I for A5b RMA is that no corrective action is needed, and Decision II does not need to be resolved.

2.3.2.4 Colby Mud Spill Resolution of DQO Decisions

Based on geophysical surveys and analytical results for TLD and soil samples collected at Colby Mud Spill, no COCs were identified resulting from the drainage and URMA releases.

PSM in the form of a lead-acid battery was identified. For PSM, the resolution of Decision I is that corrective action is required. The battery was removed from the site as part of an interim corrective action. The final resolution of Decision I for Colby Mud Spill is that no corrective action is needed, and Decision II does not need to be resolved.

2.3.2.5 J-11 Soil RMA Resolution of DQO Decisions

Soil from an area exceeding the FAL was removed during the investigation. No COCs were detected in soil after removal. Therefore, the final resolution of Decision I is that no corrective action is needed, and Decision II does not need to be resolved.

3.0 Recommendation

Corrective actions for each CAS were based on an evaluation of analytical data from the CAI, the assumed presence of COCs at select locations, a review of current and future operations at CAU 567, the risk assessment presented in [Appendix C](#), and the detailed and comparative analysis of the CAAs presented in [Appendix E](#).

An interim corrective action was completed by removing the PSM from Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill during the investigation. Confirmation samples from the remaining soil showed that no further corrective action is needed at these locations.

An interim corrective action was performed at J-11 Soil RMA, where 30.9 yd³ of soil was removed from an area where dose exceeded the FAL of 25 mrem/OU-yr. After the soil was removed, confirmation sampling showed levels were below the PAL. After the excavation at J-11 Soil RMA, radiological dose does not exceed the FAL of 25 mrem/OU-yr at Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA. Therefore, no further action is required at those CASs.

Radiological dose at Atmospheric Test Site T-1 exceeds the FAL of 25 mrem/RW-yr. It is also assumed that buried contamination at the bunker located at test GZ exceeds FALs. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in [Appendix E](#)) is closure in place with an FFACO UR. The FFACO UR was established to encompass the TRS isopleth corresponding to a dose of 25 mrem/RW-yr (see [Section A.3.4](#)) and the DCB as shown on [Figure A.3-6](#).

The FFACO URs implemented at this site will protect site workers from inadvertent exposure. The FFACO UR is defined and shown in [Attachment D-1](#). This FFACO UR requires annual inspections to certify that postings are in place, intact, and readable.

No further corrective action is required at CAU 567 based upon implementation of corrective actions at the CAU 567 CASs. The corrective actions for CAU 567 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 valid, additional evaluation may be necessary.

In accordance with the Soils RBCA document (NNSA/NFO, 2014) and Section 3.3 of the CAIP (NNSA/NFO, 2013), 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. This administrative UR (implemented as a BMP) is not part of any FFACO corrective action. Based on a correlation of the PRM-470 TRS to IA TED values as described in [Section A.2.5](#), the isopleth that encompasses the area with TED exceeding the PAL is 2.34 multiples of background. The TRS 2.34 multiples of background isopleth as shown on [Figure A.3-7](#). The administrative UR is presented in [Attachment D-1](#).

As a BMP, 15.9 yd³ of soil was removed from a location that exceeded the PAL at A5b RMA. After excavation, all levels were below the PAL based on confirmation sampling, so an administrative UR will not be implemented at the site.

All URs are recorded in the FFACO database; the Management and Operating (M&O) Contractor Geographic Information Systems (GIS); and the DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) CAU/CAS files. The development of URs for CAU 567 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 approval from NDEP.

The NNSA/NFO 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).

4.0 References

ASTM, see ASTM International.

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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 567. CAU 567 consists of the releases associated with the CASs listed in [Table A.1-1](#) located in Areas 1, 3, 5, 20, and 25 of the NNSS ([Figure A.1-1](#)). Multiple release sources are present at each CAS, and are summarized in [Table A.1-1](#). Although the need for corrective action is evaluated separately for each release, CAAs are applied to each FFACO CAS.

Table A.1-1
CAU 567 Releases with Associated CASs
(Page 1 of 2)

CAS Name	CAS Number	Area	Release
Atmospheric Test Site T-1	01-23-03	1	Atmospheric Release: Surface release of radionuclides from four atmospheric tests conducted in the 1950s. Includes deposition of radionuclides from weapons testing (fission and activation products) onto the soil surface as well as undisturbed surface deposition that was later covered with asphalt. A DCB is established at the bunker area at test GZ, where contamination has been covered with clean fill.
			CWDs: Surface and subsurface release of radionuclides from the consolidation of contaminated materials after nuclear testing.
			Drainages: Migration of radionuclides released during nuclear testing in drainages.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes a broken lead-acid battery, a bucket of lead-contaminated grease, and two areas where asphalt and debris were dumped in drainages.
Seaweed E Contamination Area	03-23-25	3	Atmospheric Release: Surface release of radionuclides (xenon gas) from the underground safety experiments Seaweed C, Seaweed D, and Seaweed E conducted October 1, 1969, during Operation Mandrel (DOE/NV, 2000; Schoengold et al., 1996). Any contamination remaining at the site would be adjacent to the emplacement hole.

Table A.1-1
CAU 567 Releases with Associated CASs
(Page 2 of 2)

CAS Name	CAS Number	Area	Release
A5b RMA	05-23-07	5	Soil Contamination and PSM: Surface release point consistent with a non-nuclear detonation site resulting in a crater and dispersion of fragments, with vaporization of DU in a small crater and ejection of DU and metal fragments to the surface in a regular pattern surrounding the crater.
			Landfills: Subsurface release from DU and other metallic debris consolidated in landfills.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes two pieces of lead.
Colby Mud Spill	20-23-08	20	Drainage: Surface release and migration of radionuclides in drilling mud spilled on May 16, 1976, from the post-test hole for the Colby test (Straume et al., 1977).
			URMA: Subsurface release of radionuclides in drilling mud that was buried after cleanup efforts for the mud spill.
			Spills and PSM: Additional contamination present at the site found during the investigation. Includes a lead-acid battery.
J-11 Soil RMA	25-23-23	25	Spill: Source is unknown but believed to be a surface release of radionuclides from a spill of liquid.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAIP (NNSA/NFO, 2013).

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

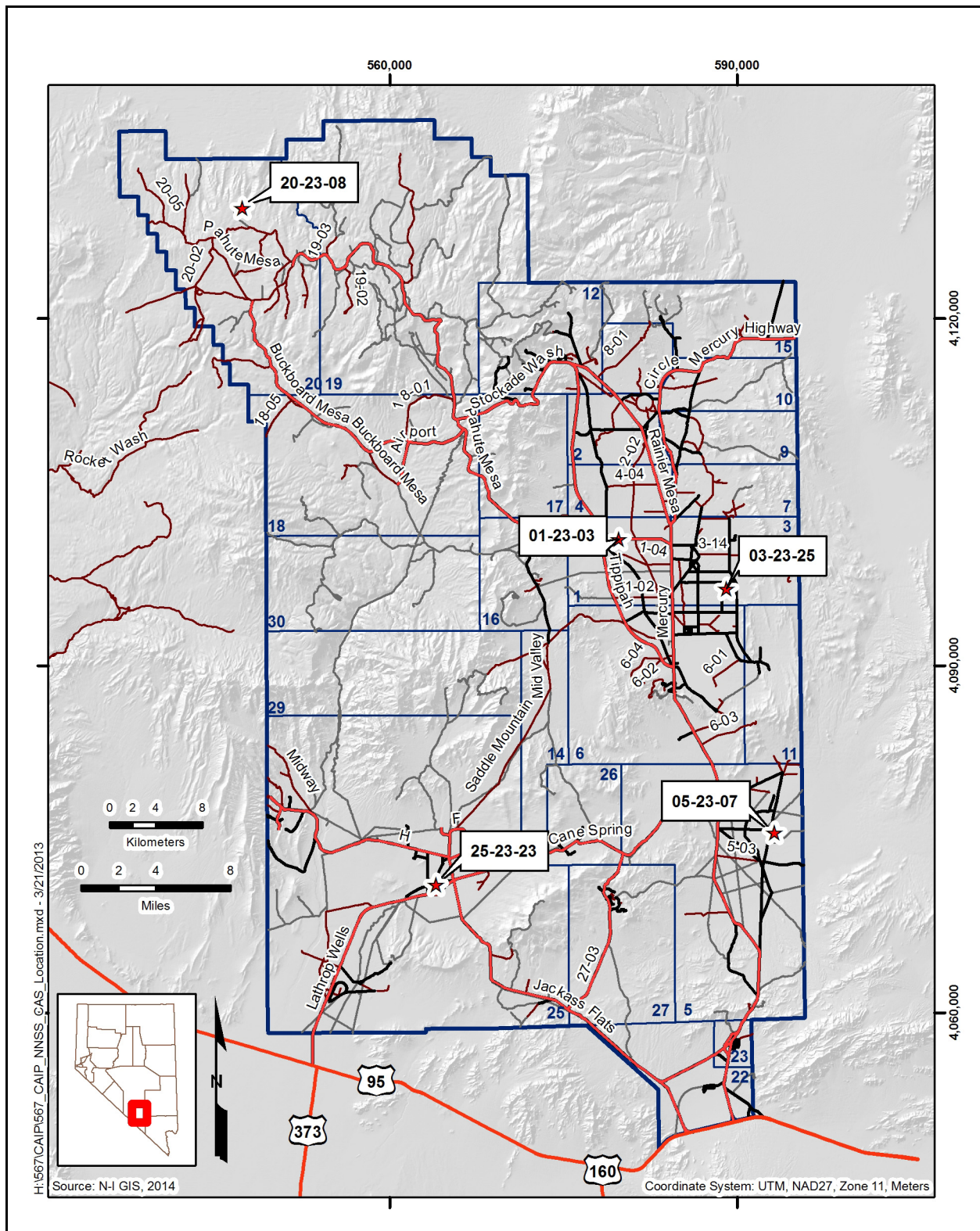


Figure A.1-1
CAU 567 CAS Location Map

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 other types of contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see [Section A.2.4](#)).

A.1.2 Contents

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

- [Section A.1.0](#) describes the investigation background, objectives, and the contents of this document.
- [Section A.2.0](#) provides an investigation overview.
- [Sections A.3.0](#) through [A.7.0](#) provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- [Section A.8.0](#) summarizes waste management activities.
- [Section A.9.0](#) discusses the QA and quality control (QC) processes followed and the results of QA/QC activities.
- [Section A.10.0](#) provides a summary of the investigation results.
- [Section A.11.0](#) 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, laboratory certificates of analyses, and analytical results—are retained in CAU 567 files as hard copy documents or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 567 CAI were conducted between August 2012 and September 2014. Investigation activities included visual surveys, radiological surveys, surface and subsurface soil sampling, and TLD sampling.

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NFO, 2013) (except any deviations described herein) and in accordance with the Soils QAP (NNSA/NSO, 2012), 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/NFO, 2014).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012), 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. The radiological and chemical FALs are presented in [Appendix C](#).

The CASs were investigated by collecting TLD samples for external radiological dose calculations and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP (NNSA/NFO, 2013) and is described in [Sections A.2.1](#) through [A.2.5](#), which provide the general investigation and evaluation methodologies.

A.2.1 Sample Locations

All sample locations for CAU 567 were selected judgmentally, using biasing factors such as radiological survey results and/or the presence of debris. One or more grab or composite samples were collected at each judgmental sample location. At Atmospheric Test Site T-1, where soil sample plots were established, soil samples were collected following a probabilistic approach. One or more composite samples were collected within each sample plot, and TLDs were located at the center of each sample plot. The subsample aliquot locations for each sample were identified using a predetermined random-start, triangular grid pattern.

All sample locations and points of interest were surveyed with a GPS instrument. [Appendix F](#) presents these GPS data in a tabular format. Additional information on the selection of sample locations is found in the CAIP and the CAS-specific sections ([Sections A.3.0](#) through [A.7.0](#)). CAU 567 sampling locations were accessible, and sampling activities at planned locations were not restricted.

A.2.2 Investigation Activities

The investigation activities as listed in [Section A.2.0](#) performed at CAU 567 were consistent with the field investigation activities specified in the CAIP (NNSA/NFO, 2013). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each CAS. The following subsections describe the specific investigation activities that took place at CAU 567.

A.2.2.1 Radiological Surveys

Aerial surveys and TRSs were conducted at the CAU 567 CASs. Aerial radiological surveys were performed at the sites in 1994 at an altitude of 200 ft with 500-ft flight-line spacing (BN, 1999).

TRSs were performed to refine and verify the aerial radiological data and to identify specific locations for sample plots and biased sample locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator as well with as a field instrument for the detection of low-energy radiation (FIDLER). 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 meters per second with the radiation detector held at a height of approximately 18 inches (in.) above the ground surface. Count rates for the PRM-470 and FIDLER are expressed in units of counts per second (cps) and counts per minute (cpm), respectively, and are evaluated qualitatively as comparative relative spatial distributions in units of multiples of background.

A.2.2.2 Radiological Field Screening

The CAS-specific sections of this document identify the locations where field screening was conducted and how the field-screening levels (FSLs) were used to aid in the selection of samples

submitted for analysis. Field-screening results (FSRs) are recorded on SCLs that are retained in project files.

Site-specific FSLs were determined each day before investigational soil sampling began. An area was 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 centimeter (cm) of soil, were collected at random locations within the selected area. The aliquots were then mixed, and 10 one-minute static counts were obtained for both alpha and beta/gamma measurements using an NE Electra instrument. The FSLs for both alpha and beta/gamma were calculated by multiplying the sample standard deviation by 2 and adding that value to the sample average.

Field screening was used to evaluate the presence of buried or subsurface contamination at Atmospheric Test Site T-1, A5b RMA, Colby Mud Spill, and J-11 Soil RMA. Field screening was limited to radiological parameters and was conducted using an NE Electra instrument. FSRs from subsurface intervals were compared to surface FSRs to determine whether a subsurface contamination layer could be distinguished from surface contamination. Buried contamination was considered to be present only if the depth interval reading exceeded the FSL by 20 percent. For locations where it was determined that buried contamination was present, the subsurface depth interval with the highest reading was collected and sent for offsite laboratory analyses except at Colby Mud Spill, where subsurface samples were submitted from two intervals at each location. (See Section A.8.4.2 of the CAIP [NNSA/NFO, 2013].)

A.2.2.3 TLD Sampling

TLDs (Panasonic UD-814) were placed at CAU 567 with the objective of collecting *in situ* measurements to determine the external radiological dose. Site-specific TLD information is provided for each CAS in [Sections A.3.0](#) through [A.7.0](#).

TLDs were also placed at background locations at each CAS to measure background radiation. The background TLDs measure dose from natural sources in areas unaffected by the CAU-related releases during field deployment. The location for the background TLDs was selected using the 1994 aerial radiation survey, as discussed in the CAIP (NNSA/NFO, 2013). 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. Therefore, the CAS-specific background TLD results were used in the calculation of radiological dose at all CASs in CAU 567.

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. 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.9.0](#). All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

A.2.2.4 Soil Sampling

Soil sampling at CAU 567 included the collection of surface soil samples within sample plot and 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 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-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 below ground surface (bgs). After collection, each aliquot was carefully placed atop a sieve (#4 mesh) fitted into a bottom pan with a plastic bag liner. Oversized material that did not pass through the sieve was returned to the original sample location.

In order to measure the impact of small point source releases over a larger area, 10-by-10-m grids were established and one aliquot was collected from nine locations within the grid, resulting in one composite grab sample. This method was used for sampling the radiological releases at A5b RMA and J-11 Soil RMA. A 2-by-2-m grid was used to sample soil adjacent to a broken lead-acid battery at

Atmospheric Test Site T-1, and a 6-by-6-m grid was used to sample soil adjacent to lead pieces at A5b RMA.

A composite grab sample was also collected from soil beneath a filter pile at Colby Mud Spill. The grid method was not used at this site; aliquots were selected based on visual evidence of staining. Biased grab samples were collected from soil where DU had been removed at A5b RMA, and in locations biased to elevated radiological readings at A5b RMA and Well J-11. Biasing factors based on field observations were not present at the Seaweed E Contamination Area; grab samples collected at this location were biased using historical documents and samples were collected at each test GZ.

Locations where there was a potential for subsurface contamination were identified in drainages and below asphalt at Atmospheric Test Site T-1, in a drainage at Colby Mud Spill, within the detonation crater at A5b RMA, and at the location of the spill at J-11 Soil RMA. At these locations, subsurface screening was conducted and when criteria were met, samples were collected as described in [Section A.2.2.2](#) to determine whether buried contamination exists. Site-specific field screening information is provided for each CAS in [Sections A.3.0](#) through [A.7.0](#).

A.2.3 Dose Calculations

Soil and TLD data are used to calculate a TED that could potentially be received by a human receptor at the site. The following subsections discuss the process for evaluating the soil and TLD data in terms of dose, so the data may be compared directly to the dose-based radiological FAL.

A.2.3.1 Internal Dose Calculations

Internal dose was calculated using the radionuclide analytical results from soil samples and the corresponding residual radioactive material guideline (RRMG) (NNSA/NFO, 2014). 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/NFO, 2014).

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/NFO, 2014) 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. Soil concentrations of plutonium isotopes are inferred from gamma spectroscopy results as described in the representativeness discussion of [Section B.1.1.1.1](#). 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 each sample plot using the results of all soil samples collected in that plot (NNSA/NFO, 2014). 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 sample plot with the maximum internal dose within the corresponding release. The internal dose for each of these locations was calculated by multiplying this ratio by the external dose value specific to each location using the following formula:

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

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.2.3.2 External Dose Calculations

External dose was calculated using TLDs. The TLDs used at CAU 567 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 be 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.

For sample locations where external dose measurements were not available, a TLD-equivalent external dose was calculated using the 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:

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

where

TLD = external dose based on TLD readings

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

Estimates of external dose at the CAU 567 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result). The background dose at each CAU 567 was determined to be the average of the background TLD results from background locations specific to that CAS. Background TLD locations at each CAS are presented in [Sections A.3.0](#) through [A.7.0](#).

A.2.3.3 Total Effective Dose

The calculated TED represents the sum of the internal dose and the external dose for each sample location. For locations where a TLD was not placed, TED was calculated directly from the soil sample analytical results. This was accomplished using the method described in [Section A.2.3.1](#) for internal dose, except the RRMGs for TED were used instead of the RRMGs for internal dose.

The calculated TED is an estimate of the true (unknown) TED. It is uncertain how well the calculated TED represents the true TED. If a calculated TED were directly compared to the FAL, any significant difference between the true TED and the calculated 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 calculated TED. The probabilistic sampling design as described in the CAIP (NNSA/NFO, 2013)

conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The 95 percent UCL of the TED is also used for determining the presence or absence of COCs (DQO Decision I). For sample locations where a TLD and multiple soil samples are collected (i.e., sample plots), this is calculated as the sum of the 95 percent UCLs of the internal and external doses. For grab sample locations where a TLD sample was collected, this is calculated as the sum of the 95 percent UCL of the external dose and the single internal dose estimate.

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, 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 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 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 567 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NFO, 2013) 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 8 hr/day and 250 day/yr). The FALs were established in [Appendix C](#) based on a dose limit of 25 mrem/yr over as presented in [Section 2.3.1](#).

Results for each of the CASs are presented in [Sections A.3.0](#) through [A.7.0](#). 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 CAS-specific results tables.

A COC is defined as any contaminant present in environmental media exceeding a corresponding 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/NFO, 2014). If COCs are present, corrective action must be considered.

A corrective action may also be required if a waste present at a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. The following were 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 any physical containment 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 any physical containment and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the potentially contaminated soil (for each radioactive contaminant) and calculating the combined resulting dose using the RRMGs for TED as described in [Section A.2.3.3](#). If the dose exceeds the FAL, then the waste would be considered to be PSM.
 - For liquid wastes, the concentration of any chemical contaminant in soil (following degradation of any physical containment and release of contaminants into soil) will be calculated using the following equation based on the concentration of contaminants in the waste, the soil water holding capacity of the soil (field capacity), and the soil bulk density. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

$$C_s = \frac{C_l \times FC_s}{P_b}$$

where

- C_s = estimated constituent concentration in soil (mg/kg)
- C_l = constituent concentration in liquid PSM (mg/L)
- FC_s = soil field capacity (0.2 kg/1,000 cm³)
- P_b = soil bulk density (1.5 kg/1,000 cm³)

A.2.5 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. A continuous spatial distribution (i.e., interpolated surface) was estimated from each of the listed radiation surveys using an inverse distance weighted interpolation technique. The average Industrial Area TED value for each study site was then matched with a radiation survey value from the interpolated surface at the corresponding geographic location. A correlation was then calculated between these data pairs for each radiation survey. Correlation statistics are 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 in the DQOs as an r^2 of 0.8.

The TED values used in the correlation were the average TED for probabilistic samples or the calculated TED for judgmental samples from biased sample locations. To protect against a Decision II false-negative decision error (the potential for a receptor to receive a dose exceeding the 25-mrem/yr FAL outside the defined boundary), the Soils Activity uses a conservative estimate of the radiation survey value corresponding to 25 mrem/yr. This is accomplished using the uncertainty of how well the calculated relationship between TED and emitted radiation (i.e., the regression) represents the assumed true relationship. This uncertainty includes the uncertainty of how well the calculated TED represents true TED and the uncertainty of how well the radiation survey instrument readings represent emitted radioactivity. These uncertainties were used to conservatively establish corrective action boundaries and administrative UR boundaries by using the 95 percent lower confidence limit (LCL) of the regression correlation as described in the Soils RBCA document (NNSA/NFO, 2014).

A.3.0 CAS 01-23-03, Atmospheric Test Site T-1

CAS 01-23-03, Atmospheric Test Site T-1, is located in the center of Area 1 of the NNSS, on Pahute Mesa Road. Releases present at the site include the surface release of radionuclides from atmospheric weapons testing, the subsequent movement of these radionuclides in drainages and to CWDs, and spills and PSM associated with test operations. Additional detail on the history of the CAS is provided in the CAIP (NNSA/NFO, 2013).

A.3.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.3.1.1 Visual Surveys

Visual surveys were conducted during site walks, while sampling, and while performing geophysical surveys and TRSs at Atmospheric Test Site T-1. One can of lead-contaminated grease and a broken lead-acid battery were identified during visual surveys. Sedimentation areas for sampling within the drainage were also identified during visual surveys.

A.3.1.2 Geophysical Surveys

Geophysical surveys were conducted at three CWDs identified in historical documents and at two areas where asphalt and other debris had been dumped in drainages. Anomalies associated with buried debris were not identified at any of these locations, and the releases were determined to be limited to the surface. [Section G.4.1 of Appendix G](#) contains detailed descriptions of the geophysical surveys and results. [Figures G.4-3, G.4-4, G.4-6, and G.4-7](#) present results for CWD #2. [Figures G.4-9, G.4-10, and G.4-12](#) present results for CWD #3. [Figures G.4-15 and G.4-17](#) present results for CWD #4. [Figures G.4-19, G.4-21, G.4-23, and G.4-26](#) present results for the drainage dumps. Sample locations were not identified as a result of the geophysical surveys.

A.3.1.3 Radiological Screening

Radiological screening was used at drainage locations to determine whether subsurface contamination is present. It was also used at 14 locations where an asphalt layer is present. Buried contamination was identified at one location (A06), and a sample was collected. No other samples were collected based on radiological screening results.

A.3.1.4 Radiological Surveys

TRSs that were performed at Atmospheric Test Site T-1 before the CAIP was published are reported in the CAIP (NNSA/NFO, 2013). Results of the preliminary investigation showed an area of elevated radioactivity that corresponds with the location of CWD #2 as described in historical documents. Additionally, two areas of unexplained radioactivity were identified in these surveys: one north of the site and one to the west. During visual surveys, it was discovered that these corresponded with locations where a mixture of asphalt and other debris had been dumped in drainages. Additional TRSs were performed in these drainage dump areas and CWD #2 during the CAI. These survey results were used to select sample locations in CWD #2 and the drainage dumps. Additional TRSs were also performed at the areas of highest radioactivity outside the DCB to collect additional information used in the selection of sample plot locations (A01 and A02). [Figure A.3-1](#) shows the combined results of TRSs performed at Atmospheric Test Site T-1. [Figure A.3-2](#) shows the placement of plot locations outside the DCB.

A.3.1.5 Sample Collection

Soil and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013). The specific CAI activities conducted at this CAS are described in the following subsections.

A.3.1.5.1 TLD Samples

TLDs were installed at 135 locations, one at each soil sample location and in an evenly spaced grid pattern across the site to calculate external doses. Four of these TLDs (locations A23, A24, A25, and A26) were placed to calculate background. [Table A.3-1](#) shows the number of TLD samples collected by type (plot, grid, subsurface, drainage, CWD, drainage dump, and background).

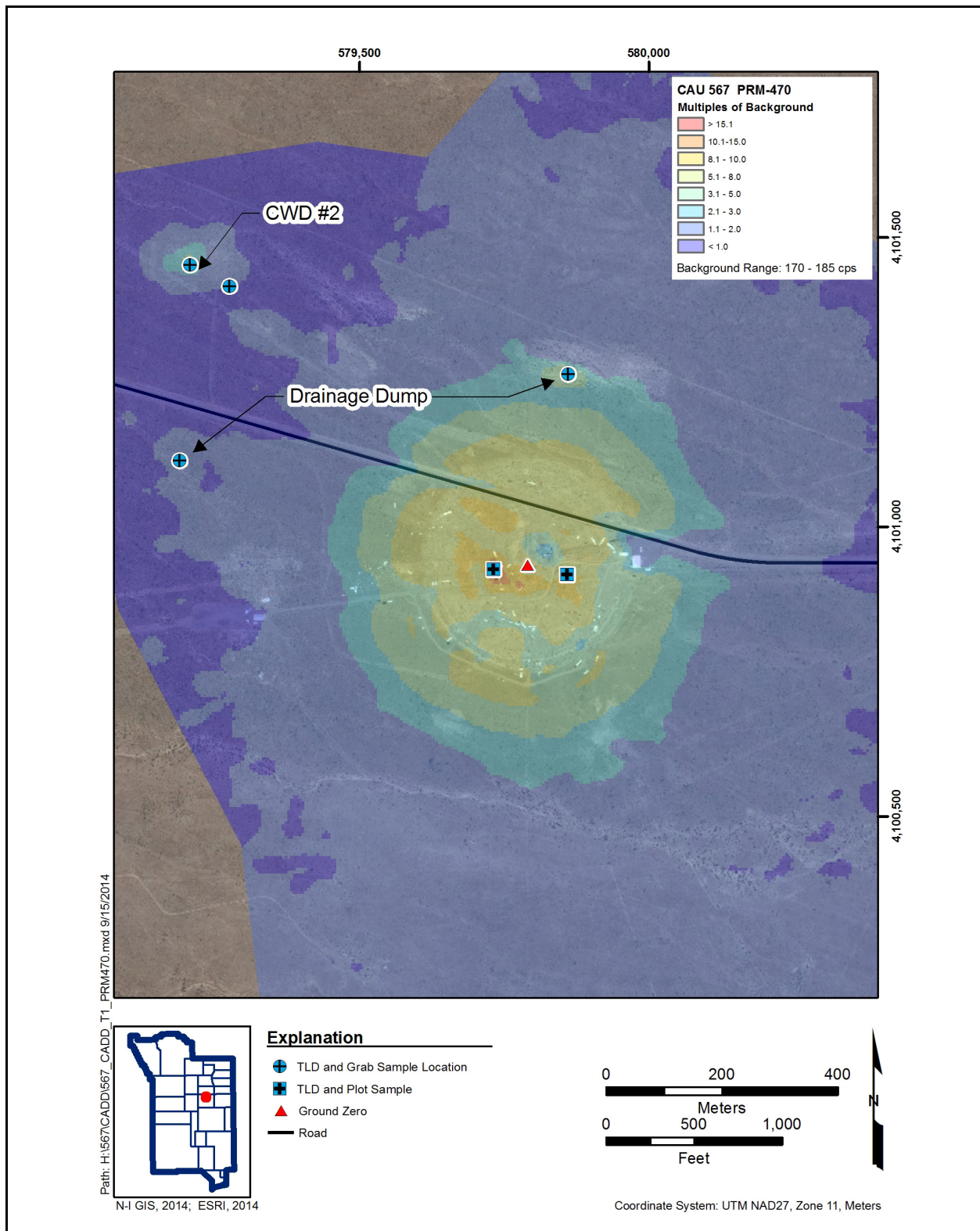
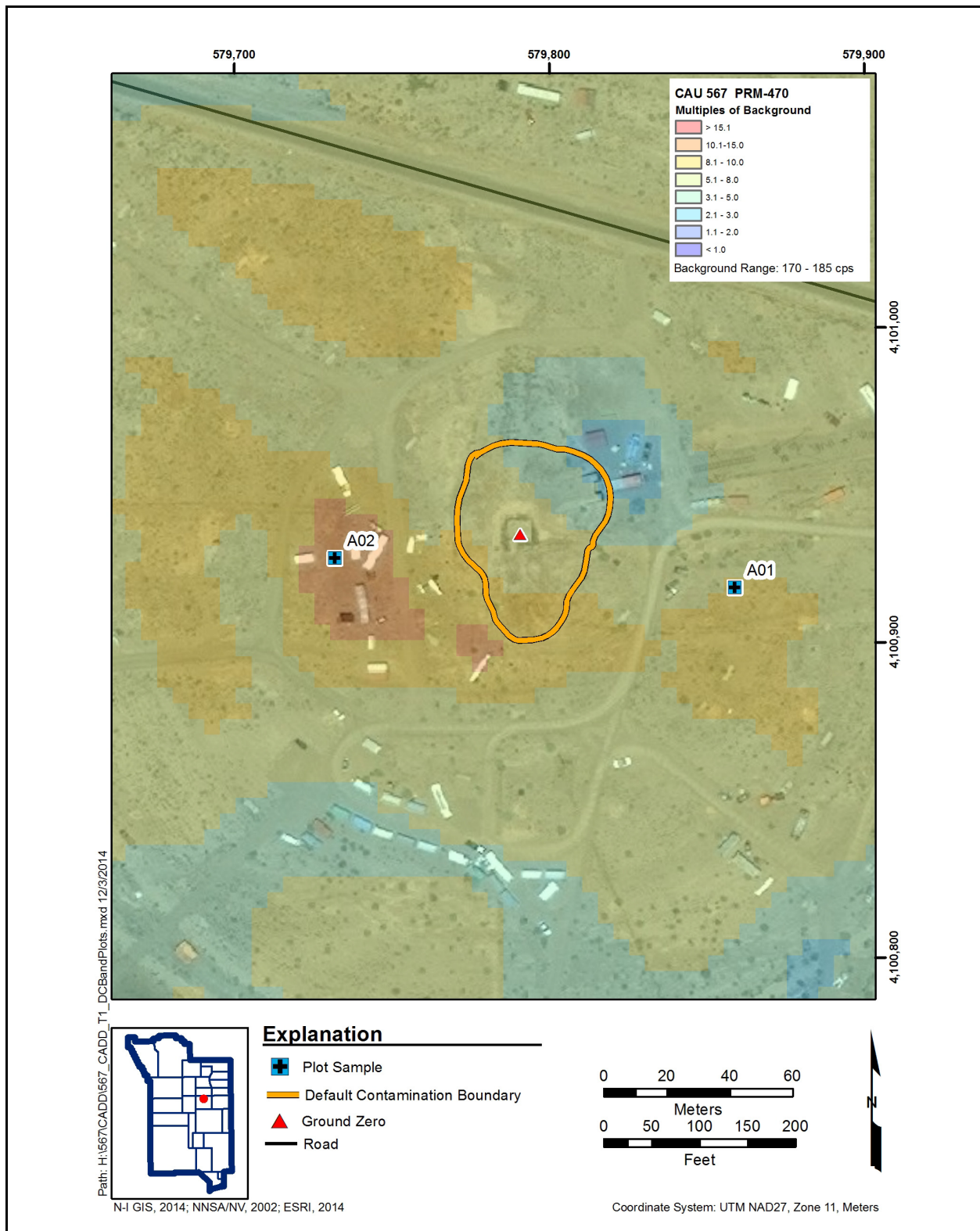


Figure A.3-1
Atmospheric Test Site T-1, TRS Results



**Figure A.3-2
Atmospheric Test Site T-1, Soil Plot Locations**

Table A.3-1
Atmospheric Test Site T-1, TLD Sample Summary

Location Type	Number of Locations	Number of TLDs ^a
Plot/Subsurface	2	4
Grid	107	107
Grid/Spills and PSM (drainage dump)	1	1
Spills and PSM (drainage dump)	1	1
Subsurface	12	12
CWD	6	6
Drainage	2	2
Background	4	4
Total	135	137

^a Number of TLDs is greater than the number of locations for some sample types because some locations had more than one TLD.

Table A.3-2 provides detailed information including location, dates placed and collected, and serial number for each TLD. Figure A.3-3 shows locations of all TLDs placed at Atmospheric Test Site T-1.

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 1 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Atmospheric Release	A01	4836	07/30/2013	11/19/2013	Plot and Subsurface
	A01	5101	07/30/2013	11/19/2013	Plot and Subsurface
	A02	3348	07/30/2013	11/19/2013	Plot and Subsurface
	A02	4474	07/30/2013	11/19/2013	Plot and Subsurface
	A03	4525	07/30/2013	11/19/2013	Subsurface
	A04	5145	07/30/2013	11/19/2013	Subsurface
	A05	4619	07/30/2013	11/19/2013	Subsurface
	A06	4591	07/30/2013	11/19/2013	Subsurface
	A07	6306	07/30/2013	11/19/2013	Subsurface
	A08	4814	07/30/2013	11/19/2013	Subsurface

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 2 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Atmospheric Release	A09	3823	07/30/2013	11/19/2013	Subsurface
	A10	4920	07/30/2013	11/19/2013	Subsurface
	A11	4408	07/30/2013	11/19/2013	Subsurface
	A12	4208	07/30/2013	11/19/2013	Subsurface
	A13	5009	08/01/2013	11/18/2013	Subsurface
	A14	3373	08/01/2013	11/18/2013	Subsurface
	A27	6077	07/30/2013	11/19/2013	Grid
	A28	5003	07/30/2013	11/19/2013	Grid
	A29	5016	07/30/2013	11/19/2013	Grid
	A30	5031	07/31/2013	11/19/2013	Grid
	A31	3114	07/31/2013	11/19/2013	Grid
	A32	4810	07/31/2013	11/19/2013	Grid
	A33	4828	07/31/2013	11/19/2013	Grid
	A34	4376	07/31/2013	11/19/2013	Grid
	A35	4833	07/31/2013	11/19/2013	Grid
	A36	4681	07/31/2013	11/19/2013	Grid
	A37	5005	07/31/2013	11/19/2013	Grid
	A38	4939	07/31/2013	11/19/2013	Grid
	A39	4936	07/31/2013	11/19/2013	Grid
	A40	4518	07/31/2013	11/19/2013	Grid
	A41	5020	07/31/2013	11/19/2013	Grid
	A42	4851	07/31/2013	11/19/2013	Grid
	A43	4906	07/31/2013	11/19/2013	Grid
	A44	5167	07/31/2013	11/19/2013	Grid
	A45	5066	07/31/2013	11/19/2013	Grid
	A46	5050	07/31/2013	11/19/2013	Grid
	A47	4188	07/31/2013	11/19/2013	Grid
	A48	4388	07/31/2013	11/19/2013	Grid
	A49	4914	07/31/2013	11/19/2013	Grid

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 3 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Atmospheric Release	A50	5183	07/31/2013	11/19/2013	Grid
	A51	4342	07/31/2013	11/19/2013	Grid
	A52	4750	07/31/2013	11/19/2013	Grid
	A53	4704	07/31/2013	11/19/2013	Grid
	A54	4896	07/31/2013	11/19/2013	Grid
	A55	4957	07/31/2013	11/19/2013	Grid
	A56	4782	07/31/2013	11/19/2013	Grid
	A57	4555	07/31/2013	11/19/2013	Grid
	A58	4758	07/31/2013	11/19/2013	Grid
	A59	4820	07/31/2013	11/19/2013	Grid
	A60	6388	07/31/2013	11/19/2013	Grid
	A61	4530	07/31/2013	11/19/2013	Grid
	A62	4807	08/01/2013	11/19/2013	Grid
	A63	4763	08/01/2013	11/18/2013	Grid
	A64	4033	08/01/2013	11/19/2013	Grid
	A65	4793	08/01/2013	11/19/2013	Grid
	A66	4391	08/01/2013	11/19/2013	Grid
	A67	4815	08/01/2013	11/19/2013	Grid
	A68	5079	08/01/2013	11/19/2013	Grid
	A69	4485	08/01/2013	11/19/2013	Grid
	A70	4803	08/01/2013	11/19/2013	Grid
	A71	4257	08/01/2013	11/19/2013	Grid
	A72	5274	08/01/2013	11/19/2013	Grid
	A73	4766	08/01/2013	11/19/2013	Grid
	A74	4446	08/01/2013	11/18/2013	Grid
	A75	4394	08/01/2013	11/18/2013	Grid
	A76	4682	08/01/2013	11/18/2013	Grid
	A77	4911	08/01/2013	11/18/2013	Grid
	A78	5058	08/01/2013	11/18/2013	Grid

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 4 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Atmospheric Release	A79	3812	08/05/2013	11/18/2013	Grid
	A80	4319	08/05/2013	11/18/2013	Grid
	A81	3597	08/05/2013	11/19/2013	Grid
	A82	4835	08/05/2013	11/18/2013	Grid
	A83	4400	08/05/2013	11/18/2013	Grid
	A84	4500	08/05/2013	11/18/2013	Grid
	A85	5194	08/05/2013	11/18/2013	Grid
	A86	4660	08/05/2013	11/18/2013	Grid
	A87	4934	08/05/2013	11/18/2013	Grid
	A88	4669	08/05/2013	11/18/2013	Grid
	A89	4457	08/05/2013	11/18/2013	Grid
	A90	4917	08/05/2013	11/18/2013	Grid
	A91	4819	08/05/2013	11/18/2013	Grid
	A92	4894	08/05/2013	11/18/2013	Grid
	A93	6335	08/05/2013	11/18/2013	Grid
	A94	4693	08/05/2013	11/18/2013	Grid
	A95	5082	08/05/2013	11/18/2013	Grid
	A96	3247	08/05/2013	11/18/2013	Grid
	A97	4995	08/05/2013	11/18/2013	Grid
	A98	5068	08/05/2013	11/18/2013	Grid
	A100	4625	08/05/2013	11/18/2013	Grid
	A101	4442	08/05/2013	11/18/2013	Grid
	A102	4169	08/05/2013	11/18/2013	Grid
	A103	5260	08/05/2013	11/18/2013	Grid
	A104	4604	08/05/2013	11/18/2013	Grid
	A105	4320	08/05/2013	11/18/2013	Grid
	A106	4641	08/05/2013	11/18/2013	Grid
	A107	4956	08/05/2013	11/18/2013	Grid
	A108	4837	08/05/2013	11/18/2013	Grid

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 5 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Atmospheric Release	A109	4440	08/05/2013	11/18/2013	Grid
	A110	3509	08/05/2013	11/18/2013	Grid
	A111	4310	08/05/2013	11/18/2013	Grid
	A112	4047	08/05/2013	11/18/2013	Grid
	A113	4868	08/05/2013	11/18/2013	Grid
	A114	4605	08/05/2013	11/18/2013	Grid
	A115	4523	08/05/2013	11/18/2013	Grid
	A116	5119	08/06/2013	11/18/2013	Grid
	A117	4717	08/06/2013	11/18/2013	Grid
	A119	4452	08/06/2013	11/18/2013	Grid
	A120	4348	08/06/2013	11/18/2013	Grid
	A121	4726	08/06/2013	11/18/2013	Grid
	A122	5275	08/06/2013	11/18/2013	Grid
	A123	5257	08/06/2013	11/18/2013	Grid
	A124	6390	08/06/2013	11/18/2013	Grid
	A125	5166	08/06/2013	11/18/2013	Grid
	A126	6305	08/06/2013	11/18/2013	Grid
	A127	4804	08/06/2013	11/18/2013	Grid
	A128	5121	08/06/2013	11/18/2013	Grid
	A129	4712	08/06/2013	11/18/2013	Grid
	A130	4354	08/06/2013	11/18/2013	Grid
	A131	4746	08/06/2013	11/18/2013	Grid
	A132	4990	08/06/2013	11/18/2013	Grid
	A133	4733	08/06/2013	11/18/2013	Grid
	A134	4413	08/06/2013	11/18/2013	Grid
	A135	4537	08/06/2013	11/18/2013	Grid
Atmospheric Release and Spills and PSM	A99	6394	08/05/2013	11/18/2013	Grid/Drainage Dump
Spills and PSM	A118	4563	08/06/2013	11/18/2013	Drainage Dump

Table A.3-2
TLDs at Atmospheric Test Site T-1
(Page 6 of 6)

Release	Location	TLD No.	Date Placed	Date Removed	Location Type
Drainage	A21	5129	08/01/2013	11/19/2013	Drainage
	A22	4988	08/01/2013	11/19/2013	Drainage
CWDs	A15	3262	07/30/2013	11/19/2013	CWD #4
	A16	1275	07/30/2013	11/19/2013	CWD #4
	A17	1813	08/01/2013	11/19/2013	CWD #3
	A18	4882	08/01/2013	11/19/2013	CWD #3
	A19	4735	08/06/2013	11/18/2013	CWD #2
	A20	6313	08/06/2013	11/18/2013	CWD #2
Background	A23	4538	08/06/2013	11/18/2013	Background
	A24	5198	08/06/2013	11/18/2013	Background
	A25	4416	08/06/2013	11/19/2013	Background
	A26	4987	08/06/2013	11/19/2013	Background

A.3.1.5.2 Soil Samples

Table A.3-3 shows the number of soil samples collected by release (Atmospheric Release, CWD, Drainage, and Spills and PSM). Soil sampling for the atmospheric release at CAU 567 consisted of the collection of composite soil plot samples at the two locations (A01 and A02) with the highest TRS readings. Subsurface screening was conducted at 14 locations where asphalt was present (see Figure A.3-4), and two samples were collected at one of these locations (A06). Soil sampling for the CWDs consisted of grab sampling at locations biased to disturbance as well as the areas of highest TRS readings. Drainage samples consisted of subsurface screening and sample collection in sediment areas. All atmospheric release, CWD, and drainage soil samples were submitted for gamma spectroscopy; plutonium (Pu)-241; and isotopic uranium (U), Pu, and americium (Am) analyses. In addition, strontium (Sr)-90 and technetium (Tc)-99 analyses were performed on the atmospheric release sample with the highest FSRs (location A02, sample A608). Sample locations are shown on Figure A.3-4.

For spills and PSM, grab samples were collected at two areas where asphalt and debris were dumped in drainages (locations A99 and A118) as well as from the area where a broken lead-acid battery was

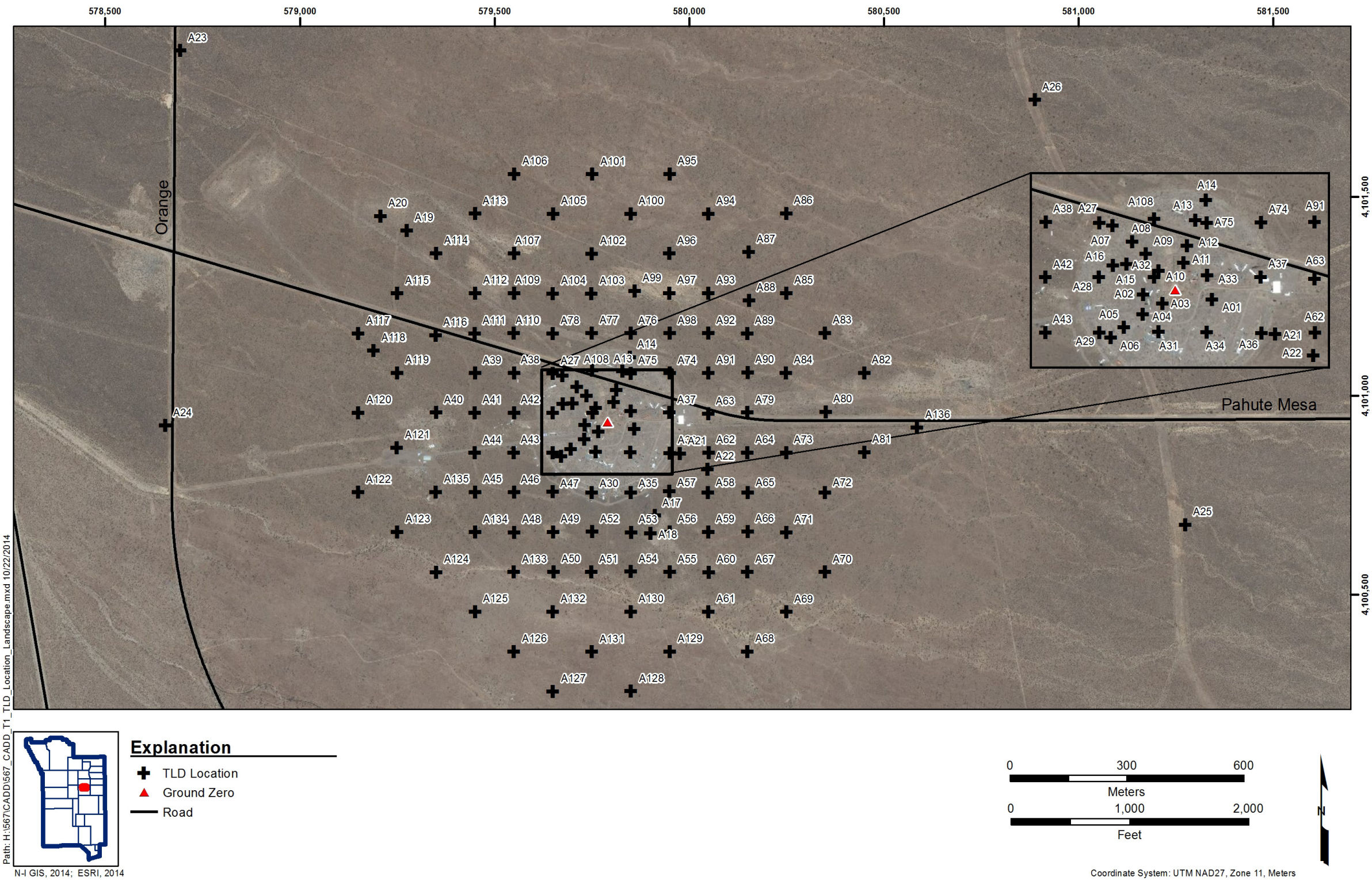


Figure A.3-3
Atmospheric Test Site T-1, TLD Locations

**Table A.3-3
Atmospheric Test Site T-1, Soil Sample Summary**

Sample Type	Number of Locations	Number of Soil Samples	Analyses (Method)
Plot	2	8	Pu-241; Isotopic U, Pu, Am; Gamma Spectroscopy (HASL-300) ^a Sr-90; Tc-99 for 1 plot sample (A608) RCRA Metals and Cr(VI) for 1 Spills and PSM sample and FD (A014 and A015)
Subsurface	1	2	
CWD	6	7 (1 FD)	
Drainage	2	2	
Spills and PSM	3	4 (1 FD)	
Total	14	23	

^aDOE, 1997

HASL = Health and Safety Laboratory

removed (location A136). Samples collected from the drainage dumps were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. Soil samples taken from soil adjacent to the broken battery, were submitted for RCRA metals and Cr(VI) analyses. A summary including the number of each type of sample collected is provided in [Table A.3-4](#). Additional information including depth and purpose for each soil sample collected for this CAS is provided in [Table A.3-4](#). Sample locations are shown on [Figure A.3-4](#).

A.3.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.3.3 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/NFO, 2013). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/RW-yr. For chemical contaminants, the results are reported as individual concentrations that

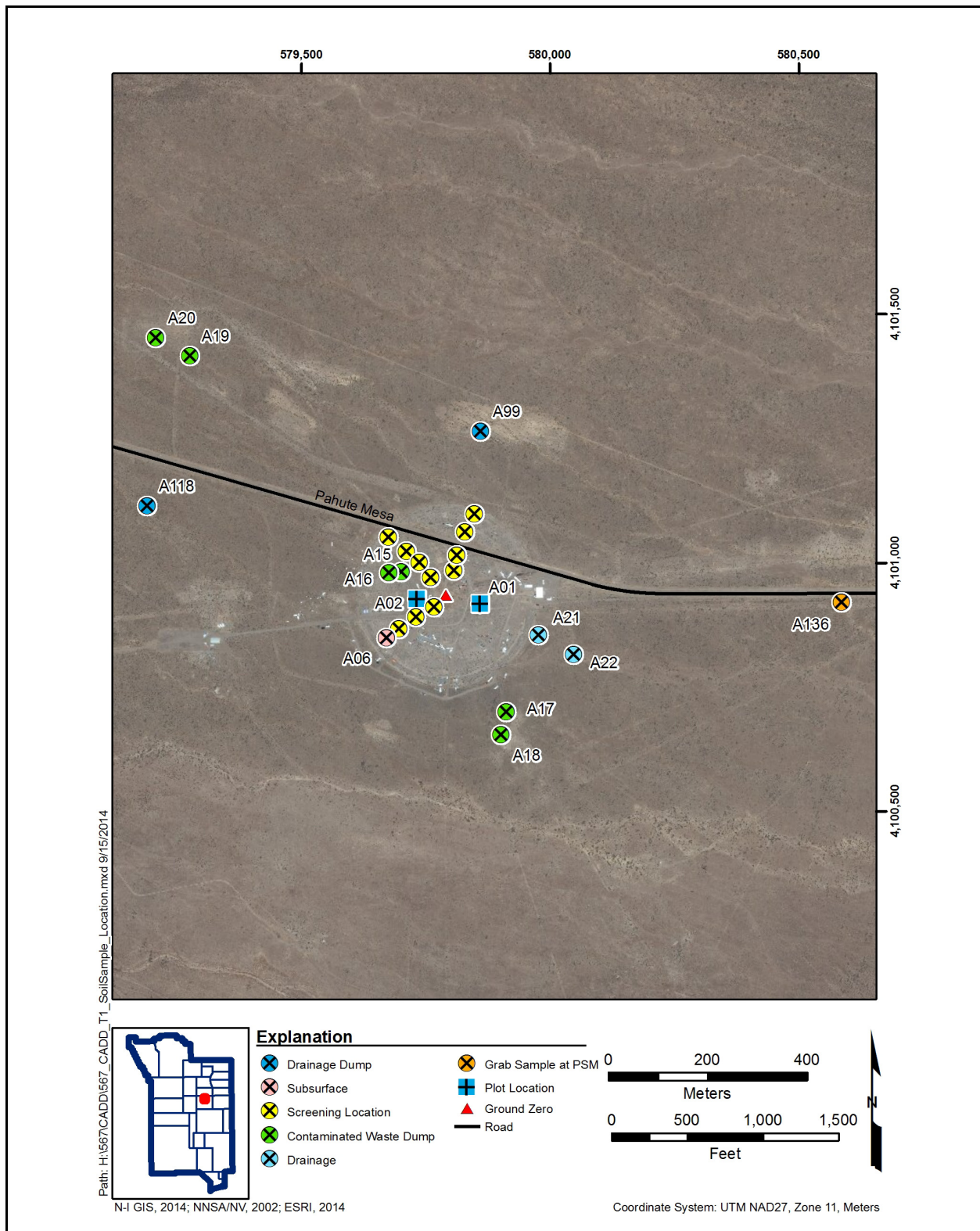


Figure A.3-4
Atmospheric Test Site T-1, Soil Sample Locations

Table A.3-4
Samples Collected at Atmospheric Test Site T-1

Release	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Atmospheric Release	A01	A601	0.0 - 2.5	Soil	Environmental
		A602	0.0 - 2.5	Soil	Environmental
		A603	0.0 - 2.5	Soil	Environmental
		A604	0.0 - 2.5	Soil	Environmental
	A02	A605	0.0 - 4.0	Soil	Environmental
		A606	0.0 - 4.0	Soil	Environmental
		A607	0.0 - 4.0	Soil	Environmental
		A608	0.0 - 4.0	Soil	Environmental
	A06	A001	0.0 - 3.0	Soil	Environmental
		A002	10.0 - 15.0	Soil	Environmental
CWD	A15	A010	0.0 - 5.0	Soil	Environmental
	A16	A011	0.0 - 5.0	Soil	Environmental
	A17	A012	0.0 - 5.0	Soil	Environmental
	A18	A013	0.0 - 5.0	Soil	Environmental
	A19	A003	0.0 - 15.0	Soil	Environmental
		A004	0.0 - 15.0	Soil	FD of #A003
	A20	A005	0.0 - 5.0	Soil	Environmental
Drainage	A21	A008	0.0 - 10.0	Soil	Environmental
	A22	A009	0.0 - 10.0	Soil	Environmental
Spills and PSM	A99	A006	0.0 - 5.0	Soil	Environmental
	A118	A007	0.0 - 5.0	Soil	Environmental
	A136	A014	0.0 - 5.0	Soil	Environmental
		A015	0.0 - 5.0	Soil	FD of #A014

are comparable to their corresponding FALs. Results that are equal to or greater than FALs are identified by bold text in the results tables.

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.3.3.1](#). Internal doses for each sample plot are summarized in

Section A.3.3.2. The TEDs for each sampled location are summarized in Section A.3.3.3. Chemical contaminant results for Atmospheric Test Site T-1 are summarized in Section A.3.3.4.

A.3.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in Section A.2.3.2. 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. External dose for subsurface sample collected at location A06 was calculated using the surface TLD results as described in Section A.2.3.2. 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.3-5.

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A01	0.40	6	3	148.0	24.9	7.4
	A02	0.48	6	3	220.0	37.0	11.0
	A03	0.19	3	3	210.4	35.3	10.5
	A04	0.20	3	3	139.8	23.5	7.0
	A05	0.37	3	3	137.5	23.1	6.9
	A06a	0.27	3	3	104.0	17.5	5.2
	A06b (subsurface)	--	--	--	190.9	32.3	9.6
	A07	0.36	3	3	139.8	23.5	7.0
	A08	0.47	3	3	148.2	24.9	7.4
	A09	0.19	3	3	144.9	24.3	7.2
	A10	0.27	3	3	77.9	13.1	3.9
	A11	0.24	3	3	64.1	10.8	3.2
	A12	0.30	3	3	137.0	23.0	6.8
	A13	0.23	3	3	95.4	16.0	4.8

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A14	0.14	3	3	68.4	11.5	3.4
	A27	0.30	3	3	92.0	15.5	4.6
	A28	0.25	3	3	99.8	16.8	5.0
	A29	0.11	3	3	82.1	13.8	4.1
	A30	0.20	3	3	57.6	9.7	2.9
	A31	0.05	3	3	119.5	20.1	6.0
	A32	0.31	3	3	86.3	14.5	4.3
	A33	0.11	3	3	75.2	12.6	3.8
	A34	0.24	3	3	89.1	15.0	4.5
	A35	0.18	3	3	65.0	10.9	3.3
	A36	0.09	3	3	48.6	8.2	2.4
	A37	0.48	3	3	95.2	16.0	4.8
	A38	0.11	3	3	47.3	7.9	2.4
	A39	0.08	3	3	17.3	2.9	0.9
	A40	0.04	3	3	5.9	1.0	0.3
	A41	0.13	3	3	27.8	4.7	1.4
	A42	0.20	3	3	60.1	10.1	3.0
	A43	0.03	3	3	42.5	7.1	2.1
	A44	0.09	3	3	18.5	3.1	0.9
	A45	0.57	3	3	39.5	6.6	2.0
	A46	0.07	3	3	32.7	5.5	1.6
	A47	0.17	3	3	69.7	11.7	3.5
	A48	0.10	3	3	16.9	2.8	0.8
	A49	0.05	3	3	18.9	3.2	0.9
	A50	0.06	3	3	14.1	2.4	0.7
	A51	0.10	3	3	17.7	3.0	0.9
	A52	0.15	3	3	42.5	7.1	2.1

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 3 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A53	0.26	3	3	47.7	8.0	2.4
	A54	0.10	3	3	21.1	3.5	1.1
	A55	0.07	3	3	14.2	2.4	0.7
	A56	0.12	3	3	29.5	5.0	1.5
	A57	0.24	3	3	63.0	10.6	3.2
	A58	0.13	3	3	25.2	4.2	1.3
	A59	0.13	3	3	22.6	3.8	1.1
	A60	0.35	3	3	24.4	4.1	1.2
	A61	0.07	3	3	7.1	1.2	0.4
	A62	0.12	3	3	36.0	6.0	1.8
	A63	0.18	3	3	16.9	2.8	0.8
	A64	0.07	3	3	13.6	2.3	0.7
	A65	0.09	3	3	11.0	1.8	0.5
	A66	0.03	3	3	7.5	1.3	0.4
	A67	0.06	3	3	5.5	0.9	0.3
	A68	0.12	3	3	8.7	1.5	0.4
	A69	0.21	3	3	12.1	2.0	0.6
	A70	0.02	3	3	2.6	0.4	0.1
	A71	0.04	3	3	4.4	0.7	0.2
	A72	0.14	3	3	16.3	2.7	0.8
	A73	0.03	3	3	3.9	0.7	0.2
	A74	0.10	3	3	66.7	11.2	3.3
	A75	0.25	3	3	83.5	14.0	4.2
	A76	0.22	3	3	66.2	11.1	3.3
	A77	0.16	3	3	64.0	10.8	3.2
	A78	0.09	3	3	44.9	7.5	2.2
	A79	0.03	3	3	7.2	1.2	0.4

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 4 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A80	0.08	3	3	7.7	1.3	0.4
	A81	0.04	3	3	1.3	0.2	0.1
	A82	0.05	3	3	3.1	0.5	0.2
	A83	0.03	3	3	2.8	0.5	0.1
	A84	0.18	3	3	14.5	2.4	0.7
	A85	0.14	3	3	8.6	1.4	0.4
	A86	0.10	3	3	6.6	1.1	0.3
	A87	0.10	3	3	6.1	1.0	0.3
	A88	0.12	3	3	10.9	1.8	0.5
	A89	0.10	3	3	10.9	1.8	0.5
	A90	0.11	3	3	14.6	2.4	0.7
	A91	0.08	3	3	26.6	4.5	1.3
	A92	0.12	3	3	22.2	3.7	1.1
	A93	0.06	3	3	17.3	2.9	0.9
	A94	0.07	3	3	6.9	1.2	0.3
	A95	0.02	3	3	3.0	0.5	0.1
	A96	0.05	3	3	10.3	1.7	0.5
	A97	0.05	3	3	11.3	1.9	0.6
	A98	0.05	3	3	35.7	6.0	1.8
	A100	0.05	3	3	7.7	1.3	0.4
	A101	0.06	3	3	5.2	0.9	0.3
	A102	0.10	3	3	14.1	2.4	0.7
	A103	0.16	3	3	23.8	4.0	1.2
	A104	0.05	3	3	14.9	2.5	0.7
	A105	0.02	3	3	5.7	1.0	0.3
	A106	0.07	3	3	5.4	0.9	0.3
	A107	0.10	3	3	4.7	0.8	0.2

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 5 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A108	0.03	3	3	21.4	3.6	1.1
	A109	0.18	3	3	13.8	2.3	0.7
	A110	0.02	3	3	15.4	2.6	0.8
	A111	0.04	3	3	8.6	1.4	0.4
	A112	0.03	3	3	2.4	0.4	0.1
	A113	0.05	3	3	2.6	0.4	0.1
	A114	0.07	3	3	4.1	0.7	0.2
	A115	0.03	3	3	1.7	0.3	0.1
	A116	0.05	3	3	4.7	0.8	0.2
	A117	0.09	3	3	2.5	0.4	0.1
	A119	0.08	3	3	3.4	0.6	0.2
	A120	0.04	3	3	0.5	0.1	0.0
	A121	0.01	3	3	0.9	0.1	0.0
	A122	0.04	3	3	3.4	0.6	0.2
	A123	0.02	3	3	3.3	0.5	0.2
	A124	0.03	3	3	7.5	1.3	0.4
	A125	2.7	3	3	5.8	1.0	0.3
	A126	0.08	3	3	7.2	1.2	0.4
	A127	0.07	3	3	4.2	0.7	0.2
	A128	0.11	3	3	7.2	1.2	0.4
	A129	0.05	3	3	4.3	0.7	0.2
	A130	0.04	3	3	5.3	0.9	0.3
	A131	0.08	3	3	6.2	1.0	0.3
	A132	0.09	3	3	10.6	1.8	0.5
	A133	0.06	3	3	3.5	0.6	0.2
	A134	0.15	3	3	12.2	2.1	0.6
	A135	0.11	3	3	8.7	1.5	0.4

Table A.3-5
Atmospheric Test Site T-1, 95% UCL External Dose for Each Exposure Scenario
(Page 6 of 6)

Release	Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (RW Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release (Surface) and Spills and PSM (Drainage Dump)	A99	0.28	3	3	112.2	18.8	5.6
Spills and PSM (Drainage Dump)	A118	0.07	3	3	27.1	4.6	1.4
Drainage	A21	0.34	3	3	97.7	16.4	4.9
	A22	0.17	3	3	43.7	7.3	2.2
CWD	A15	0.31	3	3	129.0	21.7	6.4
	A16	0.08	3	3	100.2	16.8	5.0
	A17	0.19	3	3	47.7	8.0	2.4
	A18	0.42	3	3	79.8	13.4	4.0
	A19	0.04	3	3	3.8	0.6	0.2
	A20	0.19	3	3	62.1	10.4	3.1

OU = Occasional Use Area
RW = Remote Work Area

Bold indicates the values exceeding 25 mrem/yr.
-- = Not applicable; calculated from surface TLD

A.3.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each sample plot were determined as described in [Section A.2.3.1](#). 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.3-6](#). The minimum sample size was met for both plots. Internal dose results for locations where grab samples were collected are presented in [Table A.3-7](#).

Table A.3-6
Atmospheric Test Site T-1, 95% UCL Internal Dose at Plot Locations
for Each Exposure Scenario

Release	Location	Standard Deviation (OU Scenario)	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 Release	A01	0.0	4	3	5.4	0.9	0.3
	A02	0.1	4	3	6.3	1.1	0.4

Table A.3-7
Atmospheric Test Site T-1, Internal Dose at Grab Sample Locations
for Each Exposure Scenario

Release	Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	A06a	0.0	0.0	0.0
	A06b (subsurface)	0.0	0.0	0.0
Atmospheric Release and Spills and PSM	A99	1.2	0.2	0.1
Spills and PSM	A118	2.5	0.4	0.2
CWD	A15	2.8	0.5	0.2
	A16	0.8	0.1	0.0
	A17	0.0	0.0	0.0
	A18	0.2	0.0	0.0
	A19*	0.0	0.0	0.0
	A20	0.0	0.0	0.0
Drainage	A21	3.3	0.6	0.2
	A22	0.3	0.1	0.0

*FD was taken at this location; results are average of two samples.

Table A.3-8 presents the contributions of internal and external doses to TED at each sample plot. This demonstrates that internal dose at this CAS comprises a small percentage of TED.

Table A.3-8
Atmospheric Test Site T-1, Contribution of Internal Dose to TED at Each Plot

Release	Location	Average Internal Dose (mrem/RW-yr)	Average Total Dose (mrem/RW-yr)	Percent Internal Dose
Atmospheric Release	A01	0.7	24.5	0.03
	A02	0.9	36.5	0.02

A.3.3.3 Total Effective Dose

The TED for each sample plot, grab sample 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.3-9](#).

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 1 of 6)

Release	Type	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 Release	Plot	A01	145.9	153.4	24.5	25.8	7.3	7.7
		A02	217.4	226.3	36.5	38.0	10.9	11.4
	TLD Only	A03	209.0	215.6	35.1	36.2	10.5	10.8
		A04	136.4	143.2	22.9	24.1	6.9	7.2
		A05	128.1	140.9	21.5	23.7	6.4	7.1
	TLD and Surface Grab	A06a	95.0	104.0	16.0	17.5	4.8	5.2
	TLD and Subsurface Grab	A06b (subsurface)	172.7	190.9	29.2	32.3	8.7	9.6
	TLD Only	A07	130.9	143.2	22.0	24.1	6.6	7.2
		A08	135.6	151.8	22.8	25.5	6.8	7.6
		A09	142.1	148.5	23.9	24.9	7.1	7.5
		A10	70.5	79.8	11.8	13.4	3.5	4.0
		A11	57.3	65.7	9.6	11.0	2.9	3.3

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 2 of 6)

Release	Type	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 Release	TLD Only	A12	130.1	140.4	21.9	23.6	6.5	7.1
		A13	89.8	97.8	15.1	16.4	4.5	4.9
		A14	65.2	70.1	11.0	11.8	3.3	3.5
CWD	TLD and Grab	A15	121.2	131.8	20.4	22.1	6.1	6.6
		A16	98.4	101.1	16.5	17.0	4.9	5.1
		A17	41.3	47.7	6.9	8.0	2.1	2.4
		A18	65.8	80.0	11.1	13.4	3.3	4.0
		A19	2.5	3.8	0.4	0.6	0.1	0.2
		A20	55.6	62.1	9.3	10.4	2.8	3.1
Drainage		A21	89.5	101.0	15.0	17.0	4.5	5.1
		A22	38.2	44.0	6.4	7.4	1.9	2.2
Atmospheric Release	TLD Only	A27	83.9	94.3	14.1	15.8	4.2	4.7
		A28	93.7	102.2	15.7	17.2	4.7	5.1
		A29	80.5	84.2	13.5	14.1	4.0	4.2
		A30	52.1	59.1	8.8	9.9	2.6	3.0
		A31	120.7	122.5	20.3	20.6	6.1	6.2
		A32	77.6	88.4	13.0	14.9	3.9	4.4
		A33	73.3	77.0	12.3	12.9	3.7	3.9
		A34	82.9	91.3	13.9	15.3	4.2	4.6
		A35	60.4	66.7	10.1	11.2	3.0	3.3
		A36	46.6	49.8	7.8	8.4	2.3	2.5
		A37	81.1	97.6	13.6	16.4	4.1	4.9
		A38	44.6	48.5	7.5	8.1	2.2	2.4
		A39	15.1	17.8	2.5	3.0	0.8	0.9
		A40	4.7	6.1	0.8	1.0	0.2	0.3
		A41	23.9	28.5	4.0	4.8	1.2	1.4
		A42	54.8	61.6	9.2	10.4	2.8	3.1

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 3 of 6)

Release	Type	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 Release	TLD Only	A43	42.5	43.5	7.1	7.3	2.1	2.2
		A44	15.9	18.9	2.7	3.2	0.8	1.0
		A45	20.8	40.5	3.5	6.8	1.0	2.0
		A46	31.2	33.6	5.2	5.6	1.6	1.7
		A47	65.5	71.5	11.0	12.0	3.3	3.6
		A48	13.9	17.4	2.3	2.9	0.7	0.9
		A49	17.5	19.3	2.9	3.2	0.9	1.0
		A50	12.5	14.4	2.1	2.4	0.6	0.7
		A51	14.5	18.1	2.4	3.0	0.7	0.9
		A52	38.4	43.5	6.5	7.3	1.9	2.2
		A53	40.0	48.9	6.7	8.2	2.0	2.5
		A54	18.3	21.6	3.1	3.6	0.9	1.1
		A55	12.0	14.5	2.0	2.4	0.6	0.7
		A56	26.3	30.3	4.4	5.1	1.3	1.5
		A57	56.2	64.6	9.4	10.8	2.8	3.2
		A58	21.2	25.8	3.6	4.3	1.1	1.3
		A59	18.7	23.1	3.1	3.9	0.9	1.2
		A60	12.9	25.0	2.2	4.2	0.6	1.3
		A61	5.0	7.3	0.8	1.2	0.3	0.4
		A62	32.6	36.9	5.5	6.2	1.6	1.9
		A63	11.1	17.3	1.9	2.9	0.6	0.9
		A64	11.5	14.0	1.9	2.3	0.6	0.7
		A65	8.2	11.2	1.4	1.9	0.4	0.6
		A66	6.8	7.7	1.2	1.3	0.3	0.4
		A67	3.6	5.6	0.6	0.9	0.2	0.3
		A68	5.0	8.9	0.8	1.5	0.2	0.4
		A69	5.0	12.4	0.8	2.1	0.3	0.6

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 4 of 6)

Release	Type	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 Release	TLD Only	A70	2.1	2.7	0.4	0.4	0.1	0.1
		A71	3.0	4.5	0.5	0.8	0.1	0.2
		A72	11.9	16.7	2.0	2.8	0.6	0.8
		A73	3.0	4.0	0.5	0.7	0.2	0.2
		A74	65.0	68.4	10.9	11.5	3.3	3.4
		A75	77.1	85.6	13.0	14.4	3.9	4.3
		A76	60.2	67.8	10.1	11.4	3.0	3.4
		A77	60.2	65.6	10.1	11.0	3.0	3.3
		A78	42.8	46.0	7.2	7.7	2.2	2.3
		A79	6.3	7.3	1.1	1.2	0.3	0.4
		A80	5.3	7.9	0.9	1.3	0.3	0.4
		A81	0.0	1.3	0.0	0.2	0.0	0.1
		A82	1.3	3.1	0.2	0.5	0.1	0.2
		A83	1.7	2.8	0.3	0.5	0.1	0.1
		A84	8.6	14.8	1.4	2.5	0.4	0.7
		A85	4.0	8.8	0.7	1.5	0.2	0.4
		A86	3.3	6.8	0.6	1.1	0.2	0.3
		A87	2.9	6.2	0.5	1.0	0.1	0.3
		A88	7.2	11.2	1.2	1.9	0.4	0.6
		A89	7.9	11.2	1.3	1.9	0.4	0.6
		A90	11.0	14.9	1.8	2.5	0.6	0.8
		A91	24.7	27.3	4.1	4.6	1.2	1.4
		A92	18.5	22.7	3.1	3.8	0.9	1.1
		A93	15.4	17.7	2.6	3.0	0.8	0.9
		A94	4.8	7.1	0.8	1.2	0.2	0.4
		A95	2.3	3.0	0.4	0.5	0.1	0.2
		A96	8.9	10.6	1.5	1.8	0.4	0.5

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 5 of 6)

Release	Type	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 Release	TLD Only	A97	9.8	11.6	1.6	1.9	0.5	0.6
		A98	34.7	36.6	5.8	6.1	1.7	1.8
		A100	6.2	7.9	1.0	1.3	0.3	0.4
		A101	3.3	5.3	0.5	0.9	0.2	0.3
		A102	11.2	14.5	1.9	2.4	0.6	0.7
		A103	18.7	24.4	3.1	4.1	0.9	1.2
		A104	13.4	15.2	2.3	2.6	0.7	0.8
		A105	5.0	5.8	0.8	1.0	0.3	0.3
		A106	3.1	5.5	0.5	0.9	0.2	0.3
		A107	1.5	4.8	0.3	0.8	0.1	0.2
		A108	20.9	21.9	3.5	3.7	1.1	1.1
		A109	7.8	14.1	1.3	2.4	0.4	0.7
		A110	15.2	15.8	2.6	2.7	0.8	0.8
		A111	7.4	8.8	1.2	1.5	0.4	0.4
		A112	1.5	2.4	0.3	0.4	0.1	0.1
		A113	1.0	2.7	0.2	0.5	0.1	0.1
		A114	1.7	4.2	0.3	0.7	0.1	0.2
		A115	0.8	1.8	0.1	0.3	0.0	0.1
		A116	3.2	4.9	0.5	0.8	0.2	0.2
		A117	0.0	2.5	0.0	0.4	0.0	0.1
Spills and PSM	TLD and Grab	A99	103.8	113.4	17.4	19.1	5.2	5.7
		A118	27.1	29.6	4.6	5.0	1.4	1.5
		A119	0.8	3.5	0.1	0.6	0.0	0.2
		A120	0.0	0.5	0.0	0.1	0.0	0.0
		A121	0.4	0.9	0.1	0.2	0.0	0.0
		A122	1.9	3.5	0.3	0.6	0.1	0.2
		A123	2.6	3.4	0.4	0.6	0.1	0.2

Table A.3-9
Atmospheric Test Site T-1, TED at Sample Locations (mrem/yr)
(Page 6 of 6)

Release	Type	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
Spills and PSM	TLD and Grab	A124	6.6	7.7	1.1	1.3	0.3	0.4
		A125	2.8	5.9	0.5	1.0	0.1	0.3
		A126	4.6	7.4	0.8	1.2	0.2	0.4
		A127	1.8	4.3	0.3	0.7	0.1	0.2
		A128	3.4	7.3	0.6	1.2	0.2	0.4
		A129	2.8	4.4	0.5	0.7	0.1	0.2
		A130	4.2	5.4	0.7	0.9	0.2	0.3
		A131	3.7	6.4	0.6	1.1	0.2	0.3
		A132	7.7	10.9	1.3	1.8	0.4	0.5
		A133	1.6	3.6	0.3	0.6	0.1	0.2
		A134	7.5	12.5	1.3	2.1	0.4	0.6
		A135	5.2	8.9	0.9	1.5	0.3	0.4

Bold indicates the values exceeding 25 mrem/yr.

The TED for sampling locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at locations A01, A02, A03, A06, and A08 ([Figure A.3-5](#)). Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), TED at the sampled location with the maximum TED (A06b) is predicted to decay below the TED within 10 years. The TED at this location is currently driven by europium (Eu)-43, which contributes over 95 percent to the total dose.

A.3.3.4 Chemical Contaminants

One cracked lead-acid battery was identified as PSM at Atmospheric Test Site T-1. Two samples were collected from the location (A136) where the cracked lead-acid battery was removed. These samples were analyzed for RCRA metals and Cr(VI). No other chemical samples were collected at this CAS. The analytical results exceeding minimum detectable concentrations (MDCs) from the samples are

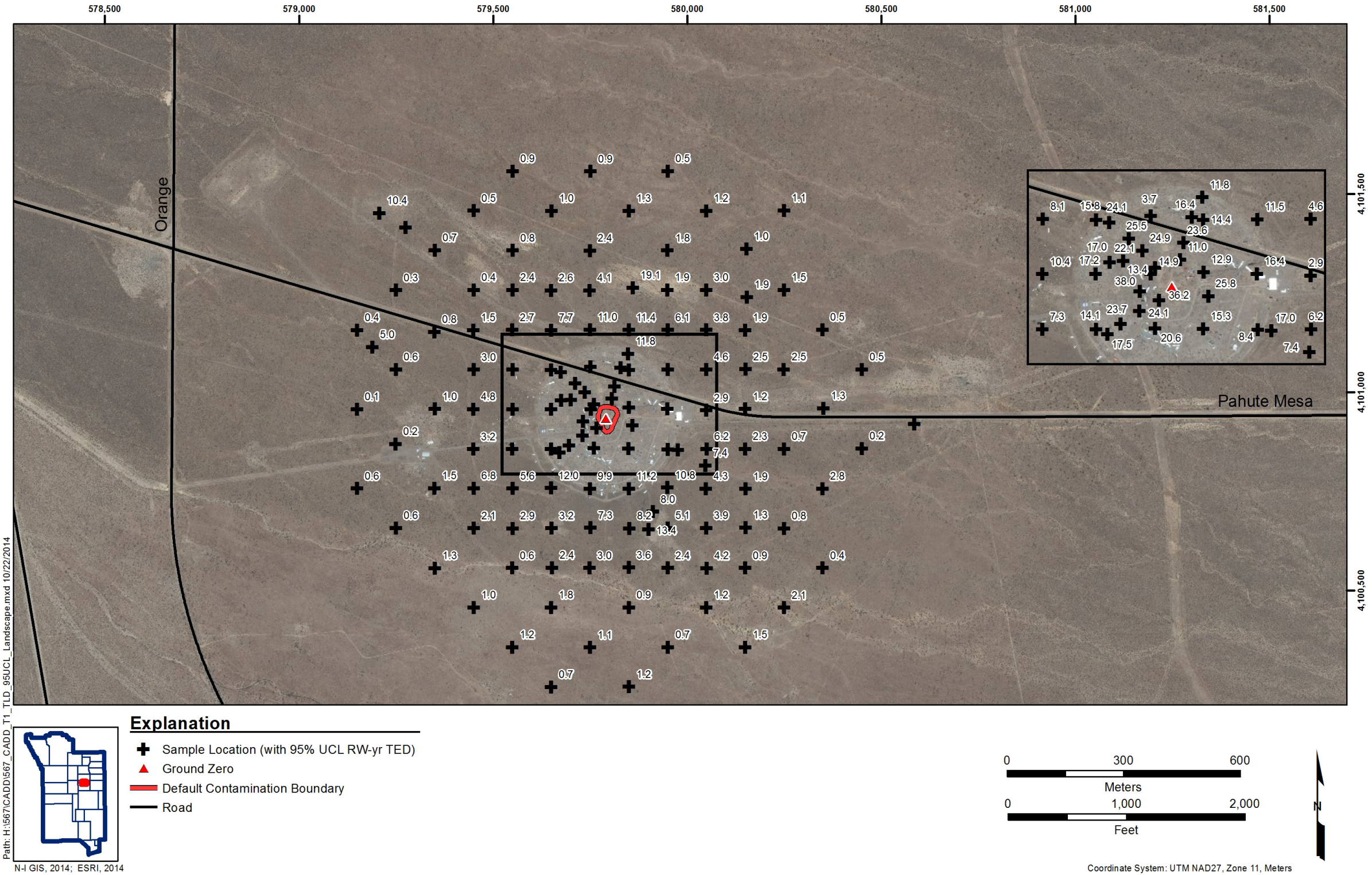


Figure A.3-5
95% UCL of the TED at Atmospheric Test Site T-1

presented in [Table A.3-10](#). Results for Cr(VI) exceeded the PAL of 5.6 milligrams per kilogram (mg/kg), but were below the site-specific FAL that was established at 8.42 mg/kg as described in [Section C.1.11](#). Sample results did not exceed FALs.

Table A.3-10
Atmospheric Test Site T-1, Sample Results for Metals

Release	Location	Sample Number	RCRA Metals						Cr(VI)
			Arsenic	Barium	Cadmium	Lead	Mercury	Selenium	
FALs (mg/kg)			23	190,000	9,300	800	43	5,100	8.42
Spills and PSM	A136	A014	5.5	220	0.25	43	--	0.55	7.4
		A015	4.1	210	0.21	57	0.042	1.1	7.0

-- = Not detected

A.3.4 Nature and Extent of COCs

PSM in the form of a bucket of lead-contaminated grease and a broken lead-acid battery was identified, and corrective actions were completed during the investigation. The grease was contained in the bucket, and no visible staining or odor was present in adjacent soil. Therefore, it was determined that the extent of the PSM was limited to the physical dimensions of the waste. The lead-acid battery was determined to be PSM based on the presence of metallic lead. As the results from two grab samples that were collected from the removal site and analyzed for RCRA metals were below the FALs, the extent of the PSM was limited to the physical dimensions of the waste.

As presented in [Section A.3.3](#), radiological contamination is present that exceeds the FAL. To determine the extent of the area where the Remote Worker TED exceeds the FAL, a correlation of radiation survey values to TED values as described in [Section A.2.5](#) was conducted for the TRS, which had a correlation of 0.96, which exceeds the minimum criteria of 0.8 as set forth in the DQOs using methods defined in the Soils RBCA document (NNSA/NFO, 2014). The inset chart in [Figure A.3-6](#) shows the LCL of this correlation (as described in [Section A.2.5](#)). The radiation survey value that corresponds to the 25-mrem/RW-yr FAL is 9.77 multiples of background, and an FFACO UR was established around this area. The affected volume of contaminated material within the

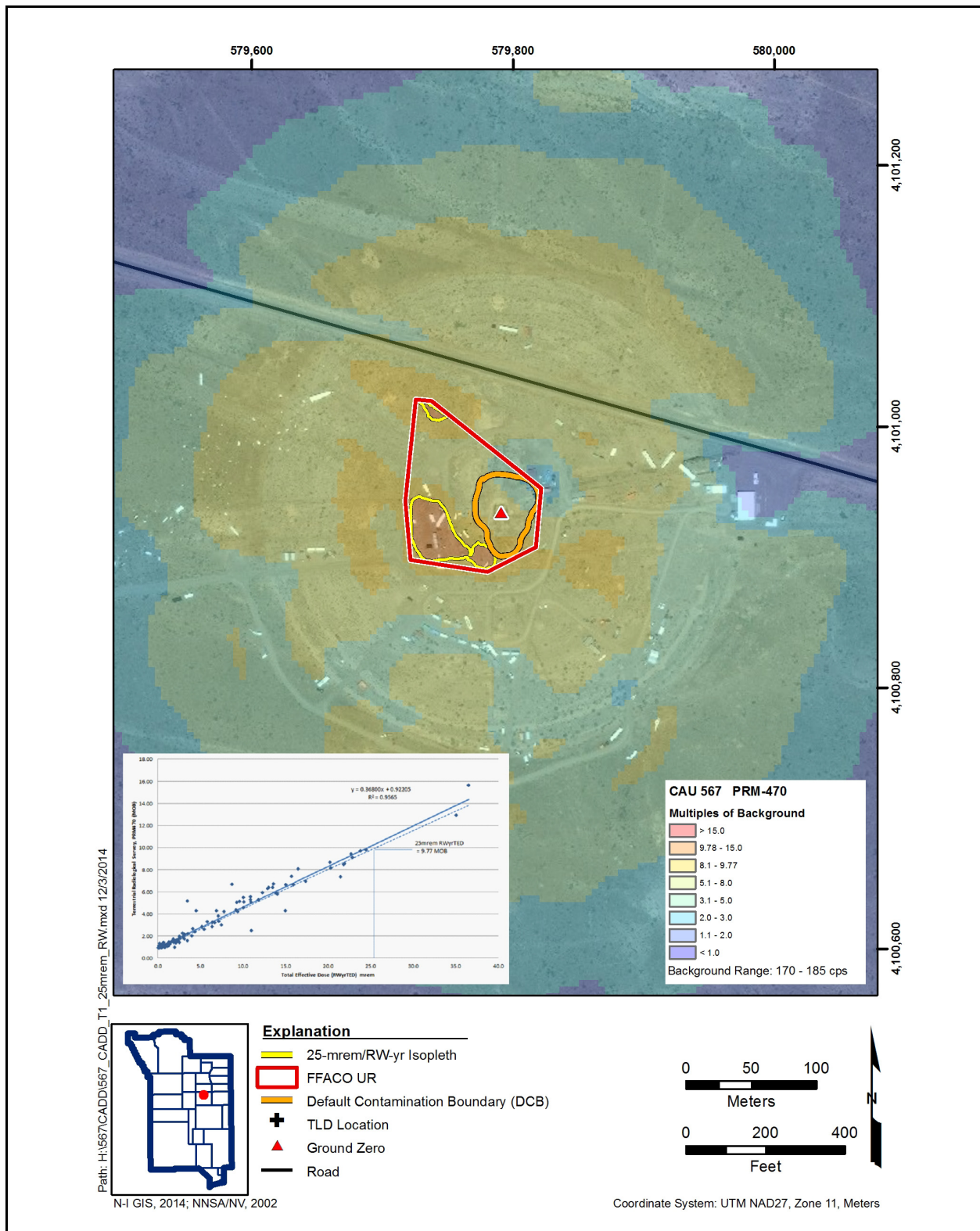


Figure A.3-6
Atmospheric Test Site T-1, 25-mrem/RW-year Isopleth and DCB

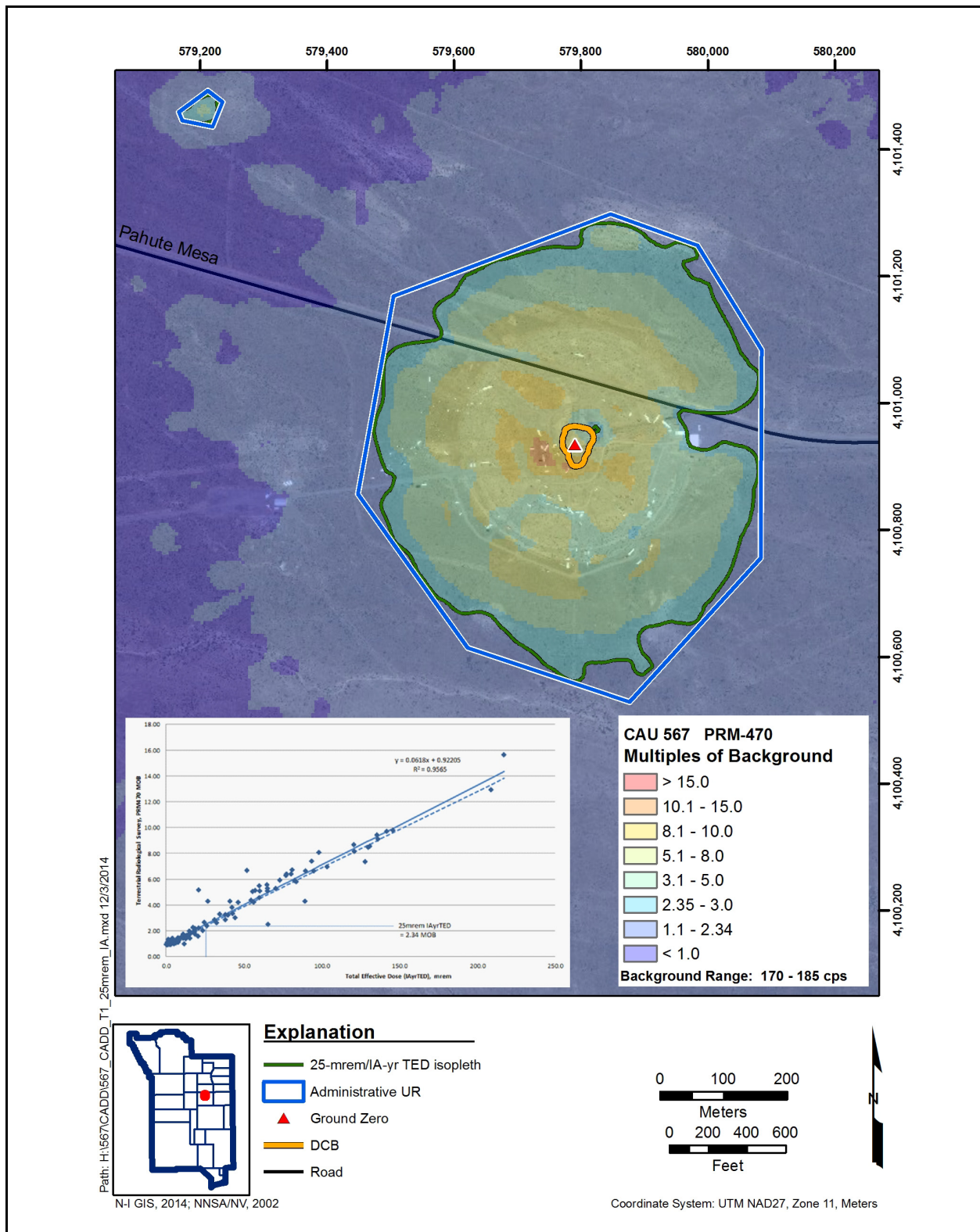
isopleth and the DCB is estimated to be 9,473 yd³. This estimate is based on assumed depth of the excavation to be 1 ft bgs within the 9.77 multiples of background isopleth and at a height of 10 ft within the area of the DCB to include the bunker and debris. The FFACO UR is presented in [Attachment D-1](#).

During investigation planning, it was assumed that buried contamination was present in the bunker area located at the test GZ, and a DCB was established with the extent of the COC contamination defined by the physical dimensions of the bunker area. The affected volume of contaminated material within this area is estimated to be 8,726 yd³. This estimate is based on the area of the DCB at a height of 10 ft to include the bunker and debris.

No COCs were identified in the drainage. The potential for future migration of COC levels of radioactivity in local drainages can be evaluated based on the physical properties of the soil and the contaminants, the 64 years since the contamination was released to the surface, and on investigation results. In the 64 years since testing at Atmospheric Test Site T-1 began, radionuclides at levels detectable by radiation surveys (either the aerial survey or TRS) 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 the site 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 1,250 ft bgs).

A.3.5 Best Management Practices

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 TED exceeds the PAL (Industrial Area scenario), a correlation of radiation survey values to the average Industrial Area TED values was conducted for the PRM-470 TRS as described in [Section A.2.5](#). The inset chart in [Figure A.3-7](#) shows the LCL of this correlation (as described in [Section A.2.5](#)). The radiation survey value that corresponds to the 25-mrem/OU-yr PAL is 2.34 multiples of background, and an administrative UR was established around this area as shown on [Figure A.3-7](#). The administrative UR is presented in [Attachment D-1](#).



A.4.0 CAS 03-23-25, Seaweed E Contamination Area

CAS 03-23-25, Seaweed E Contamination Area, is located in the eastern portion of Area 3 of the NNSS. Releases present at the site include the surface release of radionuclides from venting of three underground weapons tests. Additional detail on the history of the CAS is provided in the CAIP (NNSA/NFO, 2013).

A.4.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.4.1.1 Visual Surveys

Visual surveys were conducted during site walks, while sampling, and while performing TRSs at Seaweed E Contamination Area. Biasing factors that would indicate the potential release of contaminants were not identified during these efforts. Samples were not collected based on visual survey results.

A.4.1.2 Radiological Surveys

TRSs were performed at Seaweed E Contamination Area during the 2012 preliminary investigation, before the CAIP was published, and are reported in the CAIP (NNSA/NFO, 2013). As presented in Section 2.5.2.2 of the CAIP, radioactivity above background was not detected in the areas around the test locations. Elevated readings within the contamination area north of the Seaweed E test location were investigated as a separate CAS and closed as part of CAU 137 (NNSA/NSO, 2007). Because elevated readings were not detected, radiological surveys were not used to determine sample locations.

A.4.1.3 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013). The specific CAI activities conducted at this CAS are described in the following subsections.

A.4.1.3.1 TLD Samples

Three TLDs were placed at Seaweed E Contamination Area—one at each GZ (locations B01, B02, and B03)—to measure the external dose for the atmospheric release; and three TLDs were placed to measure background dose. [Table A.4-1](#) provides detailed information including location, dates placed and collected, and serial number for each TLD. Locations where environmental and background TLDs were placed are shown on [Figure A.4-1](#).

**Table A.4-1
TLDs at Seaweed E Contamination Area**

Release	Location	TLD No.	Date Placed	Date Removed
Atmospheric Release	B01	3854	08/07/2013	11/21/2013
	B02	5157	08/07/2013	11/21/2013
	B03	4932	08/07/2013	11/21/2013
Background	B04	4709	08/07/2013	11/21/2013
	B05	4363	08/07/2013	11/21/2013
	B06	4741	08/07/2013	11/21/2013

A.4.1.3.2 Soil Samples

Three soil samples were collected to measure the atmospheric release. Soil sampling consisted of one grab sample at each test GZ (locations B01, B02, and B03). All samples were submitted for gamma spectroscopy. Additional information including depth and purpose for each soil sample collected for this CAS is provided in [Table A.4-2](#). Sample locations are shown on [Figure A.4-1](#).

A.4.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.4.3 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/NFO, 2013). The

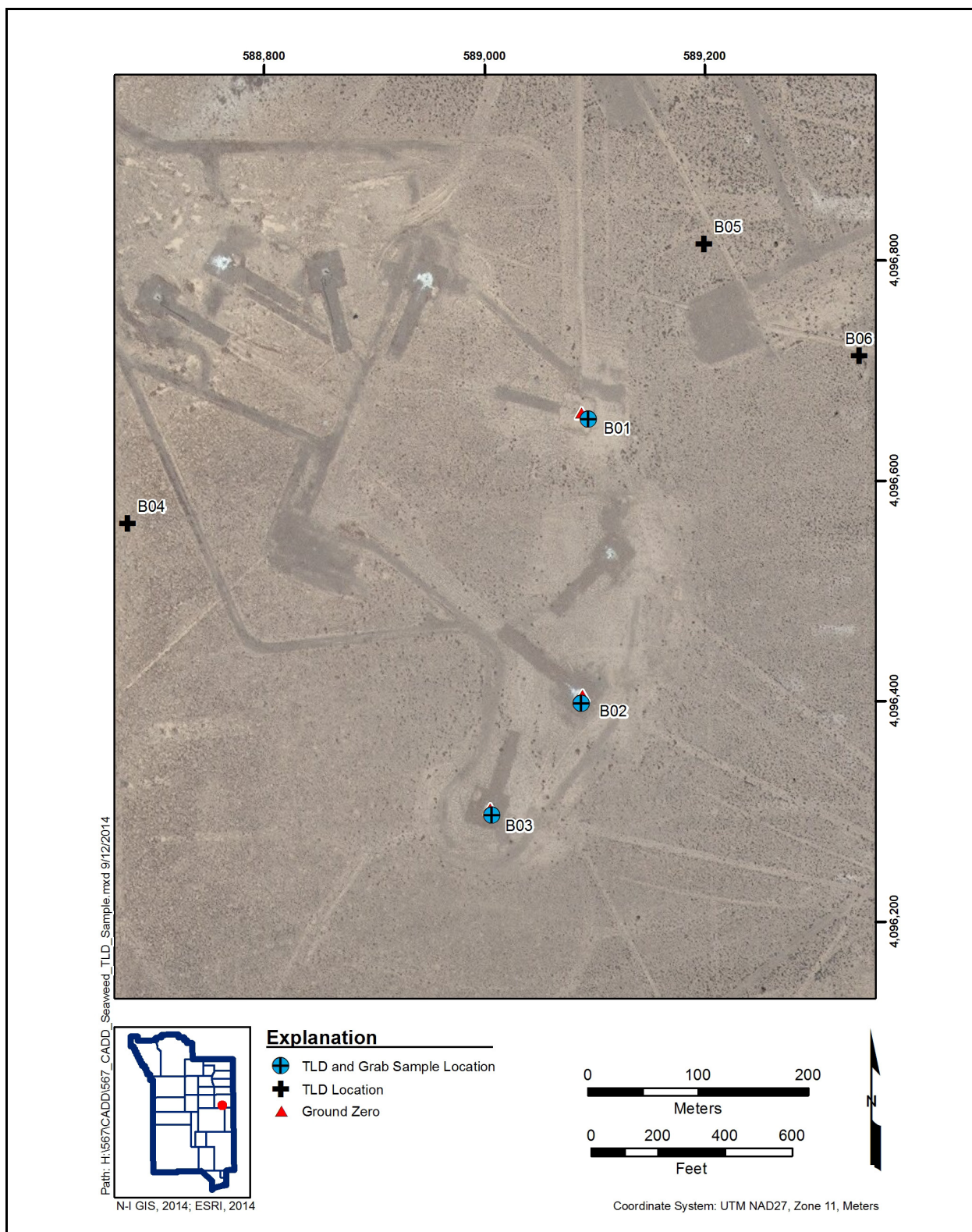


Figure A.4-1
Seaweed E Contamination Area, TLD and Sample Locations

Table A.4-2
Samples Collected at Seaweed E Contamination Area

Release	Location	Sample Number	Depth (in. bgs)	Matrix	Purpose
Atmospheric Release	B01	B001	0.0 - 3.0	Soil	Environmental
	B02	B002	0.0 - 1.0	Soil	Environmental
	B03	B003	0.0 - 1.0	Soil	Environmental

radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr.

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.4.3.1](#). Internal doses for each sample plot are summarized in [Section A.4.3.2](#). The TEDs for each sampled location are summarized in [Section A.4.3.3](#).

A.4.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in [Section A.2.3.2](#). 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.4-3](#).

Table A.4-3
Seaweed E Contamination Area, 95% UCL External Dose for Each Exposure Scenario

Release	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 Release	B01	0.2	3	3	1.2	0.2	0.1
	B02	1.7	3	3	2.1	0.4	0.1
	B03	2.5	3	3	2.0	0.3	0.1

A.4.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each sample location were determined as described in [Section A.2.3.1](#). The internal dose for each exposure scenario was indistinguishable from background and is presented in [Table A.4-4](#).

Table A.4-4
Seaweed E Contamination Area, Internal Dose for Each Exposure Scenario

Release	Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Atmospheric Release	B01	0.0	0.0	0.0
	B02	0.0	0.0	0.0
	B03	0.0	0.0	0.0

A.4.3.3 Total Effective Dose

The TED for each grab 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.4-5](#). The TED did not exceed the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/OU-yr) at any location. Results for each location are shown on [Figure A.4-2](#).

Table A.4-5
Seaweed E Contamination Area, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a
Atmospheric Release	B01	0.9	1.2	0.2	0.2	0.0	0.1
	B02	0.0	2.1	0.0	0.4	0.0	0.1
	B03	0.0	2.0	0.0	0.3	0.0	0.1

^aCalculation based on average and 95% UCL of external dose; internal dose based on one sample.

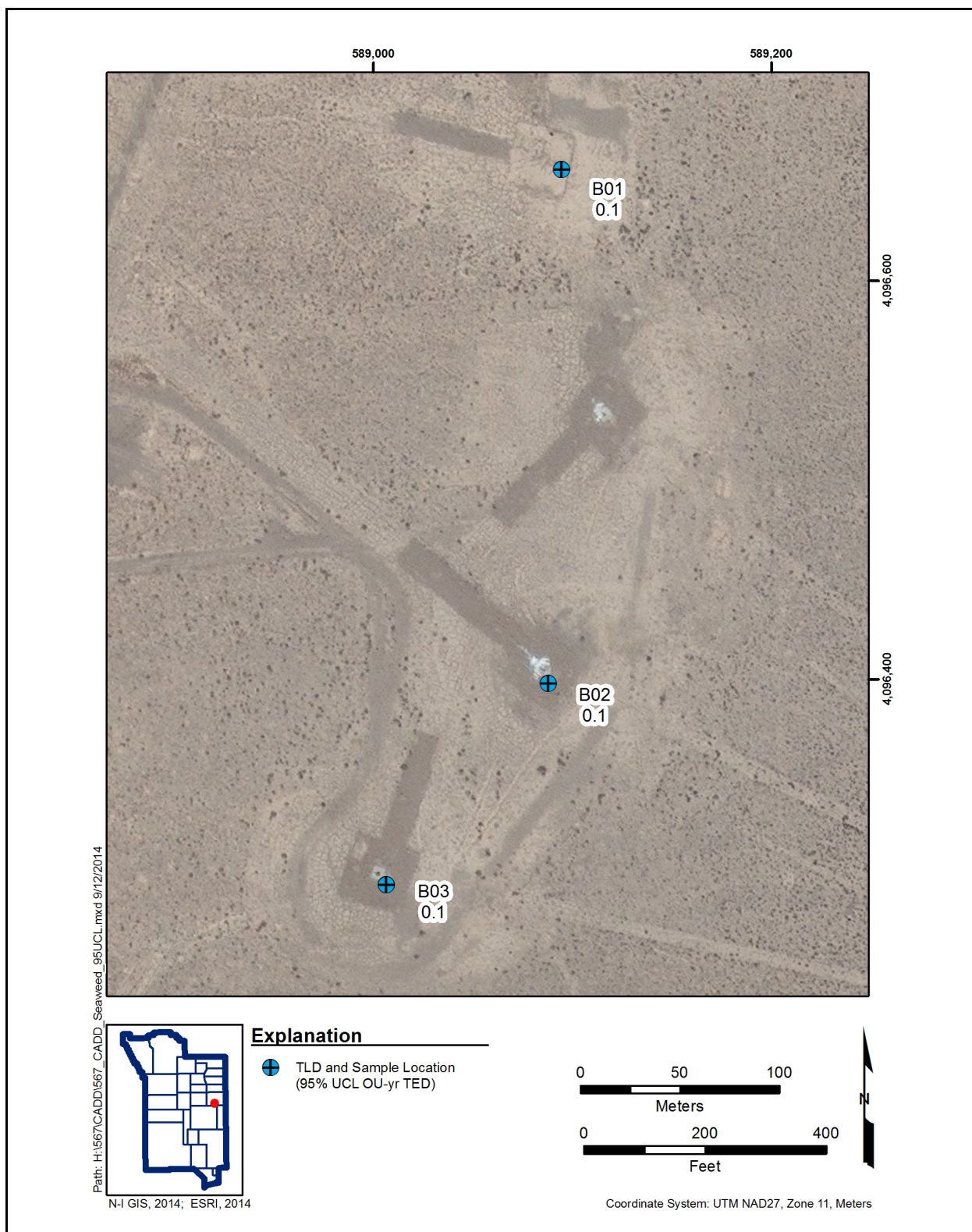


Figure A.4-2
95% UCL of TED at Seaweed E Contamination Area

A.4.4 Nature and Extent of COCs

The TED did not exceed the FAL of 25 mrem/OU-yr at any location; therefore, COCs were not identified at Seaweed E Contamination Area.

A.5.0 CAS 05-23-07, A5b RMA

CAS 05-23-07, A5b RMA, is located in the northeast portion of Area 5 of the NNSS, northwest of Frenchman Flat. DU fragments were present at the site. The release at the site is defined in the CAIP as fragments and vaporized DU in and around a small detonation crater, as well as any spills and PSM from site operations. Additional detail on the history of the CAS is provided in the CAIP (NNSA/NFO, 2013).

A.5.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.5.1.1 Visual Surveys

Visual surveys were conducted during site walks, while sampling, and while performing geophysical surveys and TRSs at A5b Soil RMA. Two pieces of lead were identified during these efforts. Visual surveys were also used to identify the boundaries of two potential landfills based on disturbed areas at the site. Visual surveys combined with radiological surveys were used to identify pieces of DU at and around the detonation crater, and to place sample locations that corresponded with the location of DU pieces.

A.5.1.2 Geophysical Surveys

Geophysical surveys were conducted at two locations identified as potential landfills. Anomalies associated with buried debris were not identified, and it was determined a release was not present and additional investigation activities were not required in the potential landfill areas. [Section G.4.2](#) of [Appendix G](#) contains full descriptions of the geophysical surveys and results. [Figures G.4-28, G.4-29, G.4-31, G.4-32, and G.4-33](#) present results of the geophysical surveys at A5b RMA. Sample locations were not identified as a result of the geophysical surveys.

A.5.1.3 Radiological Field Screening

Radiological screening was performed at location C01, the center of the detonation crater. Although subsurface intervals did not meet screening criteria (i.e., FSR was not greater than the surface FSR), two samples (C001 and C005) were collected from depth intervals to provide additional information.

A.5.1.4 Radiological Surveys

TRSs were performed at A5b RMA to identify the highest level of radioactivity. The initial grid of TLDs at the site was placed and samples were collected from the area of highest radiological readings detected during the TRS, location C01, shown on [Figure A.5-1](#). It was determined that soil removal was needed to lower radioactivity, and 15.9 yd³ of soil was excavated from this area. After the excavation, additional surveys were performed; results are shown on [Figure A.5-2](#).

A.5.1.5 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013). The specific CAI activities conducted at this CAS are described in the following subsections.

A.5.1.5.1 TLD Samples

Initially, a grid of nine TLDs spread across a 10-by-10-m plot was placed at the location of highest radioactivity (location C01). When it was determined this location would exceed the PAL, the area was excavated to remove contaminated soil. After the excavation, a confirmation grid of nine TLDs was placed at this location. Each time TLDs were placed, an additional TLD was placed to measure background doses at the site. [Table A.5-1](#) provides detailed information including location, dates placed and collected, and serial number for each TLD. [Figure A.5-3](#) shows the location of all TLDs at the site.

A.5.1.5.2 Soil Samples

Soil sampling at A5b RMA consisted of the collection of grab samples, subsurface screening and sampling, and confirmation sampling after the removal of the radioactive soil. One of the initial grab samples at the area of highest radioactivity (C007) and the confirmation sample (C008) were composite samples, with nine aliquots taken from a 10-by-10-m grid over the area where soil was

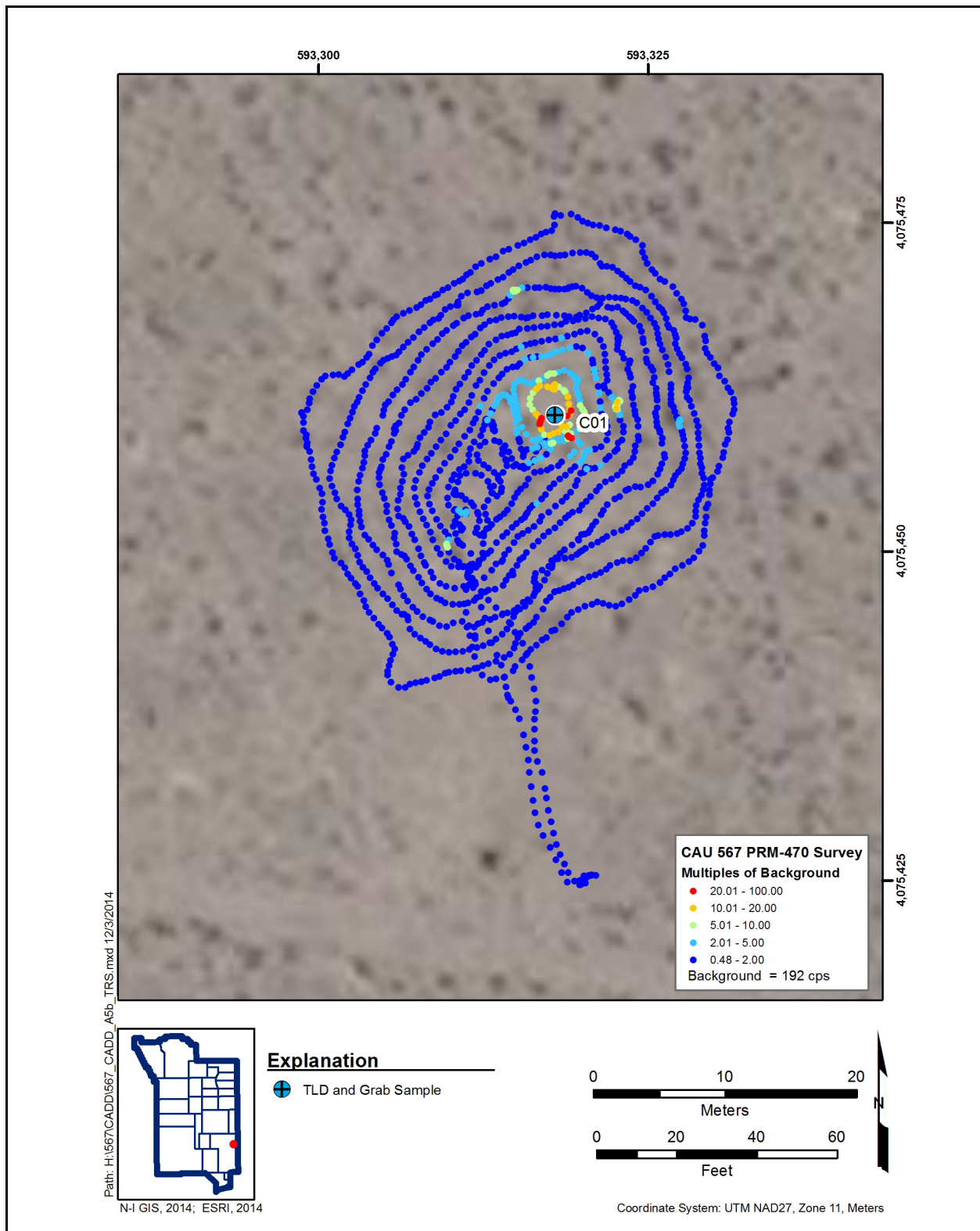


Figure A.5-1
A5b RMA, Initial TRS

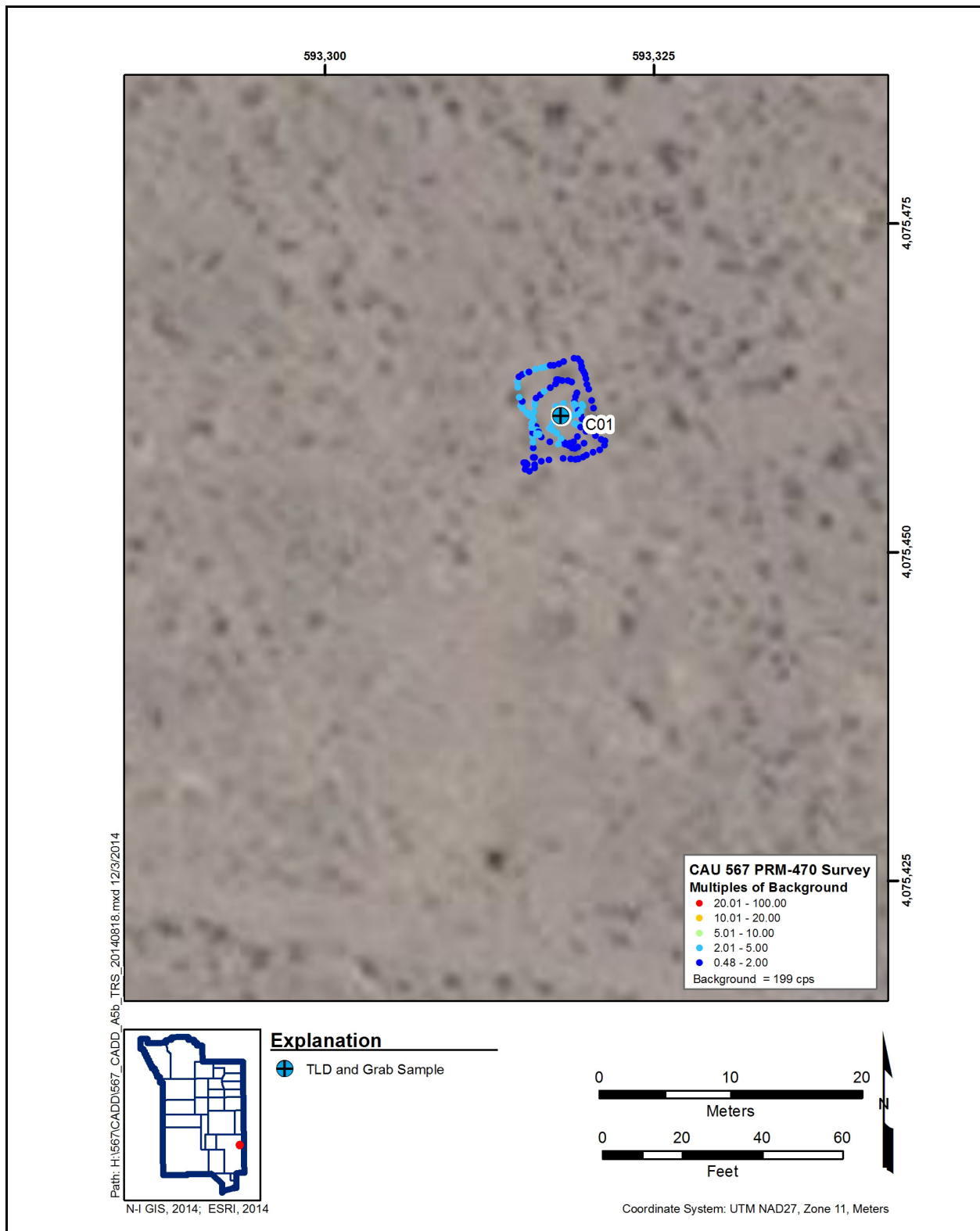


Figure A.5-2
A5b RMA, TRS after Excavation

**Table A.5-1
TLDs at A5b RMA**

Type	Location	TLD No.	Date Placed	Date Removed
Initial	C01	4644	05/19/2014	07/17/2014
		4684	05/19/2014	07/17/2014
		3769	05/19/2014	07/17/2014
		4776	05/19/2014	07/17/2014
		4482	05/19/2014	07/17/2014
		4874	05/19/2014	07/17/2014
		5136	05/19/2014	07/17/2014
		6242	05/19/2014	07/17/2014
		5037	05/19/2014	07/17/2014
Confirmation	C01	4421	07/30/2014	09/22/2014
		6219	07/30/2014	09/22/2014
		6150	07/30/2014	09/22/2014
		4339	07/30/2014	09/22/2014
		6079	07/30/2014	09/22/2014
		5028	07/30/2014	09/22/2014
		6173	07/30/2014	09/22/2014
		6359	07/30/2014	09/22/2014
		4586	07/30/2014	09/22/2014
Background	C05	5272	05/19/2014	07/17/2014
		6107	07/30/2014	09/22/2014

removed. Two grab samples (C001 and C005) were subsurface samples collected from the area before excavation, one grab sample (C004) collected from the surface before excavation. Two grab samples (C002 and C009) were also collected from locations where pieces of DU were removed (locations C02 and C03) but away from the area where soil was excavated. All soil samples except C006 were analyzed for isotopic U.

One composite grab sample was collected from a 6-by-6-m grid established in soil adjacent to two lead pieces removed from the site (location C04) and was analyzed for RCRA metals and Cr(VI).

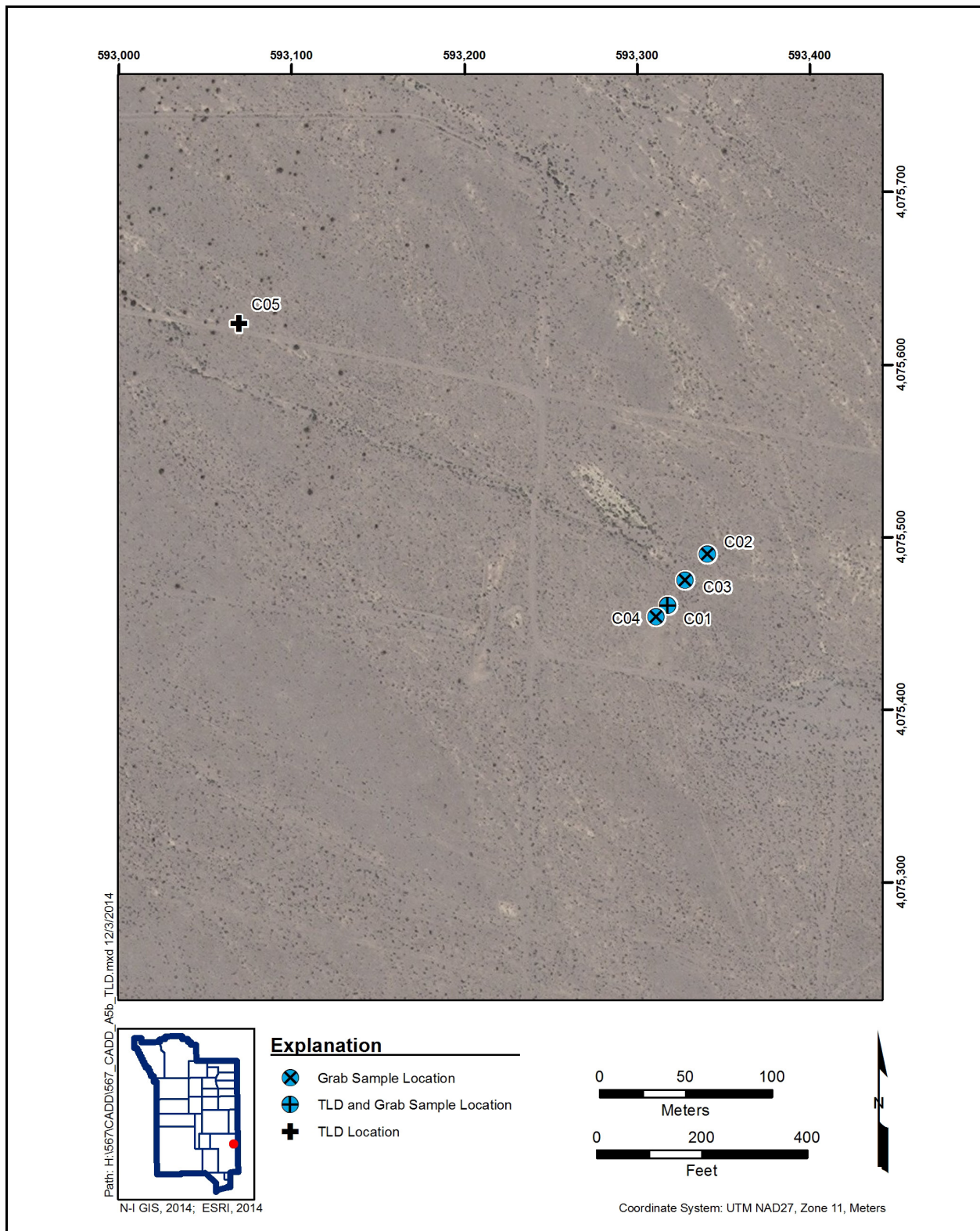


Figure A.5-3
A5b RMA, TLD and Sample Locations

Table A.5-2 provides details regarding soil samples collected at A5b RMA, and Figure A.5-3 shows sample locations.

Table A.5-2
Samples Collected at A5b RMA

Type	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Initial	C01a	C001	15.0 - 30.0	Soil	Environmental
	C01b	C004	0.0 - 5.0	Soil	Environmental
	C01c	C005	46.0 - 50.0	Soil	Environmental
	C01d	C007	0.0 - 5.0	Soil	Environmental
Confirmation (away from excavation)	C02	C002	0.0 - 5.0	Soil	Environmental
	C03	C003	0.0 - 5.0	Soil	Environmental
Confirmation (excavation area)	C01e	C008	0.0 - 5.0	Soil	Environmental
Confirmation (lead)	C04	C006	0.0 - 5.0	Soil	Environmental

A.5.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.5.3 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/NFO, 2013). The radiological results are reported as doses that 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.

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.3.3.1. Internal doses for each sample plot are summarized in

[Section A.3.3.2](#). The TEDs for each sampled location are summarized in [Section A.3.3.3](#). Chemical contaminant results for A5b RMA are summarized in [Section A.3.3.4](#).

A.5.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in [Section A.2.3.2](#). 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. External dose for subsurface sample collected at location C01 and surface samples at locations C02 and C03 was calculated using the surface TLD results as described in [Section A.2.3.2](#). After removal of DU and contaminated soil, levels of radioactivity at location C01 were indistinguishable from background. 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](#).

Table A.5-3
A5b RMA, 95% UCL External Dose for Each Exposure Scenario

Type	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)
Initial	C01a (subsurface)	N/A ^a	N/A ^a	N/A ^a	1.5	0.2	0.1
	C01c (subsurface)	N/A ^a	N/A ^a	N/A ^a	0.4	0.1	0.0
	C01d	81.5	27	3	66.5	11.2	3.3
	C02	N/A ^a	N/A ^a	N/A ^a	1.5	0.3	0.1
	C03	N/A ^a	N/A ^a	N/A ^a	0.7	0.1	0.0
Confirmation	C01e	17.8	27	3	20.1	3.4	1.0

^aCalculated value

Bold indicates the values exceeding 25 mrem/yr.

A.5.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each sample location were determined as described in [Section A.2.3.1](#). The internal dose for each exposure scenario is presented in [Table A.5-4](#).

**Table A.5-4
A5b RMA, Internal Dose for Each Exposure Scenario**

Type	Location	Sample Number	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Initial	C01a (subsurface)	C001	0.0	0.0	0.0
	C01b	C004	0.9	0.2	0.0
	C01c (subsurface)	C005	0.0	0.0	0.0
	C01d	C007	0.0	0.0	0.0
Confirmation	C02	C002	0.0	0.0	0.0
	C03	C003	0.0	0.0	0.0
	C01e	C008	0.0	0.0	0.0

A.5.3.3 Total Effective Dose

The TED for each sample plot, grab sample location, and 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.5-5](#). The TED did not exceed the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/OU-yr) at any location.

Although the FAL was not exceeded, the PAL (the 95 percent UCL of the average TED exceeding 25 mrem/IA-yr) was exceeded at location C01. As a BMP, soil was removed from that area during the investigation. The TED at location C01 after the soil removal is below the PAL. The TED at each sample location after excavation is shown on [Figure A.5-4](#).

**Table A.5-5
A5b RMA, TED at Sample Locations (mrem/yr)**

Type	Location	Sample Number	Industrial Area		Remote Work Area		Occasional Use Area	
			Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a
Initial	C01a (subsurface)	C001	1.4	1.5	0.2	0.3	0.1	0.1
	C01b	C004	46.0	67.4	7.7	11.3	2.3	3.4
	C01c (subsurface)	C005	0.4	0.5	0.1	0.1	0.0	0.0
	C01d	C007	45.1	66.5	7.6	11.2	2.3	3.3
Confirmation	C02	C002	1.4	1.5	0.2	0.3	0.1	0.1
	C03	C003	0.6	0.7	0.1	0.1	0.0	0.0
	C01e	C008	15.4	20.1	2.6	3.4	0.8	1.0

^aCalculation based on average internal dose and 95% UCL of external dose.

Bold indicates the values exceeding 25 mrem/yr.

A.5.3.4 Chemical Contaminants

One composite grab sample (C006) was collected from soil after two pieces of lead were removed from the site (location C04). The sample was analyzed for RCRA metals and Cr(VI). The analytical results exceeding MDCs from the sample are presented in [Table A.5-6](#). Results for Cr(VI) exceeded the PAL of 5.6 mg/kg but were below the site-specific FAL that was established at 8.42 mg/kg as described in [Section C.1.11](#). Sample results did not exceed the FALs.

A.5.4 Nature and Extent of COCs

Soil and TLD samples were collected from the detonation crater per Section 8.3.1 of the CAIP (NNSA/NFO, 2013). The TED did not exceed the FAL of 25 mrem/OU-yr at any location. Additionally, geophysical surveys did not detect any anomalies indicating the presence of landfills at the site. Therefore, COCs were not identified at A5b RMA.

PSM in the form of two pieces of lead were identified and corrective actions were completed during the investigation. As the results from one grab sample that was collected from the removal site and

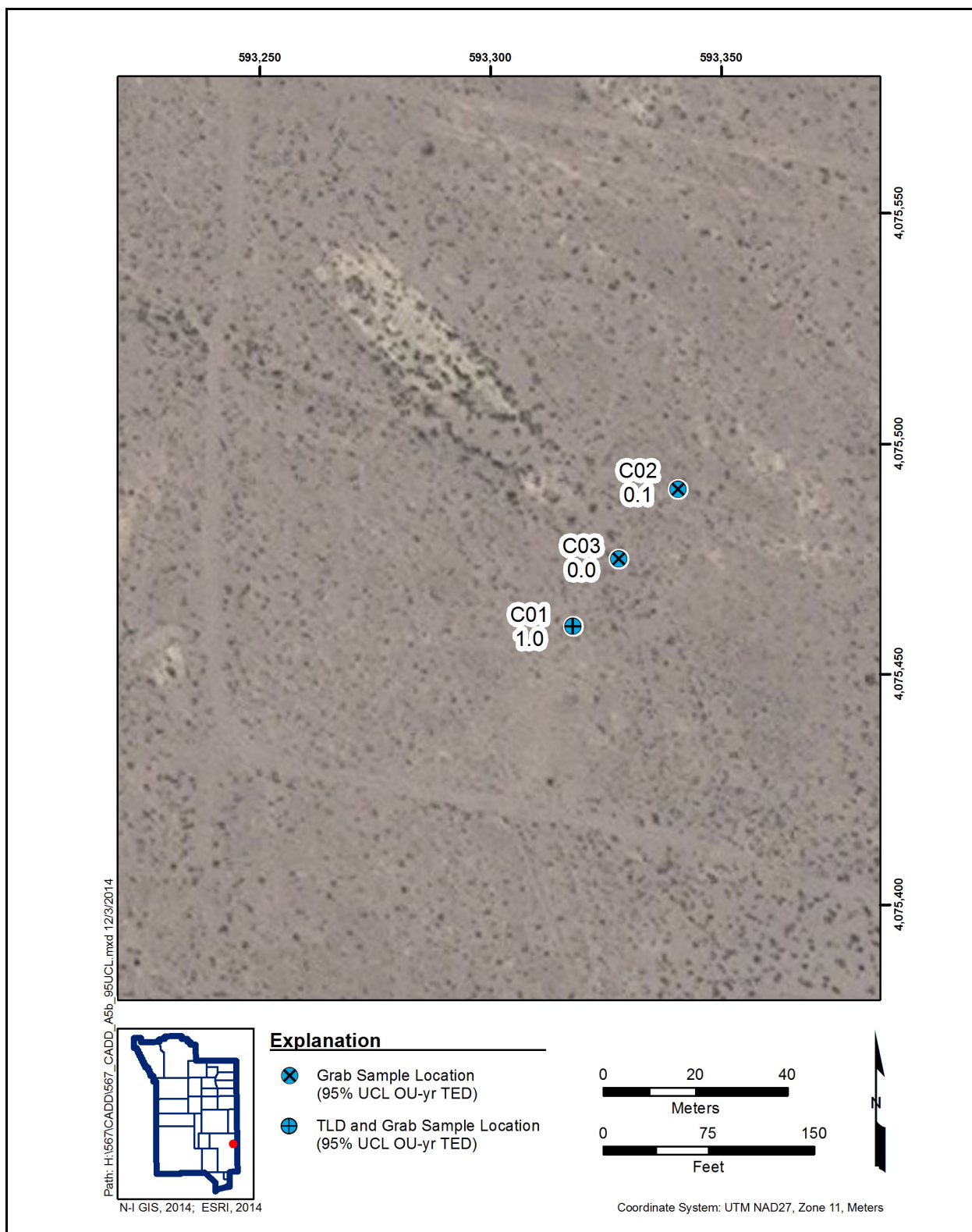


Figure A.5-4
95% UCL of TED after Excavation at A5b RMA

**Table A.5-6
A5b RMA, Sample Results for Metals**

Release	Location	Sample Number	RCRA Metals						Cr(VI)
			Arsenic	Barium	Cadmium	Lead	Mercury	Selenium	
FALs (mg/kg)			23	190,000	450	800	43	5.7	8.42
Spills and PSM	C04	C006	3.6	140	1.1	56	0.044	0.5	5.7

analyzed for RCRA metals was below the FALs, the extent of the PSM was limited to the physical dimensions of the waste.

A.5.5 Best Management Practices

Initially, the PAL (the 95 percent UCL of the average TED exceeding 25 mrem/IA-yr) was exceeded based on soil and TLD samples collected from the area of highest radiological readings, the detonation crater. In order to reduce radioactivity to levels below the PAL, 15.9 yd³ of soil and DU were removed from the crater. DU was also scattered across the site outside the crater area; several of these pieces were also removed during the investigation as well as any adjacent contaminated soil. Additional TRSs were performed, and confirmation soil samples and TLD measurements were taken from the crater area and confirmation soil samples were taken from where two of the pieces had been removed outside the crater area. It was determined using TRSs, soil samples, and TLD samples that after excavation and DU removal, the remaining TED at A5b RMA does not exceed the PAL.

A.6.0 CAS 20-23-08, Colby Mud Spill

CAS 20-23-08, Colby Mud Spill, is located on the eastern side of Area 20 of the NNSS. Releases present at the site include the surface release of radionuclides from a drilling mud spill that traveled down a drainage, the subsequent movement of the mud into an URMA during cleanup efforts, and spills and PSM associated with test and cleanup operations. Additional detail on the history of the CAS is provided in the CAIP (NNSA/NFO, 2013).

A.6.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.6.1.1 Visual Surveys

Visual surveys were conducted during site walks, while sampling, and while performing TRSs at Colby Mud Spill. During these surveys, one lead-acid battery was identified. Additionally, visual surveys were used to identify sample locations at sediment areas within the drainage and to estimate the extent of the URMA.

A.6.1.2 Geophysical Surveys

Geophysical surveys were conducted at the URMA to determine whether debris other than mud had been disposed of there during cleanup efforts. The surveys did not identify any debris in the URMA. [Appendix G](#) contains full descriptions of the geophysical surveys and results. [Figures G.4-35, G.4-36, G.4-38, and G.4-39](#) show results for geophysical surveys at Colby Mud Spill. Sample locations were not identified as a result of the geophysical surveys.

A.6.1.3 Radiological Screening

Radiological screening was used at drainage locations (D01, D02, and D03) to determine whether subsurface contamination was present. Samples were not collected based on screening results at these locations because buried contamination was not present based on the criteria described in

[Section A.2.2.2](#). Although buried contamination was also not identified within the URMA, screening was used to select three intervals for sampling at each of two locations.

A.6.1.4 Radiological Surveys

TRSs were performed at Colby Mud Spill before the CAIP was published and are reported in the CAIP (NNSA/NFO, 2013). As presented in Section 2.5.4.3 of the CAIP, radioactivity at 1.61 to 2.00 times background were detected in two areas within the drainage; however, these were determined to be the result of changes in geology (i.e., potential mineral content and radiation detection instrument geometry effects from the exposed sheer rock faces) and were not used to determine sample locations. Additional TRSs were performed in the URMA, and results are presented on [Figure A.6-1](#). Elevated radioactivity was not seen on this survey and results were not used to determine sample locations.

A.6.1.5 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013). The specific CAI activities conducted at this CAS are described in the following subsections.

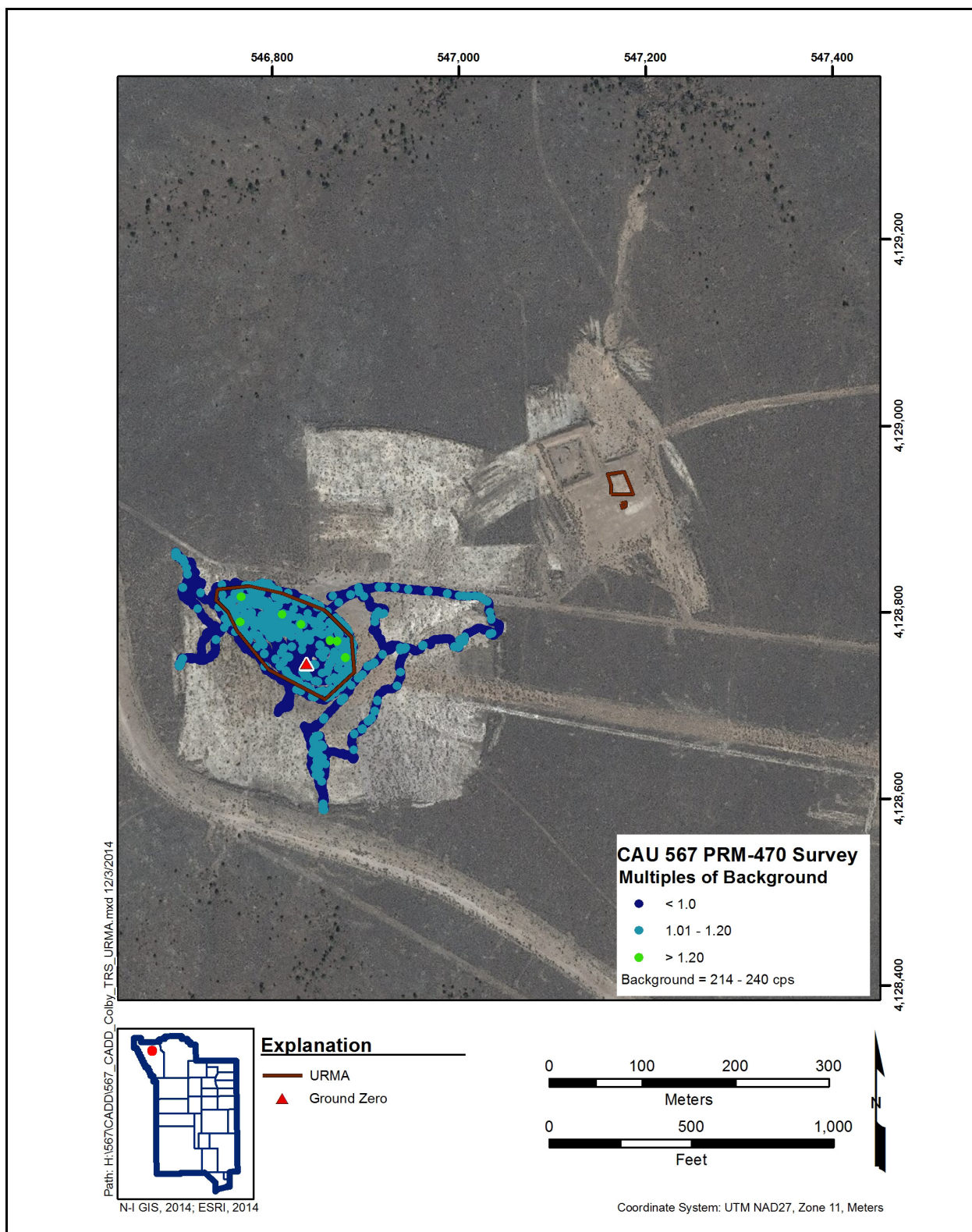
A.6.1.5.1 TLD Samples

Three TLDs were placed in the drainage at Colby Mud Spill (locations D01, D02, and D03): one at sediment locations at the base of each of the two dams, and one in a large sediment area in the center of the ravine. Three TLDs were placed to measure background dose. [Table A.6-1](#) provides detailed information including location, dates placed and collected, and serial number for each TLD.

Locations where environmental and background TLDs were placed are shown on [Figure A.6-2](#).

A.6.1.5.2 Soil Samples

Soil sampling for the drainage release at Colby Mud Spill consisted of screening of subsurface depth intervals and grab sampling at three locations selected based on visual observation of sedimentation areas within the drainage (locations D01, D02, and D03). Three samples were collected, one from each location. Soil sampling for the URMA release consisted of subsurface screening of depth intervals at two locations within the URMA (D08 and D09). These locations were selected near the center because they were most likely to contain drilling mud, and mud was present at both locations.



**Figure A.6-1
Colby Mud Spill, TRS Results**

Table A.6-1
TLDs at Colby Mud Spill

Release	Location	TLD No.	Date Placed	Date Removed
Drainage	D01	3471	08/07/2013	11/20/2013
	D02	4334	08/07/2013	11/20/2013
	D03	4866	08/07/2013	11/20/2013
Background	D04	5107	08/07/2013	11/20/2013
	D05	4664	08/07/2013	11/20/2013
	D06	4522	08/07/2013	11/20/2013

Seven samples were collected from these locations. All drainage and URMA samples were submitted for gamma spectroscopy and isotopic U, Pu, and Am analyses. Sample locations are shown on [Figure A.6-3](#).

For spills and PSM, one composite grab sample was collected from soil beneath a 5-by-4-ft pile of hydrocarbon-impacted filters (location D07). This sample was analyzed for gamma spectroscopy, RCRA metals, Cr(VI), VOCs, SVOCs, and PCBs. Additional information including depth and purpose for each soil sample collected for this CAS is provided in [Table A.6-2](#). Sample locations are shown on [Figure A.6-3](#).

A.6.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.6.3 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/NFO, 2013). The radiological results are reported as doses that 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.

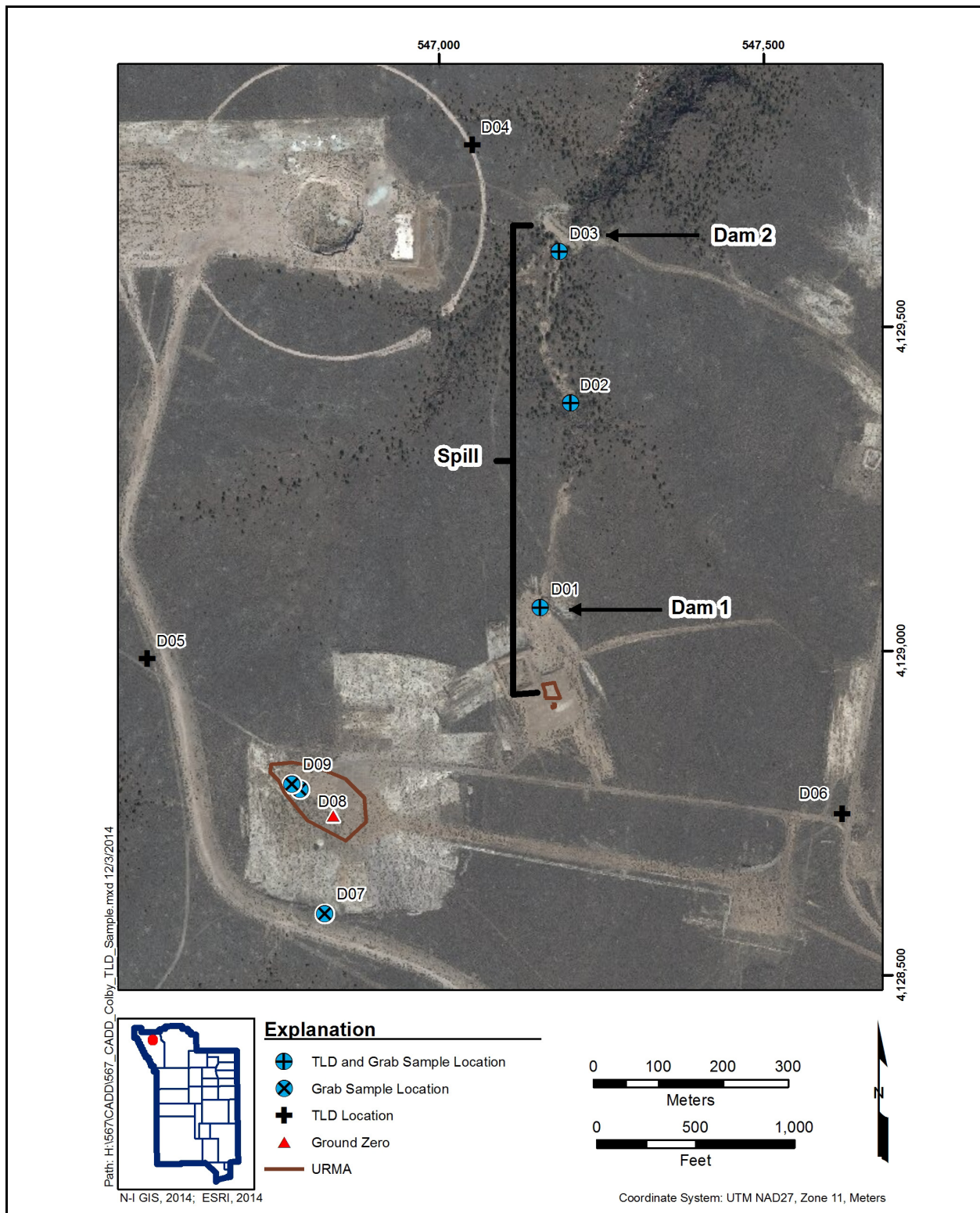


Figure A.6-2
Colby Mud Spill, TLD and Sample Locations

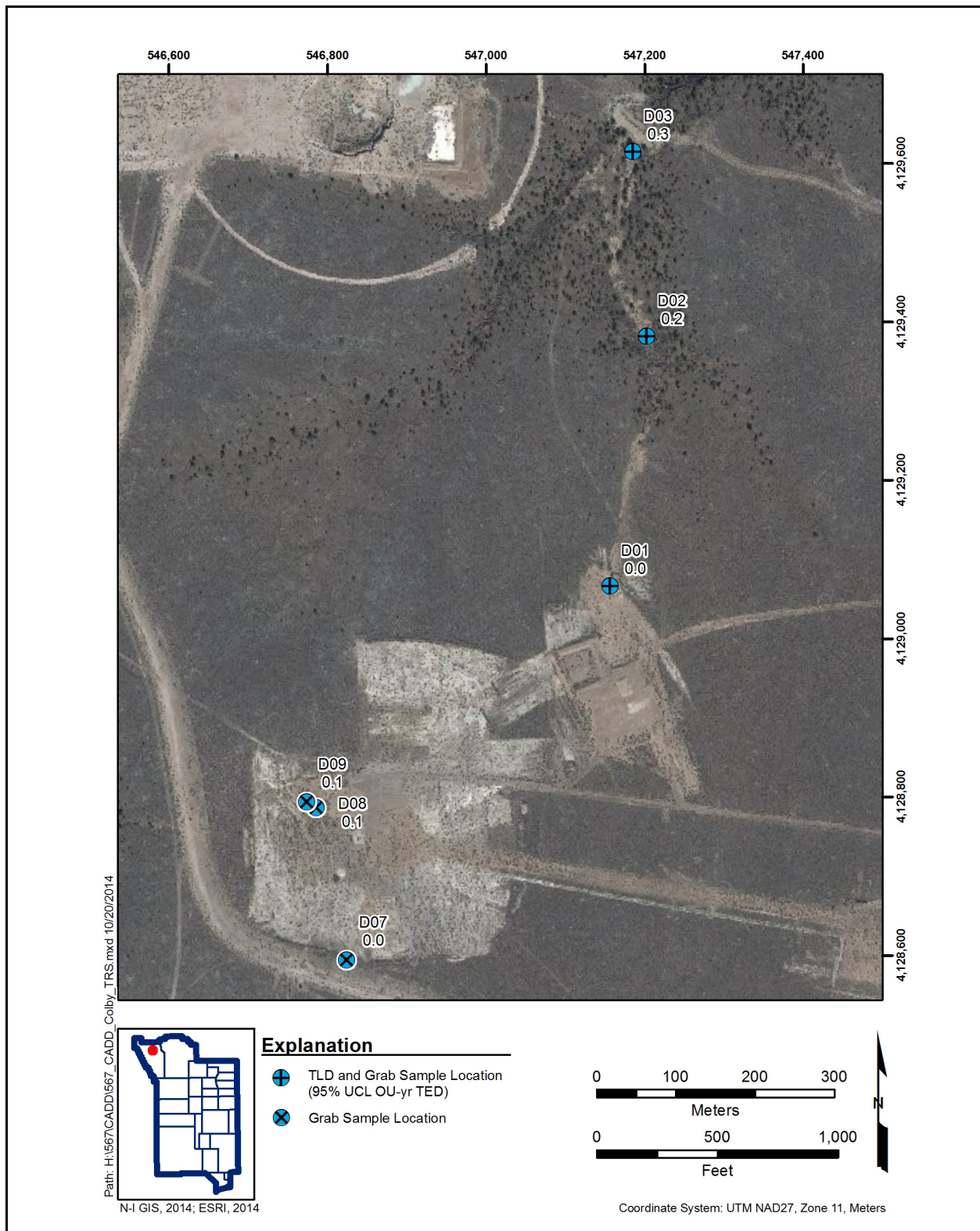


Figure A.6-3
95% UCL of TED at Colby Mud Spill

Table A.6-2
Samples Collected at Colby Mud Spill

Release	Location	Sample Number	Depth (bgs)	Matrix	Purpose
Drainage	D01	D004	0.0 - 10.0 cm	Soil	Environmental
	D02	D002	0.0 - 10.0 cm	Soil	Environmental
	D03	D003	0.0 - 10.0 cm	Soil	Environmental
URMA	D08a	D008	0.0 - 2.0 ft	Soil	Environmental
	D08b	D009	2.0 - 4.0 ft	Soil	Environmental
	D08c	D010	8.0 - 10.0 ft	Soil	Environmental
		D011	8.0 - 10.0 ft	Soil	FD of #D010
	D09a	D005	0.0 - 2.0 ft	Soil	Environmental
	D09b	D006	2.0 - 4.0 ft	Soil	Environmental
	D09c	D007	4.0 - 6.0 ft	Soil	Environmental
Spills and PSM	D07	D001	0.0 - 4.0 in.	Soil	Environmental

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.6.3.1](#). Internal doses for each sample plot are summarized in [Section A.6.3.2](#). The TEDs for each sampled location are summarized in [Section A.6.3.3](#). Chemical contaminant results for Colby Mud Spill are summarized in [Section A.6.3.4](#).

A.6.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in [Section A.2.3.2](#). 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.6-3](#). External dose for each scenario for locations where dose was calculated using the method described in [Section A.2.3.2](#) are presented in [Table A.6-4](#).

Table A.6-3
Colby Mud Spill, 95% UCL External Dose for Each Exposure Scenario

Release	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)
Drainage	D01	0.5	3	3	0.0	0.0	0.0
	D02	2.7	3	3	4.1	0.7	0.2
	D03	2.9	3	3	6.4	1.1	0.3

Table A.6-4
Colby Mud Spill, Calculated External Dose for Each Exposure Scenario

Release	Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
URMA	D08a	0.8	0.0	0.0
	D08b	2.4	0.1	0.0
	D08c*	1.8	0.3	0.1
	D09a	0.9	0.1	0.0
	D09b	2.1	0.4	0.1
	D09c	1.5	0.2	0.1
Spills and PSM	D07	0.0	0.0	0.0

*FD; value reported is average of two samples.

A.6.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each sample location were determined as described in [Section A.2.3.1](#). The internal dose for each exposure scenario is presented in [Table A.6-5](#). Internal dose was indistinguishable from background at all Colby Mud Spill sample locations.

Table A.6-5
Colby Mud Spill, Internal Dose for Each Exposure Scenario

Release	Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Drainage	D01	0.0	0.0	0.0
	D02	0.0	0.0	0.0
	D03	0.0	0.0	0.0
URMA	D08a	0.0	0.0	0.0
	D08b	0.0	0.0	0.0
	D08c*	0.0	0.0	0.0
	D09a	0.0	0.0	0.0
	D09b	0.0	0.0	0.0
	D09c	0.0	0.0	0.0
Spills and PSM	D07	0.0	0.0	0.0

*FD; value reported is average of two samples.

A.6.3.3 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.6-6](#). The TED did not exceed the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/OU-yr) at any location. The TED at all sample locations is shown on [Figure A.6-3](#).

A.6.3.4 Chemical Contaminants

One composite grab sample was collected from below a 5-by-4-ft pile of hydrocarbon-impacted filters (location D07) and analyzed for VOCs, SVOCs, RCRA metals, PCBs, and Cr(VI). VOCs, SVOCs, and PCBs did not exceed the MDCs. The analytical results exceeding MDCs from the sample are presented in [Table A.6-7](#). Results for Cr(VI) exceeded the PAL of 5.6 mg/kg, but were below the site-specific FAL that was established at 8.42 mg/kg as described in [Section C.1.11](#). Sample results did not exceed the FALs.

Table A.6-6
Colby Mud Spill, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a	Average TED	95% UCL of TED ^a
Drainage	D01	0.0	0.0	0.0	0.0	0.0	0.0
	D02	0.4	4.1	0.1	0.7	0.0	0.2
	D03	2.5	6.4	0.4	1.1	0.1	0.3
URMA	D08a	0.8	0.9	0.1	0.1	0.0	0.0
	D08b	2.2	2.4	0.4	0.4	0.1	0.1
	D08c*	1.7	1.8	0.3	0.3	0.1	0.1
	D09a	0.8	0.9	0.1	0.2	0.0	0.0
	D09b	2.0	2.2	0.3	0.4	0.1	0.1
	D09c	1.4	1.5	0.2	0.3	0.1	0.1
Spills and PSM	D07	0.0	0.0	0.0	0.0	0.0	0.0

^aCalculation based on average internal dose and 95% UCL of external dose.

*FD; value reported is average of two samples.

Table A.6-7
Colby Mud Spill, Sample Results for Metals

Release	Location	Sample Number	RCRA Metals				Cr(VI)
			Arsenic	Barium	Lead	Mercury	
FALs (mg/kg)			23	190,000	800	43	8.42
Spills and PSM	D07	D001	4.8	130	17	0.021	6.9

A.6.4 Nature and Extent of COCs

The TED did not exceed the FAL of 25 mrem/OU-yr at any location; therefore, radiological COCs were not identified at Colby Mud Spill.

PSM, in the form of one intact lead-acid battery, was identified and corrective actions were completed during the investigation. The lead-acid battery was determined to be PSM based on the presence of

metallic lead. Because the plates were contained within the battery, it was determined that the extent of the PSM was limited to the physical dimensions of the waste. At a 5-by-4-ft pile of hydrocarbon-impacted filters, one grab sample was collected and analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, and Cr(VI). All levels were below the FAL; therefore, it was determined that the extent of the hazardous constituents associated with the filters was limited to the physical dimensions of the waste.

A.7.0 CAS 25-23-23, J-11 Soil RMA

CAS 25-23-23, J-11 Soil RMA, is located in the center of Area 25 of the NNSS, at the intersection of Cane Springs Road and 1st Street. The source of the release at the site is unknown, but it is believed that the area may have been used for storage and that the release may have been a spill of radioactive liquid. Additional detail on the history of the CAS is provided in the CAIP (NNSA/NFO, 2013).

A.7.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.7.1.1 Visual Surveys

Visual surveys were conducted during site walks, while sampling, and while performing TRSs at J-11 Soil RMA. Biasing factors that would indicate the potential release of contaminants were not identified during these efforts. Samples were not collected based on visual survey results.

A.7.1.2 Radiological Surveys

TRSs that were performed at J-11 Soil RMA before the CAIP was published are reported in the CAIP (NNSA/NFO, 2013). These initial surveys were used to identify the highest level of radioactivity, which is where the initial TLD at the site was placed (location E02). Results from additional surveys that were performed to better define this area are shown on [Figure A.7-1](#). Approximately 24 yd³ of soil was removed to a depth of 6 in. in a 2-m-diameter circle around location E02. The area was resurveyed; these survey results and a depiction of the area where soil was removed are shown on [Figure A.7-2](#). It was determined that additional soil removal was needed to further reduce radioactivity at the site, and 30.9 yd³ of soil was excavated from the area. The site was again resurveyed, and results are shown on [Figure A.7-3](#).

A.7.1.3 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013). The specific CAI activities conducted at this CAS are described in the following subsections.

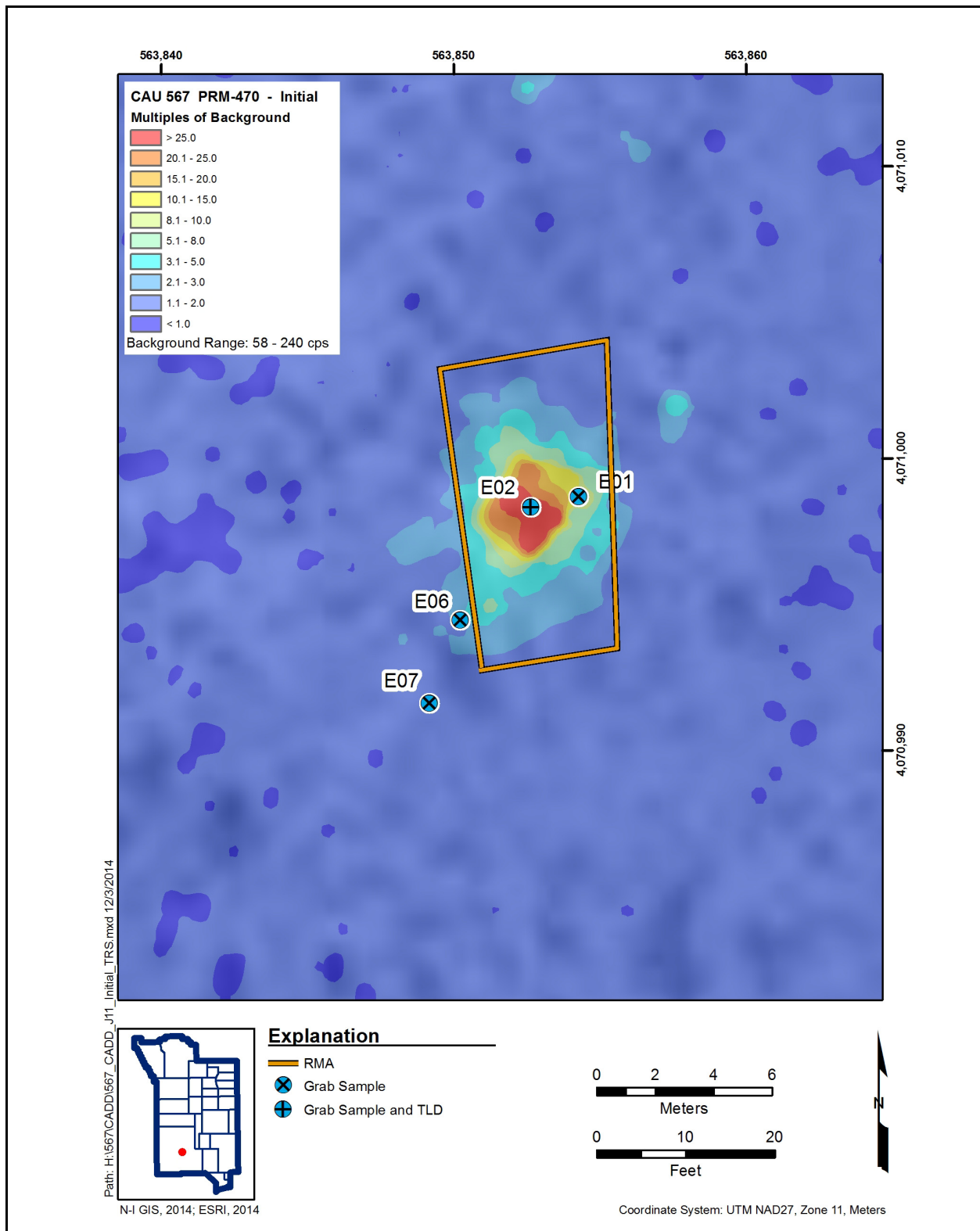


Figure A.7-1
J-11 Soil RMA, Initial TRS

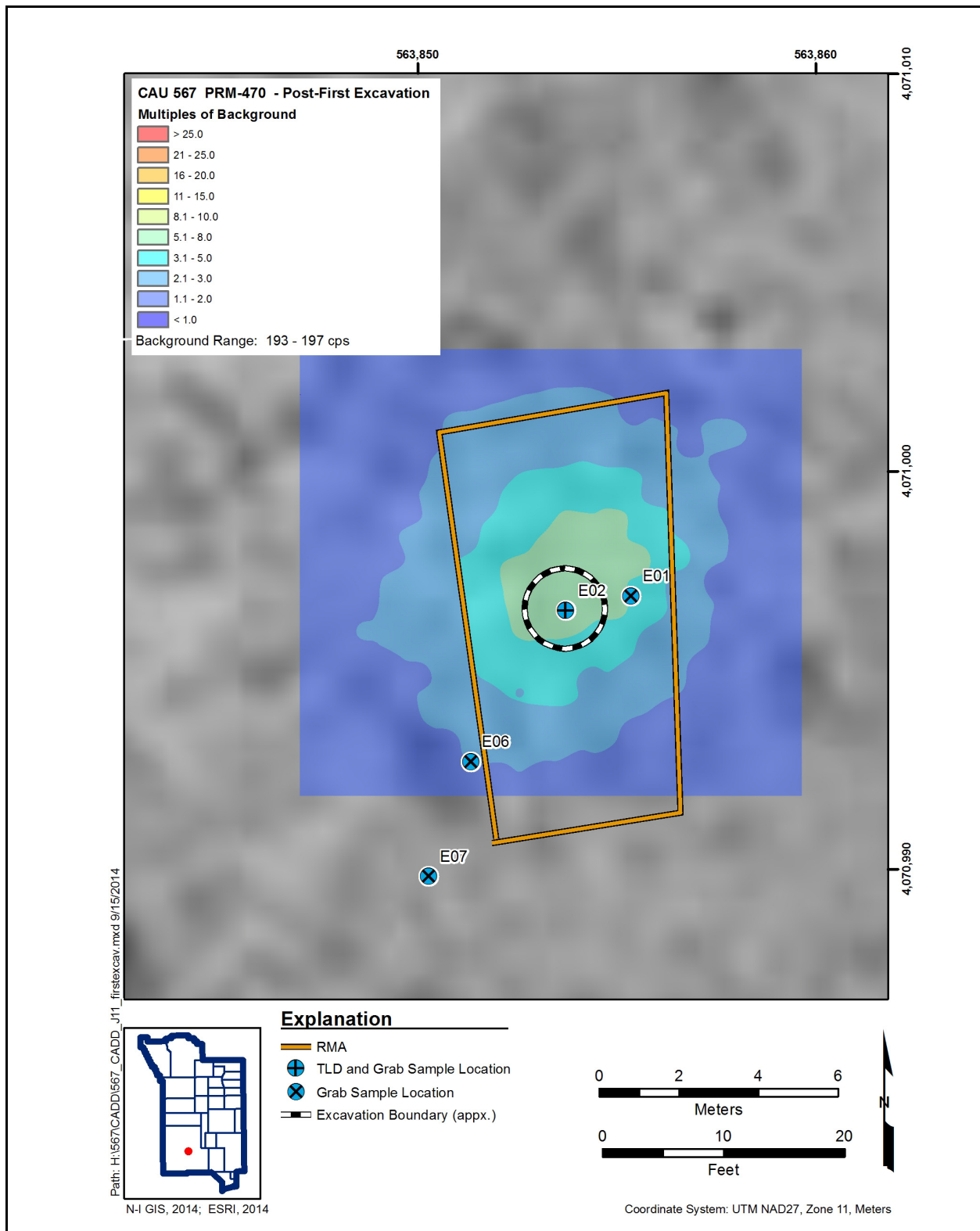


Figure A.7-2
J-11 Soil RMA, TRS after First Excavation

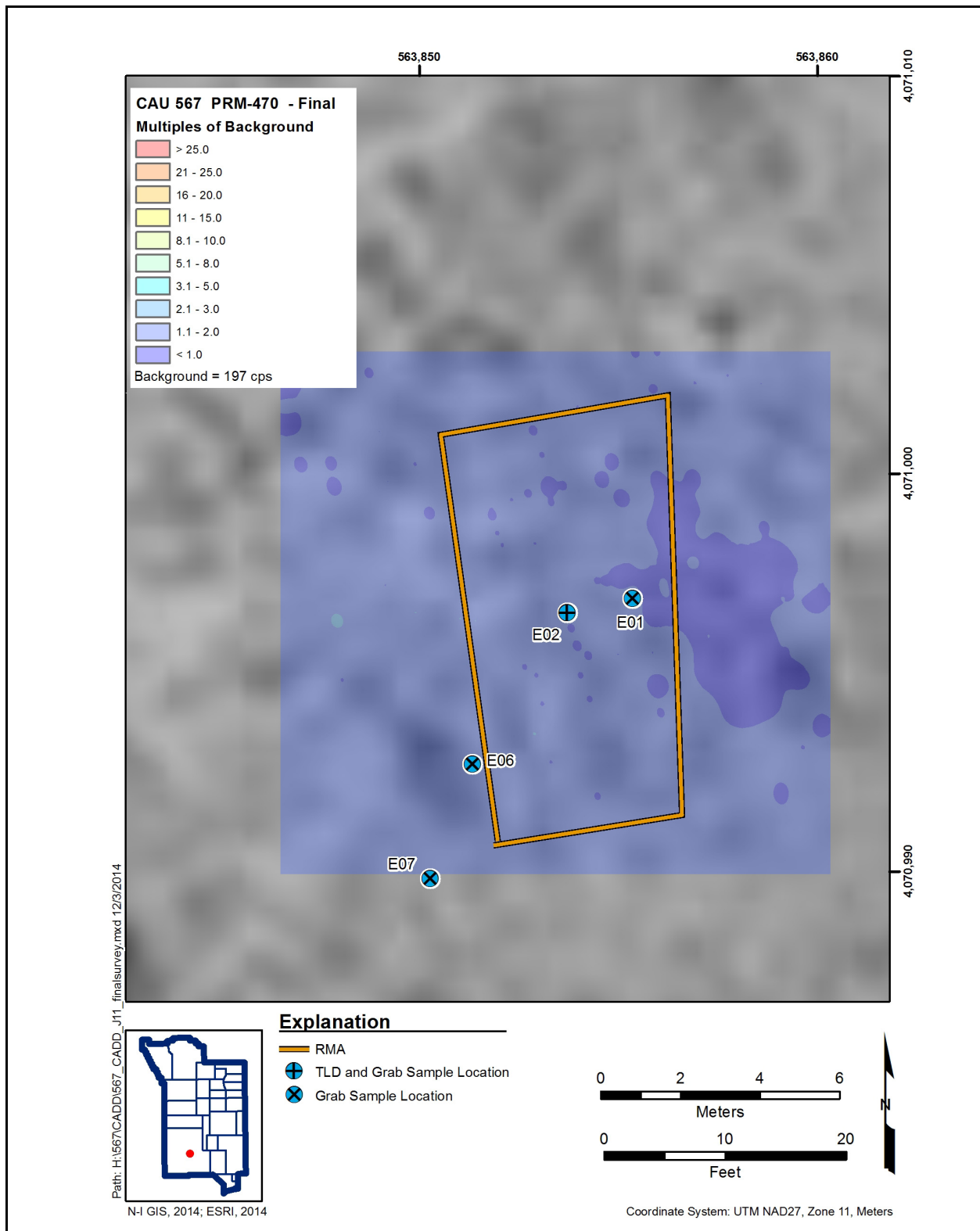


Figure A.7-3
J-11 Soil RMA, Final TRS after Second Excavation

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A.7.1.3.1 TLD Samples

Initially, one TLD was placed at the highest area of radioactivity at the site (location E02). When it was determined this location would exceed the PAL, the area was excavated to remove contaminated soil. After the excavation, a grid of nine TLDs was placed at this location. Each time TLDs were placed, additional TLDs were placed to measure background doses at the site. [Table A.7-1](#) provides detailed information including location, dates placed and collected, and serial number for each TLD. [Figure A.7-4](#) shows the location of all TLDs at the site.

**Table A.7-1
TLDs at J-11 Soil RMA**

Type	Location	TLD No.	Date Placed	Date Removed
Initial	E02	4970	08/06/2013	11/19/2013
Confirmation		5161	05/22/2014	08/19/2014
		5187	05/22/2014	08/19/2014
		4650	05/22/2014	08/19/2014
		5108	05/22/2014	08/19/2014
		4392	05/22/2014	08/19/2014
		4471	05/22/2014	08/19/2014
		4897	05/22/2014	08/19/2014
		3893	05/22/2014	08/19/2014
		6253	05/22/2014	08/19/2014
Background	E03	4791	08/06/2013	11/19/2013
	E04	4197	08/06/2013	11/19/2013
	E03	4371	05/22/2014	08/19/2014

A.7.1.3.2 Soil Samples

Soil sampling at J-11 Soil RMA initially consisted of the collection of surface and subsurface grab samples at and near the location of the highest TRS readings. Eight samples (E001 through E008) were collected to characterize the site. After this sampling effort, radioactive soil was removed from the site, and a composite confirmation sample (E009) was collected to verify that levels of radioactivity had been reduced. The confirmation sample was a composite sample, with nine aliquots taken in a 10-by-10-m grid formation over the area where soil was removed. All soil samples were

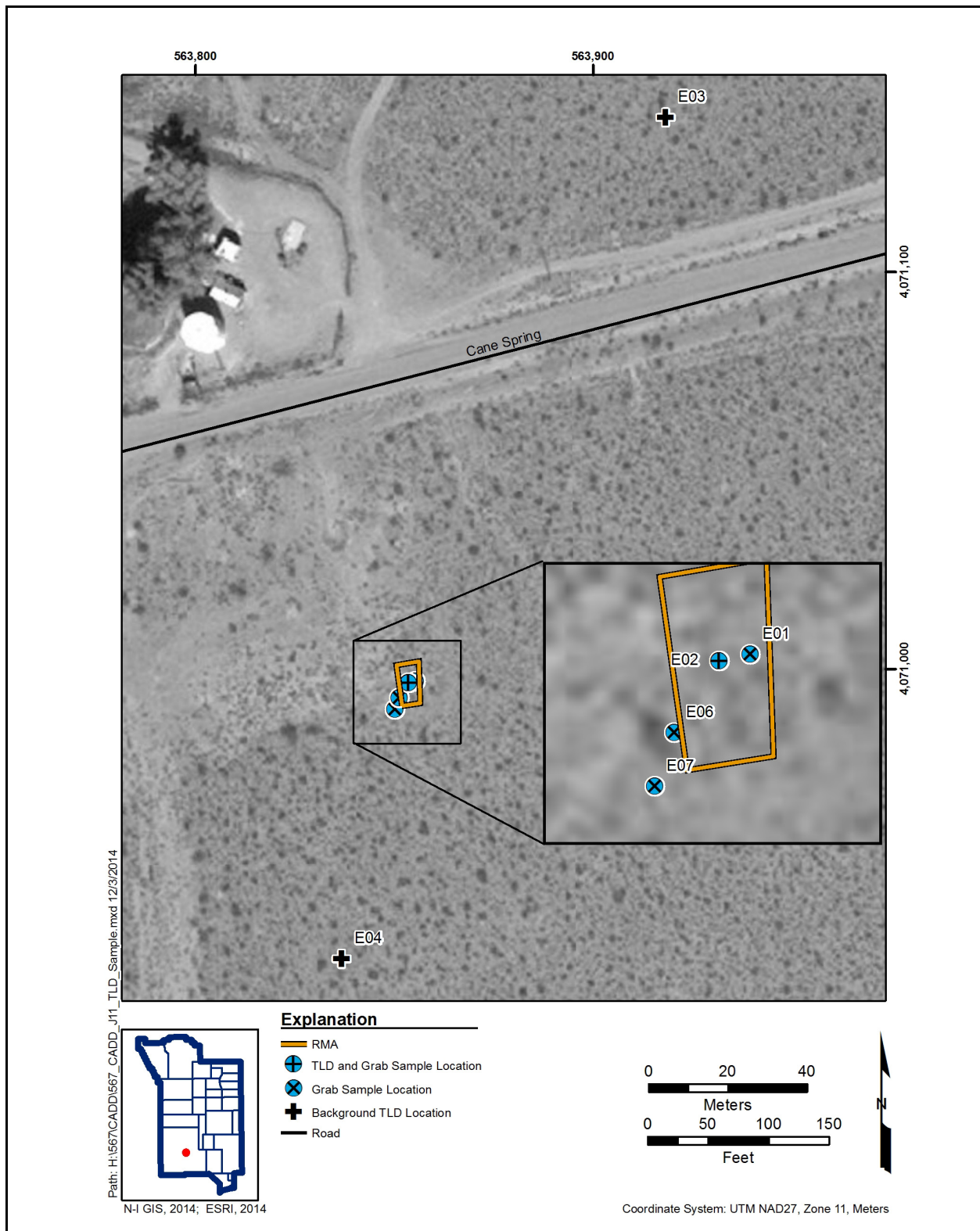


Figure A.7-4
TLD and Sample Locations at J-11 Soil RMA

submitted for gamma spectroscopy. [Table A.7-2](#) provides details regarding soil samples collected at J-11 Soil RMA, and [Figure A.7-4](#) shows sample locations.

Table A.7-2
Samples Collected at J-11 Soil RMA

Type	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Initial	E01	E001	0.0 - 5.0	Soil	Environmental
		E006	0.0 - 5.0	Soil	Environmental
	E02a	E002	0.0 - 8.0	Soil	Environmental
	E02b	E003	8.0 - 15.0	Soil	Environmental
	E02c	E004	15.0 - 23.0	Soil	Environmental
	E02d	E005	23.0 - 30.0	Soil	Environmental
	E06	E007	0.0 - 5.0	Soil	Environmental
	E07	E008	0.0 - 5.0	Soil	Environmental
Confirmation	E02e	E009	0.0 - 5.0	Soil	Environmental

A.7.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.7.3 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/NFO, 2013). The radiological results are reported as doses that 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 FALs are identified by bold text in the results tables.

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.7.3.1](#). Internal doses for each sample plot are summarized in [Section A.7.3.2](#). The TEDs for each sampled location are summarized in [Section A.7.3.3](#).

A.7.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each TLD sample location were determined as described in [Section A.2.3.2](#). 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. External dose for subsurface samples collected at location E02 were calculated using the surface TLD results as described in [Section A.2.3.2](#). After removal of contaminated soil, levels of radioactivity at location E02 were indistinguishable from background. 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](#).

Table A.7-3
J-11 Soil RMA, 95% UCL External Dose for Each Exposure Scenario

Type	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)
Initial	E02a	15.5	3	3	247.0	41.5	12.4
	E02b (subsurface)	N/A ^a	N/A ^a	N/A ^a	1,773.8	296.8	88.1
	E02c (subsurface)	N/A ^a	N/A ^a	N/A ^a	56.1	9.4	2.8
	E02d (subsurface)	N/A ^a	N/A ^a	N/A ^a	16.7	2.8	0.8
Confirmation	E02e	2.4	27	3	8.7	1.5	0.4

^aCalculated value

Bold indicates the values exceeding 25 mrem/yr.

A.7.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each sample location were determined as described in [Section A.2.3.1](#). The internal dose for each exposure scenario is presented in [Table A.7-4](#). After removal of contaminated soil, levels of radioactivity at the site are indistinguishable from background.

**Table A.7-4
J-11 Soil RMA, Internal Dose for Each Exposure Scenario**

Type	Location	Sample Number	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Initial	E01	E001	0.2	0.0	0.0
		E006	0.2	0.0	0.0
	E02a	E002	1.0	0.1	0.1
	E02b	E003	0.5	0.0	0.0
	E02c	E004	0.0	0.0	0.0
	E02d	E005	0.0	0.0	0.0
	E06	E007	0.1	0.0	0.0
	E07	E008	0.0	0.0	0.0
Confirmation	E02e	E009	0.0	0.0	0.0

A.7.3.3 Total Effective Dose

The TED for each sample plot, grab sample location, or TLD location was calculated by adding the external dose values and the internal dose values. Locations E01, E06, and E07 are within 10 m of location E02; therefore, external dose from location E02 was used to calculate the TED for these locations. 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.7-5](#).

The FAL (the 95 percent UCL of the average TED exceeding 25 mrem/OU-yr) was exceeded at location E02; however, soil was removed from this area during the investigation. The TED at location E02 after the soil removal is below the PAL.

**Table A.7-5
J-11 Soil RMA, TED at Sample Locations (mrem/yr)**

Type	Location	Sample Number	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
Initial	E01	E001	226.3	247.2	38.0	41.5	11.3	12.4
		E006	226.4	247.3	38.0	41.5	11.3	12.4
	E02a	E002	227.2	248.1	38.1	41.6	11.4	12.4
	E02b (subsurface)	E003	1,605.2	1,774.3	268.6	296.9	79.8	88.2
	E02c (subsurface)	E004	50.8	56.1	8.5	9.4	2.5	2.8
	E02d (subsurface)	E005	15.1	16.7	2.5	2.8	0.7	0.8
	E07	E007	226.2	247.1	38.0	41.5	11.3	12.4
	E08	E008	226.2	247.1	38.0	41.5	11.3	12.4
Confirmation	E02e	E009	8.1	8.7	1.4	1.5	0.4	0.4

Bold indicates the values exceeding 25 mrem/yr.

A.7.4 Nature and Extent of COCs

Initially, the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/OU-yr) was exceeded based on soil and TLD samples collected from the area of highest radiological readings. In order to reduce radioactivity to levels below the PAL, 30.9 yd³ of radioactive soil was removed. Additional TRSs were performed, and confirmation soil sample and TLD measurements were taken in the area where soil was removed. It was determined that the remaining TED at J-11 Soil RMA does not exceed the PAL; therefore, COCs are no longer present at J-11 Soil RMA.

A.8.0 Waste Management

This section addresses the characterization and management of investigation and remediation wastes. Waste management activities were conducted as specified in the CAIP (NNSA/NFO, 2013).

A.8.1 Generated Wastes

The wastes listed in [Table A.8-1](#) were generated during the field investigation activities of CAU 567. The amount, type, and source of waste placed into each container were recorded in waste management logbooks that are maintained in the CAU 567 file. Wastes were 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.

Wastes generated during the CAI were segregated into the following waste streams:

- Personal protective equipment (PPE) and disposable sampling equipment.
- Low-level radioactive waste (LLW) debris including PPE, plastic sheeting, glass/plastic sample jars, soil, sampling scoops, and aluminum foil.
- Mixed low-level radioactive waste (MLLW) generated at CASs 01-23-03 and 05-23-07.
- RCRA-regulated waste generated at CAS 01-23-03.
- Hydrocarbon-impacted industrial waste from CAS 20-23-08.
- Lead recycle materials collected at CAS 20-23-08.

A.8.2 Waste Characterization and Disposal

The waste streams generated at CAU 567 were characterized using analytical results, process knowledge, and radiological survey data. The characterization of the waste and recommended disposition was determined based on a review of the analytical results and was compared to federal and state regulations, permit requirements, and disposal or recycle facility acceptance criteria. Waste characterization documentation is maintained in the CAU 567 project file. A Waste Container Log (WCL) was created that documents the contents of each container, the volume of the waste, and the

Table A.8-1
Waste Summary Table
(Page 1 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc ^a
Solid Industrial Waste						
567D01	Debris from filter pile area and 4 empty drums	Solid Industrial Waste (hydrocarbon impacted)	Area 9, U10c Industrial Landfill	7.65 m ³	03/24/2014	LVF
567D02	Empty 5-gal can	Solid Industrial Waste	Area 9, U10c Industrial Landfill	5 lb	TBD	LVF (pending)
567D03	Empty paint cans	Solid Industrial Waste	Area 9, U10c Industrial Landfill	5 lb	TBD	LVF (pending)
310R14	PPE	Solid Industrial Waste	Area 9, U10c Industrial Landfill	~55 lb	TBD	LVF (pending)
LLW						
567A01	Debris - PPE	LLW	Area 5 RWMC	55-gal drum	TBD	CD (pending)
567A02	Debris - PPE	LLW	Area 5 RWMC	55-gal drum	TBD	CD (pending)
567A03	Debris - PPE	LLW	Area 5 RWMC	55-gal drum	TBD	CD (pending)
567C04	Remediated soil	LLW	Area 5 RWMC	12.17 m ³	12/11/2014	CD
567E04	Remediated soil	LLW	Area 5 RWMC	11.47 m ³	08/14/2014	CD
567E05	Remediated soil	LLW	Area 5 RWMC	12.17 m ³	08/14/2014	CD
MLLW						
567BAT2	Spent lead-acid battery	MLLW	Area 5 RWMC	35 lb	TBD	CD (pending)
567PB01	Elemental lead (lead pieces)	MLLW	Area 5 RWMC	95 lb	TBD	CD (pending)

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Table A.8-1
Waste Summary Table
(Page 2 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc ^a
RCRA Regulated Waste						
567A04	Grease	RCRA Waste	Offsite TSDF	10 gal	Transferred to M&O Contractor (pending)	Onsite HAZMAT transfer paperwork (pending)
Recycle Materials						
567BAT1	Spent lead-acid battery	Recycle Material	NSTec Fleet Services	35 lb	07/31/2014	WCL

^aCopies of waste disposal documents currently available are located in [Attachment D-2](#) of this document; copies of waste disposal documents not available as of the date of this document will be included in [Attachment D-2](#).

CD = Certificate of Disposal
HAZMAT = Hazardous materials
lb = Pound
LVF = Load Verification Form
m³ = Cubic meter

NSTec = National Security Technologies, LLC
RWMC = Radioactive waste management complex
TBD = To be determined
TSDF = Treatment, storage, and disposal facility

sample numbers associated with the waste. A summary of the analytical data interpretation and characterization for each waste type is provided in [Table A.8-2](#). Analytical results and comparisons to regulatory criteria are presented in [Table A.8-2](#). The executed waste shipping and disposal documentation for CAU 567 are in [Attachment D-2](#).

Table A.8-2
Waste Management Results Detected above MDCs at CAU 567

Sample Location	Sample Number	Sample Matrix	Parameter	Result	Criteria	Units
Container 567A04	A501	Solid	Lead	120	5 ^a	mg/L
			Am-241	0.0202	0.5 ^b	pCi/g
			U-234	0.52 (J)	0.934 ^b	pCi/g
			U-238	0.48	10.0 ^b	pCi/g
Container 567C04	C501 C001 C002 C003 C004 C005 C007	Soil	Cadmium	0.0034	1 ^a	mg/L
			Chromium	0.011	5 ^a	mg/L
			Lead	0.038	5 ^a	mg/L
			Cm-243	10.3	10 ^c	pCi/g
			Th-232	10.0	10 ^c	pCi/g
			U-234	99.0	100 ^c	pCi/g
			U-235	17.5	100 ^c	pCi/g
			U-238	910.0	100 ^c	pCi/g
Container 567D01	D501 D502	Soil and Fiber Material	TPH-DRO	17,000	100	mg/kg
			Lead	0.038	5 ^a	mg/L
			Lead	0.034	5 ^a	mg/L
			Selenium	0.05	1 ^a	mg/L
			2-Butanone	30.0	200 ^a	µg/L
			Cs-137	0.66	100 ^c	pCi/g
Containers 567E04 567E05	E501 E001 E002 E003 E004 E005	Soil	Cs-137	1,439.38	100 ^c	pCi/g
			Sr-90	1.1	100 ^c	pCi/g
			Th-232	1.46	10 ^c	pCi/g

^aTCLP limit (CFR, 2014b)

^bRadionuclides compared to *Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)

^cRadionuclide limits in NNSS U10c landfill permit (NNSA/NSO, 2010)

Cm = Curium

Cs = Cesium

DRO = Diesel-range organics

mg/L = Milligrams per liter

TCLP = Toxicity Characteristic Leaching Procedure

Th = Thorium

TPH = Total petroleum hydrocarbons

µg/L = Micrograms per liter

J = Estimated value.

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A.8.2.1 Industrial Solid Waste

The industrial solid waste generated during the CAU 567 CAI activities included hydrocarbon-impacted oil filter media, empty drums, empty cans, PPE, and disposable sampling equipment. Approximately 500 lb of PPE and disposable sampling equipment was generated during site activities. The PPE and disposable sampling equipment was characterized as solid industrial waste based on visual inspection, radiological survey screening, and process knowledge. The waste was bagged, marked, and placed in a roll-off for disposition at the Area 9, U10c industrial landfill located at the NNSS.

Approximately 7.7 m³ of metal debris consisting of empty metal containers and hydrocarbon-burdened, abandoned oil filters was generated at CAS 20-23-08. The waste was characterized as industrial solid waste that meets the chemical and radiological waste acceptance criteria of the Area 9, U10c solid waste landfill.

All of the empty containers were visually inspected and verified to meet the definition of a RCRA empty container. Therefore, the containers were characterized and managed as a non-regulated industrial waste. Analytical results for sample numbers D501 and D502 indicated the only COC was due to elevated levels hydrocarbon contamination. Therefore, the waste was characterized and managed as a non-regulated industrial waste.

A.8.2.2 LLW

The LLW generated during remediation activities at CAU 567 included PPE and disposable sampling equipment and soil. Three 55-gal drums (containers 567A01, 567A02, and 567A03) of PPE and disposable sampling equipment were generated and characterized as LLW that meets the waste acceptance criteria for disposal at the Area 5 RWMC.

Approximately 36 m³ of LLW soil was generated during the CAI. Analytical results from direct soil samples collected at each of the site locations were used to characterize the soil as LLW that meets the waste acceptance criteria for disposal at the RWMC. Approximately 24 m³ of LLW soil was remediated at CAS 25-23-23 and shipped for disposal on August 14, 2014. Analytical results for sample numbers E501 and E001 through E005 indicated elevated levels of Cs-137 were present. Therefore, the waste was characterized as LLW.

An additional 12 m³ of LLW soil was remediated at CAS 05-23-07. Analytical results for sample numbers C501, C001 through C005, and C007 indicated elevated levels of DU were present. Therefore, the waste was characterized as LLW.

A.8.2.3 MLLW

MLLW generated at CAU 567 included one 5-gal bucket of miscellaneous scrap lead metal collected at CAS 05-23-07 and placed into container 567PB01. A badly deteriorated battery (567BAT2) was collected at CAS 20-23-08 and containerized with the lead pieces. This container was disposed of at the Area 5 RWMC.

A.8.2.4 RCRA-Regulated Waste

One 10-gal drum (container 567A04) containing an abandoned 5-gal bucket of grease was generated and characterized as RCRA-regulated hazardous waste. The grease was sampled and analyzed for RCRA-regulated constituents. The analytical results for sample number 567A501 indicated that the lead results reported at 120 mg/L exceeded the RCRA regulatory limit of 5 mg/L. Therefore, the waste was characterized as a regulated hazardous waste. The waste will be transferred to NSTec Waste Generator Services for treatment and disposal at an offsite TSDF.

A.8.2.5 Recyclable Materials

One battery (567BAT1) collected at CAS 20-23-08 was still intact and was radiologically released from the site and transferred to the NSTec Fleet Services for offsite recycling at an approved recycling vendor.

A.9.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 567 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 sample data, 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, 2012).

A.9.1 Data Validation

Data validation was performed in accordance with the Soils QAP (NNSA/NSO, 2012) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 567 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 567 files as a hard copy and electronic media.

All laboratory data were subjected to a Tier I evaluation, while a Tier II evaluation was performed on a subset of reported data for all samples. A Tier III evaluation was performed on the analytical results for samples that represent 5 percent of the samples collected for site characterization.

A.9.1.1 Tier 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.9.1.2 Tier 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.
- Review
 - case narrative, chain of custody, and sample receipt forms;
 - lab qualifiers (applied appropriately);
 - method of analyses performed as dictated by the chain of custody;
 - raw data, including chromatograms, instrument printouts, preparation logs, and analytical logs;
 - manual integrations to determine whether the response is appropriate;
 - data package for completeness.
- Determine sample results qualifiers through the evaluation of (but not limited to)
 - tracers and QC sample results (e.g., duplicates, LCSs, blanks, matrix spikes) evaluated and used to determine sample results qualifiers;
 - sample preservation, sample preparation/extraction and run logs, sample storage, and holding time;
 - instrument and detector tuning;
 - initial and continuing calibrations;
 - calibration verification (initial, continuing, second source);
 - retention times;
 - second column and/or second detector confirmation;
 - mass spectra interpretation;
 - interference check samples and serial dilutions;
 - post-digestion spikes and method of standard additions;
 - breakdown evaluations.

- Perform calculation checks of
 - at least one analyte per QC sample and its recovery;
 - at least one analyte per initial calibration curve, continuing calibration verification, and second source recovery;
 - at least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error).
- Verify that target compound detects identified in the raw data are reported on the results form.
- Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.9.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation and the laboratory reported data. A Tier III review of 5 percent of the samples collected had Tier III validation performed by TLI Solutions, Inc. in Golden, Colorado. The Tier II and Tier III evaluations were in agreement and evaluated data was used. This review was equivalent to the Tier II review but was limited to 5 percent of samples collected.

A.9.2 QC Samples

Laboratory QC samples used to measure accuracy and precision were analyzed by the laboratory with each batch of samples submitted for analysis. Discussion can be found in [Sections A.3.0 through A.7.0](#) (see [Appendix B](#) for further discussion). Initial and continuing calibrations were also performed for each sample delivery group. When QC criteria were exceeded, qualifying flags were added to sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in CAU 567 files as both hard copy and electronic media.

During the CAI, three FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the CAIP. For these samples, the duplicate results precision (i.e., relative percent differences between the environmental sample results and their corresponding FD sample results) were evaluated.

A.9.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.9.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to uncontrolled instrument operations, sample preparations, missed holding times, spectral interferences, high or low chemical yields/spike recoveries, or out-of-control differences in duplicate precision. All laboratory nonconformances were reviewed for relevance and, where appropriate, data were qualified accordingly.

A.9.5 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, 2014a) 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.10.0 Summary

Radionuclide and chemical contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the presence and extent of COCs for CAU 567. Based on the detected or presumed presence of COCs, the following releases require corrective action:

- The atmospheric release at Atmospheric Test Site T-1 (CAS 01-23-03), where CAI sample results demonstrated soil contamination levels resulting in a dose exceeding the radiological FAL and a DCB where buried contamination is assumed to exceed the FAL. The corrective action alternative of closure in place with an FFACO UR was selected for this release.
- The spills and PSM release at Atmospheric Test Site T-1 (CAS 01-23-03), where a can of lead-contaminated grease and a broken lead-acid battery were removed from the site. Confirmation sample results demonstrated that the PSM was contained, and no further corrective action is necessary.
- The spills and PSM release at A5b RMA (CAS 05-23-07), where two pieces of lead were removed from the site. Confirmation sample results demonstrated that the PSM was contained, and no further corrective action is necessary.
- The spills and PSM release at Colby Mud Spill (CAS 20-23-08), where an intact lead-acid battery was removed from the site. The PSM was contained, and no further corrective action is necessary.
- The spill release at J-11 Soil RMA (CAS 25-23-23), where soil exceeding the FAL was removed from the site. After removal, dose is below the PAL of 25 mrem/IA-yr, and no further corrective action is necessary.

A BMP of an administrative UR was implemented at Atmospheric Test Site T-1 locations 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.

A BMP was also implemented at A5b RMA, where radioactive soil was excavated in order to lower dose below 25 mrem/IA-yr.

A summary of CAI results and actions implemented is presented in [Table A.10-1](#) for each CAU 567 release.

Table A.10-1
Summary of Investigation Results at CAU 567

CAS Number	Name	Release	COC	Corrective Action	BMP
01-23-03	Atmospheric Test Site T-1	Atmospheric	TED	Closure in place at 25-mrem/RW-yr isopleth and around the DCB	Admin UR at 25-mrem/IA-yr isopleth
		CWDs	None	None	
		Drainages	None		
		Spills and PSM	Lead	Clean closure, remove and dispose of can of grease and lead-acid battery (complete)	None
03-23-25	Seaweed E Contamination Area	Atmospheric	None	None	None
05-23-07	A5b RMA	Soil Contamination and PSM	None	None	Remove and dispose of soil at 25 mrem/IA-yr and scattered DU fragments (complete)
		Landfills	None	None	None
		Spills and PSM	Lead	Clean closure, remove and dispose of lead pieces (complete)	None
20-23-08	Colby Mud Spill	Drainage	None	None	None
		URMA	None	None	None
		Spills and PSM	Lead	Clean closure, remove and dispose of lead-acid battery (complete)	Remove and dispose of motor oil, filter pile, and paint cans (complete)
25-23-23	J-11 Soil RMA	Spill	TED	Clean closure, remove and dispose of soil at 25 mrem/OU-yr (complete)	None

A.11.0 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 567 CAIP (NNSA/NFO, 2013) 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 helps 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/NFO, 2013). 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/NFO, 2013) is as follows: “Is any COC associated with a CAU 567 release present in environmental media?” Any contaminant that is present (or is assumed to be present) at concentrations exceeding its corresponding FAL will be defined 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 constituent analysis (NNSA/NFO, 2014). 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 CAS (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)

To resolve Decision I (determine whether a COC is present at a release), samples were collected and analyzed following these two criteria:

- Samples must be collected in areas most likely to contain a COC.
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To satisfy the criteria that the samples must be collected in areas most likely to contain a COC (outside the DCBs), judgmental sample locations were selected at each CAS as follows:

Atmospheric Test Site T-1

Decision I for Atmospheric Test Site T-1 (as stipulated in the DQOs) was already resolved for the areas within the DCB because that area is already identified as requiring corrective action. Therefore, Decision I sampling only applied to those areas outside the DCB.

Sample plot locations for the atmospheric release were selected judgmentally outside the DCB at the highest radiological readings as detected during the PRM-470 TRSs. Additional screening was conducted in soil covered by asphalt. For each CWD, one sample location was selected based on the highest radiological readings, and one location was selected based on the observation of disturbance. For the two areas where asphalt and debris were dumped in drainages, samples were collected from the area of highest radiological readings; and for the broken lead-acid battery, the sample location was biased based on the presence of the battery.

Seaweed E Contamination Area

Elevated radiological readings were not detected at the site; therefore, sample locations were selected judgmentally based on proximity to each test GZ.

A5b RMA

Sample locations were selected judgmentally where DU was present in the greatest amount (i.e., the center of the detonation crater) as determined during visual and radiological surveys of the site. For the pieces of lead, the sample location was biased based on the presence of the lead.

Colby Mud Spill

Because mud was not visible and radiologically elevated locations were not identified on the TRS, sampling locations were selected judgmentally based on the presence of sedimentation areas in the drainage. This included one at the base of each of the two dams constructed in the drainage to contain the mud, and one in a wide flat sedimentation area where mud would have likely pooled. Two locations were selected in the center of the covered URMA in order to correctly locate the

buried mud. Mud was found at both of these locations, so it was confirmed that the URMA was correctly identified.

J-11 Soil RMA

Sampling locations were selected judgmentally based on the highest readings detected during PRM-470 TRSs.

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 (NNSA/NFO, 2013). 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.

Samples from all CASs were analyzed using the analytical methods listed in Section A.2.2.2 of the CAIP with the following exceptions:

- In addition to the radiological analyses, samples were collected from underneath a broken lead-acid battery, two pieces of lead, and a hydrocarbon-impacted filter pile. Samples collected at the battery and lead pieces were analyzed for RCRA metals and Cr(VI). Samples collected at the filter pile were analyzed for VOCs, SVOCs, RCRA metals, and Cr(VI).

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

Control of the false-negative decision error 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.

Selection of the sample aliquot locations within a sample plot (Atmospheric Test Site T-1) was accomplished using a random start, systematic triangular grid pattern for sample placement. This

permitted that all given locations within the boundaries of the sample plot would have an equal probability of being 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 each sample location.

The minimum number of samples required for each probabilistic sample location was calculated for both the 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):

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

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. The results of the minimum sample size calculations and the number of samples collected are presented in [Table B.1-1](#). As shown in this table, the minimum number of sample plot and TLD samples was met or exceeded. The minimum sample size calculations were conducted at probabilistic sample locations as stipulated in the CAIP (NNSA/NFO, 2013) 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

**Table B.1-1
Input Values and Determined Minimum Number of Samples for Sample Plots**

Soil Samples				
CAS	Plot	Standard Deviation (OU Scenario)	Minimum Sample Size	Samples Collected
Atmospheric Test Site T-1	A01	0.0	3	4
	A02	0.1	3	4

Note: The actual required minimum number of samples calculated by the one-sample t-test (EPA, 2006; PNNL, 2007) was less than 3. The minimum number of samples required to calculate statistics is 3.

Criterion 2 (Confidence in Detecting COCs Present in Samples)

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils QAP (NNSA/NSO, 2012). The sensitivity acceptance criterion is that analytical detection limits will be less than the corresponding FAL (NNSA/NFO, 2013). All of the chemical analyses met this criterion. For 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. The impact on DQO decisions is addressed in the assessment of completeness.

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

To satisfy the third criterion, the dataset was assessed against the acceptance criteria for the DQIs of precision, accuracy, representativeness, comparability, and completeness, as defined in the Soils QAP (NNSA/NSO, 2012). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NFO, 2013). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2013) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). The precision rate for all constituents met the CAIP criterion of 80 percent. Therefore, the CAIP criterion for precision was met for all contaminants. The potential for a false-negative DQO decision error is negligible, and the results that

were qualified for precision can be confidently used for decision making. [Table B.1-2](#) provides the results for all constituents that were qualified for precision.

**Table B.1-2
Precision Measurements**

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Pu-238	Plutonium	3	34	91.2
Pu-239/240		3	34	91.2
Am-241	Americium	3	34	91.2

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2013) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). The sample results that were qualified for accuracy are presented in [Table B.1-3](#). As stipulated in Section 4.3 of the Soils QAP, when analyses of a particular contaminant do 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.

**Table B.1-3
Accuracy Measurements**

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Cadmium	Metals	1	4	75
Lead		3	4	25
Chlorobenzene	VOCs	1	1	0

There were no analytical data qualified for accuracy that exceeded one-half the FAL. 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, 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/NFO, 2013) was used to address sampling and analytical requirements for CAU 567. 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. These inferred plutonium values will be more representative of the sampled area than the isotopic results.

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 567 CAI are considered to adequately represent contaminant concentrations of the sampled population.

Comparability

Field sampling, as described in the CAIP (NNSA/NFO, 2013), 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 567 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/NFO, 2013) 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 release-specific analytes identified in the CAIP having valid results. Rejected data (either qualified as rejected or data that failed the criterion of sensitivity) were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion.

There was no rejected data for the site. The dataset for CAU 567 has met the general 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

Decision II as presented in the CAIP (NNSA/NFO, 2013) is as follows: “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.

An interim corrective action of PSM removal was conducted at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill during the investigation. COCs were not detected in soils collected adjacent to PSM, so Decision II sampling is not required for chemical releases at these locations.

An interim corrective action of soil removal was conducted at J-11 Soil RMA. After the soil was removed, COCs were not detected in remaining soil, so Decision II sampling is not required.

Radiological COCs were not detected at Seaweed E Contamination Area, A5b RMA, or Colby Mud Spill. Therefore, Decision II does not need to be resolved.

Because COCs were detected during Decision I sampling at Atmospheric Test Site T-1, Decision II needed resolution. TLDs were placed at all sample locations and in a grid across the site. Decision II was resolved by correlating the TED at sample and TLD locations to the PRM-470 TRS to identify the isopleth that encompassed the area that exceeds the FAL. This was established at the isopleth that was 9.97 times background. Additionally, the bunker area at the test GZ was established as a DCB and requires Decision II resolution. Decision II is resolved for the DCB because the extent and boundary of the bunker (and presumed COC within) is defined as the area covered with clean fill.

The information needed to predict potential remediation waste types and volumes, and information needed to evaluate the feasibility of remediation alternatives were provided by the analytical results from soil samples. The COCs that are assumed to be in the bunker located at the GZ contained within the DCB are defined by the sample results from adjacent areas and are sufficient to evaluate CAAs.

B.1.1.3 Sampling Design

The CAIP (NNSA/NFO, 2013) stipulated that the following sampling processes would be implemented:

- Sampling of sample plots will be conducted by a combination of judgmental and probabilistic sampling approaches at Atmospheric Test Site T-1.

Result. The location of the plots were selected judgmentally, and sample aliquots were collected within each plot probabilistically as described in [Section A.2.2.4](#).

- Judgmental grab sampling will be conducted at Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA.

Result. The location of the grab samples were selected judgmentally as described in [Section A.2.2.4](#).

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

Result. Judgmental sampling was conducted at hazardous debris locations.

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, 2012). 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 radiological FALs. For other types of contamination, the test for making DQO decisions was the comparison of the maximum analyte result from each release to the corresponding FAL. Radiological FALs at Atmospheric Test Site T-1 were based on the Remote Work Area scenario. At all other sites, radiological FALs were based on an exposure duration to a site worker using the Occasional Use Area exposure scenario. All chemical FALs were based on an exposure duration to a site worker using the Industrial Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in [Table B.1-4](#).

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 567 DQOs and [Table B.1-4](#). All data collected during the CAI supported the CSM, and no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NFO, 2013) made the following commitments:

Atmospheric Test Site T-1

1. Decision I outside the DCB will be evaluated by calculating TED in two sample plots with the highest levels of radioactivity on the TRS.

Result: Decision I was resolved by the placement of TLDS and collection of environmental samples in two sample plots as required in the CAIP.

2. A minimum of 14 locations covered with asphalt will be screened for subsurface contamination.

Result. Fourteen locations covered with asphalt were screened for subsurface contamination.

3. Geophysical surveys will be conducted at CWDs.

Result. Geophysical surveys were conducted at CWDs.

**Table B.1-4
Key Assumptions**

CAS	Atmospheric Test Site T-1	Seaweed E Contamination Area	A5b RMA	Colby Mud Spill	J-11 Soil RMA
Exposure Scenario	Remote Work Area	Occasional Use Area			
Affected Media	Surface and subsurface soil; debris, such as concrete, steel, and wood				
Location of Contamination/ Release Points	Surface and shallow subsurface soil, subsurface soil within landfills	Surface soil	Surface and shallow subsurface soil	Surface and shallow subsurface soil, subsurface soil within the URMA	Surface and shallow subsurface soil
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside the boundaries of the CAU. Infiltration of precipitation through subsurface media serves as a minor driving force for migration of contaminants.				
Preferential Pathways	Vertical transport is expected to dominate over lateral transport due to infiltration.				
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Lateral and vertical extent of contamination exceeding FALs is assumed to be within the spatial boundaries.				
Groundwater Impacts	None				
Future Land Use	Nuclear and High Explosives Test		Research Test and Experiment Zone	Nuclear Test	Research Test and Experiment Zone
Other DQO Assumptions	Buried contamination is present in the bunker area at GZ.	None			

4. Subsurface screening will be conducted at the two sediment locations closest to GZ.

Result. Subsurface screening was conducted at the two sediment locations closest to GZ.

5. Address any spills or PSM found at the site.

Result. One can of lead-contaminated grease and one broken lead-acid battery were identified and were removed from the site. A sample was collected from soil adjacent to the battery.

Seaweed E Contamination Area

6. One grab sample will be collected at each test GZ.

Result. One sample was collected from each test GZ.

7. Address any spills or PSM found at the site.

Result. Spills and PSM were not identified at the site.

A5b RMA

8. DU and radiologically elevated soil will be removed from the crater, and confirmation samples will be collected at the location of highest readings from a TRS after removal.

Result. DU and soil was removed from the site as a BMP. After removal, a TRS was conducted, a grid of TLDs was placed, and a composite sample was collected from the location of the highest readings.

9. Geophysical surveys will be conducted at potential landfills.

Result. Geophysical surveys were conducted at potential landfills. Because subsurface debris was not identified, a UR was not required.

10. Address any spills or PSM found at the site.

Result. Two pieces of lead were identified and were removed from the site. A sample was collected from soil adjacent to the lead.

Colby Mud Spill

11. Three judgmental sample locations will be placed in the drainage based on the presence of sediment areas, drilling mud, or elevated TRS readings.

Result. Samples were collected at three judgmental locations in sediment areas in the drainage.

12. Soil will be collected and screened at 2-ft intervals at two locations in the URMA. The three intervals with the highest FSRs will be collected.

Result. Two locations were established, screened, and sampled per the CAIP (i.e., the three highest interval at each location were collected). Mud was present at both locations and confirms that the locations were properly selected in the URMA.

13. Address any spills or PSM found at the site.

Result. One 10-gal can of motor oil, two paint buckets, one lead-acid battery, and a 5-by-4-ft pile of hydrocarbon impacted filters were identified and were removed from the site. A sample was collected from soil adjacent to the filter pile.

J-11 Soil RMA

14. One sample location will be established at the area of the most elevated radiological readings; subsurface screening will be conducted at this location.

Result. One location was established, and screening was conducted at the area of highest readings from the TRS. Three additional locations were sampled within this area. Soil from these locations was removed as a corrective action, and an additional confirmation sample was collected.

15. Address any spills or PSM found at the site.

Result. Spills and PSM were not identified at the site.

B.1.5 Draw Conclusions from the Data

The following subsections resolve the two DQO decisions for each of the CAU 567 CASs.

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 the CAIP, 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 corrective action is required, else no further investigation is needed for that COPC in that population.

- **Result.** Because COCs were assumed to be present within the established DCB and were present at sample locations A01, A02, A03, A06, and A08 at Atmospheric Test Site T-1,

corrective action is required. COCs were not identified at Seaweed E Contamination Area or Colby Mud Spill; therefore, corrective action is not required. COCs were removed from J-11 Soil RMA; therefore, corrective action is not required.

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

- **Result.** Debris was identified as PSM, and a corrective action of PSM removal was completed at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill.

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 waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

- **Result.** TLDs and TRS results were used to resolve Decision II for the sampled locations at Atmospheric Test Site T-1. Decision II was resolved for the DCB based on the defined area (i.e., boundary) of the DCB. Decision II was resolved for the items of PSM by verifying PSM was contained within the waste. Wastes were characterized as described in [Section A.8.2](#). Therefore, no additional information is needed to complete the Decision II evaluation.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

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

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

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

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Appendix C

Risk Assessment

C.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2014b) 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 567 CAIP [NNSA/NFO, 2013]). 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/NFO, 2014) is summarized in [Figure C.1-1](#).

It is assumed that contamination exceeding the FAL is present and requires corrective action within the bunker area located at the Atmospheric Test Site T-1 GZ.

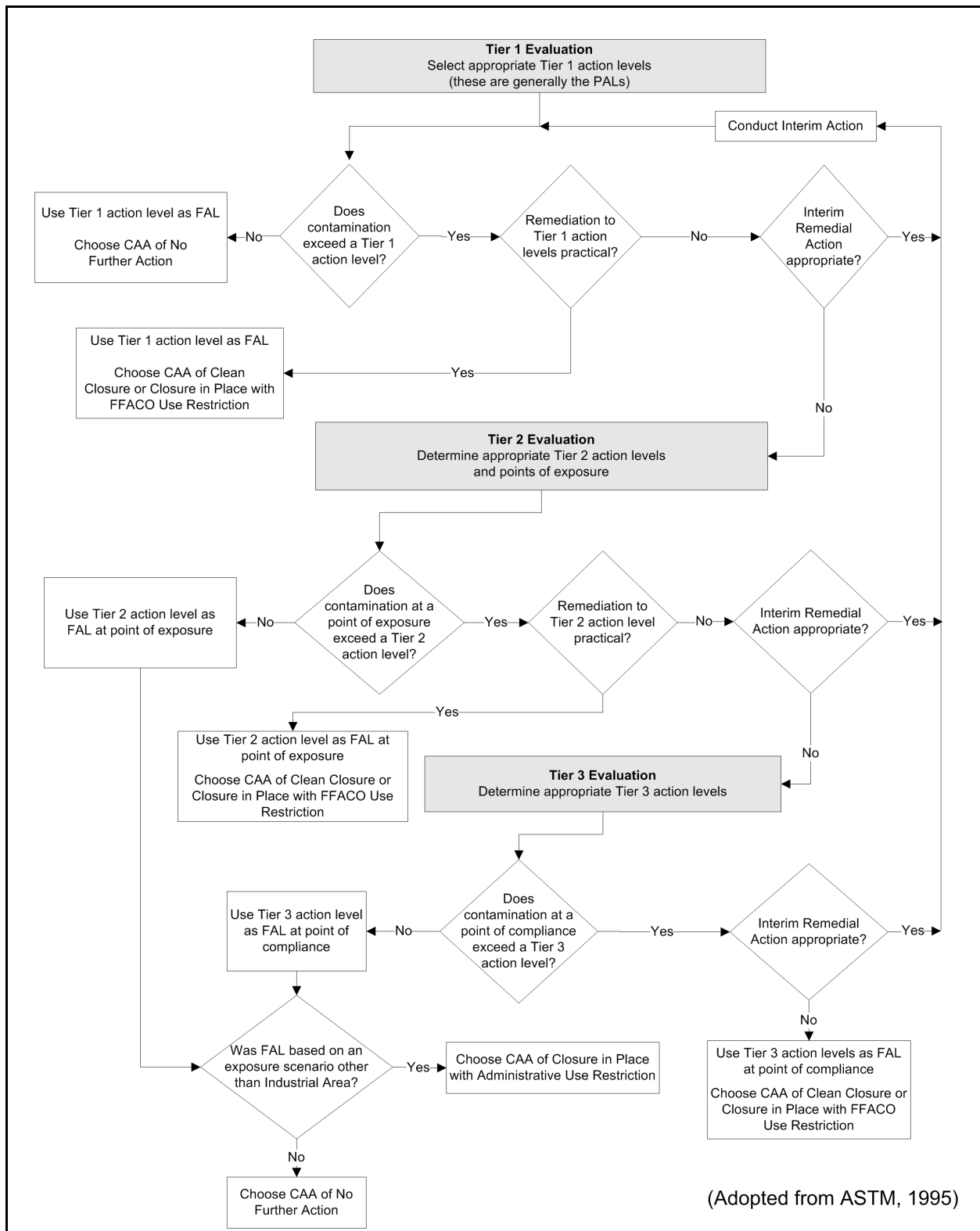


Figure C.1-1
RBCA Decision Process

The following PSM was removed under interim corrective actions during the CAI:

- Bucket of lead-contaminated grease at Atmospheric Test Site T-1
- Broken lead-acid battery at Atmospheric Test Site T-1
- Two lead pieces at A5b RMA
- Lead-acid battery at Colby Mud Spill

Soil exceeding the FAL was removed from J-11 Soil RMA as a corrective action during the investigation. As this risk evaluation is intended for use in making corrective action decisions for CAU 567 conditions at the conclusion of the CAI (after the completion of any interim corrective actions), the DCB and completed corrective actions will not be evaluated herein.

C.1.1 Scenario

CAU 567, Miscellaneous Soil Sites, comprises the following five CASs within Areas 1, 3, 5, 20, and 25 of the NNSS:

- 01-23-03, Atmospheric Test Site T-1
- 03-23-25, Seaweed E Contamination Area
- 05-23-07, A5b RMA
- 20-23-08, Colby Mud Spill
- 25-23-23, J-11 Soil RMA

Four atmospheric tests were conducted at Atmospheric Test Site T-1. Easy (Operation Tumbler-Snapper) was a weapons-related test with a yield of 12 kilotons (kt) detonated from a 300-ft tower on May 7, 1952. Simon (Operation Upshot-Knothole) was a weapons-related test with a yield of 43 kt detonated from a 300-ft tower on April 25, 1953. Apple 2 (Operation Teapot) was a weapons-related test with a yield of 29 kt detonated from a 500-ft tower on May 5, 1955. Galileo (Operation Plumbbob) was a weapons-related test with a yield of 11 kt detonated from a 500-ft tower on September 2, 1957 (DOE/NV, 2000; GE, 1979). Release sources at Atmospheric Test Site T-1 include the release of radionuclides from the four atmospheric tests, which may have been covered with asphalt resulting in a buried layer of radioactivity; consolidation and/or burial of contaminated debris; movement of contamination in drainages; and spills and PSM associated with test operations. Currently, the site is being used by the Center for Radiological/Nuclear Training at the NNSS for their CTOS program.

Seaweed E Contamination Area includes the location of three underground safety experiments (Seaweed C, Seaweed D, and Seaweed E) conducted October 1, 1969, during Operation Mandrel (DOE/NV, 2000). The release source at Seaweed E Contamination Area was the venting of the radioactive gas xenon during the underground safety experiments. Currently, the site is inactive.

The A5b RMA CAS consists of an RMA containing DU fragments. The source of the DU is unknown, but there is a small crater at the center of the site, and the distribution pattern of the DU is consistent with release from a detonation within the crater. Three disturbed areas near the debris may indicate the presence of additional buried debris, or they may be borrow or mud pits associated with nearby underground testing. The release sources at A5b RMA include PSM in the form of DU present in the surface soil, potential buried DU and other metallic debris buried in landfills, and spills and PSM associated with site activities. Currently, the site is inactive.

Colby was an underground test conducted in hole U20aa on March 14, 1976, as part of Operation Anvil (DOE/NV, 2000). After the test, on May 16, 1976, a large mud spill was discovered at the site that had occurred as a result of equipment malfunction at a post-test hole associated with the Colby test. The mud that leaked from the hole contaminated the drill pad, a fan-shaped area immediately north of the drill pad, and a flat area northeast of the drill pad; and flowed approximately a half-mile north through a ravine. During cleanup activities, contaminated dirt was placed in a 50-by-50-m area prepared in the deepest part (approximately 14 m deep) of the Colby test crater and covered with 3 ft of clean soil (Straume et al., 1977; Oswald, 1976). The release source at Colby Mud Spill is radioactive mud that traveled through a drainage after a spill, the subsequent burial of the mud in the Colby test crater, and spills and PSM associated with test and cleanup operations. Currently, the site is inactive.

J-11 Soil RMA is an area of radioactive soil inside an RMA. The source of the radioactive soil is unknown, but a scraped area adjacent to the RMA may have been used for storage, and it is possible the contamination is related to items stored in that area. The pattern of contamination at the site is consistent with a spill of radioactive liquid. Currently, the site is inactive.

C.1.2 Site Assessment

Investigation activities at all CASs included an evaluation of radiological contamination. An investigation of chemical contamination was conducted at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill. Soil samples and TLDs were used to calculate the TED to workers. Soil samples were collected to determine the presence of chemical COCs. The maximum calculated TED and MDCs for chemicals at each site are summarized in [Table C.1-1](#).

Table C.1-1
CAU 567 CASs
(Page 1 of 2)

CAS Name	CAS Number	Release	Result
Atmospheric Test Site T-1	01-23-03	Deposition of radionuclides from weapons testing (fission and activation products) onto the soil surface as well undisturbed surface deposition that was later covered with asphalt. Subsequent movement of radionuclides into CWDs and in drainages.	Assumed to exceed 25 rem/RW-yr within the DCB. <u>Maximum TED:</u> 36.5 mrem/RW-yr 217.4 mrem/IA-yr
		Release of lead onto the soil from a broken lead-acid battery.	<u>MDCs:</u> Arsenic - 5.5 mg/kg Barium - 220 mg/kg Cadmium - 0.25 mg/kg Lead - 57 mg/kg Mercury - 0.042 mg/kg Selenium - 1.1 mg/kg Cr(VI) - 7.4 mg/kg
Seaweed E Contamination Area	03-23-25	Release of radionuclides (xenon gas) from the underground safety experiments Seaweed C, Seaweed D, and Seaweed E.	<u>Maximum TED:</u> 0.0 mrem/OU-yr 0.9 mrem/IA-yr
A5b RMA	05-23-07	Surface release point consistent with a detonation site resulting in a crater and dispersion of fragments, with vaporization of DU in a small crater, and ejection of DU and metal fragments to the surface in a regular pattern surrounding the crater.	<u>Maximum TED:</u> 0.8 mrem/OU-yr 15.4 mrem/IA-yr
		Release of lead onto the soil from pieces of lead.	<u>MDCs:</u> Arsenic - 3.6 mg/kg Barium - 140 mg/kg Cadmium - 1.1 mg/kg Lead - 56 mg/kg Mercury - 0.44mg/kg Selenium - 0.5 mg/kg Cr(VI) - 5.7 mg/kg

Table C.1-1
CAU 567 CASS
(Page 2 of 2)

CAS Name	CAS Number	Release	Result
Colby Mud Spill	20-23-08	Surface release and migration of radionuclides in drilling mud spilled from the post-test hole for the Colby test, and subsequent movement of the drilling mud into an URMA during cleanup efforts.	<u>Maximum TED:</u> 0.1 mrem/OU-yr 2.5 mrem/IA-yr
		Release of hazardous constituents onto the soil from a pile of hydrocarbon-impacted filters.	<u>MDCs:</u> Arsenic - 4.8 mg/kg Barium - 130 mg/kg Lead - 17 mg/kg Mercury - 0.021 mg/kg Cr(VI) - 6.9 mg/kg
J-11 Soil RMA	25-23-23	Source is unknown but is believed to be a surface release of radionuclides from a spill of liquid.	<u>Maximum TED:</u> 0.4 mrem/OU-yr 8.1 mrem/IA-yr

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 and the completion of interim corrective actions, there are no contaminants at Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, or J-11 Soil RMA that present threat to human health, safety, and the environment; therefore, these sites were determined to be Classification 4 sites.

Contamination is present at Atmospheric Test Site T-1 within the DCB that, if excavated, could pose a threat to human health, safety, and/or the environment. Contamination is also present on the surface surrounding the DCB. Therefore, Atmospheric Test Site T-1 has been determined to be a Classification 2 site.

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/NFO, 2013) 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 is 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 (8 hr/day and 250 day/yr for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 action level for radiological contaminants is determined 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:

- EPA Region 9 RSLs (EPA, 2014a).
- Background concentrations for RCRA metals were evaluated when natural background exceeds the PAL, as is often the case with arsenic. Background is considered the mean plus two times the standard deviation of the mean based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- For COPCs without established RSLs, a protocol similar to EPA Region 9 was used to establish an action level; otherwise, an established value from another source may be chosen.

Although the PALs are based on an industrial scenario, no industrial activities are conducted at these sites, 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 releases, 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. The potential exposure pathways would be through worker contact with the contaminated soil or various debris currently present at the site. 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

An exposure time based on the Industrial Area scenario (2,000 hr/yr) was used to calculate the Tier 1 action levels (i.e., PALs). For radiological contaminants, dose values were calculated for comparison to the Tier 1 action level based on an exposure time of 2,000 hr/yr. Individual chemical analytical results were directly compared to chemical PALs.

The only sampled locations at each CAU 567 release that exceed a radiological Tier 1 action level (i.e., PAL) are listed in [Table C.1-2](#). Based on the conservative assumption that a site worker could be exposed to the maximum dose calculated at any sampled location outside the DCB at Atmospheric Test Site T-1, this site worker would receive a 25-millirem (mrem) dose at location A02 in approximately 230 hours.

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 567
(mrem/IA-yr)
(Page 1 of 3)

CAS	Location	Average TED	95% UCL TED
Atmospheric Test Site T-1	A01	145.9	153.4
	A02	217.4	226.3
	A03	209.0	215.6
	A04	136.4	143.2
	A05	128.1	140.9
	A06	172.7	190.9
	A07	130.9	143.2
	A08	135.6	151.8
	A09	142.1	148.5
	A10	70.5	79.8

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 567
(mrem/IA-yr)
(Page 2 of 3)

CAS	Location	Average TED	95% UCL TED
Atmospheric Test Site T-1	A11	57.3	65.7
	A12	130.1	140.4
	A13	89.8	97.8
	A14	65.2	70.1
	A15	121.2	131.8
	A16	98.4	101.1
	A17	41.3	47.7
	A18	65.8	80.0
	A20	55.6	62.1
	A21	89.5	101.0
	A22	38.2	44.0
	A27	83.9	94.3
	A28	93.7	102.2
	A29	80.5	84.2
	A30	52.1	59.1
	A31	120.7	122.5
	A32	77.6	88.4
	A33	73.3	77.0
	A34	82.9	91.3
	A35	60.4	66.7
	A36	46.6	49.8
	A37	81.1	97.6
	A38	44.6	48.5
	A41	23.9	28.5
	A42	54.8	61.6
	A43	42.5	43.5
	A45	20.8	40.5
	A46	31.2	33.6

Table C.1-2
Locations Where TED Exceeds the Tier 1 Action Level at CAU 567
(mrem/IA-yr)
(Page 3 of 3)

CAS	Location	Average TED	95% UCL TED
Atmospheric Test Site T-1	A47	65.5	71.5
	A52	38.4	43.5
	A53	40.0	48.9
	A56	26.3	30.3
	A57	56.2	64.6
	A58	21.2	25.8
	A60	12.9	25.0
	A62	32.6	36.9
	A74	65.0	68.4
	A75	77.1	85.6
	A76	60.2	67.8
	A77	60.2	65.6
	A78	42.8	46.0
	A91	24.7	27.3
	A98	34.7	36.6
	A99	103.8	113.4
	A118	27.1	29.6

Bold indicates the values exceeding 25 mrem/yr.

The three locations that exceeded the Tier 1 action level of 5.6 mg/kg for Cr(VI) are A136 at 7.4 and 7.0 mg/kg, C04 at 5.7 mg/kg, and D07 at 6.9 mg/kg.

C.1.7 Evaluation of Tier 1 Results

For all of the release sites other than Atmospheric Test Site T-1 and the Cr(VI) contamination at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill, contamination does not exceed the Tier 1 PAL; therefore, the FALs are set at the PAL, and no further action is required. Because Cr(VI) concentrations at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill, and the radiological contamination at Atmospheric Test Site T-1 exceed their corresponding PALs, and the industrial use

exposure scenarios used to establish the PALs are not representative of actual or projected land use at these sites, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate. For the radiological contamination at Atmospheric Test Site T-1, the risk to receptors from contaminants is due to chronic exposure to the contaminants (i.e., exposure over time). A review of the current and projected use at Atmospheric Test Site T-1 determined that workers may be present at these sites for a maximum of 240 hr/yr (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 for radiological dose at Atmospheric Test Site T-1. For the Cr(VI) contamination evaluation, it was also determined to conduct a Tier 2 evaluation using site-specific conditions as inputs to the Tier 2 evaluation and the conservative industrial use exposure times.

C.1.8 Tier 1 Remedial Action Evaluation

No remedial actions are proposed based on 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 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 Atmospheric Test Site T-1 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 areas identified the general types of work activities that are currently conducted at each site, to include fencing/posting inspection and maintenance workers, CTOS workers, and CTOS exercise participants. Site activities that may occur in the future were identified by assessing tasks related to maintenance of existing infrastructure and long-term stewardship of the site (e.g., inspection and maintenance of UR signs, trespasser). Activities related to the CTOS program include the training of radiological emergency response workers. This includes the use of Atmospheric Test Site T-1 to provide a training scenario using the residual radioactivity from the four tests conducted there to provide trainees with real conditions involving contaminated soil, steel fragments, and radioactive glass. In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NFO and/or M&O contractor departments responsible for these activities were consulted. Under the current and projected land use at these sites, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker.** Workers sent to conduct the annual inspection of the UR and demarcation areas. The URs and any demarcation areas require a periodic inspection to ensure that any required access controls are intact and legible. This may require two people to spend up to 10 hr/yr each at each CAS.
- **Trespasser.** This would include workers or individuals who do not have a specific work assignment at one of the CASs. Although the sites will be posted with warning signs, workers could potentially inadvertently enter these CAS areas and come in contact with site

contamination. This is assumed to be an infrequent occurrence (i.e., once per year) that would result in a potential exposure of less than a day (8 hours).

- **CTOS Worker.** Periodic radiologic emergency response training activities occur at the CTOS facility. These workers typically spend 18 to 24 day/yr in the general area of Atmospheric Test Site T-1, setting up and dismantling training equipment. It was conservatively assumed that this type of worker would spend 24 ten-hour days (240 hours) at Atmospheric Test Site T-1. Although workers may be present at the site for up to 240 hours, the time spent in the portion of the site that exceeds the FAL would be less; therefore, 240 hours is a conservative estimate.
- **CTOS Exercise Participant:** Emergency response professionals from around the country attend training sessions provided by CTOS. These individuals typically attend a week-long training session, with most training occurring in a classroom setting or at other sites. Each attendee typically spends less than 10 hours at Atmospheric Test Site T-1.

Under the current land use at Atmospheric Test Site T-1, the most exposed worker would be the CTOS worker, who could be exposed to site contamination for up to 240 hr/yr (Table C.1-3). Under an unrealistic but worst-case assumption that this most exposed worker were to remain at the location of the maximum dose outside the DCB for the entire maximum estimated time spent at the site (240 hr/yr), this worker could receive a maximum potential dose of 26.09 mrem/yr.

Table C.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 567 Releases

CAS	Most Exposed Worker	Exposure Time	Maximum Potential Dose
Atmospheric Test Site T-1	CTOS Worker	240 hr/yr	26.09 mrem/yr

In the CAU 567 DQOs, it was conservatively determined that the Remote Work Area exposure scenario (as listed in Section 3.1.1 of the CAIP [NNSA/NFO, 2013]) would be appropriate in calculating receptor exposure time based on current land use at Atmospheric Test Site T-1. This exposure scenario assumes exposure to site workers who are assigned to the area as a regular work site 42 day/yr, greater than the 24 days that CTOS workers are present. Site workers under the Remote Work Area scenario are assumed to be on the site for an equivalent of 336 hr/yr. As the use of this scenario provides a more conservative (longer) exposure to site contaminants than the most exposed worker (based on current and projected future land use), the development and evaluation of Tier 2 action levels were based on the Remote Work Area exposure scenario.

For the development of chemical Tier 2 action levels, under the current land use at Atmospheric Test Site T-1 and most exposed worker would be the CTOS worker, who would not be exposed to site contamination for more than 336 hr/yr. Under current land use at A5b RMA and Colby Mud Spill, the most exposed worker would be the inspection and maintenance worker, who would not be exposed for more than 10 hr/yr. In the CAU 567 DQOs, it was conservatively determined that the Remote Work Area exposure scenario would be appropriate in calculating receptor exposure time based on current land use at Atmospheric Test Site T-1 and the Occasional Use Area exposure scenario would be appropriate in calculating receptor time at A5b RMA and Colby Mud Spill (as listed in Section 3.1.1 of the CAIP [NNSA/NFO, 2013]). This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr. However, for the Tier II evaluation for Cr(VI), the Industrial Area scenario, which is more conservative, was used to develop the Tier II level. As the use of this scenario provides a more conservative (longer) exposure to site contaminants than the most exposed worker (based on current and projected future land use), the development and evaluation of Tier 2 action levels for Cr(VI) were based on the Industrial Area exposure scenario.

A site-specific outdoor industrial soil Tier 2 action level was calculated for Cr(VI) using site-specific inputs to standard risk procedures. This calculation process is described in the Soils RBCA document (NNSA/NFO, 2014). This uses the EPA Region 9 RSL Calculator (EPA, 2014b) to calculate concentration limits using carcinogenic or systemic toxicity values under specific exposure conditions. The calculator uses the latest human health toxicity values (i.e., cancer slope factors or non-cancer reference doses [RfDs]), default exposure assumptions, and physical and chemical properties. The calculator was used to assess site-specific risk by changing the default parameters to reflect site-specific risk conditions. Parameters used in the calculation of this Tier 2 action level are defined in the Soils RBCA document.

C.1.11 Comparison of Site Conditions with Tier 2 Action Levels

The TEDs calculated using the Remote Work Area exposure scenario were then compared to the 25-mrem/RW-yr Tier 2 action level. As shown in [Table C.1-4](#), some of the 95 percent UCL TED values exceeded the 25-mrem/OU-yr Tier 2 action level.

Table C.1-4
Remote Work Area TED at Locations Where TED Exceeds
the Tier 2 Action Level at CAU 567
(mrem/RW-yr)

CAS	Location	Average TED	95% UCL TED
Atmospheric Test Site T-1	A01	24.5	25.8
	A02	36.5	38.0
	A03	35.1	36.2
	A06	29.2	32.3
	A08	22.8	25.5

Bold indicates the values exceeding 25 mrem/yr.

For Cr(VI), the Tier 2 action levels were compared to maximum contaminant concentrations from each sample location. The concentrations for Cr(VI) (7.4 and 7.0 mg/kg at A136, 5.7 mg/kg at C04, and 6.9 mg/kg at D07) are less than corresponding Tier 2 action level of 8.42 mg/kg. The FAL for Cr(VI) was established as the Tier 2 action level.

C.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, soil contamination is present at Atmospheric Test Site T-1 at locations A01, A02, A03, A06, and A08. As corrective actions are practical for this release, the Tier 2 action level is established as the FAL, and corrective actions were implemented.

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 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 release. However, for CAU 567, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from single-point locations.

Soil contamination is present at Atmospheric Test Site T-1 that exceeds the FAL. As corrective actions are required for this release, the FAL is established as the Tier 2 action level. A corrective action of closure in place with an FFACO UR was implemented at the site.

The FAL was based on an exposure time of 336 hr/yr of site worker exposure to Atmospheric Test Site T-1 surface soils. If the land use is changed to a more intensive use of the site, a site worker could be potentially exposed to site contamination for longer exposure times and receive an unacceptable level of risk. Therefore, an administrative boundary was established as a BMP that would restrict a more intensive use of this site without NDEP notification. The area at Atmospheric Test Site T-1 that could potentially provide sufficient dose to cause a full-time industrial worker to receive an annual dose exceeding 25 mrem was bounded as described in [Section D.1.1](#).

The corrective actions for CAU 567 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 567. Surface soil samples, TLD measurements, TRS measurements, and geophysical surveys were collected to characterize the presence and lateral extent of radiological contamination at these sites.

D.1.1 Atmospheric Test Site T-1 Closure Activities

Based on the results of this investigation, a corrective action of closure in place with a UR was implemented and encompasses the area exceeding a dose of 25 mrem/RW-yr and the DCB. The established FFACO UR for Atmospheric Test Site T-1 is defined by the coordinates listed in the FFACO UR form and as presented in [Attachment D-1](#). Additionally, in accordance with the Soils RBCA document (NNSA/NFO, 2014) and Section 3.3 of the CAIP (NNSA/NFO, 2013), an administrative UR (as presented in [Attachment D-1](#)) was established to prevent a future site worker from receiving a dose exceeding 25 mrem/yr if there were a more intensive use of the site in the future. Both URs are recorded in the FFACO database, M&O Contractor GIS, and NNSA/NFO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require NDEP notification.

These URs were established based on the potential for a site worker to receive an inadvertent dose (assumes no radiological training or protective measures). The URs are not applicable to activities conducted under a program compliant with 10 CFR 835 (CFR, 2014) where the radiological hazards are well-defined, controls are implemented to protect workers from the radiological hazards, workers have received radiological training, and all activities are conducted under a radiological control plan.

The FFACO UR signs for Atmospheric Test Site T-1 read as follows:

WARNING
RADIOLOGICAL CONTAMINATION
FFACO Site CAU 567,
Miscellaneous Soils Sites
No activities that may alter or 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

A lead-acid battery and can of lead-contaminated grease were removed and disposed of during the investigation. COCs associated with these items were not identified in the adjacent soil.

D.1.2 A5b RMA Closure Activities

Limited excavation of DU and contaminated soil was conducted as a BMP during the investigation. In order to reduce radioactivity to levels below the PAL, 15.9 yd³ of soil and DU were removed from the crater. DU was also scattered across the site outside the crater area; several of these pieces were also removed during the investigation as well as any adjacent contaminated soil. Additional TRSs were performed, and confirmation soil samples and TLD measurements were taken from the crater area; confirmation soil samples were also taken from where two of the pieces had been removed outside the crater area. Verification surveys and samples confirm radioactivity is not present at the site at levels that would post a risk to future workers.

Two pieces of lead were removed and disposed of during the investigation. COCs associated with these items were not identified in the adjacent soil.

D.1.3 Colby Mud Spill Closure Activities

A lead-acid battery was and associated COCs were removed and disposed of during the investigation.

D.1.4 J-11 Soil RMA Closure Activities

Limited excavation of contaminated soil was conducted as a corrective action during the investigation. In order to reduce radioactivity to levels below the FAL, 30.9 yd³ of radioactive soil was removed. Additional TRSs were performed, and confirmation soil sample and TLD measurements were taken in the area where soil was removed. Verification surveys and samples confirm radioactivity is not present at the site at levels that would post a risk to future workers.

D.2.0 References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2014. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

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

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U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

Attachment D-1
Use Restrictions
(5 Pages)

Use Restriction Information

CAU Number/Description: CAU 567, Miscellaneous Soil Sites

Applicable CAS Number/Description: CAS 01-23-03, Atmospheric Test Site T-1

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
1	4101105	579738
2	4101086	579701
3	4101095	579642
4	4101140	579638
5	4101218	579646
6	4101217	579658
7	4101150	579742

Depth: 12 in. bgs

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction (UR) is to protect workers from receiving a dose exceeding 25 mrem/yr from contamination that is present at this site. This is based on the current land use which is an assumed maximum exposure period of 336 hours per year. Using the maximum calculated dose rate at this site, a worker could receive a 25-mrem dose in 230 hours of site exposure. Dose was not calculated for buried contamination present in the bunker area at test GZ but is assumed to exceed the action level of 25 mrem/RW-yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 567.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 567			
Constituent	Maximum Concentration	Action Level	Units
TED	36.5	25	mrem/RW-yr

Site Controls: Activities that are not conducted under the provisions of 10 CFR Part 835, Occupational Radiation Protection, are restricted within the area defined by the coordinates listed above and depicted in the attached figure without prior notification and approval of NDEP. The FFACO UR is recorded in the FFACO database, M&O Contractor GIS, and the NNSA Nevada Field Office CAU/CAS files. Warning signs for the FFACO UR are posted at the site.

Use Restriction Information

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
Atmospheric Test Site T-1, CWD #2		
1	4101633	579140
2	4101643	579092
3	4101656	579087
4	4101690	579133
5	4101672	579156
Atmospheric Test Site T-1, Atmospheric Release		
1	4100726	579797
2	4100811	579542
3	4101054	579369
4	4101366	579425
5	4101495	579767
6	4101446	579904
7	4101281	580005
8	4100953	580004

Depth: 12 in. bgs

Survey Source (GPS, GIS, etc): GIS

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction (UR) is to protect workers from receiving a dose exceeding 25 mrem/yr from contamination that is present at this site if the site were to be used for industrial type activities in the future. This is based on a potential future land use in which a worker would be assigned a full-time work station (i.e., 2,000 hours per year) at the location of the maximum dose. The analytical results and locations of all samples are presented in the CADD/CR for CAU 567.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	Maximum Concentration	Action Level	Units
TED	230.6	25	mrem/IA-yr

Site Controls: New activities that would cause a site worker to be exposed to site radiological contamination for a period of more than current land use (defined above) are restricted within the area defined by the coordinates listed above and depicted in the attached figure without prior notification and approval of NDEP unless the activities are conducted under the provisions of 10 CFR Part 835. The FFACO UR is recorded in the FFACO database, M&O Contractor GIS, and the NNSA Nevada Field Office CAU/CAS files. No physical site controls are required for this administrative UR.

Use Restriction Information

UR Maintenance Requirements (applies to both FFACO and Administrative UR(s) if Administrative UR exists):

Description: Warning signs for the FFACO UR will be inspected to ensure postings are in place, intact, and legible. Signs will be repaired or replaced as needed.

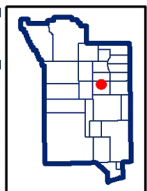
Inspection/Maintenance Frequency: Inspections will be conducted of the FFACO UR annually. Because the site is actively used, a review of land use will be conducted annually.

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: None

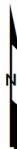
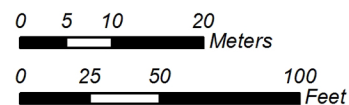
Submitted By: /s/ Rober F. Boehlecke Date: 12/12/14

HI:567CADD567_CADD_T1_FFACOUR_NAD83.mxd - 10/21/2014



**CAU 567, CAS 01-23-03
Atmospheric Test Site T-1
FFACO UR Boundary**

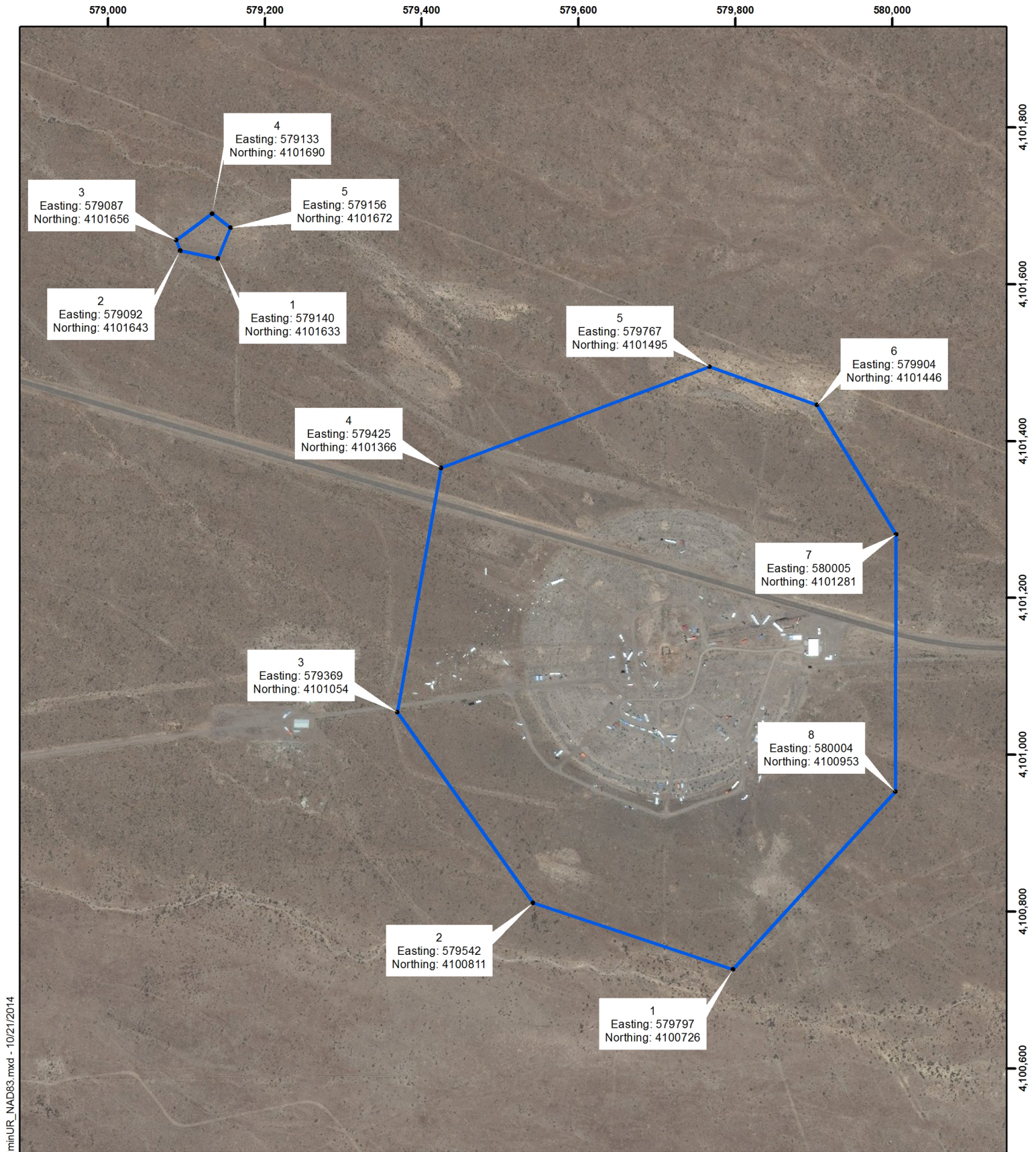
Explanation
FFACO UR



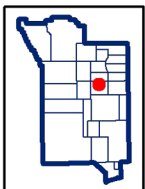
Source: N-I GIS, 2014; ESRI, 2014

Coordinate System: NAD 1983 UTM Zone 11N, Meters

UNCONTROLLED When Printed

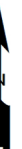
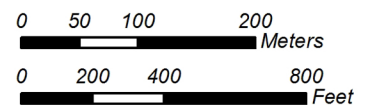


H:\567\CADD\567_CADD_T1_AdminUR_NAD83.mxd - 10/21/2014



**CAU 567, CAS 01-23-03
Atmospheric Test Site T-1
Administrative UR Boundary**

Explanation
 Administrative UR



Source: N-I GIS, 2014; ESRI, 2014

Coordinate System: NAD 1983 UTM Zone 11N, Meters

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Attachment D-2

Waste Disposal Documentation

(12 Pages)

2
NNSS LANDFILL LOAD VERIFICATION

SWO USE (Select One) AREA ☐ 23 ☐ 6 ☒ 9/10C LANDFILL

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

REQUIRED: WASTE GENERATOR INFORMATION

(This form is for rollofs, dump trucks, and other onsite disposal of materials.)

Waste Generator: Mark Hesel (N-I WO) Phone Number: 5-2124

Location / Origin: CAU 567, Bulk debris and soil for disposal ; tracking number 567D01

Waste Category: (check one) ☐ Commercial ☒ Industrial
Waste Type: (check one) ☒ NNSS ☐ Putrescible ☒ FFACO-onsite ☐ WAC Exception
☐ Non-Putrescible ☐ Asbestos Containing Material ☐ FFACO-offsite ☐ Historic DOE/NV
Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP
Pollution Prevention Category: (check one) ☒ Clean-Up ☐ Routine
Method of Characterization: (check one) ☒ Sampling & Analysis ☒ Process Knowledge ☒ Contents

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

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

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES

Check all allowable wastes that are contained within this load:

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

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

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

Additional waste accepted at the Area 9 U10c Landfill:

☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water separators
☐ Light ballasts (contact SWO) ☒ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above
☐ Hydrocarbons (contact SWO) ☒ Other Empty drums Ground Tanks

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐

☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☐ Crushed non-teme plated oil filters
☐ Plants ☐ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: _____ (if initialed, no radiological clearance is necessary.)

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

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

Print Name: Mark Hesel

Signature: /s/ Mark Hesel

Date: 3/24/14
3/28/2014

Radiological Survey Release for Waste Disposal RCT Initials

____ This container/load meets the criteria for no added man-made radioactive material
☒ This container/load meets the criteria for Radcon Manual Table 4.2 release limits.
____ This container/load is exempt from survey due to process knowledge and origin.

SIGNATURE: /s/Jeffrey J. Tappen DATE: 3/3/14

BN-0646 (10)

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

SWO USE ONLY

Load Weight (net from scale or estimate): 4500

Certifier: /s/ R. Everett
Printed Name & Signature

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-0000000006, Revision 16, shipment number ITL14009 with container number 567E04. was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser

NI

Waste Coordinator

Shipped by

Organization

Title

/S/ Mark Heser

Signature

8/14/14

Date

JON TANAKA

Received by

H220

Organization

SPECIALIST

Title

/s/ Jon Tanaka

Signature

08-14-2014

Date

NTS On-Site HazMat Transfer - Published

Tracking No: ITL14009 Mesa Number:

Carrier: NSTEC ON BEHALF OF NNSA

Vehicle: E107213

Driver: MICHAEL SMITH

Depart: 14-AUG-2014

Arrival: 14-AUG-2014

From: MARK HESER
NAVARRO-INTERA, LLC (N-I)
BASE CAMP
MERCURY, NV 89023

Area: 25
Bldg: CAU 567
Phone: 702-295-2124
Mobile: 702-496-0150

To: CHRIS CHALUPKA
NSTEC
BASE CAMP
RWMS
MERCURY, NV 89023
Area: 05
Bldg: 007
Phone: 702-295-6348
Mobile:

Entered By: MARK HESER

Date Entered: 23-JUN-2014

Modified By: MARK HESER

Date Modified: 12-AUG-2014

Shipped Material(s)

Package(s)

Unit(s)

Guide No.

UN/NA 2912, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), 7
WASTE
RADIONUCLIDES: CS-137 (6.84E+08 BQ) PHYSICAL FORM: SOLID CHEMICAL FORM: OXIDE
PACKAGE ACTIVITY: 6.84E+08 BQ CATEGORY: LSA-I - EXCEPTED FROM MARKING AND
LABELING (RADIOACTIVE - LSA MARKING WILL BE AFFIXED) EXCLUSIVE USE SHIPMENT;
CONTAINER NUMBER 567E04 (WITH TID NUMBERS 0001730, 0001670, AND 0001787)

1 INTERMODAL
CONTAINER
37900.00
POUND(S)
(GROSS)

162

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
MARK HESER 702-496-0150

In the event of an emergency on the Nevada National Security Site, immediately contact the Operations Coordination Center (OCC) Duty Manager at 702/295-0311 for assistance.

EMERGENCY RESPONSE

In the event of an incident involving Hazardous Material:

By Phone
702-295-0311

By Radio
'MAYDAY - MAYDAY - MAYDAY'

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 certify 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/ Mark Hesper Date: 8/14/14 Time: 13:20

Received by: /s/ John Tanaka Date: 8/14/14 Time: 1307

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Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL14010, with container number 567E05. was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Hesper

NI

Waste Coordinator

Shipped by

Organization

Title

/s/ Mark Hesper

Signature

8/14/14

Date

Jon Tanaka

Received by

H220

Organization

SPECIALIST

Title

/s/ Jon Tanaka

Signature

8-14-2014

Date

NTS On-Site HazMat Transfer - Published

Tracking No: ITL14010 Mesa Number:
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: E107213
Driver: MICHAEL SMITH

Depart: 14-AUG-2014

Arrival: 14-AUG-2014

From: MARK HESER
NAVARRO-INTERA, LLC (N-I)
BASE CAMP
MERCURY, NV 89023

Area: 25
Bldg: CAU 567
Phone: 702-295-2124
Mobile: 702-496-0150

To: CHRIS CHALUPKA
NSTEC
BASE CAMP
RWMS
MERCURY, NV 89023
Area: 05
Bldg: 007
Phone: 702-295-6348
Mobile:

Entered By: MARK HESER
Modified By: MARK HESER

Date Entered: 23-JUN-2014
Date Modified: 12-AUG-2014

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 2912, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), 7 WASTE RADIONUCLIDES: CS-137 (7.36E+08 BQ) PHYSICAL FORM: SOLID CHEMICAL FORM: OXIDE PACKAGE ACTIVITY: 7.36E+08 BQ CATEGORY: LSA-I - EXCEPTED FROM MARKING AND LABELING (EXCEPT RADIOACTIVE-LSA MARKING WILL BE AFFIXED); EXCLUSIVE USE SHIPMENT; CONTAINER NUMBER 567E05 (WITH TIDS 0001728, 0001654, AND 0001630)	1 INTERMODAL CONTAINER	39860.00 POUND(S) (GROSS)	162

**Emergency Response Number
702-295-0311**

Secondary Emergency Response Contact And/Or Comments
MARK HESER 702-496-0150

In the event of an emergency on the Nevada National Security 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 certify 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/ Mark Hesper Date: 8/14/14 Time: 0930

Received by: /s/ Jon Tanaka Date: 08/14/14 Time: 1045

UNCONTROLLED When Printed

Waste Container Log

COPY

1. Container ID: <u>567 Bat 1</u>	
2. Container Barcode: <u>LVEC N/A</u>	
3. CAU: <u>567</u>	4. CAS/Location: <u>20-23-08</u> 5. CAS Letter: <u>D</u>
6. Container Type: <u>Battery Casing</u> 7. Container Size: <u>Battery - 12 volt intact</u>	

8. Pre-Use Inspection Checklist:	Yes	No
Is the outside of the waste container free of defects (i.e., dents, cracks, corrosion, or other defects)?	/	
Is the container lid, door, or closure in good condition?	/	
Is the container capable of being secured with a lock or TID?	/	
Are all container welds and/or seams intact and in good condition?	/	
Are all container gaskets in place and in good condition?	N/A	
Is the container empty?	/	
Is the container free of liquids?	/	
Are the interior surfaces of the container free of defects (i.e., dents, cracks, corrosion, or other defects)?	/	

Waste Handler's Signature: /s/ Mark Hesser Badge No.: IB53550 Date: 4/8/14

Note: If any item is "No," then the container shall be segregated and a "Hold Tag" completed and affixed. Notify the WCO, WO Manager, or designee.

9. Liner(s):

Is a minimum 6-mil total liner(s) in place for solid wastes in drums? (Circle: yes (no))
 OR: Are appropriate liners in place for other types of containers? (Circle: yes (no))
 and describe Intact / Dry LEAD Acid battery Casing
 OR: If no liner(s) required, circle (N/A) - Casing meets container

10. Container Markings and Labels (applied at the time of packaging):

Container ID: 567 Bat 1 Accumulation Start Date*: N/A - exempt from RCRA if reclaimed

(* Not applicable to satellite accumulation areas)

Contents: 1 Each - lead Acid battery for recycle

Circle all Labels applied to container at time of packaging:

Haz. Waste Pend. Analysis	Non-Hazardous	PCB	Hazardous
Rad. Mat. Pend. Analysis	Hydrocarbon	Asbestos	Radioactive
Other (Describe): <u>LEAD Battery for recycle</u>			

Comments:

Waste Container Log

Directions for Waste Container Log – Waste Handler Section

A Qualified Waste Handler must complete Pages 1 through 4 of the Waste Container Log for each waste container generated. A different Qualified Waste Handler must verify each entry recorded in Section 11, Contents Log.

1. **Container ID** – Enter the CAU number, CAS letter, sequential number (i.e., ###A##).
2. **Container Barcode** – Enter the barcode number that was placed on the container when it was receipt inspected.
3. **CAU** – Enter the CAU number or project designation where the waste was generated (i.e., CAU ###).
4. **CAS/Location** – Enter the CAS number or site location identifier where the waste was generated.
5. **CAS Letter** – Enter the CAS letter associated with the CAS via the Project Field Instruction.
6. **Container Type** – Enter the container type (e.g., Steel Drum, B-25 Box, Plastic Bucket).
7. **Container Size** – Enter the container's maximum capacity (e.g., 55 gal, 5 gal, 3.5 cubic yards).
8. **Pre-Use Inspection Checklist** – Conduct an initial pre-use inspection before placing waste in the container. If the container condition changes after waste are placed in the container, then correct the Pre-Use Inspection section and notify the WCO and Environmental Compliance Manager, or designee.
9. **Linners** – Circle or Describe the type(s) of liners used for the container being filled.
10. **Container Labels/Markings (at the time of packaging)** – Circle all the appropriate boxes for labels that are placed on the container and list/describe any others applied (e.g., Container ID: ###A##; Contents: Rinsate; Accumulation Start Date: 01/01/05).
11. **Contents Log:**
 - A. **Item number** – A unique number designating each package, item, or increment of waste placed in the container (e.g., 1, 2, 3). The number should match the number on the item or package physically placed in the container.
 - B. **Date** – Date that the package is placed in the container.
 - C. **% Contam.** – Enter the percent contaminant on the waste media (example – minimum soil contamination on PPE = 1%; saturated oil absorbent pads = 100%).
 - D. **Estimated Volume (gallons)** – Estimate volume in gallons of package placed in the container. Use minus sign (-) for volume in gallons removed from the container (e.g. removed 2 gallons for waste management sample analysis).
 - E. **Waste Type (Circle and Describe)** – Circle and describe in the space provided the source of the waste (e.g., PPE – Tyvek, nitrile gloves, boots; Rinsate – Decon of backhoe bucket).
 - F. **Absorbent Type (w/Amt. and Units)** – Absorbent Type (e.g., Waste Lock, Petrosel II-G, Aquaset, None) and amount with units.
 - G. **TID Number** – If waste is being added to a container for the first time (i.e., the first Contents Log item entry), document the Tamper Indicating Device (TID) number applied as the "New" TID. When accessing a container that is already TID'd (i.e., one or more entries already listed on the Contents Log), ensure that the TID found applied to the container matches the last "New" TID number listed on the Contents Log, and record this number as the "Old" TID number on the current entry line of the Contents Log. If the found TID does not match the previous entry on the Contents Log, contact the project's Waste Operations Coordinator for resolution. Once access to the container has been completed and a new TID applied, record the number of the "New" TID.
 - H. **NNSSWAC Prohibited Waste Forms** – If the waste is known or suspected to contain, or is being analyzed for NNSSWAC LLW prohibited waste forms, then write "Known," "Suspected," or "Pending" as applicable, and the prohibited item(s); otherwise, write "None." **NNSSWAC prohibited waste forms: Free Liquids, Hazardous Waste (untreated), Chelating Agents, Compressed Gas, Transuranic Waste, Etiological Agents, Explosives/Pyrophorics, Reactive Chemicals.**
 - NNSSWAC Restricted Waste Forms** – If the waste is known, suspected, or is being analyzed for NNSSWAC LLW restricted waste forms, then write "Known," "Suspected," or "Pending" as applicable, and the restricted waste form(s); otherwise, write "None." **NNSSWAC restricted waste forms: PCBs (Solids < 500ppm), Friable Asbestos, Animal Carcasses, LDR-treated MLLW, Particulates, Beryllium (>0.1 percent); see Comments below.**
 - I. **Characterization Information** – Sample information (i.e., sample numbers, direct waste sample numbers), sample matrix (i.e., soil, oil, rinsate), radiological swipe survey, and additional information concerning the waste.
 - J. **Waste Handler (WH) Signature and Badge Number** – The WH shall sign and enter his or her badge number.
 - K. **Verifier (WH Qualified) Signature and Badge Number** – The Verifier shall sign and enter his or her badge number.

Comments: Document actions performed to meet NNSSWAC for restricted waste forms, (e.g., particulates: immobilized or secured; sealed sources: list mass, component(s), radioisotopes, and activity; asbestos and/or beryllium: how packaged, marked/labeled; animal carcasses: layered in lime) as applicable.

Note: N/A all empty fields.

Waste Container Log

Container ID: 567 Bat 1

11. Contents Log				F. Absorbent Type (w/Amt. and Units)		H. Prohibited and/or NNS Restricted Waste Forms Present or Pending Analysis		I. Characterization Information		J. Waste Handler (WH)	
A. Item Number	B. Date	C. % Contam.	D. Estimated Volume (gallons)	E. Waste Type (Circle and Describe)		G. TID Number (Old and New)	H.	I.	Signature	Badge Number	
A.	1		C. 75% lead < 1% soil	E. PPE Sampling Equip Oil	Rinsate Soil Other	F. NONE	H. LEAD - For Recycle	I. RSR # 140408-5L-19	/s/ Mark Hester	IB53550	
B.	4/8/14		D. 1 EA	Describe 1 - LEAD Acid Battery - Dry & Cracked.		G. New: N/A	Not going to Area 5 Bunc		/s/ Mark Hester	IB53550	
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature	IB60679	
B.			D.	Describe		G. Old: New:					
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature		
B.			D.	Describe		G. Old: New:					
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature		
B.			D.	Describe		G. Old: New:					
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature		
B.			D.	Describe		G. Old: New:					
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature		
B.			D.	Describe		G. Old: New:					
A.			C.	E. PPE Sampling Equip Oil	Rinsate Soil Other	F.	H.	I.	Signature		
B.			D.	Describe		G. Old: New:					

Waste Container Log

Container ID: 567 Bat 1

11. Contents Log				F. Absorbent Type (w/Amt. and Units) G. TID Number (Old and New)	H. Prohibited and/or NNSS Restricted Waste Forms Present or Pending Analysis	I. Characterization Information	J. Waste Handler (WH)	
A. Item Number	C. % Contam.	D. Estimated Volume (gallons)	E. Waste Type (Circle and Describe) PPE Sampling Equip Oil Describe Rinsate Soil Other				Signature	Badge Number
B.	D.			G. Old: New:	H.	I.	K. Verifier (WH Qualified) Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number
A.	C.			F. Old: New:	H.	I.	J. Signature	J. Badge Number
B.	D.			G. Old: New:	H.	I.	K. Signature	K. Badge Number

Waste Container Log

Container ID: 567 Bat 1

To be filled out by Waste Operations Staff or designee		
Post Closure	Contaminant Density: <u>Varies</u> (units)	
Package Gross Weight: <u>~25</u> (kg/lb)	Package Tare Weight: <u>N/A</u> (kg/lb)	
Scale ID No.: <u>N/A</u>	Scale Calibration Expiration Date: <u>N/A</u>	
Signature: <u>/s/ Mark Hesper</u>	Badge No.: <u>IB53550</u>	Date: <u>4/8/14</u>
Torque: <u>N/A</u> (ft-lb)		
Torque Wrench ID#: <u>N/A</u>	Torque Wrench Calibration Expiration Date: <u>N/A</u>	
Signature: <u>/s/ Mark Hesper</u>	Badge No.: <u>IB53550</u>	Date: <u>4/8/14</u>

NNSSWAC WASTE FORM CRITERIA REVIEW: List NNSSWAC Prohibited or Restricted Waste Forms:		
<u>LEAD Acid Battery for reclamation - Not going to Area 5 RUMC</u>		
Description and concurrence with actions taken to render NNSSWAC restricted waste forms NNSSWAC compliant:		
<u>LEAD Acid Battery</u>		
Signature: <u>/s/ Mark Hesper</u>	Badge No.: <u>IB53550</u>	Date: <u>4/8/14</u>

Final Waste Characterization (Circle all that apply):		
Hazardous	LLW	MLLW
Hydrocarbon	<u>Other:</u>	<u>LEAD Acid Battery for recycle</u>
PCB	Asbestos	Beryllium
Recommended Disposition/Disposal Pathway: <u>Transfer to NSTec Fleet Services for off-site recycle</u>		
Signature: <u>/s/ Mark Hesper</u>	Badge No.: <u>IB53550</u>	Date: <u>4/8/14</u>
Waste Disposed or Shipped for Treatment/Disposal, Date: <u>7/31/14</u>		
Signature: <u>/s/ Mark Hesper</u>	Badge No.: <u>IB53550</u>	Date: <u>7/31/14</u>

Executed Disposal Pathway/Facility: <u>Transferred to NSTec Fleet Services for final off-site recycle at approved vendor</u>		
Certificate of Treatment/Disposal Received, Date: <u>N/A</u>		
Recommended/Compliant Treatment/Disposal Confirmed, Date: <u>7/31/14</u>		
WO Mgr Signature: <u>/s/ Signature on File</u>	Badge No.: <u>IB31107</u>	Date: <u>12/10/14</u>

Container ID: 567 Bat 1

[illegible]

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number **ITL15002** with container number **567C04**, was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Hesper

NI

Waste Coordinator

Shipped by

Organization

Title

/s/ Mark Hesper

Signature

12/11/14

Date

Stephen G. Wolf

Received by

NSTEC

Organization

Waste Specialist

Title

/s/ Signature on File

Signature

12-11-14

Date

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 567, 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. This CAA evaluation is intended for use in making corrective action decisions for CAU 567 conditions at the conclusion of the CAI (after the completion of any interim corrective actions).

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 the Soils RBCA document (NNSA/NFO, 2014). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2014b) 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.1.2.1 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, 2014a]; 40 CFR 761 “Polychlorinated Biphenyls,” [CFR, 2014b]; and NAC 444.842 to 444.980, “Facilities for Management of Hazardous Waste” [NAC, 2012]).

E.1.2.2 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.1.3 Development of CAAs

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for each CAU 567 CAS. The CAAs are based on the current nature of contamination at CAU 567, 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 567:

- **Alternative 1.** No Further Action
- **Alternative 2.** Clean Closure
- **Alternative 3.** Closure in Place

E.1.3.1 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.1.3.2 Alternative 2 – Clean Closure

Alternative 2 includes excavating and disposing of impacted soil and asphalt presenting a dose exceeding the 25-mrem/RW-yr FAL to a depth of 1 ft bgs, and the removal of the bunker and soil mound above the bunker. Confirmation samples will be collected and analyzed for the presence of a COC after the contaminated soil is removed.

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

E.1.3.3 Alternative 3 – Closure in Place

Alternative 3 includes the implementation of a UR where contamination is present at levels that exceed the FAL. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to COCs exceeding the risk evaluation basis as presented in [Appendix C](#).

E.1.4 Evaluation and Comparison of CAAs

The evaluation of CAAs did not include corrective actions that were completed during the CAI. The corrective actions that were completed during the CAU 567 field investigation were as follows:

- *Removal of a bucket of lead-contaminated grease and a broken lead-acid battery at Atmospheric Test Site T-1.* This corrective action involved the removal of both PSM items. Confirmation soil samples were collected from beneath the battery and analyzed. The grease was contained within the bucket, so sampling was not required.
- *Removal of two pieces of lead at A5b RMA.* This corrective action involved the removal of two pieces of lead. A confirmation sample was collected and analyzed.
- *Removal of a lead-acid battery at Colby Mud Spill.* PSM was contained within the battery, so sampling was not required.
- *Removal of soil from an area above the FAL at J-11 Soil RMA.* After the soil was removed, sample results indicated that dose in the area was below the PAL.

Verification of the completion of these corrective actions are documented in this report. Therefore, additional corrective actions were not required nor included in the CAA evaluation.

Remaining surface contamination at Seaweed E Contamination Area, A5b RMA, Colby Mud Spill, and J-11 Soil RMA did not exceed FALs and does not require corrective action. Therefore, the corrective action of no further action was selected for these sites.

The releases that require further corrective action is the DCB and areas that exceed the FAL (25 mrem/RW-yr) at Atmospheric Test Site T-1.

Each CAA presented in [Section E.1.3](#) was evaluated by stakeholders in the CAA meeting conducted on September 16, 2014, for the CASs that require corrective action (i.e., Atmospheric Test Site T-1) based on the general corrective action standards listed in [Section E.1.2](#). This evaluation is presented in [Table E.1-1](#). The CAAs of clean closure and closure in place with UR met the general corrective action standards.

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

STANDARD #1: PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Clean Closure	Closure in Place with UR
The clean closure alternative is more protective as the contamination is removed, preventing future exposure. Minimizes impact on future generations. Future monitoring not required. The clean closure alternative increases the potential for short-term environmental damage during cleanup activities.	Considering the remoteness of the site, proximity to the public, and depth to groundwater, the closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure. Minimizes exposure to workers.
STANDARD #2: COMPLIANCE WITH ENVIRONMENTAL CLEANUP STANDARDS	
STANDARD #3: COMPLIANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL STANDARDS FOR WASTE MANAGEMENT	
Clean Closure	Closure in Place with UR
The clean closure alternative complies with cleanup standards established with the regulator through the FFACO process.	The closure in place alternative complies with closure in place standards established in the FFACO process.
STANDARD #4: CONTROL THE SOURCE(S) OF THE RELEASE	
Clean Closure	Closure in Place with UR
The clean closure alternative is more protective as the source of the release(s) is removed. Minimizes risk to future generations.	The closure in place alternative controls exposure by administrative controls and barriers, but does not remove hazard.

The two CAAs that met the general corrective action standards were further evaluated based on the remedy selection decision factors described in [Section E.1.2](#). This evaluation is presented in [Table E.1-2](#). The stakeholders determined a preferred CAA for each remedy selection decision factor.

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

DECISION FACTOR #1: LONG-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure - PREFERRED	Closure in Place with UR
The clean closure alternative is reliable and effective at protecting human health and the environment in the long term because removal of the contaminated media eliminates the future exposure of site workers and the environment. Clean closure (removal) ensures no potential migration of contamination.	The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public. When the UR is implemented through real estate operations, current site users are prohibited from being in the area for lengths of time that would result in a hazard. Contamination would not be prevented from surface migration; however, studies have shown that surface migration at these sites is minimal and does not contribute a dose exceeding the action level.
DECISION FACTOR #2: REDUCTION OF TOXITY, MOBILITY, AND/OR VOLUME	
Clean Closure - PREFERRED	Closure in Place with UR
The clean closure alternative reduces the mobility, toxicity, and volume of the contamination because the contaminated media is removed.	The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. PSM remains in place and is released to the soil.
DECISION FACTOR #3: SHORT-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure	Closure in Place with UR - PREFERRED
The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. Short-term risks to worker due to exposure to dust and similar items and safety/occupational risks during clean closure of site. The clean closure alternative introduces short-term risks during waste management activities required for clean closure (large volumes of contaminated soil and debris being removed).	The closure in place alternative would present minimal risk to site workers during installation of UR signs, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site.

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

DECISION FACTOR #4: FEASIBILITY	
Clean Closure	Closure in Place with UR - PREFERRED
The clean closure alternative is implementable. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal. The estimated time frame to execute and complete the clean closure alternative would require 14 weeks of fieldwork and increased budgets. The clean closure alternative would require extensive radiological controls.	The closure in place alternative is implementable. This alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the URs).
DECISION FACTOR #5: COST	
Clean Closure	Closure in Place with UR - PREFERRED
\$1.83 million - Large volume of waste generated (9,473 yd³) - Large disposal costs (assumes disposal on NNSS of at least LLW) - Labor intensive No maintenance costs The estimated cost for clean closure does not include potential additional disposal costs due to the volume of the waste. The estimated cost for clean closure does not include costs associated with establishing a new training facility.	\$75,000 (1st year) \$500/yr (post closure) - No waste, no disposal costs, not labor intensive Requires long-term maintenance costs (UR only). The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program. The closure in place alternative would require long-term monitoring-radiological/demarcation and posting. The closure in place alternative assumes that potential migration of contaminated soil will not affect the UR boundary.
DECISION FACTOR #6: OTHER CONSIDERATIONS (e.g., environmental setting, radiological status of site, proximity to other releases, site-specific considerations)	
Clean closure of the site would require historical assessment of the site before remediation. Clean closure would require ecological/wildlife assessment of the site before remediation. Radiological emergency response workers are currently trained at the site; it would not be useful as a training site if clean closure were implemented.	The closure in place alternative allows for potential migration of contaminants. Future mitigation/monitoring may be required to manage/control migration of contaminants. Retain use of site as training asset.

E.2.0 Recommended Alternative

The CAAs for the sites that require additional corrective actions (i.e., the DCB and locations above the FAL at Atmospheric Test Site T-1) 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 by the stakeholders for CAU 567 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer are valid, additional evaluation may be necessary.

The CAA of closure in place with UR was selected by the stakeholders in the CAA meeting conducted on September 16, 2014, as the preferred correction action for Atmospheric Test Site T-1. A corrective action of clean closure would require extensive excavations (9,473 yd³ of soil) of up to 1 ft in depth. Based on the extent of the corrective action boundaries and the infeasibility of removing large quantities of soils containing high levels of contamination, the corrective action of closure in place with an FFACO UR was selected for this CAS.

Corrective actions completed during the CAI include the removal of PSM from Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill; and the removal of soil from J-11 Soil RMA.

In addition to the corrective actions identified above, actions were implemented as a BMP. In accordance with the Soils RBCA document (NNSA/NFO, 2014) and Section 3.3 of the CAIP (NNSA/NFO, 2013), an administrative UR was identified for areas where a future site worker could receive an annual dose exceeding 25 mrem/yr if the land use were to change and a more intensive use of the area (up to a full time industrial use) was implemented. This conservative assumption is that a worker would be exposed to site contamination for a period of 2,000 hr/yr. This administrative UR is not part of any FFACO corrective action. To determine the extent of this area, a correlation of radiation survey values to the Industrial Area TED values was conducted as discussed in [Section A.2.5](#) for each area where dose is present at a level exceeding 25 mrem/IA-yr. The administrative UR boundary encompasses the TRS isopleth corresponding to a dose of 25 mrem/IA-yr. The administrative UR will be recorded and controlled in the same manner as the

FFACO UR, but will not require posting or inspections. The administrative UR is presented in [Attachment D-1](#).

Additional BMPs conducted during the investigation include the removal of 15.9 yd³ of DU and contaminated soil from A5b RMA during the investigation. Verification TRSs and sampling were conducted to ensure that dose from radiological contaminants remaining at this location was not present at levels that could impact future workers.

All URs are recorded in the FFACO database, M&O Contractor GIS, and the NNSA/NFO CAU/CAS files. The development of URs for CAU 567 are based on current land use. Any proposed activity within a use restricted area that would result in higher risk to the most exposed site worker than that presented in the risk evaluation ([Appendix C](#)) would require NDEP approval.

E.3.0 Cost Estimates

The cost estimate for clean closure is estimated to be approximately \$1.83 million to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavation, loading, and disposal of contaminated soil (approximately 9,473 yd³)
- Debris disposal
- Equipment decontamination

The estimated costs for clean closure of CAU 567 are based on removing contaminated material within the 25-mrem/yr boundary. Specifically, soil, asphalt, and debris within the DCB and the area that exceeds the FAL at Atmospheric Test Site T-1 would be removed. 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 \$75,000 for the first year and \$500 for each year thereafter.

E.4.0 References

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CFR, see *Code of Federal Regulations*.

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Code of Federal Regulations. 2014b. Title 40 CFR 761, “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.” Washington, DC: U.S. Government Printing Office.

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

U.S. Environmental Protection Agency. 1996. "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities," 1 May. In *Federal Register*, Vol. 61, No. 85.

Appendix F

Sample Location Coordinates

F.1.0 Sample Location Coordinates

The center of each sample plot and the locations of individual (judgmental) sample locations for the CAU 567 CASs were surveyed using a GPS instrument. Survey coordinates for these locations are listed in [Tables F.1-1](#) through [F.1-5](#). All coordinates are in Universal Transverse Mercator (UTM) Zone 11, North American Datum (NAD) 1927 (U.S. Western) in meters.

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 1 of 6)

Easting	Northing	Location
TLD and Plot Samples		
579859	4100917	A01
579732	4100927	A02
TLD and Grab Samples, CWDs		
579700	4100982	A15
579676	4100980	A16
579912	4100699	A17
579901	4100654	A18
579276	4101416	A19
579207	4101452	A20
TLD and Grab Samples, Drainages		
579977	4100855	A21
580047	4100816	A22
TLD and Grab Samples, Drainage Dump		
579861	4101264	A99
579190	4101114	A118
TLD and Subsurface Grab Sample		
579671	4100848	A06
Grab Sample, PSM		
580586	4100921	A136

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 2 of 6)

Easting	Northing	Location
TLD Only		
579767	4100911	A03
579731	4100891	A04
579696	4100867	A05
579675	4101051	A07
579711	4101023	A08
579737	4101000	A09
579760	4100970	A10
579807	4100984	A11
579813	4101015	A12
579829	4101062	A13
579848	4101098	A14
579650	4101056	A27
579650	4100958	A28
579650	4100857	A29
579750	4100758	A30
579760	4100859	A31
579752	4100958	A32
579850	4100962	A33
579850	4100858	A34
579850	4100758	A35
579951	4100857	A36
579950	4100958	A37
579551	4101058	A38
579450	4101057	A39
579350	4100958	A40
579450	4100958	A41
579550	4100958	A42
579550	4100857	A43

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 3 of 6)

Easting	Northing	Location
579450	4100857	A44
579451	4100758	A45
579551	4100758	A46
579650	4100759	A47
579551	4100657	A48
579651	4100658	A49
579652	4100558	A50
579749	4100557	A51
579752	4100659	A52
579851	4100657	A53
579950	4100558	A55
579851	4100559	A54
579951	4100658	A56
579949	4100760	A57
580049	4100757	A58
580049	4100658	A59
580051	4100557	A60
580050	4100458	A61
580050	4100858	A62
580049	4100955	A63
580150	4100858	A64
580151	4100757	A65
580150	4100659	A66
580150	4100557	A67
580150	4100358	A68
580250	4100457	A69
580350	4100557	A70
580250	4100657	A71
580350	4100757	A72

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 4 of 6)

Easting	Northing	Location
580250	4100857	A73
579951	4101058	A74
579850	4101056	A75
579850	4101158	A76
579750	4101158	A77
579650	4101157	A78
580150	4100958	A79
580351	4100960	A80
580451	4100858	A81
580450	4101058	A82
580349	4101158	A83
580250	4101058	A84
580251	4101258	A85
580250	4101459	A86
580154	4101362	A87
580154	4101240	A88
580149	4101157	A89
580150	4101059	A90
580050	4101058	A91
580050	4101158	A92
580050	4101258	A93
580050	4101458	A94
579950	4101558	A95
579950	4101358	A96
579950	4101259	A97
579950	4101157	A98
579850	4101457	A100
579752	4101557	A101
579750	4101357	A102

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 5 of 6)

Easting	Northing	Location
579749	4101257	A103
579650	4101258	A104
579651	4101458	A105
579551	4101558	A106
579551	4101358	A107
579752	4101064	A108
579551	4101258	A109
579550	4101158	A110
579450	4101157	A111
579451	4101258	A112
579450	4101458	A113
579350	4101359	A114
579251	4101258	A115
579349	4101153	A116
579150	4101157	A117
579250	4101058	A119
579150	4100958	A120
579249	4100870	A121
579150	4100758	A122
579250	4100658	A123
579350	4100557	A124
579451	4100458	A125
579550	4100358	A126
579650	4100257	A127
579850	4100258	A128
579950	4100357	A129
579850	4100458	A130
579750	4100357	A131
579650	4100458	A132

Table F.1-1
Sample Location Coordinates for Atmospheric Test Site T-1
(Page 6 of 6)

Easting	Northing	Location
579550	4100557	A133
579450	4100658	A134
579350	4100758	A135
Background TLDs		
578693	4101868	A23
578654	4100926	A24
581275	4100676	A25
580888	4101744	A26

Table F.1-2
Sample Location Coordinates for Seaweed E Contamination Area

Easting	Northing	Location
TLD and Grab Samples		
589095	4096656	B01
589088	4096398	B02
589007	4096297	B03
Background TLDs		
588676	4096561	B04
589341	4096713	B06
589199	4096815	B05

Table F.1-3
Sample Location Coordinates for A5b RMA

Easting	Northing	Location
TLD and Grab Sample		
593319	4075458	C01
Grab Samples		
593341	4075490	C02
593328	4075475	C03
593311	4075454	C04
Background TLD		
593070	4075624	C05

Table F.1-4
Sample Location Coordinates for Colby Mud Spill

Easting	Northing	Location
TLD and Grab Samples		
547157	4129067	D01
547203	4129382	D02
547186	4129615	D03
Grab Samples		
546824	4128594	D07
546786	4128786	D08
546774	4128794	D09
Background TLDs		
547052	4129781	D04
546551	4128988	D05
547622	4128749	D06

Table F.1-5
Sample Location Coordinates for J-11 Soil RMA

Easting	Northing	Location
TLD and Grab Sample		
563854	4070997	E02
Grab Samples		
563855	4070997	E01
563851	4070993	E06
563850	4070990	E07
Background TLDs		
563918	4071139	E03
563837	4070927	E04

Nine aliquot sample locations were established at each plot for each composite sample (4 composite samples, 36 aliquot sample locations). Visual Sample Plan software (PNNL, 2007) was used to derive coordinates for a systematic triangular grid pattern 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) of each aliquot location were recorded in the project files. It is important to note that if an offset was less than the nominal 4-in. width of core sampler, the original coordinate was not modified.

F.2.0 References

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

Appendix G

Technical Memorandum: Conduct of Geophysical Surveys at the Nevada National Security Site Corrective Action Unit 567

May 8, 2014

G.1.0 Introduction

Geophysical surveys were conducted at three CASs in CAU 567. The three CASs are geographically separated with CAS 01-23-03 (Atmospheric Test Site T-1) in Yucca Flat, CAS 05-23-07 (A5b RMA) in Frenchman Flat, and CAS 20-23-08 (Colby Mud Spill) in Pahute Mesa. The surveys were conducted between June 2013 and March 2014 to determine whether or not there are buried metallic materials indicating the potential for back-filled disposal trenches at these sites. [Figure G.1-1](#) is a map of the NNSS showing the CAS locations. The north arrows appearing on all figures in the report represent grid north, not magnetic.

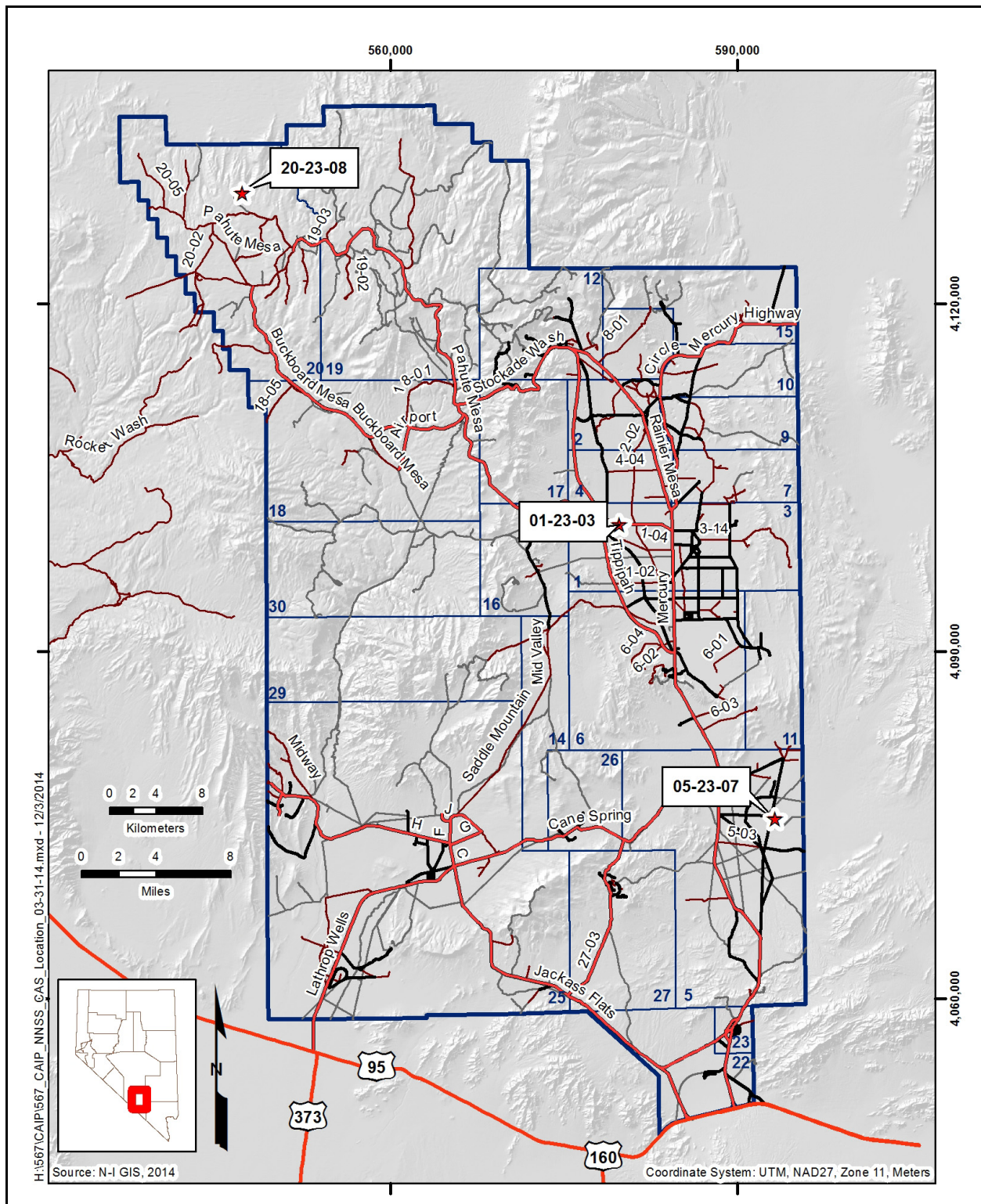


Figure G.1-1
Locations of CAU 567 CASs Surveyed

G.2.0 Equipment Used

At all but one site (CWD #4 at Atmospheric Test Site T-1), two instruments were used to conduct surveys. The first was an EM31-MK2 earth conductivity meter. The second was an EM61-MK2A time domain metal detector. Both instruments are produced by Geonics Limited of Mississauga, Ontario, Canada. At CWD #4, only the EM31-MK2 was used to conduct the survey. [Table G.2-1](#) lists the sites investigated by Area number, CAS number and description, and site name. In addition, the table shows the dates surveys were conducted and the instrument used.

Table G.2-1
Sites Investigated and Instrument Used

Area	CAS	CAS Description	Site	EM31	EM61	Date
1	01-23-03	Atmospheric Test Site T-1	CWD #2	X	--	07/01/2013
				X	--	07/30/2013
				--	X	07/01/2013
				--	X	07/31/2013
			CWD #3	--	X	07/09/2013
				X	--	11/18/2013
			CWD #4	X	--	07/09/2013
				X	--	11/18/2013
			Northern Drainage Dump	X	--	07/08/2013
				X	--	11/19/2013
				--	X	07/08/2013
				--	X	11/19/2013
			Western Drainage Dump	X	--	07/02/2013
				--	X	07/02/2013
5	05-23-07	A5b RMA	A5b RMA Potential Landfill Locations	X	--	06/03/2013
				--	X	06/04/2013
20	20-23-08	Colby Mud Spill	Colby Mud Disposal Area	X	--	03/24/2014
				--	X	03/24/2014

X = Used
-- = Not used

G.2.1 The EM31-MK2 Earth Conductivity Meter

Figure G.2-1 shows an EM31-MK2 in use on a survey. The instrument measures the conductivity of the materials (soil) interrogated and detects the presence of metal. A transmitter coil located at one end induces circular eddy current loops in the earth. Under certain conditions, the magnitude of any one of these current loops is directly proportional to the terrain conductivity in the vicinity of that loop. Each of the current loops generates a magnetic field that is proportional to the value of the current flowing within that loop. A part of the magnetic field from each loop is intercepted by the receiver coil on the opposite end of the instrument and results in an output voltage that is linearly related to the terrain conductivity.



Figure G.2-1
Photo of the EM31-MK2 in Use
Source: Geonics, 2012

Both the quadrature-phase and in-phase signals were recorded. The quadrature-phase signal is the conductivity measurement. The in-phase measurements are more sensitive to the presence of metal and are the EM31-MK2 data presented in this memorandum. The instrument was carried as shown in [Figure G.2-1](#). The EM31-MK2 is a general survey instrument and is somewhat less sensitive to the presence of small scattered pieces of metal compared to the EM61-MK2A.

An Archer 14802 field personal computer (PC) with integrated Hemisphere XF101 GPS receiver from Juniper Systems, Inc. of Logan, Utah, was used to collect the data produced by the EM31-MK2.

The data were reduced using the DAT31MK2 software (Geonics, 2012). This software allows the user to reduce the “raw” data files saved in the data logger to files containing the UTM coordinates of the data points, in meters, and the responses (quadrature-phase and in-phase) generated by the EM31-MK2. All location data collected using the field PC with integrated GPS receiver were collected in UTM 11 World Geodetic System (WGS) 84 coordinates in meters (m) and converted to the project standard UTM 11 NAD 27 coordinate system (m) using ArcMap Version 10 by ESRI (ESRI, 2012). The EM31-MK2 response data, matched to the UTM 11 NAD 27 coordinates, were then imported into Version 11 of the Surfer program by Golden Software of Golden, Colorado (Golden Software, 2012) for contouring and visualization. In addition, plots of the response values of the individual data points were prepared and the Surfer plots posted to aerial photographs of the sites, using ArcMap.

G.2.2 The EM61-MK2A Four-Channel High-Sensitivity Metal Detector

The EM61-MK2A detects both ferrous and non-ferrous conductive objects with excellent spatial resolution. Each system includes a single transmitter coil and two receiver coils. The coils are 1 m by 0.5 m in size. [Figure G.2-2](#) is a photo of the equipment with the coils mounted on wheels.

A primary magnetic field, generated by current supplied to the transmitter coil, induces eddy currents in nearby metallic objects. The induced eddy currents decay with time at a rate that is dependent on the characteristics of the object, producing a secondary magnetic field with the same rate of decay. The time-decay of the secondary magnetic field generates a signal within each of the two receiver coils, thereby detecting the presence of metal. Four time gates (channels) of data are collected. The earlier time gates (channels) improve the detection of smaller targets (Geonics, 2012). The signal



Figure G.2-2
Photo of the EM61-MK2A with Wheels Supporting Coils
(Geonics, 2012)

received is reported in units of millivolts (mV). With the coils mounted on wheels, as shown in [Figure G.2-2](#), the lowermost coil is approximately 40 cm above the ground surface. The lowermost coil doubles as both a transmitter and receiver with the transmission occurring at 75 hertz. When not transmitting, the same coil acts as a receiver. The uppermost coil is only used to receive the mV signals generated in nearby metallic objects. The field PC with integrated GPS described above for use with the EM31-MK2 was used with the EM61-MK2A. To improve positioning accuracy, a model 150-1013-00 patch antenna was connected to the integrated GPS receiver and mounted on the top coil of the EM31-MK2.

The channel 1 data are the first data collected and represent the strongest response received for any metallic debris detected. The channel 1 data are used in the figures of this memorandum.

The data were reduced using the DAT61MK2 software (Geonics, 2012). This software allows the user to reduce the “raw” data files saved in the data logger to files containing the UTM coordinates of

the data points, in meters, and the four time gate responses (channels of data) generated by the EM61-MK2A. All location data were converted to the project standard UTM 11 NAD 27 coordinate system using ArcMap Version 10 by ESRI (ESRI, 2012). The EM61-MK2A response data, matched to the UTM 11 NAD 27 coordinates, were then imported into Version 11 of the Surfer program by Golden Software of Golden, Colorado (Golden Software, 2012) for contouring and visualization. In addition, plots of the response values of the individual data points were prepared and the Surfer plots posted to aerial photographs of the sites, using ArcMap.

G.2.2.1 General Information Regarding the EM31-MK2 and EM61-MK2A Instrument Response Data

The strength of the EM31-MK2 and EM61-MK2A instrument responses is relative. It is a function of the ability of the field generated by the coils to excite a response in an object. The instrument response is affected by the size of the object, its conductivity and iron content, and the distance of the object from the coils (i.e., depth of burial). As such, a small piece of highly ferrous material at ground surface would yield a stronger response than a larger non-ferrous but conductive object also on the surface. In addition, the same piece of highly ferrous material will yield a stronger instrument response on the surface than it will if buried, and is consequently, further from the coils.

The data logger and Hemisphere XF101 GPS unit recorded the EM31-MK2 and EM61-MK2A survey data while the GPS unit was in motion during the conduct of the surveys. The locations of surface debris were recorded with a Trimble GEO Explorer 2008 or 2005 series GPS unit running ArcPad held stationary at each location. Although it is not generally the case, differences between the locations reported for the surface debris measured with the Trimble and EM31-MK2 or EM61-MK2A response data may be different by as much as a few meters due to the difference in the manner with which the GPS data were collected (i.e., stationary versus in motion).

The Trimble collected the data directly in UTM 11 NAD 27 (m). The EM31-MK2 and EM61-MK2A survey data were collected in UTM 11 WGS 84 coordinates, in meters. As noted above, the data were converted to the project standard of UTM 11 NAD 27 coordinates, in meters, before use.

G.3.0 Conduct of the Geophysical Surveys

As noted earlier, geophysical surveys were completed in three geographically separate CASs. The CASs are located in Frenchman Flat, Yucca Flat, and Pahute Mesa. The surveys were completed with both the EM31-MK2 and EM61-MK2A at all locations with one exception. This exception is for CWD #4 at Atmospheric Test Site T-1 in Yucca Flat. At this location, the EM61-MK2A was not used.

The focus at every site was the search for potential landfills containing metallic debris. Each area is discussed, in turn, in the following section.

As part of the survey process, surficial metallic debris and man-made structures/materials that might be detected by the instruments were identified at each site. The locations of these items were recorded using a Trimble GEO Explorer 2008 or 2005 series GPS unit running ArcPad. In addition to the locations, short descriptions of the items found were recorded as well. These data are stored in file CAU567_GPS_Master_Points.xlsx and are the source of the GPS points on the survey figures presented in this memorandum.

G.4.0 Survey Results

G.4.1 Atmospheric Test Site T-1

Five potential landfill locations were identified in the vicinity of Atmospheric Test Site T-1. The sites are the CWD #2, CWD #3, CWD #4, Western Drainage Dump, and Northern Drainage Dump. With one exception, both the EM61-MK2A and the EM31-MK2 were used in the surveys. The exception is at the CWD #4 site, where only the EM31-MK2 was used to conduct the surveys.

Figure G.4-1 is an aerial photo of the area indicating the relative locations of the areas investigated.

G.4.1.1 CWD #2

G.4.1.1.1 Results Using the EM31-MK2 Earth Conductivity Meter

Surveys were completed with the EM31-MK2 at CWD #2 on July 1 and July 30, 2013. Table G.4-1 lists the survey files collected using the EM31-MK2 at CWD #2 and provides comment. Figure G.4-2 shows the paths walked for the two areas surveyed. The EM31-MK2 was carried using the shoulder harness as shown in Figure G.2-1.

Figure G.4-2 shows the path walked for the survey of the southeastern area on July 1 as well as the in-phase instrument response at each data point. The survey was walked in a northeast–southwest pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were very low with no significant metal detected.

Figure G.4-3 provides a contoured representation of the EM31-MK2 in-phase survey data collected at the southeastern investigation area on July 1. The data presented are from file 070112A. The instrument readings were very low with no indication of any significant quantity of metal. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure.

Figure G.4-2 shows the path walked for the survey of the main area on July 30 as well as the in-phase instrument response at each data point. The survey was walked in a north–south pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses

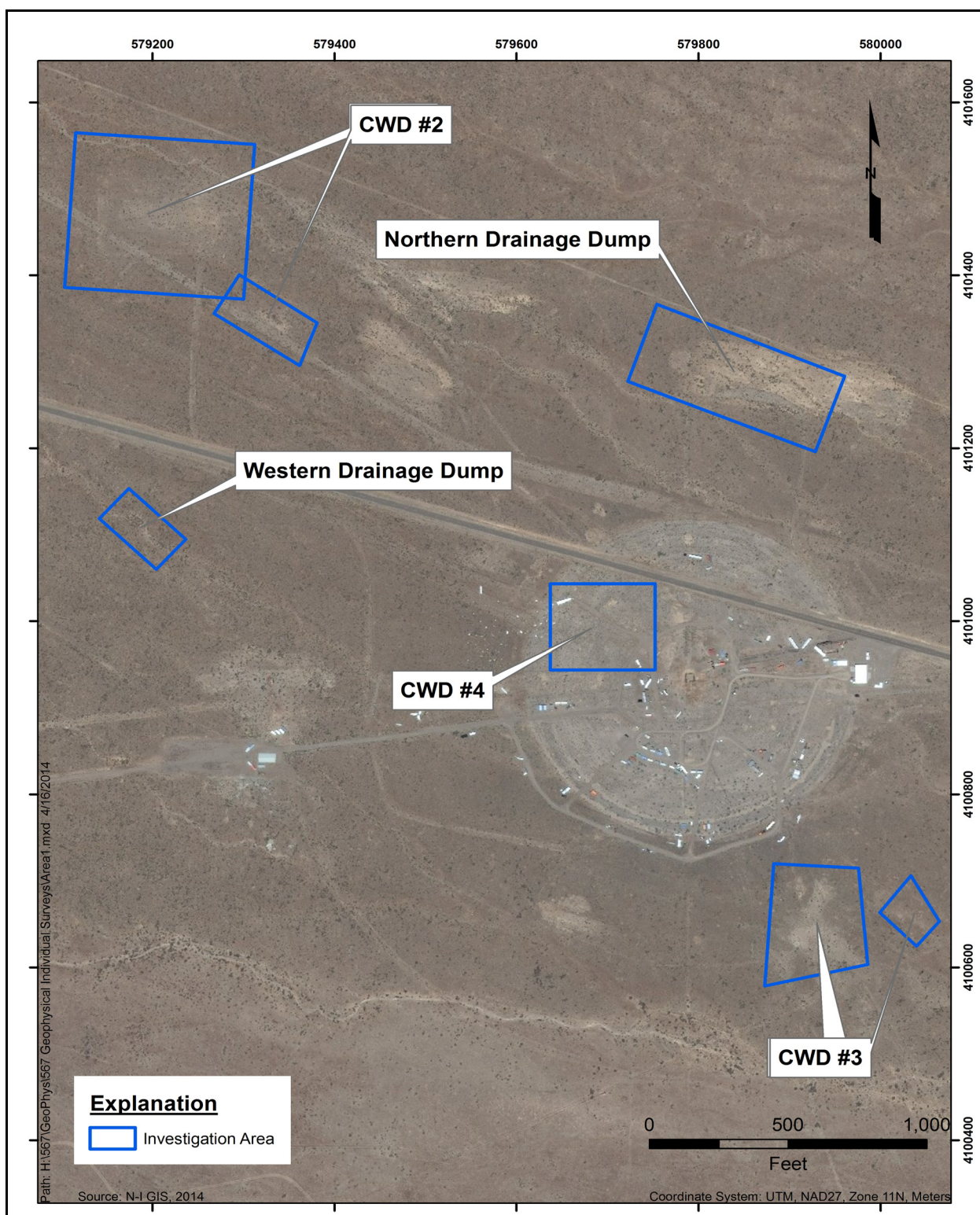


Figure G.4-1
Locations of Sites Investigated at Atmospheric Test Site T-1

Table G.4-1
Summary of Data Files Collected at CWD #2 Using the EM31-MK2

Raw Data File	Date	Comment
070112A.r31	07/01/2013	Survey of southeastern area
073012A.r31	07/30/2013	Survey of main area
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

were low with a slightly elevated response on the eastern edge of the area surveyed. No significant amount of metal was detected.

Figure G.4-4 provides a contoured representation of the EM31-MK2 in-phase survey data collected on July 30. The data presented are from file 073012A. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The instrument readings were low with no indication of any significant quantity of metal. The slightly elevated readings on the eastern edge of the area surveyed, noted above, are evident and correlate with the locations of debris noted on the surface.

G.4.1.1.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

Surveys were completed with the EM61-MK2A at CWD #2 on July 1 and July 31, 2013. The coils of the EM61-MK2A were mounted on wheels, as shown in Figure G.2-2. Table G.4-2 lists the survey files collected using the EM61-MK2A at CWD #2 and provides comment. Figure G.4-5 shows the paths walked for the two areas surveyed.

Figure G.4-5 shows the path walked for the survey of the southeastern area walked on July 1 as well as the channel 1 instrument response at each data point. The survey of the southeastern area was walked in an approximately northeast–southwest pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were very low with no significant amount of metal detected. In addition to the survey files, additional files recorded the pre- and post-survey daily instrument check data.

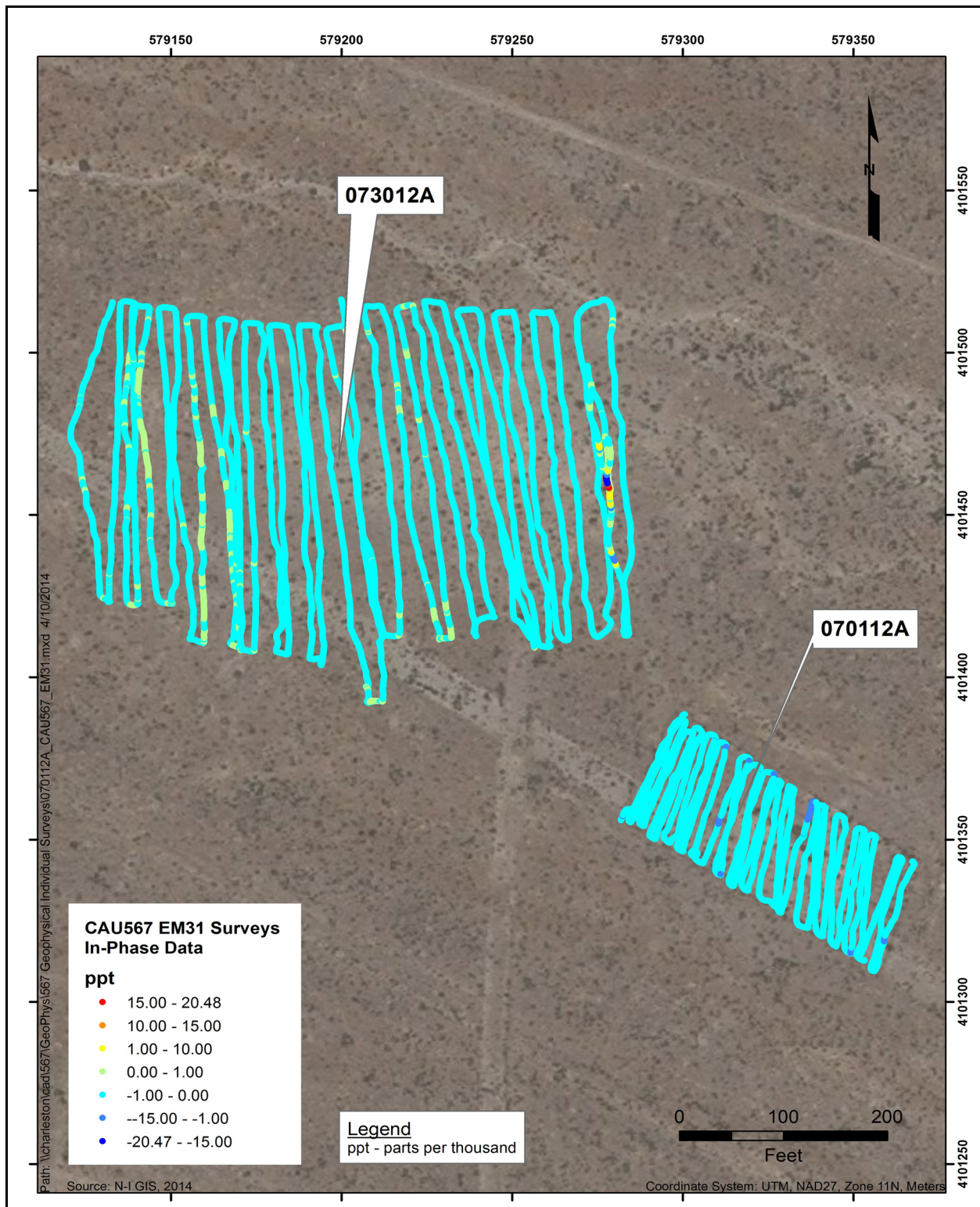


Figure G.4-2
Paths Walked for the EM31-MK2 Surveys at CWD #2

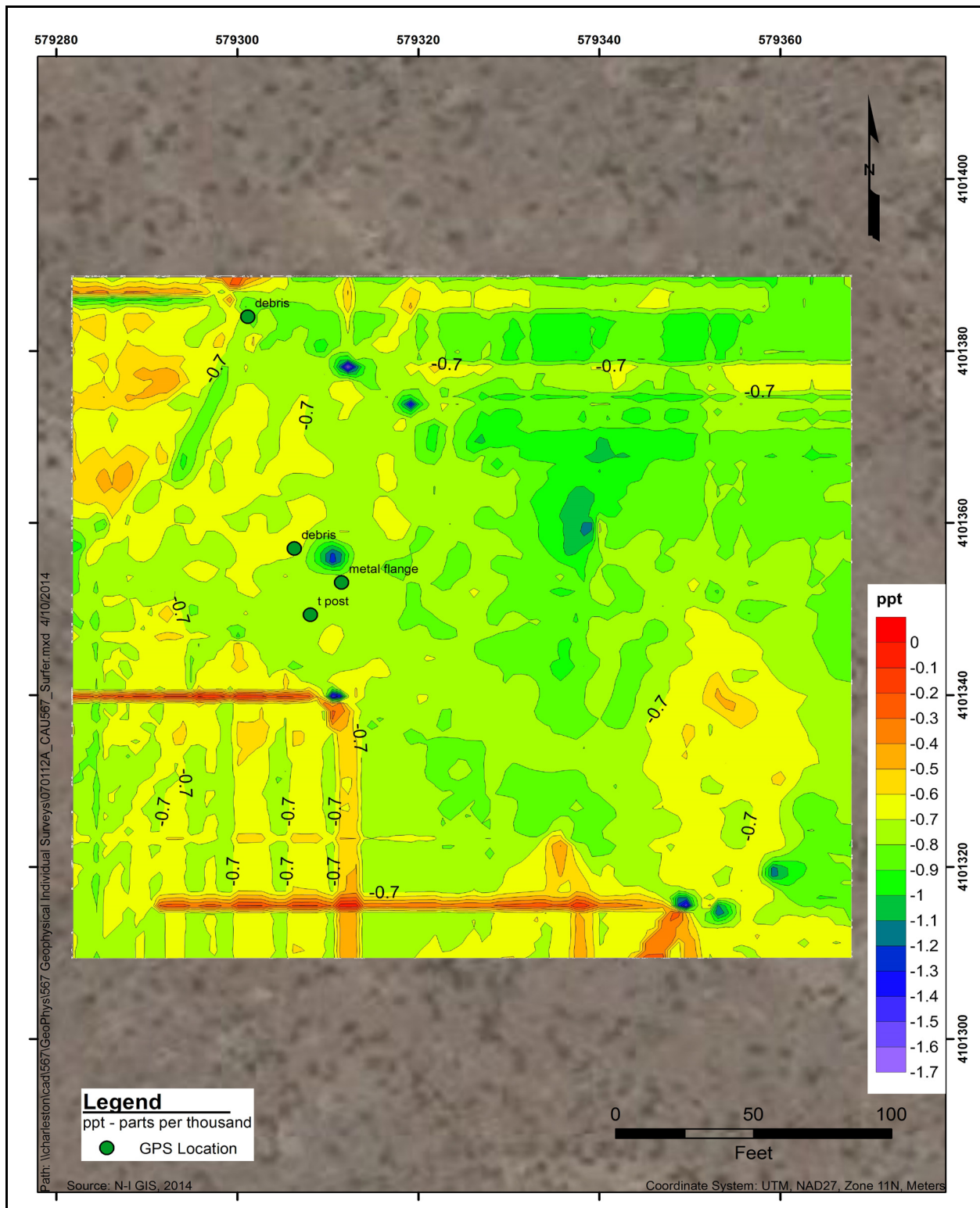


Figure G.4-3
Contoured Results of the EM31-MK2 Survey at the CWD #2 Southeastern Survey Area

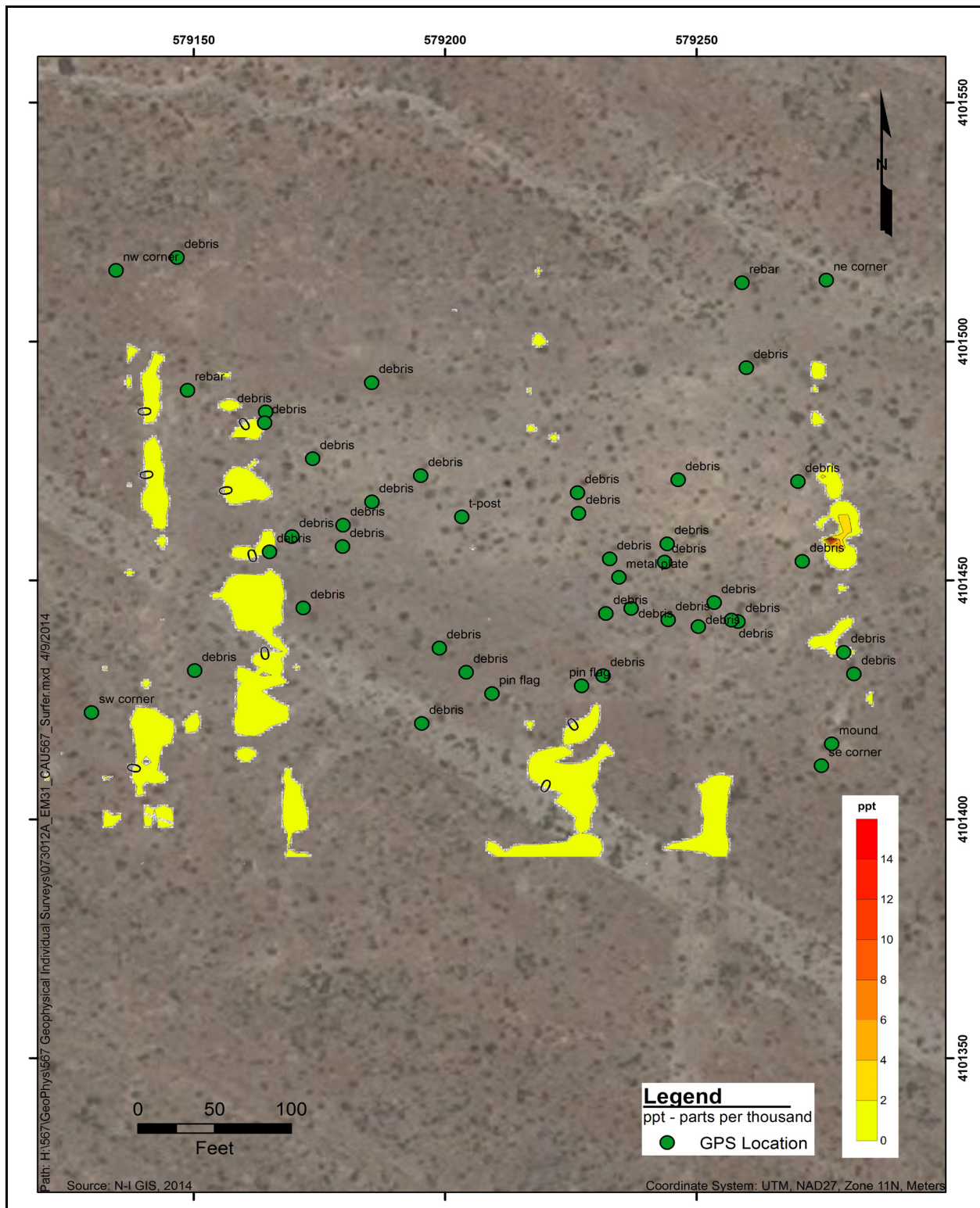


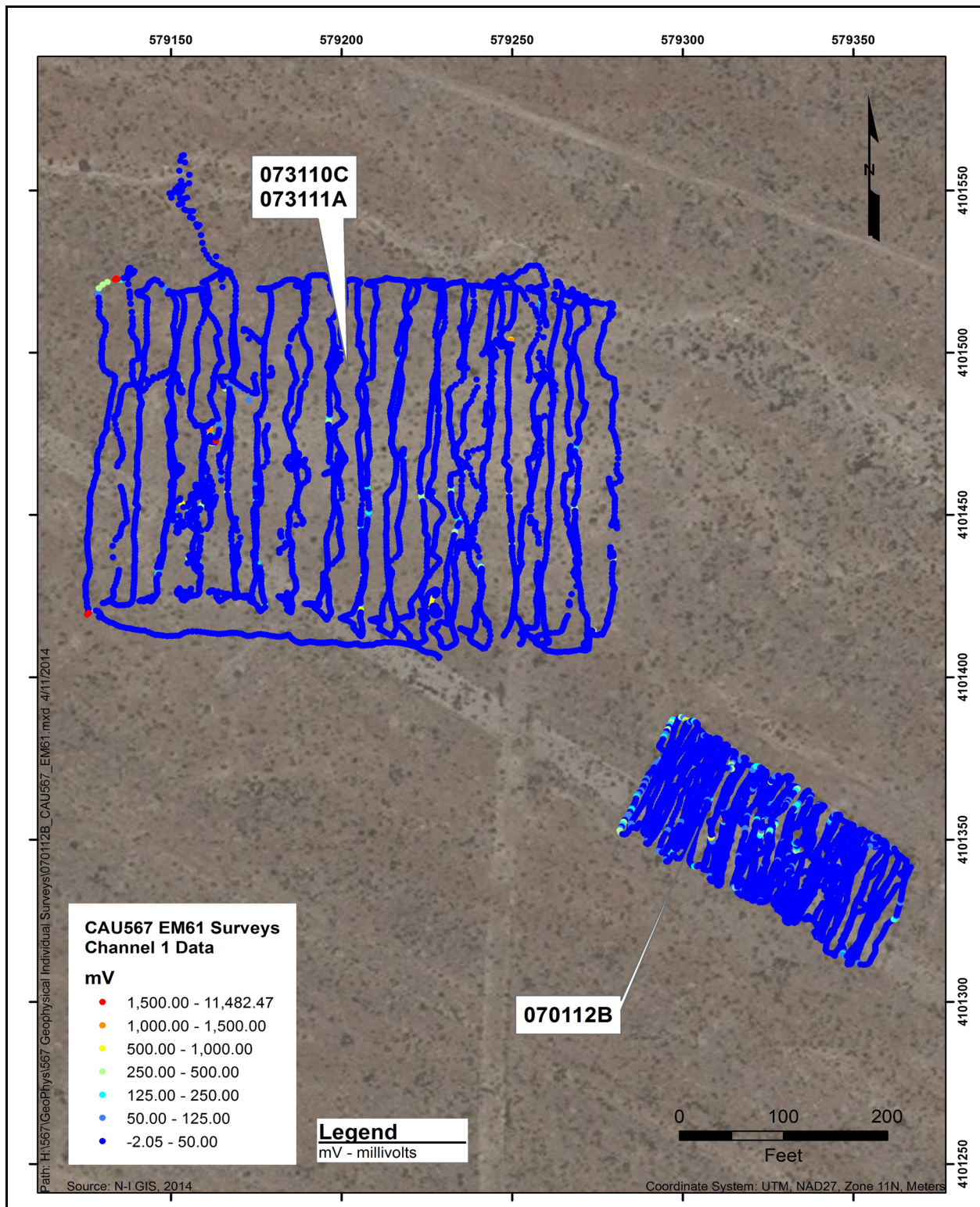
Figure G.4-4
Contoured Results of the EM31-MK2 Survey at the CWD #2 Main Survey Area

Table G.4-2
Summary of Data Files Collected at CWD #2 Using the EM61-MK2A

Raw Data File	Date	Comment
Survey Completed July 1, 2013		
070110A.r61	07/01/2013	Pre-survey instrument checks (static and with test bolt)
070110B.r61	07/01/2013	Survey of southeastern area
070112A.r61	07/01/2013	Post-survey instrument checks (static and with test bolt)
Survey Completed July 31, 2013		
073110A.r61	07/31/2013	Pre-survey static instrument check
073110B.r61	07/31/2013	Pre-survey instrument check with test bolt
073110C.r61	07/31/2013	Begin survey of main area
073111A.r61	07/31/2013	Finish survey of main area
073113A.r61	07/31/2013	Post-survey static instrument check
073113B.r61	07/31/2013	Post-survey instrument check with test bolt
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

Figure G.4-6 provides a contoured representation of the EM61-MK2 channel 1 survey data collected at the southeastern area surveyed on July 1. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The data presented are from file 070112B. The instrument readings were very low with no indication of any significant amount of metal. Two small pieces of metal are indicated near 579,310 m East and 4,101,355 m North. These anomalies correlate to pieces of metal observed on the surface.

Figure G.4-5 also shows the path walked for the main survey area on July 31 as well as the channel 1 instrument response at each data point. The survey is divided into files 073110C and 073111A. There were no problems encountered during the surveys, and the survey was divided into two files merely to allow the operator to rest. The survey was walked in a north–south pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were generally low, but with elevated responses at the northwest and southwest corner markers as well as at a few additional locations within the area surveyed. No significant amount of metal was detected.



**Figure G.4-5
Paths Walked for the EM61-MK2A Surveys at CWD #2**

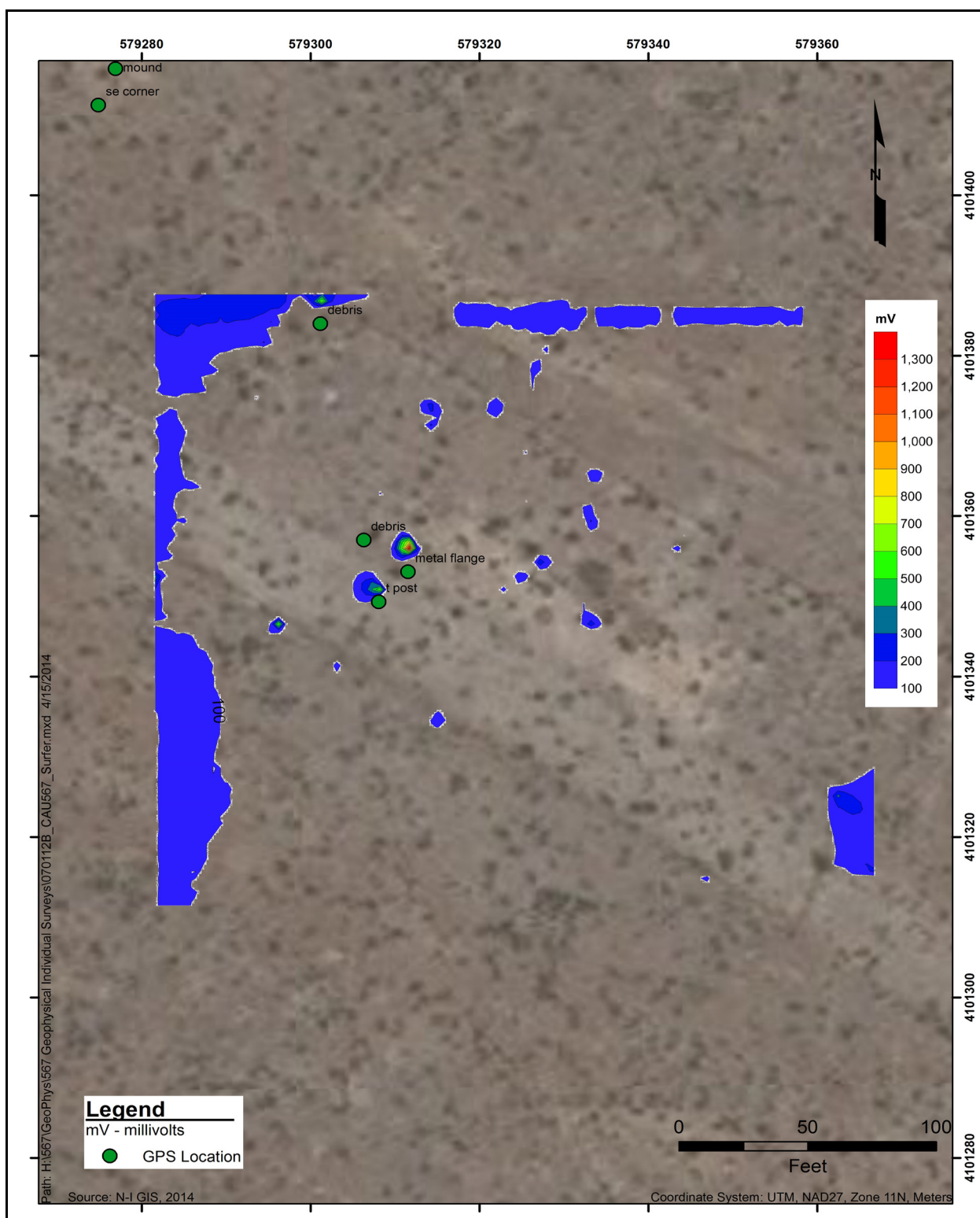


Figure G.4-6
Contoured Results of the EM61-MK2A Survey at the CWD #2
Southeastern Survey Area

[Figure G.4-7](#) provides a contoured representation of the EM61-MK2A channel 1 survey data collected at the main survey area on July 31. The data presented are from files 073110C and 073111A. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The instrument readings were low with no indication of any significant amount of metal.

G.4.1.2 CWD #3

G.4.1.2.1 Results Using the EM31-MK2 Earth Conductivity Meter

Surveys were completed with the EM31-MK2 at CWD #3 on November 18, 2013. Two areas were surveyed, a smaller area to the east and a larger area to the west. [Table G.4-3](#) lists the survey files collected using the EM31-MK2 at CWD #3 and provides comment. [Figure G.4-8](#) shows the paths walked for the two areas surveyed as well as the survey files associated with each. The EM31-MK2 was carried using the shoulder harness as shown in [Figure G.2-1](#).

In addition to the paths walked, [Figure G.4-8](#) shows the in-phase instrument response at each data point. Two surveys were conducted at the larger area to the west. File 111812A records the data as the survey was walked in a north–south pattern. File 111813B records the data as the survey was walked in an east–west pattern. For both surveys, each traverse was roughly parallel to the previous traverse. The figure shows that the instrument in-phase responses were generally low with the exception of two prominent areas of elevated response in the general vicinity of 579,920 m East and 4,100,637 m North. The higher responses are discussed below.

[Figure G.4-9](#) provides a contoured representation of the EM31-MK2 in-phase data collected on November 18 at the western area surveyed. The data presented are from files 111812A and 111813B. The instrument readings were low with the exception of the two prominent areas of elevated readings seen in the figure. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The figure shows that the easternmost lobe of the elevated readings corresponds to the location of a vault and pipe. The westernmost lobe of elevated readings corresponds to a bunker.

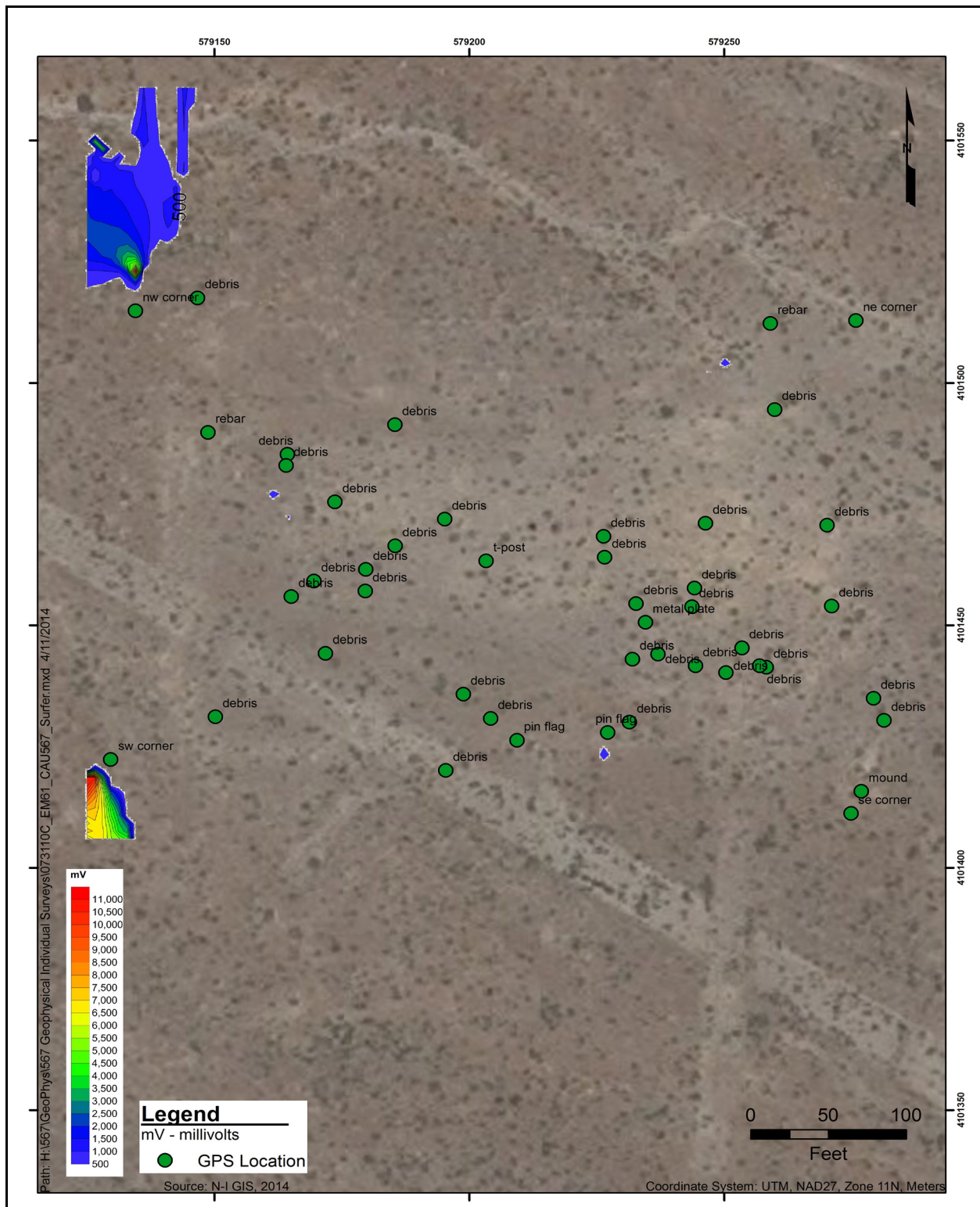


Figure G.4-7
Contoured Results of the EM61-MK2A Survey at the CWD #2 Main Survey Area

Table G.4-3
Summary of Data Files Collected at CWD #3 Using the EM31-MK2

Raw Data File	Date	Comment
111812A.r31	11/18/2013	Survey of western area walked north–south
111813A.r31	11/18/2013	Survey of the eastern area
111813B.r31	11/18/2013	Survey of western area walked east–west
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

Figure G.4-8 shows the path walked as well as the instrument in-phase response at each data point for the eastern survey area. This area is represented by file 111813A. The survey was walked in a northeast–southwest pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were uniformly low. No significant amount of metal was detected.

Figure G.4-10 provides a contoured representation of the EM31-MK2 in-phase survey data collected November 18 in the eastern area surveyed. The data presented are from file 111813A. The instrument readings were low with no indication of any significant amount of metal.

G.4.1.2.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

A survey was completed with the EM61-MK2A at CWD #3 on July 9, 2013. The coils of the EM61-MK2A were mounted on wheels, as shown in Figure G.2-2. Figure G.4-11 shows the path walked for the survey as well as the channel 1 instrument response at each data point. The area surveyed roughly comprises the southeastern quadrant of the western area surveyed using the EM31-MK2, as described above. The survey was walked in an approximately north–south pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were generally low with some areas of higher responses. The higher responses are discussed below with the presentation of the contoured data. In addition to the survey files, additional files recorded the pre- and post-survey daily instrument check data. Table G.4-4 lists the survey files collected using the EM61-MK2 at CWD #3 and provides comment.

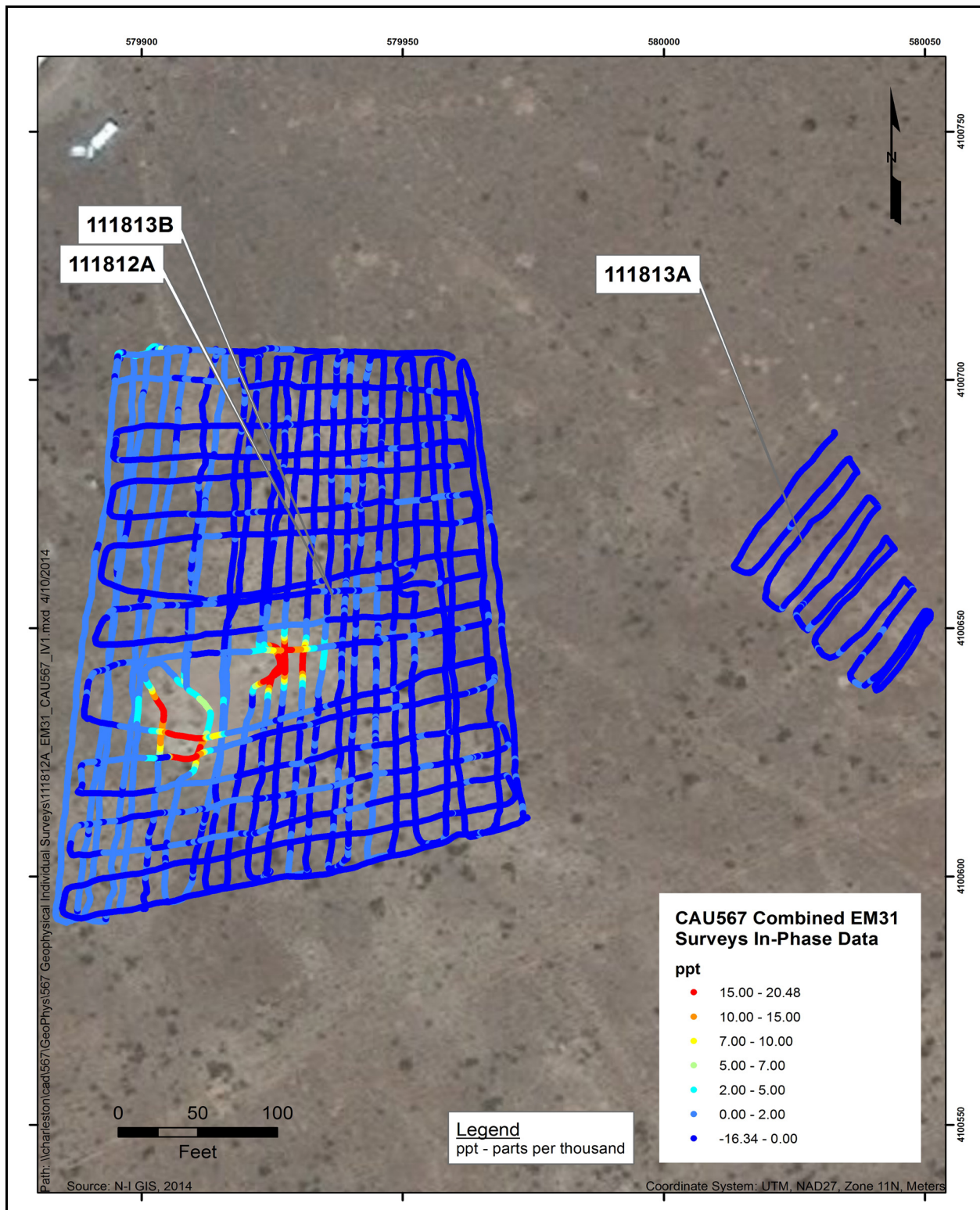


Figure G.4-8
Paths Walked for the EM31-MK2 Surveys at CWD #3

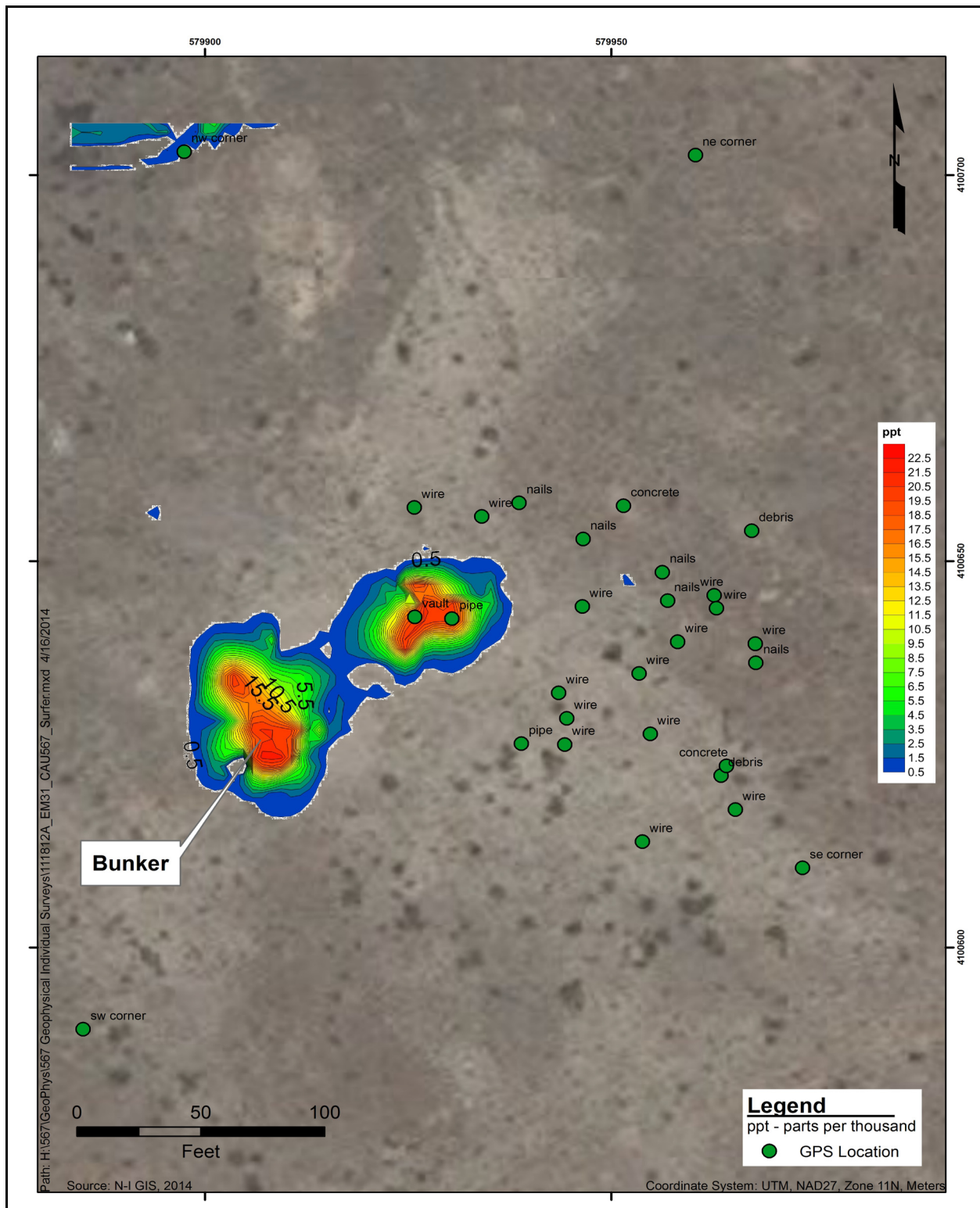


Figure G.4-9
Contoured Results of the EM31-MK2 Survey at the CWD #3 Western Survey Area

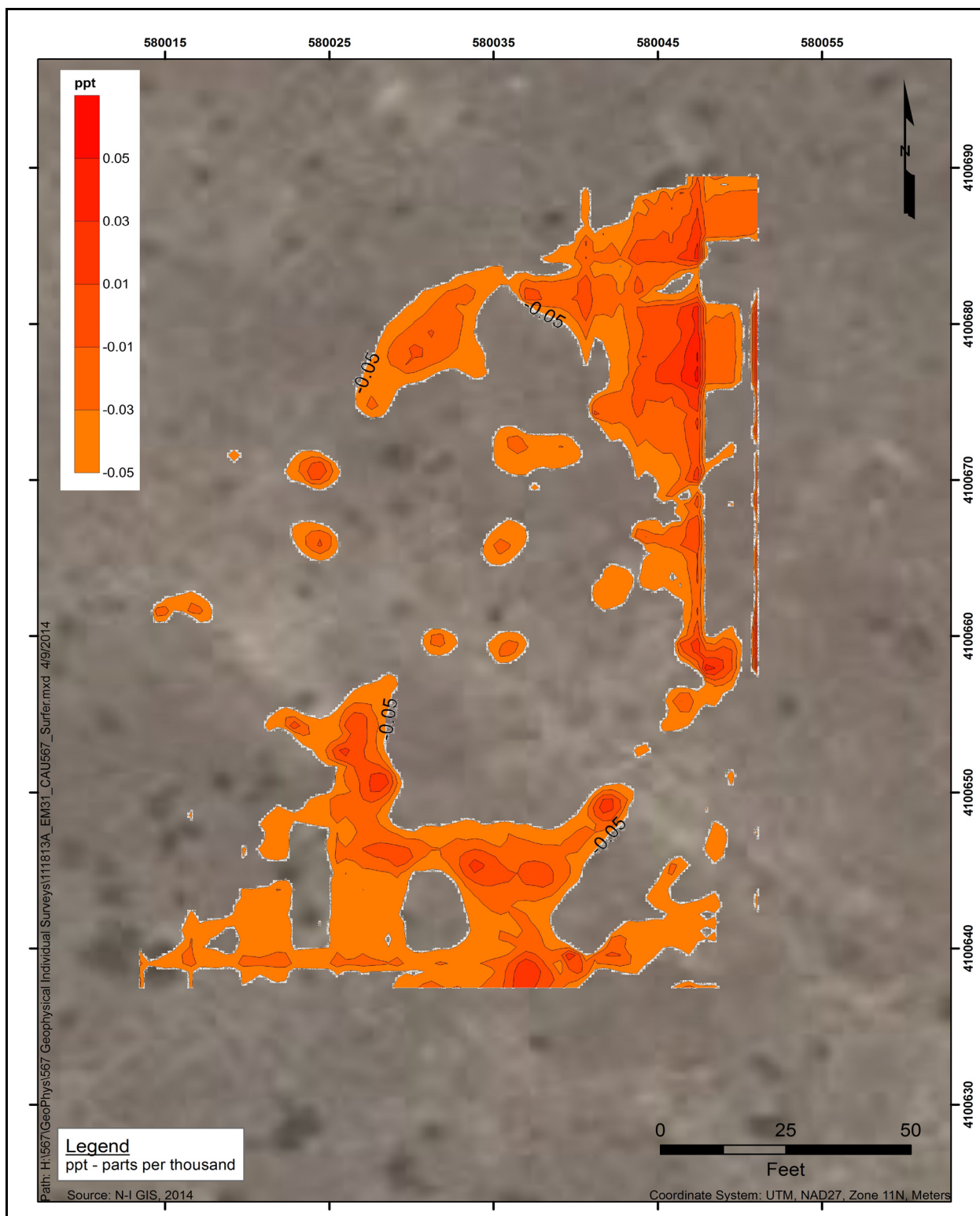


Figure G.4-10
Contoured Results of the EM31-MK2 Survey at the CWD #3 Eastern Survey Area

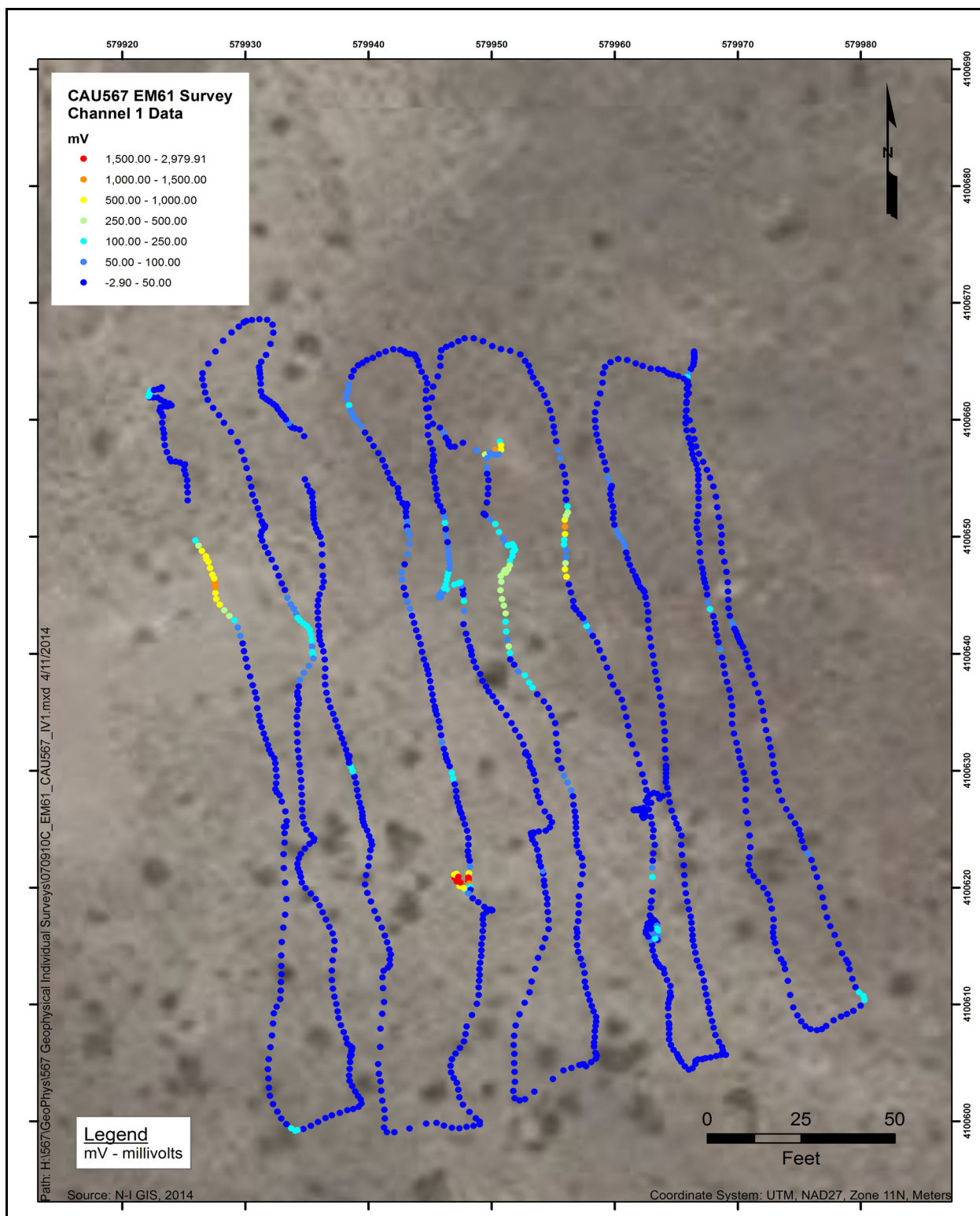


Figure G.4-11
Path Walked for the EM61-MK2A Survey at CWD #3

Table G.4-4
Summary of Data Files Collected at CWD #3 Using the EM61-MK2A

Raw Data File	Date	Comment
070910A.r61	07/09/2013	Pre-survey static instrument check
070910B.r61	07/09/2013	Pre-survey instrument check with test bolt
070910C.r61	07/09/2013	Survey
070911A.r61	07/09/2013	Post-survey static instrument check
070911B.r61	07/09/2013	Post-survey instrument check with test bolt
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

Figure G4-12 provides a contoured representation of the EM61-MK2 in-phase survey data collected on July 9. The data presented are from file 070910C. The instrument readings were generally low with the exception of three anomalies. The high instrument response in the northwest area of the figure is the same as that detected using the EM31-MK2 and corresponds to the vault and pipe observed at the surface and shown on the figure. A less prominent anomaly is observed to the east associated with concrete, nails, and wire noted at the surface. To the south, a third prominent anomaly is seen at approximately 579,947 m East and 4,100,620 m North. This anomaly is not associated with any metal observed at the surface and appears to represent a small piece of buried metal.

G.4.1.3 CWD #4

The CWD #4 site was investigated using only the EM31-MK2.

G.4.1.3.1 Results Using the EM31-MK2 Earth Conductivity Meter

Surveys were completed with the EM31-MK2 at CWD #4 on July 9 and November 18, 2013.

Table G.4-5 lists the survey files collected using the EM31-MK2 at CWD #4 and provides comment. Although the surveys were completed in the same general area, the paths walked did not entirely overlap. The EM31-MK2 was carried using the shoulder harness as shown in Figure G.2-1.

Figure G4-13 shows the paths walked for all of the CWD #4 surveys. The figure shows that the 070913A, 111809A, and 111810A surveys generally overlap with surveys 111809A and 111810A directly overlapping. The 111810B survey investigated a contiguous but separate area to the southeast. For all the surveys, each traverse was roughly parallel to the previous traverse.

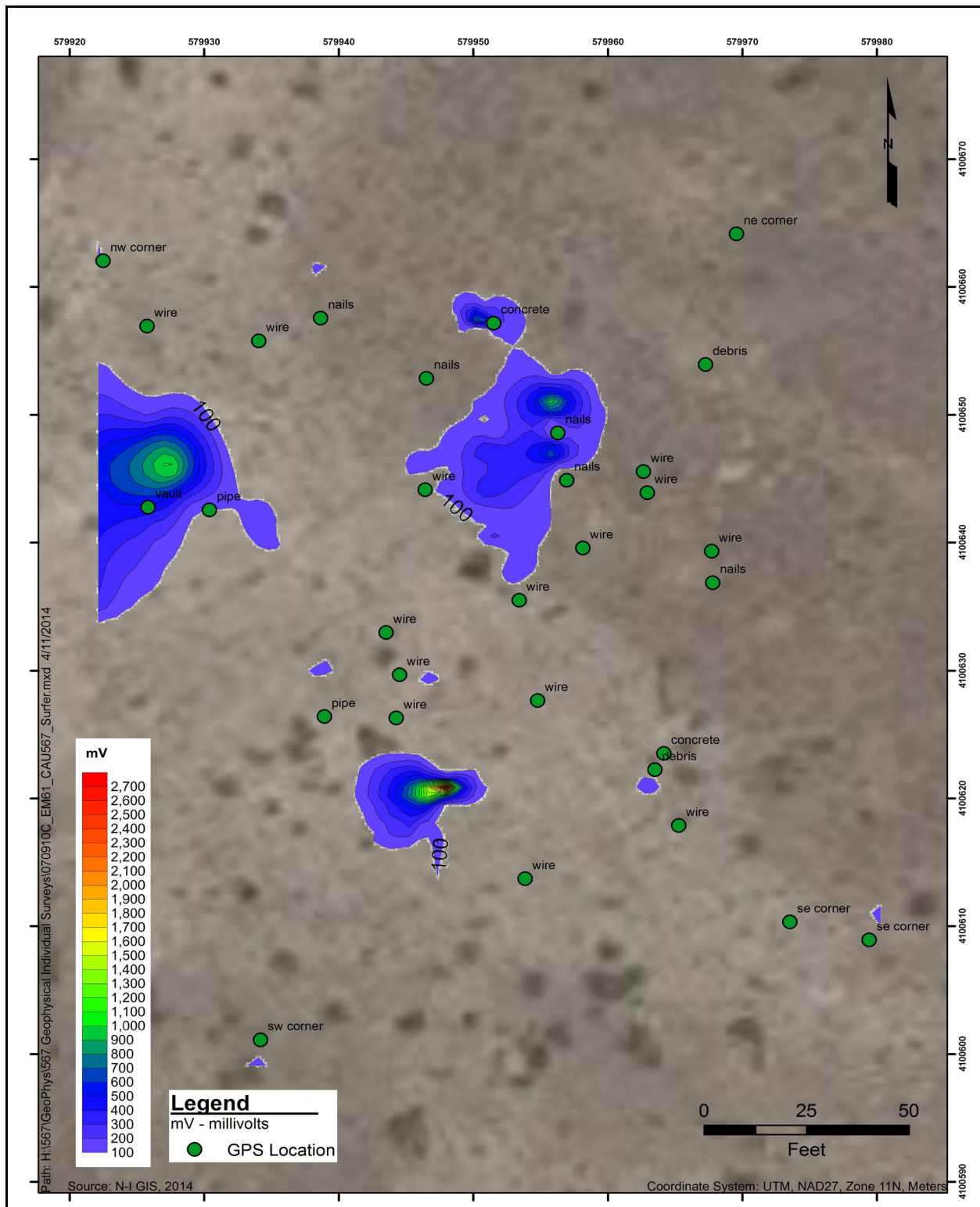


Figure G.4-12
Contoured Results of the EM61-MK2A Survey at the CWD #3 Western Survey Area

Table G.4-5
Summary of Data Files Collected at CWD #4 Using the EM31-MK2

Raw Data File	Date	Comment
070913A.r31	07/09/2013	Survey of the main area walked northwest–southeast
111809A.r31	11/18/2013	Survey of the main area walked east–west
111810A.r31	11/18/2013	Survey of the main area walked north–south
111810B.r31	11/18/2013	Survey of southeastern area
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

Figure G.4-14 shows the paths walked for the surveys in the main survey area as well as the in-phase instrument response at each data point. The figure shows areas of elevated instrument in-phase response are found in each of the surveys. These are discussed in more detail below with the presentation of the contoured data.

Figure G.4-15 provides a contoured representation of the EM31-MK2 in-phase survey data collected at the main area surveyed. The data presented are from files 070913A, 111809A, and 111810A. The instrument readings were low with the exception of the four prominent areas of elevated readings (numbered) and the northwest corner. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The figure shows that the areas of elevated instrument response numbered 1 and 4 are associated with concrete and a mostly buried pad, respectively. The areas of elevated instrument response numbered 2 and 3 are not associated with any metal observed at the surface. Although anomalies 2 and 3 do not appear to represent significant amounts of buried metal, some metal is present in the subsurface at these locations.

As shown in Figure G.4-13, the 111810B survey was conducted adjacent to the southeast corner of the main survey area. Figure G.4-16 shows the path walked for this survey as well as the instrument in-phase response at each data point. Figure G.4-16 shows that the instrument in-phase response was generally low with the exception of the last traverse at the northwestern end of the survey. The elevated readings are discussed below with the discussion of the contoured values.

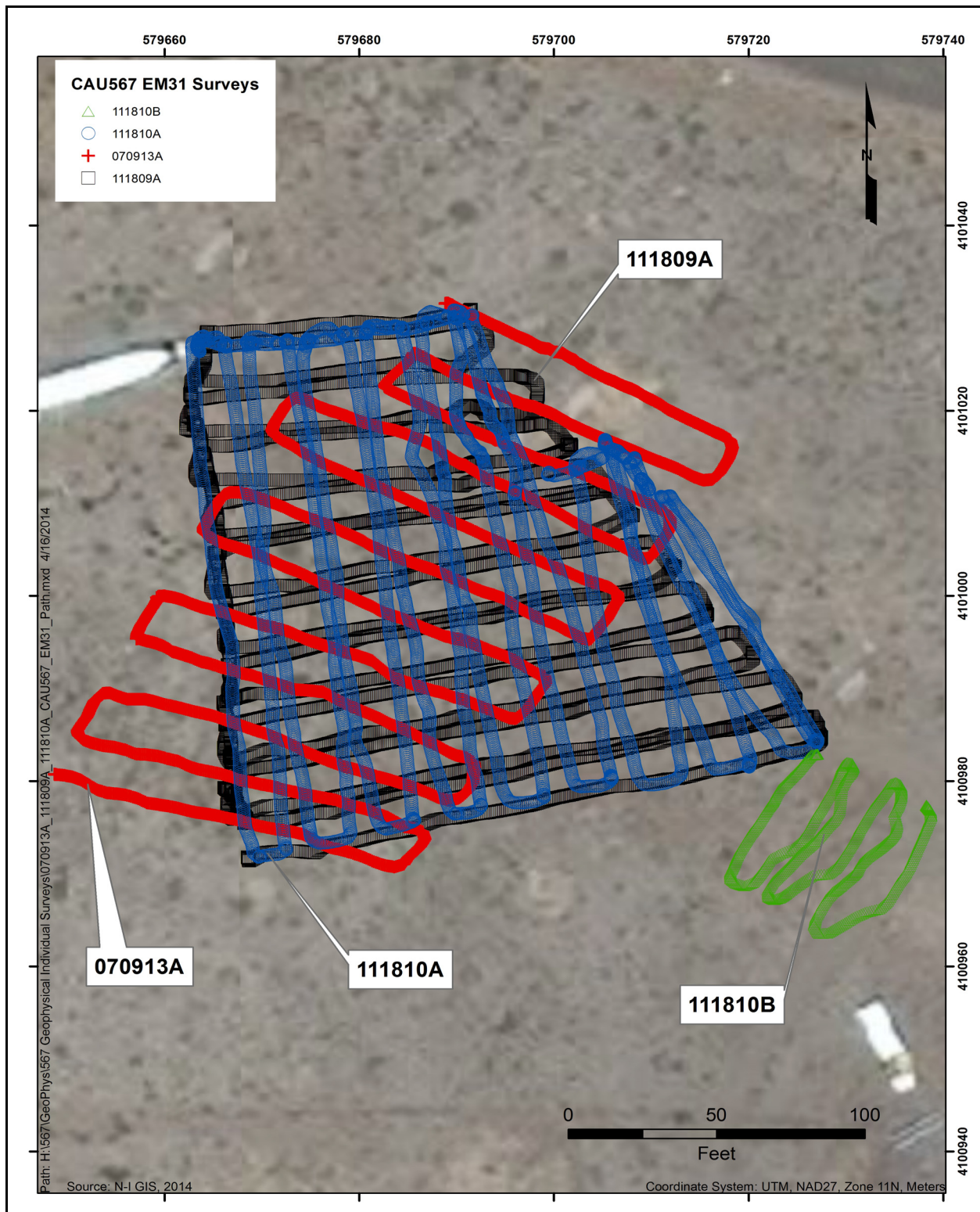


Figure G.4-13
Paths Walked for the EM31-MK2 Surveys at CWD #4

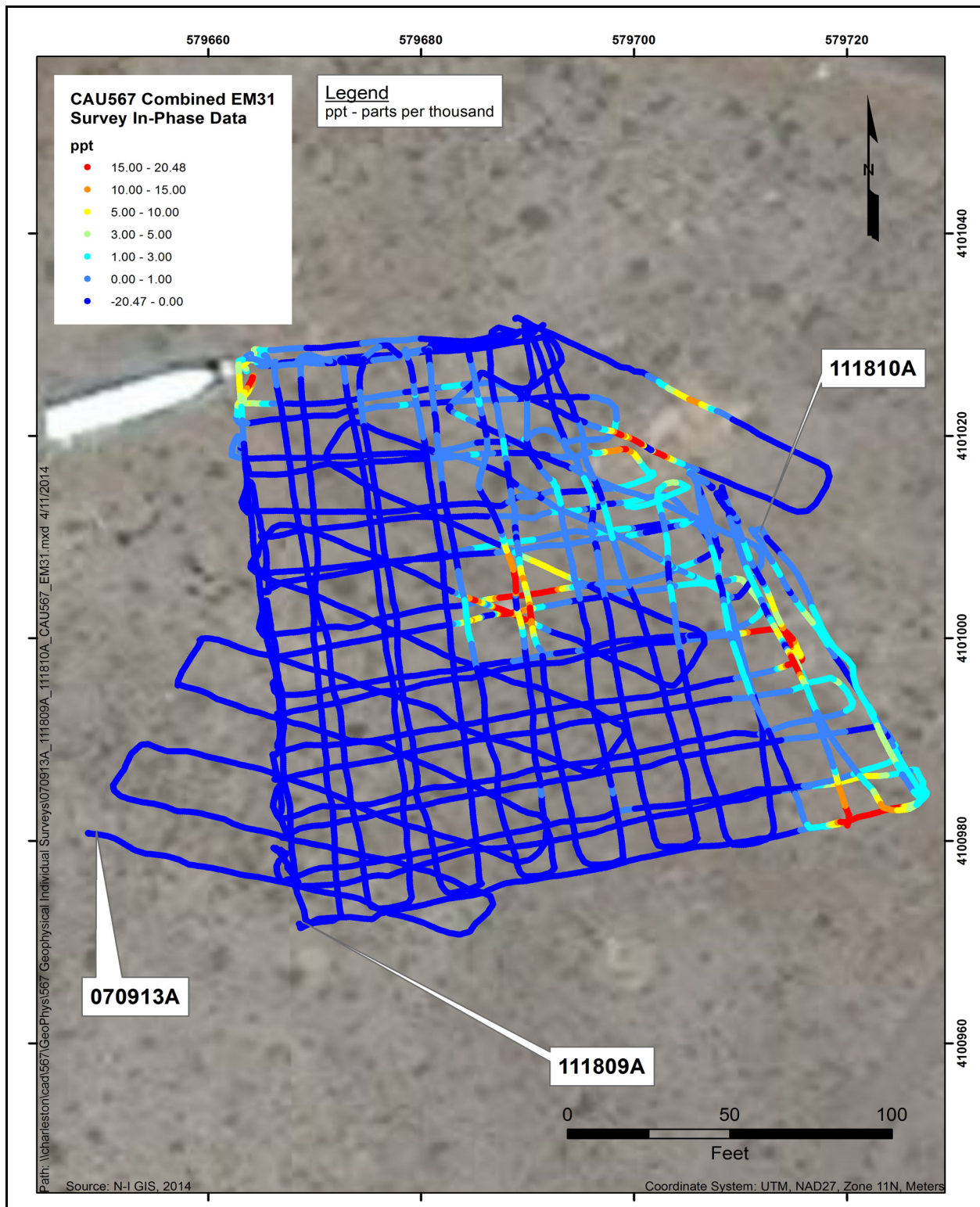


Figure G.4-14
Paths Walked for the EM31-MK2 Surveys at the CWD #4 Main Survey Area

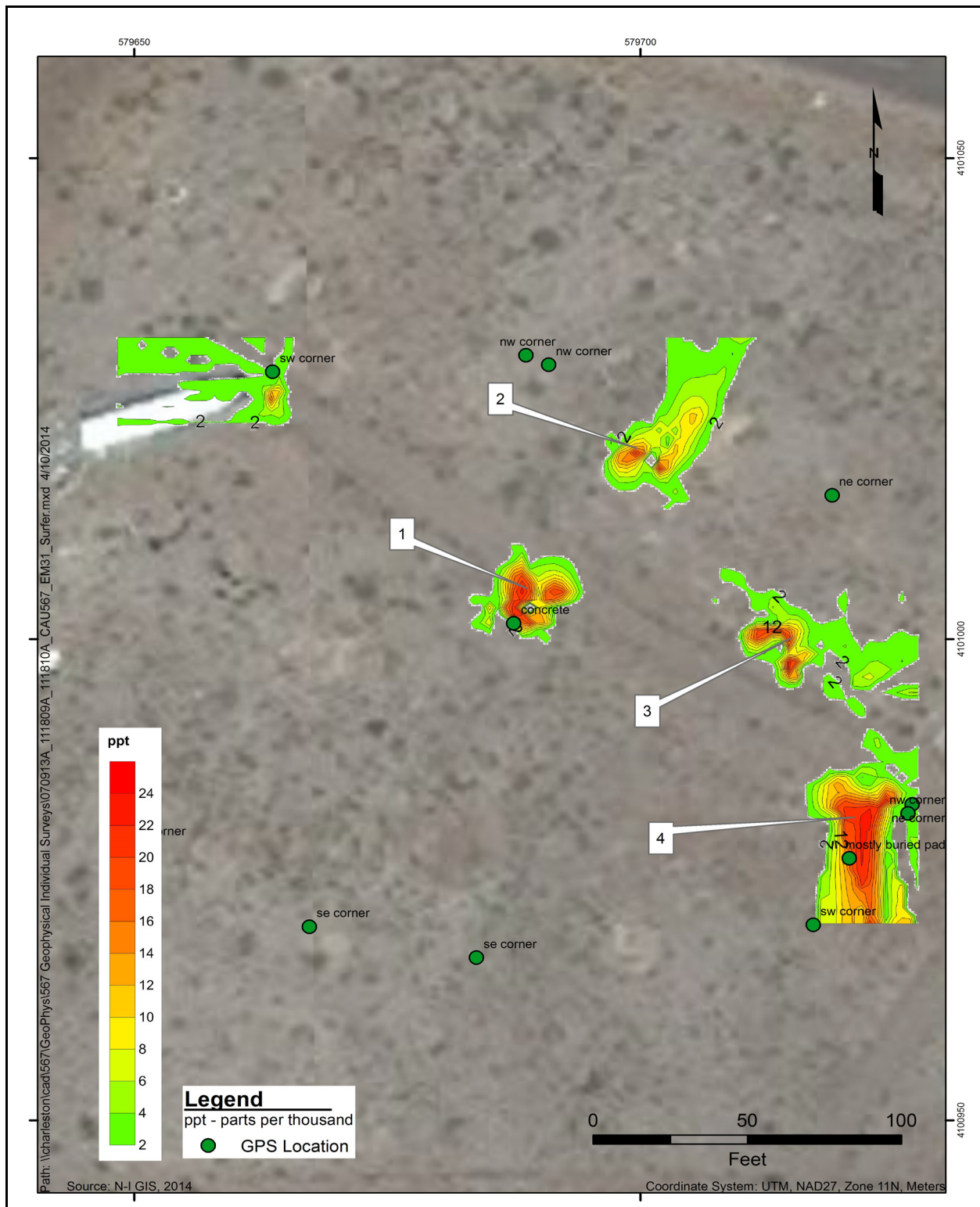


Figure G.4-15
Contoured Results of the EM31-MK2 Surveys at the CWD #4 Main Survey Area

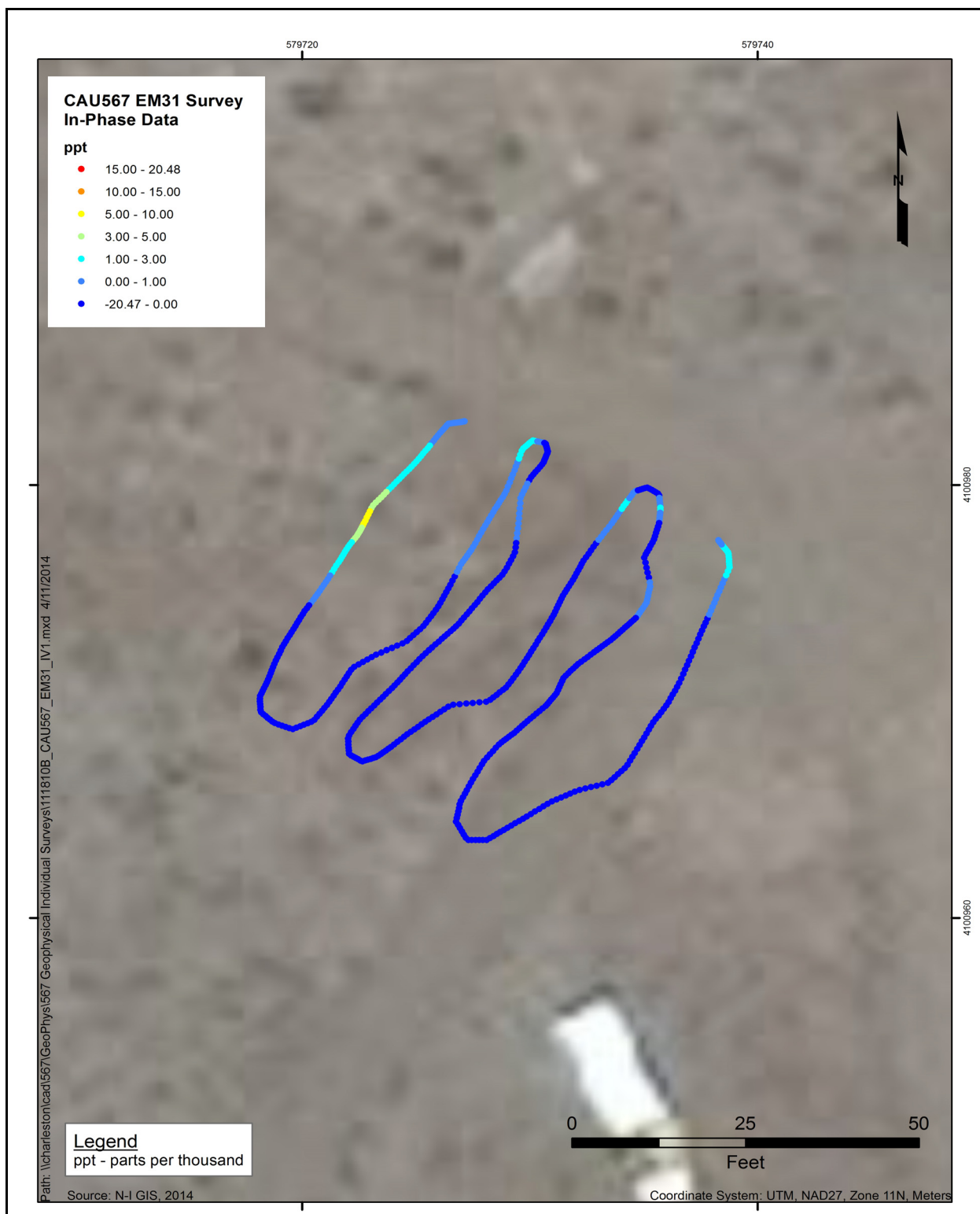


Figure G.4-16
Path Walked for the EM31-MK2 Survey at the CWD #4 Southeastern Survey Area

Figure G.4-17 provides a contoured representation of the EM31-MK2 in-phase survey data collected to the southeast of the main survey area. The data presented are from file 111810B. The area of elevated readings on the northwestern edge of this survey corresponds to the mostly buried pad discussed above for the main survey area.

Although the areas of elevated in-phase instrument response numbered 1 and 4 in Figure G.4-15 correspond to metal observed at the surface, it cannot be known whether the anomalies are due solely to the observed items unless they are removed and the area resurveyed.

G.4.1.4 Western Drainage Dump

Figure G.4-1 shows the site location relative to the other areas investigated in CAS 012303.

G.4.1.4.1 Results Using the EM31-MK2 Earth Conductivity Meter

A survey was completed with the EM31-MK2 at the Western Drainage Dump on July 2, 2013.

Table G.4-6 lists the survey files collected using the EM31-MK2 at the Western Drainage Dump and provides comment. The EM31-MK2 was carried using the shoulder harness as shown in Figure G.2-1.

Figure G.4-18 shows the path walked for the survey as well as the in-phase instrument response at each data point. The data presented are from file 070212A. The figure shows that the instrument in-phase responses were low with no significant amounts of metal detected.

Figure G.4-19 provides a contoured representation of the EM31-MK2 in-phase survey data collected at the Western Drainage Dump. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The instrument readings were low. The slightly elevated readings correspond to metallic debris observed on the surface. No significant amounts of metal were detected in the area surveyed.

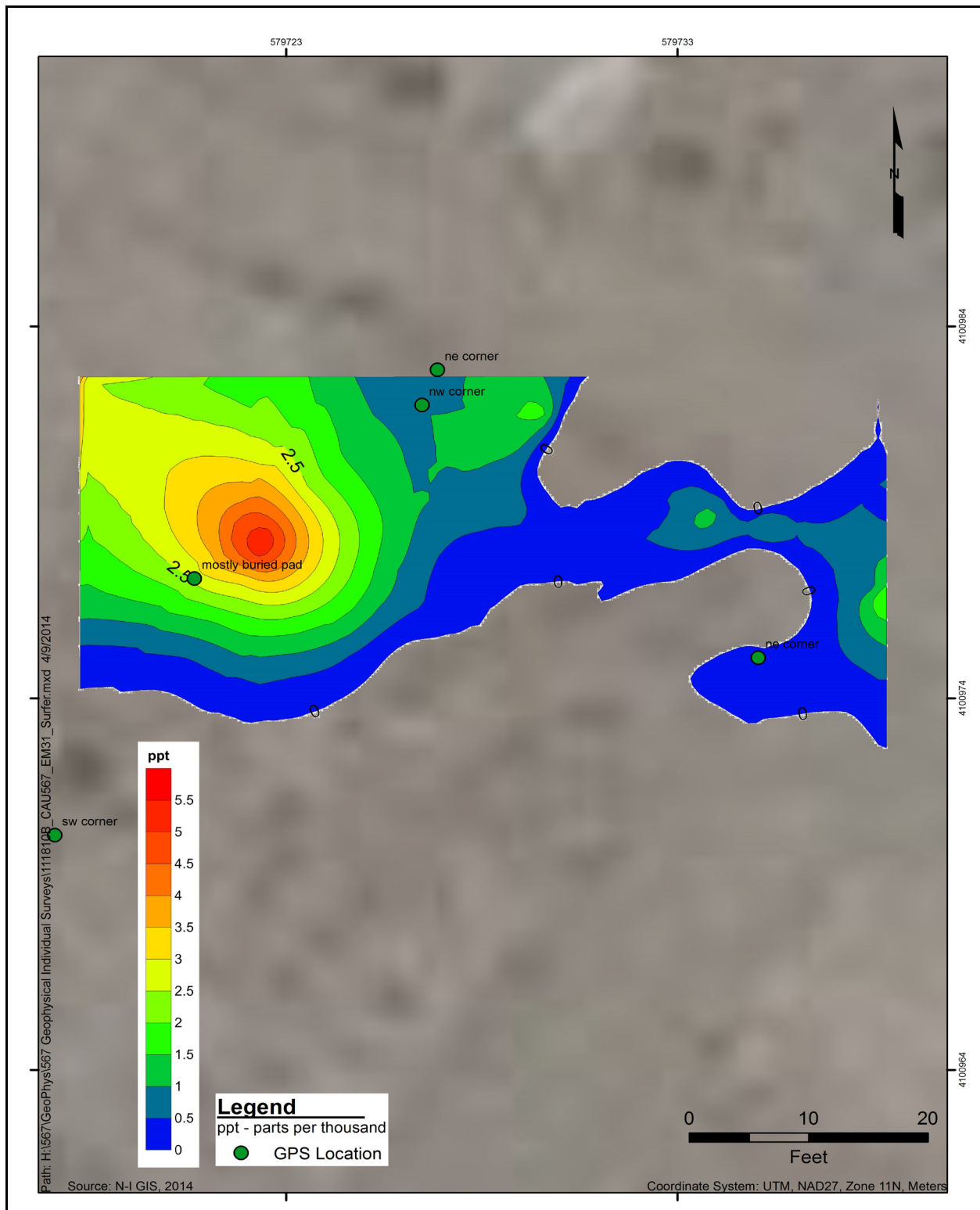


Figure G.4-17
Contoured Results of the EM31-MK2 Survey at the CWD #4 Southeastern Survey Area

Table G.4-6
Summary of Data Files Collected at Western Drainage Dump Using the EM31-MK2

Raw Data File	Date	Comment
070212A.r31	07/02/2013	Survey walked northwest–southeast
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

G.4.1.4.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

A survey was completed with the EM61-MK2A at the Western Drainage Dump on July 2, 2013.

Table G.4-7 lists the survey files collected using the EM61-MK2 at the Western Drainage Dump and provides comment. The coils of the EM61-MK2A were mounted on wheels, as shown in Figure G.2-2.

Figure G.4-20 shows the path walked for the survey on July 2 as well as the channel 1 instrument response at each data point. The data presented are from file 070210C. The survey was walked in an approximately northwest–southeast pattern with each traverse roughly parallel to the previous traverse. The figure shows that the instrument responses were generally low with one area of higher readings. In addition to the survey files, additional files recorded the pre-survey daily instrument check data. Table G.4-7 shows that the post-survey instrument check was not completed this day.

Figure G.4-21 provides a contoured representation of the EM61-MK2 channel 1 survey data collected on July 2. The data presented are from file 070210C. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The instrument readings were low with two areas of somewhat elevated readings in the northeast corner of the area surveyed. The northernmost of the anomalies is associated with metallic debris noted at the surface. A second anomaly, approximately 10 ft south of the first, is not directly associated with metallic debris at the surface and probably represents a piece of buried metal. No significant amounts of metal were detected in the area surveyed.

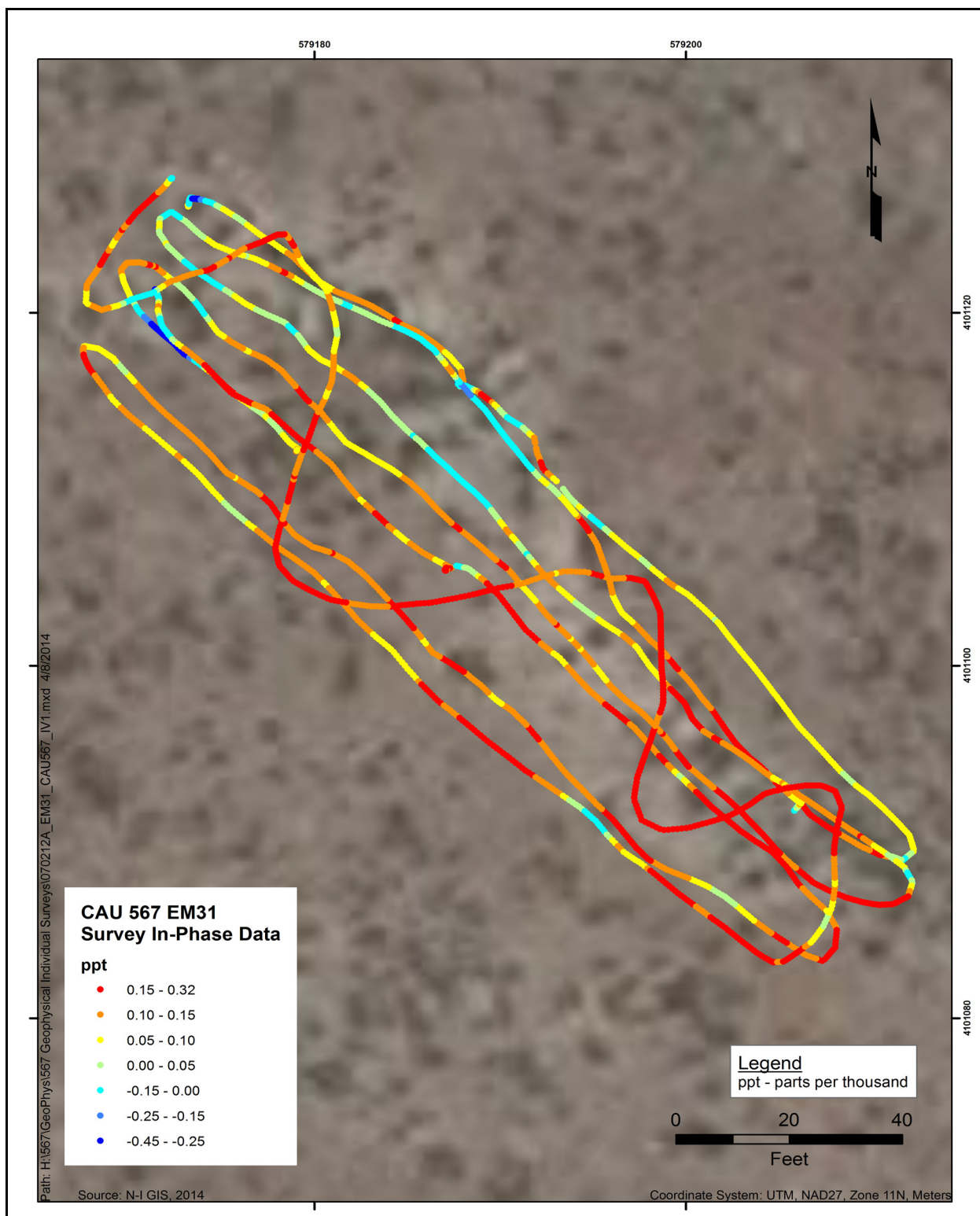


Figure G.4-18
Path Walked for the EM31-MK2 Survey at the Western Drainage Dump

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Table G.4-7
Summary of Data Files Collected at Western Drainage Dump Using the EM61-MK2A

Raw Data File	Date	Comment
070210A.r61	07/02/2013	Pre-survey static instrument check
070210B.r61	07/02/2013	Pre-survey instrument check with test bolt
070210C.r61	07/02/2013	Survey
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

G.4.1.5 Northern Drainage Dump

Surveys of the Northern Drainage Dump were run with both the EM31-MK2 and EM61-MK2A.

[Figure G.4-1](#) shows the site location.

G.4.1.5.1 Results Using the EM31-MK2 Earth Conductivity Meter

Surveys were completed with the EM31-MK2 at the Northern Drainage Dump on July 8 and November 19, 2013. [Table G.4-8](#) lists the survey files collected using the EM31-MK2 at the Northern Drainage Dump and provides comment. The EM31-MK2 was carried using the shoulder harness as shown in [Figure G.2-1](#).

[Figure G.4-22](#) shows the paths walked for the surveys as well as the in-phase instrument response at each data point. The data presented are from files 070810A and 111909A. The figure shows that the area walked July 8 was smaller but somewhat wider than the area surveyed on November 19. The instrument in-phase responses were low with no significant amounts of metal detected.

[Figure G.4-23](#) provides a contoured representation of the EM31-MK2 in-phase survey data collected at the Northern Drainage Dump. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The instrument readings were low. In most cases, the elevated readings correspond to metallic debris observed on the surface. In some cases, this is not true and the anomalies likely represent small pieces of buried metal. No significant amounts of metal were detected in the area surveyed.

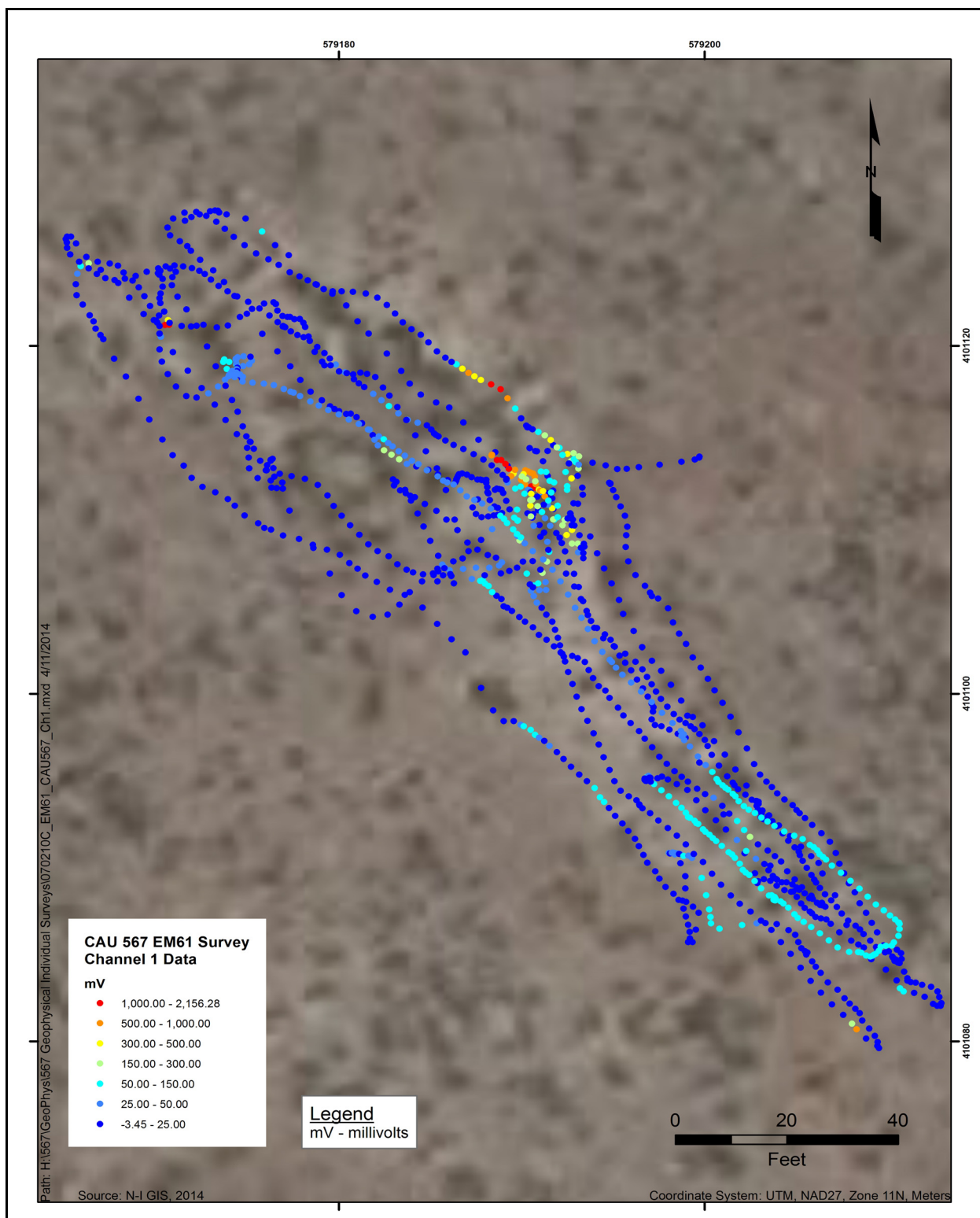


Figure G.4-20
Path Walked for the EM61-MK2A Survey at the Western Drainage Dump

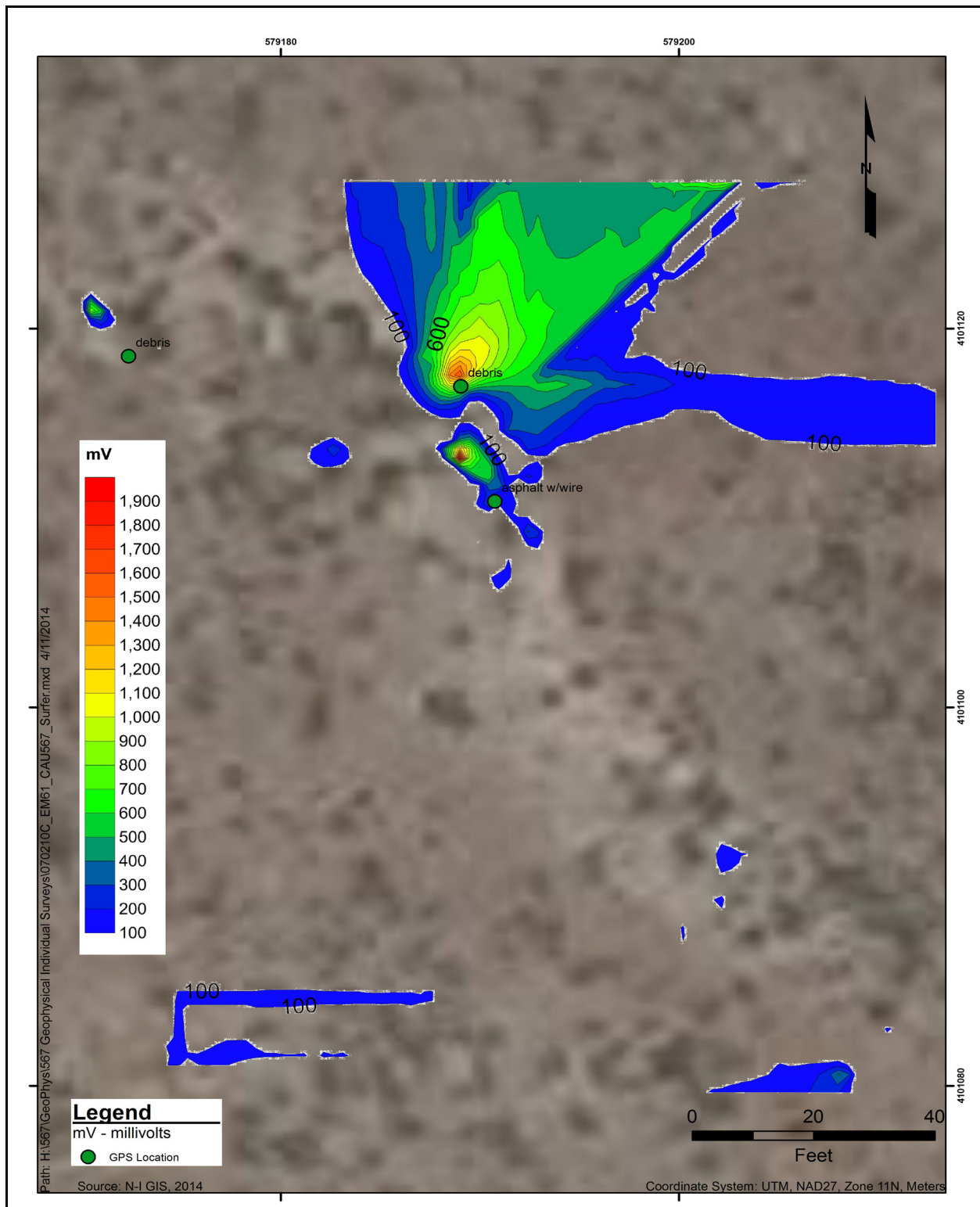


Figure G.4-21
Contoured Results of the EM61-MK2A Survey at the Western Drainage Dump

Table G.4-8
Summary of Data Files Collected at Northern Drainage Dump Using the EM31-MK2

Raw Data File	Date	Comment
070810A.r31	07/08/2013	Survey walked northwest–southeast
111909A.r31	11/19/2013	Survey walked north–south
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

G.4.1.5.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

Surveys were completed with the EM61-MK2A at the Northern Drainage Dump on July 8 and November 19, 2013. [Table G.4-9](#) lists the survey files collected using the EM61-MK2 at the Northern Drainage Dump and provides comment. The coils of the EM61-MK2A were mounted on wheels, as shown in [Figure G.2-2](#).

[Figure G.4-24](#) shows the paths walked for the surveys. All of the combined paths walked on November 19 are shown in red with the path walked for the survey on July 8 shown in dark blue. The figure shows that the area walked July 8 was smaller but somewhat wider than the area surveyed on November 19.

[Figure G.4-25](#) shows the paths walked for the surveys as well as the channel 1 instrument response at each data point. The data presented are from files 070810C and 111910C, 111912A, 111912B, 111913A, and 111913B. Numerous files were required to conduct the survey on November 19 due to the intermittent loss of GPS coverage. The figure shows that the instrument responses were generally low over most of the area surveyed, but there are groups of somewhat elevated channel 1 response readings. In addition to the survey files, additional files recorded the pre- and post-survey daily instrument check data.

[Figure G.4-26](#) provides a contoured representation of the EM61-MK2 in-phase survey data collected on July 8 and November 19. The data presented are from all of the survey files collected both days. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figure. The figure shows scattered somewhat elevated channel 1 instrument responses. These responses are indicative of scattered pieces of metal and not a significant accumulation of metal such as might be found in a landfill.

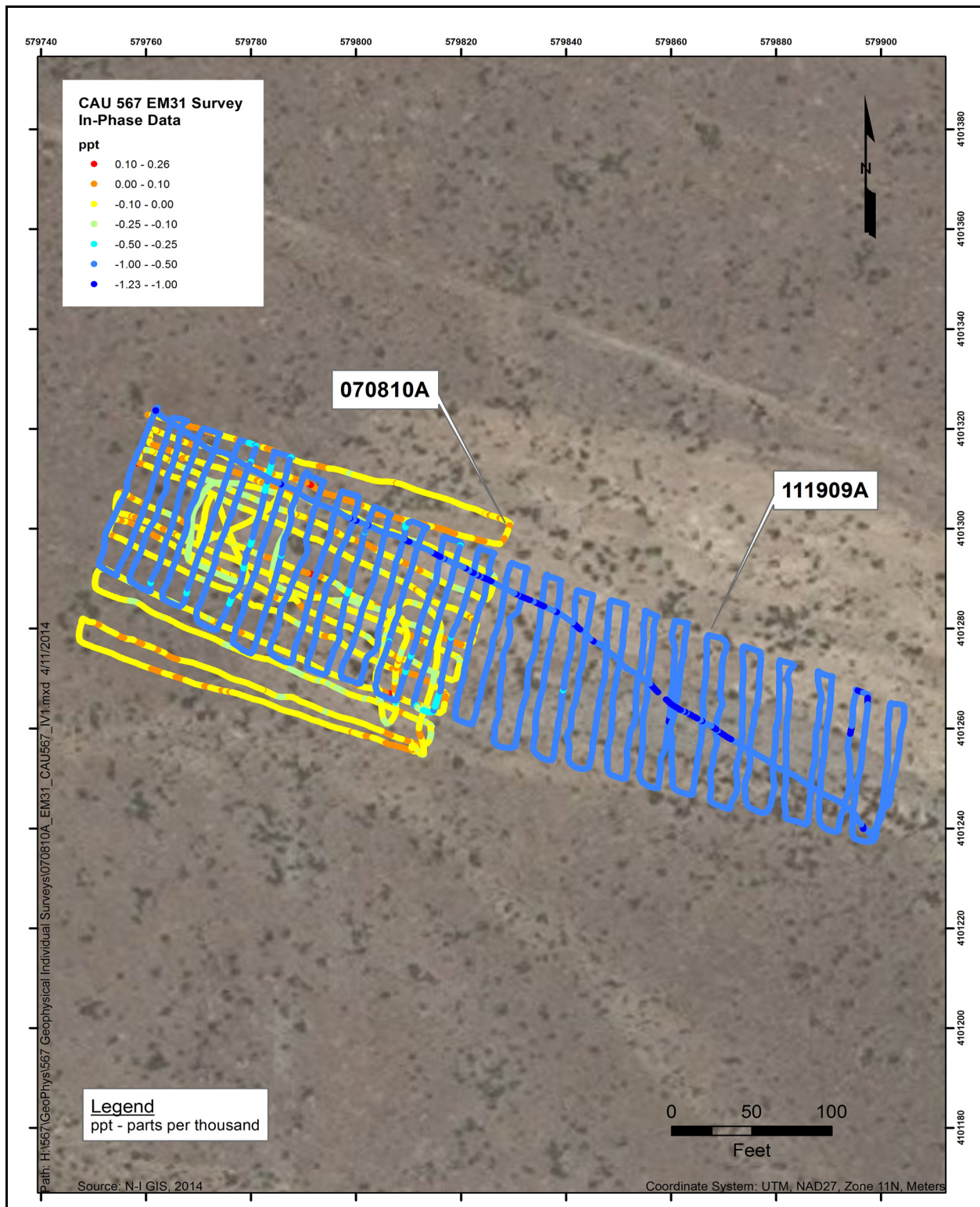


Figure G.4-22
Paths Walked for the EM31-MK2 Surveys at the Northern Drainage Dump

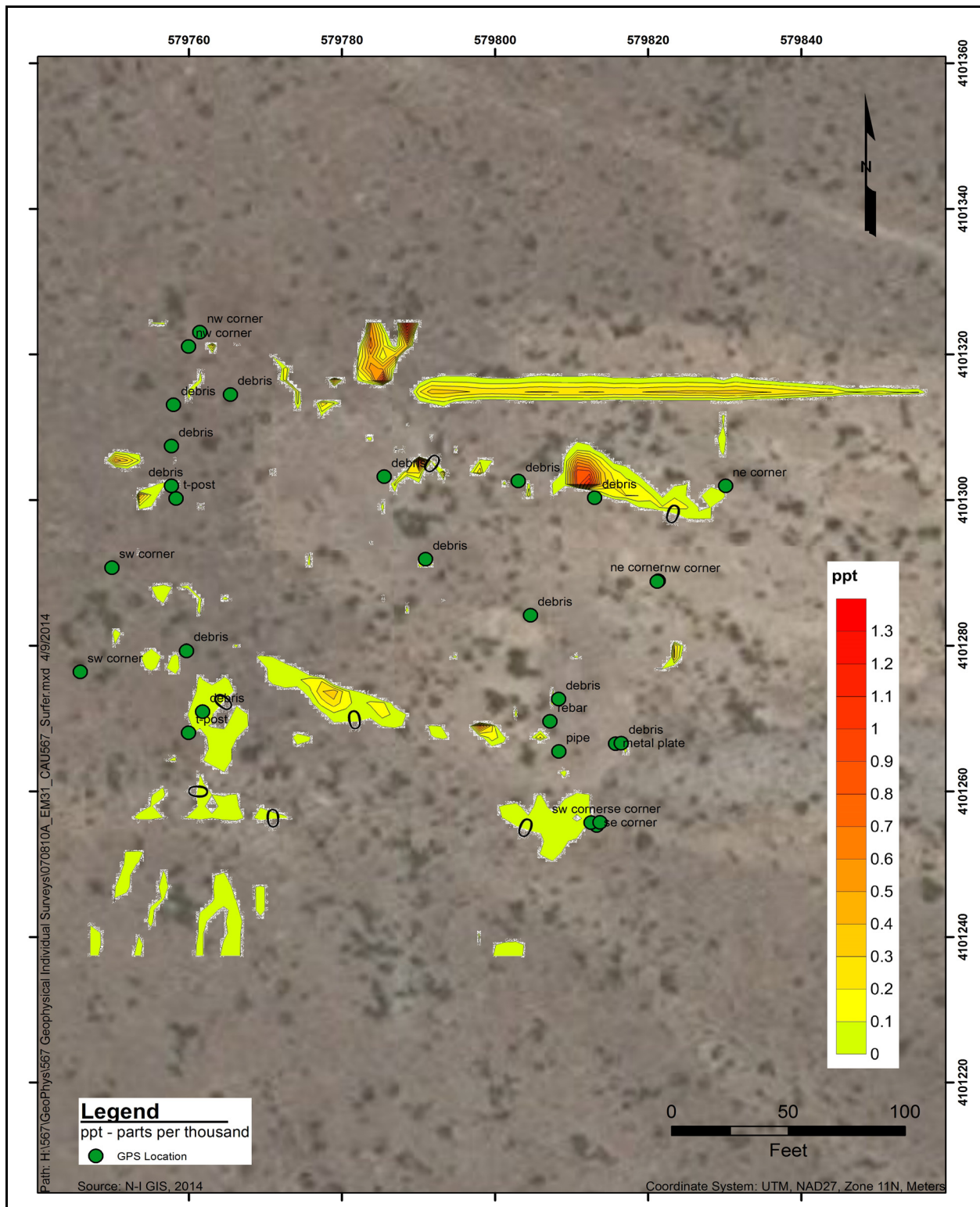


Figure G.4-23
Contoured Results of the EM31-MK2 Surveys at the Northern Drainage Dump

Table G.4-9
Summary of Data Files Collected at Northern Drainage Dump Using the EM61-MK2A

Raw Data File	Date	Comment
Survey Completed July 8, 2013		
070812A.r61	07/08/2013	Pre-survey static instrument check
070812B.r61	07/08/2013	Pre-survey instrument check with test bolt
070810C.r61	07/08/2013	Survey
070813A.r61	07/08/2013	Post-survey static instrument check
070813B.r61	07/08/2013	Post-survey instrument check with test bolt
Survey Completed November 19, 2013		
111910A.r61	11/19/2013	Pre-survey static instrument check
111910B.r61	11/19/2013	Pre-survey instrument check with test bolt
111910C.r61	11/19/2013	Survey segment
111912A.r61	11/19/2013	Survey segment
111912B.r61	11/19/2013	Survey segment
111913A.r61	11/19/2013	Survey segment
111913B.r61	11/19/2013	Survey segment
111914A.r61	11/19/2013	Post-survey static instrument check
111914B.r61	11/19/2013	Post-survey instrument check with test bolt
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

G.4.2 A5b RMA

Three potential landfill locations were identified in the vicinity of A5b RMA. These areas were the focus of the geophysical surveys conducted. Both the EM31-MK2 and the EM61-MK2A were used for the surveys.

G.4.2.1 Results Using the EM31-MK2 Earth Conductivity Meter

The surveys completed with the EM31-MK2 were conducted June 3, 2013. [Figure G.4-27](#) shows the paths of the two surveys conducted to investigate the areas of concern. In addition, the figure indicates the in-phase instrument response at each data point. The responses detected were low and do not indicate the presence of anything but scattered small pieces of metal.

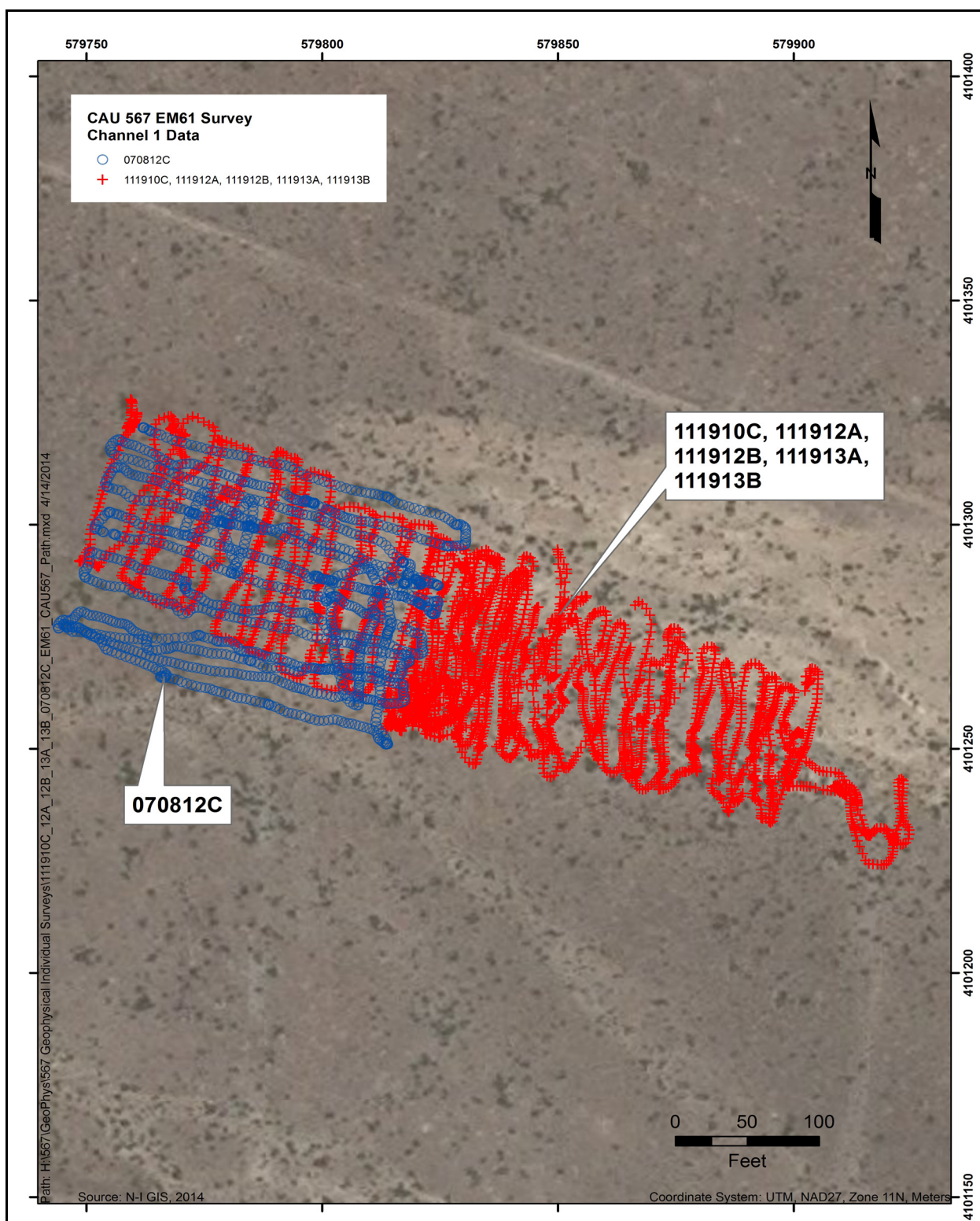


Figure G.4-24
Paths Walked for the EM61-MK2A Surveys at the Northern Drainage Dump

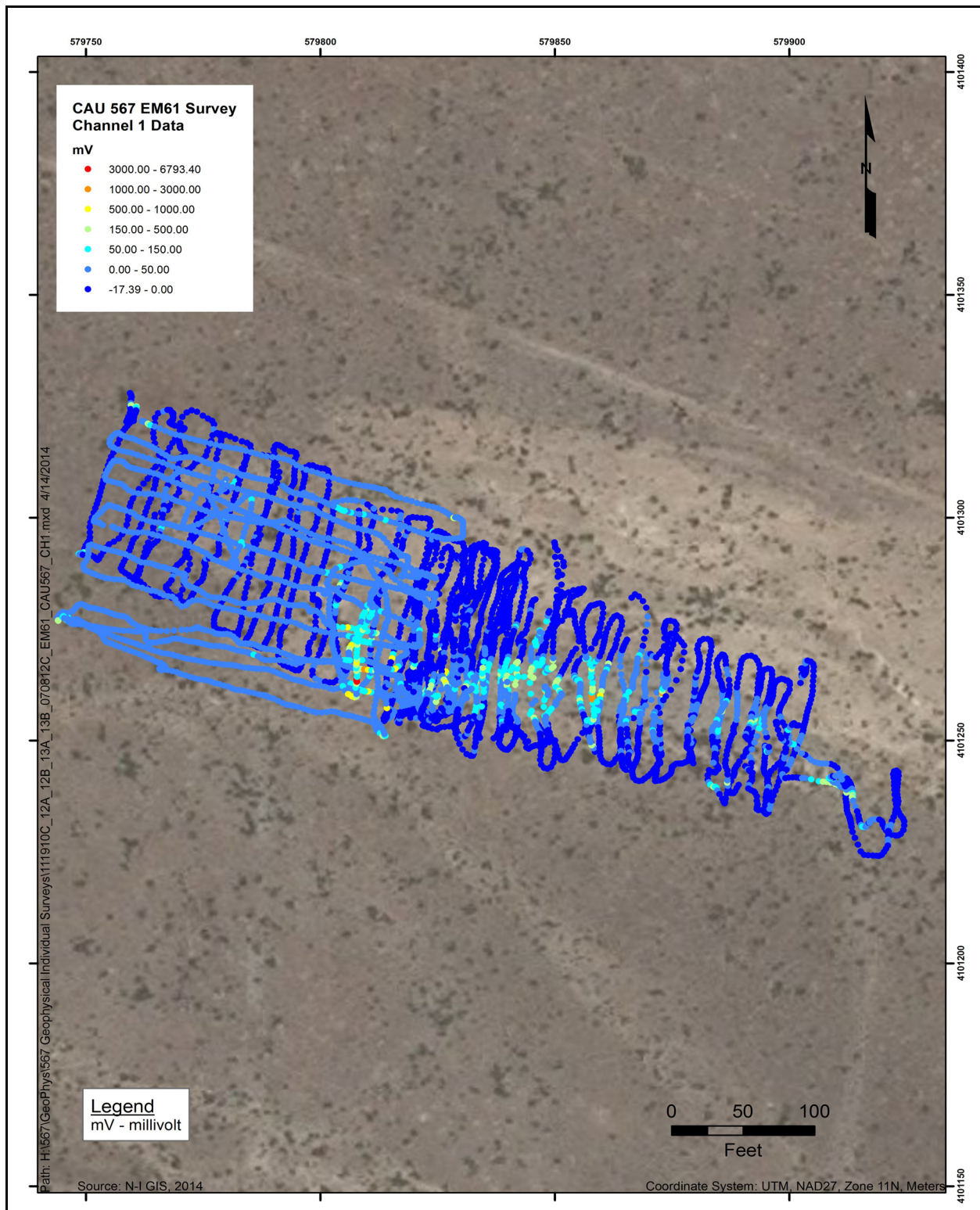


Figure G.4-25
Paths Walked for the EM61-MK2A Surveys at the Northern Drainage Dump
with the Channel 1 Instrument Responses

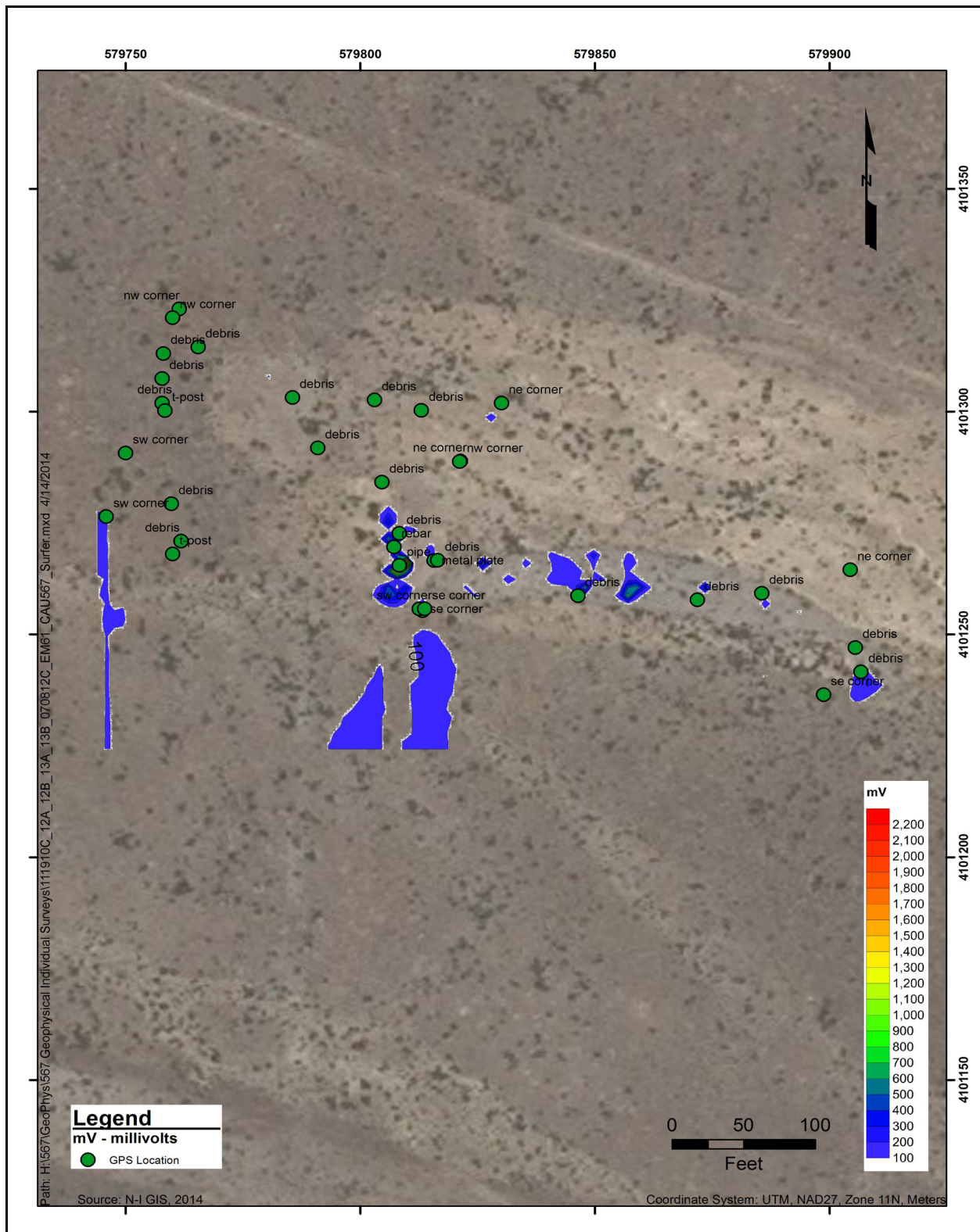


Figure G.4-26
Contoured Results of the EM61-MK2A Surveys at the Northern Drainage Dump

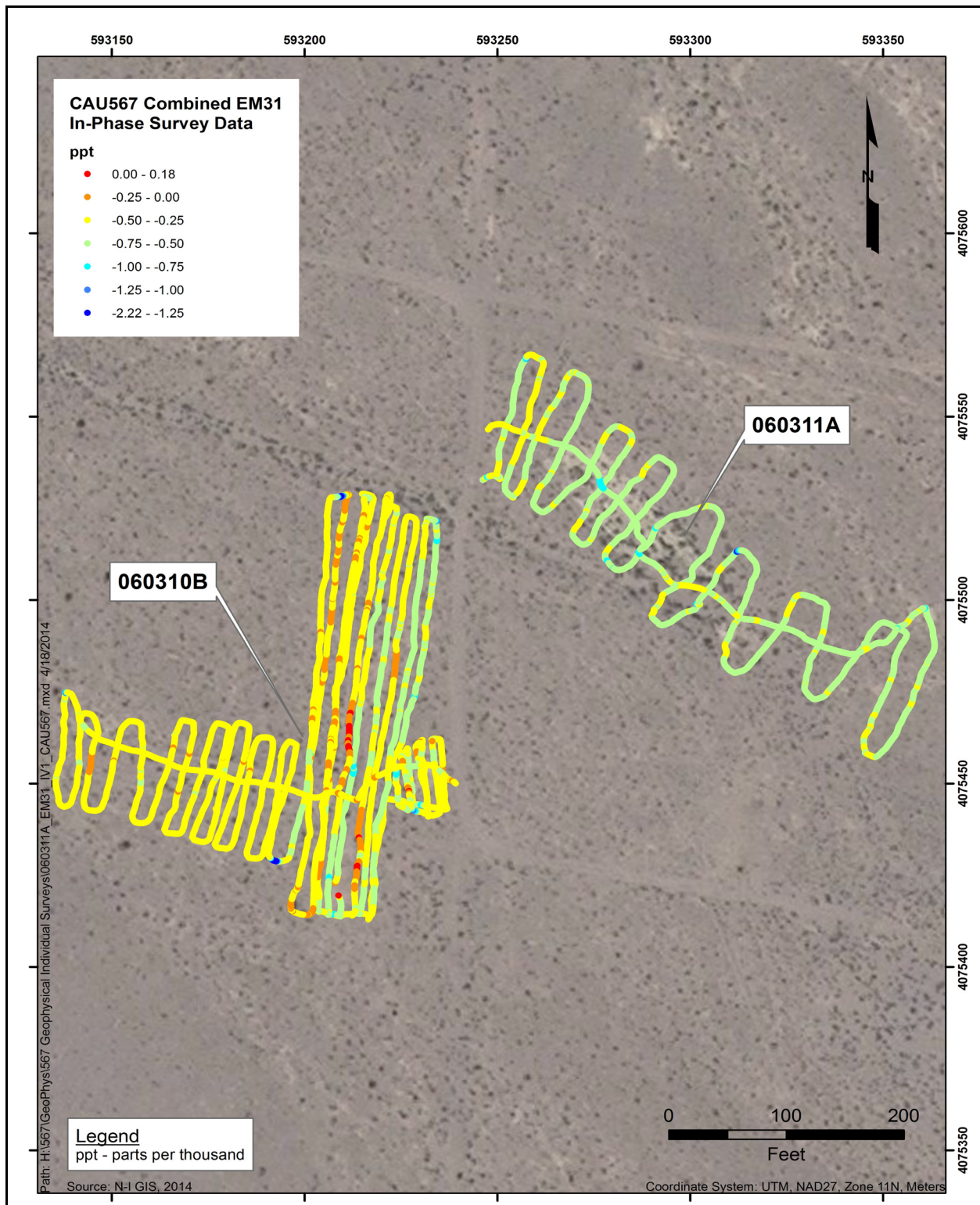


Figure G.4-27
Paths Walked for the EM31-MK2 Surveys at A5b RMA

The EM31-MK2 was carried using the shoulder harness as shown in [Figure G.2-1](#). [Figure G.4-27](#) shows that each traverse was roughly parallel to the previous traverse. [Table G.4-10](#) lists the survey files collected using the EM31-MK2 and provides comment.

Table G.4-10
Summary of Data Files Collected at A5b RMA Using the EM31-MK2

Raw Data File	Date	Comment
060311A.r31	06/03/2013	Northeastern investigation area
060310B.r31	06/03/2013	Central and western investigation areas
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

[Figure G.4-28](#) provides a contoured representation of the EM31-MK2 in-phase survey for the potential landfill area to the east. The data represented are from file 060311A. The values are uniformly low, and only scattered small pieces of metal are indicated.

[Figure G.4-29](#) provides a contoured representation of the EM31-MK2 in-phase survey data for the potential landfill areas to the west. The data represented are from file 060310B. The values are uniformly low, and only scattered small pieces of metal are indicated.

G.4.2.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

The surveys completed with the EM61-MK2A were conducted June 4, 2013. [Table G.4-11](#) summarizes the survey files collected using the EM61-MK2A and provides comment on each. The coils of the EM61-MK2A were mounted on wheels, as shown in [Figure G.2-2](#). Three separate surveys, identified as 060411B, 060412A, and 060413A, were conducted to investigate the areas of interest. The paths walked for each survey are shown in [Figure G.4-30](#). In addition to the survey files, additional files recorded the pre- and post-survey daily instrument check data.

In addition to the paths walked for the surveys on June 4, [Figure G.4-30](#) shows the channel 1 instrument response at each data point. The figure shows that lines walked for the surveys are generally parallel. Deviations in the lines are due to the presence of vegetation that the instrument had to be wheeled around. As seen in the EM31-MK2 in-phase survey data, the values are uniformly low, and only scattered small pieces of metal are indicated.

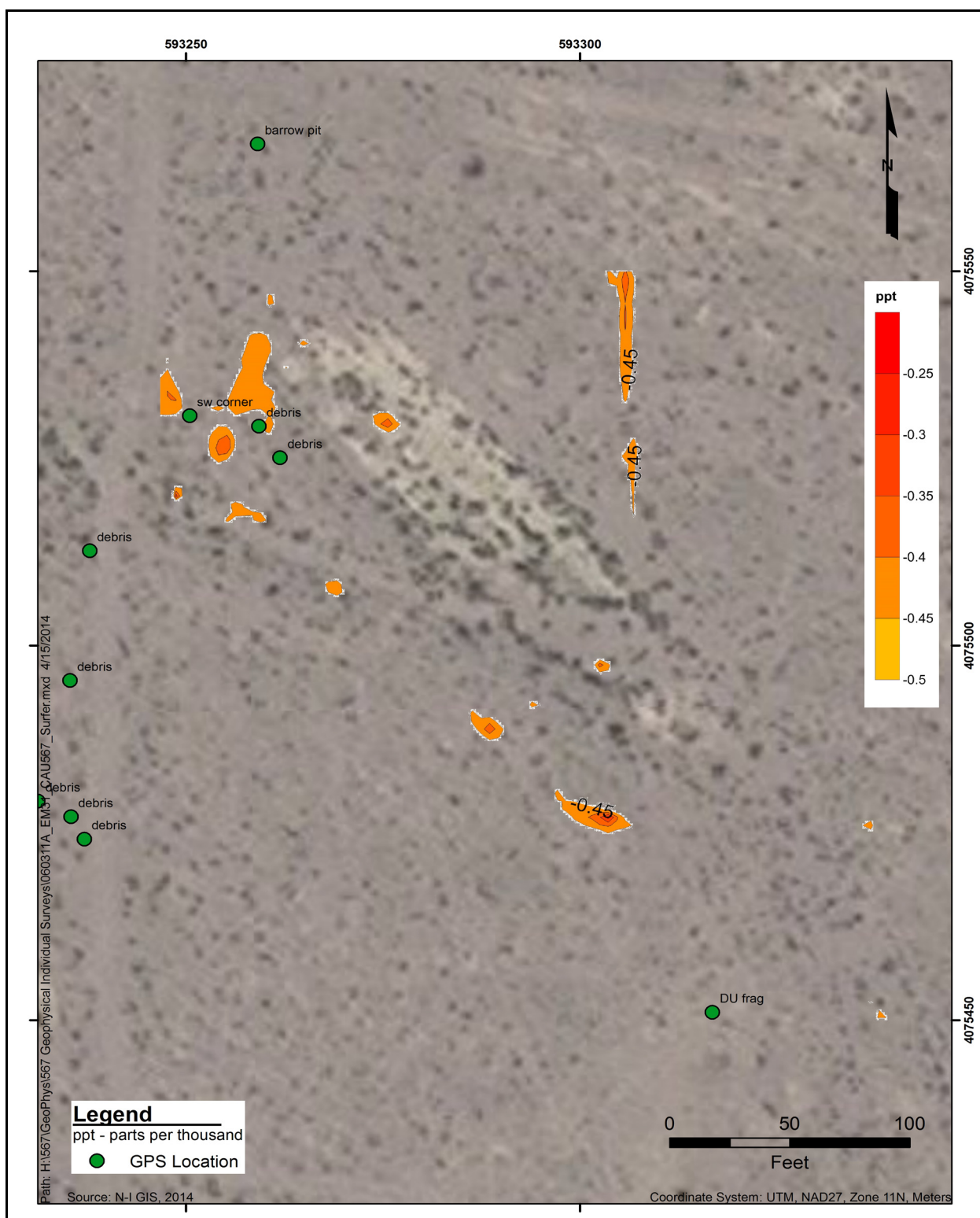


Figure G.4-28
Contoured Results of the EM31-MK2 Survey at the Eastern Potential Landfill Area

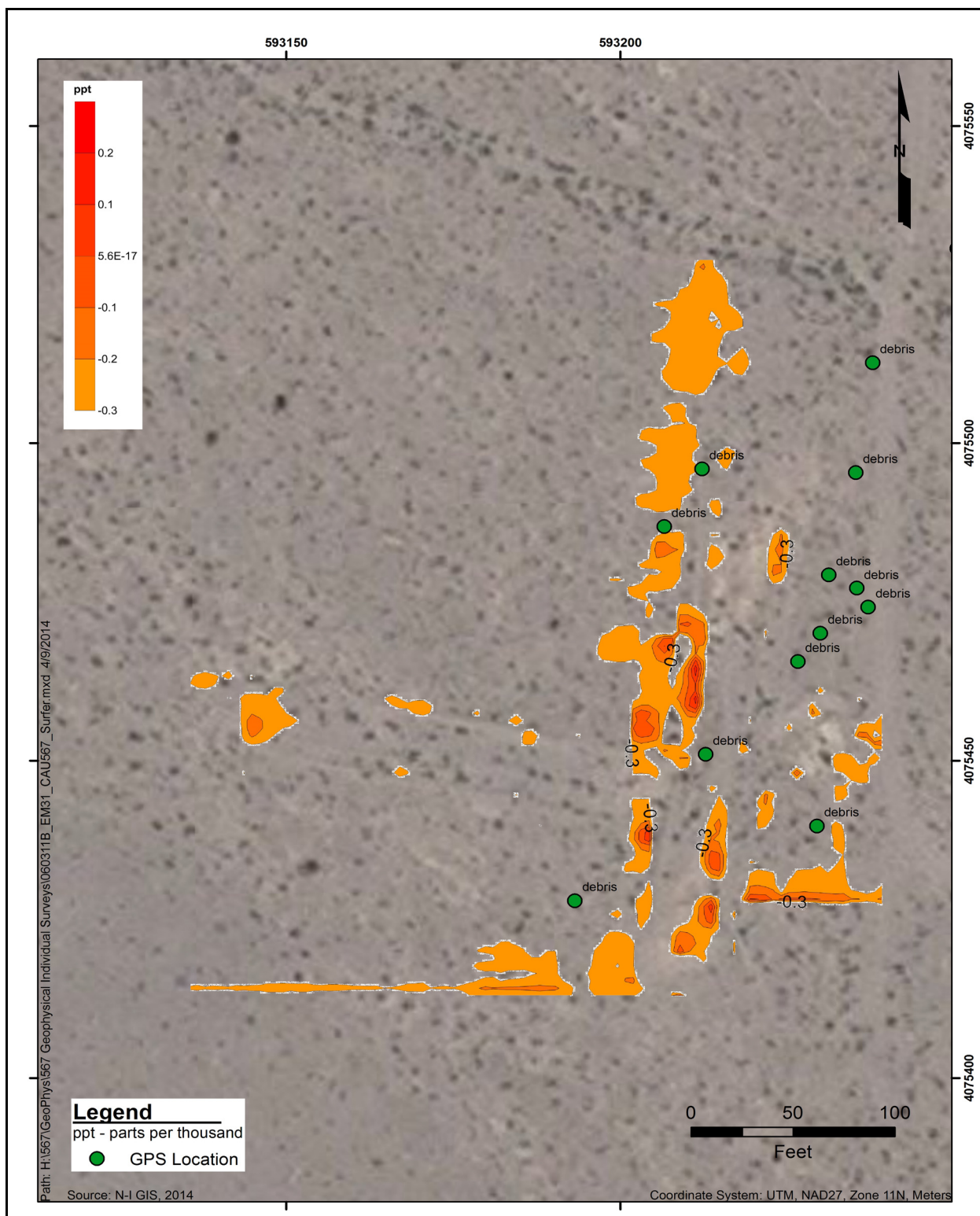


Figure G.4-29
Contoured Results of the EM31-MK2A Survey at the Western Potential Landfill Area

Table G.4-11
Summary of Data Files Collected at A5b RMA Using the EM61-MK2A

Raw Data File	Date	Comment
060411A.r61	06/04/2013	Pre-survey equipment checks (static and with test bolt)
060411B.r61	06/04/2013	Central area survey
060412A.r61	06/04/2013	Western area survey
060413A.r61	06/04/2013	Northeastern area survey
060413B.r61	06/04/2013	Post-survey equipment checks (static and with test bolt)
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

Figures G.4-31 through G.4-33 show the EM61-MK2A channel 1 instrument responses. The locations of the reference points, the metallic debris noted at the surface, and the corners of the areas surveyed are posted on the figures. The locations where metallic debris was observed at the surface as well as geographic reference points are shown on the figures.

Figure G.4-31 provides a contoured representation of the EM61-MK2A channel 1 response data in the northeastern potential landfill area. The figure presents the 060413A survey data. The figure shows that no significant areas of elevated response were detected. The response data are indicative of small scattered pieces of metal.

Figure G.4-32 provides a contoured representation of the EM61-MK2A channel 1 response data in the central potential landfill area. The figure presents the 060411B survey data. The figure shows that no significant areas of elevated response were detected. The response data are indicative of small scattered pieces of metal.

Figure G.4-33 provides a contoured representation of the EM61-MK2A channel 1 response data in the western potential landfill area. The figure presents the 060412A survey data. The figure shows that no significant areas of elevated response were detected. The response data are indicative of small scattered pieces of metal.

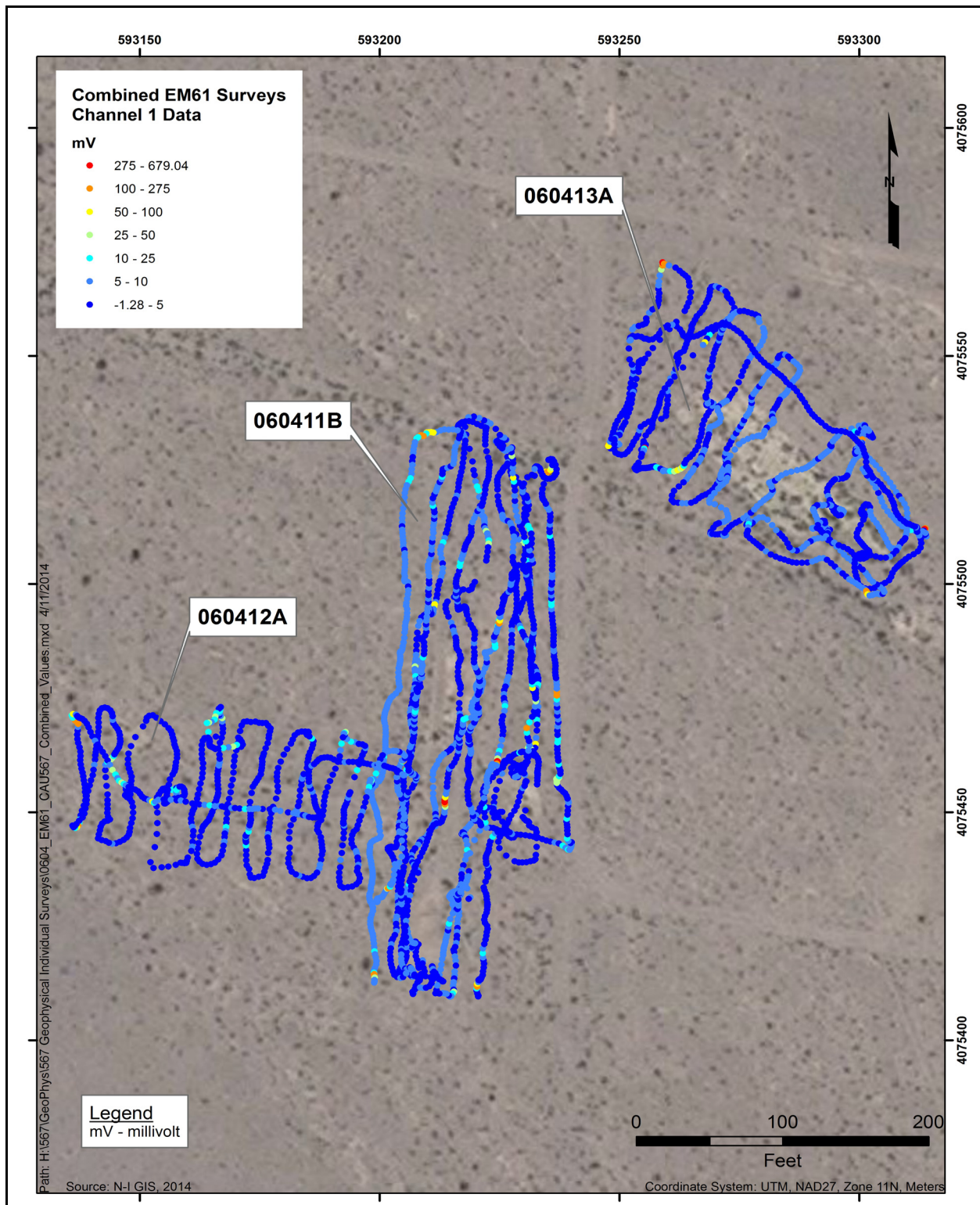


Figure G.4-30
Paths Walked for the EM61-MK2A Surveys at A5b RMA

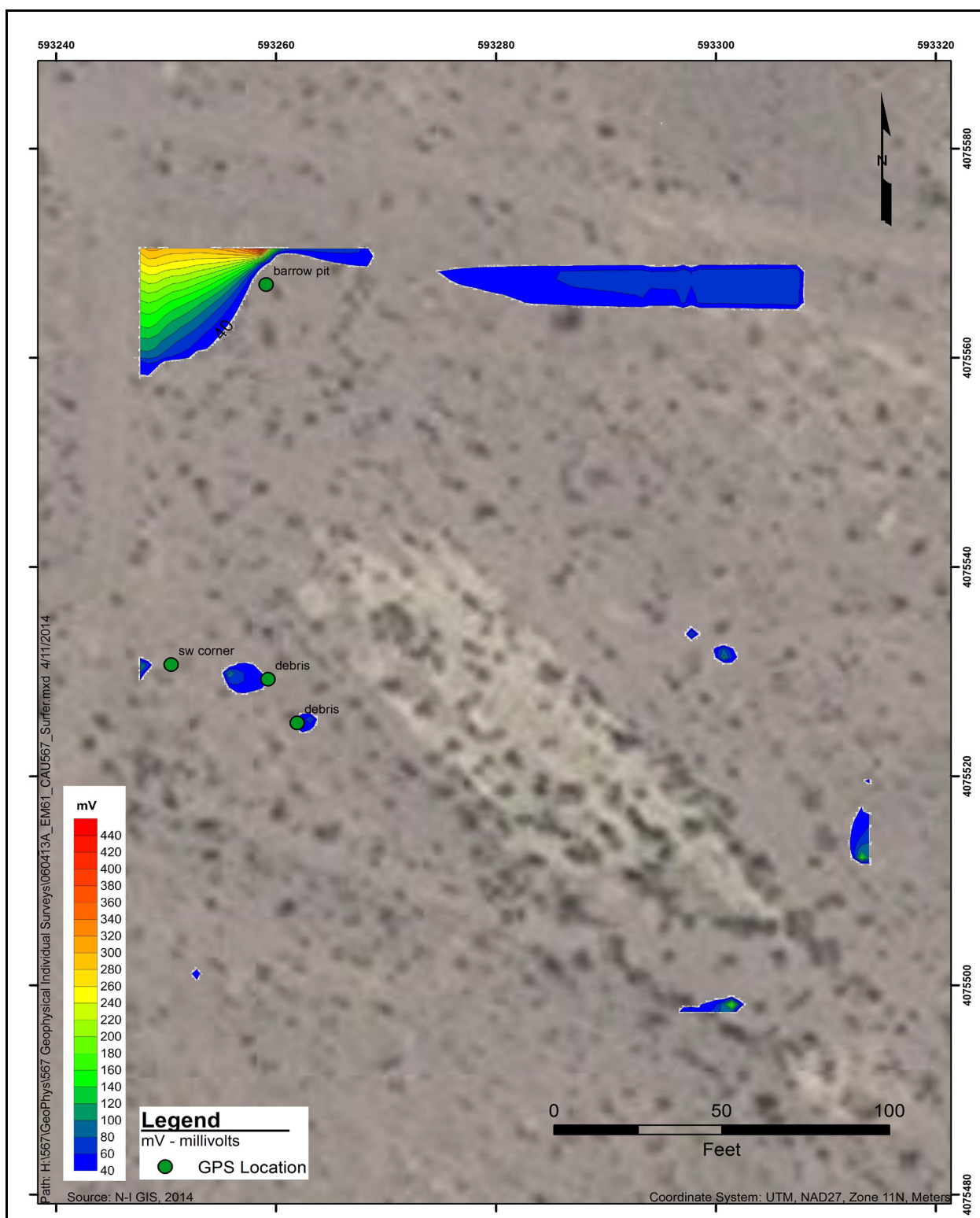


Figure G.4-31
Contoured Results of the EM61-MK2A Survey at the Eastern Potential Landfill Area

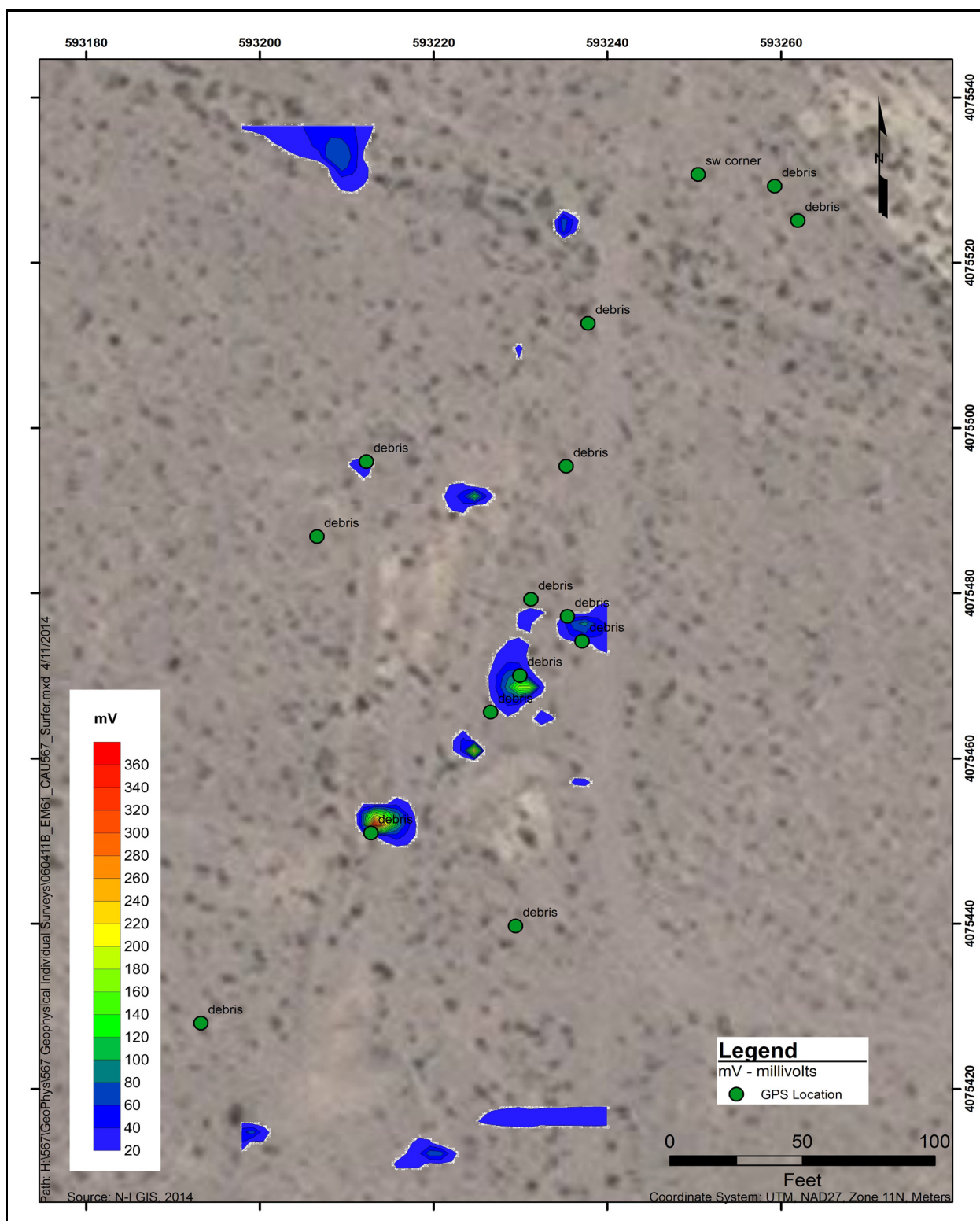
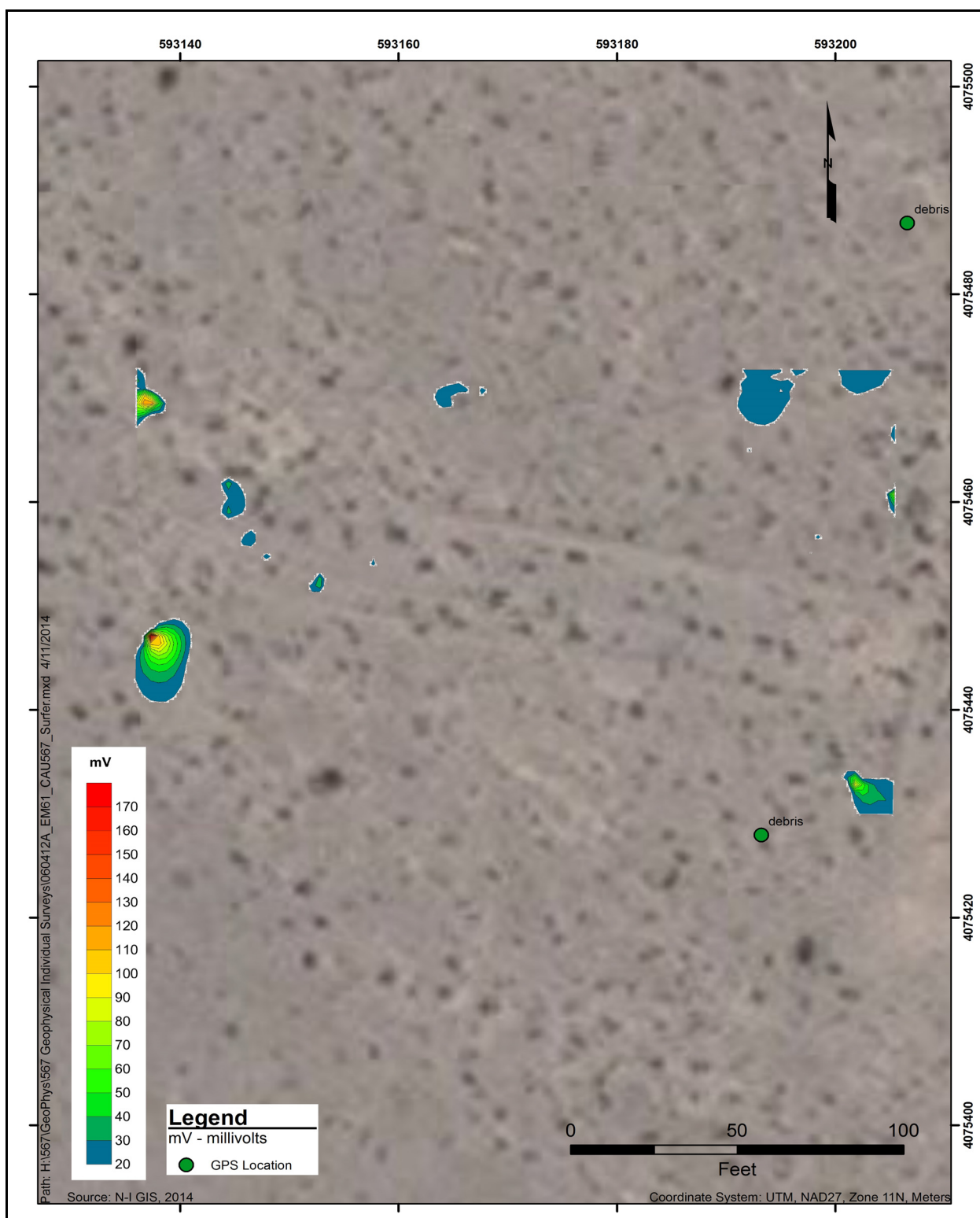


Figure G.4-32
Contoured Results of the EM61-MK2A Survey at the Central Potential Landfill Area

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G.4.3 Colby Mud Spill

The focus of the geophysical surveys completed at Colby Mud Spill was a mud disposal area. In addition, a small earth mound with some metal exposed at the surface on the northeastern side of the mud disposal area was investigated. Both the EM31-MK2 and the EM61-MK2A were used in the surveys.

G.4.3.1 Results Using the EM31-MK2 Earth Conductivity Meter

The surveys completed with the EM31-MK2 were conducted March 24, 2014. [Table G.4-12](#) shows the survey files collected using the EM31-MK2 and provides comment. The EM31-MK2 was carried using the shoulder harness as shown in [Figure G.2-1](#).

Table G.4-12
Summary of Data Files Collected at Colby Mud Spill Using the EM31-MK2

Raw Data File	Date	Comment
032410B.r31	03/24/2014	Survey of the mud disposal area
032410C.r31	03/24/2014	Survey of the small mound
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

[Figure G.4-34](#) shows the paths walked for the surveys as well as the instrument in-phase response at each data point. The 032410B survey at the mud disposal area was walked in a northeast–southwest pattern. Each traverse was roughly parallel to the previous traverse. The 032410C survey at the small mound was walked both north–south and east–west.

[Figure G.4-34](#) shows that somewhat elevated instrument response was detected with both surveys. The data from the mud disposal area and small mound are discussed further below with the presentation of the contoured data for each survey.

Mud Disposal Area

[Figure G.4-35](#) provides a contoured representation of the EM31-MK2 in-phase survey data for the mud disposal area. The data represented are from file 032410B. The values are generally low. The few points where the response values are somewhat higher are indicative of scattered small pieces of metal.

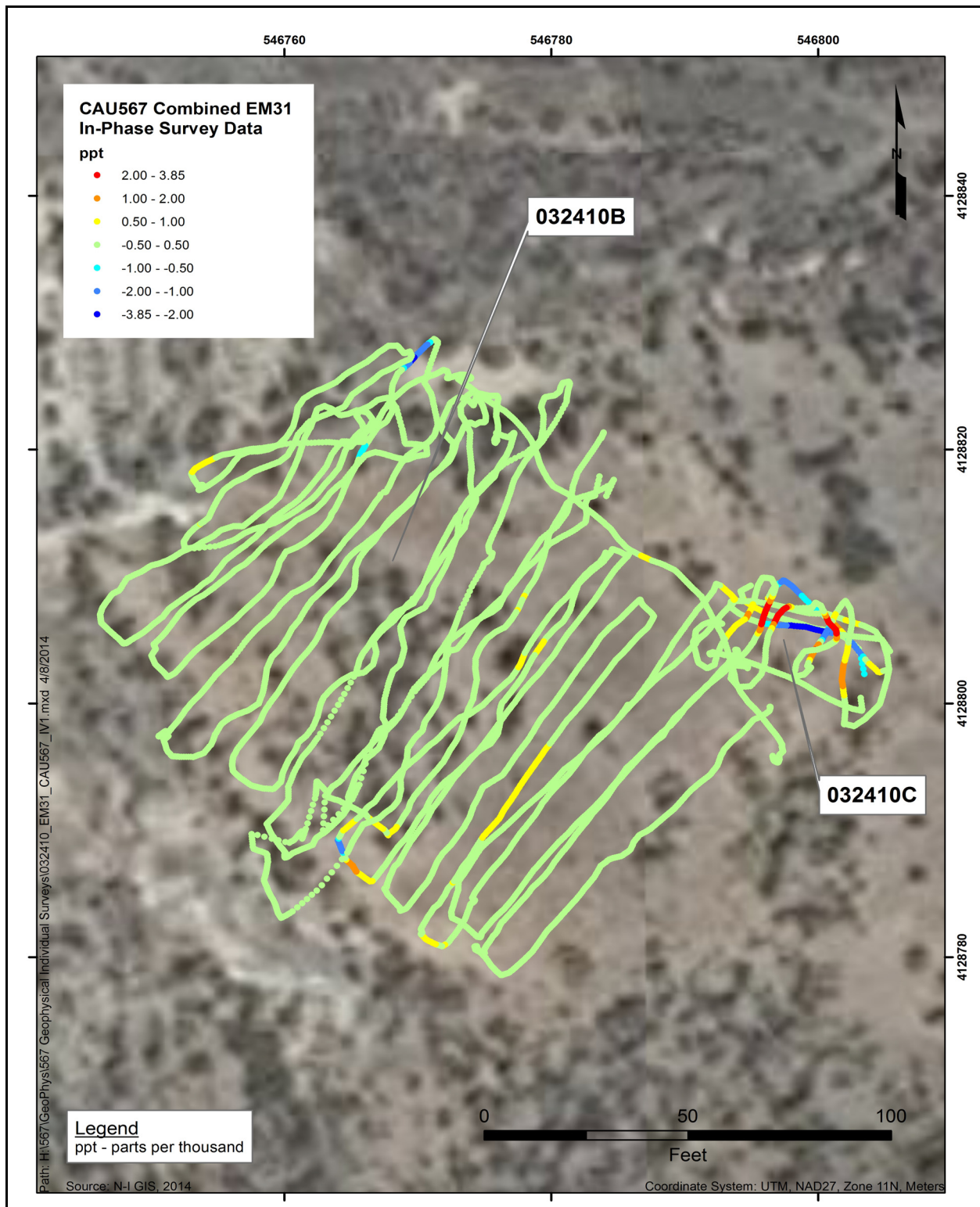


Figure G.4-34
Paths Walked for the EM31-MK2 Surveys at Colby Mud Spill

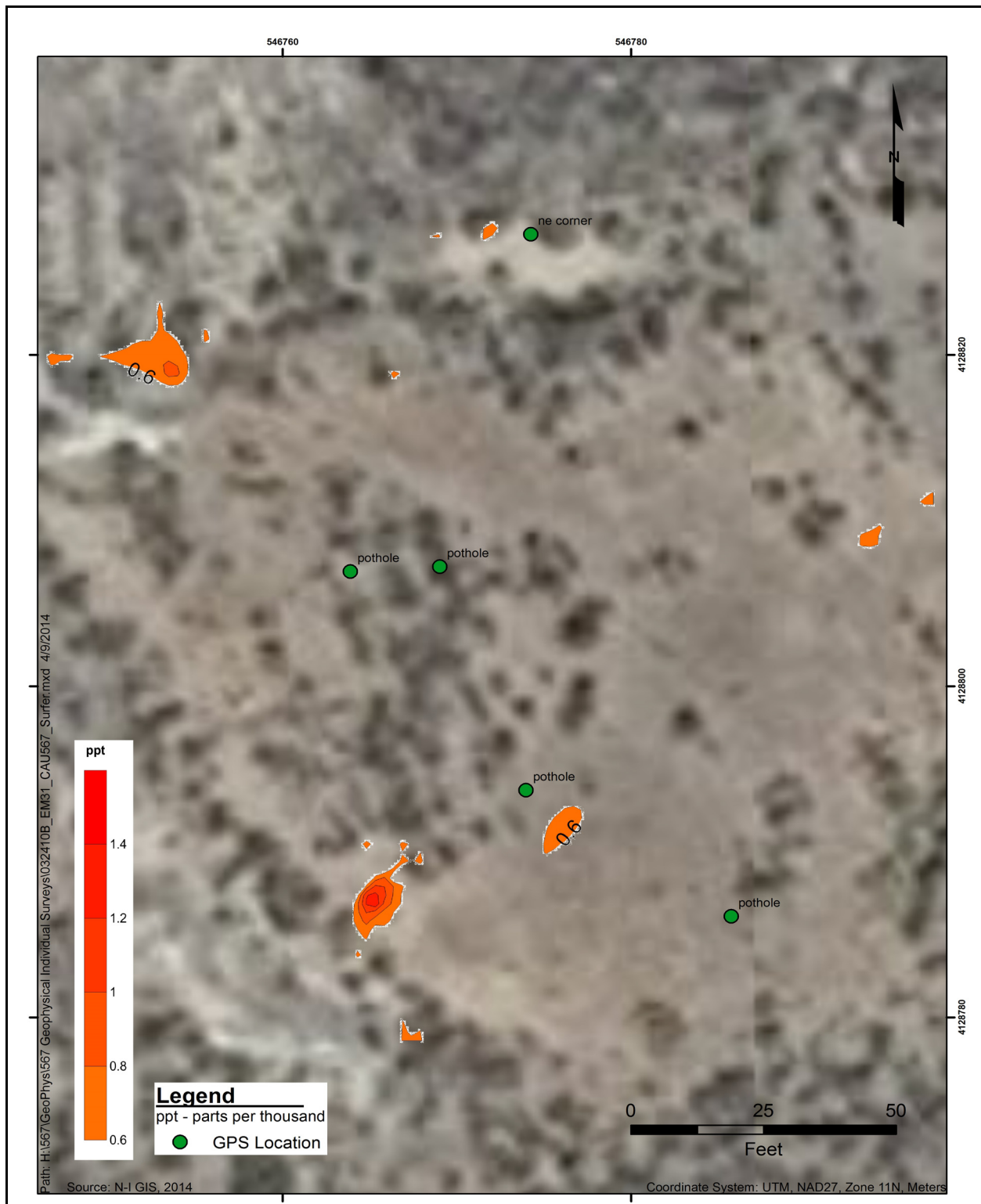


Figure G.4-35
Contoured Results of the EM31-MK2 Survey at the Mud Disposal Area

Small Mound

Figure G.4-36 provides a contoured representation of the EM31-MK2 in-phase survey data for the small mound adjacent to the mud disposal area. Pieces of metal are exposed at the surface at the eastern end of the mound. The data represented are from file 032410C. The figure shows points of higher in-phase response. Metal is clearly present in the mound through observation of pieces exposed at the surface and the in-phase response values shown here. However, the data do not indicate a continuous disposal area with significant amounts of metal. The data do indicate a half-dozen pieces of scattered metal.

G.4.3.2 Results Using the EM61-MK2A Four-Channel High-Sensitivity Metal Detector

The surveys completed with the EM61-MK2A were conducted March 24, 2014. Table G.4-13 summarizes the survey files collected using the EM61-MK2A and provides comment on each. The coils of the EM61-MK2A were mounted on wheels, as shown in Figure G.2-2.

Two separate surveys, identified as 032413B and 032413C, were required to complete the survey of the mud disposal area due to a temporary loss of GPS coverage during the 032413B survey. The survey of the small mound adjacent to the mud disposal area was captured in a single file (i.e., 032413D.r61). The paths walked for each survey are shown in Figure G.4-37. The lines walked for the surveys are generally parallel. Deviations in the lines are due to the presence of vegetation that the instrument had to be wheeled around. In addition to the survey files, additional files recorded the pre- and post-survey daily instrument check data.

Figure G.4-37 shows the instrument channel 1 response at each data point. The figure shows that somewhat elevated instrument responses were detected with both surveys. The data from the mud disposal area and small mound are discussed further below with the presentation of the contoured data for each survey.

Mud Disposal Area

Figure G.4-38 provides a contoured representation of the EM61-MK2A channel 1 survey data for the mud disposal area. The data represented are from files 032413B and 032413C. The figure shows only one prominent area of somewhat elevated channel 1 instrument response, which is located in the

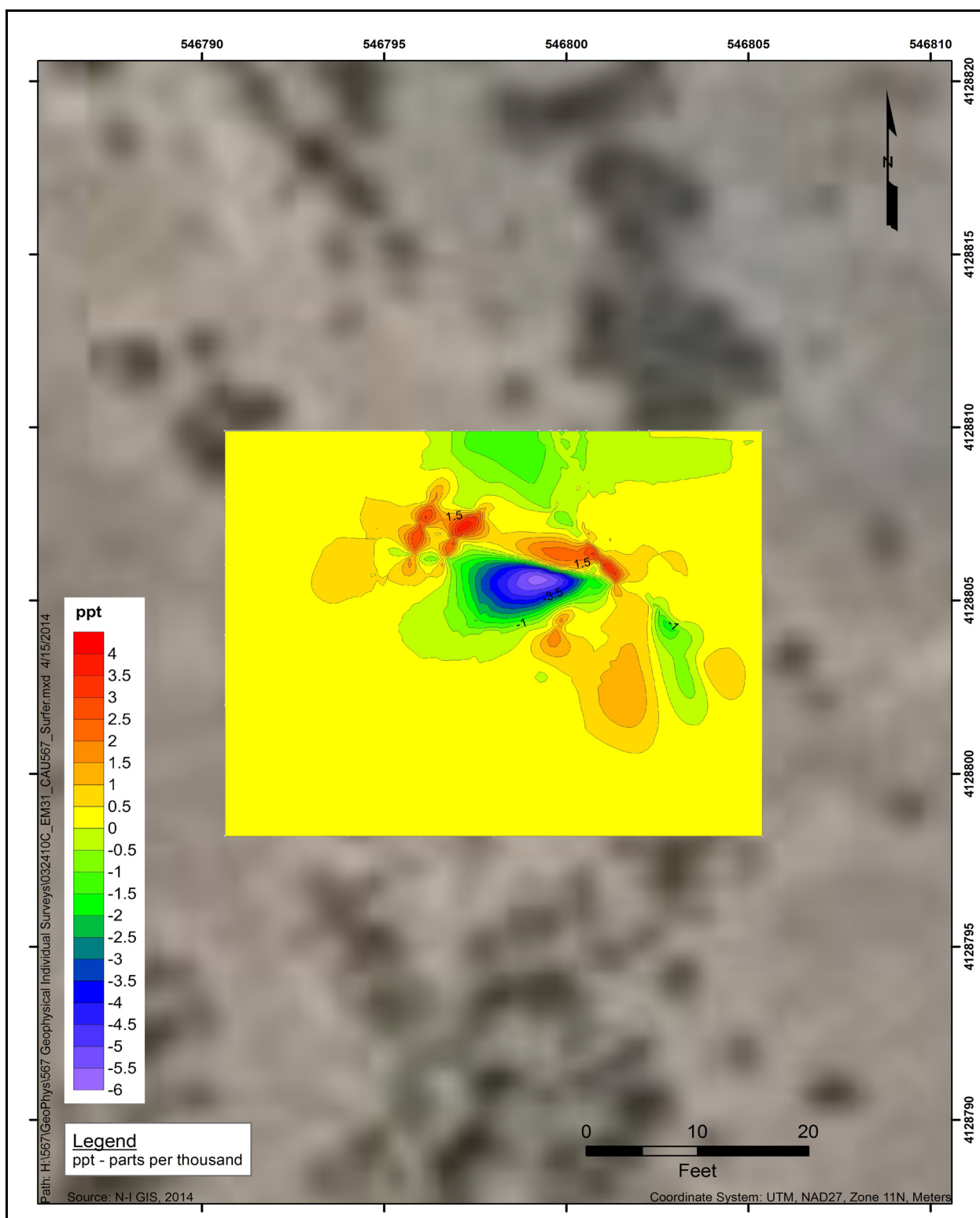


Figure G.4-36
Contoured Results of the EM31-MK2 Survey at the Small Mound

Table G.4-13
Summary of Data Files Collected at Colby Mud Spill Using the EM61-MK2A

Raw Data File	Date	Comment
032413A.r61	03/24/2014	Pre-survey equipment checks (static and with test bolt)
032413B.r61	03/24/2014	Mud disposal area survey segment
032413C.r61	03/24/2014	Mud disposal area survey segment
032413D.r61	03/24/2014	Small mound survey
032413E.r61	03/24/2014	Post-survey equipment checks (static and with test bolt)
CAU567_GPS_Master_Points.xlsx	Various	Table of locations/objects surveyed

southwestern corner of the area surveyed. In addition, there are several other lower amplitude responses. The values are generally low. The few points where the response values are somewhat higher are indicative of scattered small pieces of metal.

Small Mound

Figure G.4-39 provides a contoured representation of the EM61-MK2A channel 1 survey data for the small mound adjacent to the mud disposal area. Pieces of metal are exposed at the surface at the eastern end of the mound. The data represented are from file 032413D. The figure shows points of elevated in-phase response. Metal is clearly present in the mound through observation of pieces exposed at the surface and the channel 1 response values shown here. However, the data do not indicate a continuous disposal area with significant amounts of metal. The data do indicate a half-dozen pieces of scattered metal.

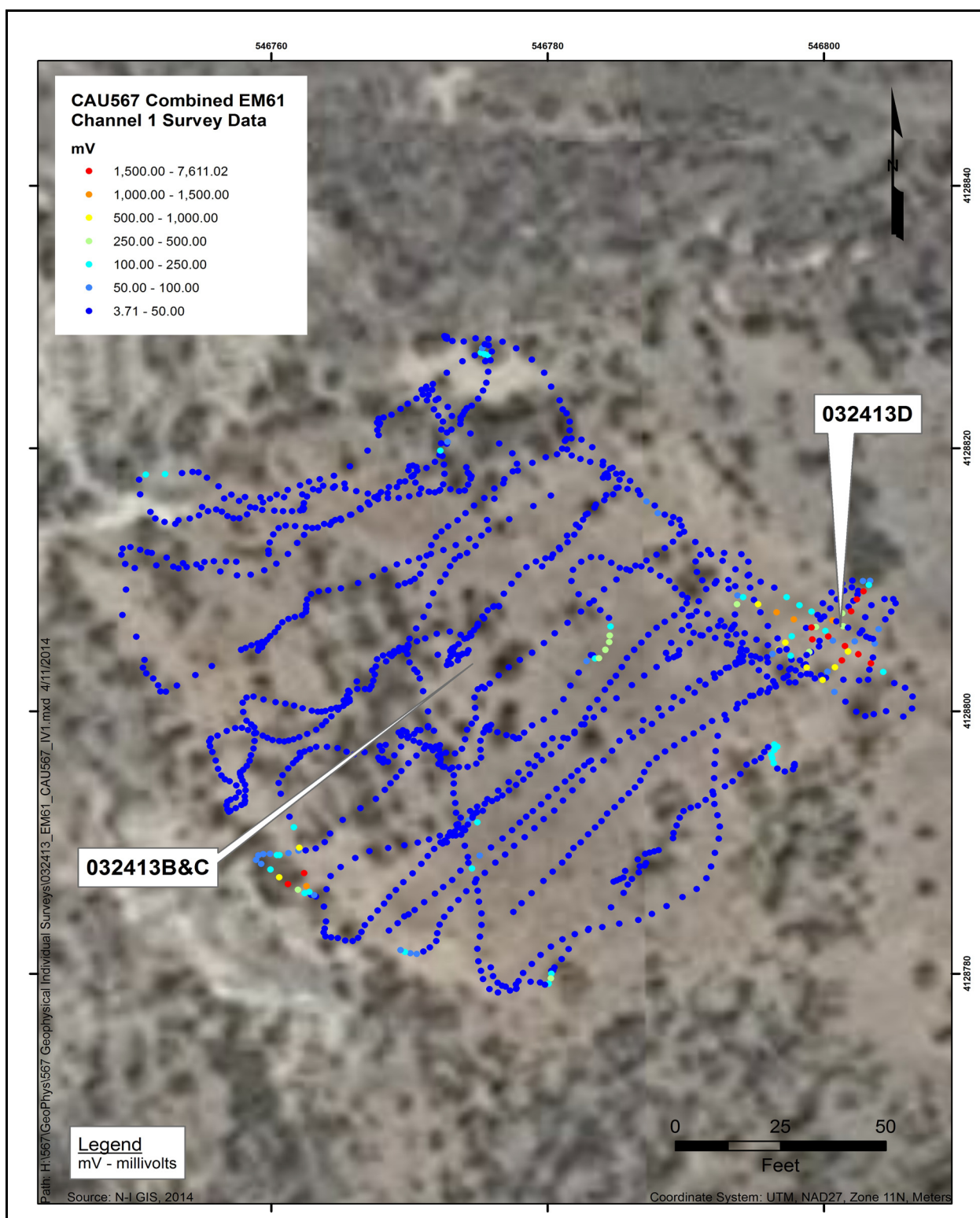


Figure G.4-37
Paths Walked for the EM61-MK2A Surveys at Colby Mud Spill

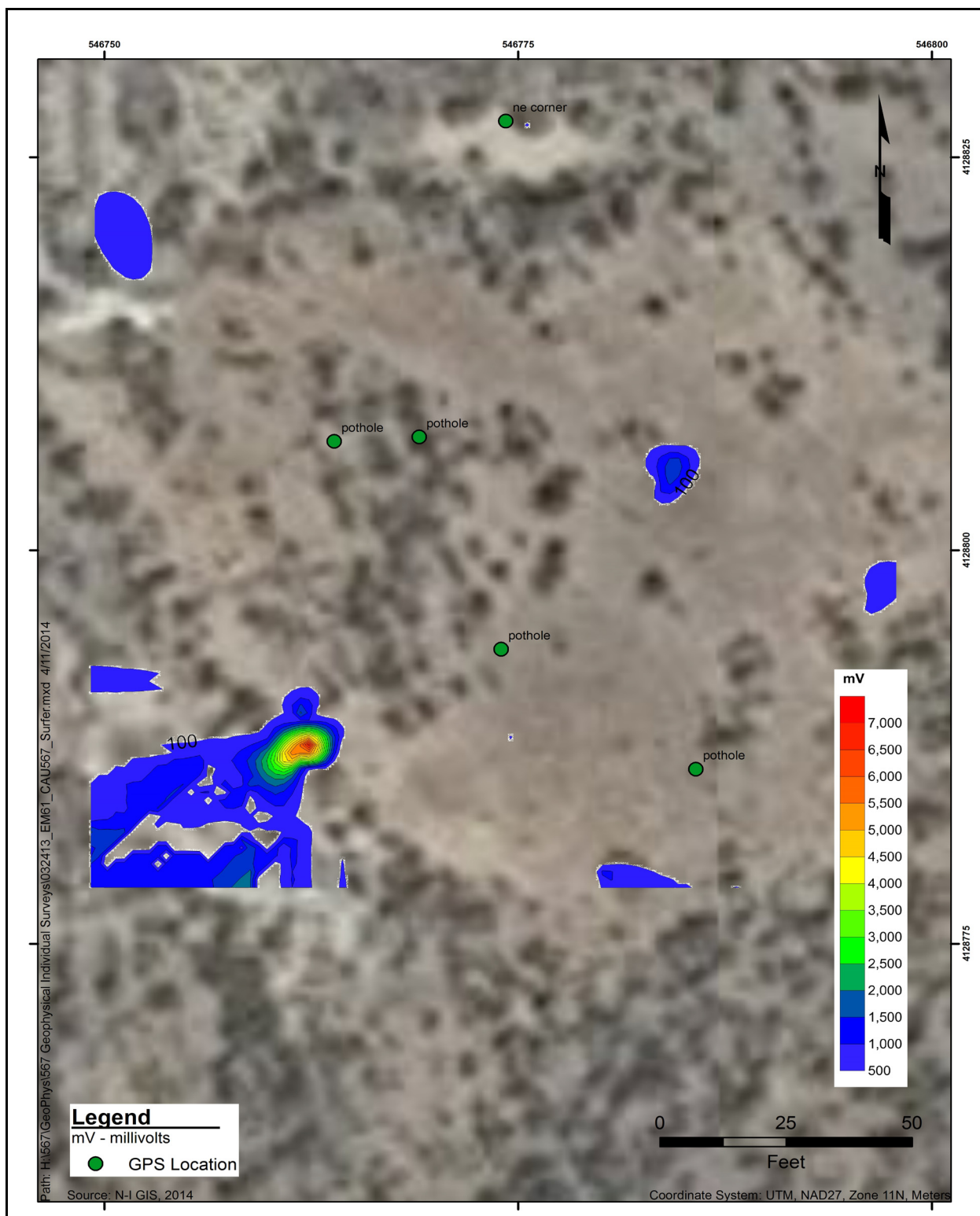


Figure G.4-38
Contoured Results of the EM61-MK2A Survey at the Mud Disposal Area

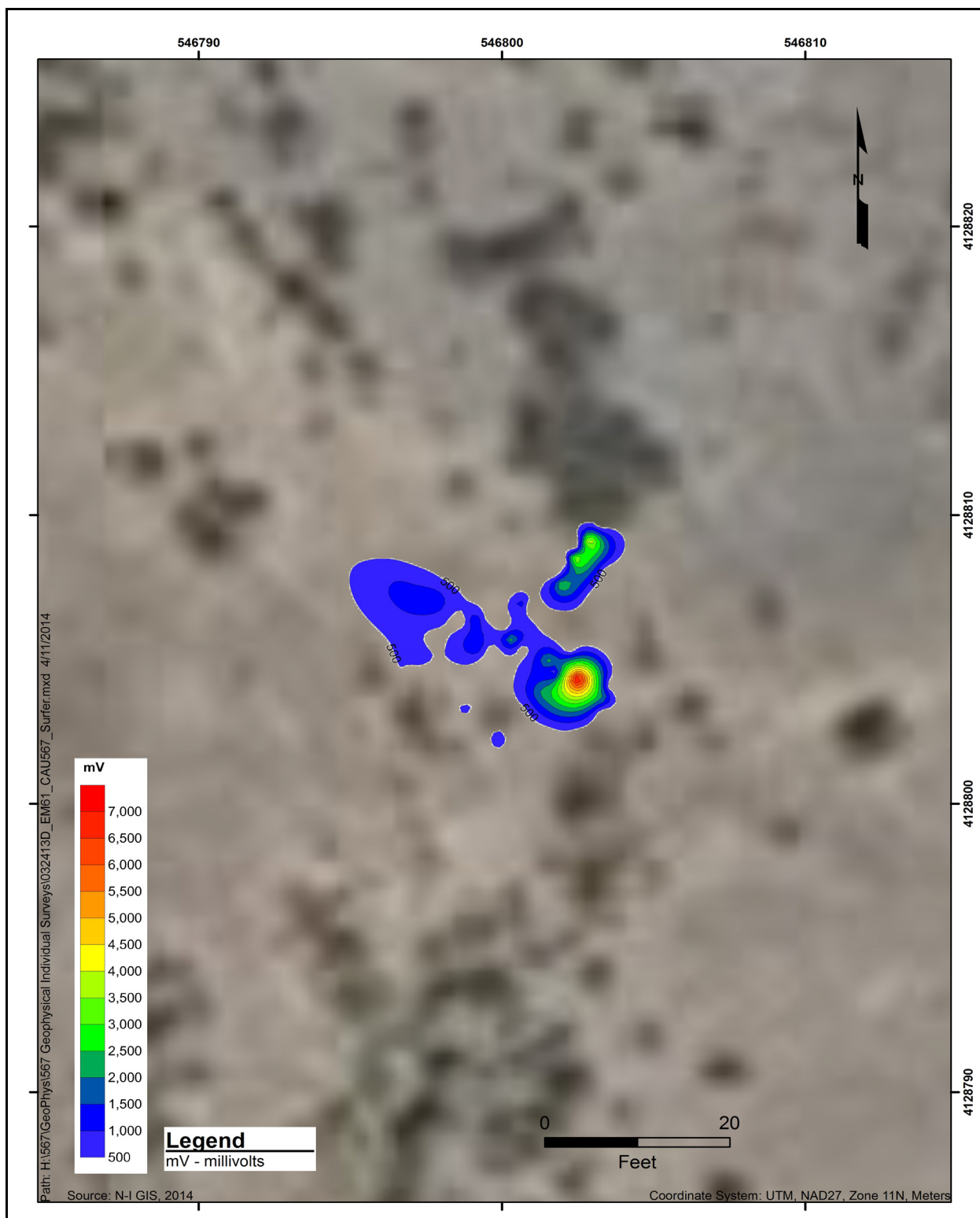


Figure G.4-39
Contoured Results of the EM61-MK2A Survey at the Small Mound

G.5.0 Conclusions

Geophysical surveys were conducted at three CASs in CAU 567. The three CASs are geographically separated with CAS 01-23-03 (Atmospheric Test Site T-1) in Yucca Flat, CAS 05-23-07 (A5b RMA) in Frenchman Flat, and CAS 20-23-08 (Colby Mud Spill) in Pahute Mesa.

At all but one site (CWD #4 at Atmospheric Test Site T-1), both the EM31-MK2 and the EM61-MK2A were used to conduct the surveys over generally the same areas. At CWD #4, only the EM31-MK2 was used to conduct the surveys. In all cases, there was strong agreement between the results from both instruments, although the EM61-MK2A generally provides a more detailed and focused response.

No significant accumulations of buried metal were detected at any of the areas investigated. The anomalies that could represent a landfill, principally those detected in the main area surveyed at CWD #3, are readily explained by observations at the surface (i.e., bunker and vault).

Numerous instrument responses appear to be due to metallic debris observed at the surface. However, this assumption cannot be verified unless the debris is removed and another survey completed.

G.6.0 References

ESRI. 2012. *ArcMap Version 10*. Available at <http://www.esri.com/software/arcgis>.

Geonics Limited, see Geonics.

Geonics. 2012. *Electromagnetic Geophysical Instrumentation*. Available at <http://geonics.com>.

Golden Software. 2012. *Surfer Version 11*. Available at
<http://www.goldensoftware.com/products/surfer/surfer.shtml>.

N-I GIS, see Navarro-Intera Geographic Information Systems.

Navarro-Intera Geographic Information Systems. 2014. ESRI ArcGIS Software.

Appendix H

Nevada Division of Environmental Protection Comments

(8 Pages)

Nevada Environmental Management Operations Activity

DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 567: Miscellaneous Soil Sites, Nevada National Security Site, Nevada	2. Document Date:	10/23/2014
3. Revision Number:	0	4. Originator/Organization:	Navarro-INTERA
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	6. Date Comments Due:	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, 702-486-5850 ext. 232 and 237	9. Reviewer's Signature:	

10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Executive Summary, Page ES-2, 2nd Paragraph		2nd Sentence: Clarify here briefly why the Remote Work Area exposure scenario was selected for Atmospheric Test Site T-1 (i.e., currently being actively used as a training facility).	Added information to clarify usage at all sites. Sentences now read: Atmospheric Test Site T-1 is currently used as a training facility with personnel present approximately 24 days per year; therefore, the radiological FAL was established based on the Remote Work Area exposure scenario (336 hours of annual exposure). For the remaining sites, where regular activities are not conducted, the radiological FAL was established based on the Occasional Use exposure scenario (80 hours of annual exposure).	Yes
2.) Section A.3.1.2, Page A-15, 1st Paragraph		Add the location (i.e., page ranges) in App. G where the results are presented for this CAS.	Added callout to the Section and Figures where geophysical results are presented.	Yes
3.) Section 2.1.1, Page 11, 3rd Paragraph		2nd Sentence: Reference is made elsewhere (i.e., Table 1-1, 2.2.1.1, App. D) to a "bunker", but this feature is not depicted in any figures. Is this the same location as "GZ"? Clarify.	References to the bunker throughout the document were changed to indicate it is located at test GZ. Affected pages: 3, 10, 12, 18, 24, 26, A-1, A-45, B-10, B-11, B-13, C-1, Use Restriction Form.	Yes
4.) Section A.3.3.3, Page A-41, 1st Paragraph		2nd Sentence: Change from "...will decay..." to "is predicted to decay"; 3rd Sentence: change "us currently" to "is currently".	Comment incorporated as suggested.	Yes
5.) Section A.3.3.4, Page A-41, 1st Paragraph		3rd Sentence: before "Cr(VI)" add the phase, "hexavalent chromium" for first use.	Cr(VI) is defined at first use on page 17. No change was made to the document.	Yes

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6.) Section A.3.4, Page A-43, 2nd Paragraph		2nd Sentence: "minimum criteria of 0.8...". Clarify whether this criteria was set forth in RCRA or in DQOs. 3rd Sentence: add brief explanation of the statistical plot inset in Figure A.3-6; 3rd Sentence: Add "FFACO" to "UR"; 4th Sentence: provide a brief explanation of how the volume of contaminated material was estimated. Last sentence: Add "FFACO" to "UR".	2nd sentence changed to read: ...the minimum criteria of 0.8 as set forth in the DQOs using methods defined in the Soils RBCA document (NNSA/NFO, 2014). 3rd sentence: Added before the 3rd sentence: "The inset chart in Figure A.3-6 shows the LCL of this correlation (as described in Section A.2.5)." Additional text was also added to Section A.2.5, after the last paragraph, related to this correlation: "These uncertainties were used to conservatively establish corrective action boundaries and administrative UR boundaries by using the 95 percent lower confidence limit (LCL) of the regression correlation as described in the Soils RBCA document (NNSA/NFO, 2014)." Added the following text after the 4th sentence: This estimate is based on assumed depth of the excavation to be 1 ft. bgs within the 9.77 multiples of background isopleth and at a height of 10 ft within the area of the DCB to include the bunker and debris. "FFACO" added before "UR" in 3rd and last sentence.	Yes
7.) Figure A.3-6, Page A-44		Three sets of boundary lines are depicted in red, making interpretation difficult; suggest revise presentation for clarity.	Changed color of boundary lines as suggested, also changed color of boundaries on Figures A.3-2 and A.3-7 for consistency.	Yes

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8.) Section A.3.4, Page A-45, 1st Paragraph		Last sentence: provide a brief explanation of how the volume of contaminated material was estimated.	Added the following sentence: "This estimate is based on the area of the DCB at a height of 10 ft to include the bunker and debris."	Yes
9.) Section A.3.5, Page A-45, 1st Paragraph		2nd Sentence: add brief explanation of the statistical plot inset in Figure A.3-7.	Added to the end of the 2nd and before the 3rd sentence: "as described in Section A.2.5. The inset chart in Figure A.3-7 shows the LCL of this correlation (as described in Section A.2.5)." Additional text was also added to Section A.2.5, after the last paragraph, related to this correlation: "These uncertainties were used to conservatively establish corrective action boundaries and administrative UR boundaries by using the 95 percent lower confidence limit (LCL) of the regression correlation as described in the Soils RBCA document (NNSA/NFO, 2014)."	Yes
10.) Section A.4.1.2, Page A-47, 1st Paragraph		1st Sentence: insert "and" after "published"; also provide time frame when TRS was conducted.	Comment incorporated as suggested, noted that preliminary investigation was conducted in 2012.	Yes
11.) Section A.5.0, Page A-54, 1st Paragraph		2nd Sentence: after "fragments" add "and vaporized" IAW with Table 1-1.	Comment incorporated as suggested.	Yes
12.) Section A.5.1.2, Page A-54, 1st Paragraph		Add the location (i.e., page ranges) in Appendix G where the results are presented for this CAS.	Added callout to the Section and Figures where geophysical results are presented.	Yes

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10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
13.) Section A.5.4, Page A-63, 1st Paragraph		1st Sentence: verify the reference to Section 8.3.1. in final CAIP is correct.	Verified that the reference is correct per the ROTC. No change was made to the document.	Yes
14.) Section A.5.5, Page A-65, 1st Paragraph		Last sentence: add "using TRS" after "determined".	Added "using TRSs, soil samples, and TLD samples."	Yes
15.) Section A.6.1.2, Page A-66, 1st Paragraph		Add the location (i.e., page ranges) in Appendix G where the results are presented for this CAS.	Added callout to the Section and Figures where geophysical results are presented.	Yes
16.) Figure A.6-1, Page A-68		Figure 2-5 of CAIP shows two areas designated as URMA, while this figure shows one; add Colby GZ (U-20aa) to this figure.	Added URMA demarcation and ground zero to figure as suggested.	Yes
17.) Figure A-6.2, Page A-70		Add Colby GZ and URMA boundaries; modify the figure to show the general extent and direction of the spill flow.	Added URMA demarcation, ground zero, and extent of spill to figure as suggested.	Yes
18.) Section A.6.3, Page A-69, 2nd Paragraph		The information in this paragraph appears to refer to Atmospheric Test T-1, not Colby. Verify.	Updated callouts to refer to correct sections.	Yes
19.) Section A.7.1.2, Page A-76, 1st Paragraph		4th Sentence: estimate volume of soil removed.	Comment incorporated as suggested.	Yes
20.) Figure A.7-1, Page A-77		Add RMA demarcation IAW with Figure 2-6 CAIP; consider adding it in following figures as appropriate for spatial reference.	RMA demarcation added to Figures A.7-1, A.7-2, A.7-3, and A.7-4	Yes

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21.) Figure A.7-3, Page A-79		In figure title add, "after Second Excavation" following "Final TRS".	Comment incorporated as suggested.	Yes
22.) Section A.7.3, Page A-83, 1st Paragraph		The information in this paragraph appears to refer to Atmospheric Test T-1, not J-11 RMA. Verify.	Updated callouts to refer to correct sections.	Yes
23.) Section C.1.6, Page C-8, 2nd Paragraph		1st Sentence: suggest replace "All sampled locations..." with "The only sampled locations...". 2nd Sentence: suggest remove the speculative phase, "on the unrealistic but". 2nd Sentence: is the scenario for A06 being cited just an example? Clarify.	Edits made to first and second sentences as suggested. Reference to Location A06 was changed to A02, which is the maximum calculated dose.	Yes
24.) Section C.1.7, Page C-10, 1st Paragraph		3rd Sentence: clarify the assertion that "remediation to... is not appropriate" to established CAA selection factors in Appendix E.	Reworded sentence: "Because Cr(VI) concentrations at Atmospheric Test Site T-1, A5b RMA, and Colby Mud Spill, and the radiological contamination at Atmospheric Test Site T-1 exceed their corresponding PALs, and the industrial use exposure scenarios used to establish the PALs are not representative of actual or projected land use at these sites, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate."	Yes
25.) Section C.1.7, Page C-11, 1st Paragraph		2nd Sentence: redundant, exposure over time is mentioned parenthetically in preceding sentence.	Deleted sentence	Yes

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26.) Section C.1.7, Page C-11, 1st Paragraph		3rd Sentence: suggest replace "few hours" with the quantitative estimates cited in C.1.10.	Changed "only a few hours" to "a maximum of 240 hr/yr"	Yes
27.) Section C.1.10, Page C-11, 3rd Paragraph		The document is mostly unclear about what CTOS is, how it is and will be used; how exposures will be controlled; and what organization(s) will be responsible for these issues after FFACO closure. We suggest using this section (or other) to expand on this within the context of current and projected land use and the potential exposed populations mentioned in last sentence.	Added the following sentence to the paragraph: "Activities related to the CTOS program include the use of Atmospheric Test Site T-1 to provide a training scenario using the residual radioactivity from the four tests conducted there to provide trainees with real conditions involving contaminated soil, steel fragments, and radioactive glass."	Yes
28.) Section C.1.10, Page C-12, 4th Paragraph		Because CTOS is an active training site, it may be appropriate to mention a fourth category of those potentially exposed to contamination, i.e., 'exercise participants', 'members of the public', i.e. number of students, time on site, allowable TED, etc., although these exposures are assumed to be lower than for "site workers".	The following category was added: "CTOS Exercise Participant: Emergency response professionals from around the country attend training sessions provided by CTOS. These individuals typically attend a week-long training session, with most training occurring in a classroom setting or at other sites. Each attendee typically spends less than 10 hours at Atmospheric Test Site T-1."	Yes

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10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
29.) Section C.1.10, Page C-13, 1st Paragraph		1st Sentence: FFACO UR figure in Appendix D, and Figure 3-2 in CAIP show trailers and related site infrastructure and development inside or very near the FFACO UR and CAIP DCB, implying occupancy or use within in or very near areas potentially exceeding Tier 1 action levels. Clarify.	Paragraph reworded as follows: "Under the current land use at Atmospheric Test Site T-1, the most exposed worker would be the CTOS worker, who could be exposed to site contamination for up to 240 hr/yr (Table C.1-3). Under an unrealistic but worst-case assumption that this most exposed worker were to remain at the location of the maximum dose outside the DCB for the entire maximum estimated time spent at the site (240 hr/yr), this worker could receive a maximum potential dose of 26.09 mrem/yr."	Yes
30.) Section C.2.0, Page C-16, 3rd Paragraph		2nd Sentence: the word "at" is not correct.	Deleted word "at"	Yes
31.) Section D.1.1, Page D-1, 1st Paragraph		"Site Controls" section of UR Info sheet appears to exempt activities conducted under 10 CFR 835; clarify why this exemption was cited and what are some of the more likely types of activities involved.	Added the following paragraph after the 1st paragraph: "TThese URs were established based on the potential for a site worker to receive an inadvertent dose (assumes no radiological training or protective measures). The URs are not applicable to activities conducted under a program compliant with 10 CFR 835 (CF4, 2014) where the radiological hazards are well-defined, controls are implemented to protect workers from the radiological hazards, workers have received radiological training, and all activities are conducted under a radiological control plan."	Yes

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32.) Section Appendix D, Pages 1 of 3, URI		Should read "total effective dose - TED"; reference should be made to Remote Work Area: 25mm per Remote Work Area year (mrem/RMO-yr).	Added "RW" when talking about action level.	Yes
33.) Table E.1-2, Pages E-8, 9		Decision Factor 3, 2nd column: clarify that no new or additional fencing is proposed for either FFACO or Admin UR.	Removed reference to fencing.	Yes

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