Nevada
Environmental
Restoration
Project

DOE/NV--761

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada

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Revision No.: 0

November 2001

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CORRECTION ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 487: THUNDERWELL SITE, TONOPAH TEST RANGE, NEVADA

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

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CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 487: THUNDERWELL SITE, TONOPAH TEST RANGE, NEVADA

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List of Acronyms and Abbreviations

CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CLP	Contract Laboratory Program
COC	Contaminant of concern
COPC	Contaminant of potential concern
CR	Closure Report
CRDL	Contract-required detection limit
DOE	U.S. Department of Energy
DQO	Data quality objective
DQI	Data quality indicators
DU	Depleted uranium
EPA	U.S. Environmental Protection Agency
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level(s)
FSR	Field-screening results
ft	Foot (feet)
GPS	Global positioning system
HE	High explosives
HWAA	Hazardous waste accumulation area
ICP	Inductively coupled plasma
IDL	Instrument detection limit
in.	Inch(es)
ITLV	IT Corporation, Las Vegas

List of Acronyms and Abbreviations *(Continued)*

LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MDL	Method detection limit
mg/kg	Milligram per kilogram
mi	Mile
MRL	Minimum reporting limit
MS/MSD	Matrix spike/matrix spike duplicate
NDEP	Nevada Division of Environmental Protection
NIST	National Institute for Standards and Technology
NNSA	National Nuclear Security Administration
PAL	Preliminary action level(s)
PB	Penetration blank
PETN	Pentaerythritol tetranitrate
pCi/g	Picocurie per gram
ppm	Part per million
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	*Resource Conservation and Recovery Act*
RPD	Relative percent difference
SDG	Sample delivery group
SNL/NM	Sandia National Laboratories, New Mexico
SVOC	Semivolatile organic compound(s)
TTR	Tonopah Test Range
TPU	Total propogated uncertainties
VOC	Volatile organic compound

List of Acronyms and Abbreviations *(Continued)*

%R	Percent recovery
µg/kg	Micrograms per kilograms

Executive Summary

This Corrective Action Decision Document/Closure Report has been prepared for Corrective Action Unit (CAU) 487: Thunderwell Site, Tonopah Test Range, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO, 1996). This CAU is located within the Tonopah Test Range, Nevada.

Corrective Action Unit 487 is comprised of the following Corrective Action Site (CAS):

- CAS RG-26-001-RGRV; Thunderwell Site

The scope of this Corrective Action Decision Document/Closure Report is to justify and recommend that no further corrective action is required at CAU 487. To achieve this, the following actions are required:

- Review the current site conditions, including the concentration and extent of contamination.
- Document activities performed on subsurface anomalies and place use restriction on areas.
- Document housekeeping activities at surface anomalies.
- Document closure of the rest of the CAU.

On April 2 through May 16, 2001, a corrective action investigation was performed as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada* (DOE/NV, 2001). The following objectives of the corrective action investigation were completed:

- Verify the location of the surface and subsurface anomalies and tubes.
- Identify the presence and the vertical and lateral extent of contaminants of potential concern.
- Remove surface and excavated subsurface debris, radiologically screen, and stockpile the debris for removal.
- Provide sufficient information and data to develop appropriate corrective actions for the CAS.

Analytes detected during the corrective action investigation were evaluated against preliminary action levels to determine contaminants of concern for CAU 487. Assessment of the data generated from corrective action investigation activities indicates the preliminary action levels were not exceeded for total volatile organic compounds, tantalum, lithium, boron, high explosives, isotopic uranium, and gamma spectrometry for any of the soil samples collected from CAU 487. Analysis for total semivolatile organic compounds revealed only one sample exceeded the preliminary action level for the compound bis (2-ethylhexyl) phthalate. Bis (2-ethylhexyl) phthalate is primarily used as a placticizer in products such as teething rings, pacifiers, soft squeeze toys, balls, shower curtains, raincoats, and other products that must stay flexible. It is believed that plastic coating on wire was found at the sample location is responsible for the detection of this constituent. The analysis for total *Resource Conservation and Recovery Act* metals determined that several samples had elevated readings for arsenic that exceeded preliminary action levels. The readings are consistent with native soils for the region. Additionally, several housekeeping activities were completed at surface anomaly locations throughout the site, under best management practices.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office (NNSA/NV), provides the following recommendations.

- No further corrective action is required at CAU 487.
- No Corrective Action Plan is required.
- A Notice of Completion to the NNSA/NV, is requested from the Nevada Division of Environmental Protection for the closure of CAU 487.
- Corrective Action Unit 487 should be moved from Appendix III to Appendix IV of the *Federal Facility Agreement and Consent Order.*
- A use restriction is required to be placed on two areas at the east and west ends of the site due to the size and extent of subsurface debris at CAU 487.

1.0 Introduction

This Corrective Action Decision Document/Closure Report (CADD/CR) has been prepared for Corrective Action Unit (CAU) 487: Thunderwell Site, Tonopah Test Range (TTR), Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada, the U.S. Department of Energy (DOE), and the U.S Department of Defense (FFACO, 1996). Corrective Action Site (CAS) RG 26-001-RGRV, Thunderwell Site, is the only CAS within CAU 487. Corrective Action Unit 487 is located in the northwest portion of the TTR, Nevada. The TTR is approximately 235 miles (mi) northwest of Las Vegas, Nevada, as shown in Figure 1-1. The location of CAU 487 within the TTR is shown in Figure 1-2.

The CADD and CR have been combined into one report because no further action is recommended for this site. Sample data collected during corrective action investigation indicate that a contaminant of concern (COC), bis (2-ethylhexyl) phthalate, was present in the soils exceeding regulatory action levels at one location at the site. Arsenic exceeded regulatory action levels throughout the site. The CADD/CR provides or references the specific information necessary to recommend the “no further action” alternative for the CAS within CAU 487 with the exception of the two areas where large quantities of subsurface debris exists. At those locations, a use restriction will be placed on the areas to allow Nevada Division of Environmental Protection (NDEP) to regulate the activities proposed in the future.

1.1 Purpose

The Thunderwell Site was used for a series of tests conducted by Sandia National Laboratories in New Mexico (SNL/NM) in the early to mid-1960s. The tests consisted of explosives detonated at the bottom of large cylindrical steel tubes approximately 15 to 50 feet (ft) in length; 2, 4, and 6 ft in diameter; and constructed of 1/2-inch (in.) thick steel. Process knowledge indicates that at least one of the tests units contained depleted uranium (DU). It was stated that metals such as tantalum, lithium, and boron were also possibly used during the tests. Additional information relating to the site history, planning, and scope of the investigation is presented in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 2001) and will not be repeated in this report.

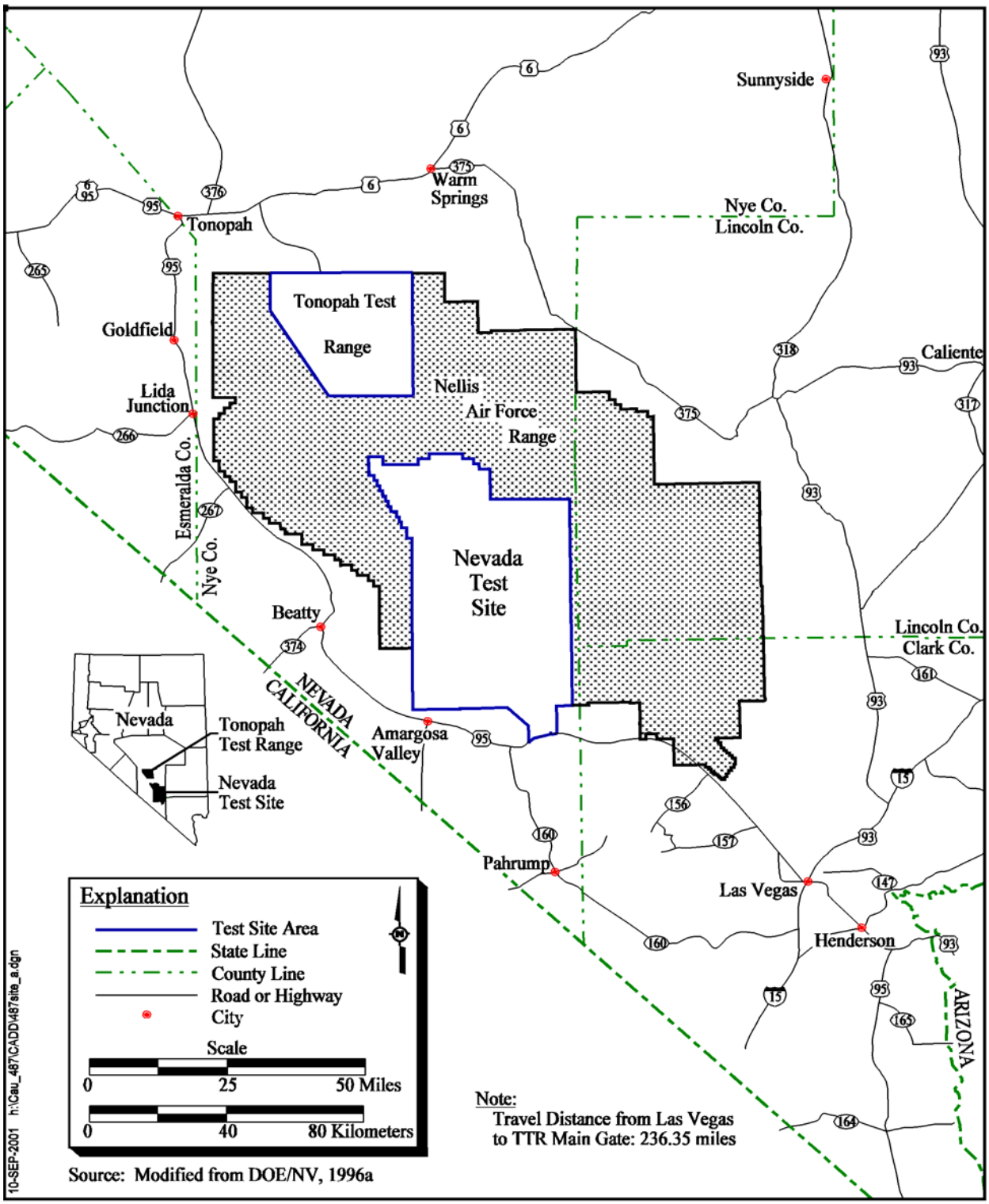

Figure 1-1
Tonopah Test Range Location Map

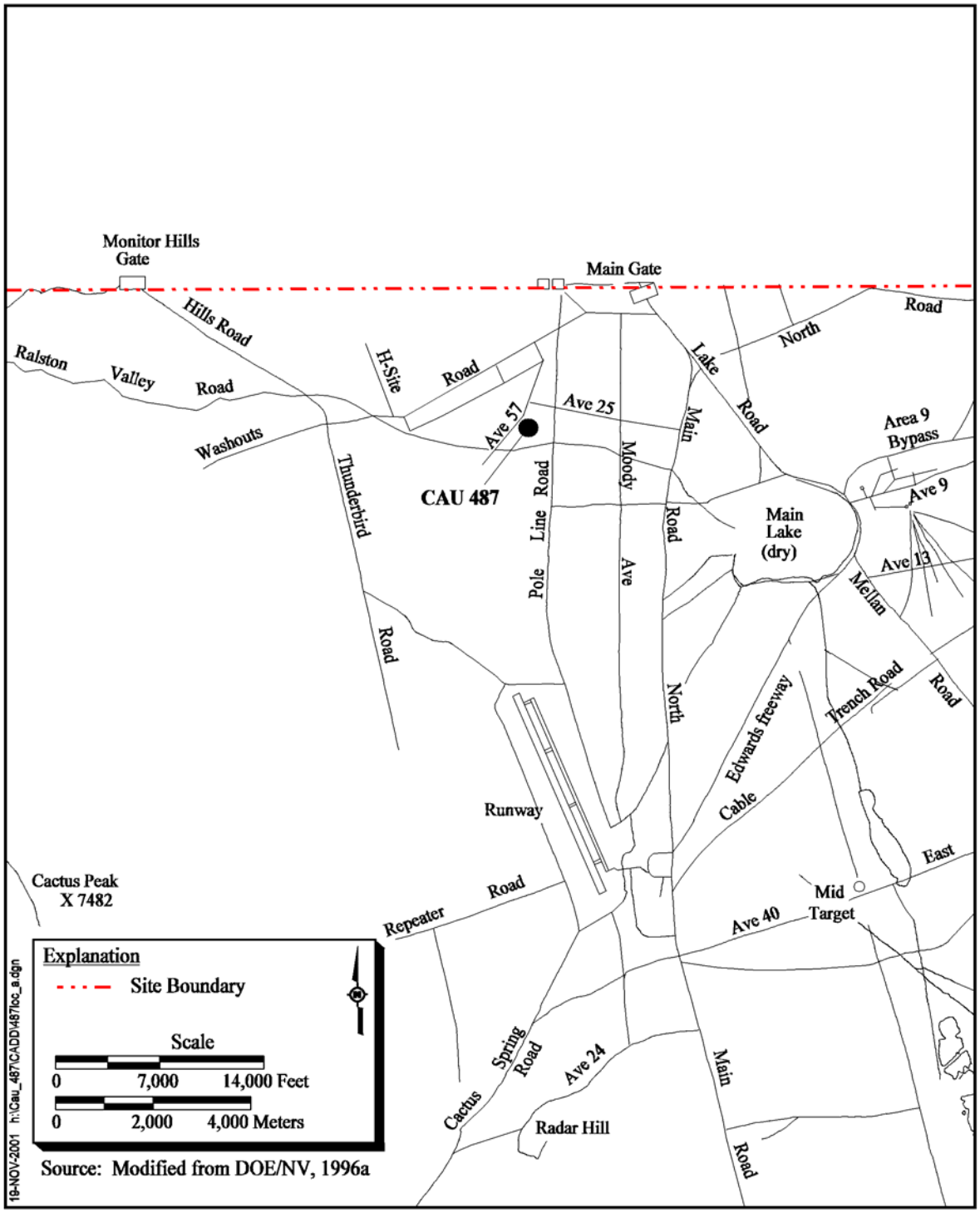

Figure 1-2
Location of CAU 487 at Tonopah Test Range

This CADD/CR provides justification for the closure of CAU 487 without further action. This justification is based on process knowledge and the results of investigative activities conducted in accordance with the *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada* (DOE/NV, 2001). The corrective action investigation report is provided in Appendix A.

A use restriction has been applied to two areas within the CAU to restrict any subsurface activity that may alter or modify the designated areas. The remainder of the site will merit the "no further action" alternative because no significant contamination was found at the site.

1.2 Scope

The scope of this CADD/CR is to justify and recommend that no further corrective action is required at CAU 487. To achieve this scope, the following actions were implemented:

- Review the current site conditions, including the concentration and extent of contamination.
- Justify the application of the a use restriction at two locations at CAU 487 so that further activities at those locations will require notification to NDEP prior to implementation.
- Document Notice of Completion and closure of CAU 487.

1.3 CADD/CR Contents

This CADD/CR is divided into the following sections:

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

Section 2.0 - Corrective Action Investigation Summary: summarizes the investigation field activities, the results of the investigation, and the justification for no further action.

Section 3.0 - Recommendation: recommends no further action and closure of CAU 487 with a use restriction placed on two areas.

Section 4.0 - References: provides a list of all referenced documents.

Appendix A: *Corrective Action Investigation Report for CAU 487: Thunderwell Site, Tonopah Test Range, Nevada*: provides a description of the project objectives, field investigation and sampling activities, investigation results, and quality assurance.

Appendix B: Data Assessment: summarizes the investigation results as they meet the requirements set forth during the data quality objective (DQO) process.

Appendix C: Risk Assessment: identifies the risk associated with this site based on investigation and analytical results.

Appendix D: Soil Boring Logs: provides a geological and physical representation of each borehole drilled during the investigation.

Appendix E: Use Restrictions: provides the documents submitted for the use restriction on two areas of the site.

Appendix F: Documentation of Housekeeping Closure Activities.

Appendix G: Response to NDEP Comments.

All work was performed in accordance with the following documents:

- *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada,* Rev. 0, DOE/NV--676 (DOE/NV, 2001)
- *Industrial Sites Quality Assurance Project Plan* (QAPP), Rev. 1, DOE/NV--372 (DOE/NV, 1996b)
- FFACO (1996)
- *Project Management Plan,* Rev. 0 (DOE/NV, 1994)

2.0 Corrective Action Investigation Summary

The following sections describes the results of the investigation activities conducted at CAU 487. For detailed investigation results, please refer to Appendix A.

2.1 Site-Specific Background Information

A walkover survey was conducted during the preliminary assessment of the site in March 2000. At that time, 16 tubes and depressions consistent with tubes were identified. These locations originally identified were labeled with a "T" for tube and numbered 1-16. In addition, there were 18 anomalies which were not consistent with tubes identified. These locations were labeled with an "A" for anomaly and numbered 1-18.

In July 2000, a geophysical survey was performed at the site to further identify any tubes that may not be visible from the surface. An additional 12 tube-like anomalies were identified and labeled "TA" for tube-anomaly and numbered 1-12. It was determined that any subsurface tubes or tube-anomalies would be excavated to confirm the presence of a tube and then drilled within the tubes.

Corrective action investigation activities were performed as set forth in the CAIP (DOE/NV, 2001) from April 2 through May 16, 2001. During the investigation an additional eight tubes were found using a Shonstadt Magnetometer while locating the global positioning system (GPS) coordinates for subsurface TA locations. After these anomalies were being excavated they were labeled TAs and numbered 13-19.

2.2 Investigation Activities

Excavation activities were performed at anomalies and tube-anomalies located throughout the site. During excavation it was planned that samples from anomaly locations would be submitted for laboratory analysis only if the field-screening results (FSRs) exceeded field-screening levels (FSLs) or if extensive debris or hazardous debris was uncovered. None of the FSRs exceeded FSLs for excavation activities. However, extensive debris was encountered at two locations. As a result, all samples were sent for full suite analysis, which consisted of total semivolatile organic compounds

(SVOCs), total *Resource Conservation and Recovery Ac*t (RCRA) metals, explosives, total volatile organic compounds (VOCs), tantalum, lithium, boron, isotopic uranium, and gamma spectrometry for waste management purposes. Debris that was removable was collected and staged near the anomaly or hazardous waste accumulation area (HWAA) for removal. Housekeeping activities were performed on surface debris. If during excavation activities a tube was not identified at a location, they were excavated to the capacity of the backhoe. If no tube or debris was located, selected locations were drilled to confirm the vertical extent of the disturbed soils.

Surface radiological FSLs were established by collecting 20 samples from undisturbed locations outside the boundaries of the CAS. Background radiological samples were then collected from a boring located in two undisturbed areas of the site to establish subsurface radiological FSLs. Four radiological background samples were submitted for isotopic uranium and gamma spectrometry confirmatory analyses. Four samples were submitted to the laboratory from these locations for the full suite of analyses. Two boreholes were continuously cored in undisturbed locations and soil core logged to assess site geology.

Locations that contained a tube (tube and tube-anomaly) were drilled using rotary-sonic drilling to collect samples and assess the geology inside the tubes. A common element amongst all tubes was wire, wood debris, and steel plates. All locations were sampled. At locations where refusal was met, samples were collected from soils directly above refusal. Analysis for samples sent to the laboratory were determined based upon FSRs. Samples that did not exceed FSLs were sent to the laboratory for partial suite analysis (total SVOCs, total RCRA metals, and explosives). Samples that exceeded FSLs were sent to the laboratory for full suite analysis (partial suite plus total VOCs, tantalum, lithium, boron, isotopic uranium, and gamma spectrometry). All borehole locations were backfilled using clean fill material or a bentonite plug.

2.3 Results

Results for the activities performed, analytical results, and assessment of DQO criteria are summarized in the following sections.

2.3.1 Analytical Data Summary

The corrective action investigation results indicated the following:

- All total VOCs and high explosives results were below the preliminary action levels (PALs) outlined in the CAIP (DOE/NV, 2001).
- All concentrations for total SVOCs were below the PALs outlined in the CAIP with the exception of bis (2-ethylhexyl) phthalate at one location. The sample collection log and geology borehole log noted that there were plastic covered wires and debris at the interval where the samples were collected. The plastic insulation is believed to be the source of the elevated bis (2-ethylhexyl) phthalate. The sample collected below the exceeded interval had total SVOCs that exceeded minimum reporting limits (MRLs) but did not exceed PALs.
- All concentrations of total RCRA metals and tantalum, lithium, and boron in soil samples were below PALs established in the CAIP (DOE/NV, 2001) except for arsenic. Although the concentrations of arsenic exceeded the PAL, the concentrations are considered representative of ambient conditions for the TTR (NBMG, 1998; Moore, 1999).
- Isotopic uranium results for soil samples are not considered to be statistically different from background based upon a normalized difference from their respective established background levels.
- Gamma spectrometry results for soil samples are not considered to be statistically different from background based upon a normalized difference from their respective established background levels.
- Field-screening results did exceed established field-screening levels at three tube locations. Samples were collected and step out samples were determined in accordance with the CAIP.

2.3.2 Assessment of Data Quality Objectives

The analytical results and evaluation of the conceptual model indicate that the DQOs were met for the site as detailed in the CAIP for CAU 487. A full comparison of the activities and analytical results of the investigation as compared to the DQOs are summarized in Appendix B.

2.4 Justification for No Further Action

Analytical results were evaluated against PALs to determine COCs for CAU 487. Analytical results did not exceed PALs except for arsenic concentrations in several soil samples and bis(2-ethylhexyl) phthalate in one soil sample. Bis(2-ethylhexyl) phthalate is a commonly used

plasticizer found in household and industrial products (i.e., wire casing) (Syracuse, 2000). The concentrations of arsenic are considered ambient at this site (NBMG, 1998; Moore, 1999), and the bis(2-ethylhexyl) phthalate associated with wire debris found in the interval was not above PALs in the sample collected below the affected interval. Therefore, no further corrective action is necessary for this site.

A use restriction will be placed on the two locations where extensive debris remains as shown on Figure A.2-1 and Appendix E. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. There are no hazardous materials associated with the use restriction. There are no annual monitoring or inspection requirements associated with the use restriction.

3.0 Recommendation

Based on the results of the corrective action investigation discussed in Appendix A, no COCs have been identified in the soil at CAU 487 that pose an unacceptable risk to human health or the environment with the exception of specific conditions noted during sample collection or site conditions. Therefore, the NNSA/NV provides the following recommendations:

- No further corrective action is required at CAU 487.
- No Corrective Action Plan is required.
- A Notice of Completion to NNSA/NV is requested from NDEP for the closure of CAU 487.
- CAU 487 should be moved from Appendix III to Appendix IV of the FFACO.
- A use restriction has been placed on two anomalies at CAU 487 because the extent and size of the debris prohibits removal.

4.0 References

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

FFACO, see *Federal Facility Agreement and Consent Order.*

Federal Facility Agreement and Consent Order. 1996 (as amended). Agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M. Todd (SAIC), entitled "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV: IT Corporation.

NBMG, see Nevada Bureau of Mines and Geology.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Prepared by J.V. Tingley, S.B. Castor, S.I. Weiss, L.J. Garside, J.G. Price, D.D. LaPointe, H.F. Bonham, and T.P. Lugaski. Reno, NV.

Syracuse Research Corporation. 2000. *Draft Toxicological Profile for Di (2-Ethylhexyl) Phthalate.* Atlanta, GA: U.S. Dept. of Health and Human Services.

U.S. Department of Energy, Nevada Operations Office. 1994. *Project Management Plan*, Rev. 0. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996a. *Final Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada*, DOE/EIS--243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996b. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 1, DOE/NV--372. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2001. *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada,* Rev. 0, DOE/NV--676. Las Vegas, NV.

Appendix A

Corrective Action Investigation Results for CAU 487: Thunderwell Site, Tonopah Test Range, Nevada

A.1.0 Introduction

This appendix presents the investigation activities and analytical results from the corrective action investigation conducted at CAU 487: Thunderwell Site, Tonopah Test Range, Nevada. CAU 487 consists of one CAS:

- CAS RG-26-001-RGRV, Thunderwell Site

The corrective action investigation was conducted in accordance with the requirements set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada* (DOE/NV, 2001), as developed under the *Federal Facility Agreement and Consent Order* (FFACO, 1996).

The Thunderwell Site was used for a series of tests conducted by SNL/NM in the early to mid-1960s. The tests consisted of explosives detonated at the bottom of large cylindrical steel tubes approximately 15 to 50 ft in length; 2, 4, and 6 ft in diameter; and constructed of 1/2-in. thick steel. Process knowledge indicates that at least one of the tests units contained DU. It was stated that metals such as tantalum, lithium, and boron were also possibly used during the tests. Additional information relating to the site history, planning, and scope of the investigation is presented in the CAIP (DOE/NV, 2001) and will not be repeated in this report.

A.1.1 Project Objectives

The following were the primary objectives for the investigation:

- Excavate anomalies to determine the presence of a tube.
- Identify the lateral and vertical extent of miscellaneous metal debris.
- Drill identified tubes to verify vertical extent and field screen to determine if contamination is present.
- Generate sufficient information and data to develop appropriate corrective actions for the CAS.

The selection of locations for soil sample collection were based on field screening, site conditions, and the strategy devised in the DQO process as outlined in the CAIP (DOE/NV, 2001). Additional

boreholes were drilled and sampled during the site investigation to establish background analytical data at two undisturbed locations outside the site boundaries.

A.1.2 Report Content

This report contains information and data in sufficient detail to support the recommendation for no further action in the CADD/CR. The contents of this report are listed below:

- Section A.1.0 describes the investigation background, objectives, and the report content.
- Section A.2.0 provides information regarding field activities and sampling methods.
- Section A.3.0 summarizes the results of the laboratory analyses from the investigation sampling.
- Section A.4.0 discusses the quality assurance (QA) and quality control (QC) procedures that were followed and the results of the QA and QC activities.
- Section A.5.0 is a summary of the investigation results for CAU 487.
- Section A.6.0 provides the cited references.

The complete field documentation and laboratory data, including Field Activity Daily Logs, Sample Collection Logs, Analysis Request/Chain-of-Custody Forms, soil sample descriptions, laboratory certificates of analyses, analytical results, and surveillance results are retained in the project files.

A.2.0 Field Investigation and Sampling Activities

The CAU 487 field investigation was conducted between April 2 and May 16, 2001. Rotosonic drilling and excavation with a backhoe and an excavator were the methods used to investigate the tubes and subsurface miscellaneous anomalies.

The investigation and sampling program was managed in accordance with the requirements set forth in the CAIP (DOE/NV, 2001). Field activities were performed under an approved site-specific health and safety plan (ITLV, 2001). Samples were collected by following approved protocols and procedures for sample collection, decontamination, chain of custody, shipping, and field screening as indicated in the CAIP (DOE/NV, 2001) and documented using Field Activity Daily Logs, soil boring logs, and sample collection logs. The QC samples (e.g., field blanks, equipment rinsate blanks, trip blanks, and sample duplicates) were collected as required by the CAIP (DOE/NV, 2001), the Industrial Sites Quality Assurance Project Plan (QAPP) (DOE/NV, 1996), and approved procedures.

A.2.1 Site Description

Tonopah Test Range is approximately 240 mi northwest of Las Vegas, Nevada (Figure 1-1). The CAU 487 corrective action investigation was conducted near the intersection of Station 57 Road and Avenue 27, at a location approximately 1 square mile in size (Figure 1-2). Initial investigation locations were based on site visits, geophysical surveys, process knowledge, and interviews with TTR employees.

A.2.2 Investigation Activities

The following is a summary of the corrective action investigation activities specific to each of the different areas within the CAS at this CAU.

This section describes specific drilling, excavation, sampling, and housekeeping information for CAU 487. Figure A.2-1 shows the location of each boring and excavation.

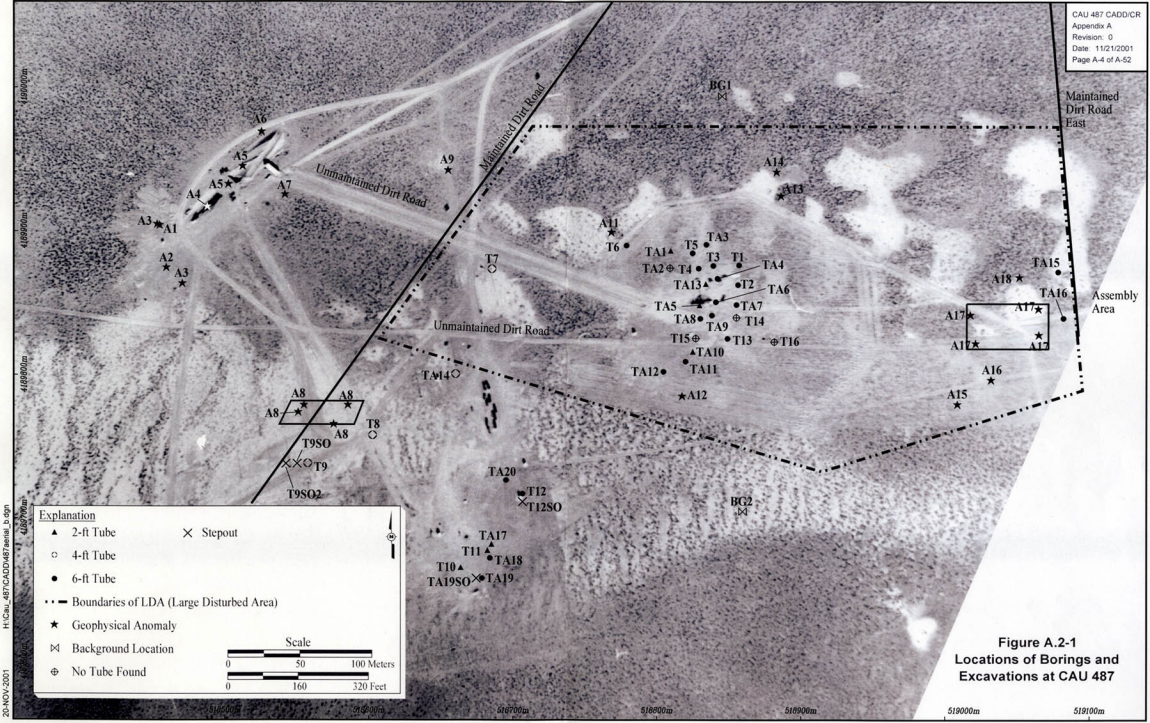

Figure A.2-1
Locations of Borings and Excavations at CAU 487

A.2.2.1 Field Screening

Field screening was performed as specified in the CAIP (DOE/NV, 2001). Samples were field screened for VOCs, alpha/beta-emitting radionuclides, and explosives. Established FSLs were used to guide sample collection and to provide a basis for the selection of additional environmental samples for laboratory analyses.

Volatile organic compounds were field screened with a photoionization detector, using the headspace method. The FSL for headspace VOCs was established at 20 parts per million (ppm). None of the samples exceeded VOC FSLs.

Radionuclides (alpha/beta-emitters) were field screened with an NE Electra alpha/beta scintillator. The radiological FSL was defined as the mean background activity level plus two times the standard deviation of 20 background sample readings. Radiological FSLs were established for surface samples. Surface FSLs were determined by collecting readings from 20 background surface samples collected from an undisturbed areas at the north and south boundaries of the site. Three sample locations identified elevated radiological emitters and those locations were sampled and step-out samples were performed to identify if there was lateral migration. The interval below each elevated sample did not exceed FSLs.

Field screening for explosives was conducted with a Strategic Diagnostics Incorporated (SDI) colorimetric test kit. A FSL of 5 ppm was established in the DQO process and two samples at two locations exceeded this FSL. One of the samples which had elevated radiological field screening levels also exceeded FSLs for explosives. This location was sampled and a step-out was performed to identify if the contamination had migrated laterally. The interval below the elevated level did not exceed FSLs. Sample locations where FSLs were exceeded were submitted for laboratory analysis and step-out samples were collected and field screened. Based on field-screening results, at least one sample from the step-out location was submitted for laboratory analysis.

A.2.2.2 Background Samples

A background borehole was drilled outside of the site boundaries to the north and the south of the site boundaries. Field screening was performed for VOCs, alpha/beta-emitting radionuclides, and

explosives on soil cores. Four background environmental samples were submitted from the 30-ft and 70-ft from TH1BG and from 35-ft and 70-ft from TH2BG. The sample intervals were determined per the historical information which indicated that tubes were 25 and 50 ft in length. All background samples were submitted for the full suite of analytes to provide a baseline for analytes specific to the CAU.

A.2.2.3 Excavation Investigation Description

During the excavation activities, two locations had extensive amounts of buried debris. At A8 and A17, the debris was extensive and after consulting the NNSA/NV and NDEP, it was determined that the debris would be left in place and a use restriction implemented for both areas. Samples were collected at each anomaly and submitted for laboratory analysis (samples TH08E03 and TH08E08 from anomaly A8 samples THA17E05N and THAE05S from anomaly A17). No tube was identified at subsurface tube locations T14, T15, and T16. Due to the extent of disturbed soil T15 and T16 were drilled and sampled within the disturbed material. No anomaly excavation locations had FSRs which exceeded FSLs.

A.2.2.4 Borehole Investigation Description

A total of 32 boreholes were drilled into the interior of the tube during the investigation. Two of the originally identified locations were drilled and no tube was present (T15, T16). At three locations (TA7, TA12, TA20), it was not possible to identify the disturbed native soil interface because of refusal. Three step-out boreholes (TA19, T9, T12) were drilled to define lateral extent of contamination based on exceeded FSLs. Field screening was performed at 5-ft intervals. Samples were submitted from the interval with the highest FSR and the native soil interface. At most locations a steel or aluminum plate was encountered within the tubes and the native soil interface was identified by drilling through the plates. However, more than one plate was encountered in five tubes (TA4, TA8, TA18, T2, T4), and drilling continued until the native soil interface was clearly defined. Debris associated with tests (e.g., wires, rope, and rubber) was recovered from the core of the majority of boreholes during drilling. Samples were submitted for the partial suite unless FSRs exceeded the FSLs, except QC samples. If field screening levels were

exceeded, then the samples were submitted for the full suite (TA19, T9, T12). Geology was logged for the length of the core and can be found in Appendix D.

A.2.2.5 Sample Collection

A total of 99 environmental soil samples were collected and submitted for laboratory analyses. In addition, five QC duplicate samples, two QC source blanks, five matrix spike/matrix spike duplicate (MS/MSD), six QC field blank, one QC equipment rinsate blank, and 39 QC trip blanks were collected and submitted for laboratory analysis. A list of the samples collected and the parameters analyzed for are presented in Table A.2-1. The analytical parameters and laboratory analytical methods used for these investigations are presented in Table A.2-2. Samples collected for chemical and radiological analyses were analyzed by Paragon Analytics, Inc. in Fort Collins, Colorado.

Each sample container identified for laboratory analysis was wrapped in protective bubble wrap (if applicable), placed into a sealable bag, and stored in either an iced cooler or refrigerator with a trip blank (if applicable). Sample media collected but not submitted to the laboratory was placed with unused cores and returned to the collection site.

The analytical parameters were selected through the application of site process knowledge according to the *Guidance for the Data Quality Objectives Process* (EPA, 1994b) and agreed upon during the DQO meeting. Preliminary action levels for off-site laboratory analytical methods were determined during the DQO process and are based on NDEP Corrective Action Regulations (NAC, 1998) and the U.S. Environmental Protection Agency (EPA) Preliminary Remediation Goals (PRGs) (EPA, 2000b) for chemical parameters under the industrial scenario. The PALs for laboratory radiological methods are isotope-specific and are defined as the maximum activity for that isotope found in previously analyzed environmental samples taken from undisturbed background locations from the north and south boundaries of the site and background samples collected outside the boundaries of the CAU. The results of the DQO process are documented in the CAIP (DOE/NV, 2001), with the remainder of the analytical requirements documentation retained in the project files. Sampling activities were designed to detect contaminants of potential concern and conducted to either confirm or disprove the assumptions made in the DQO process.

Table A.2-1
Samples Collected During the CAU 487 Field Investigation
(Page 1 of 5)

Sample Number	Collection Method	Depth (ft bgs)	Sample Matrix	Sample Type	Parameters Analyzed
Environmental (Characterization) Soil Samples					
TH06E03	Backhoe	3	Soil	Environmental	Set 2
TH08E03	Backhoe	3.5	Soil	Environmental	Set 2
TH08E08	Backhoe	8	Soil	Environmental	Set 2
TH1BG30	Drilling	30 - 31	Soil	Background Environmental	Set 2
TH1BG70	Drilling	70 - 71	Soil	Background Environmental	Set 2
TH2BG30	Drilling	30 - 31	Soil	Background Environmental	Set 2
TH2BG70	Drilling	70 - 71	Soil	Background Environmental	Set 2
THTA1210	Drilling	10 - 11	Soil	Environmental	Set 1
THTA1230	Drilling	30 - 31	Soil	Environmental	Set 1
THTA1132	Drilling	32.5 - 33.5	Soil	Environmental	Set 2
THTA1199	Drilling	32.5 - 33.5	Soil	Field Duplicate of THTA1132	Set 2
THTA1140	Drilling	40 - 41	Soil	Environmental	Set 1
THTA1150	Drilling	50 - 51	Soil	Environmental	Set 1
THTA1017	Drilling	17 - 18	Soil	Environmental	Set 1
THTA1020	Drilling	19.5 - 20.5	Soil	Environmental and MS/MSD	Set 1 & 2
THT1320	Drilling	20 - 21	Soil	Environmental	Set 1
THT1329	Drilling	29.5 - 30	Soil	Environmental	Set 1
THTA701	Drilling	0 - 1	Soil	Environmental	Set 1
THTA710	Drilling	10 - 11	Soil	Environmental	Set 1
THT237	Drilling	37 - 38	Soil	Environmental	Set 1
THT259	Drilling	59 - 60	Soil	Environmental	Set 1
THTA420	Drilling	20 - 21	Soil	Environmental	Set 1
THTA425	Drilling	25 - 26	Soil	Environmental	Set 1
THTA1318	Drilling	18 - 19	Soil	Environmental	Set 2
THTA1399	Drilling	18 - 19	Soil	Field Duplicate of THTA1318	Set 2
THTA1320	Drilling	20 - 21	Soil	Environmental and MS/MSD	Set 2
THTA640	Drilling	40 - 41	Soil	Environmental	Set 1
THTA650	Drilling	50 - 51	Soil	Environmental	Set 1
THTA515	Drilling	15 - 16	Soil	Environmental	Set 1
THTA520	Drilling	20 - 21	Soil	Environmental	Set 1
THTA825	Drilling	25	Soil	Environmental	Set 1

Table A.2-1
Samples Collected During the CAU 487 Field Investigation
(Page 2 of 5)

Sample Number	Collection Method	Depth (ft bgs)	Sample Matrix	Sample Type	Parameters Analyzed
THTA826	Drilling	26 - 27	Soil	Environmental	Set 1
THT330	Drilling	30 - 31	Soil	Environmental	Set 1
THT365	Drilling	65 - 66	Soil	Environmental	Set 1
THT370	Drilling	70 - 71	Soil	Environmental	Set 1
THT110	Drilling	10 - 11	Soil	Environmental	Set 1
THT140	Drilling	40 - 41	Soil	Environmental	Set 1
THTA915	Drilling	15 - 16	Soil	Environmental	Set 1
THA18E01	Backhoe	1 - 2	Soil	Environmental	Set 1
THA17E05N	Backhoe	5 - 6	Soil	Environmental	Set 1
THA17E05S	Backhoe	5 - 6	Soil	Environmental	Set 1
THTA920	Drilling	20 - 21	Soil	Environmental	Set 1
THT1510	Drilling	10 - 11	Soil	Environmental	Set 1
THT1520	Drilling	20 - 21	Soil	Environmental and MS/MSD	Set 2
THT450	Drilling	50 - 51	Soil	Environmental	Set 1
THT465	Drilling	65 - 66	Soil	Environmental	Set 2
THT499	Drilling	65 - 66	Soil	Field Duplicate of THT465	Set 2
THTA315	Drilling	15 - 16	Soil	Environmental	Set 1
THTA342	Drilling	42 - 43	Soil	Environmental	Set 1
THT540	Drilling	40 - 41	Soil	Environmental	Set 1
THT543	Drilling	43 - 44	Soil	Environmental	Set 1
THTA120	Drilling	20 - 21	Soil	Environmental	Set 1
THTA121	Drilling	21 - 22	Soil	Environmental	Set 1
THT1610	Drilling	10 - 11	Soil	Environmental	Set 1
THT1615	Drilling	15 - 16	Soil	Environmental	Set 1
THT629	Drilling	29 - 30	Soil	Environmental	Set 1
THT650	Drilling	50 - 51	Soil	Environmental	Set 1
THT1201	Drilling	0 -1	Soil	Environmental	Set 2
THT1235	Drilling	35 - 36	Soil	Environmental	Set 1
THT1242	Drilling	42 - 43	Soil	Environmental	Set 1
THT1299	Drilling	42 - 43	Soil	Field Duplicate of THT1242	Set 1
THT1251	Drilling	51 - 52	Soil	Environmental	Set 1
THT1101	Drilling	0 -1	Soil	Environmental	Set 1

Table A.2-1
Samples Collected During the CAU 487 Field Investigation
(Page 3 of 5)

Sample Number	Collection Method	Depth (ft bgs)	Sample Matrix	Sample Type	Parameters Analyzed
THT1125	Drilling	25 - 26	Soil	Environmental	Set 1
THT1025	Drilling	25 - 26	Soil	Environmental	Set 1
THT1038	Drilling	38 - 39	Soil	Environmental	Set 1
THTA1835	Drilling	35 - 36	Soil	Environmental and MS/MSD	Set 2
THTA1856	Drilling	56 - 57	Soil	Environmental	Set 1
THTA1730	Drilling	30 - 31	Soil	Environmental	Set 1
THTA1735	Drilling	35 - 36	Soil	Environmental	Set 1
THT12S01	Drilling	0 - 1	Soil	Environmental	Set 2
THT12S05	Drilling	5 - 6	Soil	Environmental	Set 1
THTA1901	Drilling	0 - 1	Soil	Environmental	Set 2
THTA1901W	Drilling	0 - 1	Soil	Environmental	Set 2
THTA1923	Drilling	23 - 24	Soil	Environmental	Set 1
THT815	Drilling	15 - 16	Soil	Environmental	Set 1
THT820	Drilling	20 - 21	Soil	Environmental	Set 1
THT905	Drilling	5 - 6	Soil	Environmental	Set 2
THT921	Drilling	21 - 22	Soil	Environmental	Set 1
THT9S05W	Drilling	5 - 6	Soil	Environmental	Set 2
THT9S15W	Drilling	15 - 16	Soil	Environmental	Set 1
THT9S201	Drilling	0 - 1	Soil	Environmental	Set 1
THT9S210	Drilling	10 - 11	Soil	Environmental	Set 1
THT717	Drilling	17 - 18	Soil	Environmental	Set 1
THT720	Drilling	20 - 21	Soil	Environmental	Set 1
THTA1415	Drilling	15 - 16	Soil	Environmental	Set 1
THTA1420	Drilling	20 - 21	Soil	Environmental	Set 1
THTA1530	Drilling	30 - 31	Soil	Environmental	Set 1
THTA1550	Drilling	50 - 51	Soil	Environmental	Set 1
THTA2005	Drilling	5 - 6	Soil	Environmental	Set 1
THTA2015	Drilling	15 - 16	Soil	Environmental	Set 1
THTA1640	Drilling	40 - 41	Soil	Environmental	Set 1
THTA1650	Drilling	50 - 51	Soil	Environmental	Set 1
TH17E10A	Backhoe	10	Soil	Environmental	Set 2
TH17E08B	Backhoe	8	Soil	Environmental	Set 2

Table A.2-1
Samples Collected During the CAU 487 Field Investigation
(Page 4 of 5)

Sample Number	Collection Method	Depth (ft bgs)	Sample Matrix	Sample Type	Parameters Analyzed
TH17E03C	Backhoe	3	Soil	Environmental	Set 1
TH17E05D	Backhoe	5	Soil	Environmental	Set 1
TH17E05E	Backhoe	5	Soil	Environmental	Set 1
TH17E03F	Backhoe	3	Soil	Environmental	Set 1
TH17E01G	Backhoe	1	Soil	Environmental	Set 1
TH17E05H	Backhoe	5	Soil	Environmental	Set 1
TH17E07I	Backhoe	7	Soil	Environmental and MS/MSD	Set 2
TH17E05J	Backhoe	5	Soil	Environmental	Set 2
TH17E99J	Backhoe	5	Soil	Field Duplicate of TH17E05J	Set 2
Field Quality Control Samples					
TH00E00	N/A	N/A	Water	Source Blank	Set 2
TH00E01	N/A	N/A	Water	Equipment Rinsate Blank	Set 2
TH1BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH2BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH3BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH4BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH5BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH6BGTB	N/A	N/A	Water	Trip Blank	Total VOCs
TH99ETB	N/A	N/A	Water	Trip Blank	Total VOCs
TH98ETB	N/A	N/A	Water	Trip Blank	Total VOCs
TH08ETB	N/A	N/A	Water	Trip Blank	Total VOCs
TH08BTB	N/A	N/A	Water	Trip Blank	Total VOCs
THTA11TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTB11TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTA10TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTB10TB	N/A	N/A	Water	Trip Blank	Total VOCs
THT13FB	N/A	N/A	Water	Field Blank	Set 2
THTC7TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTA13TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTB13TB	N/A	N/A	Water	Trip Blank	Total VOCs
THT3FB	N/A	N/A	Water	Field Blank	Set 2
THTCT3TB	N/A	N/A	Water	Trip Blank	Total VOCs

Table A.2-1
Samples Collected During the CAU 487 Field Investigation
(Page 5 of 5)

Sample Number	Collection Method	Depth (ft bgs)	Sample Matrix	Sample Type	Parameters Analyzed
THTDT3TB	N/A	N/A	Water	Trip Blank	Total VOCs
THT15TB	N/A	N/A	Water	Trip Blank	Total VOCs
THTB15TB	N/A	N/A	Water	Trip Blank	Total VOCs
THT1200	N/A	N/A	Water	Field Blank	Set 2
THT1297	N/A	N/A	Water	Trip Blank	Total VOCs
THT1298	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1897	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1898	N/A	N/A	Water	Trip Blank	Total VOCs
THT12S97	N/A	N/A	Water	Trip Blank	Total VOCs
THT12S98	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1900	N/A	N/A	Water	Field Blank	Set 2
THT9S97	N/A	N/A	Water	Trip Blank	Total VOCs
THT9S98	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1600	N/A	N/A	Water	Source Blank	Set 2
THTA1597	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1598	N/A	N/A	Water	Trip Blank	Total VOCs
THTA1500	N/A	N/A	Water	Field Blank	Set 2
THA1797	N/A	N/A	Water	Trip Blank	Total VOCs
THA1798	N/A	N/A	Water	Trip Blank	Total VOCs
TH17E96	N/A	N/A	Water	Trip Blank	Total VOCs
TH17E95	N/A	N/A	Water	Trip Blank	Total VOCs
TH17E00J	N/A	N/A	Water	Field Blank	Set 2
TH17E94	N/A	N/A	Water	Trip Blank	Total VOCs
TH17E93	N/A	N/A	Water	Trip Blank	Total VOCs

ft = Feet
bgs = Below ground surface
MS/MSD = Matrix spike/matrix spike duplicate
NA = Not applicable

Set 1 = Analytical parameters are total RCRA metals, high explosives, total SVOCs
Set 2 = Analytical parameters are total VOCs, total SVOCs, total RCRA metals, tantalum, lithium, boron, isotopic uranium, gamma spectrometry

Table A.2-2
Laboratory Analytical Methods Used for the CAU 487 Investigation Samples

Analytical Parameter	Analytical Method
Total volatile organic compounds	SW-846 8260B[a]
Total semivolatile organic compounds	SW-846 8270C[a]
Total RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)	Water - SW-846 6010B/7470A[a] Soil - SW-846 6010B/7471A[a]
Metals (tantalum, lithium, boron)	Water - SW-846 6010B/7470A[a] Soil - SW-846 6010B/7471A[a]
High Explosives	SW-846 8330[a]
Isotopic Uranium	Water - HASL-300[b] and EPA 908.0[c] Soil - HASL-300[b]
Gamma Spectrometry	Water - EPA 901.1[c] Soil - HASL-300[b]

[a]EPA *Test Methods for Evaluating Solid Waste*, Physical/Chemical Methods, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996)
[b]*Environmental Measurements Laboratory Procedures Manual*, HASL-300 (DOE, 1997)
[c]*Prescribed Procedures for Measurements of Radioactivity in Drinking Water* (EPA, 1980) or equivalent method

A.2.2.6 Housekeeping Debris

Surface debris (e.g., I-beams, wood planks, cables) identified throughout the site (A11, A13, A14) was handled as housekeeping. The debris, which was mostly wood and metal, was screened for alpha/beta-emitting radionuclides and then piled at the east or west end of the site. Documentation for the disposal of housekeeping debris is included in Appendix F.

A small amount of asbestos containing material, not associated with Thunderwell testing was collected from the surface in the vicinity of anomaly A-8 for disposal. Documentation for the disposal of asbestos debris is included in Appendix F.

A.2.2.7 Geotechnical Samples

Geotechnical samples were not submitted for laboratory analysis because migration of COCs was not a concern at this site based on analytical results. The bis(2-ethylhexyl) phthalate found in sample THTA1399 exceeded that PAL; however, that sample was the duplicate of THTA1318

which did not exceed the PAL. Analytical results for bis(2-ethylhexyl) phthalate are discussed in Section A.3.2 and Appendix C. Based on these results and the above discussion it was determined that contaminant migration is not an issue and geotechnical samples were not submitted for analysis.

A.3.0 Investigation Results

The analytical results of samples collected from the CAU 487 investigation have been compiled, evaluated, and assessed to determine the presence and/or extent of contamination and data usability. The analytical results are summarized in the following subsections.

A.3.1 Total Volatile Organic Compound Results

Total VOC results for soil samples submitted for analysis above minimum reporting limits (MRLs) as established in the CAIP (DOE/NV, 2001) are found in Table A.3-1. No VOCs were detected in soil samples at concentrations exceeding PALs (EPA, 2000a).

Table A.3-1
Soil Sample Results for Total VOCs Detected Above Minimum Reporting Limits

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)	
		Methylene Chloride	Acetone
Preliminary Action Levels (µg/kg)[a]		21,000	6,200,000
TH06E03	3	17	--
TH08E03	3.5	29	--
TH08E08	8	18	--
TH17E10A	10	--	24
THTA1318	18 - 19	11	--
THTA1320	20 - 21	8.5	--
THTA1399	18 - 19	9.5	--

[a]Based on U.S. Environmental Protection Agency. 2000b. *Region 9 Preliminary Remediation Goals (PRGs)*, 1 November. Prepared by S.J. Smucker. San Francisco, CA.

µg/kg = Micrograms per kilogram
-- = Not detected above minimum reporting limits

A.3.2 Total Semivolatile Organic Compound Results

Total SVOC results for soil samples submitted for analysis above MRLs as established in the CAIP (DOE/NV, 2001) are found in Table A.3-2. Sample number THTA1399 (which is a QC sample of

THTA1318), exceeded the PAL for bis(2-ethylhexyl) phthalate. However, the sample THTA1318 did not exceed PALs for any analytes. Bis(2-ethylhexyl) phthalate is a commonly used plasticizer used to make the coverings for wires and everyday household and industrial items (Syracuse, 2000). The sample collection log and geology borehole log noted that plastic covered wires and debris were present at the interval where the samples were collected. The sample collected below the exceeded interval, THTA1320, had bis(2-ethylhexyl) phthalate that exceeded MRLs but did not exceed PALs. Eight other samples exceeded the MRL for bis(2-ethylhexyl) phthalate, and the results did not meet nor exceed the PALs.

Table A.3-2
Soil Sample Results for Total SVOCs Detected Above Minimum Reporting Limits

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)	
		Bis(2-Ethylhexyl) Phthalate	Di-n-Octyl Phthalate
Preliminary Action Levels (µg/kg)[a]		180,000	10,000,000
THT1025	25 - 26	760	--
THT237	37 - 38	540	--
THTA1017	17 - 18	13,000	--
THTA1020	19.5 - 20.5	1,400	--
THTA1318	18 - 19	34,000 (J)[b]	400
THTA1320	20 - 21	9,600 (J)[b]	--
THTA1399	18 - 19	470,000 (J)[c]	3,600
THTA1530	30 - 31	670	--
THTA420	20 - 21	1,300	450
THTA425	25 - 26	490	--

[a]Based on U.S. Environmental Protection Agency. 2000b. *Region 9 Preliminary Remediation Goals (PRGs)*, 1 November. Prepared by S.J. Smucker. San Francisco, CA.
[b]Qualifier added to laboratory data; record accepted. Value exceeded linear range of instrument.
[c]Qualifier added to laboratory data; record accepted. Internal standard area count exceeded the QC limits.

ft = Feet
bgs = Below ground surface
QC = Quality control
µg/kg = Micrograms per kilograms
-- = Not detected above minimum reporting limits
J = Estimated value

A.3.3 High Explosives

High explosives results for soil samples submitted for analysis above MRLs as established in the CAIP (DOE/NV, 2001) are found in Table A.3-3. High explosives were not detected in soil samples at concentrations exceeding PALs (EPA, 2000b).

Table A.3-3
Soil Sample Results for High Explosives Detected Above Minimum Reporting Limits

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)			
		2-Nitrotoluene	4-Nitrotoluene	4-Amino-2, 6-DNT	PETN
Preliminary Action Levels (mg/kg)[a]		1,000	1,000	NI	NI
THT237	37 - 38	9.2	--	--	--
THT450	50 - 51	--	4.8 (J)	0.51 (J)	17
THTA420	20 - 21	4.5	--	--	2.7
THTA425	25 - 26	0.46	--	--	--
THTA650	50 - 51	20	--	--	6.3
THTA825	25	1.4	--	--	--

[a]Based on U.S. Environmental Protection Agency. 2000b. *Region 9 Preliminary Remediation Goals (PRGs)*, 1 November. Prepared by S.J. Smucker. San Francisco, CA.

mg/kg = Milligrams per kilogram
NI = Not identified
J = Estimated value. Qualifier added to laboratory data; record accepted. Surrogate recovery exceeded the upper limits.
-- = Not detected above minimum reporting limits

A.3.4 Total RCRA Metals Results

The total RCRA metals results for soil samples detected above MRLs (DOE/NV, 2001) are presented in Table A.3-4. Except for arsenic, all the total RCRA metal results were below PALs (DOE/NV, 2001; EPA, 2000b).

Arsenic was detected above the PAL of 2.7 milligrams per kilogram (mg/kg) in nearly all of the soil samples analyzed. The arsenic concentrations for the samples exceeding PALs ranged from 3.7 mg/kg (TH17E01G) to 32 mg/kg (THTA1399 duplicate of THTA1318) with a mean concentration of 10.84 mg/kg.

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 1 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
TH06E03	3	2.4	50	--	--	2.2	3.7	16	--	--	--	--
TH08E03	3.5	5.9	82	12	--	3.8	5.7	49	--	--	--	--
TH08E08	8	9.5	73	12	--	5.2	5.6	40	--	--	--	--
TH17E05J	5	4.7	64	--	--	3.4	4.5	26	--	--	--	--
TH17E07I	7	4.7	58	12	--	3.8	4.2	28	--	--	--	--
TH17E08B	8	5.4	53	12	--	3.9	4.5	35	--	--	--	--
TH17E10A	10	4.6	54	13	--	3.6	4.3	38	--	--	--	--
TH17E99J	5	4.3	64	11	--	3.8	4.4	28	--	--	--	--
TH1BG30	30 - 31	9.5	140	15	--	5.4	11	63	--	1.2	1.3	--
TH1BG70	70 - 71	16	170	--	--	3.5	13	260	--	--	--	6.8
TH2BG30	30 - 31	6.9	130	27	--	4.7	9.7	630	--	--	--	9.9
TH2BG70	70 - 71	12	120	14	--	4.5	6.7	460	0.13 (B)	--	--	8.7 (J)[b]
THT1201	0 - 1	6.8	120	21	--	6.3	7.7	62	--	--	--	--
THT12S01	0 - 1	7.6	100	16	--	5.8	7.6	73	--	--	--	5.7
THT1520	20 - 21	14	82	30	--	8.3	11	93 (J)[c]	--	--	--	7.2 (J)[b]
THT450	50 - 51	8.2	100	--	--	150	8.1	53 (J)[c]	--	--	--	--
THT465	65 - 66	30	540	--	--	3.5	13	110 (J)[c]	--	--	--	--
THT499	65 -66	26	450	--	--	3.6	9.6	120 (J)[c]	--	--	--	--

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 2 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
THT9S05W	5 - 6	6.3	26	--	--	1.3	2	9	--	--	--	--
THTA1020	19.5 - 20.5	11	93	17	--	9.9	12	55	--	--	--	7.4
THTA1132	32.5 - 33.5	6.6	93	--	--	6.1	5.8	44	--	--	2.2 (J)[d]	--
THTA1199	32.5 - 33.5	6.1	72	11 (B)	--	7	5.1	45	--	--	2.4 (J)[d]	--
THTA1318	18 - 19	24 (J)[e]	130	6.8	5.3 (J)[f]	4.1	23	65	1.9 (J)[d]	7.3 (J)[d]	--	--
THTA1320	20 - 21	30 (J)[e]	84	21	--	11	21	92	--	--	--	8.1 (J)[b]
THTA1399	18 - 19	32 (J)[e]	110	--	4.8 (J)[f]	4	12	84	1.6 (J)[d]	5.4 (J)[d]	--	--
THTA1530	30 - 31	5.1	89	12	--	4.3	6.8	51	--	--	--	--
THTA1835	35 - 36	15	110	38	--	5.9	8.5	290	--	--	--	9.1 (J)[b]
THTA1901	0 - 1	13	110	25	--	4	10	440	--	--	--	6.7
TH17E01G	1	3.7	49	--	--	3.1	4	--	--	--	--	--
TH17E03C	3	4	46	--	--	2.9	4.2	--	--	--	--	--
TH17E03F	3	4	50	--	--	3.1	3.8	--	--	--	--	--
TH17E05D	5	4.6	94	--	--	3.3	4.1	--	--	--	--	--
TH17E05E	5	3.8	47	--	--	3	3.8	--	--	--	--	--
TH17E05H	5	4	50	--	--	3	3.4	--	--	--	--	--
THA17E05N	5 - 6	3.8	42	--	--	3.5	3.8	--	--	--	--	--
THA17E05S	5 - 6	3.9	42	--	--	2.9	3	--	--	--	--	--

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 3 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
THA18E01	1 - 2	6.6	97	--	--	6.4	6.1	--	--	--	--	--
THT1025	25 - 26	15	130	--	--	5.8	12	--	--	--	2.5	--
THT1038	38 - 39	12	180	--	--	2.4	20	--	--	0.79	--	--
THT110	10 - 11	6.6	84	--	59 (J)[d]	7.1	8.5	--	--	--	1.6	--
THT1101	0 - 1	10	100	--	--	6.2	12	--	--	--	--	--
THT1125	25 - 26	17	73	--	--	4.4	14	--	--	--	--	--
THT1235	35 - 36	12	180	--	--	4.8	16	--	--	0.63 (J)[d]	--	--
THT1242	42 - 43	10	150	--	--	56	9.2	--	--	--	--	--
THT1251	51 - 52	22	290	--	--	--	6.6	--	--	--	--	--
THT1299	42 - 43	9.4	110	--	--	56	7.3	--	--	--	--	--
THT12S05	5 - 6	10	47	--	--	2.5	2.8	--	--	--	--	--
THT1320	20 - 21	7.3	71	--	--	6.5	6.7	--	--	0.73	--	--
THT1329	29.5 - 30	30	79	--	--	3.2	7.6	--	--	--	--	--
THT140	40 - 41	15	210	--	--	2.3	13	--	--	--	--	--
THT1510	10 - 11	8	42	--	--	2	2.7	--	--	--	--	--
THT1610	10 - 11	5.4	76	--	--	3.5	4.8	--	--	--	--	--
THT1615	15 - 16	8.4	94	--	--	4	6.9	--	--	--	--	--
THT237	37 - 38	7.3	110	--	--	19	6.9	--	--	0.6	--	--

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 4 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
THT259	59 - 60	14	170	--	--	3.3	9.7	--	--	--	--	--
THT330	30 - 31	7.5	44	--	--	3.7	4	--	--	--	--	--
THT365	65 - 66	25	240	--	0.89 (J)[d]	3.3	11	--	--	--	--	--
THT370	70 - 71	15	390	--	0.78 (J)[d]	3.7	15	--	--	--	--	--
THT540	40 - 41	7.4	88	--	--	32	5.8	--	--	--	--	--
THT543	43 - 44	10	260	--	--	2.4	20	--	--	0.66 (J)[d]	--	--
THT629	29 - 30	7.3	79	--	--	6.8	6	--	--	--	--	--
THT650	50 - 51	9.7	1,100	--	--	--	28	--	--	--	--	--
THT717	17 - 18	9.9	120	--	--	9.2	11	--	--	0.79	--	--
THT720	20 - 21	4.4	41	--	--	3.5	5.1	--	---	--	--	--
THT9S15W	15 - 16	4.9	120	--	--	2	8.1	--	--	--	--	--
THT9S201	0 - 1	6	150	--	--	6.5	8.5	--	--	--	--	--
THT9S210	10 - 11	12	110	--	--	10	9.7	--	--	--	--	--
THTA1017	17 - 18	7.6	86	--	--	14	21	--	--	--	--	--
THTA1140	40 - 41	10	160	--	4	30	10	--	--	--	--	--
THTA1150	50 - 51	3.8	160	--	--	--	10	--	--	--	--	--
THTA120	20 - 21	13	71	--	--	8.9	12	--	--	--	--	--
THTA121	21 - 22	12	64	--	--	7.4	11	--	--	--	--	--

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 5 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
THTA1210	10 - 11	12	86	--	--	5.4	7.1	--	--	--	--	--
THTA1230	30 - 31	7.1	85	--	--	5.3	6.8	--	--	--	--	--
THTA1415	15 - 16	6.4	110	--	--	56	5.9	--	--	--	2.6 (J)[d]	--
THTA1420	20 - 21	1.5	160	--	--	2.2	9.7	--	--	--	--	--
THTA1550	50 - 51	17	300	--	--	4.3	24	--	--	0.83	--	--
THTA1640	40 - 41	8.2	120	--	--	3.7	5.9	--	--	--	--	--
THTA1650	50 - 51	17	720	--	--	3.6	7.1	--	--	--	--	--
THTA1730	30 - 31	11	180	--	--	4.8	11	--	--	--	--	--
THTA1735	35 - 36	8	780	--	--	2.5	14	--	--	--	--	--
THTA1856	56 - 57	11	290	--	--	2.7	10	--	--	--	--	--
THTA2005	5 - 6	7.4	58	--	--	8.9	4.9	--	--	--	1.3 (J)[d]	--
THTA2015	15 - 16	6.4	120	--	--	3.9	7.3	--	--	--	--	--
THTA315	15 - 16	8.8	85	--	--	4.7	7.4	--	--	--	1.5	--
THTA342	42 - 43	10	200	--	--	11	14	--	--	--	--	--
THTA420	20 - 21	8.9 (J)[e]	90	--	--	17	8.7	--	--	--	--	--
THTA425	25 - 26	8.2 (J)[e]	73	--	--	7.9	6.6	--	--	--	--	--
THTA515	15 - 16	9.1	72	--	--	3.8	6.2	--	--	--	--	--
THTA520	20 - 21	8.5	47	--	--	6.8	9.5	--	--	--	--	--

Table A.3-4
Soil Sample Results for Total RCRA Metals, Tantalum, Lithium, and Boron Detected Above Minimum Reporting Limits
(Page 6 of 6)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)										
		Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Lithium	Mercury	Selenium	Silver	Tantalum
Preliminary Action Levels (mg/kg)[a]		2.7	100,000	79,000	810	450	750	41,000	610	10,000	10,000	NI
THTA640	40 - 41	5	64	--	--	4.2	4.8	--	--	--	--	--
THTA650	50 - 51	23	210	--	--	27	9.6	--	--	--	--	--
THTA701	0 - 1	6	58	--	--	4	5.4	--	--	--	--	--
THTA710	10 - 11	5.5	66	--	--	3.7	5.1	--	--	--	--	--
THTA825	25	10	68	--	--	8.5	7.9	--	--	--	--	--
THTA826	26 - 27	17	260	--	--	2.1	13	--	--	--	--	--
THTA915	15 - 16	7.2	63	--	--	4.4	5.7	--	--	--	--	--
THTA920	20 - 21	20	52	--	--	8.2	9.5	--	--	--	--	--

[a]Based on U.S. Environmental Protection Agency. 2000b. *Region 9 Preliminary Remediation Goals (PRGs)*, 1 November. Prepared by S.J. Smucker. San Francisco, CA.
[b]Qualifier added to laboratory data; record accepted. Poor matrix spike recovery/<30% recovery.
[c]Qualifier added to laboratory data; record accepted. Spike recovery was outside control limits.
[d]Qualifier added to laboratory data; record accepted. Poor duplicate precision.
[e]Qualifier added to laboratory data; record accepted. Duplicate precision analyses were outside control limits.
[f]Qualifier added to laboratory data; record accepted. ICP serial dilution recovery was not met. Matrix effects may exist.

ft = Feet
bgs = Below ground surface
mg/kg = Milligrams per kilogram
B = Value less than the IDL, but greater than or equal to the CRDL.
CRDL = Contract-required detection limit
IDL = Instrument detection limit
ICP = Inductively coupled plasma
NI = Not identified
-- = Not detected above minimum reporting limits
J = Estimated value

The PAL of 2.7 mg/kg is lower than the 7 to 8 mg/kg mean concentration of arsenic in silt from the Nellis Air Force Range (NBMG, 1998; Moore, 1999) and lower than range of concentrations of 6 to 43 mg/kg in soils from locations near the TTR (SNL, 1999). Background boreholes from the CAU were drilled outside of the CAU. The arsenic readings from these two areas are from the north TH1BG (9.5 mg/kg-30 ft bgs, 16 mg/kg-70 ft bgs) and from the south TH2BG (6.9 mg/kg-30 ft bgs, 12 mg/kg-70 ft bgs). All results from the background boreholes exceeded PALs. Additional data from previous sampling efforts in or near Area 3 also reveal arsenic concentrations as high as 24.1 mg/kg from undisturbed locations (DOE/NV, 1998). Although arsenic concentrations presented in Table A.3-4 exceed the PAL of 2.7 mg/kg, these levels are considered representative of ambient conditions at the sites.

A.3.5 Tantalum, Lithium, Boron

Results for tantalum, lithium, and boron in soil samples submitted for analysis were above MRLs as established in the CAIP (DOE/NV, 2001) and are identified in Table A.3-4. Lithium and boron were not detected in soil samples at concentrations exceeding action levels (EPA, 2000b). There is no established PAL for tantalum. Background boreholes from the CAU were drilled outside of the CAU. The tantalum readings from these two areas are from the north TH1BG (ND-30 ft bgs, 6.8 mg/kg-70 ft bgs) and from the south TH2BG (9.9 mg/kg-30 ft bgs, 8.7 (J) mg/kg-70 ft bgs). Tantalum results for environmental samples were compared to background data, no significant differences were noted.

A.3.6 Isotopic Uranium Results

Isotopic uranium results for soil samples detected above MRLs (DOE/NV, 2001) are presented in Table A.3-5. Each analytical result does not exceed normalized difference comparison at a 95 percent confidence level and is not distinguishable from background concentrations listed in the *Off-Site Radiation Exposure Review Project, Phase II Soils Program* (McArthur and Miller, 1989) or the *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (Atlan-Tech, 1991); therefore, they do not exceed PALs (DOE/NV, 2001).

Table A.3-5
Soil Sample Results for Isotopic Uranium Detected Above Minimum Reporting Limits

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)		
		Uranium-234[a]	Uranium-235[a]	Uranium-238[b]
Background Concentration Range (pCi/g)		2.56	0.13	4.2
TH06E03	3	1.16 ± 0.19	--	1.11 ± 0.18
TH08E03	3.5	2.1 ± 0.32	0.191 ± 0.052 (J)	1.28 ± 0.21
TH08E08	8	1.83 ± 0.28	0.129 ± 0.041 (J)	1.28 ± 0.21
TH17E05J	5	1.37 ± 0.23	0.07 ± 0.032 (LT)	1.2 ± 0.21
TH17E07I	7	1.76 ± 0.30	--	1.23 ± 0.22
TH17E08B	8	1.33 ± 0.24	0.08 ± 0.043 (LT)	1.11 ± 0.21
TH17E10A	10	1.49 ± 0.24	0.055 ± 0.026 (LT)	1.19 ± 0.20
TH17E99J	5	1.61 ± 0.27	0.08 ± 0.034 (LT)	1.28 ± 0.22
TH1BG30	30 - 31	1.33 ± 0.26	0.076 ± 0.042 (LT)	1.18 ± 0.24
TH1BG70	70 - 71	0.96 ± 0.20	--	0.96 ± 0.21
TH2BG30	30 - 31	0.95 ± 0.20	--	0.96 ± 0.20
TH2BG70	70 - 71	1.26 ± 0.26	--	1.1 ± 0.23
THT1201	0 - 1	1.38 ± 0.22	0.084 ± 0.032 (LT)	1.21 ± 0.20
THT12S01	0 - 1	1.5 ± 0.24	0.131 ± 0.041 (LT)	1.31 ± 0.21
THT1520	20 - 21	1.53 ± 0.28	0.065 ±0.035 (LT)	1.24 ± 0.23
THT465	65 - 66	1.17 ± 0.23	--	1.1 ± 0.22
THT499	65 - 66	0.97 ± 0.22	--	1.14 ± 0.25
THT9S05W	5 - 6	1.52 ± 0.27	0.115 ± 0.047 (LT)	1.25 ± 0.23
THTA1132	32.5 - 33.5	1.29 ± 0.25	--	1.13 ± 0.23
THTA1199	32.5 - 33.5	1.21 ± 0.24	0.083 ± 0.43 (LT)	1.05 ± 0.22
THTA1320	20 - 21	1.63 ± 0.29	0.069 ± 0.036 (LT)	1.33 ± 0.24
THTA1318	18 - 19	1.45 ± 0.27	--	1.23 ± 0.23
THTA1399	18 - 19	1.45 ± 0.33	--	1.01 ± 0.25
THTA1835	35 - 36	1.92 ± 0.29	0.085 ± 0.030 (LT)	1.33 ± 0.21
THTA1901	0 - 1	1.37 ± 0.22	0.083 ± 0.030 (LT)	1.17 ± 0.19

[a]Background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (Atlan-Tech, 1991)
[b]Background concentration listed or derived in *Off-Site Radiation Exposure Review Project, Phase II Soil Program* (McArthur and Miller, 1989)

ft = Feet
bgs = Below ground surface
MDC = Minimum detectable concentration
pCi/g = Picocuries per gram
J = Estimated value. Qualifier added to laboratory data; record accepted. Duplicate comparison was outside control limits for U-235.
LT = Result is less than requested MDC, greater than sample-specific MDC
-- = Not detected above minimum reporting limit

A.3.7 Gamma Spectrometry Results

Gamma spectrometry results for soil samples detected above MRLs (DOE/NV, 2001) are presented in Table A.3-6. Each analytical result does not exceed normalized difference comparison at a 95 percent confidence level and is not distinguishable from background concentrations listed in the *Off-Site Radiation Exposure Review Project, Phase II Soil Program* (McArthur and Miller, 1989) or the *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (Atlan-Tech, 1991); therefore, they do not exceed PALs (DOE/NV, 2001).

A.3.8 Geotechnical Results

Contamination was identified during the investigation above PALs at one location. The sample collected at the interval below the contamination did not exceed PALs. The contamination for bis(2-ethylhexyl) phthalate is associates with the debris found at the sample interval. Similar debris at other locations did not exceed the PALs for bis(2-ethylhexyl) phthalate. In addition, arsenic exceeded the PALs at nearly all locations sampled. The PAL of 2.7 mg/kg is lower than the 7 to 8 mg/kg mean concentration of arsenic in silt from the Nellis Air Force Range (NBMG, 1998; Moore, 1999) and lower than range of concentrations of 6 to 43 mg/kg in soils from locations near the TTR (SNL, 1999). Geotechnical samples were not submitted to the laboratory for analysis.

Table A.3-6
Soil Sample Results for Gamma Spectrometry Detected Above Minimum Reporting Limits
(Page 1 of 2)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)							
		Ac-228[a]	Bi-212[b]	Bi-214[a]	K-40[a]	Pb-212[a]	Pb-214[b]	Th-234[b]	Tl-208[a]
Background Concentration Range (pCi/g)		<0.19-3.64	<0.19-3.64	<0.1-3.47	8.3-97.7	<0.19-3.64	<0.1-3.47	<0.1-3.47	0.5-3.38
TH06E03	3	1.27 ± 0.27	1.45 ± 0.62	0.88 ± 0.19	28.4 ± 4.9	1.45 ±0.27	0.91 ± 0.18	--	0.46 ± 0.10
TH08E03	3	1.24 ± 0.35	--	1.25 ± 0.31	28.6 ± 5.7	1.48 ± 0.31	1.23 ± 0.27	2.28 ± 0.87	0.57 ± 0.16
TH08E08	8	1.29 ± 0.33	--	1.1 ± 0.27	25.1 ± 4.9	1.51 ± 0.30	1.2 ± 0.25	--	0.5 ± 0.13
TH17E05J	5	1.25 ± 0.33	--	1.08 ± 0.27	33.6 ± 6.3	1.75 ± 0.34	1.27± 0.27	--	0.5 ± 0.13
TH17E07I	7	1.02 ± 0.44	--	1.2 ± 0.29	30.1 ± 5.9	1.62 ± 0.32	1.07 ± 0.24	--	0.51 ± 0.14
TH17E08B	8	1.24 ± 0.34	--	1.17 ± 0.30	28.1 ± 5.5	1.7 ± 0.34	1.17 ± 0.26	--	0.47 ± 0.11
TH17E10A	10	1.24 ± 0.33	--	0.93 ± 0.26	25.7 ± 5.2	1.63 ± 0.33	1.05 ± 0.24	--	0.45 ± 0.13
TH17E99J	5	1.32 ± 0.34	--	1.04 ± 0.27	28.1 ± 5.5	1.65 ± 0.33	1.1 ± 0.25	--	0.48 ± 0.13
TH1BG30	30 - 31	1.38 ± 0.36	--	1.23 ± 0.31	27.8 ± 5.5	1.83 ± 0.37	1.31 ± 0.29	--	0.57 ± 0.15
TH1BG70	70 - 71	--	--	0.96 ± 0.32	25.5 ± 5.8	0.91 ± 0.28	0.98 ± 0.28	--	0.37 ± 0.15
TH2BG30	30 - 31	1.13 ± 0.34	--	0.83 ± 0.26	27 ± 5.5	1.34 ± 0.31	0.91 ± 0.24	--	0.42 ± 0.13
TH2BG70	70 - 71	1.02 ± 0.39	--	1.03 ± 0.33	31 ± 6.7	1.24 ± 0.32	1.04 ± 0.27	--	0.36 ± 0.15
THT1201	0 - 1	1.47 ± 0.42	--	1.55 ± 0.39	28 ± 5.7	1.98 ± 0.40	1.33 ± 0.30	--	0.58 ± 0.17
THT12S01	0 - 1	1.54 ± 0.36	--	0.89 ± 0.25	27.4 ± 5.3	1.71 ± 0.34	1.23 ± 0.27	--	0.47 ± 0.12
THT1520	20 - 21	1.75 ± 0.44	--	1 ± 0.29	32.9 ± 5.6	2.18 ± 0.44	1.43 ± 0.32	--	0.57 ± 0.16
THT465	65 - 66	1.02 ± 0.36	--	0.94 ± 0.31	25.6 ± 5.6	1.92 ± 0.40	1.02 ± 0.27	--	0.51 ± 0.16
THT499	65 - 66	1.58 ± 0.45	--	0.85 ± 0.25	24.4 ± 5.1	1.7 ± 0.36	0.95 ± 0.25	--	0.51 ± 0.15
THT9S05W	5 - 6	1.21 ± 0.30	--	0.88 ± 0.23	26.6 ± 5.1	1.42 ± 0.29	1.04 ± 0.23	--	0.44 ± 0.12
THTA1132	32.5 - 33.5	1.22 ± 0.36	--	1.23 ± 0.31	27.9 ± 5.6	1.53 ± 0.33	1.09 ± 0.26	--	0.5 ± 0.15
THTA1199	32.5 - 33.5	1.47 ± 0.30	1.53 ± 0.61	1.05 ± 0.22	27.3 ± 4.8	1.66 ± 0.31	1.23 ± 0.23	--	0.449 ± 0.099

Table A.3-6
Soil Sample Results for Gamma Spectrometry Detected Above Minimum Reporting Limits
(Page 2 of 2)

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)							
		Ac-228[a]	Bi-212[b]	Bi-214[a]	K-40[a]	Pb-212[a]	Pb-214[b]	Th-234[b]	Tl-208[a]
Background Concentration Range (pCi/g)		<0.19-3.64	<0.19-3.64	<0.1-3.47	8.3-97.7	<0.19-3.64	<0.1-3.47	<0.1-3.47	0.5-3.38
THTA1318	18 - 19	1.42 ± 0.36	--	1.09 ± 0.28	32.1 ± 6.3	1.65 ± 0.33	1.11 ± 0.24	--	0.44 ± 0.13
THTA1320	20 - 21	1.54 ± 0.44	--	1.17 ± 0.35	32.6 ± 6.5	2.59 ± 0.50	1.31 ± 0.31	--	0.67 ± 0.19
THTA1399	18 - 19	1.45 ± 0.34	--	1.17 ± 0.28	30.4 ± 5.7	1.76 ± 0.34	1.01 ± 0.23	--	0.5 ± 0.13
THTA1835	35 - 36	1.42 ± 0.41	--	1.12 ± 0.36	25.1 ± 5.4	1.72 ± 0.37	1.3 ± 0.31	--	0.52 ± 0.17
THTA1901	0 - 1	1.48 ± 0.44	--	1.07 ± 0.31	24 ± 5.1	1.38 ± 0.30	1.22 ± 0.28	--	0.54 ± 0.16

[a]Background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (Atlan-Tech, 1991)
[b]Background concentration listed or derived in *Off-Site Radiation Exposure Review Project, Phase II Soil Program* (McArthur and Miller, 1989)

-- = Not detected above minimum reporting limits
pCi/g = Picocuries per gram
ft = Feet
bgs = Below ground surface
Ac = Actinium
Bi = Bismuth
Cs = Cesium
K = Potassium
Pb = Lead
Th = Thorium
Tl = Thallium

A.4.0 Quality Assurance

This section contains a summary of the QA/QC measures implemented during the sampling, analysis, and investigation activities for CAU 487 corrective action investigation. The following sections of this appendix discuss the data validation process and an evaluation of the data quality indicators (DQIs) of precision, accuracy, completeness, representativeness, and comparability for analytical results.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any contaminants of potential concern (COPCs) present. The QA/QC was implemented for all laboratory samples including documentation, data verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Industrial Sites QAPP (DOE/NV, 1996).

A.4.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (DOE/NV, 1996) and approved procedures. All laboratory data from samples collected and analyzed for CAU 487 were evaluated for data quality according to the EPA Functional Guidelines (EPA, 1994 and 2000a). These guidelines are implemented in a tiered process and are presented in Section A.4.1.1 through Section A.4.1.3. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results passed data-validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

One hundred percent of the data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on six samples.

A.4.1.1 Tier I Evaluation

Tier I evaluation for both chemical and radiological analysis examines (but is not limited to):

- Sample count/type consistent with chain of custody

- Analysis count/type consistent with chain of custody
- Correct sample matrix
- Significant problems stated in cover letter or case narrative
- Completeness of certificates of analysis
- Completeness of contract laboratory program (CLP) or CLP-like packages
- Completeness of signatures, dates, and times on chain of custody
- Condition-upon-receipt variance form included
- Requested analyses performed on all samples
- Date received/analyzed given for each sample
- Correct concentration units indicated
- Electronic data transfer supplied
- Results reported for field and laboratory QC samples
- Whether or not the deliverable met the overall objectives of the project
- Proper field documentation accompanies project packages

A.4.1.2 Tier II Evaluation

Tier II evaluation for both chemical and radiological analysis examines (but is not limited to):

Chemical:

- Correct detection limits achieved
- Sample date, preparation date, and analysis date for each sample
- Holding time criteria met
- QC batch association for each sample
- Cooler temperature upon receipt
- Sample pH for aqueous samples, as required
- Detection limits properly adjusted for dilution, as required
- Blank contamination evaluated and applied to sample results/qualifiers
- Matrix spike/matrix spike duplicate (MS/MSD) percent recovery (%R) and relative percent difference (RPDs) evaluated and applied to laboratory results/qualifiers
- Field duplicate RPDs evaluated using professional judgement and applied to laboratory results/qualifiers
- Laboratory duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Surrogate %Rs evaluated and applied to laboratory results/qualifiers
- Laboratory control sample %R evaluated and applied to laboratory results/qualifiers
- Initial and continuing calibration evaluated and applied to laboratory results/qualifiers
- Internal standard evaluated and applied to laboratory results/qualifiers
- Mass spectrometer tuning criteria
- Organic compound quantitation
- Inductively coupled plasma (ICP) interference check sample evaluation
- Graphite furnace atomic absorption quality control
- ICP serial dilution effects

- Recalculation of 10 percent of laboratory results from raw data

Radioanalytical:

- Correct detection limits achieved
- Blank contamination evaluated and applied to sample results/qualifiers
- Certificate of Analysis consistent with data package documentation
- Quality control sample results (duplicates, laboratory control samples, laboratory blanks) evaluated and applied to laboratory result qualifiers
- Sample results, error, and minimum detectable activity evaluated and applied to laboratory result qualifiers
- Detector system calibrated to National Institute for Standards and Technology (NIST) traceable sources
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations
- Detector system response to daily, weekly, and monthly background and calibration checks, which may include 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
- QC sample results (e.g., calibration source concentration, percent recovery, and RPD) verified
- Spectra lines, emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration
- Recalculation of 10 percent of laboratory results from raw data

A.4.1.3 Tier III Evaluation

A Tier III evaluation looks at all the items evaluated in the Tier II evaluation, but for only a limited number of samples (typically 5 percent). It serves as a check on the Tier II process. The Tier III review includes the additional evaluations:

Chemical:

- Recalculation of laboratory results from raw data

Radioanalytical:

- Radionuclides and their concentration appropriate considering their decay schemes and half-lives

- Each identified line in spectra verified against emission libraries and calibration results
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results
- Recalculation of laboratory results from raw data

A Tier III review of 6 samples was conducted by TechLaw, Inc. in Lakewood, Colorado. The qualifiers for the three samples analysed for radiochemical analysis did not change based on the Tier III review. The qualifiers for chemical analysis regarding three samples (THTA1318, THTA1399, THTA1320) was changed for lithium based on the review, lithium results should have been estimated at the Tier II level. This review has been reflected for that sample delivery group (SDG).

A.4.2 Quality Control Samples

There were 39 trip blanks, six field blanks, two source blanks, one equipment rinsate blanks, five MS/MSD, and five field duplicates collected and submitted for laboratory analysis as shown in Table A.3-1. The quality control samples and duplicates were assigned individual sample numbers and sent to the laboratory "blind." Additional samples were selected by the laboratory to be analyzed as laboratory duplicates. Documentation related to the collection and analysis of these samples is retained in project files.

A.4.2.1 Field Quality Control Samples

Review of the field-blank analytical data for the CAU 487 soil sampling indicates that cross contamination from field methods did not occur during sample collection. Field, equipment rinsate, and source blanks were analyzed for the parameters listed in Table A.2-1 and trip blanks were analyzed for VOCs only. Several different contaminants were detected in some of the samples but they were below or slightly above the contract required detection limit (CRDLs).

During the sampling events, five field duplicate soil samples were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-1. For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding field duplicate sample results) were evaluated to the guidelines set forth in EPA Functional Guidelines (EPA, 1994 and 2000a).

A.4.2.2 Laboratory Quality Control Samples

Analysis of method QC blanks were performed on each sample delivery group (SDG) for inorganics. Analysis for surrogate spikes and preparation blanks (PBs) were performed on each SDG for organics only. Initial and continuing calibration and laboratory control samples (LCS) were performed for each SDG by Paragon Analytics, Inc. The results of these analyses were used to qualify associated environmental sample results according to EPA Functional Guidelines (EPA, 1994 and 2000a). Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

A.4.3 Field Nonconformances

One field nonconformance was identified regarding trip blanks not sent to the laboratory with the associated samples. This nonconformance was issued in accordance with IT Corporation, Las Vegas (ITLV) Standard Quality Practice: ITLV 0404, “Collection of Field Quality Control Samples”. It was determined that the water samples THT13FB, TH00E00, and TH00E01, and soil samples THTA701, THTA710, THT237, THT259, and TH06E03 did not have the correct associated trip blanks. The trip blanks associated with these SDGs were discarded with samples discarded in the field. Because of the error in sending the wrong trip blanks to the laboratory, the samples were analyzed without the required associated trip blanks. Documentation of the nonconformance is retained in the project files.

A.4.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in analytical instrumentation operation, sample preparation, extractions, and fluctuations in internal standard and calibration results. Sixteen laboratory issued nonconformances were identified. The nonconformances have been accounted for the data qualification process. Documentation of the nonconformances are retained in project files.

A.4.5 Data Quality Indicators

In this section, specific data measurements are defined that were used to determine if the quality control objectives established for this investigation were met and if the resulting data were deemed

useful for the purpose for which it was collected. Data were evaluated against specific criteria to verify the achievement of DQI goals established to meet the project DQOs as provided in the Industrial Sites QAPP (DOE/NV, 1996) and the CAU 487 CAIP (DOE/NV, 2001). The DQIs for this project include precision, accuracy, representativeness, completeness, and comparability.

A.4.5.1 Precision

Precision is a measure of agreement among a replicate set of measurements of the same property under similar conditions. This agreement is expressed as the RPD between duplicate measurements (EPA, 1996). The RPD is determined by dividing the difference between the replicate measurement values by the average measurement value and multiplying the result by 100, or:

$$RPD = \left| 100 \times [(a_1 - a_2)/(a_1 + a_2)/ 2] \right|$$

Where

a_1 = The sample value, and
a_2 = The duplicate sample value.

Determinations of precision can be made for field samples, laboratory duplicates, or both. For field samples, duplicates are collected simultaneously with a sample from the same source under similar conditions in separate containers. The duplicate sample is treated independently of the original sample in order to assess field impacts and laboratory performance on precision through a comparison of results. Laboratory precision is evaluated as part of the required laboratory internal QC program to assess performance of analytical procedures. The laboratory sample duplicates are an aliquot, or subset, of a field sample generated in the laboratory. They are not a separate sample but a portion of an existing sample. Typically, other laboratory duplicate QC samples include MSD and laboratory control sample duplicate (LCSD) samples for organic, inorganic and radiological analyses. Since field duplicates often do not contain adequate radionuclide concentration to determined the RPD, MSDs are prepared and analyzed with the selected sample batches.

The variability in the results from the analysis of field duplicates is generally greater than the variability in the results of laboratory duplicates. This higher variability for field duplicates results from the increased potential to introduce factors influencing the analytical results during sampling,

sample preparation, containerization, handling, packaging, preservation, and environmental conditions before the samples reach the laboratory. Laboratory QC samples assess only the variability of results introduced by sample handling and preparation in the laboratory and by the analytical procedure, which also impacts field duplicates. In addition, the variability in duplicate results is expected to be greater for soil samples than water samples, primarily due to the inherent nonhomogeneous nature of soil samples, despite sample preparation methods that include mixing to improve sample homogeneity.

A.4.5.1.1 Precision for Chemical Analysis

The RPD criteria used for assessment of laboratory sample duplicate precision associated with SVOCs, VOCs, and metals analytical results of samples collected at CAU 487 are established in the EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994.) The RPD criteria for explosives are established by the laboratory to evaluate precision for MSD and LCSD analyses. The control limits are evaluated at the laboratory on a quarterly basis by monitoring the historical data and performance for each method. No review criteria for field duplicate RPD comparability have been established; therefore, the laboratory sample duplicate criteria were applied to the review of field duplicates.

Precision values for organic and inorganic analysis that are within the established control criteria indicate that analytical results for associated samples are valid. The RPD values that are outside the criteria for organic analysis do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgement about the quality of the reported analytical results. Inorganic laboratory sample duplicate RPD values outside the established control criteria do result in the qualification of associated analytical results as estimated. Out of control RPD values do not necessarily indicate that the data is not useful for the purpose intended; however, it is an indication that data precision should be considered for the overall assessment of the data quality and potential impact on data application in meeting project site characterization objectives.

The assessment of precision is only conducted for analytical results when either the sample or duplicate result is above the instrument detection limit (IDL) or the method detection limit (MDL), as applicable. When a positive result for a parameter of interest is indicated, precision is

determined. Consequently, when both the sample and duplicate results are "nondetects" or analytical results are below the applicable limit of detection for the instrument or method, associated sample results are not included in the calculation of precision. For example, a sample analyzed for total RCRA metals by method EPA 6010 provides results for arsenic, barium, cadmium, chromium, lead, selenium and silver. If the analytical results yield positive results or "detects" for only four of the seven analytes, then the number of measurements used in the calculation of precision for this analysis is limited to the four positive results. Method-specific precision as RPD is determined by taking the number of measurements within criteria, dividing that by the number of measurements analyzed, and multiplying by 100.

For the purpose of determining data precision of sample analyses for CAU 487, all water and soil samples including field QC samples (i.e., trip blanks, equipment rinsate samples, field blanks, etc.) were evaluated and incorporated into the precision calculation.

Precision for the measurement of target compounds or analytes collected at CAU 487 was determined for VOCs, SVOCs, explosives, and metals.

Table A.4-1 provides the field and laboratory duplicate precision analysis results.

Inorganic laboratory sample duplicate RPD values outside the established control criteria result in a qualification as estimated for that measurement of all associated samples in the SDG. For example, if a laboratory sample duplicate had an RPD value for lead outside the established control criteria, lead results for all of the samples in that SDG would be qualified and estimated.

Arsenic results for seven samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria. Cadmium results for 12 samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria. Chromium results for two samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria. Selenium results for 42 samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria. Silver results for 15 samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria. Mercury results for 15 samples were qualified as estimated for associated laboratory duplicate RPDs exceeding criteria

Table A.4-1
Chemical Precision Measurements for CAU 487

	ORGANICS			INORGANICS	
	VOCs	SVOCs	Explosives	*METALS	MERCURY
Field Duplicate (FD) Precision					
Total Number of FD Measurements	276	355	75	47	5
Total Number of RPDs within criteria	276	353	75	45	4
FD % Precision	100	99.44	100	95.74	80.00
Laboratory Sample Duplicate (Lab-Dup) Precision					
Total Number of Lab-Dup Measurements	N/A	N/A	N/A	107	12
Total Number of RPDs within criteria	N/A	N/A	N/A	98	10
Lab-Dup % Precision	N/A	N/A	N/A	92	83
Laboratory Control Sample Duplicate (LCSD) Precision					
Total Number of LCSD Measurements	85	198	240	124	17
Total Number of RPDs within criteria	85	198	238	124	17
LCSD % Precision	100	100	99.17	100	100
Matrix Spike Duplicate (MSD) Precision					
Total Number of MSD Measurements	30	121	121	107	13
Total Number of RPDs within criteria	25	119	121	106	13
MSD % Precision	83.33	98.35	100	99.07	100

* As = Arsenic
Ba = Barium
Cd = Cadmium
Cr = Chromium
Pb = Lead
Se = Selenium
Ag = Silver
B = Boron
Li = Lithium
Ta = Tantalum

Sample THTA1318 and its field duplicate THTA1399 had SVOCs RPD criteria exceeded for bis(2-ethylhexyl)phthalate and di-n-octylphthtalate. Metals RPD criteria for this sample were exceeded for lead. Selenium and mercury RPD criteria were exceeded for Sample THTA1132 and its field duplicate THTA1199.

Only inorganic laboratory sample duplicate analysis has review criteria; therefore, only RPD values from laboratory sample duplicates that are outside the established limits will result in qualified data.

Out of control RPD values do not necessarily indicate that the data is not useful for the purpose intended. It does indicate that precision should be considered for the overall assessment of the data quality and impact to the application of associated data to meeting the project's objectives.

A.4.5.1.2 Precision for Radiochemical Analysis

The RPD control limit for radiochemical measurements has been set at 35 percent for soil and 20 percent for water. If the RPD is exceeded, samples will be qualified. Field duplicates will be evaluated, but samples will not be qualified based on their results. The MSD results outside the control limit may not result in qualification of the data. An assessment of the entire analytical process including the sample matrix is conducted to determine if qualification is warranted.

The evaluation of precision based on duplicate RPD requires that both the sample and its duplicate have concentrations of the target radionuclide exceeding five times their minimum detectable concentration. This excludes many measurements because the samples contain nondetectable or low levels of the target radionuclide. However, there are two other methods for evaluating duplicate data, based on the measurement uncertainty, which are associated with every radioanalytical result. One precision test requires that the difference between the duplicate results does not exceed the sum of their total propagated uncertainties (TPU), and is utilized when the RPD is not applicable. The other precision test, which is always evaluated, is the normalized difference expressed by:

$$Normalized \quad Difference \quad \frac{S-D}{\sqrt{(TPU_S)^2 + (TPU_D)^2}}, where$$

Where:

S = Sample Result
D = Duplicate result
TPU_S = 2σ TPU of the sample
TPU_D = 2σ TPU of the duplicate
σ = standard deviation

The control limit for the normalized difference is -1.96 to 1.96, which represent a confidence level of 95 percent.

Samples are qualified based on these duplicate tests for laboratory prepared duplicates, but not field duplicates. Depending on the sample concentration, typically only one duplicate evaluation needs to be performed.

A duplicate comparison that is outside control limits does not necessarily indicate that the data is not useful for the purpose intended; however, it is an indication that data precision should be considered for the overall assessment of the data quality and potential impact on data application in meeting project site characterization objectives.

For the purpose of determining data precision of sample analysis for CAU 487, all water and soil samples, including field duplicates, were evaluated and incorporated into Table A.4-2 through Table A.4-5.

The isotopic gamma analysis provides results for 40 radionuclides. Only two or three of these radionuclides are usually present in sufficient concentrations to allow the determination of their RPDs. The duplicate data for the remaining radionuclides is compared using the normalized difference and comparison of the result difference to the uncertainty sum. The MSD samples were not analyzed by the laboratory because of the difficulty in preparing homogeneous spiked duplicates and the radioactive waste produced.

Table A.4-2
Laboratory Gamma Spectrometry Precision

	Number within Criteria	Number performed	% Precision
Laboratory sample RPDs	20	20	100
Matrix Spike RPDs	NA	NA	NA
Normalized Difference	560	560	100
Sample difference > sum of uncertainties	538	540	99.63

Table A.4-3
Laboratory Isotopic Uranium Precision

	Number within Criteria	Number performed	% Precision
Laboratory sample RPDs	25	25	100
Matrix Spike RPDs	12	12	100
Normalized Difference	39	39	100
Sample difference > sum of uncertainties	10	11	90.91

Table A.4-4
Field Gamma Spectrometry Precision

	Number within Criteria	Number performed	% Precision
RPDs	10	10	100
Normalized Difference	160	160	100
Sample difference > sum of uncertainties	149	150	99.33

Table A.4-5
Field Isotopic Uranium Precision

	Number within Criteria	Number performed	% Precision
RPDs	8	8	100
Normalized Difference	12	12	100
Sample difference > sum of uncertainties	4	4	100

The isotopic uranium analysis includes the measurement of three radionuclides, two of which often occur in concentrations sufficient for RPD evaluation. As shown by the uranium precision results in Table A.4-3, 98.9 percent of the tests were within limits.

Overall, the precision for the radioanalytical measurements was very high. The percentage of acceptable results measuring laboratory precision ranged from 98.9 percent for the isotopic uranium analysis to 99.8 percent for the gamma analysis. A total of 1,204; or 99.8 percent, of the 1,207 gamma and isotopic uranium laboratory precision tests performed, were acceptable.

The results of the duplicate comparison of the field duplicates is provided in Table A.4-4 and Table A.4-5. The precision for all the field duplicates was an exceptional 100 percent.

Since the average percentage of acceptable results for all the precision tests (including both laboratory and field duplicates) was greater than 99 percent, radiochemical measurements performed for CAU 487 should be considered valid in regard to precision.

A.4.5.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that result from sampling and analytical operations.

A.4.5.2.1 Accuracy for Chemical Analysis

Accuracy is determined by analyzing a reference material of known pollutant concentration or by reanalyzing a sample to which a material of known concentration or amount of pollutant has been added (spiked). Accuracy is expressed as % R for the purposes of evaluating the quality of data reported for CAU 487.

Matrix spike samples are prepared by adding a known concentration of a target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used to determine the laboratory's overall efficiency by comparing the percent recovered to the known true value. For example, a sample that is spiked with 10 ppm of a known analyte should produce a reported result of 10 ppm greater than the value

of the sample itself. Consequently, the accuracy for this analysis would be reported as 100 percent. Matrix spike recoveries within the specified criteria for organic and inorganic analyses indicate the laboratory is operating within established controls and producing valid, quality results. Matrix spike results outside the control limits for organic analyses may not result in qualification of the data. An assessment of the entire analytical process is performed to determine the quality of the data and whether qualification is necessary.

The LCSs are generated to provide accuracy of analytical methods and laboratory performance. They are prepared, extracted (as required by method), analyzed and reported once per SDG, per matrix. For organic analyses, laboratory control limits are used to evaluate the accuracy of all analyses. The control limits are evaluated at the laboratory quarterly by monitoring the historical data and performance for each method. The acceptable limits for inorganic analyses are established in the EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994). Sample results within established control ranges for organic and inorganic analyses show when the analytical method is accurate and the data provided are valid.

Surrogates (system monitoring compounds) are used to assess the method performance for each sample analyzed for organic analyses. Control limits established by the laboratory are also used to evaluate the accuracy of the surrogate recoveries. Factors beyond the laboratory's control, such as sample matrix effects, can cause the measured values to be outside of the established criteria. Therefore, the entire sampling and analytical process must be evaluated when determining the quality of the analytical data provided.

Table A.4-6 identifies the number of matrix spike, laboratory control, and surrogate measurements performed for CAU 487. The table presents the total number of measurements analyzed, the number of measurements within the specified criteria, and the percent-accuracy of each method. Method specific accuracy was determined by taking the number of measurements within criteria, dividing that by the total number of measurements analyzed, and multiplying by 100. Surrogates were analyzed for each sample in the organic analyses; therefore, the number of surrogates is significantly greater than the number of matrix spike and laboratory control samples.

Table A.4-6
Laboratory Accuracy Measurements for CAU 487

	ORGANICS			INORGANICS	
	VOCs	SVOCs	Explosives	*Metals	Mercury
Matrix Spike (MS) Accuracy					
Total number of MS measurements	60	242	242	214	26
Total number of MS measurements within criteria	52	242	204	195	26
MS % Accuracy	86.67	100	84.30	91.12	100
Laboratory Control Sample (LCS) Accuracy					
Total number of LCS measurements	170	407	480	258	34
Total number of LCS measurements within criteria	170	407	434	258	34
LCS % Accuracy	100	100	90.42	100	100
Surrogate Accuracy					
Total number of measurements	5175	8023	1724	N/A	N/A
Total number of measurements NOT affected by out-of-control surrogates	5173	7739	1665	N/A	N/A
Surrogate %accuracy	99.96	96.46	96.58	N/A	N/A

The matrix spike accuracy results for organic analyses in Table A.4-6 includes the total number of matrix spike measurements per analysis and the number of matrix spike measurements within the criteria. All samples for organic analyses within the associated SDG are not qualified, only the native sample in which the spike was added. Although, several matrix spikes where outside of criteria (recovery above the control limit) in organic analyses, all associated sample results were nondetect, so no samples were estimated due to high VOC and explosives matrix spike recoveries. Inorganic matrix spike results outside of the established control criteria do result in data qualified as estimated for all the samples in that batch. However, only the analyte(s) outside of control requires qualification. For example, in this CAU matrix spike recovery for lithium exceeded criteria and lithium results for samples (THT1520, THT450, THT465, and THT499) in that particular SDG were estimated. Two samples (THTA1318 and THTA1399) were rejected in this CAU due to a nondetect result and a matrix spike recovery less than 30 percent.

Table A.4-6 includes the total number of LCS measurements per analysis and the number of LCS measurements within criteria. Laboratory control samples within the specified criteria for organic and inorganic analyses indicate the laboratory is producing valid data. Laboratory control samples outside of the established criteria result in the qualification of inorganic data and may result in the qualification of organic data. In organic analyses, an evaluation of the overall analytical process is performed to determine if data qualification is necessary. Inorganic LCS recoveries outside of established controls require data to be qualified for the individual analyte out of control. If the LCS criteria are not met, the laboratory performance and method accuracy are in question. In explosives analyses, out-of-control LCSs were above control limits (indicating high bias). Because all associated samples analyzed for explosives were nondetect, no samples were estimated due to the high LCS spike recovery.

Surrogates reported within established control criteria indicate laboratory method performance and matrix influences on the samples and result in quality, valid data. Table A.4-6 includes the total number of sample measurements performed for each method and the total number of sample measurements qualified for surrogate recoveries exceeding criteria. The estimated VOC, SVOC and explosives data in this CAU do not necessarily indicate the data is not useful. Data qualification is one factor to be considered in the overall assessment of the data quality and the impact to the project's objectives.

Accuracy for the measurement of target analytes collected at CAU 487 was determined for VOCs, SVOCs, explosives, and metals.

For the purpose of determining data accuracy of sample analysis for CAU 487, all water and soil samples including field QC samples (i.e., trip blanks, equipment rinsate samples, field blanks, etc.) were evaluated and incorporated into the accuracy calculation.

A.4.5.2.2 Accuracy for Radiochemical Analysis

The LCS and MS are used to determine the accuracy of radioanalytical measurements. The LCS is prepared by adding a known concentration of the radionuclide being measured to a sample that does not contain radioactivity (i.e., distilled water). This sample is analyzed with the field samples using

the same sample preparation, reagents, and analytical methods employed for the samples. One LCS is prepared with each batch of samples for analysis by a specific measurement.

The MS samples are prepared by adding a known concentration of a target analyte to a specified field sample with a measured concentration. The MS samples are analyzed to determine if the measurement accuracy is affected by the sample matrix. The MS samples are analyzed with sample batches when requested.

The accuracy of the LCS determination is expressed as a percent recovery by the following:

$$\text{\% Recovery (\% R)} = \frac{\text{Amount of Analyte Measured}}{\text{Amount of Analyte Added}} \times 100$$

The accuracy of the MS determination is expressed as a percent recovery by the following:

$$\text{\% Recovery (\% R)} = \frac{\text{MS Result - Sample Result}}{\text{Amount of Analyte Added}} \times 100$$

If the results are within acceptable control limits, qualifiers will not be added to the field samples analyzed with the LCS and/or MS. However, MS results outside this control range may not result in qualification of the data. An assessment of the entire analytical process including the sample matrix is performed to determine if qualification is necessary.

Tables A.4-7 and A.4-8 identify the number of matrix spikes and laboratory control samples, including soil and water matrices, measured for each radiochemical measurement for CAU 487. The percent accuracy for the procedure is determined as the number of MS or LCS samples analyzed within the control limits divided by the total number analyzed, and multiplied by 100.

Table A.4-7
Laboratory Control Sample (LCS) Accuracy

	Gamma	Isotopic Uranium
Total Number	79	42
Total Number within Criteria	79	42
LCS % Accuracy	100	100

Table A.4-8
Matrix Spike (MS) Accuracy

	Gamma	Isotopic Uranium
Total Number	NA	16
Total Number within Criteria	NA	16
MS % Accuracy	NA	100

Each isotopic gamma LCS sample contains four or five radionuclides, each of which has a percent recovery determined. Matrix spike measurements are usually not performed with gamma measurements because of the difficulty in preparing homogeneous samples and the radioactive waste created.

Three uranium radionuclides are added to the isotopic uranium LCS and MS samples, but the U-235 concentration is usually too low to allow evaluation.

Laboratory control samples within the specified criteria for radiological analyses indicate the laboratory is producing valid data. If the LCS criteria are not met, the laboratory performance and method accuracy are in question. Radiological LCS recoveries outside of established controls require data to be qualified for the individual analyte out of control. Since LCS recoveries were 100 percent for all analyses, no data was qualified based on LCS performance. Because all LCS and MS recoveries were 100 percent for all analyses included in CAU 487, the laboratory accuracy can be considered exceptional.

A.4.6 Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid. A sampling and analytical requirement of 80 percent completeness was achieved for this project (Table A.4-9) (DOE/NV, 1996). For CAU 487, components used to measure completeness were total number of samples sent to the laboratory, but not analyzed due to problems with samples (e.g., broken bottles, insufficient quantity, temperature excursions); and samples that were collected and sent but never received by the laboratory. Percent completeness was determined by dividing the total number of samples analyzed by the total number of samples sent to the laboratory and multiplying by 100. See Table A.4-9 and Table A.4-10 for results of completeness per analytical method.

Table A.4-9
CAU 487 Completeness Table
Total Parameters

	EPA6010	EPA7470	EPA8260	EPA8270	EPA8330	HASL300	ISOU	Totals
Total # Parameters Analyzed								
Total Usable Parameters	906	113	5175	8022	1724	1435	108	17483
Total Not Usable Parameters	2	0	0	1*	0	5	0	8
Percent Completeness	99.8	100	100	99.9	100	99.7	100	99.9

***** Field Blank

The specified sampling locations were utilized as planned. All samples were collected as specified in the CAIP (DOE/NV, 2001). All sample containers reached the laboratory intact and properly preserved (when applicable). Sample temperature was maintained during shipment to the laboratory, and sample chain of custody was maintained during sample storage and/or shipment (DOE/NV, 1996).

Table A.4-10
CAU 487 Completeness Table
Total Samples

	EPA6010	EPA7470	EPA8260	EPA8270	EPA8330	HASL300	ISOU	Totals
Total # samples sent to laboratory	113	113	78	113	115	36	36	604
Total # samples analyzed	113	113	75	113	115	36	36	601
Percent completeness	100	100	96	100	100	100	100	99.5
Total # samples not analyzed:								
- Broken bottles, lids, etc	0	0	0	0	0	0	0	0
- Analysis cancelled per ITLV	0	0	3	0	0	0	0	3
(THTA7TB; THTB7TB; THTD7TB)								
- Samples not received at laboratory	0	0	0	0	0	0	0	0
- Samples put on hold	0	0	0	0	0	0	0	0

A.4.7 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EPA, 1987). Representativeness was assured by collecting the specified number of samples from proper sampling locations and analyzing them by the approved analytical methods (DOE/NV, 2001). A review of field documentation suggests that representative samples were collected and analyzed in accordance with approved procedures and plans; this is confirmed through several field surveillances conducted for this investigation that did not find any nonconformances (see Section A.4.3). Table A.4-11 represents the number of rejected samples based on the analytical results. Because field-collected blank data were shown to be “clean” (Section A.4.2), this indicates that environmental analytical data were representative of the media sampled and cross contamination was not introduced during the sampling process.

Table A.4-11
CAU 487 Rejected Data Table

	EPA6010	EPA7470	EPA8260	EPA8270	EPA8330	HASL300	ISOU	Totals	% Rejected
Total # samples of rejected - Field	0	0	0	0	0	0	0	0	0
Total # samples affected by rejected qualifiers - laboratory	2	0	0	1	0	5	0	8	1.3
Total # samples affected by rejected qualifiers - laboratory (reanalysis)	0	0	0	0	0	0	0	0	0

A.4.8 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 1987). To ensure comparability, all samples were subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria. The CAU 487 field and sampling activities were performed and documented in accordance with approved procedures, and all samples were collected in accordance with the CAIP (DOE/NV, 2001). Approved standard methods and procedures were also used to analyze and report this data (e.g., CLP and/or CLP-like data packages). This approach ensures that the data from this project can be compared to other datasets. Based on the minimum comparability requirements specified in the Industrial Sites QAPP (DOE/NV, 1996), all requirements were met.

A.5.0 Summary

Analysis of the data generated from corrective action investigation activities at CAU 487 indicates the following:

Analytes detected during the corrective action investigation were evaluated against preliminary action levels to determine contaminants of concern for CAU 487. Assessment of the data generated from corrective action investigation activities indicates the preliminary action levels were not exceeded for total volatile organic compounds, tantalum, lithium, boron, high explosives, isotopic uranium, and gamma spectrometry for any of the soil samples collected from CAU 487.

Analyses for total semivolatile organic compounds revealed one sample exceeded the preliminary action level for bis (2-ethylhexyl) phthalate. It was determined that the sample location contained plastic insulation from wires that would contribute to the elevated reading.

The analysis for total RCRA metals determined that several samples had elevated readings for arsenic that exceeded preliminary action levels. The readings are consistent with native soils for the region.

Additionally, several housekeeping activities were completed at surface anomaly locations throughout the site, under best management practices.

Debris at A8 and A17 exceeded the volume for removal. There is a use restriction on these locations due to the amount and extent of the debris buried.

A.6.0 References

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Appendix B

Data Assessment

B.1.0 Data Assessment

This appendix provides an assessment of CAU 487 investigation results to determine whether the data met the DQOs and can support their intended use in the decision-making process. This assessment includes a reconciliation of the data with the conceptual site model(s) established for this project.

B.1.1 Statement of Usability

This section provides an evaluation of the DQIs in interpreting the degree of acceptability or usability of the reported data in the decision-making process.

B.1.1.1 Precision

Heterogeneity in the sampled material from the CAU 487 site is evidenced by the difference in reported precision between the laboratory and field duplicates shown in Table A.4-1 through Table A.4-5, and Table A.4-7. Accounting for sample heterogeneity, the precision of the dataset is demonstrated to be very high. Laboratory measurement error associated with analytical measurement variability is well within acceptable limits.

B.1.1.2 Accuracy

Laboratory accuracy for the CAU 487 dataset was 100 percent for SVOCs, mercury, isotopic uranium, and gamma. The laboratory accuracy for VOCs was 86.67 percent, explosives was 84.30 percent, and for metals was 91.12 percent. The complete datasets are identified in Table A.4-6 through Table A.4-9.

B.1.1.3 Completeness

The analytical results for two VOC analyses were rejected because sample temperature was not documented during storage. The analytical results for three SVOC analyses were rejected due to possible matrix effects or because internal standard area count exceeded the QC limits. These rejected data do not affect closure decisions because data from other depths can be used.

The CAU 487 dataset provides sufficient information to support the decisions and meets the data quality objectives for completeness stipulated in the CAIP.

B.1.1.4 Representativeness

A review of field documentation suggest that representative samples were collected and analyzed in accordance with approved procedures and plans is confirmed through several field surveillances conducted for this investigation which revealed 1 nonconformance (see Section A.4.3). Because field-collected blank data were shown to be "clean" (see Section A.4.2), this indicates that environmental analytical data were representative of the media sampled and cross contamination was not introduced during the sampling process.

CAU 487 data are representative of site characteristics and the dataset satisfies the data quality objectives for representativeness stipulated in the CAIP.

B.1.1.5 Comparability

Field sampling activities were performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved standardized methods and procedures were also used to analyze, report, and validate the data. There is a high confidence that datasets within this project are comparable to all other datasets generated using standardized quality procedures. The CAU 487 dataset is comparable to datasets that were used to generate regulatory criteria and the dataset for meeting the data quality objectives stipulated in the CAIP.

B.1.2 Reconciliation of DQOs to Conceptual Model(s)

This section provides a reconciliation of the data collected and analyzed during this investigation with the preliminary conceptual site models established in the DQO process.

B.1.2.1 Initial Conceptual Models

A conceptual model was developed for CAU 487 as presented in the CAIP (DOE/NV, 2001) based on historical information, geophysical and radiological surveys from July 2000, and process information. A second conceptual model was developed based on initial investigation observations. This data assessment reconciles the investigation results with these conceptual models.

The general conceptual model was applied at all of CAU 487. The general conceptual model included soil potentially impacted by surface disposal or release of contaminants during a series of tests conducted by Sandia National Laboratories in the 1960s. This model assumed that any contamination would be located at the surface and subsurface based on two types of debris; tubes and subsurface buried anomalies. The extent of underlying soil impact was expected to be dependent upon the volume of disturbed soil resulting from of tube installation, the volume of debris; depth of tube, geologic conditions, the nature of COPCs, and other factors.

B.1.2.2 Investigation Design and Contaminant Identification

The conceptual models were used as the basis for identifying appropriate sampling strategies and data collection methods.

To address the conceptual model, surface and subsurface samples were collected for analyses designed to define the extent of the anomalies identified in the CAIP. A biased strategy was developed to focus the investigation on areas of potential contamination. The model assumed that the contamination would be limited to the boundaries of the site due to the minimal potential for migration based on the geological and historical information for the site.

Implementation of the investigation design has shown that contamination did not extend beyond the anomaly; therefore, it did not extend beyond the boundaries of the CAS. This is reasonable because the model predicts that the extent of impact of any contaminated effluent released to soil is limited (DOE/NV, 2001).

B.1.2.3 Contaminant Nature and Extent

The presence of contamination was identified by sample results showing COPC soil concentrations exceeding PALs, thereby defining COCs at the CAS. Soil sample results demonstrated that the vertical and lateral extent of COCs was limited to the physical boundaries of the general subsurface model defined in the CAIP (DOE/NV, 2001). Field screening was conducted and samples were also collected at locations that bounded contaminated areas as demonstrated by analytical results less than action levels. This confirmed that the contamination extent was limited to the vicinity of an identified anomaly. Minimal amounts of contamination found were attributed to the debris found within the

anomalies. The contamination was not significant. The CAS-specific investigation findings, analytical results, and descriptions of site conditions are presented in Appendix A. The extent of identified COCs is described in Section 2.3 and Appendix A.

B.1.3 Conclusions

Revisions to the conceptual model were not required.

B.2.0 References

U.S. Department of Energy, Nevada Operations Office. 2001. *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada*, Rev. 0, DOE/NV--676. Las Vegas, NV.

Appendix C

Risk Assessment

C.1.0 Risk Assessment

A detailed assessment of risk for no action and evaluation alternatives was not performed for this CAU because COCs exceeding PALs are not expected to impact human health or the environment due to the physical constraints and no possibility for migration. Two contaminants were identified as a result of laboratory results for CAU 487 SVOC, bis(2-ethylhexyl) phthalate and *RCRA* metal, arsenic.

Bis(2-ethylhexyl) phthalate is the plasticizer known as DEHP. DEHP is a commonly used plasticizer used to make the coverings for wires and everyday household and industrial items (Syracuse, 2000). Appendix A, Section A.3.2 details the levels for the one effected interval and the levels of the associated samples.

Arsenic exceeded the PALs at nearly all of the soil sample locations at CAU 487. Appendix A, Section A.3.4 details the findings and supporting documentation regarding arsenic. Arsenic levels are elevated at the CAU due to the soils in the region and are not considered a hazard.

A use restriction was placed on two areas of the CAU, A8 and A17, because of the large amounts of subsurface debris in both areas. Appendix E details the use restriction and provides maps and coordinates for the locations of the debris.

Appropriate controls will be placed on the CAU and no further action will be recommended.

C.2.0 References

Syracuse Research Corporation. 2000. *Draft Toxicological Profile for Di (2-Ethylhexyl) Phthalate.* Atlanta, GA: U.S. Dept. of Health and Human Services.

Appendix D

Soil Boring Logs

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** TH1BG **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/9/01 **Date Completed:** 4/10/01 **Elevation:** 1623.729 **Northing:** 4189994.278 **Easting:** 518844.819 **Total Depth:** 72.5 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate brown 5YR 4/4 sandy silt, moist.	TH1BG01 0 - 1	5.8/1576	1.7	0.044
-5		Grayish orange pink 5YR 7/2 sandy silt 90%, gravels 10%, dry.				
		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.				
-10		Moderate yellowish brown 10YR 5/4 sandy silt 80%, coarse sand 20%.				
-15		Moderate yellowish brown 10YR 5/4 sandy silt 90%, coarse sand 10%.	TH1BG15 15 - 16	48/1566	4.5	0.267
-20		Moderate yellowish brown 10YR 5/4 fine sandy silt 90%, gravels 10%				
-25						
-30		Moderate yellowish brown 10YR 5/4 silt with volcanic clasts and musculite flakes.	TH1BG30* 30 - 31	41/1539	6.1	0.00
-35		Moderate yellowish brown 10YR 5/4 silty clay layer, moist.				
		Very pale orange 10YR 8/2 compressed sandy silt.				
-40						
-45			TH1BG45 45 - 46	12/1440	6.1	0.356
-50						
-55		Very pale orange 10YR 8/2 silty clay 85%, clasts 15%. Orange, white and brown streaks present. Appeared weathered and unstratified.				
-60			TH1BG60 60 - 61	17/1208	6.4	0.178
-65		Dusky yellow 5Y 6/4 and light olive gray 5Y 5/2 silty clay 95%, clasts 5%.				
-70		Yellowish gray 5Y 7/2 silty clay 85%, clasts 15%, slightly moist. Orange and black streaks present. White stratified layers and clasts also present.	TH1BG70* 70 - 71	35/1333	6.4	0.400
		Dark yellowish orange 10YR 6/6 consolidated silty clay 90%, clasts 10%.				
		Yellowish gray 5Y 7/2 silty clay 80%, clasts 20%. Moderate brown 5YR 4/4 and dusky yellow 5Y 6/4 stratified layers present. Calcite-like cements also found in clasts.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** TH2BG **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/10/01 **Date Completed:** 4/11/01 **Elevation:** 1624 **Northing:** 4189705.089 **Easting:** 518859.478 **Total Depth:** 72.5 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 silty clay 90%, gravels 10%.	TH2BG01 0 - 1	12/1333	5.8	0.0578
-5		Very pale orange 10YR 8/2 silty coarse sand 90%, gravels 10%.				
-10		Pale yellowish brown 10YR 6/2 compressed sandy silt 95%, gravels 5%.				
-15		Moderate yellowish brown 10YR 5/4 silty clay 80%, coarse sand 10%, gravels 10%.	TH2BG14 14 - 15	NA	NA	1.289
		Dark yellowish orange 10YR 6/6 silt 90%, gravels 10%.	TH2BG15 15 - 16	12/1375	6.4	0.0622
-20		Light brown 5YR 5/6 silt 90%, gravels 10%. White calcite stringers present.				
-25		Dark yellowish orange 10YR 6/6 and very pale orange 10YR 8/2 compressed silt layers 95%, clasts 5%.				
-30		Pale olive 10YR 6/2 and orange silt 90%, white shale clasts 10%. Harder drilling was noted.	TH2BG30* 30 - 31	29/1350	7.5	0.267
-35		Yellowish gray 5Y 7/2 silt 85%, white shale clasts 15%.				
-40		Dusky yellow 5Y 6/4 silt with orange and white calcite streaks.				
		Moderate brown 5YR 3/4 silty clay with white calcite streaks.				
-45		Very pale orange 10YR 8/2 silt with orange silt. A chalky pale greenish yellow 10Y 8/2 gypsum layer was also present.	TH2BG45 45 - 46	6/1368	6.9	0.444
-50		Grayish orange 10YR 7/4 consolidated silt, very pale orange 10YR 8/2 layers also present.				
-55		Yellowish gray 5Y 7/2 dense silty clay with orange and brown layers.				
-60			TH2BG60 60 - 61	23/1401	6.4	0.178
-65						
-70			TH2BG70* 70 - 71	17/1387	5.8	0.400
		Yellowish gray 5Y 7/2 dense silty clay with moderate brown 5YR 3/4 streaks 90%, irregular shaped shale pieces from 1/2" to 4" 10%. Brown spotted marking found on some pieces.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT1 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/19/01 **Date Completed:** 4/19/010 **Elevation:** 1622.9 **Northing:** 4189876.456 **Easting:** 518856.798 **Total Depth:** 42'

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 80%, gravels 10%, cobbles 10%.	THT101 0 - 1	35/1451	2.0	-0.044
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THT105 5 - 6	29/1414	2.6	-0.089
-10		Steel plate 9.5'. Wires and wood recovered at 10'. Wires also recovered at 25' and 31'.	THT110* 10 - 11	29/1449	2.4	-0.089
-15			THT115 15 - 16	59/1467	2.6	0.00
-20			THT120 20 - 21	35/1308	2.8	0.044
-25			THT125 25 - 26	52/1438	2.6	0.000
-30			THT130 30 - 31	46/1409	2.8	0.000
-35			THT135 35 - 36	41/1328	2.1	0.178
-40		Weathered, poorly sorted silt with white, orange and brown bedding planes. Wire found at 39.5'. Interface 40'. More consolidated silt and harder drilling was noted.	THT140* 40 - 41	17/1382	2.1	0.000

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT2 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/16/01 **Date Completed:** 4/16/01 **Elevation:** 1622.3 **Northing:** 4189862.706 **Easting:** 518856.119 **Total Depth:** 61 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-4 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THT2011 0 - 1	23/1368	4.8	0.133
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.	THT205 5 - 6	29/1342	4.6	0.178
-10			THT210 10 - 11	12/1421	5.2	0.356
-15			THT215 15 - 16	17/1301	4.8	0.578
-20			THT220 20 - 21	29/1342	5.6	0.400
-25			THT225 25 - 26	35/1442	3.2	0.356
-30			THT230 30 - 31	52/1442	4.2	0.356
-35		Steel plate 34'. Dark yellowish brown 10YR 4/2 silt 80%, gravels 10%, coarse sand 10%. Wires and wood present.	THT235 35 - 36	23/1296	3.8	0.267
			THT237* 37 - 38	29/1359	2.6	0.089
-40		Steel plate 37'. Moderate yellowish brown 10YR 5/4 sandy silt 85%, gravels 15%. More compressed.	THT240 40 - 41	12/1398	3.2	0.267
-45		Moderate yellowish brown 10YR 5/4 sandy silt 80%, gravels 10%, coarse sand 10%.	THT245 45 - 46	58/1266	2.2	0.267
-50		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.				
-55		Steel plate 50.5'. Void from 50.5' - 59'.				
			THT259* 59 - 60	58/1319	4.1	-0.222
-60		Interface 59'. Moderate yellowish brown 10YR 5/4 silt 80%, large white cobbles 10%, gravels 10%.				
		Yellowish gray 5Y 7/2 silt with dark yellowish orange 10YR 6/6 layers 95%, gravels 5%.				

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/18/01
Project Number: 799417.01030160	**Date Completed:** 4/19/01
Borehole Number: THT3	**Elevation:** 1623.4
Logged By: Mack Yaun	**Northing:** 4189876.079
Drilled By: Boart Longyear	**Easting:** 518838.972
Drilling Method: Rotosonic	**Total Depth:** 71 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Yellowish gray 5Y 7/2 and dark yellowish orange 10YR 6/6 sandy silt 90%, gravels 10%. Organics present.	THT301 0 - 1	64/1345	4.6	0.267
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.	THT305 5 - 6	69/1350	4.8	0.578
-10			THT310 10 - 11	41/1424	5.1	0.356
-15			THT315 15 - 16	23/1403	4.4	0.222
-20			THT320 20 - 21	58/1375	4.1	0.000
		Very pale orange 10YR 8/2 compressed silt 90%, gravels 10%.				
-25		Moderate yellowish brown 10YR 5/4 compressed silt 85%, coarse sand 10%, gravels 5%.	THT325 25 - 26	81/1451	5.1	0.133
-30		Moderate yellowish brown 10YR 5/4 and pale greenish yellow 10Y 8/2 silt with white calcite and dark yellowish orange 10YR 6/6 stringers 80%, gravels 10%, white cobbles 10%.	THT330* 30 - 31	64/1553	4.8	0.133
-35		Moderate yellowish brown 10YR 5/4 sandy silt 85%, gravels 10%, coarse sand 5%.				
-40		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.	THT340 40 - 41	69/1461	4.1	0.000
-45			THT345 45 - 46	58/1507	5.2	0.178
-50		Steel plate 49'. Fill material, wood, wires and pieces of steel and aluminum present. Silicon like substance also found.	THT350 50 - 51	81/1394	5.8	0.133
-55			THT355 55 - 56	58/1435	5.9	0.044
-60						
-65			THT365* 65 - 66	58/1283	4.0	0.044
-70		Interface 67'. Yellowish gray 5Y 7/2 compressed silt with orange stringers.	THT370* 70 - 71	17/1400	2.3	0.089

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/24/01
Project Number: 799417.01030160	**Date Completed:** 4/24/01
Borehole Number: THT4	**Elevation:** 1622.7
Logged By: Mack Yaun	**Northing:** 4189874.176
Drilled By: Boart Longyear	**Easting:** 518828.809
Drilling Method: Rotosonic	**Total Depth:** 66 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 80%, large white cobbles 10%, gravels 10%.	THT401 0 - 1	29/1361	1.9	0.267
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.	THT405 5 - 6	23/1342	1.3	0.133
-10			THT410 10 - 11	41/1282	2.7	0.222
-15			THT415 15 - 16	12/1335	4.2	0.133
-20			THT420 20 - 21	69/1449	3.4	0.267
-25			THT425 25 - 26	35/1349	3.4	0.089
-30			THT430 30 - 31	69/1440	3.3	0.089
-35			THT435 35 - 36	69/1468	3.8	0.267
-40			THT440 40 - 41	35/1324	4.4	0.267
		Steel plate 41'. Fill material. Wood and wire found at 49.5'. Appeared to be concrete at 50'.				
-45			THT445 45 - 46	41/1350	3.7	0.133
-50			THT450* 50 - 51	52/1278	3.7	0.133
		Aluminum plate 51'. Void from 51' - 54'.				
-55		Pale yellowish brown 10YR 6/2 silt with calcite stringers 95%, coarse sand 5%.	THT455 55 - 56	29/1320	4.1	0.089
-60		Grayish orange pink 10R 8/2 sandy silt 80%, gravels 10%, coarse sand 10%. Wire present at 60'.	THT462 62 - 63	29/1431	4.2	0.178
-65		Interface 64'. Moderate yellowish brown 10YR 5/4 silt with moderate greenish yellow 10Y 7/4 and grayish orange pink 10R 8/2 silt layers.	THT465* 65 - 66	17/1340	4.1	0.222

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/25/01
Project Number: 799417.01030160	**Date Completed:** 4/25/01
Borehole Number: THT5	**Elevation:** 1623.6
Logged By: Mack Yaun	**Northing:** 4189885.357
Drilled By: Boart Longyear	**Easting:** 518824.537
Drilling Method: Rotosonic	**Total Depth:** 45 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Grayish orange 10YR 7/4 sandy silt 85%, gravels 10%, cobbles 5%.	THT501 0 - 1	46/1430	1.8	0.178
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%. Wire and wood present 10' - 40'.	THT505 5 - 6	23/1507	1.7	0.222
-10			THT510 10 - 11	35/1368	1.8	0.000
-15			THT515 15 - 16	69/1470	1.7	-0.044
-20			THT520 20 - 21	64/1445	1.7	0.133
-25			THT525 25 - 26	35/1421	1.8	0.000
-30			THT530 30 - 31	46/1317	1.7	-0.044
-35			THT535 35 - 36	23/1375	1.7	0.089
-40			THT540* 40 - 41	41/1336	1.7	0.133
		A streak of fine white powder was found in the sample at 40.5'	THT543* 43 - 44	17/1322	1.9	0.356
		Moderate yellowish brown 10YR 5/4 silt 90%, gravels 10%.				
-45		Interface 43'. Weathered, poorly sorted silt with white, orange and brown bedding planes. Black flaky biotite material present.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT6 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/25/01 **Date Completed:** 4/25/01 **Elevation:** 1622.6 **Northing:** 4189890.155 **Easting:** 518778.666 **Total Depth:** 52 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-8 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Moderate yellowish brown 10YR 5/4 sandy clay. Moist.	THT601 0 - 1	6/1322	3.8	-0.044
-5			THT605 5 - 6	12/1299	3.4	0.089
-10			THT610 10 - 11	35/1183	3.4	0.133
-15			THT615 15 - 16	23/1386	3.3	-0.044
-20			THT620 20 - 21	17/1319	3.5	0.089
		Wood, wire and debris found from 22' - 49'.				
-25			THT625 25 - 26	23/1382	3.8	-0.178
-30		White crystal pocket present at 29'.	THT629* 29 - 30	35/1254	3.4	0.178
-35			THT635 35 - 36	35/1460	3.4	-0.133
-40			THT640 40 - 41	6/1350	3.5	0.044
-45			THT645 45 - 46	17/1405	3.8	-0.089
-50		Pale greenish yellow 10Y 8/2 silt with weathered poorly sorted silt with white and orange bedding planes 90%, gravels 10%.	THT650* 50 - 51	35/1234	3.5	0.222
		Interface 50'. Pale olive 10Y 6/2 consolidated silt 85%, cobbles 10%, gravels 5%.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT7 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/2/01 **Date Completed:** 5/2/01 **Elevation:** 1622.495 **Northing:** 4189873.889 **Easting:** 518685.286 **Total Depth:** 21 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-9 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated undiferentiated, well sorted 90%, gravels 10%	THT701 0 - 1	55/1409	5.8	-0.267
-5			THT705 5 - 6	48/1330	3.7	-0.133
-10			THT710 10 - 11	28/1343	5.1	-0.178
		Steel plate 12'. Void from 12' - 17'.				
-15						
		Grayish orange 10YR 7/4 compressed silt 85%, gravels 5%, coarse sand 10%.	THT717* 17 - 18	62/1293	4.8	-0.089
		Interface 18'. Moderate yellowish brown 10YR 5/4 silt 80%, gravels 10%, coarse sand 10%.	THT720* 20 - 21	35/1376	3.7	0.222
-20		Moderate yellowish brown 10YR 5/4 and very pale orange 10YR 8/2 compressed silt layers, gravels 5%, coarse sand 10%.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT8 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/1/01 **Date Completed:** 5/1/01 **Elevation:** 1621.9 **Northing:** 4189758.17 **Easting:** 518602.644 **Total Depth:** 21 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated undiferentiated, well sorted 90%, gravels 10%	THT801 0 - 1	35/1304	4.8	-0.133
-5		Moderate yellowish brown 10YR 5/4 silt 95%, gravels 5%.	THT805 5 - 6	21/1347	4.6	-0.222
-10		Fill material.	THT810 10 - 11	28/1380	4.7	-0.267
-15			THT815* 15 - 16	41/1319	4.2	-0.311
		Steel plate 16'.				
-20		Interface 19'. Grayish yellow 5Y 8/4 clay with white calcite layers. Shale layers present at 19.5'.	THT820* 20 - 21	14/990	4.2	0.039
		Dark yellowish orange 10YR 6/6 silt with shale layers.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT9 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/1/01 **Date Completed:** 5/1/01 **Elevation:** 1622.4 **Northing:** 4189738.511 **Easting:** 518557.566 **Total Depth:** 24 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-11 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated undiferentiated, well sorted 90%, gravels 10%	THT901 0 - 1	48/1273	1.4	4.622
-5			THT905* 5 - 6	28/1233	4.1	5.422
-10			THT910 10 - 11	35/1236	1.9	0.000
-15		Steel plate 14.5'. A 2" plastic plug and wood debris found at 15'.	THT915 15 - 16	28/1297	5.0	-0.222
-20		Interface 20'. Weathered, poorly sorted silt with white, orange and black bedding planes. White gypsum like rock with black biotite flakes present. A yellowish gray 5Y 8/1 waxy clay-like material was also present.	THT920 20 - 21	28/1140	3.8	0.044
			THT921* 21 - 22	28/1159	3.9	0.356

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT9S1 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/2/01 **Date Completed:** 5/2/01 **Elevation:** 1622.4 **Northing:** 4189738.511 **Easting:** 518557.566 **Total Depth:** 16 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-12 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt, gravels 10%, coarse sand 10%.	THT9S01W 0 - 1	35/1370	1.6	0.089
-5			THT9S05W* 5 - 6	110/1508	1.6	-0.044
		Grayish orange 10YR 7/4 and very pale orange 10YR 8/2 compressed silt 95%, gravels 5%.				
-10			THT9S10W 10 - 11	97/1380	2.9	0.178
-15		Moderate yellowish brown 10YR 5/4 silt 75%, gravels 5%, coarse sand 10%, white cobbles 10%.	THT9S15W* 15 - 16	21/1126	3.1	0.089

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT9S2 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/2/01 **Date Completed:** 5/2/01 **Elevation:** 1622.4 **Northing:** 4189738.511 **Easting:** 518557.566 **Total Depth:** 11 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Very pale orange 10YR 8/2 fine silt 85%, gravels 15%. More compressed at 10'.	THT9S201* 0 - 1	35/1320	4.7	0.000
-5			THT9S205 5 - 6	28/1376	1.9	0.000
-10			THT9S210* 10 - 11	90/1328	3.7	1.556

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/30/01
Project Number: 799417.01030160	**Date Completed:** 4/30/01
Borehole Number: THT10	**Elevation:** 1622.2
Logged By: Mack Yaun	**Northing:** 4189666
Drilled By: Boart Longyear	**Easting:** 518663.777
Drilling Method: Rotosonic	**Total Depth:** 40 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THT1001 0 - 1	48/1337	1.1	-0.133
-5			THT1005 5 - 6	69/1409	1.1	-0.311
-10		Moderate yellowish brown 10YR 5/4 compressed fine silt. Wire and wood embedded in silt. Large mass of wire found at 14'.	THT1010 10 - 11	55/1359	1.5	-0.267
-15		Grayish orange 10YR compressed silt 95%, gravels 5%. Wire and wood at 20'.	THT1015 15 - 16	53/1396	1.9	0.533
-20						
-25			THT1025* 25 - 26	46/1300	1.5	-0.133
		Grayish orange 10YR compressed silt 80%, gravels 10%, cobbles 10%. Wood at 33'.				
-30			THT1030 30 - 31	80/1189	1.5	0.133
-35		Yellowish gray 5Y 8/1 silt.	THT1034 34 - 35	20/1400	2.6	0.178
			THT1038* 38 - 39	40/1180	1.9	0.133
-40		Interface 38'. Yellowish gray 5Y 7/2 silt with weathered, poorly sorted silt with white, orange and black bedding planes.				

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/26/01
Project Number: 799417.01030160	**Date Completed:** 4/26/01
Borehole Number: THT11	**Elevation:** 1622.2
Logged By: Mack Yaun	**Northing:** 4189677.845
Drilled By: Boart Longyear	**Easting:** 518682.258
Drilling Method: Rotosonic	**Total Depth:** 30 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Dark yellowish orange 10YR 6/6 moist sandy silt 90%, gravels 10%. Organics present.	THT1101* 0 - 1	17/1257	1.8	-0.178
-5		Moderate yellowish brown 10YR 5/4 moist sandy silt 90%, gravels 10%.	THT1105 5 - 6	23/1276	1.9	-0.311
-10			THT1110 10 - 11	35/1292	1.9	-0.356
-15			THT1115 15 - 16	17/1262	1.9	-0.356
-20			THT1120 20 - 21	35/1326	2.0	-0.400
-25		Dark yellowish orange 10YR 6/6, grayish orange 10 YR 7/4 and yellowish gray 5Y 7/2 silt. Interface 24'. Yellowish gray 5Y 7/2 and pale greenish yellow 10Y 8/2 silt.	THT1125* 25 - 26	12/1153	2.0	-0.400
-30						

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT12 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/26/01 **Date Completed:** 4/26/01 **Elevation:** 1622.8 **Northing:** 4189711.757 **Easting:** 518706.599 **Total Depth:** 52 ft

Depth (ft)	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0	Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THT1201* 0 - 1	121/1474	1.9	18.993
-5	Moderate yellowish brown 10YR 5/4 compressed silt 80%, gravels 10%, cobbles 10%.	THT1205 5 - 6	46/1382	1.5	0.667
-10		THT1210 10 - 11	58/1430	1.9	0.089
-15	Moderate yellowish brown 10YR 5/4 silty clay with yellowish gray 5Y 7/2 streaks	THT1215 15 - 16	52/1482	1.5	0.444
-20		THT1220 20 - 21	29/1486	1.9	0.222
-25	Dark yellowish orange 10YR 6/6 silty clay with orange and white streaks 95%, white clasts 5%.	THT1225 25 - 26	41/1451	1.9	0.311
-30		THT1230 30 - 31	41/1417	2.0	0.133
-35		THT1235* 35 - 36	41/1419	2.5	4.178
-40	Wood present at 39.5'. Core barrel lost in hole at 40'. Offset and redrilled.	THT1242 42 - 43	59/1419	1.4	0.267
-45	Aluminum plate 40'. Moderate yellowish brown 10YR 5/4 silt 80%, gravels 10%, coarse sand 5%, white cobbles 5%. Wire and rope also present.	THT1245 45 - 46	46/1394	1.8	-0.178
-50	Interface 43'. Same description as above with no debris and more consolidated silt.	THT1251* 51 - 52	52/1331	1.9	-0.089
	Grayish yellow 5Y 8/4 and pale greenish yellow 10Y 8/2 silt, gravels 5%, cobbles 5%.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT12S **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/1/01 **Date Completed:** 5/1/01 **Elevation:** 1622.8 **Northing:** 4189711.757 **Easting:** 518706.599 **Total Depth:** 11 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-17 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THT12S01* 0 - 1	69/1421	1.1	0.000
		Very pale orange 10YR 8/2 fine silt 85%, gravels 15%. More compressed at 6'.				
-5			THT12S05* 5 - 6	69/1411	1.5	-0.311
		Pale yellowish brown 10YR 6/2 silty sand 95%, coarse sand 5%.				
		Light brown 5YR 5/6 sandy silt 10%, gravels 5%, coarse sand 5%.				
-10			THT9S210 10 - 11	48/1331	1.3	-0.311

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT13 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/12/01 **Date Completed:** 4/12/01 **Elevation:** 1623.7 **Northing:** 4189825.355 **Easting:** 518848.829 **Total Depth:** 32 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 moist sandy silt 95%, gravels 5%. Tube was 2' bgs.	THT1301 0 - 1	23/1227	1.8	-0.178
-5			THT1305 5 - 6	29/1326	1.9	-0.044
-10			THT1310 10 - 11	23/1248	2.2	-0.044
-15			THT1315 15 - 16	17/1382	1.6	-0.178
-20		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 5%, angular shale pieces 5%. Wires present 21' - 22'.	THT1320* 20 - 21	23/1350	1.7	-0.133
		Steel plate 22'.				
-25			THT1325 25 - 26	12/1317	1.7	-0.044
-30		Interface 29.5'. Yellowish gray 5Y 7/2 silt 90%, shale layers 10%.	THT1329* 29 - 30	29/1294	2.0	-0.133

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT15 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/24/01 **Date Completed:** 4/24/01 **Elevation:** 1623.5 **Northing:** 4189826.619 **Easting:** 518829.978 **Total Depth:** 20.5 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-19 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Backfill. Tube 2.5' bgs.	THT1501 0 - 1	41/1350	4.7	0.178
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.				
-5			THT1505 5 - 6	12/1379	5.7	0.533
		Dark yellowish orange 10YR 6/6 silty sand 60%, coarse sand 30%, gravels 10%.				
-10			THT1510* 10 - 11	69/1442	1.7	0.400
		Grayish orange 10YR 7/4 compressed silt 95%, gravels 5%.				
-15			THT1515 15 - 16	52/1507	1.9	0.444
		Very pale orange 10YR 8/2 sandy silt 80%, gravels 10%, coarse sand 10%.	THT1520* 20 - 20.5	23/1400	1.5	0.533
-20		Light brown 5YR 5/6 silty clay 90%, gravels 5%, coarse sand 5%.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THT16 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/25/01 **Date Completed:** 4/25/01 **Elevation:** 1625.9 **Northing:** 4189823.149 **Easting:** 518881.297 **Total Depth:** 16 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 moist sandy silt 90%, gravels 10%.	THT1601 0 - 1	29/1345	3.4	-0.089
-5			THT1605 5 - 6	64/1324	3.5	0.222
		Moderate yellowish brown 10YR 5/4 moist sandy silt 80%, gravels 10%, cobbles 10%.				
-10		Moderate yellowish brown 10YR 5/4 compressed silt 90%, gravels 10%.	THT1610* 10 - 11	23/1368	4.2	0.133
-15		Moderate yellowish brown 10YR 5/4 silty clay 95%, gravels 5%.	THT1615* 15 - 16	23/1438	4.2	0.178

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA1 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/25/01 **Date Completed:** 4/25/01 **Elevation:** 1622.9 **Northing:** 4189886.611 **Easting:** 518809.389 **Total Depth:** 23 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THTA101 0 - 1	35/1442	3.2	0.133
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THTA105 5 - 6	23/1384	3.8	0.044
-10			THTA110 10 - 11	46/1433	3.2	0.089
-15		Wires and rope found at 15'. Orange discoloration at 16'. Steel plate at 20'.	THTA115 15 - 16	93/1472	3.8	0.089
-20		Moderate yellowish brown 10YR 5/4 silt 80%, coarse sand 10%, gravels 10%. Interface 21'.	THTA120* 20 - 21	69/1403	3.1	0.044
			THTA121* 21 - 22	46/1512	3.5	0.089

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/24/01
Project Number: 799417.01030160	**Date Completed:** 4/25/01
Borehole Number: THTA3	**Elevation:** 1622.7
Logged By: Mack Yaun	**Northing:** 4189890.862
Drilled By: Boart Longyear	**Easting:** 518834.126
Drilling Method: Rotosonic	**Total Depth:** 43 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THTA301 0 - 1	12/1421	2.9	0.444
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THTA305 5 - 6	41/1433	3.9	0.267
-10			THTA310 10 - 11	23/1437	3.7	0.267
-15			THTA315* 15 - 16	64/1317	3.9	0.222
-20			THTA320 20 - 21	46/1285	4.2	0.311
-25			THTA325 25 - 26	6/1370	3.4	0.222
-30			THTA330 30 - 31	35/1405	3.4	0.267
-35		Steel plate. Wires also recovered.	THTA335 35 - 36	46/1498	7.0	0.089
			THTA340 40 - 41	29/1363	1.4	0.089
-40		Moderate yellowish brown 10YR 5/4 sandy silt 80%, coarse sand 5%, white clasts 15%. Some fill material present.	THTA342* 42 - 43	52/1347	5.0	0.176

Interface 42'. Moderate yellowish brown 10YR 5/4 silt 90%, gravels 5%, coarse sand 5%.

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA4 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/17/01 **Date Completed:** 4/17/01 **Elevation:** 1622.7 **Northing:** 4189867.104 **Easting:** 518841.896 **Total Depth:** 28 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 80%, gravels 10%, cobbles 10%.	THTA401 0 - 1	12/1421	2.9	0.444
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THTA405 5 - 6	41/1433	3.9	0.267
-10		Steel plate. Wires also recovered.	THTA410 10 - 11	23/1437	3.7	0.267
-15		Steel plate.	THTA415 15 - 16	64/1317	3.9	0.222
-20		Aluminum plate. Wires also recovered.	THTA420* 20 - 21	46/1285	4.2	0.311
-25		Interface 24.5'. Pale yellowish brown 10YR 6/2 silt 85%, coarse sand 5%, gravels 10%. Pale yellowish orange 10YR 8/6 and yellowish gray 5y 7/2 stratified layers present.	THTA425* 25 - 26	6/1370	3.4	0.222

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA5 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/18/01 **Date Completed:** 4/18/01 **Elevation:** 1622.7 **Northing:** 4189848.664 **Easting:** 518829.418 **Total Depth:** 22 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-24 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%, moist. Organics present.	THTA501 0 - 1	58/1497	4.5	0.711
-5			THTA505 5 - 6	29/1389	2.0	0.622
-10		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 85%, gravels 10%, cobbles 5%.	THTA510 10 - 11	69/1451	3.4	0.756
-15			THTA515* 15 - 16	58/1553	3.6	0.089
-20		Interface 19'. Moderate yellowish brown 10YR 5/4 silt, gravels 10%, cobbles 5%.	THTA520* 20 - 21	64/1514	3.4	0.089

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/18/01
Project Number: 799417.01030160	**Date Completed:** 4/18/01
Borehole Number: THTA6	**Elevation:** 1623.1
Logged By: Mack Yaun	**Northing:** 4189850.767
Drilled By: Boart Longyear	**Easting:** 518840.794
Drilling Method: Rotosonic	**Total Depth:** 55 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%. Wires present at surface.	THTA601 0 - 1	52/1475	3.4	0.089
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 80%, 10% gravels, cobbles 10%.	THTA605 5 - 6	64/1607	4.7	0.222
-10			THTA610 10 - 11	41/1465	5.2	0.178
-15			THTA615 15 - 16	93/1585	3.8	0.222
-20			THTA620 20 - 21	64/1541	4.0	0.356
-25			THTA625 25 - 26	41/1537	5.0	0.311
-30			THTA630 30 - 31	52/1606	5.8	0.222
-35			THTA635 35 - 36	87/1467	5.6	0.444
		Void				
-40		Wood and pieces of aluminum found.	THTA640* 40 - 41	58/1502	6.1	0.356
-45			THTA645 45 - 46	58/1389	6.2	1.244
-50		Interface 50'. Grayish orange 10YR 7/4 weathered silt.	THTA650* 50 - 51	75/1419	4.8	0.578
-55						

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA7 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/16/01 **Date Completed:** 4/16/01 **Elevation:** 1623.2 **Northing:** 4189848.884 **Easting:** 518855.067 **Total Depth:** 19 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-26 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THTA701* 0 - 1	58/1477	1.6	0.089
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.				
-5			THTA705 5 - 6	35/1479	1.8	0.133
-10			THTA710* 10 - 11	64/1525	4.2	0.356
-15		Steel plate 15'. No recovery at 15' - 16'. Fill material from 16' - 18'. Refusal at 18'. Offset and redrilled. Steel was again found at 15'. No recovery from 15' - 19'. Refusal at 19'.	THTA716 16 - 17	35/1505	4.8	NA

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/18/01
Project Number: 799417.01030160	**Date Completed:** 4/18/01
Borehole Number: THTA8	**Elevation:** 1623.1
Logged By: Mack Yaun	**Northing:** 4189839.263
Drilled By: Boart Longyear	**Easting:** 518830.014
Drilling Method: Rotosonic	**Total Depth:** 27 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%. Organics present.	THTA801 0 - 1	23/1356	5.7	0.133
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 85%, gravels 10%, cobbles 5%.				
-5			THTA805 5 - 6	23/1435	4.8	0.311
-10			THTA810 10 - 11	23/1386	4.7	0.133
		Plate at 12'.				
		Moderate yellowish brown 10YR 5/4 silty sand 80%, gravels 10%, coarse sand 10%.				
-15		Void				
		Fill material. Pieces of steel found.				
-20			THTA820 20 - 21	69/1460	7.1	0.267
		Grayish orange 10YR 7/4 compressed silt 85%, gravels 10%, coarse sand 5%. Appeared to be native soil but debris was found further down.	THTA825* 25 - 26	69/1574	6.1	0.267
-25		Moderate yellowish brown 10YR 5/4 silty sand 80%, gravels 10%, coarse sand 10%. Pieces of aluminum and wire found.	THTA826* 26 - 27	12/1283	5.7	0.578
		Interface 26'. Pale yellowish orange 10YR 8/2 silt. Appeared to be weathered rock.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA9 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/19/01 **Date Completed:** 4/24/01 **Elevation:** 1622.9 **Northing:** 4189841.513 **Easting:** 518838.04 **Total Depth:** 23 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		The tube was 2.5' below ground surface (bgs).	THTA901 0 - 1	35/1454	3.5	-0.044
		Moderate yellowish brown 10YR 5/4 sandy silt 80%, gravels 10%, large white cobbles 10%.				
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 85%, gravels 10%, cobbles 5%.	THTA905 5 - 6	64/1553	2.9	0.311
-10			THTA910 10 - 11	46/1407	2.9	0.089
-15		Steel plate at 14'. Fill material. Steel plate and pieces of wire found.	THTA915* 15 - 16	52/1523	4.8	0.089
-20		Interface 20'. Dark yellowish orange 10YR 6/6 silt 90%, gravels 5%, coarse sand 5%.	THTA920* 20 - 21	41/1521	1.3	0.356

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA10 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/12/01 **Date Completed:** 4/12/01 **Elevation:** 1622.8 **Northing:** 4189816.317 **Easting:** 518824.756 **Total Depth:** 31 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Light brown 5YR 5/6 sandy silt 90%, gravels 10%.	THTA1001 0 - 1	14/1378	2.8	0.133
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%, with angular shale clasts. Wires found 10' - 13'.				
-5			THTA1005 5 - 6	6/1495	3.2	0.178
-10			THTA1010 10 - 11	35/1467	2.2	0.0
-15			THTA1015 15 - 16	46/1380	1.1	0.0
			THTA1017* 17 - 18	35/1513	1.3	0.044
		Steel plate 18'. Interface 18'. Moderate brown 5YR 4/4 sandy silt 80%, gravels 10%, coarse sand 10%. Harder drilling noted at 22'.				
-20			THTA1020* 20 - 21	23/1468	1.8	0.222
		Light brown 5YR 5/6 silt 80%, gravels 20%. White gypsum rocks present.				
-25		Pale greenish yellow 10Y 8/2 silt with orange, white and black streaks.	THTA1025 25 - 26	17/1166	0.3	0.0
		Yellowish gray 5Y 7/2 tightly compacted silt 95%, gravels 5%.				
-30		Grayish orange 10YR 7/4 and yellowish gray 5Y 7/2 tightly compacted silt, gravels 10%.	THTA1030 30 - 31	23/1278	1.1	-0.089

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA11 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/12/01 **Date Completed:** 4/12/01 **Elevation:** 1622.8 **Northing:** 4189809.448 **Easting:** 518819.726 **Total Depth:** 51 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THTA1101 0 - 1	17/1481	1.1	-0.222
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft, noncompacted, unconsolidated, undifferentiated, well sorted 90%, 5% gravels, cobbles 5%.	THTA1105 5 - 6	13/1409	2.6	-0.133
-10			THTA1110 10 - 11	17/1447	3.4	-0.044
-15			THTA1115 15 - 16	23/1507	2.8	0.044
-20			THTA1120 20 - 21	29/1460	3.0	-0.088
-25			THTA1125 25 - 26	6/1400	3.3	0.133
-30			THTA1130 30 - 31	58/1416	3.0	0.222
		Steel plate 32.5' and wire present.	THTA1132* 32 - 33	58/1444	2.8	0.266
-35		Moderate yellowish brown 10YR 5/4 sandy silt 80%, gravels 10%, coarse sand 10%. Small white rocks and angular shale pieces present.	THTA1135 35 - 36	41/1409	3.4	0.266
-40		Interface 41'. Moderate yellowish brown 10YR 5/4 sandy silt with orange, black and white streaking. White gypsum layer present. Some metal debris and wires present. Could be sluff from an upper interval.	THTA1140* 40 - 41	46/1426	3.8	0.355
-45		Pale yellowish orange 10YR 8/6 silt.	THTA1145 45 - 46	23/1283	3.2	0.533
-50		Yellowish gray 5Y 7/2 silt with stratified layers.	THTA1150* 50 - 51	41/1262	3.1	0.622
		Light brown 5YR 5/6 silt 80%, gravels 10%, coarse sand 10%.				
		Very pale orange 10YR 8/2 weakly cemented silt.				
		Pale greenish yellow 10YR 8/2 silt with orange streaking and black musculite flakes. Pale greenish yellow rocks also present.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA12 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/11/01 **Date Completed:** 4/11/01 **Elevation:** 1622.9 **Northing:** 4189802.374 **Easting:** 518804.422 **Total Depth:** 31 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Moderate yellowish brown 10YR 5/4 sandy clay 80%, gravels 20%. Moist.	THTA1201 0 - 1	0/1440	5.2	0.400
-5		Light brown 5YR 5/6 and pale olive 10YR 6/2 sandy silt 85%, gravels 10%, coarse sand 5% with white unconsolidated round formations 1/2" to 1 1/2" diameter.	THTA1205 5 - 6	29/1398	4.7	0.356
		Fill material. Moderate yellowish brown 10YR 5/4 sandy clay 80%, gravels 20%. Moist.				
-10			THTA1210* 10 - 11	64/1456	5.6	0.578
-15			THTA1215 15 - 16	23/1342	4.4	0.356
-20			THTA1220 20 - 21	15/1357	4.7	0.133
-25			THTA1225 25 - 26	17/1461	5.7	0.578
-30			THTA1230* 30 - 31	23/1386	5.8	0.400
		Moderate yellowish brown 10YR 5/4 and yellowish gray 5Y 7/2 silt with pale yellowish green stratified layers 90%, gravels 5%, shale layers 5%. A steel plate was encountered at 31'. The plate was penetrated but the drill rig was damaged when when trying to obtain next interval.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA13 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 4/17/01 **Date Completed:** 4/17/01 **Elevation:** 1623.9 **Northing:** 4189863.446 **Easting:** 518833.807 **Total Depth:** 22 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-32 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Moderate yellowish brown 10YR 5/4 sandy silt 90%, gravels 10%.	THTA1301 0 - 1	6/1428	2.8	0.089
-5		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THTA1305 5 - 6	35/1453	2.9	0.044
-10			THTA1310 10 - 11	35/1322	2.6	0.089
-15			THTA1315 15 - 16	17/1336	3.9	0.044
		Band of grayish black discoloration with wires present.	THTA1318* 18 - 19	23/1491	3.8	0.222
-20		Steel plate 19'. Interface 19'. Pale yellowish brown 10YR 6/2 compressed silt 80%, gravels 10%, coarse sand 10%.	THTA1320* 20 - 21	41/1451	4.8	-0.222
		Moderate yellowish brown 10YR 5/4 sandy silt 85%, gravels 10%, coarse sand 5%.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA14 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/2/01 **Date Completed:** 5/2/01 **Elevation:** 1621.7 **Northing:** 4189800.875 **Easting:** 518660.233 **Total Depth:** 21 ft	CAU 487 CADD/CR Appendix D Revision: 0 Date: 11/21/2001 Page D-33 of D-39

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Very pale orange 10YR 8/2 sandy silt 90%, gravels 10%. Organics present.	THTA1401 0 - 1	69/1326	4.9	-0.222
-5		Moderate yellowish brown 10YR 5/4 compressed silt 95%, gravels 5%.	THTA1405 5 - 6	41/1244	3.3	-0.267
-10		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.	THTA1410 10 - 11	41/1271	4.9	-0.267
-15		Steel plate and aluminum plate encountered from 14' - 14.5'. A plastic plug and wires were also found.	THTA1415* 15 - 16	28/1388	5.8	-0.311
-20		Interface 17'. Grayish orange 10YR 7/4 silt 90%, pale greenish yellow 5Y 7/2 clasts 10% with calcite stringers visible.	THTA1420* 20 - 21	41/1209	4.5	-0.267
		Light olive gray 5Y 5/2 and yellowish gray 5Y 7/2 silt 90%, gravels 10%.				
		White rock with black musculite flakes and pale greenish yellow 10Y 8/2 waxy clay-like substance.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA15 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/3/01 **Date Completed:** 5/3/01 **Elevation:** 1622.9 **Northing:** 4189871.931 **Easting:** 519078.109 **Total Depth:** 55 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Very pale orange 10YR 8/2 sandy silt 90%, gravels 10%.	THTA1501 0 - 1	35/1403	2.9	0.089
-5		Fill material. Moderate yellowish brown 10YR 5/4 sandy clay 90%, gravels 5%, coarse sand 5%. Moist.	THTA1505 5 - 6	35/1415	3.3	0.222
-10			THTA1510 10 - 11	21/1372	2.5	0.178
-15			THTA1515 15 - 16	48/1314	2.1	0.222
-20			THTA1520 20 - 21	64/1541	2.5	0.356
-25			THTA1525 25 - 26	41/1537	2.9	0.311
		Steel plate 26.5'. Fill material. Moderate yellowish brown 10YR 5/4 sandy clay 85%, gravels 5%, coarse sand 10%. Less moist.				
-30		Mass of wire found throughout 30' - 35' interval. Additional wire found at 38'.	THTA1530* 30 - 31	52/1606	2.7	0.222
-35			THTA1535 35 - 36	87/1467	2.5	0.444
-40			THTA1540 40 - 41	58/1502	2.9	0.356
-45			THTA1545 45 - 46	58/1389	2.8	1.244
-50		Interface 50'. Yellowish gray 5Y 7/2 consolidated silt with orange and black layers throughout.	THTA1550* 50 - 51	75/1419	2.5	0.578
-55						

Project Name: CAU 487, Thunderwell Site	**Date Started:** 5/2/01
Project Number: 799417.01030160	**Date Completed:** 5/2/01
Borehole Number: THTA16	**Elevation:** 1624.1
Logged By: Mack Yaun	**Northing:** 4189839.687
Drilled By: Boart Longyear	**Easting:** 519081.851
Drilling Method: Rotosonic	**Total Depth:** 53 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Tube was 2' bgs.	THTA1601 0 - 1	28/1353	1.7	-0.444
		Moderate yellowish brown 10YR 5/4 silt 90%, gravels 10%.				
-5		Pale yellowish brown 10YR 6/2 sandy silt 80%, gravels 10%, coarse sand 10%. Moist at 7'.	THTA1605 5 - 6	28/1353	1.8	-0.400
-10		Moderate yellowish brown 10YR 5/4 moist sandy silt 70%, gravels 10%, coarse sand 15%, cobbles 5%. Moist.	THTA1610 10 - 11	76/1295	1.4	-0.400
-15			THTA1615 15 - 16	28/1318	2.1	-0.444
-20			THTA1620 20 - 21	62/1399	1.6	-0.444
-25			THTA1625 25 - 26	55/1380	2.5	-0.489
		Steel plate 27'. Void from 27' - 37'.				
-30						
-35						
		Moderate yellowish brown 10YR 5/4 silty clay with pockets of yellowish gray 5Y 7/2 silty clay.				
-40			THTA1640* 40 - 41	48/1353	2.1	-0.444
-45			THTA1645 45 - 46	21/1343	1.6	-0.489
		Dark yellowish orange 10YR 6/6 sandy silt 85%, gravels 5%, coarse sand 10%.				
-50			THTA1650* 50 - 51	21/1161	1.6	-0.489
		Interface 50'. Grayish yellow 5Y 8/4 chalky silt with layers of pale yellowish orange 10YR 8/6 and yellowish gray 5Y 7/2 consolidated silty clay. Gypsum appeared to be present.				

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/30/01
Project Number: 799417.01030160	**Date Completed:** 4/30/01
Borehole Number: THTA17	**Elevation:** 1621.7
Logged By: Mack Yaun	**Northing:** 4189682.198
Drilled By: Boart Longyear	**Easting:** 518685.072
Drilling Method: Rotosonic	**Total Depth:** 35 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Fill Material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%. A mass of wires were present from 10' - 15'. Wire also found at 30'.	THTA1701 0 - 1	20/1252	6.4	-0.044
-5			THTA1705 5 - 6	20/1182	5.8	0.133
-10			THTA1710 10 - 11	66/1263	5.4	0.622
-15			THTA1715 15 - 16	53/1239	4.7	0.222
-20			THTA1720 20 - 21	27/1335	4.9	0.311
-25			THTA1725 25 - 26	73/1252	5.2	0.089
-30			THTA1730* 30 - 31	27/1169	4.7	0.400
		Steel plate 31'. Pale yellowish brown 10YR 6/2 compressed silt, gravels 5%, coarse sand 5%. Mass of wire at 31.5'.				
-35		Interface 32'. Yellowish gray 5Y 7/2 and moderate yellowish brown 10YR 5/4 silt with some pale yellowish orange 10YR 8/6 streaks, gravels 15%.	THTA1735* 35 - 36	40/1222	4.0	-0.044

Project Name: CAU 487, Thunderwell Site	**Date Started:** 4/30/01
Project Number: 799417.01030160	**Date Completed:** 4/30/01
Borehole Number: THTA18	**Elevation:** 1621.9
Logged By: Mack Yaun	**Northing:** 4189672.492
Drilled By: Boart Longyear	**Easting:** 518683.993
Drilling Method: Rotosonic	**Total Depth:** 58 ft

Depth (ft)	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0	Moderate yellowish brown 10YR 5/4 silt 90%, gravels 10%.	THTA1801 0 - 1	27/1352	2.6	0.0
-5	Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, gravels 10%.	THTA1805 5 - 6	46/1367	2.6	-0.133
-10		THTA1810 10 - 11	33/1352	2.3	-0.222
-15		THTA1815 15 - 16	86/1263	3.4	-0.178
-20	Pale yellowish brown 10YR 6/2 compressed silt.	THTA1820 20 - 21	13/1408	2.6	-0.133
-25	Grayish orange 10YR 7/4 compressed silt.	THTA1825 25 - 26	73/1209	3.0	-0.133
-30	Yellowish gray 5Y 7/2 silty clay with brown and orange streaks.	THTA1830 30 - 31	33/1254	3.0	0.133
-35	Moderate yellowish brown 10YR 5/4 silty clay 90%, yellowish gray 5Y 7/2 clasts 10%.	THTA1835* 35 - 36	46/1341	2.6	0.400
-40		THTA1840 40 - 41	27/1137	2.6	0.133
-45	Steel plate 45'. Moderate yellowish brown 10YR 5/4 silty clay 90%, yellowish gray 5Y 7/2 clasts 10%. More compressed. Wire found at 50'.	THTA1850 50 - 51	7/1311	2.3	-0.178
-50	Aluminum plate 52'. Fill material.	THTA1855 55 - 56	13/1327	1.9	-0.178
-55	Interface 54'. Moderate yellowish brown 10YR 5/4 silt 90%, greenish white gravels 10%. Gypsum was also present.	THTA1856* 56 - 57	33/1271	2.3	0.089

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA19 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/1/01 **Date Completed:** 5/1/01 **Elevation:** 1623.1 **Northing:** 4189658.449 **Easting:** 518678.435 **Total Depth:** 24 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Tube 2' bgs.	THTA1901* 0 - 1	117/1262	1.5	-0.311
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels.				
-5			THTA1905 5 - 6	83/1225	1.9	-0.222
-10			THTA1910 10 - 11	48/1304	1.5	-0.133
		Aluminum plate 12'. Grayish orange 10YR 7/4 silt 90%, gravels 5%, coarse sand 5%. Borehloe was offset at 12.5' due to cave in.				
-15		Void 15' - 20.5.				
-20		Grayish orange 10YR 7/4 and yellowish gray 5Y 7/2 compressed silt with white and orange stringers.	THTA1920 20 - 21	55/1322	1.5	-0.178
			THTA1923* 23 - 24	41/1095	1.9	-0.044
		Interface 23'. Light olive gray 5Y 5/2, grayish orange 10YR 7/4 and yellowish gray 5Y 7/2 silt 95%, gravels 5%. Harder drilling was noted.				

Project Name: CAU 487, Thunderwell Site **Project Number:** 799417.01030160 **Borehole Number:** THTA20 **Logged By:** Mack Yaun **Drilled By:** Boart Longyear **Drilling Method:** Rotosonic	**Date Started:** 5/3/01 **Date Completed:** 5/3/01 **Elevation:** 1622.1 **Northing:** 4189726.82 **Easting:** 518695.086 **Total Depth:** 18 ft

Depth (ft)	Lithology	Lithologic Description	Sample Number ft bgs	Field Screening α/β dpm	VOCs ppm	RDX ppm
0		Tube 3.5' bgs.	THTA2001 0 - 1	33/1335	1.8	-0.311
		Fill material. Very pale orange 10YR 8/2 fine sandy silt, very soft noncompacted, unconsolidated, undifferentiated, well sorted 90%, 10% gravels. Wood present at 5.5' and 9'. Obstructions at 12' and 14'.				
-5			THTA2005* 5 - 6	27/1384	1.8	-0.356
-10			THTA2010 10 - 11	20/1302	1.9	-0.222
-15			THTA2015* 15 - 16	33/1267	7.1	-0.400
		Refusal 18'.				

Appendix E

Use Restriction for CAU 487

Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, NV 89193-8518

RECEIVED
FFACO/ITLV
Date 10-1-01
Initials

SEP 26 2001

E. V. Hopper
Chief, Environmental Flight
4349 Duffer Dr., Ste. 1601
Nellis AFB, NV 89191-7007

SUBMITTAL OF THE CAU USE RESTRICTION INFORMATION FORM FOR CAU 487: THUNDERWELL SITE, TONOPAH TEST RANGE, NEVADA

Please find enclosed three copies of the subject CAU Use Restriction Information form for your office to file in your GIS system. This use restriction is subsurface only. At the A8 anomalies restricted area, the Air Force may continue to use the road and maintain the utilities buried above the restricted area. This site is on the Tonopah Test Range. The use restriction coordinates are in UTM Zone 11, NAD27 (meters). A reply letter is requested stating that the use restriction information has been recorded.

If you have any questions, please contact Kevin J. Cabble, of my staff, at 295-5000.

Runore C. Wycoff, Director
Environmental Restoration Division

ERD:KJC

Enclosure:
As stated

cc w/encl:
G. K. Laskar, DOE/AL, Albuquerque, NM
USAF Liaison Office, NNSA/NV,
Las Vegas, NV
USAF/Air Warfare Center, RMO/RML,
Nellis AFB, NV
Northern Range Commander, TTR,
Tonopah, NV
Vern Gabbard, SNL/TTR, Tonopah, NV
P. J. Liebendorfer, NDEP, Carson City, NV
Supervisor, NDEP, Las Vegas, NV
W. F. Johnson, BN, Mercury, NV
R. B. Jackson, BN, Mercury, NV

cc w/o encl:
K. K. Beckley, NDEP, Carson City, NV
M. A. DeBurle, NDEP, Carson City, NV
DTRA Environmental, M/S 645, Mercury, NV
Eric Shanholtz, DTRA, Mercury, NV
LTC P. M. Loomis, DTRA M/S 645, Mercury, NV
R. L. Kidman, IT, Las Vegas, NV
G. M. Romano, IT, Las Vegas, NV
K. A. Hoar, ESHD, NNSA/NV, Las Vegas, NV
R. C. Wycoff, ERD, NNSA/NV, Las Vegas, NV
J. L. Appenzeller-Wing, ERD, NNSA/NV, Las Vegas, NV
P. L. Hall, EM, NNSA/NV, Las Vegas, NV

CAU Use Restriction Information

CAU Number/Description: CAU 487, Thunderwell Site

Applicable CAS Numbers/Descriptions: CAU RG 26-001-RGRV, Thunderwell Site

Contact (organization/project): DOE/NV Industrial Sites Project Manager

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

Survey Date: 5/16/01 **Survey Method (GPS, etc.):** GPS

Site Monitoring Requirements: None

Required Frequency (quarterly, annually?): Not Applicable

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

Use Restrictions

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

Comments: See the Closure Report for additional information on the condition of the site(s) and any monitoring and/or inspection requirements.

Submitted By: _____ **Date:** _____

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

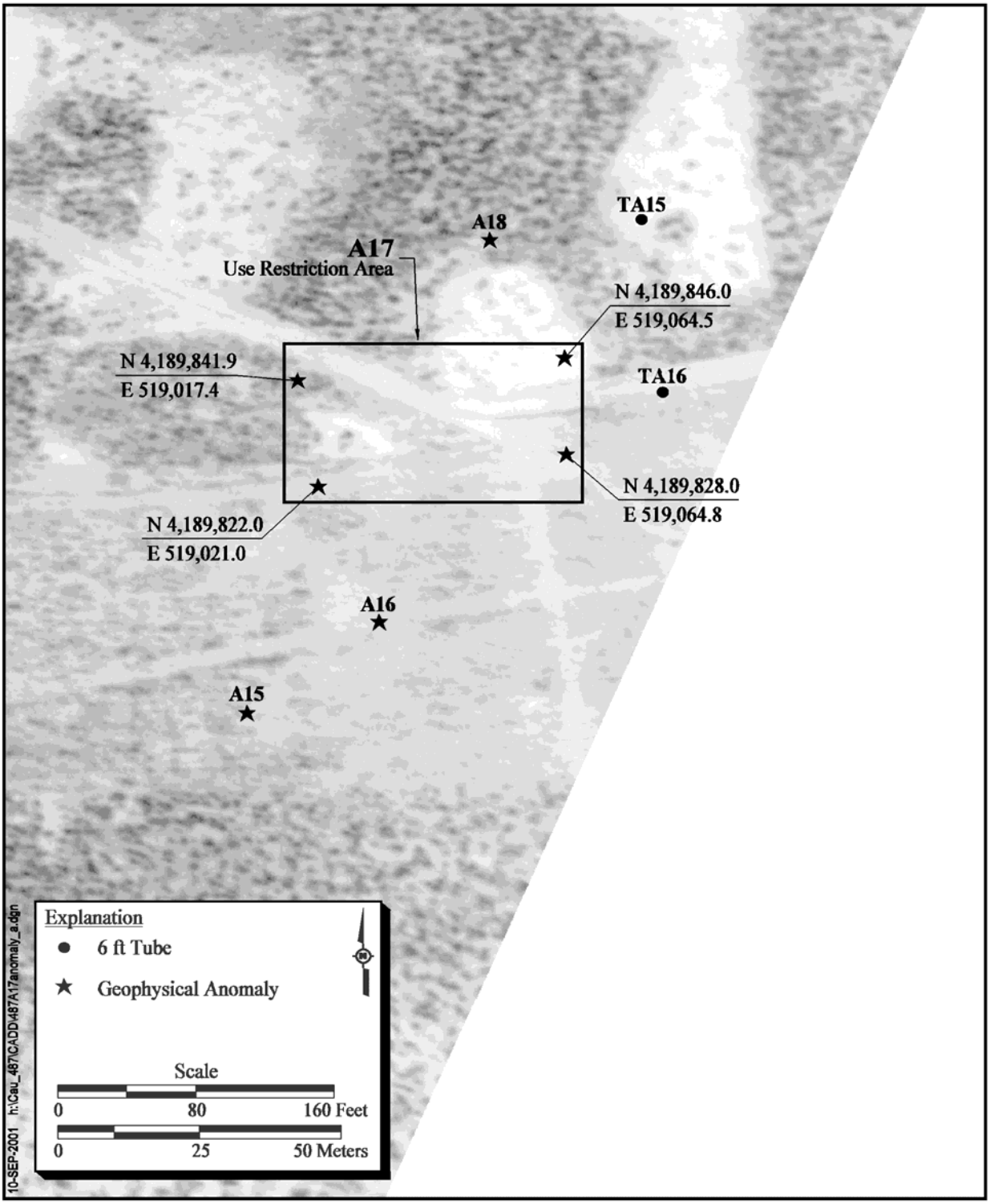


Figure E.1-1
CAU 487 A17 Anomalies

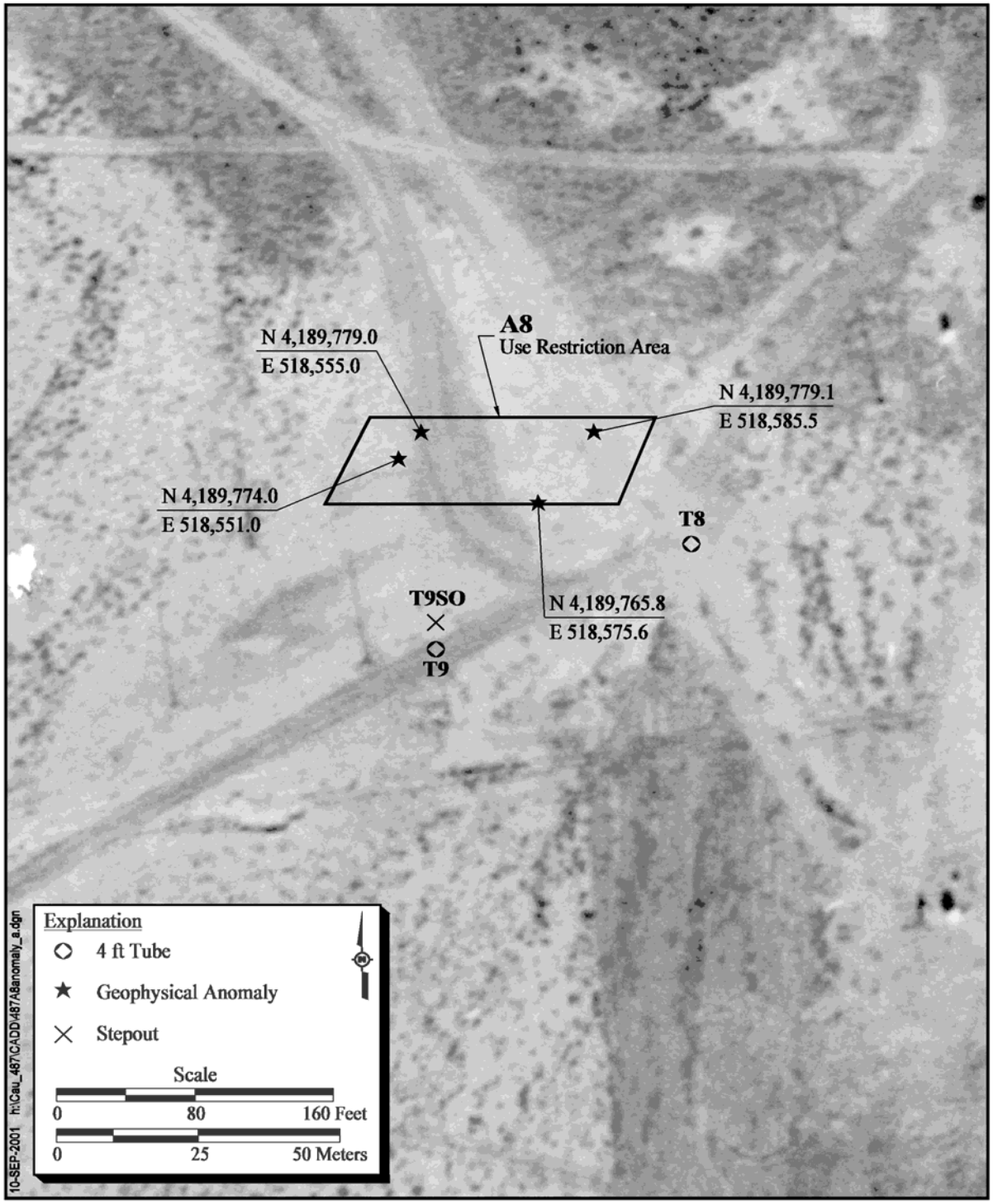


Figure E.1-2
CAU 487 A8 Anomalies

Appendix F

Documentation of Housekeeping Closure Activities

FFACO Corrective Action Site Housekeeping Closure Verification Form

Closure Verification Date: May 7, 2001

CAS Number: RG 26-001-RGRV

CAU Number: 487, Thunderwell Site

General Location: Tonopah Test Range

Elevation: Approximately 6,000 ft

Latitude: 37.85729463

Northing: 4189797.369

Longitude: -116.7891387

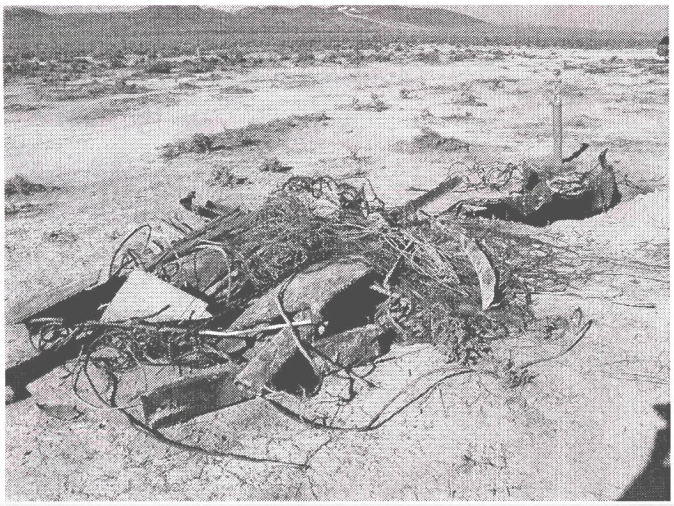
Easting: 518549.351

Coordinate/Elevation Data Obtained from NORTH AMERICAN DATUM, 1927.

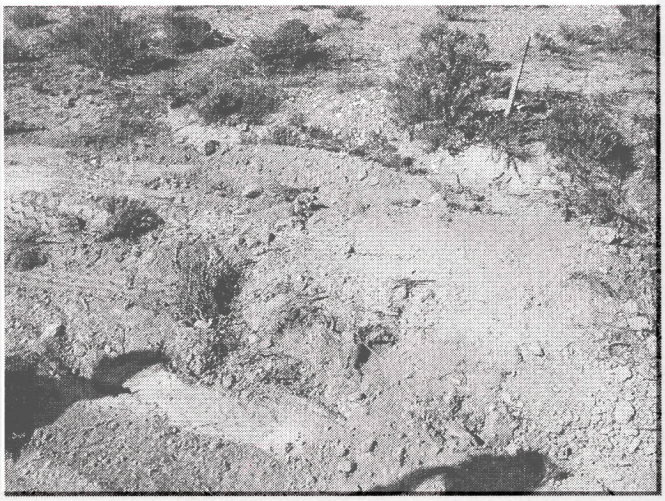
Site Access Route: Intersection of Avenues 25 and 57.

Waste Item(s) Originally at Site	Apparent Waste Type*
scrap metal, wires, wood, asbestos containing	scrap metal, asbestos containing, sanitary, salvageable

*** Sanitary, Scrap Metal, Asbestos Containing, PCB, Salvageable, Hazardous, Radioactive, Mixed, Unknown, Other**



CAS Prior to Cleanup
Photograph date: 3/2001
Typical Surface Debris Consolidated for Disposal



CAS After Cleanup
Photograph date: 5/7/2001

Current Site Description/Observations: Surface debris from across CAU 487 has been removed from the site for disposal (see attached shipping paper and memos).

✓ **No Further Action Required at Corrective Action Site**

R. Lynn Kidman (Industrial Sites Project Manager)	Original Signature in Project File	11/20/01
Corrective Action Coordinator/Designee	**(Signature)**	**Date**

INTERNATIONAL TECHNOLOGY CORPORATION

ITLV RECORD OF

X TELECON
□ MEETING

Project Name	Number	Cost Code
CAU 487		

Date: 11/5/01	Time: 14:20	CALL FROM x NAME: David Weston CALL TO □

Other Participants - Name/Location/Representing: N/A	CALL FROM □ NAME: **Jerry Elliston** CALL TO x
	Telephone Number: **295-8181**
	Company Name: **Westinghouse**
	Address:
Topic: Debris disposal from CAU 487 Thunderwell Site at TTR	City: **Tonopah Test Range**
	State: / Zip Code:

Summary (Decisions & Specific Actions Required by Named Persons):

Question:
Where was the disposal debris at the CAU 487 Thunderwell Site taken to?

Answer:
After the proper radiological surveys were completed by ITLV, the wood debris was disposed of in the landfill at TTR, and the metal debris was transported in two truckloads to the Nevada Test Site (NTS). Jerry also stated that the he believes that the metal debris was used for recycling. He also said he would fax a copy of the paperwork for the NTS shippment.

Required Action:

None.

Signature and Date to affirm Concurrence of Participants (as appropriate):

DOE/NVO	IT Corporation **Jeff Johnson**	BNC
Distribution: Original to Project File Copy to Project Manager Copy to Preparer	x Other Distribution (By Preparer) **David Weston**	Prepared by (Signature):

SF 6951-PRA (7-94)

PROPERTY REMOVAL AUTHORIZATION
TONOPAH TEST RANGE

19153

Vehicle No. E-28005 Vehicle Make MACK Date 8-29-01

Name TOMMY OTTESON SS# 530-66-0803

The following property is authorized for removal from Tonopah Test Range:

Quantity	Description including property and/or serial number
1 LOT	SCRAP IRON
	LAST ITEM 9.05 LBS
	I T CORP

Anyone who knowingly converts to his own use, or the use of another, anything of value belonging to the United States Government may be subject to a maximum penalty of a $10,000 fine, or ten years imprisonment, or both (PUBLIC LAW 772, 80th CONGRESS).

I certify that the property listed above is: ☒ Government owned

☐ Company owned ☐ Personally owned and is being removed

☒ Permanently ☐ Temporarily, to be returned on 8-29-01 Date

Final Destination of Property HTS

Tommy Otteson Signature of Bearer

The authorized individuals, whose signatures appear below, certify to the best of their knowledge and belief that the above-listed property is not Government-owned property coming under the jurisdiction of the DOE or the USAF, or if so, that such removal has been approved by an authorized official.

Inspection: Main Gate

Sgt. Kurt M. Baller
Security Checkpoint for Property

Date: 08-29-01 Time: 0648

Authorization:

Name 15121 Org.

Date: 08-27-01 Time: 1240L

Distribution: White Copy - Gate Yellow - Bearer Pink - Originator

ASI-TTR #15

*U.S. GPO: 1997-673-443/66000

SF 6951-PRA (7-94)

PROPERTY REMOVAL AUTHORIZATION
TONOPAH TEST RANGE

CAU 487 CADD/CR
Appendix F
Revision: 0
Date: 11/21/2001
Page F-4 of F-5

19154

Vehicle No. E28009 Vehicle Make WHITE Date 8-29-01

Name John William Salois SS# ~~526-64-6043~~ 530-66-0635

The following property is authorized for removal from Tonopah Test Range:

Quantity	Description including property and/or serial number
1 LOT	SCRAP IRON
	LAST ITEM 6000 LBS I.T. CORP

Anyone who knowingly converts to his own use, or the use of another, anything of value belonging to the United States Government may be subject to a maximum penalty of a $10,000 fine, or ten years imprisonment, or both (PUBLIC LAW 772, 80th CONGRESS).

I certify that the property listed above is: ☒ Government owned

☐ Company owned ☐ Personally owned and is being removed

☒ Permanently ☐ Temporarily, to be returned on 8-29-01 Date

Final Destination of Property HTS

Signature of Bearer

The authorized individuals, whose signatures appear below, certify to the best of their knowledge and belief that the above-listed property is not Government-owned property coming under the jurisdiction of the DOE or the USAF, or if so, that such removal has been approved by an authorized official.

Inspection: Mani Date

Sgt. Kurt M. Bates
Security Checkpoint for Property

Authorization:

Name 1542-1 Org.

Date: 08-29-01 Time: 0645

Date: 08-27-01 Time: 1240

Distribution: White Copy - Gate Yellow - Bearer Pink - Originator

ASI-TTR #15

*U.S. GPO: 1997-673-443/66000

IT CORPORATION

Memorandum

To: Jeff Johnson

Date: November 20, 2001

From: David Weston DW

Page: 1 of 1

Subject: Disposal of Asbestos Containing Material (ACM) from Corrective Action Unit (CAU) 487

On November 1, 2001, ACM was located at CAU 487, Thunderwell Site. The ACM was inspected by a certified asbestos inspector and pre-determined to contain asbestos for health and safety reasons. A sample was taken from the ACM for confirmatory data. The remaining ACM was properly stored in a 55 gallon steel drum at CAU 405 located in Area 3 at the Tonopah Test Range. The ACM was confirmed to contain asbestos through the analysis and will be disposed of at the Nevada Test Site at a permitted landfill with the CAU 405 waste.

cc: Lynn Kidman
Jill Dale

Appendix G

Nevada Environmental Restoration Project Document Review Sheet

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada	2. Document Date:
3. Revision Number: 0	4. Originator/Organization: IT Corporation
5. Responsible DOE/NV ERP Project Mgr.: Janet Appenzeller-Wing	6. Date Comments Due: October 15, 2001
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No.: John A. Wong, NDEP, 486-2866	9. Reviewer's Signature:

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1) Section 2.2 Page 63rd Sentence		Sentence is ambiguous and appears to be contradictory (i.e., ...partial suite analyses for anomaly locations only during excavation...if FSRs did not exceed FSLs, and ...no sample locations exceeded FSLs, then samples submitted for full suite...). Please clarify and modify the sentence as appropriate to.	Text changed to read, "During excavation it was planned that samples from anomaly locations would be submitted for laboratory analysis only if the field-screening results (FSRs) exceeded field-screening levels (FSLs) or if extensive amounts or hazardous debris was uncovered. None of the FSRs exceeded FSLs for excavation activities. However, extensive debris was encountered at two locations. As a result, all samples were sent for full suite analysis, which consisted of total semivolatile organic compounds (SVOCs), total *Resource Conservation and Recovery Ac*t (RCRA) metals, explosives, total volatile organic compounds (VOCs), tantalum, lithium, boron, isotopic uranium, and gamma spectrometry for waste management purposes."	Yes
2) Section 2.2 Page 7Last Paragraph4th Sentence		Sentence is ambiguous; please modify so that NDEP can interpret the meaning of this sentence.	Text changed to read, "Analysis for samples sent to the laboratory were determined based upon FSRs. Samples that did not exceed FSLs were sent to the laboratory for partial suite analysis (total SVOCs, total RCRA metals, and explosives). Samples that exceeded FSLs were sent to the laboratory for full suite analysis (partial suite plus total VOCs, tantalum, lithium, boron, isotopic uranium, and gamma spectrometry)."	Yes

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NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
3) Appendix A Page A-13 Section A.2.2.7 2nd Sentence		The rationale stated here is invalid. The concentration of BEHP detected in sample THTA1399 was reported as 470,000 ug/kg, and qualified as estimated, which is an indication that the true concentration could be higher (or lower). The PAL for BEHP is 180,000 ug/kg. To state that "contamination is not an issue..." based on rationale that the duplicate sample concentration was below the PAL is inadequate and inappropriate. Provide additional rationale to support the claim that there is no SVOC contamination (i.e., what are the SVOC results for neighboring samples collected in the area?). If such rationale cannot be provided, NNSA/NV should follow the actions described in the CAIP for exceedence of PALs.	Text changed to read, "Total SVOC results for soil samples submitted for analysis above MRLs as established in the CAIP (DOE/NV, 2001) are found in Table A.3-2. Sample number THTA1399 (which is a QC sample of THTA1318), exceeded the PAL for bis(2-ethylhexyl) phthalate. However, the sample THTA1318 did not exceed PALs for any analytes. Bis(2-ethylhexyl) phthalate is a commonly used plasticizer used to make the coverings for wires and everyday household and industrial items (Syracuse, 2000). The sample collection log and geology borehole log noted that plastic covered wires and debris were present at the interval where the samples were collected. The sample collected below the exceeded interval, THTA1320, had bis(2-ethylhexyl) phthalate that exceeded MRLs but did not exceed PALs. Eight other samples exceeded the MRL for bis(2-ethylhexyl) phthalate, and the results did not meet nor exceed the PALs."	Yes
4) Appendix E		The CAU Use Restriction Information provided in this appendix should contain a text description and pertinent discussion. Also, the distribution list for this document and Use Restriction should include USAF, Nellis AFB (E. V. Hopper).	Additional text was added to Section 2.4. The draft CADD/CR was distributed to USAF, Nellis AFB (E. V. Hopper); however, they were not included in the draft document distribution list. The distribution list was corrected for the final document.	Yes

[a] Comment Types: M = Mandatory, S = Suggested.

Return Document Review Sheets to DOE/NV Environmental Restoration Division, Attn: QAC, M/S 505.

This is a draft, predecisional U.S. Department of Energy document and is not releasable to the public.

Distribution

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Supervisor, Las Vegas Office State of Nevada Bureau of Federal Facilities Division of Environmental Protection 555 E. Washington, Suite 4300 Las Vegas, NV 89101	1 (Controlled)*
Sabrina Lawrence Environmental Restoration Division U.S. Department of Energy National Nuclear Security Administration Nevada Operations Office P.O. Box 98518, M/S 505 Las Vegas, NV 89193-8518	1 (Controlled)*
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Jeffrey Johnson IT Corporation P.O. Box 93838 Las Vegas, NV 89193	1 (Uncontrolled)
Jill Dale IT Corporation P.O. Box 93838 Las Vegas, NV 89193	1 (Uncontrolled)

RECORD OF TECHNICAL CHANGE

Technical Change No. 1 Page 1 of 1

Project/Job No. 840224 Date 12/11/02

Project/Job Name Industrial Sites CAU 487 Thunderwell Site

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

Jeff Johnson (Name) Task Manager (Title)

Justification: This Record of Technical Change (ROTC) is required to be consistent with FFACO guidelines for Use Restriction information in the *Corrective Action Decision Document/Closure Report for CAU 487: Thunderwell Site, Tonopah Test Range, Nevada*, Rev. 0, DOE/NV 761.

Changes

Appendix E, Pages E-3 through E-5: Replace Use Restriction information for CAS RG-26-001-RGRV with modified Use Restriction information (see attached pages).

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

Applicable Project-Specific Document(s): *Corrective Action Decision Document/Closure Report for CAU 487: Thunderwell Site, Tonopah Test Range, Nevada*, Rev. 0, DOE/NV 761 (November, 2001).

Approved By: Janet Appenzeller-Wing Date 1/6/03
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

Date 1-6-03
Runore C. Wycoff, Division Director
Environmental Restoration Division

Client Notified Yes X No ___ Date 12/11/02
NDEP Concurrence: Date 1/8/03

Contract Change Order Required Yes ___ No X
Contract Change Order No. ___

CAU Use Restriction Information

CAU Number/Description: CAU 487, Thunderwell Site

Applicable CAS Numbers/Descriptions: CAU RG 26-001-RGRV, A17 Anomalies

Contact (organization/project): DOE/NV Industrial Sites Project Manager

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Northwest Corner E=519017.4 N=4189841.9
Northeast Corner E=519064.5 N=4189846.0
Southeast Corner E=519064.8 N=4189828.0
Southwest Corner E=519021.0 N=4189822.0

Survey Date: 5/16/01 **Survey Method (GPS, etc.):** GPS

Site Monitoring Requirements: None

Required Frequency (quarterly, annually?): Not Applicable

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

Use Restrictions

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

Comments: The use restriction is for subsurface contamination . There are no monitoring or inspection requirements associated with this Use Restriction. See the Closure Report for additional information on the condition of the site. The restricted area is identified by postings.

Submitted By: Kevin Cabble **Date:** 12/11/02
Kevin Cabble

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

P:\Ind-Sites\IS_Common\use restrictions\CAU 487 8A subsurface.wpd

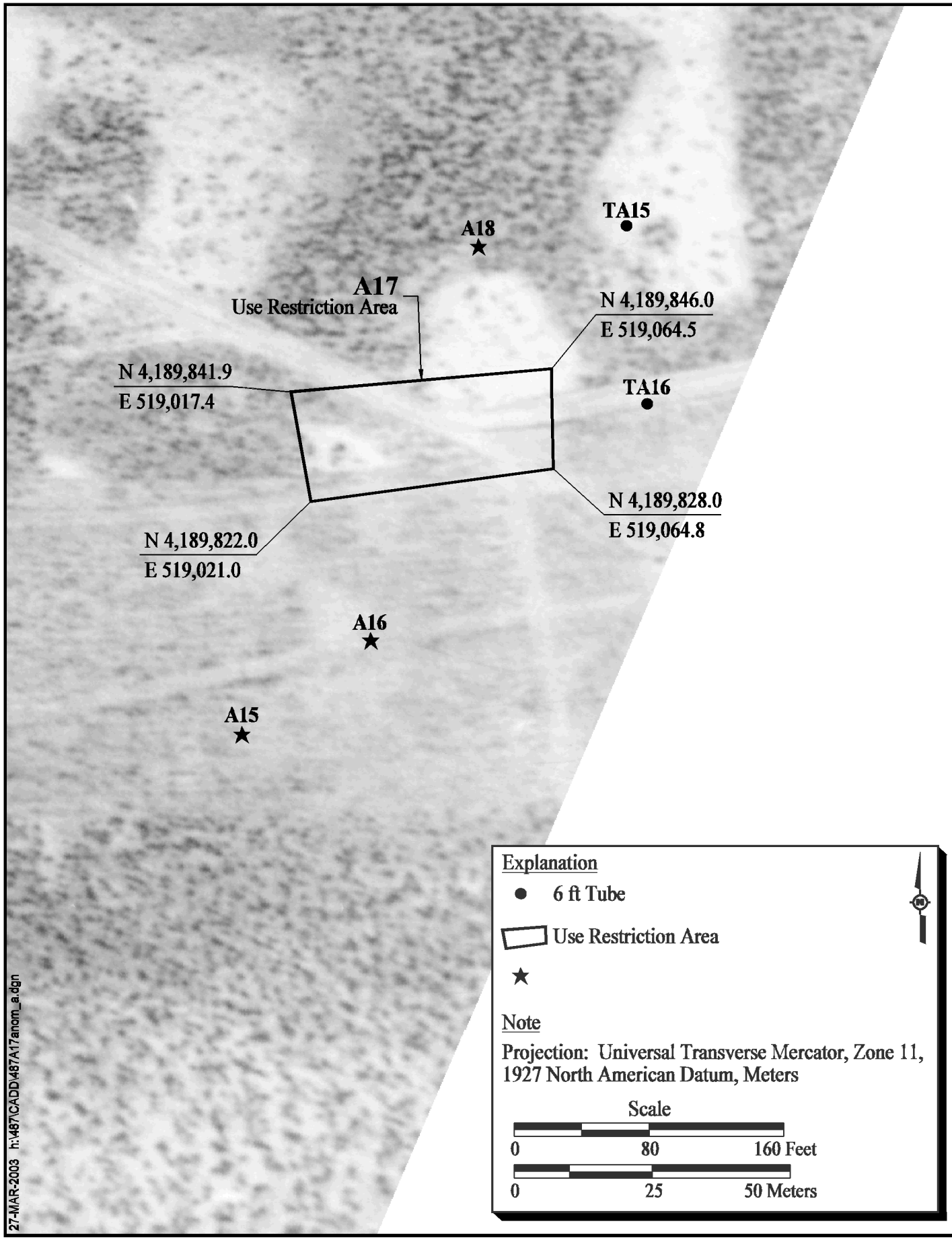

Figure E.1-1
CAU 487 Thunderwell Site CAS RG-26-001-RGRV
A17 Anomalies Subsurface Use Restriction

This is a draft, predecisional U.S. Department of Energy document and is not releasable to the public.

CAU Use Restriction Information

CAU Number/Description: CAU 487, Thunderwell Site

Applicable CAS Numbers/Descriptions: CAU RG 26-001-RGRV, A8 Anomalies

Contact (organization/project): DOE/NV Industrial Sites Project Manager

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Northwest Corner E=518555.0 N=4189779.0
Northeast Corner E=518585.5 N=4189779.1
Southeast Corner E=518575.6 N=4189765.8
Southwest Corner E=518551.0 N=4189774.0

Survey Date: 5/16/01 **Survey Method (GPS, etc.):** GPS

Site Monitoring Requirements: None

Required Frequency (quarterly, annually?): Not Applicable

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

Use Restrictions

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

Comments: The use restriction is for subsurface contamination . There are no monitoring or inspection requirements associated with this Use Restriction. See the Closure Report for additional information on the condition of the site.

Submitted By: Kevin Cabble **Date:** 12/11/02
Kevin Cabble

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

P:\Ind-Sites\IS_Common\use restrictions\CAU 487 8A subsurface.wpd

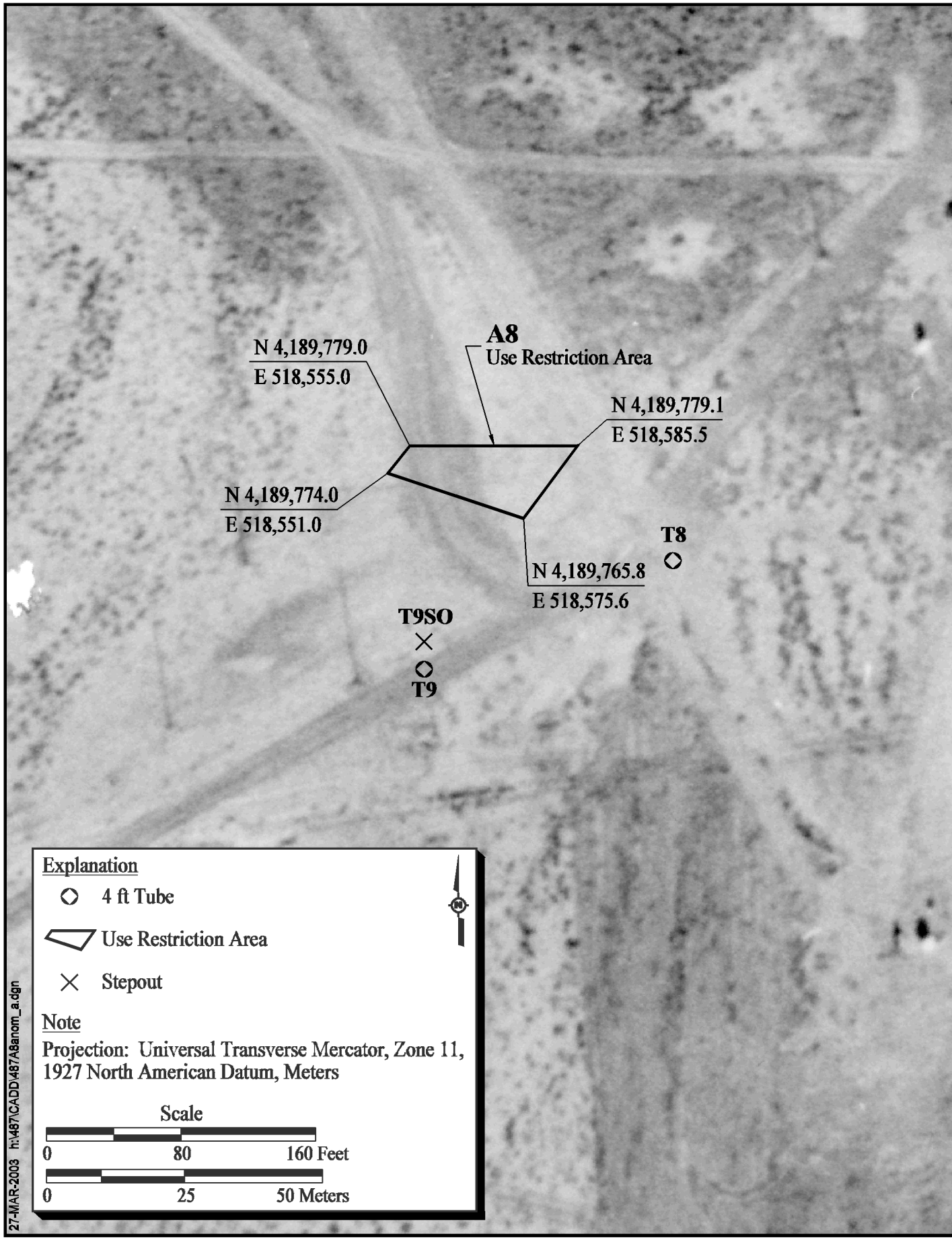

Figure E.1-2
CAU 487 Thunderwell Site CAS RG-26-001-RGRV
A8 Anomalies Subsurface Use Restriction

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RECORD OF TECHNICAL CHANGE

Technical Change No. 2 Page 1 of 1

Project/Job No. Industrial Sites Date

Project/Job Name ~~Corrective Action Investigation Plan for~~ CAU 487: Thunderwell Site, TTR

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

Laura Pastor (Name) Project Task Manager (Title)

Description of Change

1. **Section 2.4 Justification for No Further Action**, page 9. Replace the last paragraph with the following two paragraphs:

- "A use restriction will be placed on location A17 where surface/subsurface steel structures exist, and location A8 where extensive underground debris below three feet below ground surface remains. These use restrictions are shown on Figure A.2-1, E.2-4 and E.4-4. There are no hazardous materials associated with the use restrictions. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. A post-closure inspection is associated with both use restrictions."

- "The post closure inspection of CAS RG-26-001-RGRV will consist of semi-annual (twice per year) visual inspections of the monument markers and postings to verify that they are in-place, intact, and readable. Visual inspections of the monuments and signage, and indications of ground disturbance within the use restriction area will be conducted. Observations and any modifications and/or repairing to the monuments or posting will be included in the *Tonopah Test Range Post-Closure Inspection Annual Report.*"

2. **Appendix A, Page 4:** Replace Figure A.2-1 with updated Figure (attached).

3. **Appendix E, Pages E-1 through E-4:** Replace all pages with modified use restriction information and Figures E.1-1 and E.1-2 for CAS RG-26-001-RGRV (attached).

Justification: This ROTC is required to include semi-annual inspections and for consistency with FFACO guidelines for use restriction information in the *Corrective Action Decision Document/Closure Report for Corrective Action Unit 487:Thunderwell Site, Tonopah Test Range, Nevada*, Revision 0, November 2001.

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

Applicable Project-Specific Document(s): **Corrective Action Decision Document/Closure Report for Corrective Action Unit 487:Thunderwell Site, Tonopah Test Range, Nevada, Revision 0, November 2001.**

Approved By:

/s/ Janet Appenzeller-Wing Date 6/28/04
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

/s/ Monica Sanchez Date 6/28/04
Monica Sanchez, Acting Division Director
Environmental Restoration Division

Date
Nevada Department of Environmental Protection

RECORD OF TECHNICAL CHANGE

Technical Change No. 2 Page 1 of 1

Project/Job No. Industrial Sites Date

Project/Job Name Corrective Action Investigation Plan for CAU 487: Thunderwell Site, TTR

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

Laura Pastor (Name) — Project Task Manager (Title)

Description of Change

1. **Section 2.4 Justification for No Further Action, page 9.** Replace the last paragraph with the following two paragraphs:

- "A use restriction will be placed on location A17 where surface/subsurface steel structures exist, and location A8 where extensive underground debris below three feet below ground surface remains. These use restrictions are shown on Figure A.2-1, E.2-4 and E.4-4. There are no hazardous materials associated with the use restrictions. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. A post-closure inspection is associated with both use restrictions."

- "The post closure inspection of CAS RG-26-001-RGRV will consist of semi-annual (twice per year) visual inspections of the monument markers and postings to verify that they are in-place, intact, and readable. Visual inspections of the monuments and signage, and indications of ground disturbance within the use restriction area will be conducted. Observations and any modifications and/or repairing to the monuments or posting will be included in the *Tonopah Test Range Post-Closure Inspection Annual Report*."

2. **Appendix A, Page 4:** Replace Figure A.2-1 with updated Figure (attached).

3. **Appendix E, Pages E-1 through E-4:** Replace all pages with modified use restriction information and Figures E.1-1 and E.1-2 for CAS RG-26-001-RGRV (attached).

Justification: This ROTC is required to include semi-annual inspections and for consistency with FFACO guidelines for use restriction information in the *Corrective Action Decision Document/Closure Report for Corrective Action Unit 487:Thunderwell Site, Tonopah Test Range, Nevada*, Revision 0, November 2001.

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

Applicable Project-Specific Document(s): Corrective Action Decision Document/Closure Report for Corrective Action Unit 487:Thunderwell Site, Tonopah Test Range, Nevada, Revision 0, November 2001.

Approved By:

/s/ Janet Appenzeller-Wing — Date 6/28/04
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

/s/ Monica Sanchez — Date 6/25/04
Monica Sanchez, Acting Division Director
Environmental Restoration Division

/s/ Don Elle — Date 6/30/04
Nevada Department of Environmental Protection

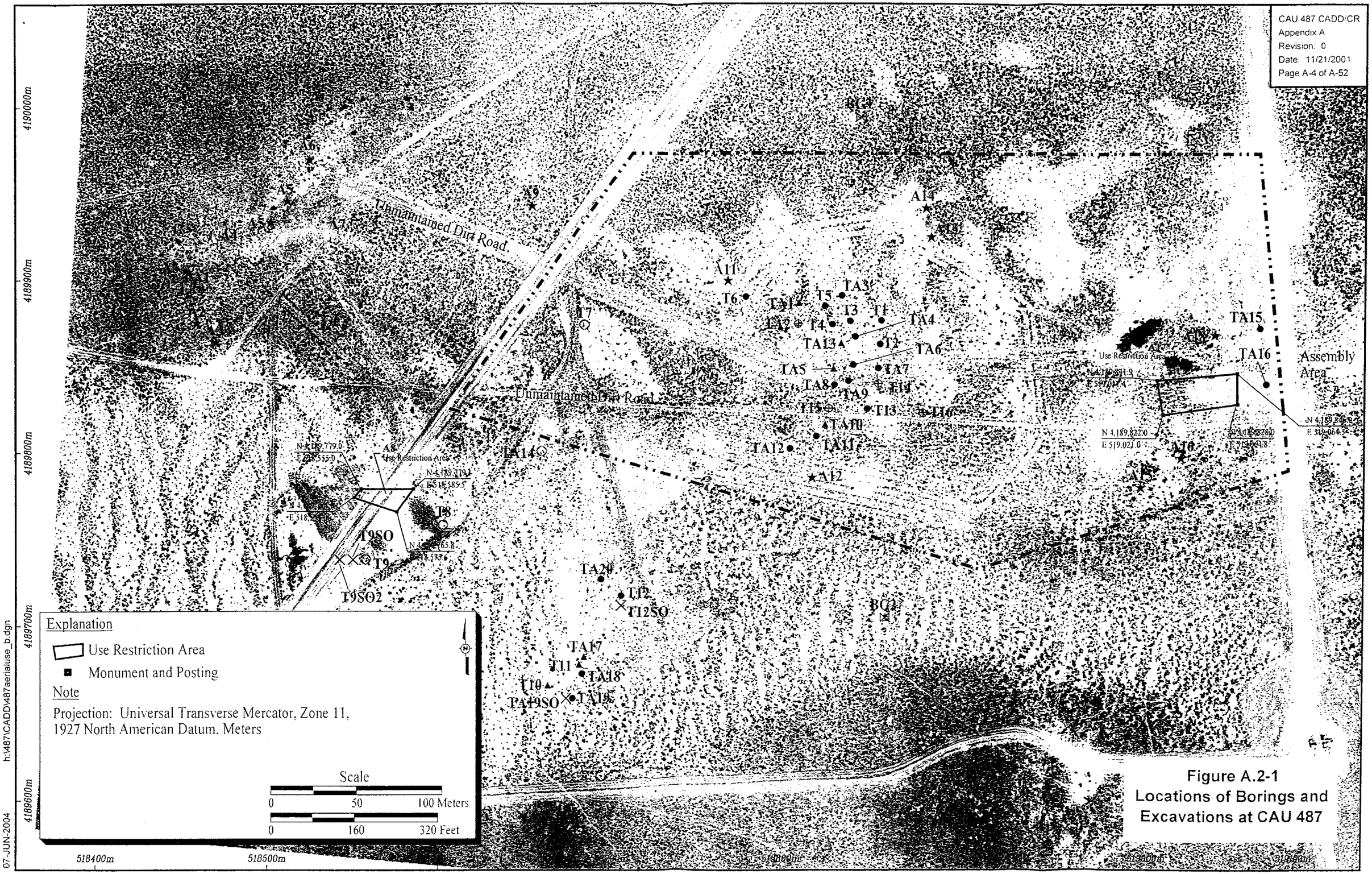


Figure A.2-1
Locations of Borings and Excavations at CAU 487

CAU Use Restriction Information

CAU Number/Description: CAU 487, Thunderwell Site

Applicable CAS Numbers/Descriptions: CAS RG 26-001-RGRV, A17 Anomalies

Contact (organization/project): NNSA/NSO Industrial Sites Project Manager

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Northwest Corner E=519017.4 N=4189841.9
Northeast Corner E=519064.5 N=4189846.0
Southeast Corner E=519064.8 N=4189828.0
Southwest Corner E=519021.0 N=4189822.0

Survey Date: 5/16/01 **Survey Method (GPS, etc.):** GPS

Site Monitoring Requirements: Inspections of postings and monuments.

Required Frequency (quarterly, annually?): Semi-annual

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

Use Restrictions

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

Comments: This Use Restriction is for surface/subsurface debris only. The restricted area is identified with corner monuments and postings. Semi-annual post-closure inspections will be conducted to ensure postings and monuments are intact and in-place. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. See the Corrective Action Decision Document/Closure Report for additional information on the condition of the site.

Submitted By: /s/ Kevin Cabble **Date:** 6-17-04
Kevin Cabble, NNSA/NSO Task Manager

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

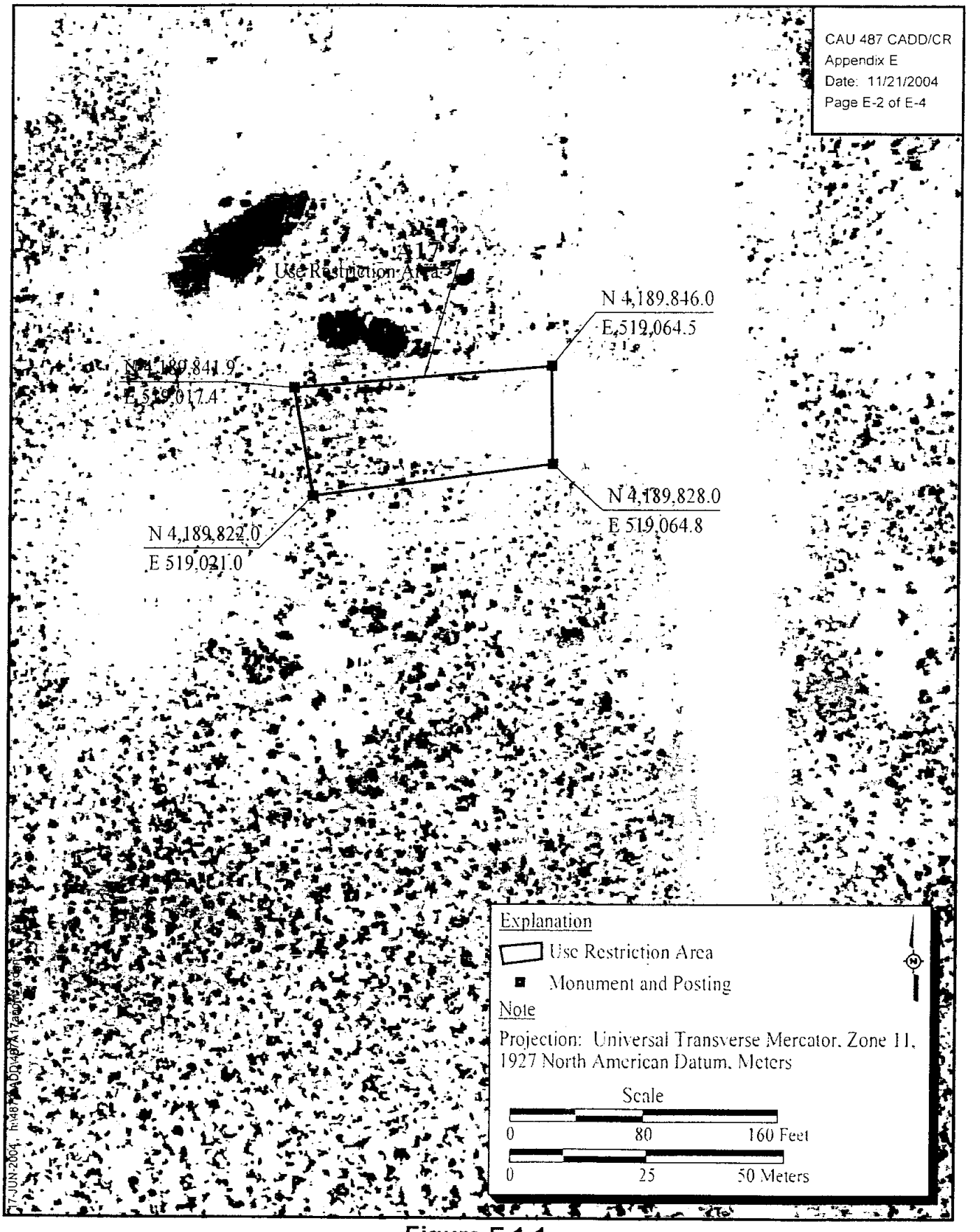


Figure E.1-1
CAU 487 Thunderwell Site CAS RG-26-001-RGRV
A17 Anomalies Subsurface Use Restriction

CAU Use Restriction Information

CAU Number/Description: CAU 487, Thunderwell Site

Applicable CAS Numbers/Descriptions: CAS RG 26-001-RGRV, A8 Anomalies

Contact (organization/project): NNSA/NSO Industrial Sites Project Manager

Surveyed Area (UTM, Zone 11, NAD 27, meters):
Northwest Corner E=518555.0 N=4189779.0
Northeast Corner E=518585.5 N=4189779.1
Southeast Corner E=518575.6 N=4189765.8
Southwest Corner E=518551.0 N=4189774.0

Survey Date: 5/16/01 **Survey Method (GPS, etc.):** GPS

Site Monitoring Requirements: Inspection of postings and monuments

Required Frequency (quarterly, annually?): Semi-annual
If Monitoring Has Started, Indicate Last Completion Date: Not Applicable

Use Restrictions

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

Comments: This Use Restriction is for subsurface debris only. The restricted area is identified with corner monuments and postings. Semi-annual post-closure inspections will be conducted to ensure postings and monuments are intact and in-place. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. See the Corrective Action Decision Document/Closure Report for additional information on the condition of the site.

Submitted By: /s/ Kevin Cabble **Date:** 6-17-04
Kevin Cabble, NNSA/NSO Task Manager

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

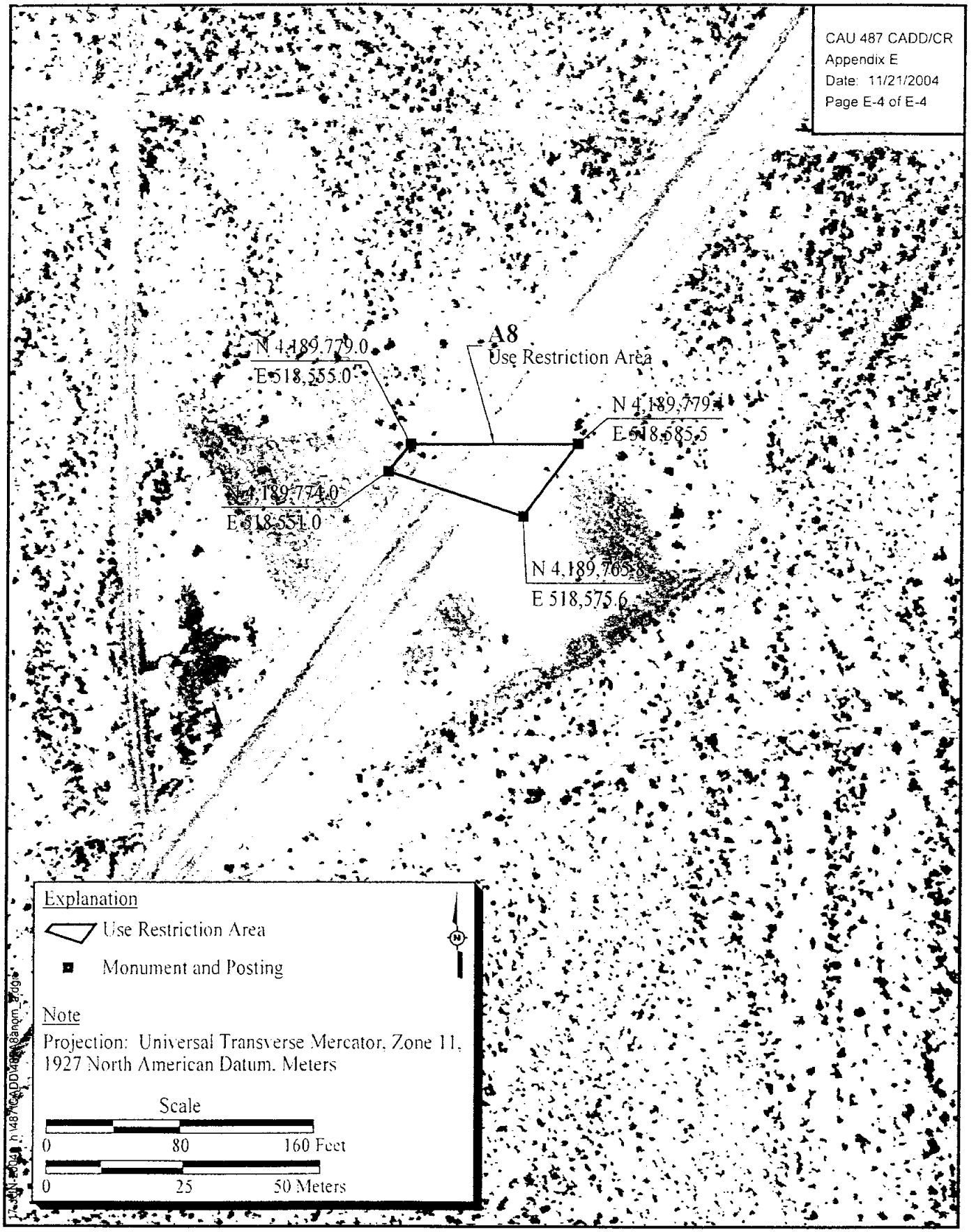


Figure E.1-2
CAU 487 Thunderwell Site CAS RG-26-001-RGRV
A8 Anomalies Subsurface Use Restriction

This is a draft, predecisional U.S. Department of Energy document and is not releasable to the public.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 487
CAU Description: Thunderwell Site (TTR)
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--761-ROTC 3 **Page** 1 of 11

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 11/19/2019

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

Tiffany Gamero
Requestor Name

Long-Term Monitoring Activity Lead
Requestor Title

Description of Change:

1. This ROTC replaces the Use Restriction (UR) information listed in the documentation for CAU 487.

   UR forms have been updated to list all UR requirements, including but not limited to: post-closure site controls (signs, fencing, etc.), inspection and maintenance requirements, and Geographic Information Systems (GIS) coordinate information. The UR requirements and form(s) included in this ROTC represent the current corrective action requirements for each Corrective Action Site (CAS) in this CAU and supersede information concerning corrective action and post-closure requirements in existing documentation.

2. UR boundary coordinate values changed due to conversion from North American Datum (NAD) 1927 to NAD 1983 for CAS RG-26-001-RGRV.

Justification:

1. Some changes in the UR requirements from those found in closure documents have been subsequently modified in letters, memos, and inspection reports. This has resulted in difficulty in determining current post-closure requirements. A review of the post-closure requirements for this CAU has been conducted to ensure that all requirements have been identified and documented on the new UR form. The new UR form was developed to be inclusive of all requirements for long-term monitoring and standardize information contained in the URs consistent with current protocols.

2. UR boundary coordinates need to be in one standardized coordinate system.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 487
CAU Description: Thunderwell Site (TTR)
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--761-ROTC 3 **Page** 2 of 11

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 11/19/2019

Schedule Impacts:

No impacts to schedule.

ROTC applies to the following document(s):

- U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2001. Corrective Action Decision Document/Closure Report for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada, Rev. 0, DOE/NV--761. Las Vegas, NV.
- ROTC 1 for CAU 487 CADD/CR (DOE/NV--761), dated 12/11/2002.
- ROTC 2 for CAU 487 CADD/CR (DOE/NV--761), signed 06/30/2004.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 487
CAU Description: Thunderwell Site (TTR)
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--761-ROTC 3 **Page** 3 of 11

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 11/19/2019

Approvals:

Date 12/5/2019

Tiffany Gamero
Activity Lead
Environmental Management (EM) Nevada Program

Date 12/9/19

Bill Wilborn
Deputy Program Manager, Operations
Environmental Management (EM) Nevada Program

Date 12/18/19

FOR Christine Andres
Chief, Bureau of Federal Facilities
Nevada Division of Environmental Protection (NDEP)

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

General Information

Use Restriction (UR) Type(s):	FFACO Only
Corrective Action Unit (CAU) Number & Description:	487 - Thunderwell Site (TTR)
Corrective Action Site (CAS) Number & Description:	RG-26-001-RGRV - Thunderwell Site
CAU/CAS Owner:	Industrial Sites - ER
Note:	N/A

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

Basis for FFACO UR

Summary Statement: This FFACO UR is established to protect workers from inadvertent exposure to uncontaminated debris.

FFACO UR Physical Description

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

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
FFACO Boundary 1	1	518,496	4,189,964
	2	518,472	4,189,972
	3	518,476	4,189,977
	4	518,506	4,189,977
	5	518,496	4,189,964
FFACO Boundary 2	1	518,942	4,190,020
	2	518,938	4,190,040
	3	518,985	4,190,044
	4	518,985	4,190,026
	5	518,942	4,190,020

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Boundary Applies to: Both Surface and Subsurface

Depth is unknown.

Survey Source: GPS

FFACO UR Requirements

Site Controls:

This FFACO UR is recorded as described in **Section IV. Recordation Requirements** to restrict activities within the area by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Control	Criteria
Monuments	Present and standing.
Signage	Present and legible.

Inspection Frequency: Annual

Additional Considerations:

Consideration	Criteria
None	None

Requirements Comments: N/A

Section II. Administrative UR

An Administrative UR is not identified for this site.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Section III. Supporting Documentation

UR Source Document(s)

ROTC 3 for CAU 487 CADD/CR (DOE/NV--761), dated 11/19/2019.

Murphy, T.H., Nevada Division of Environmental Protection, Bureau of Federal Facilities. 2006. Letter to J.B. Jones (NNSA/NSO) titled NNSA/NSO Request to Reduce the Frequency of Post-Closure Monitoring of Corrective Action Units (CAU) 400, 404, 407, 423, 424, 426, 427, 453, and 487 at Tonopah Test Range (TTR), Nevada, 5 December. Las Vegas, NV.

ROTC 2 for CAU 487 CADD/CR (DOE/NV--761), signed 06/30/2004.

ROTC 1 for CAU 487 CADD/CR (DOE/NV--761), dated 12/11/2002.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2001. Corrective Action Decision Document/Closure Report for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada, Rev. 0, DOE/NV--761. Las Vegas, NV.

Attachments

- FFACO UR Boundary Maps (UTM, Zone 11, NAD 83 meters)
- Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

Section IV. Recordation Requirements

Recordation:

The above UR(s) are recorded in the:

- FFACO Database
- NNSA M&O Contractor GIS
- USAF (Nellis Air Force Base Range Operations) GIS
- EM Nevada Program CAU/CAS Files

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

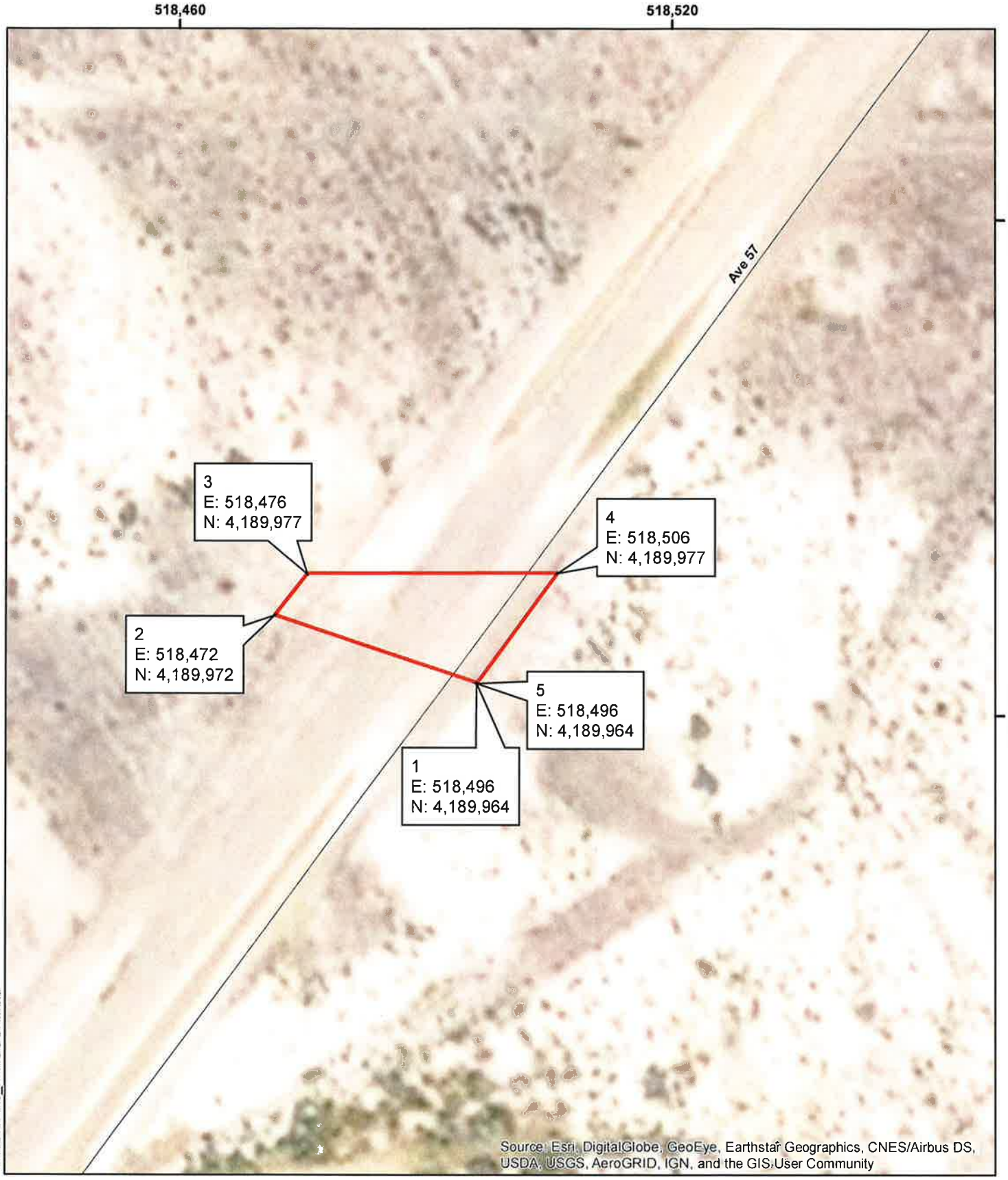
Section V. EM Nevada Program Approval

Date: 12/5/2019

Tiffany Gamero

Activity Lead

EM Nevada Program



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CAU 487, CAS RG-26-001-RGRV
Thunderwell Site
FFACO UR Boundary 1

Explanation

FFACO UR

Unimproved Road

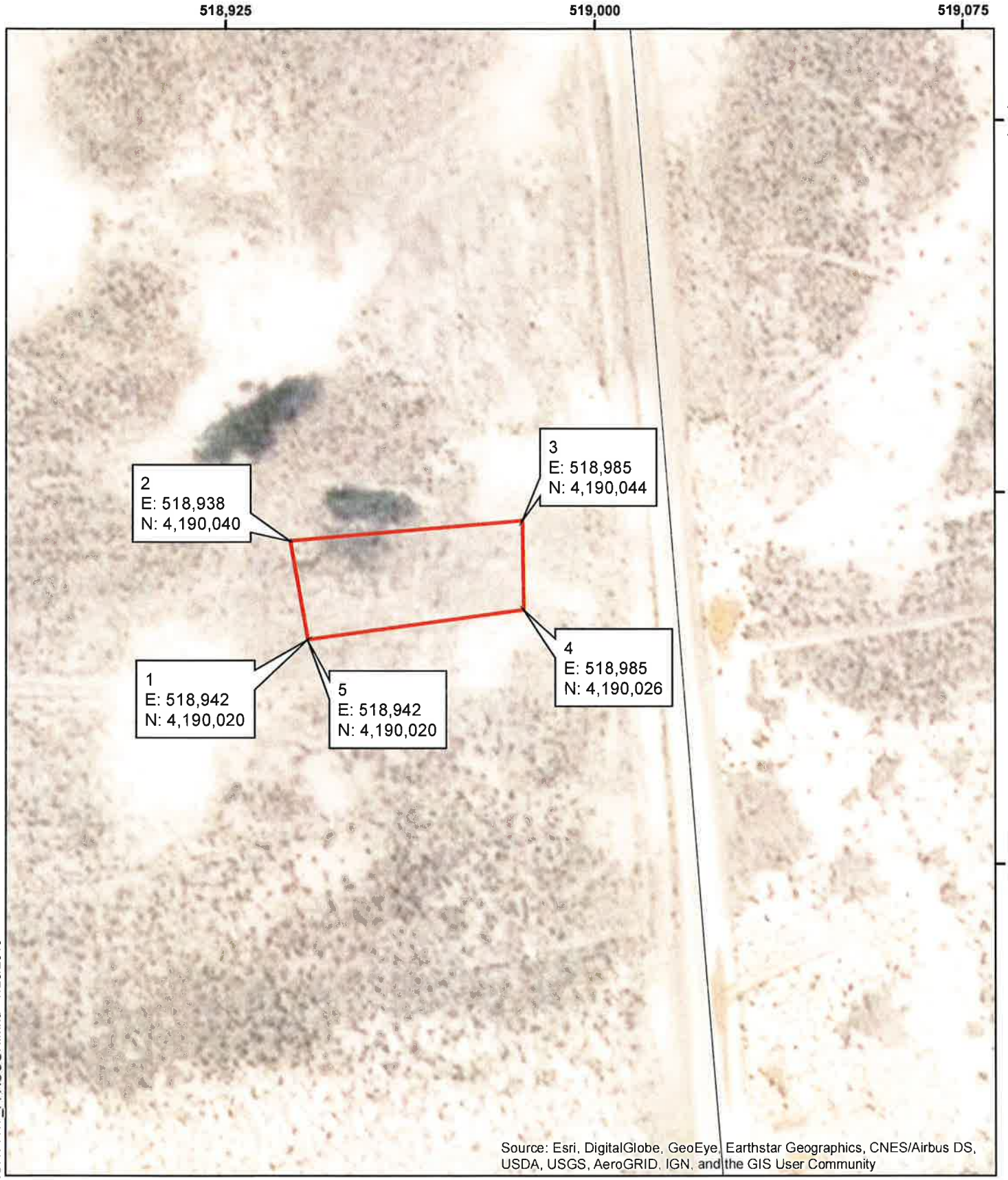
0 5 10 20 Meters

0 20 40 80 Feet

N

Source: Navarro GIS, 2019

Coordinate System: NAD 1983 UTM Zone 11N, Meter



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CAU 487, CAS RG-26-001-RGRV
Thunderwell Site
FFACO UR Boundary 2

Explanation

FFACO UR

Unimproved Road

0 10 20 40 Meters

0 30 60 120 Feet

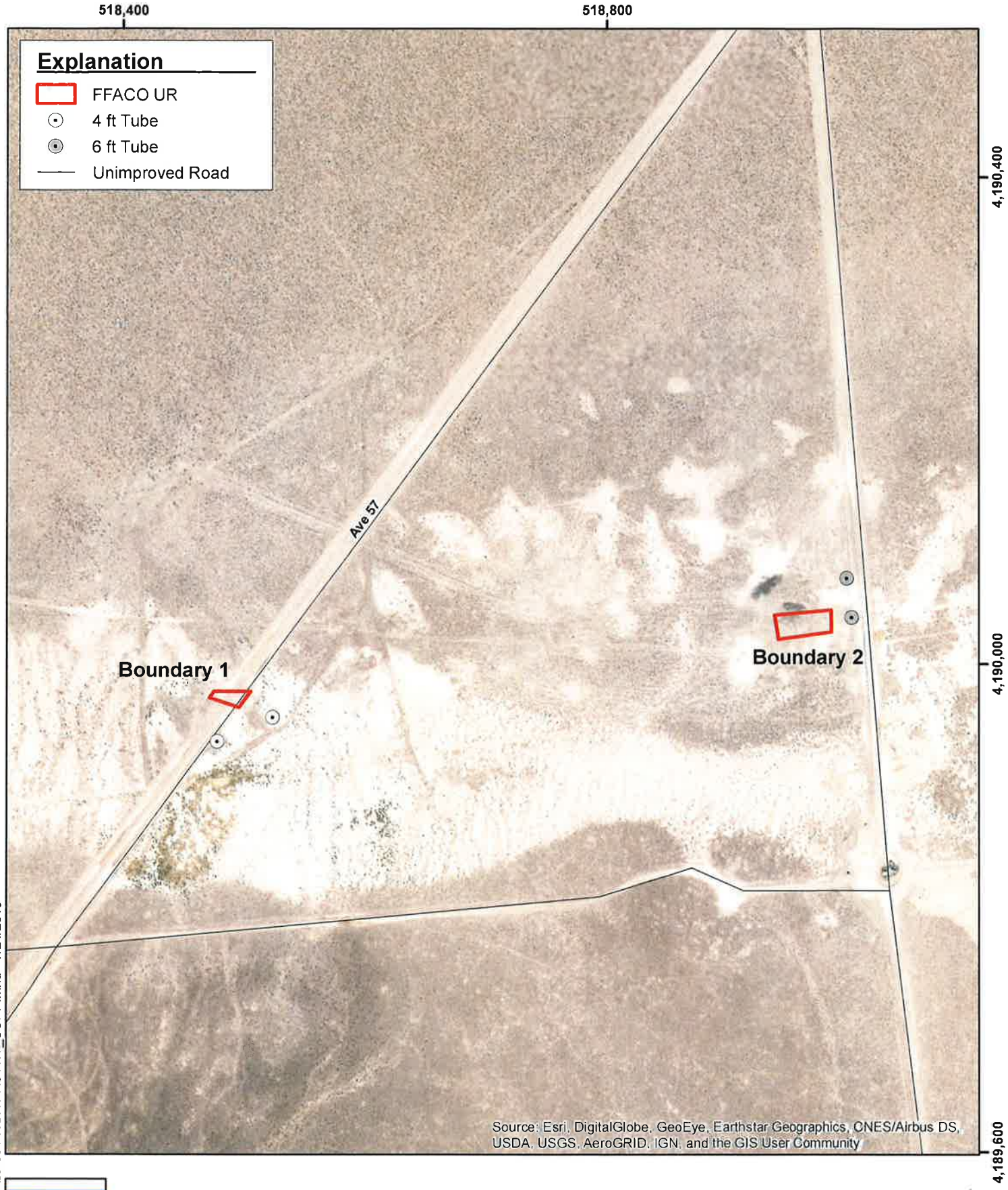
N

Source: Navarro GIS, 2019

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.



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Source: Navarro GIS, 2019

CAU 487, CAS RG-26-001-RGRV
Thunderwell Site
Supplemental Information
General Location of Site Features

0 40 80 160 Meters

0 150 300 600 Feet

N

NOTE: Size and location of features are approximated

Coordinate System: NAD 1983 UTM Zone 11N, Meter