Nevada
Environmental
Restoration
Project

DOE/NV--676

Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site Tonopah Test Range, Nevada

Controlled Copy No.: ___
Revision No.: 0

January 2001

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

RECORD OF TECHNICAL CHANGE

Technical Change No. 1

Project/Job No. 799417.01030160

Date 04/20/01

Project/Job Name Industrial Sites/CAU 487 Thunderwell Site

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

Jeffrey Johnson (Name)

Task Manager (Title)

Technical Change:
Page 19 of 27, 1st paragraph, last sentence

Delete the above sentence that reads:
Upon completion of sampling activities, all open boreholes will be filled to the ground surface with a bentonite grout mixture.

Add the following paragraph:
Upon completion of sampling activities, all open boreholes will be filled to the ground surface. If all field screening results are less than field screening levels, then the borehole will be backfilled with additional native soil obtained in the vicinity of the borehole. If field screening results are greater than field screening levels, the borehole will be backfilled with a bentonite grout mixture.

Justification:
There are large subsurface voids within some tubes that are being characterized using roto-sonic drilling. After all cuttings are returned to a borehole there is remaining open void space. An excessive amount of bentonite grout mixture would be required to backfill the borehole.

Technical Change:

Page A-16 of A-23, Add the following paragraph after existing paragraph:
If large quantities of debris are encountered DOE/NV and NDEP will determine if the debris should be removed as part of the characterization process. The determination will be made based on the amount and type of debris encountered, waste type, the location of the debris, and the location of utilities or other restrictions. The volume/characteristics of debris removed will be documented. If the debris is non hazardous, there is no evidence of staining or odors and field screening levels are not exceeded, the debris will be disposed of as sanitary waste or will be removed for recycling. Samples of soil surrounding and under the debris will be collected for laboratory analysis as determined by site conditions and the Site Supervisor.

Justification:
The debris will be removed to complete characterization activities and limit future disruption of utilities or access to the area.

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

Applicable Project-Specific Document(s): *Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada*, Rev. 0, January , 2001; DOE/NV--676

CC:

Approved By: [signature] Date 5/1/01
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

[signature] Date 5/1/01
for Runore C. Wycoff, Division Director
Environmental Restoration Division

Client Notified Yes X No ___ Date ___
NDEP Concurrence Yes___ No ___ Date ___
Contract Change Order Required Yes ___ No X
Contract Change Order No. ___

RECORD OF TECHNICAL CHANGE

Technical Change No. 2

Project/Job No. 799417.01030160 Date 5/14/2001

Project/Job Name Industrial Sites/CAU 487 Thunderwell Site

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

Jeffrey Johnson	Task Manager
(Name)	(Title)

Technical Change:

Page 18 of 27, Section 4.2.1, 2nd paragraph, delete last 2 sentences

Replace with:

When possible, excavations will be backfilled on a daily basis. In the event that the soil piles will remain overnight, excavations greater than 3-ft in depth will be enclosed with barrier fencing and posted. The Site Supervisor will be responsible for identifying the proper soil management technique .

Justification:

It may be necessary to leave excavations open to evaluate or complete additional requirements.

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

Applicable Project-Specific Document(s): *Corrective Action Investigation Plan for Corrective Action Unit 487, Thunderwell Site, Tonopah Test Range, Nevada*, Rev 0, January 2001; DOE/NV–676

Technical Change No. 2

Project/Job No. 799417.01030160

Project/Job Name Industrial Sites/CAU 487 Thunderwell Site

Date 05/14/2001

CC:

Approved By: Janet Appenzeller-Wing Date 5/14/01

Janet Appenzeller-Wing, Project Manager

Industrial Sites Project

for Monica Sanchez Date 5/14/01

Runore C. Wycoff, Division Director

Environmental Restoration Division

Client Notified Yes X No ____ Date ____

Contract Change Order Required Yes ___ No ____

Contract Change Order No. ____

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DOE/NV--676

CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 487: THUNDERWELL SITE TONOPAH TEST RANGE, NEVADA

DOE Nevada Operations Office
Las Vegas, Nevada

Controlled Copy No.: ___

Revision No.: 0

January 2001

CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 487:
THUNDERWELL SITE
TONOPAH TEST RANGE, NEVADA

Approved by: Signature Approved Date: 1/02/01

Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

Approved by: Signature Approved Date: 1/02/01

Runore C. Wycoff, Division Director
Environmental Restoration Division

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List of Acronyms and Abbreviations

ALARA	As-low-as-reasonably-achievable
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site(s)
CAU	Corrective Action Unit(s)
COPC	Contaminant(s) of potential concern
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DOT	U.S. Department of Transportation
DQO	Data Quality Objective(s)
DU	Depleted uranium
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening levels
ft	Foot (feet)
HE	High explosives
IDW	Investigation-derived waste
in.	Inch(es)
ITLV	IT Corporation, Las Vegas Office
LAPS	Large Areas Plastic Scintillator
LDA	Large disturbed area
LLW	Low-level radioactive waste
MS/MSD	Matrix spike/matrix spike duplicate

List of Acronyms and Abbreviations *(Continued)*

NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
PAL	Preliminary action level(s)
PID	Photoionization detector
PPE	Personal protective equipment
ppm	Part(s) per million
PRG	Preliminary Remediation Goal
QAPP	*Quality Assurance Project Plan*
QA	Quality assurance
QC	Quality control
RCRA	*Resource Conservation and Recovery Act*
SNL/NM	Sandia National Laboratories/New Mexico
SSHASP	Site-specific health and safety plan
SVOC	Semivolatile organic compound(s)
TTR	Tonopah Test Range
VOC	Volatile organic compound(s)

Executive Summary

This Corrective Action Investigation Plan for Corrective Action Unit 487, Thunderwell Site at the Tonopah Test Range has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada, U.S. Department of Energy, and the U.S. Department of Defense. Corrective Action Unit 487 is comprised of the Thunderwell Site (RG 26-001-RGRV).

Historically, the Thunderwell Site was used for a series of tests conducted by Sandia National Laboratories/New Mexico in the early to mid 1960s. The tests consisted of high explosives detonated at the bottom of large cylindrical steel tubes that were approximately 20 to 50 feet in length, 2 to 6 feet in diameter, and 1/2-inch thick steel. According to interviews the steel cylindrical tubes were anchored into the ground with the excess extending from the ground surface to give the appearance of a "shotgun." Interviews indicate that the tubes may have been buried as deep as 50 feet and partially backfilled after a test for future use. Process knowledge indicates that at least one of the test units contained depleted uranium. The test units and corresponding instrumentation were suspended from A-frame structures above the tubes. This instrumentation measured the impact from the shock wave via cables leading from the unit to a support structure. It was estimated that as much as 2,000 pounds of explosives were placed in the ground at the bottom of the tubes for each test. The test units were projected by the detonation approximately 100 feet to 1 mile from the steel tubes. There was one recorded incident involving a depleted uranium ballast that was broken during a test; however, all other test units were reported to have remained fully intact and were recovered and returned to Sandia National Laboratories/New Mexico. Debris from the tests and subsequent operations was either scattered or buried throughout the site. For the purpose of this investigation, anomalies other than the tubes are identified as miscellaneous areas. These anomalies may exist due to buried debris areas or tubes from the tests conducted throughout the site. A March 2000 walk-over survey identified 16 anomalies as tubes used during the "bagpipe" tests (Bull, 2000). During a July 2000 geophysical survey, 12 additional subsurface anomalies were identified as tube-like structures (SAIC, 2000). The walk-over and geophysical surveys identified 18 other miscellaneous anomalies which do not possess characteristics consistent with the tubes. Based on these two anomaly sets (i.e., tubes and miscellaneous areas), the generalized conceptual site model for investigating this Corrective Action Unit is as follows:

- Unknown volumes and concentrations of contaminants were possibly released to the surface and subsurface soils at the Corrective Action Site within Corrective Action Unit 487 as a result of activities surrounding the “bagpipe” tests in the 1960s. Released contaminants would have consisted primarily of high explosives, *Resource Conservation and Recovery Act* metals, and possibly depleted uranium, tantalum, lithium, boron, and other chemical contaminants.

- Lateral contamination is not expected to extend beyond the historical boundaries as defined by site visits and historical aerial photographs for the Corrective Action Site. Historical documentation states that the test units were recovered intact with the exception of one depleted uranium ballast that was broken during the LTUB5A test. It is unknown if this test extended beyond the boundaries of the Thunderwell Site; however, it is not expected that it did so.

- Vertical contamination is not expected to extend beyond 60 or 70 feet below ground surface at the Corrective Action Unit.

- Arid climate limits infiltration, while high evapotranspiration rates restrict the mobility of contaminants of potential concern.

- Underground utilities, adverse weather conditions, the presence of explosives, and range activities may create practical and/or physical constraints to the field investigation.

- Potential exposures to personnel would be ingestion, inhalation, and/or dermal contact with contaminants of potential concern in soils during subsurface investigation activities.

A more detailed conceptual site model is presented in Section 3.0 of this plan. The conceptual site model serves as the basis for the sampling strategy.

The technical approach for investigating this Corrective Action Unit consists of the following activities:

- Excavation will be conducted under the guidance of experienced Explosive Ordnance Disposal trained personnel to characterize the tubes. Identified subsurface tubes and geophysical tube-like anomalies will be excavated to a depth sufficient to verify the location and size of the tube.

- Drilling and sample handling activities will be conducted under the guidance of experienced Explosive Ordnance Disposal trained personnel.

- Samples will be field screened for high explosives, volatile organic compounds, and alpha/beta-emitting radionuclides. Samples will be submitted for laboratory analysis for semivolatile organic compounds, high explosives, and *Resource Conservation and Recovery*

Act metals. If field-screening levels for radionuclides and volatile organic compounds are exceeded, the samples will be submitted off site for analysis for those constituents.

- Excavation and sample handling activities will be conducted under the guidance of experienced Explosive Ordnance Disposal trained personnel to characterize the miscellaneous geophysical anomalies.

- Surface soil sampling and subsurface sampling will be conducted using excavation and/or hand-tool collection methods for field screening and laboratory analyses at biased locations within the area of each miscellaneous anomaly. These samples will be field screened for high explosives, volatile organic compounds, and alpha/beta-emitting radionuclides. Samples will be submitted for laboratory analysis for semivolatile organic compounds, high explosives, and *Resource Conservation and Recovery Act* metals. If field-screening levels for radionuclides and volatile organic compounds are exceeded, then the samples will be submitted off site for analysis for those constituents.

- Collect samples for geotechnical/hydrological analyses at Site Supervisor's discretion. Section 4.1 contains the collection criteria for these samples.

Additional sampling and analytical details are presented in Section 4.0 of this plan. Details of the waste management strategy for the Corrective Action Unit are included in Section 5.0.

Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Field work will be conducted following approval of the plan. The results of the field investigation will be used to evaluate corrective action alternatives in the Corrective Action Decision Document.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada Division of Environmental Protection (NDEP); the U.S. Department of Energy, Nevada Operations Office (DOE/NV); and the U.S. Department of Defense (DoD) (FFACO, 1996).

This CAIP contains the environmental sample collection strategy, objectives, and the criteria for conducting site investigation activities at the single Corrective Action Site (CAS) that comprises Corrective Action Unit (CAU) 487, Thunderwell Site at the Tonopah Test Range (TTR). The TTR is included in the Nellis Air Force Range and is approximately 236 miles northwest of Las Vegas, Nevada (Figure 1-1).

Corrective Action Unit 487 is comprised of the Thunderwell Site (CAS RG 26-001-RGRV) (Figure 1-2).

Historically, 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 high explosives (HE) detonated at the bottom of large cylindrical steel tubes that were approximately 20 to 50 feet (ft) in length, 2 to 6 ft in diameter, and made of 1/2-inch (in.) thick steel. According to interviews, the steel cylindrical tubes were anchored into the ground, with the excess extending from the ground surface to give the appearance of a "shotgun." Interviews indicate that the tubes may have been buried as deep as 50 ft and partially backfilled after a test to be used for future use. Process knowledge indicates that at least one of the test units contained depleted uranium (DU). The test units and corresponding instrumentation were suspended from A-frame structures above the tubes. The instrumentation measured the impact from the shock wave on each test unit via cables leading to a support structure. It was estimated that as much as 2,000 pounds of explosives were placed at the bottom of the tubes for each test. The test units were projected by the detonation approximately 100 ft to 1 mile from the steel tubes. There was one recorded incident involving a DU ballast that was broken during a test; however, other test units were reported to have remained fully intact. Documentation indicates that all test units were recovered and returned to SNL/NM. Historical photographs indicate that debris from these tests and subsequent operations may have been scattered

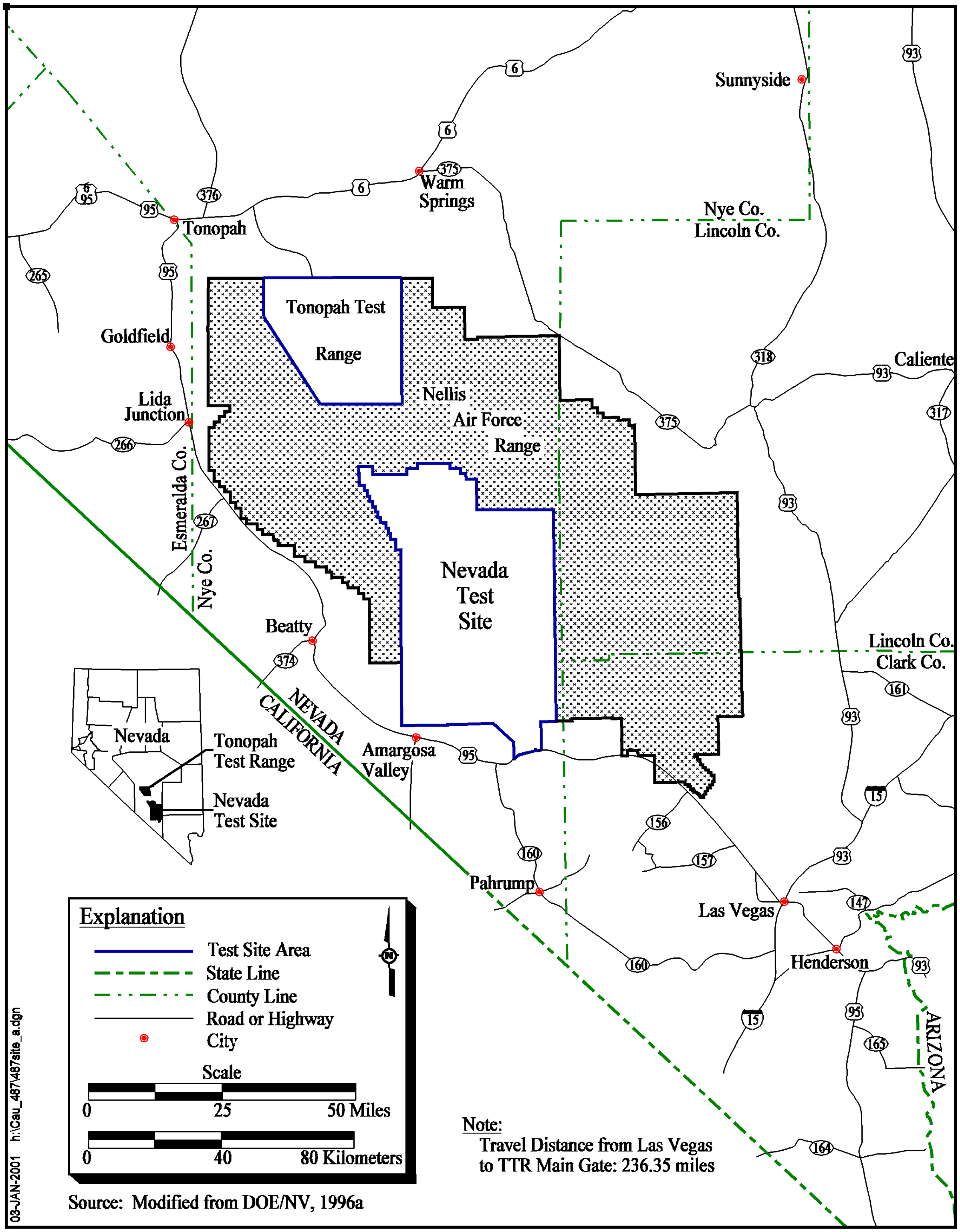

Figure 1-1
Location of Tonopah Test Range

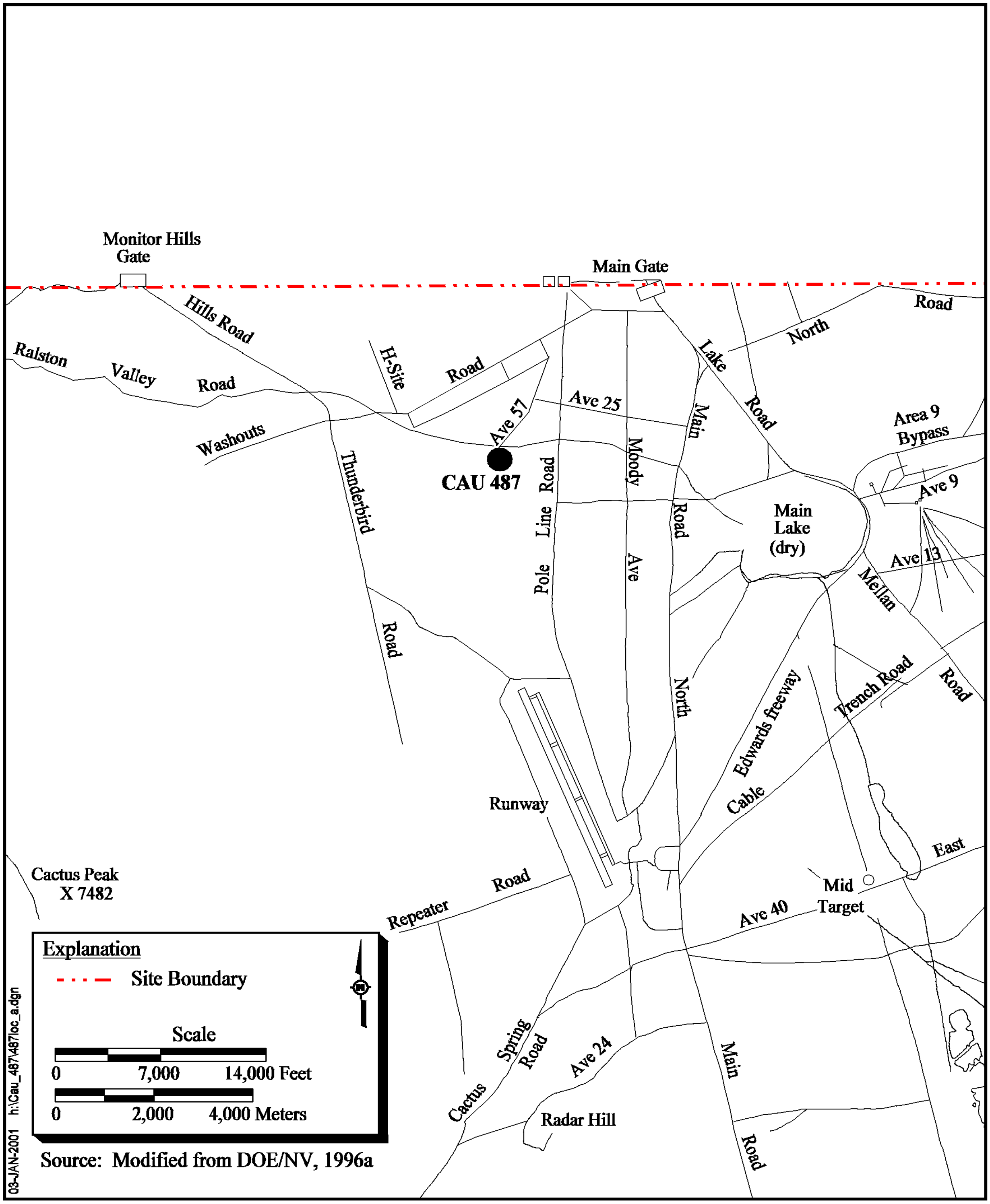

Figure 1-2
Tonopah Test Range
Thunderwell Site Location

and buried throughout the site. For the purpose of this investigation, areas other than the tubes are identified as miscellaneous areas. These anomalies may exist due to buried debris areas or tubes from the tests conducted throughout the site. A March 2000 walk-over survey identified 16 anomalies as tubes used during the “bagpipe” tests (Bull, 2000). During a July 2000 geophysical survey, 12 additional subsurface anomalies were identified as tube-like structures (SAIC, 2000). The walk-over and geophysical surveys identified 18 other miscellaneous anomalies, which do not possess characteristics consistent with the tubes.

1.1 Purpose

The purpose of the corrective action investigation plan is as follows:

- Determine if contaminants of potential concern (COPCs) are present at the CAS.
- Determine if COPC concentrations exceed field-screening levels (FSLs).
- Determine if COPC concentrations exceed preliminary action levels (PALs).
- Determine the nature and extent of contamination with enough certainty to support selection of corrective action alternatives for the CAS.

This CAIP was developed using the U.S. Environmental Protection Agency’s (EPA) Data Quality Objectives (DQOs) (EPA, 2000a) process. The DQOs are used to clearly define the goals for collecting environmental data, determine data uses, and design a data collection program that will satisfy these goals and uses. A DQO scoping meeting was held prior to preparation of this plan. A brief summary of the DQOs is presented in Section 3.4 and detailed summaries of the DQO process and results are included in Appendix A.

1.2 Scope

The scope of this CAIP is to resolve the problem statement identified in the DQO process, which states that hazardous and/or radioactive wastes were potentially generated at CAU 487, Thunderwell Site (see Appendix A). Additionally, existing information about the nature and extent of contamination at the CAU is insufficient to evaluate and select preferred corrective actions for the sites. The scope of the corrective action investigation for the CAU includes the activities described in the following sections to answer the problem statement.

1.2.1 Tubes

- Excavation will be conducted under the guidance of experienced Explosive Ordnance Disposal (EOD) trained personnel to identify and support characterization of the tubes. Identified subsurface geophysical anomalies that are suspected to be tubes will be excavated to a depth sufficient to verify the location and size of the tube.

- Drilling and sampling will be conducted under the guidance of experienced EOD trained personnel at all identified tube locations to characterize the tubes.

- Samples from within the tubes will be field screened for HE, volatile organic compounds (VOCs), and alpha/beta-emitting radionuclides. Samples will be submitted for laboratory analysis for semivolatile organic compounds (SVOCs), HE, and *Resource Conservation and Recovery Act* (RCRA) metals. If FSLs for radionuclides and/or VOCs are exceeded, the samples will be submitted for laboratory analysis of those constituents.

- Samples will be collected for geotechnical/hydrological analyses as determined by the Site Supervisor. Section 4.1 contains the collection criteria for these samples.

1.2.2 Miscellaneous Areas

- Excavation and sample handling activities will be conducted under the guidance of experienced EOD personnel to support characterization at the miscellaneous geophysical anomalies other than suspected tubes.

- Surface soil sampling and subsurface sampling will be conducted using excavation and/or hand-tool collection methods for field screening and laboratory analyses at biased locations within each miscellaneous anomaly. These samples will be field screened for HE, VOCs, and alpha/beta-emitting radionuclides. Samples will be submitted for laboratory analysis for SVOCs, HE, and RCRA metals. If FSLs for radionuclides and/or VOCs are exceeded, then the samples will be submitted for analysis of those constituents.

- Collect samples for geotechnical/hydrological analyses will be collected. Section 4.1 contains the collection criteria for analysis of these samples.

1.3 CAIP Contents

Section 1.0 of this CAIP provides an introduction to this project, including the purpose and scope for this corrective action investigation. The remainder of the document details the investigation strategy. The FFACO (1996) requires that CAIPs address the following elements:

- Management
- Technical aspects
- Quality assurance
- Health and safety
- Public involvement
- Field sampling
- Waste management

The managerial aspects of this project are discussed in the DOE/NV *Project Management Plan* (DOE/NV, 1994) and the site-specific Field Management Plan that will be developed prior to field activities. The technical aspects of this CAIP are contained in Section 3.0 and Section 4.0 of this document, and in the DQO summary presented in Appendix A. General field and laboratory quality assurance (QA) and quality control (QC) issues, including collection of QC samples, are presented in the *Industrial Sites Quality Assurance Project Plan* (QAPP) (DOE/NV, 1996b). Field activities will be performed according to the current version of the IT Corporation, Las Vegas (ITLV) *Health and Safety Plan* and will also be supplemented with a site-specific health and safety plan (SSHASP) written prior to the start of field work. As required by the DOE/NV Integrated Safety Management System, these documents outline the requirements for protecting the health and safety of workers and the public, and procedures for protection of the environment. No CAU-specific public involvement activities are planned at this time; however, an overview of public involvement is documented in the "Public Involvement Plan" in Appendix V of the FFACO (1996). Field sampling activities are discussed in Section 4.0 of this CAIP, and waste management issues are discussed in Section 5.0. The project schedule and records availability information for this CAIP are discussed in Section 6.0, and Section 7.0 provides a list of project references. Appendix B contains project organization information. Appendix C contains analytical requirements for this project. Appendix D contains the Document Review Sheets for comments received from the NDEP.

2.0 Facility Description

Appendix A provides general background information and knowledge as examined during the DQO process as it relates to the history of the TTR and CAU 487. The information utilized during the DQO process includes historical aerial photographs, drawings and site maps, and interviews with TTR personnel.

2.1 Physical Setting

The TTR is characterized by north-northwest trending mountain ranges and closed alluvial basins. The TTR is situated in a broad, closed structural basin which is bordered by broad plateaus and mesas. The Thunderwell Site is closest to a broad basin called Cactus Flats, a relatively flat, internally drained basin, covered almost entirely by alluvial material estimated to be greater than 1,000 ft thick. Topography at TTR indicates that surface water eventually flows into Cactus Flats, which includes Main and Antelope Lakes. Cactus Flats has a mean elevation of approximately 6,000 ft above mean sea level.

Depth to groundwater at the closest wells to Thunderwell Site, which are located at the north end of TTR, is estimated at 350 to 400 ft below ground surface (bgs), with flow generally to the north-northwest (DOE/NV, 1996a).

2.2 Operational History

The Thunderwell Site is located in the northwest portion of the TTR, approximately 5 miles northwest of the Area 3 control point at the intersection of Avenue 25 and Avenue 57. During a March 2000 visit, the site was found to be clear of any stored materials. Metal scraps and pieces, porcelain pieces, and other debris were found scattered around the general area. Some of the steel tubes are visible at ground level; however, buried tubes have been identified through surface disturbance and geophysical surveys. Surface disturbances are evident in aerial photographs as indicated by visible debris piles (Figure 2-1).

Historical documentation indicates that the Thunderwell Site was operational between 1960 and 1967. The site was vacated following the tests. Aerial photographs from 1963 and 1993 provide

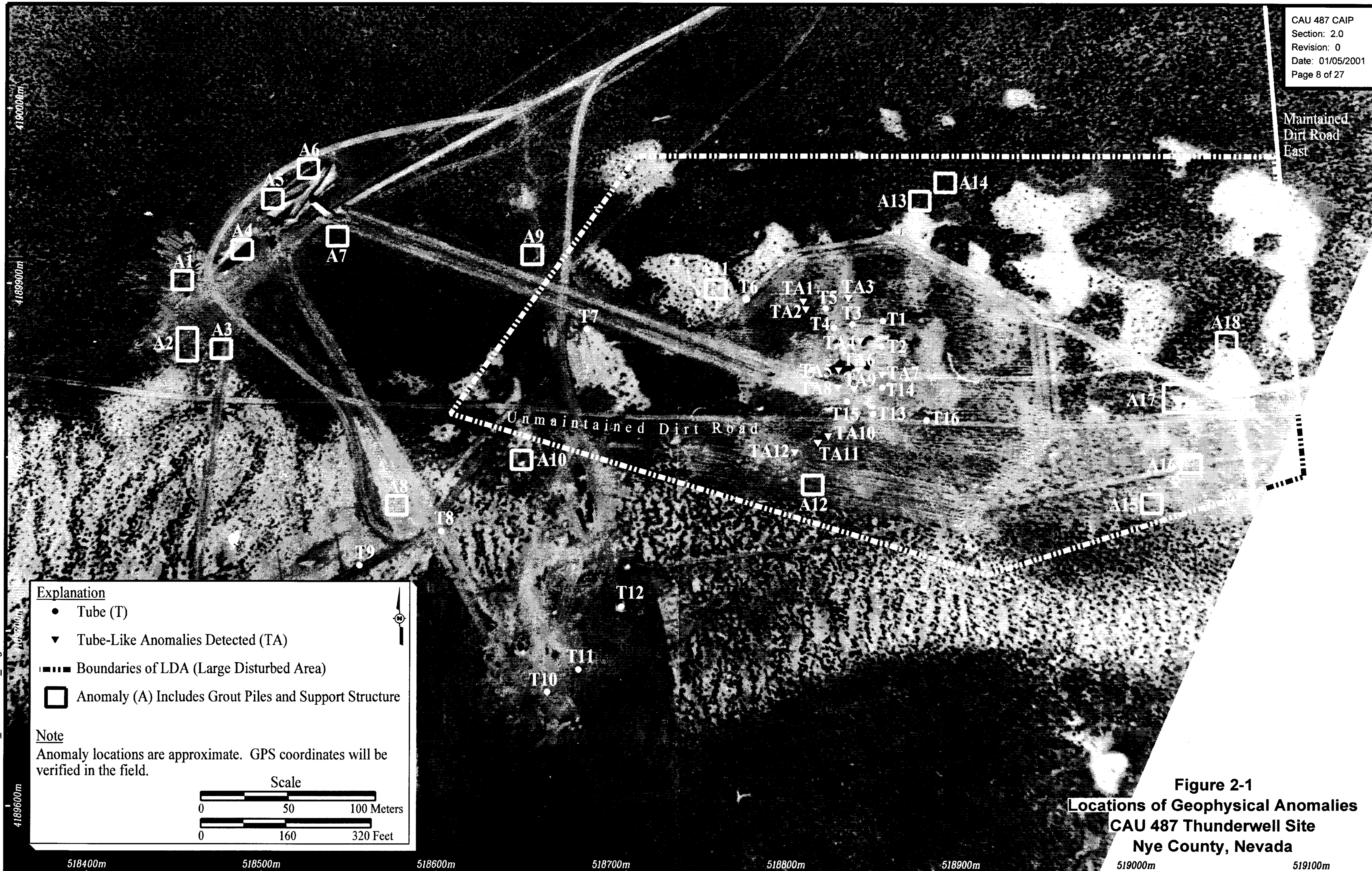

Figure 2-1
Locations of Geophysical Anomalies
CAU 487 Thunderwell Site
Nye County, Nevada

h:\Cau_487\487aerial_b.dgn
01/03/01

historical evidence of the locations that were utilized at the site. Site investigations conducted in March and July of 2000 indicated evidence of buried and surface debris in dirt mounds and areas throughout the site (SAIC, 2000). The majority of the central area of the site was designated as the large disturbed area (LDA) during the July 2000 geophysical survey. The LDA contains most of the surface and subsurface anomalies. The area is visible through aerial photographs because of the evident soil grading. Twenty-three tubes and seven of the miscellaneous geophysical anomalies were tentatively identified in the LDA. Five identified tube anomalies and 11 miscellaneous anomalies are located outside the LDA throughout the remainder of the CAU. The 5 tube anomalies outside of the LDA are located in the southwest area of the site. The majority of the miscellaneous anomalies, outside of the LDA, are located in the northwest portion of the site. No activities are known to have occurred at the site since the experiments were conducted.

A 1993 radiological screening of CAU 487 did not identify any radiological hazards. In July 2000, a radiological drive-over survey was performed using a Large Area Plastic Scintillator (LAPS) detector (IT, 2000). No radiological hazards were identified during the survey.

2.3 Waste Inventory

Unknown volumes and concentrations of DU, HE, and RCRA metals may have been released to surface and subsurface soils at CAU 487. Process knowledge of potential waste for CAU 487 are discussed in the following sections.

2.3.1 Tubes

The known contaminants are steel cylindrical tubes buried 10 to 50 ft bgs. Process knowledge indicates residue from HE and RCRA metals may exist at the bottom of the tubes. The tubes have been backfilled with dirt; however, it is unknown whether or not grout was used as a filler inside or around the tubes.

The original survey identified 16 tubes in this CAU (Bull, 2000); however, geophysical surveys conducted in July 2000 located 12 additional anomalies tentatively identified as tubes (SAIC, 2000).

2.3.2 Miscellaneous Areas

There are several different types of areas under this classification:

- In the northwest portion of the site, there are mounds of dirt that have been identified through site visits and aerial photographs to indicate areas of activity during the Thunderwell tests. Geophysical results indicate subsurface debris in these areas.
- There are at least two identified grout piles evident at the site. Process knowledge does not conclude that grout was used during testing at Thunderwell; however, documented interviews indicate that grout may have been used to anchor the tubes during the construction of the site.
- There is a partially buried wooden box in the northeast area of the site. The use of the box and its contents are unknown.
- To the south of the wooden box, a ramp area exists that consists of 10 mounds of dirt, containing apparent metal and cables, approximately 4 to 6 ft above ground surface. There is no process knowledge available regarding this ramp area.
- Another dirt pile is located in the northwest corner of the site that has similar features to a ramp area. Geophysical surveys confirmed subsurface debris in this portion of the LDA.
- Two support structures in the LDA were originally identified in the walk-over survey. The debris in the LDA is consistent with process knowledge regarding the A-frame structures that were built to suspend the test units over the tubes during the “Thunderwell” tests.
- The geophysical surveys in July 2000 identified an anomaly under the road in the southwest tube area; however, there is no historical or process knowledge to support the burial of any materials under the road at this location.
- Various small debris is scattered throughout the site include: porcelain pieces, metal scraps (less than a foot in diameter), cables, and miscellaneous metal components (e.g., brackets, bolts, and nuts).
- Two areas identified at the site have drill cuttings and black volcanic rock scattered. The volcanic rock is not consistent with the geological makeup of the area. There is no process knowledge known for the volcanic rock; however, the drilling performed for the tubes would be a reasonable assumption for the drill cuttings.

2.4 Release Information

Exact quantities of contaminants released at CAU 487 are unknown. Migration of COPCs at the Thunderwell Site are expected to be limited laterally to areas identified for the testing and dumping, and vertically to an estimated maximum depth of 60 to 70 ft. Subsurface releases may have occurred near the tubes, with the possibility that HE-contaminated soil will be identified. Additionally, lateral and vertical migration of COPCs is expected to be minimal due to expected low concentrations of possible releases of COPCs, limited transport driving forces, and relatively low mobility of COPCs identified at the CAU. Site-specific release information is discussed in the following sections.

2.4.1 Tubes

The only evidence of release information available is regarding one test. The test number LTUB5A had a broken DU ballast during the event. The DU was a component of at least one test article used during the "bagpipe" tests at the Thunderwell Site during the 1960s. No information has been found to document the location of the tube used to conduct the test or the location where the test unit landed. Process knowledge indicates that HE was used for all tests; however, the information regarding the amounts and the results of the tests are conflicting.

2.4.2 Miscellaneous Areas

There is no release information available regarding any of the miscellaneous areas. This includes any information regarding debris existing from tests where a release may have occurred.

2.5 Investigation Background

In accordance with the DOE/NV *National Environmental Policy Act* (NEPA) compliance program, a NEPA checklist will be completed prior to commencement of site investigation activities at CAU 487. This checklist compels DOE/NV to evaluate their proposed project against a list of several potential environmental impacts which include, but are not limited to: air quality, chemical use, waste generation, noise levels, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation by the DOE/NV NEPA Compliance Officer.

Site investigation activities associated with CAU 487 have been identified and documented in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996a).

2.5.1 Tubes

A radiological screening was performed in 1993, and at that time there were no radiological hazards identified. In July 2000, a drive-over and more extensive surface radiological survey was performed. This survey confirmed there are no surface radiological hazards at the site up to approximately 10 in. bgs.

Historical documentation and walk-over surveys identified 16 tubes. An additional 12 geophysical anomalies were identified as suspected tubes. No documentation was found to suggest that previous sampling occurred at this site. Information on historical activities at the Thunderwell Site was interpreted from historical aerial photographs and interviews. An historical photo from approximately 1963 provided an overview of where activities took place and the possible presence of tubes, which is consistent with the 2000 geophysical survey.

2.5.2 Miscellaneous Areas

A radiological screening was conducted at the site in 1993; at that time, there was no significant radiological hazards identified. In July 2000, a drive-over and more extensive surface radiological survey was performed. The July 2000 survey confirmed that the radiological surface conditions of the site were indistinguishable from the background up to approximately 10 in. bgs.

A geophysical survey was performed in July 2000. The geophysical survey provided an accurate distinction where metal debris was buried at the site. In addition, a 1963 aerial photograph provides a clearer interpretation of the roads and the areas of activity at the site. There is no documentation available to indicate that previous sampling occurred at this site. Information on historical activities about the Thunderwell Site was interpreted from aerial photographs from 1963 and 1993 (BN, 1999; IT, 1993).

3.0 Objectives

The DQOs are qualitative and quantitative statements that specify the quality of the data required to support potential courses of action for CAU 487. The DQOs were developed to clearly define the purposes for which environmental data will be used and to design a data collection program that will satisfy these purposes. One element of the DQO process is the formulation of a conceptual site model.

3.1 Conceptual Site Model

The conceptual models for CAU 487 are detailed in Appendix A, Table A.2-1. The scope and strategy of this investigation will be revised if the conceptual model provided in this CAIP fails. The CAU 487 conceptual model may fail if substantially different historical, operational information is discovered, or field observations demonstrate the nature or extent of contamination associated with the CAU is substantially different than anticipated. If necessary, a rescoping of the investigation will be conducted.

3.2 Contaminants of Potential Concern

During the DQO process, COPCs for the CAU were identified through process knowledge and site history. The following lists provide the site-specific analytes to be measured through field screening and/or laboratory analysis to determine the nature and extent of potential contamination:

- Total VOCs
- Total SVOCs
- Total RCRA metals
- Total metals
- HE
- Radionuclides (DU)

Table A.3-1 in Appendix A lists the COPCs to be analyzed, and the appropriate FSLs and PALs. Appendix C provides the analytical requirements which include minimum reporting limits, analytical methods, precision, and accuracy for all the analytes. Specific analyses required for disposal of investigation-derived waste (IDW) are identified in Section 5.0 of this CAIP.

Geotechnical and hydrological analyses may be performed at the Site Supervisor's discretion to support closure in-place of subsurface debris. Bioassessment samples may be collected at the Site Supervisor's discretion if field screening detects VOC concentrations greater than FSLs.

3.3 Preliminary Action Levels

The following sections describe the FSLs and PALs for CAU 487. Field-screening levels for on-site field-screening methods will be used to determine the presence of contamination and guide the investigation.

3.3.1 Field-Screening Levels

The following FSLs will be used for on-site field-screening methods:

- Volatile organic compound headspace screening levels using a photoionization detector (PID) are established at 20 parts per million (ppm) or 2.5 times background, whichever is greater.
- Explosives (as an indicator of the presence of degraded explosives and propellant compounds) will be screened with colorimetric field kits with established screening levels as shown in Table A.3-1 (Appendix A).
- Radiation (alpha and beta) screening levels are defined as the mean background activity level plus two times the standard deviation of the mean background activity level (to be determined prior to start of field activities) and monitored during sampling.

Concentrations exceeding FSLs will indicate potential contamination at that sample location. This information will be documented and the investigation will continue to delineate the extent of the contamination. Additionally, this data may be used to select additional discretionary laboratory sample locations.

3.3.2 Chemical Preliminary Action Levels

Off-site laboratory analytical results will be compared to the following PALs to evaluate the need for possible corrective actions:

- NDEP Corrective Action Regulations 445A.2272 (NAC, 1998)
- EPA Region IX Preliminary Remediation Goals (PRGs) for Industrial Soils (EPA, 2000b)

The comparison of laboratory results to PALs will be discussed in the Corrective Action Decision Document (CADD). Laboratory results above PALs indicate the presence of COPCs at levels that may require corrective action. Laboratory results below PALs indicate that corrective action is not necessary. Based on the results of this field investigation, the evaluation of potential corrective actions and the justification for a preferred action will be included in the CADD.

3.3.3 Radiological Preliminary Action Levels

The PALs for radionuclides in soils are isotope-specific and are defined as the maximum concentration for that isotope found in environmental samples taken from undisturbed background locations. Subsurface background samples will be collected to establish the radiological PALs for the Northwest portion of TTR where the Thunderwell Site is located. These samples will establish a basis for comparison for the surface conditions collected in the radiological survey (IT, 2000) to establish representative PALs.

3.4 Data Quality Objectives Process Discussion

Details of the DQO process are presented in Appendix A. The DQO results for CAU 487 indicate the need for combined biased sampling approaches. Due to the potential for surface, shallow subsurface, and subsurface migration of COPCs, an investigation consisting of surface and subsurface sampling was identified. Table A.6-1 in Appendix A provides decision points and rules specific to the CAU that will be used to guide the field investigation.

4.0 Field Investigation

This section of the CAIP contains the sampling approach for investigating CAU 487. All sampling activities will be conducted in compliance with the Industrial Sites QAPP (DOE/NV, 1996b) and other applicable, approved procedures and instructions. Quality assurance and quality control requirements for field and laboratory environmental sampling are provided in Section 4.4.2 and in the Industrial Sites QAPP.

Field activities will be performed in accordance with an approved SSHASP which incorporates the principles of the DOE/NV Integrated Safety Management System. Safety, health, and protection of the environment take precedence over expediency. Site personnel will take every reasonable step to reduce the possibility of injury, illness, or accident, and to protect the environment during all project activities. The following will be taken into consideration when assessing the hazards associated with field activities:

- Potential hazards to site personnel and the public include, but are not limited to: chemicals (such as RCRA metals, VOCs, and SVOCs), DU, tantalum, boron, lithium, explosives, adverse and rapidly changing weather, remote location, and heavy equipment operations including excavation and drilling activities

- Proper training of all site personnel to recognize and mitigate the anticipated hazards

- Work controls to reduce or eliminate the hazards including engineering controls, substitution of less hazardous materials, and personal protective equipment (PPE)

- Occupational exposure monitoring to prevent overexposures to hazards such as radionuclides, chemicals, and physical agents (e.g., heat, cold, high winds)

- Use of the “as-low-as-reasonably-achievable” (ALARA) principle when dealing with radiological hazards

- Emergency and contingency planning and communications to include medical care and evacuation, decontamination and spill control measures, and appropriate notification of project management

4.1 Technical Approach

The following list describes general activities that may be executed during the site investigation for CAU 487. Specific details of activities for each classification area of the CAU are provided in Section 4.3.1 through Section 4.3.2.

- Conduct exploratory excavation (trenching) to collect surface and subsurface soil samples, and to define subsurface features at the miscellaneous areas where geophysical surface and subsurface anomalies have been identified.
  - If contamination extends beyond the capabilities of the excavation technique (approximately 12 ft), drilling may be initiated.
- Conduct exploratory excavation (trenching) to identify subsurface geophysical anomalies identified as possible tubes (subsurface initial depth, width, and condition).
- Collect surface and subsurface soil samples at biased locations using rotary-sonic drilling for all identified tubes.
- Field screen all site-specific samples for VOCs, explosives, and radionuclides.
- Analyze select site-specific soil samples for total SVOCs, total RCRA metals, and explosives. Analyze select site-specific soil samples for total VOCs if VOC FSLs are exceeded, and for isotopic uranium, tantalum, boron, and lithium if radiological FSLs are exceeded.
- Collect samples from the interface of native soils and disposal features, as defined by soil staining, geology, and presence of debris for field screening.
- Collect and analyze geotechnical samples if subsurface debris is encountered at the discretion of the Site Supervisor.
- Collect quality control samples.

This investigation strategy will allow the nature of the CAU to be determined. In general, the contents of each location and the underlying soil will be investigated until a soil sample from an interval with contaminant concentrations below appropriate FSLs is obtained. Should the maximum vertical limit of excavation be reached or if a tube is encountered, and field-screening results indicate the presence of contaminants above FSLs, drilling will be initiated and 5-ft intervals will be sampled until two consecutive samples below FSLs have been obtained. If contamination is more extensive than anticipated, the maximum investigation depth will be limited by the capability of the selected drilling method. If this occurs, the investigation will be rescoped.

4.2 Field Activities

The subsurface investigation of CAU 487 will include excavation and drilling methods. Select samples will be field screened for VOCs, explosives, and alpha/beta-emitting radionuclides.

Biased sampling will be conducted during the field investigation to assess the extent of COPCs and determine if COPC concentrations exceed PALs for the sites. Samples collected from the CAU will be analyzed according to the appropriate COPC table provided in Section A.3.0.

4.2.1 Excavation Activities

Excavation activities will use a backhoe and/or hand tools to obtain surface and subsurface soil samples, and to define vertical and lateral extent of contamination in identified or possible disposal features. These anomalies have been identified through geophysical surveys, aerial photographs, and current surface features. The anomalies will be evaluated to confirm the presence of disposal materials and, if verified, to define the extent of the contamination. Drilling will also be utilized for soil sampling if the vertical extent of contamination, as determined through field screening, extends beyond excavation capabilities.

Damage to roads and utilities will be minimized. Excavated soil will be stored in a manner which will prevent run-on and runoff. Upon completion of the investigation activities, excavated soil will be returned to the excavation nearest its original location, as practical. Excavations will be backfilled on a daily basis. In the event that the soil piles will remain overnight, the Site Supervisor will be responsible for identifying the proper soil management technique.

4.2.2 Drilling Methods

Should excavation methodology be inadequate to assess the vertical extent of contaminants at the disposal areas or if a tube is encountered, drilling will be initiated. Drilling will be the method of investigation for all the tubes.

If elevated field-screening results are identified during advancement of the initial borings, horizontal step-out borings may be advanced to evaluate the extent of lateral and vertical contaminant migration. Step-out borings will be located 5 ft from the outer edge of the identified tube or the initial borehole, whichever is greater, and drilled to a depth sufficient to sample the interval correlative to the deepest contamination (above FSLs) encountered in the initial borehole. Based on field-screening results, additional step-outs (beyond the initial step-outs) may be needed to delineate plume geometry. These step-outs will be performed at 10-ft intervals until field-screening results are below FSLs. Soils will be collected immediately upon retrieval in a polyurethane bag after extrusion from the core barrel. Soils will then be containerized in accordance with approved sampling procedures or instructions. Excess drill cuttings not collected as samples will be returned to the boring from which they originated or containerized and managed as IDW. Upon completion of sampling activities, all open boreholes will be filled to the ground surface with a bentonite grout mixture.

4.2.3 Field Screening

Site-specific field screening for VOCs, explosives, and/or radiological activity will be performed to guide the investigation and sampling selection and to assist with health and safety and waste management decisions. The headspace method (PID) will be utilized to field screen for VOCs. Field screening for elevated explosives levels will be performed using a colorimetric test kit. An alpha/beta scintillator (i.e., Electra or equivalent) will be utilized to field screen for elevated radiological activity. The FSLs for these field-screening methods are detailed in Section 3.3.1.

4.3 CAS Site-Specific Investigation Strategy

This site has been divided into two investigation areas (i.e., tubes and miscellaneous areas).

4.3.1 Tubes

Approximately 28 tubes have been identified through field investigations or geophysical surveys. The tubes which are identified at the surface will have drilling initiated. Tubes that are subsurface and have been identified through field investigations or geophysical surveys will be uncovered to confirm width of tube and determine the condition of the tube wall. After excavation has confirmed the anomaly is a tube, drilling will be initiated down the interior of the tube. Two subsurface soil samples will be collected at one biased location within the suspected interior of each tube, and one at the interface if identified or at a maximum depth if FSLs are not exceeded. If FSLs are exceeded, then one sample will be taken at the highest field-screening results interval and at either the interface or at two intervals past the level in which acceptable FSLs are achieved. Rotary-sonic drilling will be used to collect the samples. Step-out borings will be determined according to the width of the tube if field-screening results exceed FSLs. Borings will continue at 5-ft intervals (or as determined by the Site Supervisor); if FSLs are exceeded at the 60-ft depth interval, drilling will continue to a maximum depth of 100 ft bgs. Field screening for VOCs will be conducted using a PID, radiological screening with a handheld NE Electra, and explosives with a colorimetric test kit, respectively.

4.3.2 Miscellaneous Areas

Biased sampling will be conducted at the area of the CAU using excavation methodology. Biased sample locations have been identified at locations that have been identified through the site investigations and geophysical surveys. Should field screening determine that contamination has extended beyond the boundaries of the Thunderwell Site, project management will be contacted and a decision will be made at that time whether or not to continue the assessment beyond the current CAU boundaries. If the depth of contamination exceeds the capability of excavation methods, drilling may be initiated at the Site Supervisor's discretion. Field screening for VOCs will be conducted using a PID, radiological screening with a handheld NE Electra, and explosives with a colorimetric test kit, respectively.

4.4 Sampling Criteria

All sampling activities for CAU 487 will be conducted in compliance with the requirements of the Industrial Sites QAPP (DOE/NV, 1996b) and this CAIP. Section 4.4.1 through Section 4.4.4 provide details on the type of sample collection that will be performed during the field investigation. The CAU-specific investigation strategy, proposed sampling locations, and details on the field screening are provided in Section 4.3.

Records will be maintained for a visual classification of the soil from boreholes, field-screening measurements, and all other pertinent data. Relevant and required sampling information (e.g., date, time, sample interval) will be documented in accordance with the Industrial Sites

QAPP (DOE/NV, 1996b). Approved chain of custody procedures (DOE/NV, 1994) will be followed to assure sample integrity.

All equipment which contacts soil to be sampled will be decontaminated in accordance with written, approved, and controlled procedures. All sampling equipment will be decontaminated prior to each sampling event to minimize the potential for cross-contamination of samples from different locations.

All of the samples will be field screened and a limited number of these samples will be submitted to the off-site laboratory. Samples to be analyzed will be selected based on the results of field screening and minimum sampling requirements. The actual number of samples analyzed will depend on decisions made in the field.

4.4.1 Environmental Samples

Environmental samples will be collected for laboratory analyses. Samples targeted for VOC analysis will be given highest priority when being collected and will not be composited. Samples with no volatilization concerns will be collected with priority given to those with the shortest holding times. Samples submitted to the laboratory will be analyzed in accordance with Appendix C.

4.4.2 Quality Control Samples

Quality control samples will be collected, as required, by the Industrial Sites QAPP (DOE/NV, 1996b). These samples will include trip blanks, equipment blanks, source blanks, field blanks, field duplicates, and matrix spike/matrix spike duplicates (MS/MSD) samples. Except for trip blanks, all QC samples will be analyzed for applicable parameters as listed in Table A.3-1 for the CAS. Trip blanks will only be analyzed for VOCs. With the exception of MS/MSD, QC samples will be submitted to the laboratory blind. Additional QC samples may be submitted at the discretion of the Site Supervisor.

4.4.3 Background Samples

Background data for radionuclides and RCRA metals will be collected by drilling a borehole in an undisturbed area approximately 50 to 100 ft from disturbed areas at the Thunderwell Site. Background samples will be field screened for radiological activity every 5 ft from the surface to

60 ft bgs. The field-screening data will be used to establish FSLs as described in Section 3.3.1. Three samples will be submitted for laboratory analysis to confirm the background data collected and to assist in waste management decisions. Samples will be analyzed for RCRA metals to establish FSLs representative of the northwest area of TTR.

4.4.4 Geotechnical Samples

In addition to environmental samples, at least one geotechnical sample will be collected from the specific areas of the Thunderwell Site to characterize the geologic and hydrologic properties of soils. The geotechnical analyses listed in Table 4-1 will be performed by an off-site laboratory. The methods shown are minimum standards, equivalent or superior testing methods may be used.

Table 4-1
Geotechnical Analyses

Analysis	Method
Initial moisture content	ASTM[a] D2216
Dry bulk density	EM[b] 1110-2-1906
Calculated porosity	EM[b] 1110-2-1906
Saturated hydraulic conductivity	ASTM[a] D5084
Unsaturated hydraulic conductivity	van Genuchten[c]
Particle-size distribution	ASTM[a] D422-63(90)
Water-release (moisture retention) curve	ASTM[a] D3152

[a]American Society for Testing and Materials (ASTM, 1996)
[b]U.S. Army Corps of Engineers (USACE, 1970)
[c]van Genuchten, 1980

5.0 Waste Management

Management of IDW will be based on regulatory requirements, field observations, field screening, and laboratory analysis of CAU 487 investigation samples. Decontamination activities will be performed according to approved contractor procedures as specified in the field sampling instructions and as appropriate for the COPCs likely to be identified within each area of the CAU.

Waste other than soil is potentially contaminated waste only by virtue of contact with potentially contaminated media. Therefore, sampling and analysis of IDW, separate from analyses of site characterization samples, may not be necessary. However, rinsate or other samples may be taken to support waste management activities (e.g., DU soil samples). The data generated as a result of site characterization and process knowledge will be used to assign the appropriate waste type (i.e., solid waste [nonhazardous], hazardous, low-level radioactive waste [LLW], or mixed) to the IDW. Solid waste (nonhazardous), hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with all applicable federal, state, local, U.S. Department of Energy (DOE), and contractor regulations and procedures.

5.1 Waste Minimization

Corrective action investigation activities have been planned to minimize IDW generation. To minimize the amount of rinsate generated, decontamination activities will only use as much water as necessary to decontaminate equipment and personnel. Disposable sampling equipment, decontamination rinsate, and PPE will be segregated to the greatest extent possible to minimize the generation of hazardous, radioactive, and/or mixed waste.

5.2 Potential Waste Streams

Process knowledge indicates the potential for hazardous and/or radioactive materials to be present at CAU 487, Thunderwell Site. There is a potential that solid (nonhazardous), LLW, hazardous, mixed, and/or hydrocarbon waste may be generated during field activities. The probability of hydrocarbon waste is not anticipated unless there is discharge during refueling operations at the site. Specific waste materials generated during the investigation may include, but are not limited to, the following:

- Decontamination rinsate
- Potentially contaminated disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, trowels, hand augers)
- PPE potentially contaminated during field activities
- Potentially contaminated soil

Waste will be segregated into multiple waste streams: containerized soil, potentially contaminated PPE and sampling equipment, and decontamination rinsate. Further segregation may be implemented within each waste stream, as appropriate.

5.3 Investigation-Derived Waste Management

All IDW generated inside the exclusion zones at CAU 487 will be managed according to mixed waste requirements as a best management practice until a waste determination is made.

Any IDW generated during this investigation will be segregated by waste stream and placed in packages meeting U.S. Department of Transportation (DOT) specifications, appropriate for the type and amount of waste generated.

5.4 Analysis Required for the Disposal of IDW

Additional analytical data may be required to characterize the IDW. These analyses will support waste classification to meet waste acceptance criteria prior to disposal at the NTS and at off-site locations. Sampling strategies have been reviewed to ensure that sufficient analyses to support IDW disposal have been planned. The required analyses are summarized in Table 5-1. Samples submitted for laboratory analysis will be analyzed according toTable C.1-1 in Appendix C.

Table 5-1
Analysis Required for the Disposal of IDW

Corrective Action Site	Isotopic Uranium	Gamma Spectrometry	Percent of Samples
Miscellaneous Disposal Areas	Required	Required	10
Tubes	Required	Required	10

6.0 Duration and Records Availability

6.1 Duration

After submittal of the Final CAIP for CAU 487 to NDEP (FFACO milestone deadline of February 28, 2001), the following is a tentative schedule of activities (in calendar days):

- Day 0: Preparation for field work will begin.
- Day 35: The field work, including field screening and sampling will begin. Samples will be shipped to meet laboratory holding times.
- Day 75: The field work will be completed.
- Day 160: The quality-assured analytical sample data will be available for NDEP review.
- The FFACO date for the CADD is November 26, 2001.

6.2 Records Availability

Historic information and documents referenced in this plan are retained in the DOE/NV project files in Las Vegas, Nevada. These documents can be obtained through written request to the DOE/NV Project Manager. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the DOE Project Manager. The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO.

7.0 References

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Appendix A

Data Quality Objectives Worksheets

A.1.0 Introduction

A.1.1 Problem Statement

Potentially hazardous wastes were generated at CAU 487, Thunderwell Site. CAU 487 consists of CAS RG 26-001-RGRV (FFACO, 1996). Existing information about the nature and extent of contamination is insufficient to evaluate and select preferred corrective actions for this site.

This site will be investigated based on DQOs developed by representatives of NDEP and DOE/NV. This investigation will determine if COPCs are present and if concentrations exceed regulatory levels in soils underlying and immediately surrounding the site. If COPCs are detected, the lateral and vertical extent of contamination will be determined. This investigation will focus on collection of data to determine if the site meets the requirements for clean closure with no land-use restriction under NDEP, RCRA, and DOE requirements.

A.1.2 DQO Kickoff Meeting

Table A.1-1 lists the participants present at the FFACO-required DQO Kickoff Meeting and any subsequent meetings. The goal of the DQO process is to establish the quantity and quality of environmental data required to support corrective action decisions for the CAU. The process ensures that the information collected will provide sufficient and reliable information to identify, evaluate, and technically defend the chosen corrective action. Unless otherwise required by the results of this DQO and stated in the CAIP, this investigation will adhere to the *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996c).

Table A.1-1
DQO Meeting Participants

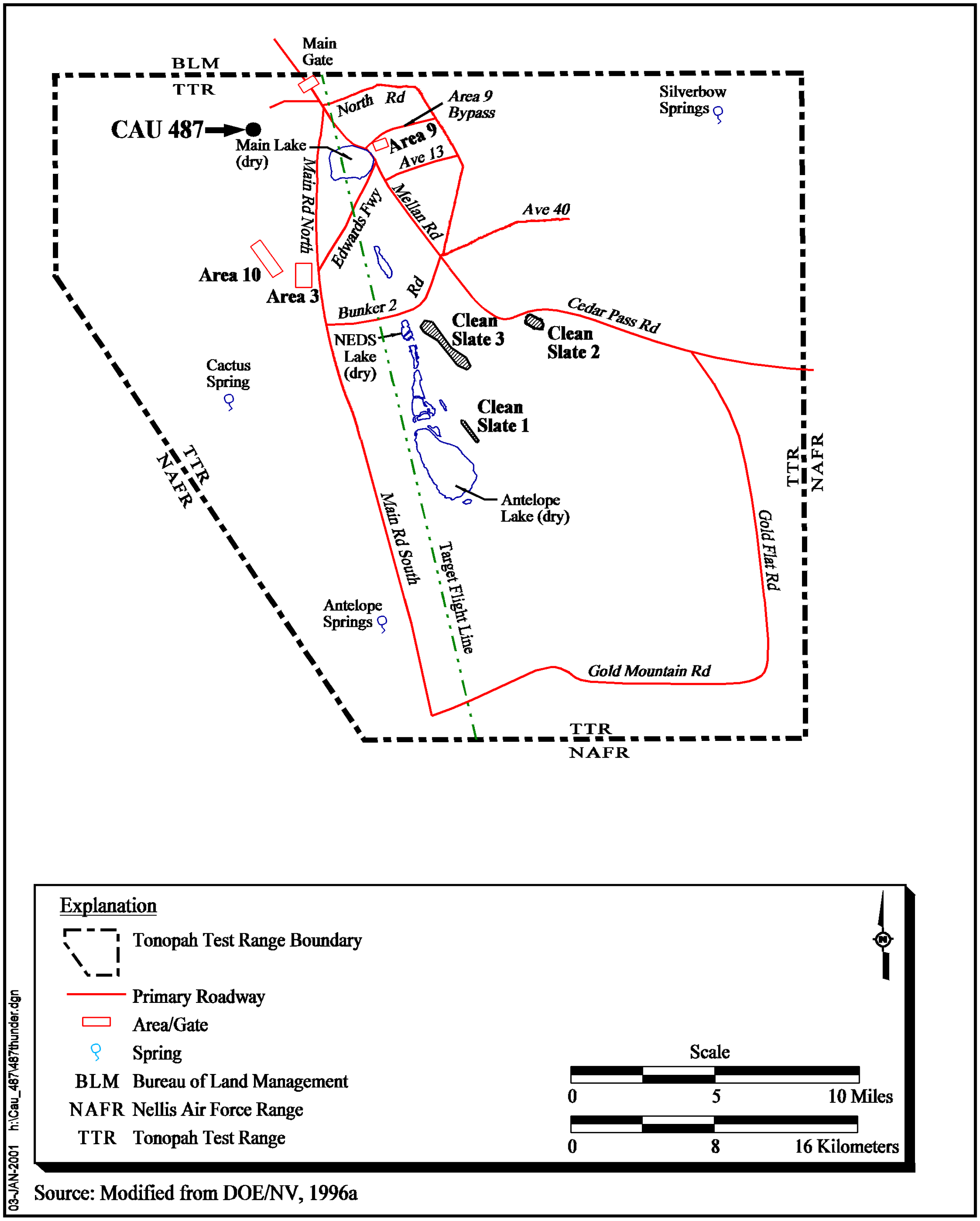
Proposed Participants	Affiliation	Meeting Date September 26, 2000
		Kickoff Meeting
Stacey Alderson	ITLV	X
Kevin Cabble	DOE/NV	X
Lydia Coleman	ITLV	X
Jill Dale	ITLV	X
Syl Hersh	ITLV	X
Brad Jackson	ITLV	X
Jeffrey Johnson	ITLV	X
David Madsen	BN	X
Mike McKinnon	NDEP	X
Mike Monahan	ITLV	X
Julie Snelling-Young	ITLV	X
Milinka Watson-Garrett	ITLV	X
Jeanne Wightman	ITLV	X
John Wong	NDEP	X

BN - Bechtel Nevada
DOE/NV - U.S. Department of Energy, Nevada Operations Office
ITLV- IT Corporation, Las Vegas Office
NDEP - Nevada Division of Environmental Protection

A.2.0 Conceptual Model

Unknown volumes and concentrations of DU, HE, RCRA metals, and other chemicals may have been released in surface and subsurface soils at CAU 487. The approximate location of the CAU is shown on Figure A.2-1. The releases were a result of various activities that include: detonation of explosives within approximately 28 or 29 tubes (anchored as much as 50 ft into the ground with a test unit suspended above the tube), and miscellaneous identified surface and subsurface activities associated with the tests. Section 2.0 of the CAIP describes the operational history, waste inventories, release information, and investigative background for the CAU.

An outline of site-specific elements of the conceptual model for CAU 487 is provided in Table A.2-1.



Source: Modified from DOE/NV, 1996a

Figure A.2-1
Thunderwell Site CAU 487 at Tonopah Test Range (TTR)

Table A.2-1
Conceptual Model for CAU 487, Thunderwell Site (TTR)
(Page 1 of 4)

Conceptual Model Element	Assumptions	Source
Tubes	• Tubes located throughout the site were consistent with the information regarding the tests performed during the early to mid-1960s. • The site was used to detonate HE at the bottom of steel tubes approximately 20 to 50 ft in length, 2 to 6 ft in diameter and 1/2-in. thick. The tubes were anchored approximately 12 to 50 ft deep, with the excess sticking out of the ground. • It was estimated that as much as 2,000 pounds of HE were placed at the bottom of a tube for each test. • There are 28 or 29 geophysical anomalies that are consistent with tubes. Approximately twelve anomalies do not extend beyond the surface, so it cannot be determined from the surveys or the process knowledge if they are definitely tubes. However, 16 of the 28 anomalies are identifiable as tubes from the surface. • The tube areas are vegetated consistent with the site. The locations of the tubes are in the southwest portion of the site and in the large disturbed area. Soils are disturbed in the areas of known or suspected tubes. • Different types of the HE used during the tests has been identified through interviews with Pantex employees. The types include: Boracitol (i.e., trinitrotulene [TNT] and boric acid), Baratol (i.e., TNT and barium nitrate), Cyclotol (TNT and cyclotrimethylene trinitramine [RDX] mixture), Composition B-3, Composition B, trinitrophenylmethyl nitramine (Tetryl), and pentaerythritol tetranitrate (PETN). • Historical documentation indicates that DU was used during at least one of the tests. Process knowledge supports the concept that tantalum, lithium, and boron were also used in at least one of the test articles. These elements are anticipated if DU is identified in the tubes.	Interviews with former TTR employees (Edwards, 2000a and 2000b; Norris, 2000; Statler, 2000; Truman, 1998; Blackwell, 2000; Lathrop, 1994); Federal Facility Preliminary Assessment (Ecology and Environment, 1989); Geophysical Surveys (SAIC, 2000); Telecon interviews with Pantex employees (ITLV, 2000c)

Table A.2-1
Conceptual Model for CAU 487, Thunderwell Site (TTR)
(Page 2 of 4)

Conceptual Model Element	Assumptions	Source
Miscellaneous areas	• There are two support structure areas that are from the A-frames used to hold the test units above the tubes. • Two grout piles exist that are believed to be used for the construction of the tubes. • A wooden box is partially buried at the site. There is no documentation to support the burial, and process knowledge for the use is unknown. • Soils in the area are disturbed. • A large geophysical anomaly was identified under the road in the western area of the southwest metal tube area. There is no process knowledge to determine the reason it was buried at the site. • Surface and subsurface debris, tubes, and geophysical anomalies not identified in the original site walkover survey are distributed over the site. Geophysical data was consistent with the process knowledge. It is suspected that the subsurface anomalies are cables, metal, and tube-related debris. Metal debris is suspected to be buried based on process knowledge and walkover surveys. Soils are disturbed. • Historical documentation indicates that DU was used during at least one of the tests. Process knowledge supports the concept that tantalum, lithium, and boron were also used in at least one of the test articles. These elements are anticipated if DU is identified in the miscellaneous areas.	IT photographs (ITLV, 2000a); aerial photos (BN, 1999; ITLV, 1993); Geophysical survey report (ITLV, 2000a); Site Evaluation Form (ITLV, 2000d); TTR Work Plan (DOE/NV, 1996a); Interviews with former TTR employees, Geophysical Surveys (SAIC, 2000); Radiological Report (IT, 2000b); noted regarding the Thunderwell Tests (SNL Archives Center, 2000)

Table A.2-1
Conceptual Model for CAU 487, Thunderwell Site (TTR)
(Page 3 of 4)

Conceptual Model Element	Assumptions	Source
Lateral extent of potential contaminants	Lateral extent of potential contamination is unknown; however, subsurface effects are limited by relatively low contaminant concentrations, low volume, and/or low mobility of constituents.	Process knowledge
	COPCs may have been redistributed across the surface of the Thunderwell Site through regrading activities and possible cleanup activities. Lateral contamination was not identified beyond the defined historical boundaries of the site. Materials removed from the site were consolidated in miscellaneous areas located throughout the site.	Process knowledge
	The radius of lateral contamination is not expected to extend beyond the original boundaries established at the Thunderwell Site.	Process knowledge
Vertical extent of potential contaminants	The vertical extent of potential contamination is approximately 60 to 70 ft below the surface. Vertical extent should be limited by low contaminant concentrations, low volumes, and relatively low mobility of COPCs.	Process knowledge
	At the Thunderwell Site, the groundwater level beneath CAU 487 is approximately 350 to 400 ft; therefore, downward movement of COPCs at the Thunderwell Site likelihood is minimal.	Process knowledge
	Vertical extent of contamination is not expected to extend beyond a depth of 60 to 70 ft.	Process knowledge
Physical and practical constraints	U.S. Air Force and/or Sandia range activities; underground/above ground utilities; adverse weather conditions; restricted access; heavy equipment and resource availability; health and safety concerns; approval of the CAIP; potentially explosive/combustible material at the Thunderwell Site are reasons for activities to be delayed.	Site knowledge; Site visits (ITLV, 2000d)
Future use	The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* states that future use will be similar to current use.	Assumptions are defined in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996b)
Potential exposures	Potential exposure includes ingestion, inhalation, or dermal contact (absorption) of COPCs in the soil due to inadvertent exposure during investigation	Process knowledge

Table A.2-1
Conceptual Model for CAU 487, Thunderwell Site (TTR)
(Page 4 of 4)

Conceptual Model Element	Assumptions	Source
Waste management	No evidence of listed waste has been found; waste will be considered characteristic unless contrary information is discovered during the investigation.	Process knowledge

A.3.0 Potential Contaminants

The COPCs at CAU 487 are a result of the testing performed in the 1960s. The source of potential contamination associated with the approximately 28 or 29 tubes and miscellaneous areas are: DU (i.e., U-238, U-235, and U-234), HE, RCRA metals, and other potential chemical contaminants. Table A.3-1 identifies the field-screening methods or COPCs for the CAU. Specific analyses required for the disposal of IDW will be identified in Section 5.0 of the CAIP. Samples submitted for laboratory analysis will be analyzed according to Appendix C of the CAIP.

Table A.3-1
Field Screening and Laboratory Analysis Requirements for the Thunderwell Site, CAU 487, CAS RG-26-001-RGRV

Potential Contaminants	Field-Screening Method	Field-Screening Level	Preliminary Action Level	Analytical Method	Practical Quantitation Limit (soil/water)
Volatile Organic Compounds	Headspace	20 ppm or 2.5 X background (use greater value)	PRGs[a] NAC 445A[b]	See Appendix C	See Appendix C
Semivolatile Organic Compounds	N/A	N/A	PRGs[a] NAC 445A[b]		
Total Metals	N/A	N/A	PRGs[a] NAC 445A[b]		
Explosives	Explosives colorimetric field test kit	5 ppm (total)	PRGs[a]		
Radionuclides (Isotopic Uranium)	Electra (alpha/ beta scintillator	Mean plus 2 standard deviations of 20 background sample readings	Isotope-specific value based on maximum isotopic background data		

[a]EPA *Region IX Industrial Preliminary Remediation Goals (PRGs)* (EPA, 2000)
[b]*Nevada Administrative Code* (NAC, 1998)

N/A - Not Applicable

A.4.0 Decisions and Inputs

A.4.1 Decisions

Decisions to be resolved by the investigation include:

- Determine if COPCs are present at the site.
- Determine if COPC concentrations exceed FSLs.
- Determine if COPC concentrations exceed PALs.
- Determine the nature and extent of contamination with enough certainty to develop and evaluate a range of potential corrective actions, including closure in place and clean closure.

A.4.2 Inputs and Strategy

Input to the decisions include those elements of information used to support the decisions in addressing the identified problem. A list of information input, existing data, identified data gaps, and brief strategies are discussed in Table A.4-1.

Table A.4-1
Decisions, Inputs, and General Strategies
(Page 1 of 2)

Decision	Input	Existing Data	Data Gap	Strategy
Are COPCs present above PALs at site?	Potential contaminant identification	Process knowledge of potentially exploded or dumped material	Exact COPCs	Collect laboratory samples; analyze for COPCs
	Potential contaminant concentration	No sampling data available	Do concentrations exceed PALs?	Collect samples from soil; perform field screening and compare results to FSLs; submit samples for laboratory analysis from biased locations that represent worst case for contamination and confirmatory clean locations; compare results to PALs
	Potential contaminant distribution	Approximate boundaries of site are known; vertical and lateral extent limited by minimal driving forces, low volumes, and concentrations	Vertical and lateral extent of COPCs	Use excavation or drilling to establish potential depth of COPCs; conduct step-outs as required to determine lateral extent if COPCs are detected; collect laboratory samples to confirm extent
Are potential contaminants migrating?	Meteorologic data	Data on annual precipitation, evapotranspiration, and weather	None identified	No specific meteorological data collection anticipated; general weather and wind speed and direction noted on daily field logs
	Geologic/hydrologic data	General geologic/hydrologic characteristics of site; background concentrations for arsenic typically higher than PALs	Existence and characteristics of differing permeability zones	Field log all core by qualified Geologist; collect and analyze geotechnical samples at discretion of Site Supervisor
	Radioactive decay	Low probability of uranium at the Thunderwell Site	Presence and type of radionuclides	Establish background; field screen for alpha/beta-emitting radionuclides using an alpha/ beta scintillation detector (i.e., Electra) to guide collection of samples for radiological COPCs analysis

Table A.4-1
Decisions, Inputs, and General Strategies
(Page 2 of 2)

Decision	Input	Existing Data	Data Gap	Strategy
Data sufficient to support closure options?	No further action	Historical evidence that COPCs were released to the environment	Presence, concentration, and extent of COPCs	Insufficient evidence to proceed without investigation; collect field and laboratory samples; compare laboratory results to PALs; if no COPCs above PALs, prepare CADD/Closure Report (CR)
	Closure in place	Potential for radiological and RCRA constituents; PALs; assume use restrictions	Presence, concentration, and extent of COPCs	Collect field and laboratory samples; compare lab results to PALs; if no COPCs above PALs, prepare CADD/CR; otherwise prepare CADD
	Clean closure by contaminant removal	Potential for radiological and RCRA constituents; PALs	Presence, concentration, and extent of COPCs	Collect field and laboratory samples; compare lab results to PALs; if no COPCs above PALs, prepare CADD/CR; otherwise prepare CADD

A.5.0 Investigation Strategy

Biased sampling will be conducted during the field investigation to assess the extent of COPCs and determine if COPC concentrations exceed PALs for the sites. Samples collected from the CAU will be analyzed according to the appropriate COPC table, as provided in Section A.3.0.

Geotechnical samples may be collected at the Site Supervisor's discretion. Geotechnical samples will be collected if subsurface contamination is encountered during the field investigation. At least one geotechnical sample will be collected and analyzed for:

- Initial moisture content
- Dry bulk density
- Calculated porosity
- Moisture retention characteristics
- Particle size distribution
- Saturated and unsaturated hydraulic conductivity

Investigation of the CAU may include use of excavation and/or rotary-sonic drilling. All soil samples will be field screened for VOCs, HE, and alpha/beta-emitting radionuclides.

A.5.1 Thunderwell Site

Records will be kept of the soil description, field-screening measurements, and all other relevant data. All pertinent and required sampling information (i.e., date, time, sample interval) will be documented in accordance with the Industrial Sites QAPP (DOE/NV, 1996c). Approved chain of custody procedures will be followed to ensure the defensibility of the data.

The Thunderwell Site will be divided into two categories: tubes and miscellaneous areas. Anomalies previously identified through photographs and historical investigation, as well as the anomalies identified through the geophysical survey conducted that are consistent with the identified areas, will be handled in the methods designated appropriate for that area. The method of investigation and sampling for each area will differ due to the conditions and most appropriate method of sampling.

A.5.1.1 Tubes

Preliminary investigation and geophysical surveys have identified the locations of the tubes and their approximate diameter. Sixteen of the tubes are visible from the ground level, and approximately twelve or thirteen of the tube-like anomalies are buried without surface evidence. Each of the tubes that are identified will be drilled, field screened, and sampled. Subsurface anomalies identified in the geophysical survey as tubes will be uncovered to the appropriate depth so that the size and condition of the tube can be identified prior to drilling. In the event that the anomaly is not a tube, the anomaly will be classified as a part of the associated miscellaneous areas. Identifying the width of the tubes that will be sampled will allow drilling to be performed in the interior of the tubes to provide definitive data about actual tube depths and subsurface contamination levels. The borings will be positioned in the interior of the tube whenever possible through guidance of trained EOD personnel. No attempt will be made to drill through the wall of the steel tubes.

Field screening will be performed at 5-ft intervals, below the extent of the excavation for buried tubes, to a maximum of 60 ft bgs if the disturbed/native interface can be determined, or until field-screening results are below FSLs. If an interface is not determined and field-screening results are above FSLs, then drilling will continue until two consecutive samples are collected with field-screening results less than FSLs or to a maximum of 100 ft bgs will be performed.

If FSLs are not exceeded, environmental samples will be submitted from the native/backfill interface or the bottom of the borehole, whichever is deeper. One sample will be submitted from within the disturbed interval past the interface as a confirmatory sample. If FSLs are exceeded, an environmental sample will be submitted from the location with the highest field-screening results and from the second sample with field-screening results less than FSLs or the bottom of the borehole, whichever is deeper.

A.5.1.2 Miscellaneous Areas

Biased investigation will entail collecting environmental and field-screening samples from the surface or subsurface to confirm or refute the conceptual model for this category, to assess migration of contaminants, and to determine if contaminants are present in concentrations exceeding PALs for the site. The highest potential contamination area based on field screening will be targeted for an upper bounding sample. Other sample locations will be targeted to define the extent of the contaminated area above action levels. Regions exceeding FSLs would necessitate horizontal step-out sample collection locations or deeper backhoe excavation or possibly borings to investigate potential contaminant migration.

Surface and subsurface sample collection will be conducted at biased sample locations using a backhoe and/or hand tools. Biased sample locations will be identified through geophysical surveys, aerial photos, and current surface features. The excavation will investigate the soils to identify anomalies to the maximum reach of the excavation technique and/or two consecutive intervals below acceptable FSLs. Surface sampling may also be conducted at biased sample locations. If the vertical extent of contamination is not identified by the extent of the excavation technique, drilling may be initiated. Field screening for VOCs, explosives, and alpha/beta-emitting radionuclides will be conducted. Samples identified for laboratory analyses will be analyzed for those parameters listed in Table A.3-1.

Excavation will begin outside of an anomaly and progress towards the center to define the lateral extent of an identified feature. At the interface of native soil and the feature (as defined by soil discoloration, geology, or debris), a soil sample will be collected from both the native soil outside of the feature and either discolored soil or soil from around debris for field screening. If the debris is located and is nonhazardous, of limited quantity, and field-screening results are less than FSLs, additional excavation will not be required. If there is evidence of staining, odors, large quantity of debris, or if FSLs are exceeded, then excavation will continue vertically down the interface collecting samples approximately every 5 ft until the vertical extent is identified or to the extent of the excavation technique. If the vertical extent is identified, a sample will be collected from native soil at a depth below and near the feature. If the vertical extent is not identified by the extent of the excavation technique, drilling may be initiated. Field screening for VOCs, explosives, and alpha/beta-emitting radionuclides will be conducted. Samples identified for laboratory analyses will be analyzed for those parameters listed in Table A.3-1.

Field screening will be performed on any debris found in the miscellaneous areas to determine if contamination is present. If there is evidence of staining, odors, large quantity of debris, or if FSLs are exceeded, then environmental samples will be taken from the specified location. If the debris field screened is nonhazardous, small in quantity, and field-screening results are below FSLs, then it will be removed from the site for disposal and environmental samples will not be submitted for laboratory analysis. A minimum of ten percent of samples collected for field screening will be submitted for laboratory analysis for confirmation of field-screening results. Large surface debris will be field screened and consolidated for disposal.

A.6.0 Decision Rules

The following decision rules are applicable to the CAU and will be used to guide the investigation and subsequent data evaluation for CAU 487:

- If during the investigation either of the following occur, then the investigation will be halted and rescoped as necessary:
  - The conceptual model fails to such a degree that rescoping is required.
  - Sufficient data are collected to support evaluation of corrective actions.
- If field screening indicates no COPCs above FSLs, then a sample at the next prescribed subsurface location will be field screened if practical. If no COPCs are indicated, confirmatory laboratory sample will be submitted at the discretion of the Site Supervisor per Section 4.1 of the CAIP.
- If field screening indicates the presence of COPCs above FSLs, then the investigation will continue to determine the extent of COPCs until field-screening results are below FSLs; whereupon, a sample will be submitted for laboratory analysis to verify field-screening results. Samples will also be submitted for laboratory analysis from the subsurface interval that represents the worst-case, field-screening result and at the discretion of the Site Supervisor. Additional samples may be required for waste management purposes.
- If laboratory results indicate the presence of contaminants of concern above PALs, then a CADD will be prepared.
- If no COPCs are identified above PALs, then a CADD/Closure Report will be prepared according to the outline agreed upon by NDEP and DOE/NV. This type of CADD incorporates the elements of the regular CADD and the corrective action plan and serves as the closure report for the site.

Table A.6-1 provides additional decision points and rules.

Table A.6-1
Activity-Specific Decision Points and Rules
(Page 1 of 2)

Investigation Activity	Decision Point	Decision Result	Decision Rule
Tubes			
Drilling	Can an interface be determined (identified by fill/native soil)?	Yes	Field screen at 5-ft intervals to interface.
		No	Field screen at 5-ft intervals to a maximum depth of 60 ft bgs if interface cannot be determined and FSLs are not exceeded.
	Do field data indicate contamination exceeds FSLs?	Yes, interface not determined	If the interface cannot be determined and contamination exceeds two 5-ft intervals beyond 90 ft bgs, then halt the investigation; conceptual model fails; notify NDEP.
		Yes, interface determined	If interface is determined, then field screen two 5-ft intervals past the exceeded levels to an acceptable FSL. Collect highest FSL interval and second interval past acceptable level not to exceed 100 ft bgs. If second level exceeds 100 ft bgs, conceptual model fails, notify NDEP.
		No	If interface can or cannot be determined, collect sample at a maximum depth and collect one other sample for analysis in accordance with Section 4.1 of the CAIP (per Site Supervisor); then investigation complete.
Miscellaneous Areas			
Excavation	Can an interface be determined or debris identified (identified by fill/ native soil)?	Yes	Field screen the interface; submit the highest field-screening result.
		No	Collect sample from the estimated center of the anomaly.
	Can disposal feature be identified (i.e., discolored soil, geology, or debris)?	Yes	Continue with planned subsurface investigation.
		No	Collect confirmatory sample from the bottom of the excavation near the estimated center of the anomaly.
	Do field data indicate potential contamination at depths beyond excavation capability?	Yes	Continue subsurface investigation by excavation sample collection until maximum extent of the excavation technique; if FSLs are not acceptable, then initiate an appropriate drilling method.
		No	Continue with planned investigation using excavation method two levels past acceptable FSLs to verify decreasing levels, then determine investigation is complete.

Table A.6-1
Activity-Specific Decision Points and Rules
(Page 2 of 2)

Investigation Activity	Decision Point	Decision Result	Decision Rule
Drilling	Does drilling stop due to an obstruction with elevated FSLs within the tube?	Yes	Collect a sample at the point where the drilling stops and field screen the sample for VOCs, HE, and alpha/beta-emitting radionuclides, then continue drilling. If drilling cannot continue, contact NDEP, conceptual model fails.
		No	Continue drilling until interface or below FSLs.

A.7.0 Decision Error

Biased sampling will be conducted within CAU 487. Biased sampling is appropriate because areas of concern are well defined (i.e., through geophysical surveys or physical evidence on the ground surface) or can be reasonably assumed (i.e., based on aerial photo interpretation and landmarks).

A.7.1 Biased Sampling

The biased sampling strategy targets the worst-case contamination by sampling locations with the highest potential for contamination. This will ensure that the extent of the contamination has been adequately located and identified. Planned sample intervals may be substituted with sample intervals that indicate highest contamination for that sample location as indicated by visual and/or other field-screening techniques. At least 10 percent of the samples with field-screening results below field-screening levels will be obtained from the predetermined sampling locations to define the lower limit of the impact (if any) on soils. Field-screening results will be confirmed by off-site laboratory analysis for these samples.

All soil samples will be field screened for VOCs, HE, and alpha/beta-emitting radionuclides. Selected samples from each sample location will be sent to the laboratory for analysis for the appropriate COPCs listed in Table A.3-1, as discussed in Section 4.1 of the CAIP. This sampling strategy will ensure that contamination in the soil has been adequately located, identified, and quantified.

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Appendix B

Project Organization

B.1.0 Project Organization

The DOE/NV Industrial Sites Project Manager is Janet Appenzeller-Wing, and her telephone number is (702) 295-0461. The DOE/NV Industrial Sites Task Manager for CAU 487 is Kevin Cabble, and his phone number is (702) 295-5000.

The names of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate DOE/NV plan. However, personnel are subject to change, and it is suggested that the Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Biweekly Activity Report prior to the start of field activities.

Appendix C

Analytical Table

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 1 of 6)

Parameter or Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	Regulatory Limit	Relative Percent Difference (RPD)[a]	Percent Recovery (%R)[b]
ORGANICS						
Total Volatile Organic Compounds	Water	8260B[c]	Analyte-specific estimated quantitation limits[d]	Not Applicable (NA)	14[e]	61-145[e]
	Soil				24[e]	59-172[e]
Toxicity Characteristic Leaching Procedure (TCLP) VOCs						
Benzene	Aqueous	1311/8260B[c]	0.050 mg/L[d]	0.5 mg/L[d]	14[e]	61-145[e]
Carbon Tetrachloride			0.050 mg/L[d]	0.5 mg/L[d]		
Chlorobenzene			0.050 mg/L[d]	100 mg/L[d]		
Chloroform			0.050 mg/L[d]	6 mg/L[d]		
1,2-Dichloroethane			0.050 mg/L[d]	0.5 mg/L[d]		
1,1-Dichloroethene			0.050 mg/L[d]	0.7 mg/L[d]		
Methyl Ethyl Ketone			0.050 mg/L[d]	200 mg/L[d]		
Tetrachloroethene			0.050 mg/L[d]	0.7 mg/L[d]		
Trichloroethene			0.050 mg/L[d]	0.5 mg/L[d]		
Vinyl Chloride			0.050 mg/L[d]	0.2 mg/L[d]		
Total Semivolatile Organic Compounds	Water	8270C[c]	Analyte-specific estimated quantitation limits[d]	NA	50[e]	9-127[e]
	Soil				50[e]	11-142[e]
TCLP SVOCs						
o-Cresol	Aqueous	1311/8270C[c]	0.10 mg/L[d]	200 mg/L[d]	50[e]	9-127[e]
m-Cresol			0.10 mg/L[d]	200 mg/L[d]		
p-Cresol			0.10 mg/L[d]	200 mg/L[d]		
Cresol (total)			0.30 mg/L[d]	200 mg/L[d]		
1,4-Dichloro-benzene			0.10 mg/L[d]	7.5 mg/L[d]		
2,4-Dinitrotoluene			0.10 mg/L[d]	0.13 mg/L[d]		

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 2 of 6)

Parameter or Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	Regulatory Limit	Relative Percent Difference (RPD)[a]	Percent Recovery (%R)[b]
Hexachloro-benzene	Aqueous	1311/8270C[c]	0.10 mg/L[d]	0.13 mg/L[d]	50[e]	9-127[e]
Hexachloro-butadiene			0.10 mg/L[d]	0.5 mg/L[d]		
Hexachloro-ethane			0.10 mg/L[d]	3 mg/L[d]		
Nitrobenzene			0.10 mg/L[d]	2 mg/L[d]		
Pentachloro-phenol			0.50 mg/L[d]	100 mg/L[d]		
Pyridine			0.10 mg/L[d]	5 mg/L[d]		
2,4,5-Trichloro-phenol			0.10 mg/L[d]	400 mg/L[d]		
2,4,6-Trichloro-phenol			0.10 mg/L[d]	2 mg/L[d]		
Total Pesticides	Water	8081A[c]	Analyte-specific (CRQL)[e]	NA	27[e]	38-131[e]
	Soil				50[e]	23-139[e]
TCLP Pesticides						
Chlordane	Aqueous	1311/8081A[C]	0.0005 mg/L[e]	0.03 mg/L[d]	27[e]	38-131[e]
Endrin			0.001 mg/L[e]	0.02 mg/L[d]		
Heptachlor			0.0005 mg/L[e]	0.008 mg/L[d]		
Heptachlor Epoxide			0.0005 mg/L[e]	0.008 mg/L[d]		
gamma-BHC (Lindane)			0.0005 mg/L[e]	0.4 mg/L[d]		
Methoxychlor			0.005 mg/L[e]	10 mg/L[d]		
Toxaphene			0.05 mg/L[e]	0.5 mg/L[d]		
Polychlorinated Biphenyls (PCBs)	Water	8082[c]	Analyte-specific contract required quantitation limits (CRQL)[e]	NA	Lab-specific[f]	Lab-specific[f]
	Soil					
Total Herbicides	Water	8151A[c]	1.3 µg/L[c]	NA	Lab-specific[f]	Lab-specific[f]
	Soil		66 µg/kg[c]			
TCLP Herbicides						
2,4-D	Aqueous	1311/8151A[c]	0.002 mg/L[d]	10 mg/L[d]	Lab-specific[f]	Lab-specific[f]
2,4,5-TP			0.00075 mg/L[d]	1 mg/L[d]		

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 3 of 6)

Parameter or Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	Regulatory Limit	Relative Percent Difference (RPD)[a]	Percent Recovery (%R)[b]
Total Petroleum Hydrocarbons (TPH)	Water Gasoline	8015B modified[c]	0.1 mg/L[g]	NA	Lab-specific[f]	Lab-specific[f]
	Soil Gasoline		0.5 mg/kg[g]			
	Water Diesel		0.5 mg/L[g]			
	Soil Diesel		25 mg/kg[g]			
Nitroaromatics and Nitramines	Water	8330[c]	5 µg/L[v]	NA	Lab-specific[f]	Lab-specific[f]
	Soil		0.35 mg/kg[v]			
Polychlorinated Dioxins and Furans	Water	8280A/8290[c]	0.05 µg/L[c]	NA	Lab-specific[f]	Lab-specific[f]
	Soil		5 µg/kg[c]			
INORGANICS						
Total *Resource Conservation and Recovery Act* (RCRA) Metals						
Arsenic	Water	6010B[c]	10 µg/L[g,h]	NA	20[h]	75-125[h]
	Soil	6010B[c]	1 mg/kg[g,h]			
Barium	Water	6010B[c]	200 µg/L[g,h]			
	Soil	6010B[c]	20 mg/kg[g,h]			
Cadmium	Water	6010B[c]	5 µg/L[g,h]			
	Soil	6010B[c]	0.5 mg/kg[g,h]			
Chromium	Water	6010B[c]	10 µg/L[g,h]			
	Soil	6010B[c]	1 mg/kg[g,h]			
Lead	Water	6010B[c]	3 µg/L[g,h]			
	Soil	6010B[c]	0.3 mg/kg[g,h]			
Mercury	Water	7470A[c]	0.2 µg/L[g,h]			
	Soil	7471A[c]	0.1 mg/kg[g,h]			
Selenium	Water	6010B[c]	5 µg/L[g,h]			
	Soil	6010B[c]	0.5 mg/kg[g,h]			
Silver	Water	6010B[c]	10 µg/L[g,h]			
	Soil	6010B[c]	1 mg/kg[g,h]			

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 4 of 6)

Parameter or Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	Regulatory Limit	Relative Percent Difference (RPD)[a]	Percent Recovery (%R)[b]
TCLP RCRA Metals						
Arsenic	Aqueous	1311/6010B[c] 1311/7470A[c]	0.10 mg/L[g,h]	5 mg/L[d]	20[h]	75-125[h]
Barium			2 mg/L[g,h]	100 mg/L[d]		
Cadmium			0.05 mg/L[g,h]	1 mg/L[d]		
Chromium			0.10 mg/L[g,h]	5 mg/L[d]		
Lead			0.03 mg/L[g,h]	5 mg/L[d]		
Mercury			0.002 mg/L[g,h]	0.2 mg/L[d]		
Selenium			0.05 mg/L[g,h]	1 mg/L[d]		
Silver			0.10 mg/L[g,h]	5 mg/L[d]		
Cyanide	Water	9010B[c]	0.01 mg/L[h]	NA	20[h]	75-125[h]
	Soil		1.0 mg/kg[h]			
Sulfide	Water	9030B/9034[c]	0.4 mg/L[c]	NA	Lab-specific[f]	Lab-specific[f]
	Soil or Sediment		10 mg/kg[g]			
pH/Corrosivity	Water	9040B[c]	NA	pH >2[i]	Lab-specific[f]	Lab-specific[f]
	Soil	9045C[c]		pH<12.5[i]		
Ignitability	Water	1010[c]	NA	Flash Point <140° F[d]	NA	NA
	Soil	1030[c]		Burn Rate[c] >2.2 mm/sec nonmetals; >0.17 mm/sec metals		
RADIOCHEMISTRY						
Gamma-emitting Radionuclides[j]	Water	EPA 901.1[k]	Isotope-specific[m]	NA	20	Tracer Yield 30-105 Laboratory Control Sample Yield 80-120
	Soil	HASL 300[l]			35	
Isotopic Plutonium[j]	Water	NAS-NS-3058[n,o]	1 pCi/L	NA	20	
	Soil		0.1 pCi/g Pu-238[p] 0.4 pCi/g Pu-239/240[p]		35	
Isotopic Uranium[j]	Water	NAS-NS-3050[q,r]	2 pCi/L	NA	20	
	Soil		1 pCi/g		35	
Strontium - 90[j]	Water	SM 7500-Sr[s]	5 pCi/L	NA	20	
	Soil	Martin 79[t]	1 pCi/g[u]		35	

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 5 of 6)

Parameter or Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	Regulatory Limit	Relative Percent Difference (RPD)[a]	Percent Recovery (%R)[b]
Gross Alpha	Water	EPA 900.0[k]	3 pCi/L	NA	20	Tracer Yield 30-105 Laboratory Control Sample Yield 80-120
	Soil	SM 7110[s]	1 pCi/g		35	
Gross Beta	Water	EPA 900.0[k]	4 pCi/L	NA	20	Tracer Yield 30-105 Laboratory Control Sample Yield 80-120
	Soil	SM 7110[s]	3 pCi/g		35	

Table C.1-1
Laboratory Chemical, Toxicity Characteristic Leaching Procedure, and Radiochemistry Analytical Requirements for Industrial Sites
(Page 6 of 6)

[a]RPD is used to Calculate Precision.
Precision is estimated from the relative percent difference of the concentrations measured for the matrix spike and matrix spike duplicate analyses of unspiked field samples, or field duplicates of unspiked samples. It is calculated by:
RPD = 100 x $\{(|C_1-C_2|)/[(C_1+C_2)/2]\}$, where C_1 = Concentration of the analyte in the first sample aliquot, C_2 = Concentration of the analyte in the second sample aliquot.

[b]%R is used to Calculate Accuracy.
Accuracy is assessed from the recovery of analytes spiked into a blank or sample matrix of interest, or from the recovery of surrogate compounds spiked into each sample. The recovery of each spiked analyte is calculated by: %R = 100 x (C_s-C_u/C_n), where C_s = Concentration of the analyte in the spiked sample, C_u = Concentration of the analyte in the unspiked sample, C_n = Concentration increase that should result from spiking the sample

[c]U.S. Environmental Protection Agency's (EPAs) *Test Methods for Evaluating Solid Waste*, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996)

[d]Estimated Quantitation Limit as given in SW-846 (EPA, 1996)

[e]EPA *Contract Laboratory Program Statement of Work for Organic Analysis* (EPA, 1988b; 1991; and 1994b)

[f] In-House Generated RPD and %R Performance Criteria
It is necessary for laboratories to develop in-house performance criteria and compare them to those in the methods. The laboratory begins by analyzing 15-20 samples of each matrix and calculating the mean %R for each analyte. The standard deviation (SD) of each %R is then calculated, and the warning and control limits for each analyte are established at ± 2 SD and ± 3 SD from the mean, respectively. If the warning limit is exceeded during the analysis of any sample delivery group (SDG), the laboratory institutes corrective action to bring the analytical system back into control. If the control limit is exceeded, the sample results for that SDG are considered unacceptable. These limits are reviewed after every 20-30 field samples of the same matrix and are updated at least semiannually. The laboratory tracks trends in both performance and control limits by the use of control charts. The laboratory's compliance with these requirements is confirmed as part of an annual laboratory audit. Similar procedures are followed in order to generate acceptance criteria for precision measurements.

[g]*Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996)

[h]EPA *Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a; 1994a, and 1995)

[i]RCRA Regulations and Keyword Index, 1998 Edition

[j]Isotopic minimum detectable concentrations are defined during the DQO process and specified in the CAIP, as applicable.

[k]*Prescribed Procedures for Measurements of Radioactivity in Drinking Water* (EPA, 1980) or equivalent method

[l]*Environmental Measurements Laboratory Procedures Manual* (DOE, 1997) or equivalent method

[m]Isotope-Specific Minimum Reporting Limit to be specified in CAIP

[n]*The Radiochemistry of Plutonium* (Coleman, 1965) or equivalent method

[o]*Separation and Preconcentration of Actinides from Acidic Media by Extraction Chromatography* (Horwitz, et al., 1993) or equivalent method

[p]The *Nevada Test Site Performance Objective Criteria* requirement for certifying that hazardous waste has no added radioactivity requires that the total plutonium (the sum of the Pu-238, 239, 240 concentrations) not exceed 0.5 pCi/g (BN, 1995).

[q]*The Radiochemistry of Uranium* (Grindler, 1962) or equivalent method

[r]*Separation and Preconcentration of Uranium from Acidic Media by Extraction Chromatography* (Horwitz, et al., 1992) or equivalent method

[s]*Standard Methods for the Examination of Water and Waste Water* (APHA, 1995) or equivalent method

[t]Determination of Strontium-89 and -90 in soil with Total Sample Decomposition (Analytical Chemistry, 1979) or equivalent method

[u]The 1.0 pCi/g concentration is approximately twice the concentration of fallout Sr-90 in background surface soils reported in the *Environmental Monitoring Report for the Proposed Ward Valley California Low-Level Radioactive Waste Facility* (Atlan-Tech, 1992).

[v]Paragon Laboratory-generated reporting limits

Definitions:
µg/kg = Microgram(s) per kilogram
mg/kg = Milligram(s) per kilogram
pCi/L = Picocurie(s) per liter
mg/L = Milligram(s) per liter
pCi/g = Picocurie(s) per gram
µg/L = Microgram(s) per liter

C.1.0 References

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Appendix D

Response to NDEP Comments

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Investigation Plan for Corrective Action Unit 487: Thunderwell Site, Tonopah Test Range, Nevada	2. Document Date: October 2000
3. Revision Number: 0	4. Originator/Organization: IT Corporation
5. Responsible DOE/NV ERP Project Mgr.: Janet Appenzeller-Wing	6. Date Comments Due: December 1, 2000
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) Page ES-2, 1st Bullet		Specify what *"...defined historical boundaries...'* are.	Text has been modified to define historical boundaries at the Thunderwell Site.	Accept
2) Section 1.0, 2nd Paragraph, Page 1		*"...The TTR is...approximately 255 kilometers (140 miles) northwest...".* According to Figure 1-1, TTR is 236 miles from Las Vegas. Modify sentence to reflect actual distance.	Mileage has been changed to reflect 236 miles.	Accept
3) Section 3.3.1, 2nd Bullet, (also Section 4.2.3), Page 13		What are *"...colimetric field kits..."?* Are these different than colorimetric field tests? Specify the tests/kits to be used for screening explosives in the field.	Colimetric has been changed to colorimetric throughout the document.	Accept

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to DOE/NV Environmental Restoration Division, Attn: QAC, M/S 505.

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