

Nevada
Environmental
Restoration
Project

DOE/NV--1260



Corrective Action Investigation Plan for Corrective Action Unit 546: Injection Well and Surface Releases Nevada Test Site, Nevada

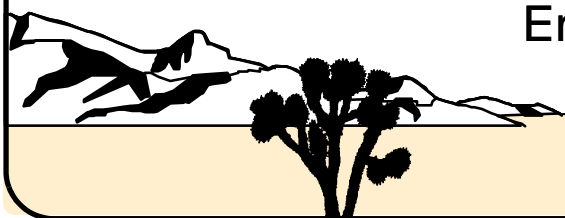
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**CORRECTIVE ACTION INVESTIGATION PLAN FOR
FOR CORRECTIVE ACTION UNIT 546:
INJECTION WELL AND SURFACE RELEASES
NEVADA TEST SITE, NEVADA**

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

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CORRECTIVE ACTION UNIT 546:
INJECTION WELL AND SURFACE RELEASES
NEVADA TEST SITE, NEVADA**

Approved by: /s/ Kevin J. Cabble Date: 02/26/2008

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List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
Ci	Curie
CFR	<i>Code of Federal Regulations</i>
COC	Contaminant of concern
COPC	Contaminant of potential concern
CSM	Conceptual site model
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
FAL	Final action level
FFACO	<i>Federal Facility Agreement and Consent Order</i>
ft	Foot
GPS	Global Positioning System
HASL	Health and Safety Laboratory

List of Acronyms and Abbreviations (Continued)

HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
in./yr	Inches per year
ISMS	Integrated Safety Management System
LCS	Laboratory control sample
LLNL	Lawrence Livermore National Laboratory
LOS	Line of site
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mi	Mile
mm/yr	Millimeters per year
mrem/yr	Millirem per year
MS	Matrix spike
N/A	Not applicable
NAC	<i>Nevada Administrative Code</i>
NAD	North American Datum
NCRP	National Council on Radiation Protection and Measurement
ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
NEPA	<i>National Environmental Policy Act</i>
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NRS	<i>Nevada Revised Statutes</i>

List of Acronyms and Abbreviations (Continued)

NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
NTSWAC	<i>Nevada Test Site Waste Acceptance Criteria</i>
NV/YMP	Nevada Yucca Mountain Project
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
POC	Performance Objective for the Certification of Nonradioactive Hazardous Waste
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary remediation goal
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RadCon	Radiological Control
RBCA	Risk-based corrective action
RCA	Radiologically controlled area
RCRA	<i>Resource Conservation and Recovery Act</i>
RESRAD	Residual Radioactive
RL	Reporting limit
RMA	Radioactive material area
RPD	Relative percent difference
SDWS	Safe Drinking Water Standards
SNJV	Stoller-Navarro Joint Venture
SSTL	Site-specific target level

List of Acronyms and Abbreviations (Continued)

SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total petroleum hydrocarbons
TSCA	<i>Toxic Substance Control Act</i>
USGS	U.S. Geological Survey
UST	Underground storage tank
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
VSP	Visual Sample Plan
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 546 is located in Areas 6 and 9 of the Nevada Test Site, which is approximately 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 546 is comprised of two Corrective Action Sites (CASs) listed below:

- 06-23-02, U-6a/Russet Testing Area
- 09-20-01, Injection Well

These sites are being investigated because existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives. Additional information will be obtained by conducting a corrective action investigation (CAI) before evaluating corrective action alternatives and selecting the appropriate corrective action for each CAS. The results of the field investigation will support a defensible evaluation of viable corrective action alternatives that will be presented in the Corrective Action Decision Document.

The sites will be investigated based on the data quality objectives (DQOs) developed on November 8, 2007, by representatives of the Nevada Division of Environmental Protection and U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office. The DQO process has been used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 546.

[Appendix A](#) provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS.

The scope of the CAI for CAU 546 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct visual surveys to identify biasing factors that may include staining, discoloration, disturbance of native soil, or other indication of potential contamination.
- Conduct remaining radiological surveys.
- Collect and submit environmental samples for laboratory analysis to determine whether contaminants of concern (COCs) are present.

- If COCs are present, collect additional step-out samples to define the extent of the contamination.
- Collect samples of investigation-derived waste, as needed, for waste management purposes.
- Collect quality control samples.

The following activity is not included in the scope of the field sampling activities for CAU 546:

- It is assumed that COCs associated with wastes that were placed into the injection well are present in subsurface soil at CAS 09-20-01. A corrective action of Close In Place with a use restriction will be implemented for this subsurface contamination.

This Corrective Action Investigation Plan has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada; DOE, Environmental Management; U.S. Department of Defense; and DOE, Legacy Management (FFACO, 1996; as amended January 2007). 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. Fieldwork will be conducted following approval of the plan.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 546: Injection Well and Surface Releases, Nevada Test Site (NTS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management (FFACO, 1996; as amended January 2007).

Corrective Action Unit 546 is located in Areas 6 and 9 of the NTS, which is approximately 65 miles (mi) northwest of Las Vegas, Nevada ([Figure 1-1](#)). Corrective Action Unit 546 is comprised of the two Corrective Action Sites (CASs) shown on [Figure 1-1](#) and listed below:

- 06-23-02, U-6a/Russet Testing Area
- 09-20-01, Injection Well

The Corrective Action Investigation (CAI) will include field inspections, radiological surveys, sampling of environmental media, analysis of samples, and assessment of investigation results, where appropriate. Data will be obtained to support corrective action alternative evaluations and waste management decisions.

1.1 Purpose

The CAU 546 CASs are being investigated because hazardous and/or radioactive constituents may be present in concentrations that could potentially pose a threat to human health and the environment. Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CAS 06-23-02 and for surface soil at CAS 09-20-01. Additional information will be generated by conducting a CAI before evaluating and selecting corrective action alternatives. Sufficient information is available to recommend a corrective action alternative for the subsurface soil at CAS 09-20-01.

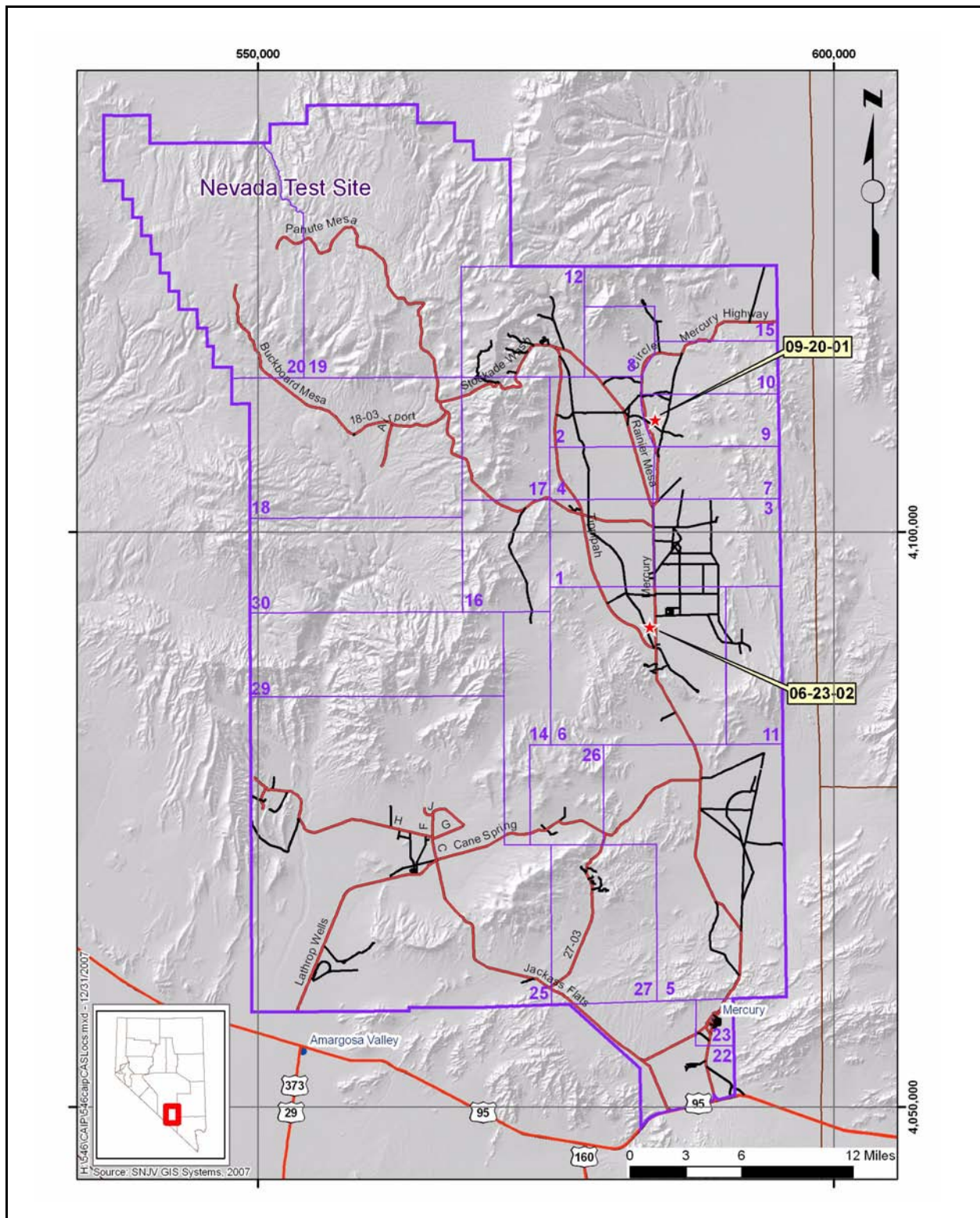


Figure 1-1
Nevada Test Site Map with CAU 546 CAS Locations

Classified core and decontamination wastes (both liquid and solidified) were disposed of in the injection well at CAS 09-20-01. It can be expected that these wastes would include mixed fission products, plutonium, uranium, and potentially metals and/or organic solvents at levels above final action levels (FALs). For safety reasons, any new sampling boreholes at this CAS would have to be drilled at some distance from the injection well. Therefore, sample results could not be used reliably to disprove the presence of COCs around the injection well. Because of this, it is assumed that COCs are present at CAS 09-20-01, and a corrective action of Close in Place with a use restriction will be implemented for the subsurface contamination. The collection of subsurface samples by drilling would present significant risks to workers; may not provide useful additional information on the nature and extent of contamination; and would not affect the selected corrective action of Close in Place. The area of the use restriction will be presented in the Corrective Action Decision Document (CADD). Investigation of disposal holes within CAU 542 with similar histories and similar conceptual site models (CSMs) revealed that contamination had not migrated more than 15 feet (ft) from the release point at the bottom of the well.

Potential surface releases at this CAS have not been documented and insufficient information exists regarding potential surface contamination. Therefore, samples will be collected near the injection well and below a drum that is present in the area as part of the CAI. The results will be used to recommend a surface corrective action alternative.

1.1.1 Corrective Action Unit 546 History and Description

Corrective Action Unit 546, Injection Well and Surface Releases, consists of two inactive sites located in Areas 6 and 9. The two CAU 546 sites consist of a testing area that has numerous potential environmental concerns and an injection well. The CAU 546 sites were used to support nuclear testing conducted in the Yucca Flat area. The operational histories for each CAU 546 CAS are detailed in [Section 2.2](#).

1.1.2 Data Quality Objective Summary

The sites will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP); DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO); Stoller-Navarro Joint Venture (SNJV); and

National Security Technologies, LLC (NSTec). The DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 546. This CAIP describes the investigative approach developed to collect the data needs identified in the DQO process. While a detailed discussion of the DQO methodology and the DQOs specific to each CAS are presented in [Appendix A](#), a summary of the DQO process is provided below.

The DQO problem statement for CAU 546 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 546.” To address this question, the resolution of two decision statements is required:

- Decision I: “Is any contaminant of potential concern (COPC) associated with the CAS present in environmental media at a concentration exceeding its corresponding final action level (FAL)?” Any contaminant associated with a CAS that is present at concentrations exceeding its corresponding FAL will be defined as a contaminant of concern (COC). A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006a). If a COC is detected, then Decision II must be resolved. If a COC is not detected, the investigation for that CAS is complete.
- Decision II: “If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?” Sufficient information is defined to include:
 - Identifying the lateral and vertical extent of COC contamination in environmental media.
 - The information needed to determine potential remediation waste types.
 - The information needed to evaluate the feasibility of remediation alternatives.

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in [Appendix A](#). The information necessary to resolve the DQO decisions will be generated for each CAU 546 CAS by collecting and analyzing samples collected during a field investigation. The presence of contamination at each CAS will be determined by collecting and analyzing samples following a judgmental sampling approach. Therefore, samples will be collected from locations that are most likely to contain a COC.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO processes, the scope of the CAI for CAU 546 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct visual surveys to identify biasing factors that may include staining, discoloration, disturbance of native soil, or other indication of potential contamination.
- Conduct radiological surveys on areas not previously surveyed.
- Collect and submit environmental samples for laboratory analysis to determine whether COCs are present.
- If COCs are present, collect additional step-out samples to define the nature and extent of the contamination.
- Collect samples of investigation-derived waste (IDW), as needed, for waste management purposes.
- Collect quality control (QC) samples.

The following activity is not included in the scope of the field sampling activities for CAU 546:

- It is assumed that COCs associated with wastes that were placed into the injection well are present in subsurface soil at CAS 09-20-01. A corrective action of Close In Place with a use restriction will be implemented for this subsurface contamination (see [Section 1.1](#)).

Contamination of environmental media originating from activities not identified in the CSM of any CAS will not be considered as part of this CAU, unless the CSM and the DQOs are modified to include the release. If not included in the CSM, contamination originating from these sources will not be considered for sample location selection, and/or will not be considered COCs. If such contamination is present, the contamination will be identified as part of another CAS (either new or existing).

1.3 Corrective Action Investigation Plan Contents

[Section 1.0](#) presents the purpose and scope of this CAIP, while [Section 2.0](#) provides background information about CAU 546. Objectives of the investigation, including CSMs, are presented in

[Section 3.0](#). Field investigation and sampling activities are discussed in [Section 4.0](#), and waste management issues for this project are discussed in [Section 5.0](#). General field and laboratory quality assurance (QA) (including collection of QA samples) are presented in [Section 6.0](#) and the Industrial Sites Quality Assurance Project Plan (QAPP) (NNSA/NV, 2002). The project schedule and records availability are discussed in [Section 7.0](#). [Section 8.0](#) provides a list of references.

[Appendix A](#) provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS, [Appendix B](#) contains the project organization information, and [Appendix C](#) contains the NDEP comment responses.

2.0 Facility Description

Corrective Action Unit 546 is comprised of two CASs that were grouped together based on the closure strategy and the agency responsible for closure. These two CASs were the last complex ER CASs in Appendix II of the FFACO and, therefore, were consolidated into one CAU. The CASs are located in Areas 6 and 9 and include CASs 06-23-02, U-6a/Russet Testing Area, and CAS 09-20-01, Injection Well.

2.1 Physical Setting

This section describes the general physical setting of the Yucca Flat Hydrographic Area where both CASs are located. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for this area of the NTS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (USGS, 1990); *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996a). These documents show that Yucca Flat is a closed basin that is slowly being filled with alluvial deposits eroding from the surrounding mountains (USGS, 1996).

The direction of groundwater flow in Yucca Flat generally is northeast to southwest. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (USGS, 1996). The average precipitation at Station UCC on the Yucca Flat dry lake is 6.67 inches per year (in./yr) (NOAA, 2007). The recharge rate to the Yucca Flat area is relatively low (1.76 millimeters per year [mm/yr]), and the thickness of the unsaturated zone extends to more than 600 ft below ground surface (bgs) (USGS, 1996).

Local topography within the vicinity of the CASs present in the Yucca Flat area can influence the migration of potential contaminants released from a CAS. At CAS 06-23-02, there is a diversion ditch that was used to prevent surface runoff flow from interfering with area activities. The ditch would divert water to flow from west to north and opens to flat land. Ultimately, the system of

washes around Yucca Flat terminate at the dry lake bed (Yucca Flat). Because CAS 09-20-01 is located in a crater, surface runoff is not a concern.

The nearest groundwater well to CAS 06-23-02 is UE-6d, which is approximately 3,000 ft northwest of the site. The depth to groundwater at this well is 1,514 ft (USGS and DOE, 2007). The nearest well to CAS 09-20-01 is ER-2-1, which is approximately 5,260 ft southwest. The depth to groundwater at this well is 1,725 ft (USGS and DOE, 2007).

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 546 that may have resulted in potential releases to the environment. The CAS-specific summaries are designed to describe the current definition of each CAS and illustrate all significant, known activities.

2.2.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

Corrective Action Site 06-23-02 consists of the potential release of contaminants to the soil in the overall Russet testing area including: two muckpiles, a discharge pit, a posted vent line, a posted soil pile, and a subsurface anomaly. This CAS is the location of the Russet test that was conducted on March 5, 1968. Russet was a nuclear test conducted by the Los Alamos National Laboratory and U.S. Department of Defense as a part of Operation Crosstie. The test was conducted in an extensive network of subsurface tunnels and drift systems. The Russet test area was the location of pre- and post-test activities. [Figure A.2-2](#) is a photograph of the CAS.

2.2.2 Corrective Action Site 09-20-01, Injection Well

Corrective Action Site 09-20-01 consists of a potential release of contaminants to the soil surrounding the injection well and below an adjacent drum. Although the CAS description is “Injection Well” in the FFACO, the CAS was used as a disposal hole. This CAS is located within the U-9u crater, which was created as a result of the Raritan Test. The test was conducted at a depth of 595 ft by Lawrence Livermore National Laboratory (LLNL) on September 6, 1962, as a part of Operation Storax. By 1963, the injection well appears to be present in historical photographs, and documentation states that the injection well was still active in 1988. [Figure A.2-10](#) shows a photograph of this CAS.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. Historical information and site visits indicate that the sites contain wastes such as metal, wood, wire, cables, concrete, piping, and other miscellaneous debris.

2.3.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

Solid waste items identified at CAS 06-23-02 include debris such as wood, concrete, metal, electrical boxes, piping, construction debris, wires, and cables. Potential waste types may include sanitary waste, hydrocarbon waste, *Resource Conservation and Recovery Act* (RCRA) hazardous waste, radioactive waste, and mixed waste. The waste types that may be generated during the CAI include debris, IDW, decontamination liquids, and soils.

2.3.2 Corrective Action Site 09-20-01, Injection Well

Solid waste items identified at CAS 09-20-01 include debris such as wood, metal, and cables. Potential waste types may include sanitary waste, hydrocarbon waste, RCRA hazardous waste, radioactive waste, and mixed waste. The waste types that may be generated during the CAI include debris, IDW, decontamination liquids, and soils.

2.4 Release Information

Known or suspected releases from the CASs, including potential release mechanisms, and migration routes associated with each of the CASs are described in the following subsections. Potentially affected media for all CASs include surface and shallow subsurface soil. Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils, debris and/or structures. Site workers may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

The following subsections contain CAS-specific descriptions of known or suspected releases associated with CAU 546.

2.4.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

Operations at this CAS may have resulted in a potential release of contamination to the soil in the Russet testing area. Potential sources of a release include two muckpiles, a discharge pit, a soil pile, a vent line, a subsurface anomaly, and the overall testing area. If a release occurred, it is expected that there would have been limited lateral and vertical migration. Therefore, any contamination present is expected to be located in the vicinity of the release.

2.4.2 Corrective Action Site 09-20-01, Injection Well

Disposal activities (core and liquid and solidified decontamination wastes) at this CAS may have resulted in a potential release of contamination to the soil surrounding the injection well and drum. A release may have occurred if there were spills during disposal or if the drum was emptied onsite. If a release occurred, it is expected to be minimal and to have remained within the crater boundary.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 546 sites. More detailed discussions of these investigations are found in [Appendix A](#). No previous investigative results have been identified for soils or materials currently present at these CASs.

2.5.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

At the time of the Russet test, remote telemetry radiation monitoring units were set up to record a release if one occurred. It was determined that there was a release but that most of the release had ceased by H+12 hours, and it was believed to be a low-level seepage through cables and line of site (LOS) piping that reached the surface (Author Unknown, 1968). The release was a result of the nuclear test and also special operations packaging activities that took place in 1974. The release consisted of iodine-131, -133, -135, xenon-138, uranium-235 (5.9×10^{-5} Curie [Ci]), and uranium-238 (2.4×10^{-5} Ci) (DOE/NV, 1996b). The released xenon and iodine are gases with short half-lives and are not considered an environmental concern; however, the uranium has a half-life such that, if present, would be an environmental concern (Tung, 2007). The LOS piping has been removed from the site and is no longer a source of potential future release. However, there is a vent line present that is shown on a site sketch to connect to the U-6a Reentry Shaft (Scolman, 1969).

In 2007, a radiological walkover survey was performed on the two muckpiles, discharge pit, posted soil pile, and vent line. Although the survey has been completed in these areas, the results have not been finalized. The preliminary survey results indicate there are no radiological concerns, as the readings at the site were not distinguishable from background levels (SNJV, 2007). The remainder of the CAS is currently being surveyed.

A geophysical survey has been completed on areas of interest in the overall Russet testing area. The surveys determined that there may be debris buried in the muckpiles. At the soil pile, the geophysical signature from the fence posts, concrete pad, and surface debris prevented a determination of the presence of buried objects. A subsurface anomaly measuring 43 by 33 ft was identified near the southern edge of the southern muckpile. The depth of the object, or objects, is unknown, but the surface of the anomaly is not deeper than approximately 13 ft, due to survey instrument capabilities. Also identified was a shallow pipe that leads from the discharge pit to a concrete pad west of the pit (Weston Solutions, Inc., 2007).

2.5.2 *Corrective Action Site 09-20-01, Injection Well*

In 2007, a radiological walkover survey was performed in the area of the injection well and no elevated readings were identified. The maximum reading is approximately equal to the mean undisturbed background radiation emission rate. Therefore, no beta/gamma radiological conditions within the CAS could be distinguished from the surrounding area.

2.5.3 *National Environmental Policy Act*

The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996a) includes site investigation activities such as those proposed for CAU 546.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed before beginning site investigation activities at CAU 546. This checklist requires NNSA/NSO project personnel to compare proposed project activities to a list of potential impacts that include, but are not limited to: air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of

the appropriate level of NEPA documentation by the NNSA/NSO NEPA Compliance Officer. This will be accomplished before mobilization for the field investigation.

3.0 Objectives

This section presents an overview of the DQOs for CAU 546 and formulation of the CSM. Also presented is a summary of the contaminants reasonably suspected to be present at each CAS (i.e., target contaminants), the COPCs, the preliminary action levels (PALs) for the investigation, and the process used to establish FALs. Additional details and figures depicting the CSM are in [Appendix A](#).

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM is also used to support appropriate sampling strategies and data collection methods. The CSM has been developed for CAU 546 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs. [Figure 3-1](#) depicts a tabular representation of the conceptual pathways to receptors from CAU 546 sources. [Figure 3-2](#) depicts a graphical representation of the CSM. If evidence of contamination inconsistent with this CSM is identified during investigation activities, the situation will be reviewed, the CSM revised, the DQOs re-assessed, and a recommendation made as to how to proceed. In such cases, decision-makers listed in [Section A.3.1](#) will be notified and given the opportunity to comment on, and/or concur with, the recommendation.

The following sections discuss future land use and identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 546.

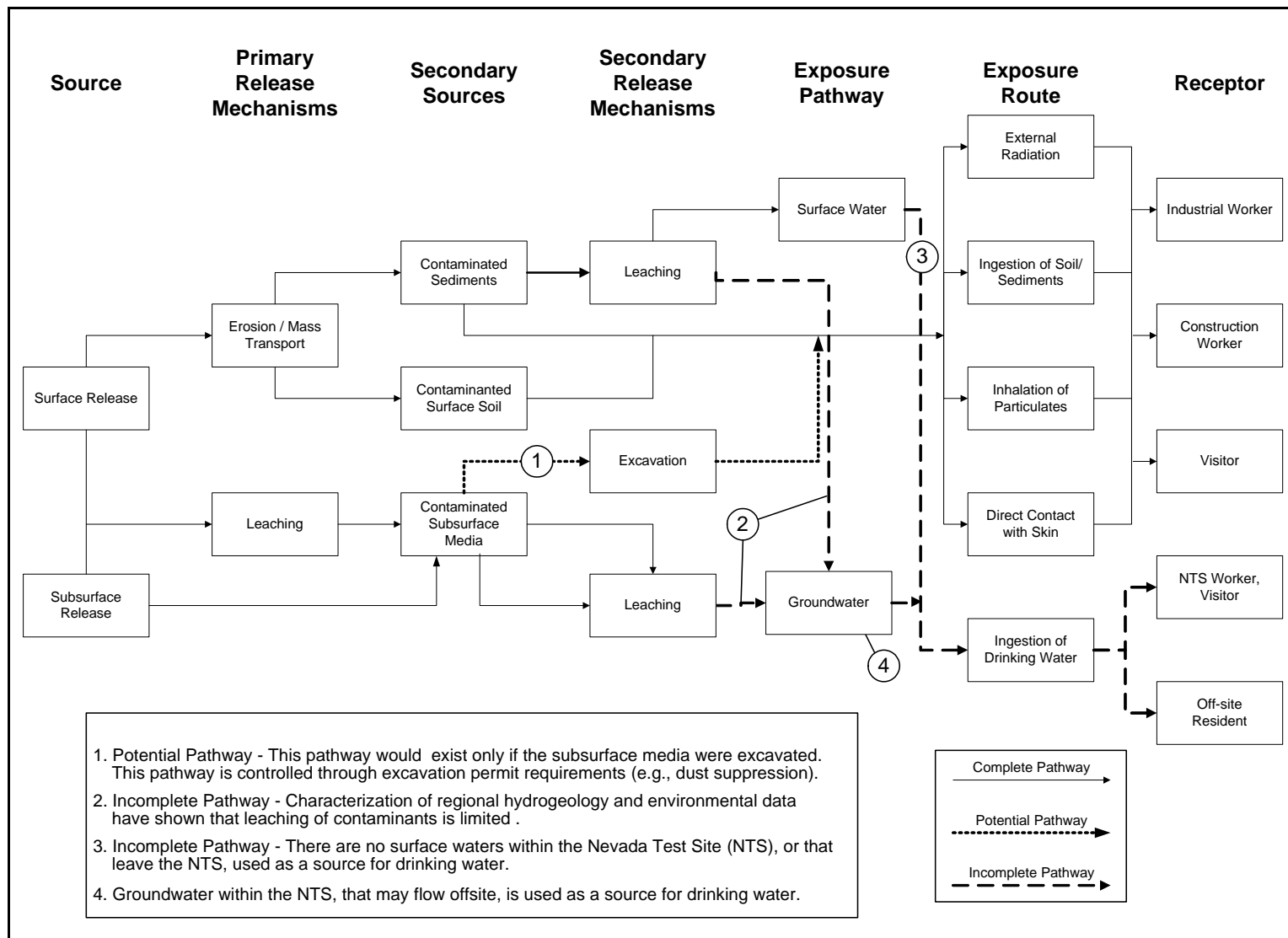


Figure 3-1
Conceptual Site Model Diagram

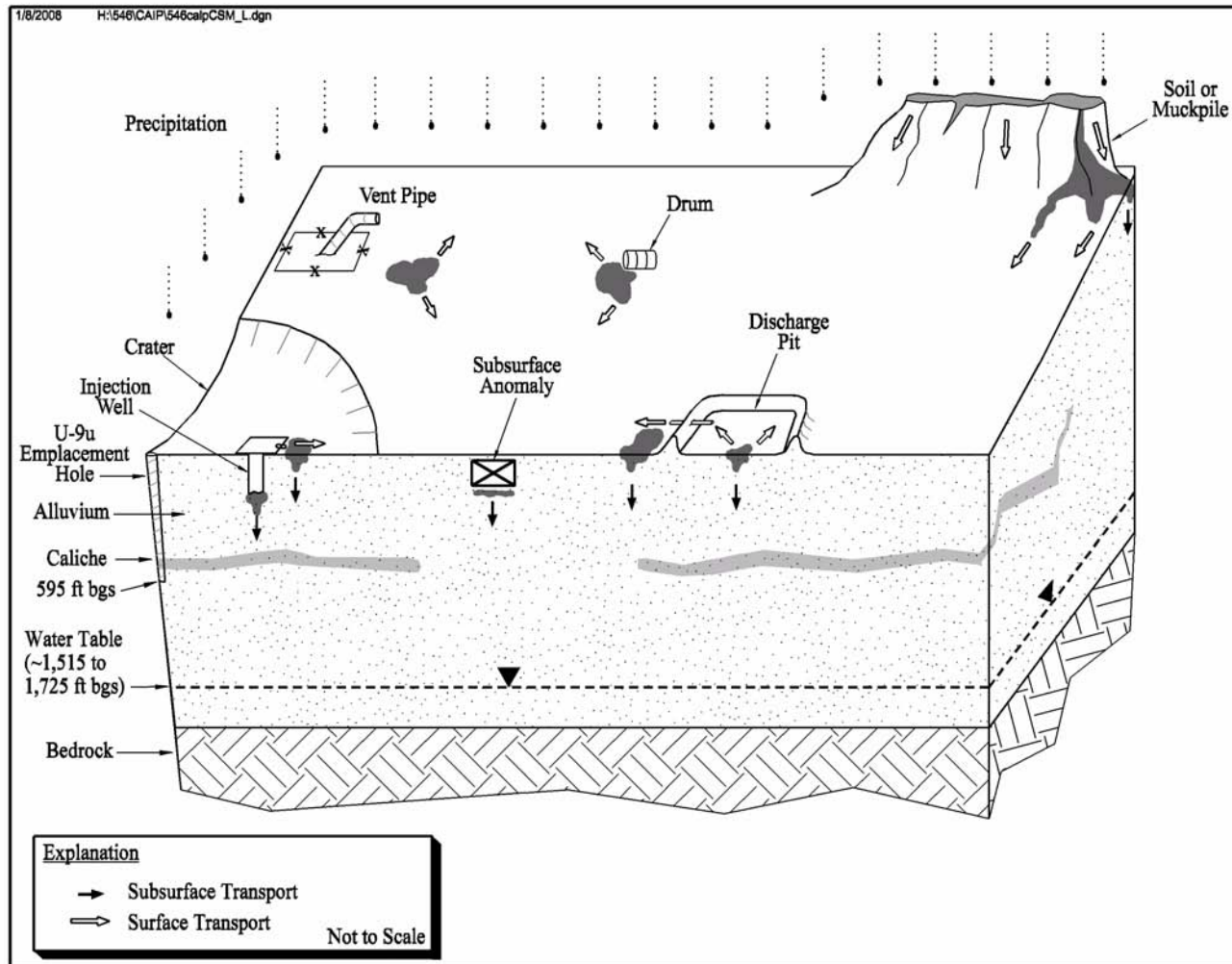


Figure 3-2
Conceptual Site Model for CAU 546

3.1.1 Land-Use and Exposure Scenarios

Corrective Action Sites 06-23-02 and 09-20-01 are located in the land-use zone described as the “Nuclear Test Zone.” This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

All land-use zones where the CAU 546 CASs are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

The exposure scenario for both CAU 546 CASs (based on current and projected future land uses) is the Occasional Use Area. This exposure scenario assumes exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site for intermittent or short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 8 hours per day, 10 days per year, for 5 years.

3.1.2 Contaminant Sources

The potential contamination sources for CAU 546 CSM are:

- Muck/soil piles at CAS 06-23-02.
- Radiological releases to the soil from the vent line or possibly from post-test pipe assemblies at CAS 06-23-02.
- Effluent released to the surface soil in and possibly outside of the discharge pit from piping at CAS 06-23-02.
- The subsurface anomaly at CAS 06-23-02.
- Spills and leaks to the surface soil in the testing area at CAS 06-23-02 and near the injection well and drum at CAS 09-20-01.
- Liquid decontamination waste and solid disposed material released to the subsurface soil from the injection well at CAS 09-20-01.

3.1.3 Release Mechanisms

Release mechanisms for the CSM are from spills or leaks onto surface soils from testing activities, effluent discharge, disposal of waste; or processes such as dumping muck and potentially contaminated soil onto the surface, burial of potentially contaminated items such as the subsurface anomaly, or accidental releases from testing in the area. The injection well is a release mechanism to subsurface soil from the liquid decontamination waste or solid disposed material.

3.1.4 Migration Pathways

Migration pathways include the lateral migration of potential contaminants away from the release point and vertical migration of potential contaminants into subsurface soils.

Migration is influenced by physical and chemical characteristics of the contaminants and media. Contaminant characteristics include, but are not limited to: solubility, density, and adsorption potential. Media characteristics include permeability, porosity, water saturation, sorting, chemical composition, and organic content. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with high solubility, low affinity for media, and low density can be expected to be found further from release points. These factors affect the migration pathways and potential exposure points for the contaminants in the various media under consideration.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (potential evapotranspiration at the Area 3 Radiological Waste Management Site has been estimated at 62.6 in./yr [Shott et al., 1997]) and limited precipitation for this region (average of 6.67 in./yr [NOAA, 2007]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at the CASs are expected to be predominately vertical although spills or leaks at the ground surface may also have limited lateral migration before infiltration. The depth of infiltration (shape of the subsurface contaminant plume) will be dependent upon the type, volume, and duration of the discharge as well as the presence of relatively impermeable layers that could

modify vertical or horizontal transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils.

Contaminants released to a wash, or a diversion ditch in the case of CAS 06-23-02, are subject to much higher transport mechanisms than contaminants released to other surface areas. Washes, such as those in the Yucca Flat area, are generally dry but are subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identifiable by hydrologists as sedimentation areas.

3.1.5 Exposure Points

Exposure points for the CSM are expected to be areas of surface contamination where visitors and site workers will come in contact with soil surface. Subsurface exposure points may also exist if construction workers come in contact with contaminated media during excavation activities.

3.1.6 Exposure Routes

Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of, or direct contact with, contaminated media. Site workers may also be exposed to radiological contamination by performing activities in proximity to radiologically contaminated materials.

3.1.7 Additional Information

Information concerning topography, geology, climatic conditions, hydrogeology, floodplains, and infrastructure at the CAU 546 CASs is available and presented in [Section 2.1](#) as it pertains to the investigation. This information has been addressed in the CSM and will be considered during the evaluation of corrective action alternatives, as applicable. Climatic and site conditions (e.g., surface and subsurface soil descriptions), and specific structure descriptions, will be recorded during the CAI.

3.2 Contaminants of Potential Concern

The COPCs for CAU 546 are defined as the list of constituents represented by the analytical methods identified in [Table 3-1](#) for Decision I environmental samples taken at each of the CASs. The constituents reported for each analytical method are listed in [Table 3-2](#).

The list of COPCs is intended to encompass all of the contaminants that could potentially be present at each CAS. These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Contaminants detected at other similar NTS sites were also included in the COPC list to reduce the uncertainty about potential contamination at the CASs. This is because complete information regarding activities performed at the CAU 546 sites is not available.

During the review of site history documentation, process knowledge information, personal interviews, and inferred activities associated with the CASs, some of the COPCs were identified as targeted contaminants at specific CASs. Targeted contaminants are those COPCs for which evidence in the available site and process information suggests that they may be reasonably suspected to be present at a given CAS. The targeted contaminants are required to meet a more stringent completeness criteria than other COPCs thus providing greater protection against a decision error (see [Sections A.1.0 through A.7.0](#)). Targeted contaminants for each CAU 546 CAS are identified in [Table 3-3](#).

**Table 3-1
Analytical Program^a**

Analyses	CAS 06-23-02	CAS 09-20-01
Organic Contaminants of Potential Concern (COPCs)		
Total Petroleum Hydrocarbons-Diesel-Range Organics	X	X
Polychlorinated Biphenyls	X	X
Semivolatile Organic Compounds	X	X
Volatile Organic Compounds	X	X
Inorganic COPCs		
<i>Resource Conservation and Recovery Act Metals</i>	X	X
Radionuclide COPCs		
Gamma Spectroscopy ^b	X	X
Isotopic Uranium	X	X
Isotopic Plutonium	X	X
Strontium-90	X	X
Waste Characterization Analyses		
Gross Alpha	X	X
Gross Beta	X	X
Tritium	X	X

^aThe COPCs are the constituents reported from the analytical methods listed.

^bResults of gamma analysis will be used to determine whether further radioanalytical analysis is warranted.

X = Required analytical method

Table 3-2
Constituents Reported by Analytical Methods

VOCs		SVOCs		TPH	PCBs	Metals	Isotopic Radionuclides
1,1,1-Trichloroethane	Dichlorodifluoromethane	2,3,4,6-Tetrachlorophenol	Di-n-octyl Phthalate	TPH (Diesel-Range Organics and Gasoline-Range Organics)	Aroclor 1016	Arsenic	Gross Alpha/Beta
1,1,1,2-Tetrachloroethane	Ethyl methacrylate	2,4-Dimethylphenol	Fluoranthene		Aroclor 1221	Barium	Plutonium-239/240
1,1,2,2-Tetrachloroethane	Ethylbenzene	2,4-Dinitrotoluene	Fluorene		Aroclor 1232	Beryllium	Plutonium-238
1,1,2-Trichloroethane	Isobutyl alcohol	2,4,5-Trichlorophenol	Hexachlorobenzene		Aroclor 1242	Cadmium	Strontium-90
1,1-Dichloroethane	Isopropylbenzene	2,4,6-Trichlorophenol	Hexachlorobutadiene ^a		Aroclor 1248	Chromium	Uranium-234
1,1-Dichloroethene	m-Dichlorobenzene (1,3)	2-Chlorophenol	Hexachloroethane		Aroclor 1254	Lead	Uranium-235
cis-1,2-Dichloroethene	Methacrylonitrile	2-Methylnaphthalene	Indeno(1,2,3-cd)pyrene		Aroclor 1260	Mercury	Uranium-238
1,2-Dichloroethane	Methyl methacrylate	2-Methylphenol	Naphthalene ^b		Aroclor 1268	Selenium	Tritium
1,2-Dichloropropane	Methylene chloride	2-Nitrophenol	Nitrobenzene			Silver	Gamma-emitting Radionuclides
1,2,4-Trichlorobenzene	N-Butylbenzene	3-Methylphenol ^a	N-Nitroso-di-n-propylamine				
1,2,4-Trimethylbenzene	N-Propylbenzene	4-Chloroaniline	Pentachlorophenol				Actinium-228
1,2-Dibromo-3-chloropropane	o-Dichlorobenzene (1,2)	4-Methylphenol ^a	Phenanthrene				Americium-241
1,3,5-Trimethylbenzene	p-Dichlorobenzene (1,4)	4-Nitrophenol	Phenol				Cobalt-60
1,4-Dioxane	p-isopropyltoluene	Acenaphthene	Pyrene				Cesium-137
2-Butanone	sec-Butylbenzene	Acenaphthylene	Pyridine				Europium-152
2-Chlorotoluene	Styrene	Aniline					Europium-154
2-Hexanone	tert-Butylbenzene	Anthracene					Europium-155
4-Methyl-2-pentanone	Tetrachloroethene	Benzo(a)anthracene					Potassium-40
Acetone	Toluene	Benzo(a)pyrene					Niobium-94
Acetonitrile	Total Xylenes	Benzo(b)fluoranthene					Lead-212
Allyl chloride	Trichloroethene	Benzo(g,h,i)perylene					Lead-214
Benzene	Trichlorofluoromethane	Benzo(k)fluoranthene					Thorium-234
Bromodichloromethane	Vinyl acetate	Benzoic Acid					Thallium-208
Bromoform	Vinyl chloride	Benzyl Alcohol					Uranium-235
Bromomethane		Bis(2-ethylhexyl) phthalate					
Carbon disulfide		Butyl benzyl phthalate					
Carbon tetrachloride		Carbazole					
Chlorobenzene		Chrysene					
Chloroethane		Dibenzo(a,h)anthracene					
Chloroform		Dibenzofuran					
Chloromethane		Diethyl Phthalate					

^aMay be reported as 3,4-methylphenol

^bMay be reported with VOCs

PCB = Polychlorinated biphenyl

SVOC = Semivolatile organic compound

TPH = Total petroleum hydrocarbons

VOC = Volatile organic compound

**Table 3-3
 Targeted Analytes for CAU 546**

CAS	Chemical Targeted Analyte(s)	Radiological Targeted Analyte(s)
06-23-02	None Identified	Plutonium-238, Plutonium-239/240, Uranium-235, Uranium-238
09-20-01	None Identified	None Identified

Plutonium and uranium are targeted analytes at CAS 06-23-02. The Russet test was conducted using a plutonium device and, because there was an accidental release and muck was brought to the surface, plutonium may be present onsite. Uranium has been identified as being released during a special packaging operation that took place several years after the test and, therefore, is a targeted analyte. No targeted analytes have been identified for CAS 09-20-01 due to a lack of previous investigation results and historical reports containing specific potential contaminant information.

3.3 Preliminary Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation, therefore streamlining the consideration of remedial alternatives. The risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006a). This process conforms with *Nevada Administrative Code* (NAC) Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006c). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006d) requires the use of American Society for Testing and Materials (ASTM) Method E 1739-95 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary.”

This RBCA process, summarized in [Figure 3-3](#), defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels or the FALs may be calculated using a Tier 2 evaluation.
- Tier 2 evaluation – Conducted by calculating Tier 2 site-specific target levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total petroleum hydrocarbons (TPH) concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.
- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

This process includes a provision for conducting an interim remedial action if necessary and appropriate. The decision to conduct an interim action may be made at any time during the investigation and at any level (tier) of analysis. Concurrence from the decision-makers listed in [Section A.3.1](#) will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site following completion of any interim actions. Interim actions conducted will be reported in the investigation report.

The FALs (along with the basis for their selection) will be proposed in the investigation report, where they will be compared to laboratory results in the evaluation of potential corrective actions.

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Region 9 Risk-Based Preliminary Remediation Goals (PRGs)* for contaminant constituents in industrial soils (EPA, 2004a). Background concentrations for RCRA metals will be used instead of PRGs when natural background concentrations exceed the PRG, which is often the case with arsenic on the NTS. Background is considered the mean plus two standard deviations for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training

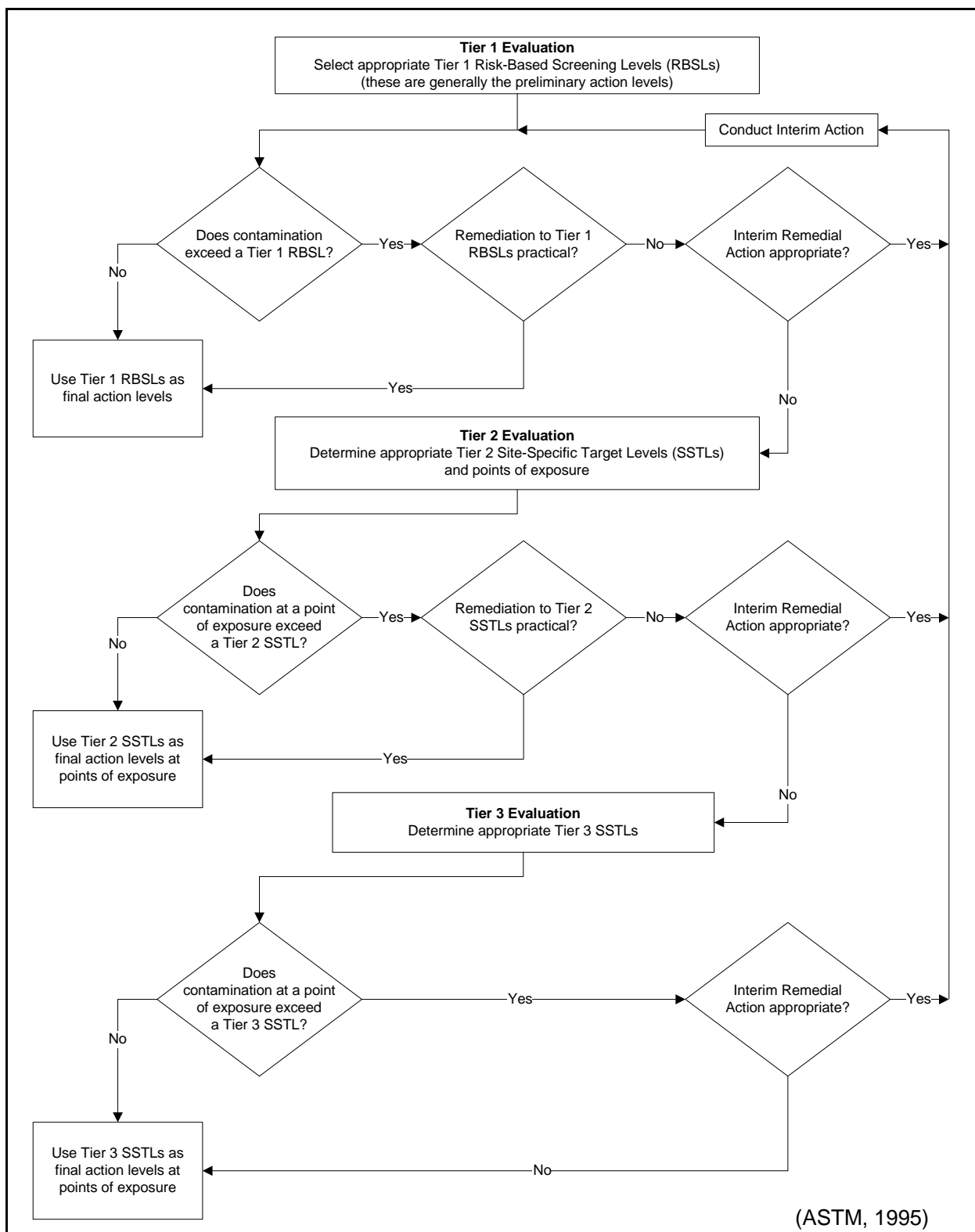


Figure 3-3
Risk-Based Corrective Action Decision Process

Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

3.3.2 Total Petroleum Hydrocarbon PALs

The PAL for TPH is 100 parts per million (ppm) as listed in NAC 445A.2272 (NAC, 2006e).

3.3.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the National Council on Radiation Protection and Measurement (NCRP) Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) using a 25 millirem per year (mrem/yr) dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land-use scenarios as presented in [Section 3.1.1](#).

Solid media such as concrete and/or structures may pose a potential radiological exposure risk to site workers if contaminated. The radiological PAL for solid media will be defined as the unrestricted-release criteria defined in the *NV/YMP Radiological Control (RadCon) Manual*: Article 422, Table 4-2 (NNSA/NSO, 2004).

3.4 Data Quality Objective Process Discussion

This section contains a summary of the DQO process that is presented in [Appendix A](#). The DQO process is a strategic planning approach based on the scientific method that is designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommendation of corrective actions (i.e., No Further Action, Clean Closure, or Close in Place).

The DQO strategy for CAU 546 was developed at a meeting on November 8, 2007. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and to

design a data collection program that will satisfy these purposes. During the DQO discussions, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 546 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 546.” To address this question, the resolution of two decision statements is required:

- Decision I: “Is any COC present in environmental media within the CAS?” If a COC is detected, then Decision II must be resolved. Otherwise, the investigation for that CAS is complete.
- Decision II: “If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?” Sufficient information is defined to include:
 - Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
 - The information needed to determine potential remediation waste types.
 - The information needed to evaluate the feasibility of remediation alternatives (bioassessment if natural attenuation or biodegradation is considered and geotechnical data if construction or evaluation of barriers is considered).

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes (if released) that are present at a site to impose COCs into site environmental media. To evaluate the potential for a future release from source material introducing a COC to the surrounding environmental media, the following conservative assumptions were made:

- That the vent line or possibly piping assemblies would fail at some point and contaminants would be released to the surrounding media.
- That muck or potentially contaminated soil in the pile will release contaminants to the surrounding media.
- That the resulting concentration of contaminants in the surrounding media would be greater than applicable action levels.

Decision I samples will be submitted to analytical laboratories for the analyses listed in [Table 3-1](#). Decision II samples will be submitted for the analysis of all unbounded COCs. In addition, samples will be submitted for analyses as needed to support waste management or health and safety decisions.

The data quality indicators (DQIs) of precision, accuracy, representativeness, completeness, comparability, and sensitivity needed to satisfy DQO requirements are discussed in [Section 6.2](#). Laboratory data will be assessed in the investigation report to confirm or refute the CSM and determine whether the DQO data needs were met.

To satisfy the DQI of sensitivity (presented in [Section 6.2.8](#)), the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. Analytical methods and target minimum detectable concentrations (MDCs) for each CAU 546 COPC are provided in [Tables 3-4](#) and [3-5](#). The MDC is the lowest concentration of a chemical or radionuclide parameter that can be detected in a sample within an acceptable level of error. Due to changes in analytical methodology and analytical laboratory contracts, information in [Tables 3-4](#) and [3-5](#) that varies from corresponding QAPP information will supersede the QAPP (NNSA/NV, 2002).

Table 3-4
Analytical Requirements for Radionuclides for CAU 546

Analysis ^a	Matrix	Analytical Method	Minimum Detectable Concentration (MDC) ^b	Laboratory Precision	Laboratory Accuracy (%R)
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1 ^c	< Preliminary Action Levels	RPD 35% ^f	Laboratory Control Sample 80-120%R
	Nonaqueous	HASL-300 ^d		ND ^g -2<ND ^g <2	
Other Radionuclides					
Tritium	Aqueous	EPA 906.0 ^c	< Preliminary Action Levels	RPD 35% ^f ND ^g -2<ND ^g <2	Laboratory Control Sample 80-120%R
	Nonaqueous	Approved Laboratory Procedure ^e			Chemical Yield 30-105%R (not applicable for tritium and gross-alpha/beta)
Gross Alpha	All	EPA 900.0 ^c			Matrix Spike Sample 61-140%R (tritium and gross alpha/beta only)
Gross Beta	All	EPA 900.0 ^c			
Plutonium-238	All	HASL-300 ^d			
Plutonium-239/240	All	HASL-300 ^d			
Strontium-90	All	HASL-300 ^d			
Uranium-234	All	HASL-300 ^d			
Uranium-235	All	HASL-300 ^d			
Uranium-238	All	HASL-300 ^d			

^aApplicable constituents are listed in [Table 3-2](#).

^bThe MDC is the lowest concentration of a radionuclide present in a sample and can be detected with a 95% confidence level.

^c*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980)

^d*The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997b)

^eLaboratory procedure must be approved by appropriate project personnel.

^f*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)

^gND is not RPD; rather, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (DOE, 1997a)

EPA = U.S. Environmental Protection Agency

HASL = Health and Safety Laboratory

ND = Normalized difference

RPD = Relative percent difference

%R = Percent recovery

< = Less than

Table 3-5
Analytical Requirements for Chemical COPCs for CAU 546

Analysis ^a	Matrix	Analytical Method (SW-846) ^b	Minimum Detectable Concentration (MDC) ^c	Laboratory Precision	Laboratory Accuracy (%R)
ORGANICS					
Total Volatile Organic Compounds	All	8260B	< Preliminary Action Levels	Lab-specific ^d	Lab-specific ^d
TCLP Volatile Organic Compounds	Leachate	1311/8260B	≤ Regulatory Limits	Lab-specific ^d	Lab-specific ^d
Total Semivolatile Organic Compounds	All	8270C	< Preliminary Action Levels	Lab-specific ^d	Lab-specific ^d
TCLP Semivolatile Organic Compounds	Leachate	1311/8270C	≤ Regulatory Limits	Lab-specific ^d	Lab-specific ^d
Polychlorinated Biphenyls	All	8082	< Preliminary Action Levels	Lab-specific ^d	Lab-specific ^d
Total Petroleum Hydrocarbons-Diesel-Range Organics	All	8015B (modified)		Lab-specific ^d	Lab-specific ^d
INORGANICS					
Metals	All	6010B	< Preliminary Action Levels	RPD 35% (nonaqueous) ^e 20% (aqueous) ^e	Matrix Spike Sample 75-125%R ^b
TCLP Metals	Leachate	1311/6010B	≤ Regulatory Limits	Absolute Difference ^f ±2x RL (nonaqueous) ^f ±1x RL (aqueous) ^f	Laboratory Control Sample 80-120%R ^f

^aApplicable constituents are listed in [Table 3-2](#).

^b*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) (EPA, 1996)

^cThe MDC is the lowest concentration that can be reliably achieved within specified limits of accuracy and precision.

^dRPD and %R performance criteria are developed by the analytical laboratory according to approved procedures.

^e*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)

^f*USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004b)

RL = Reporting limit

RPD = Relative percent difference

TCLP = Toxicity Characteristic Leaching Procedure

%R = Percent recovery

< = Less than

≤ = Less than or equal to

± = Plus or minus

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 546 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for each CAU 546 CAS by collecting and analyzing samples generated during a field investigation. The presence and nature of contamination at CASs 06-23-02 and 09-20-01 will be evaluated using a judgmental approach. Although the judgmental approach will be used, random sample locations may be selected in the absence of biasing factors within a potential source of contamination (e.g., muckpile, soil pile).

The following activity is not included in the scope of the field sampling activities for CAU 546:

- It is assumed that COCs associated with wastes that were placed into the injection well are present in subsurface soil at CAS 09-20-01. A corrective action of Close In Place with a use restriction will be implemented for this subsurface contamination (see [Section 1.1](#)).

If there is a waste present that has the potential to release significant contamination into site environmental media, that waste will be sampled. If it is determined that a COC is present at any CAS, that CAS will be further addressed by determining the extent of contamination before evaluating corrective action alternatives.

Because this CAIP only addresses contamination originating from the CAU, it may be necessary to distinguish overlapping contamination originating from other sources. For example, widespread surface radiological contamination originating from atmospheric tests will not be addressed in the CAU 546 investigation. To determine whether contamination is from the CAU or from other sources, soil samples may be collected from locations outside the influence of releases from the CAS, if necessary.

Modifications to the investigative strategy may be required should unexpected field conditions be encountered at any CAS. Significant modifications shall be justified and documented before implementation. If an unexpected condition indicates that conditions are significantly different than

the corresponding CSM, the activity will be rescoped and the identified decision-makers will be notified.

4.2 Field Activities

Field activities at CAU 546 include site preparation, sample location selection, and sample collection activities.

4.2.1 Site Preparation Activities

Site preparation activities conducted before the investigation may include, but not be limited to: relocation or removal of surface debris, construction of hazardous waste accumulation areas (HWAAs) and site exclusion zones, providing sanitary facilities, construction of decontamination facilities, and temporarily moving staged equipment. Before significant field activities take place, the U-6a Reentry Shaft will need to be securely covered or a durable fence re-installed to prevent human or animal intrusion. Additionally, it is anticipated that site preparation activities will also include assessing the interior of the vent line and possibly the associated piping assemblies.

Before mobilization for collecting investigation samples, the following preparatory activities will also be performed:

- Radiological surveys of the remainder of the testing area at CAS 06-23-02.
- Visual surveys at both CASs within CAU 546 to identify any staining, discoloration, disturbance of native soils, or other indication of potential contamination.

4.2.2 Sample Location Selection

At CASs 06-23-02 and 09-20-01, biasing factors (including field-screening results) will be used to select the most appropriate samples from a particular location for submittal to the analytical laboratory. Biasing factors to be used for selection of sampling locations are listed in [Section A.5.2.1](#). In the absence of biasing factors in areas of potential contamination, random sample locations will be selected. As biasing factors are identified or random sample locations are selected, they will be documented in the appropriate field documents.

The CAS-specific sampling strategy and the estimated locations of biased samples for each CAS are presented in [Appendix A](#). The number, location, and spacing of step-outs may be modified by the Task Manager or Site Supervisor, as warranted by site conditions, to achieve DQO criteria stipulated in [Appendix A](#). Where sampling locations are modified by the Task Manager or Site Supervisor, the justification for these modifications will be documented in the field activity daily log.

4.2.3 Sample Collection

The CAU 546 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in this section.
- Collect required QC samples.
- Collect waste management samples.
- Collect soil samples from locations outside the influence of releases from the CAS, if necessary.
- Perform radiological characterization surveys of construction materials and debris as necessary for disposal purposes.
- Record Global Positioning System (GPS) coordinates for each environmental sample location.

Decision I surface soil samples (0 to 0.5 ft bgs) and shallow subsurface soil samples will be collected. If biasing factors are present in soils below locations where Decision I samples were collected, subsurface Decision I soil samples will also be collected by hand augering, backhoe excavation, direct-push, or drilling techniques, as appropriate. Decision I subsurface soil samples will be collected at depth intervals selected by the Task Manager or Site Supervisor, based on biasing factors, to a depth where the biasing factors are no longer present.

Decision II sampling will consist of further defining the extent of contamination where COCs have been confirmed. Step-out (Decision II) sampling locations at each CAS will be selected based on the CSM, biasing factors, field-screening results, existing data, and the outer boundary sample locations where COCs were detected. In general, step-out sample locations will be arranged in a triangular pattern around areas containing a COC at distances based on site conditions, COC concentrations,

process knowledge, and biasing factors. If COCs extend beyond step-out locations, additional Decision II samples will be collected from locations further from the source. If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be re-evaluated, then work will be temporarily suspended, NDEP notified, and the investigation strategy re-evaluated. A minimum of one analytical result less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination. The lateral and vertical extent of COCs will only be established based on validated laboratory analytical results (i.e., not field screening).

4.2.4 Sample Management

The laboratory requirements (i.e., detection limits, precision, and accuracy) to be used when analyzing the COPCs are presented in [Tables 3-4](#) and [3-5](#). The analytical program for each CAS is presented in [Table 3-1](#). All sampling activities and QC requirements for field and laboratory environmental sampling will be conducted in compliance with the QAPP (NNSA/NV, 2002) and other applicable, approved procedures.

4.3 Safety

A site-specific health and safety document will be prepared and approved before initiating the field effort. As required by the DOE Integrated Safety Management System (ISMS) (DOE/NV, 1997), this document outlines the requirements for protecting the health and safety of the workers and the public. The ISMS program requires that site personnel will reduce or eliminate the possibility of injury, illness, or accidents, and to protect the environment during all project activities. The following safety issues will be taken into consideration when evaluating the hazards and associated control procedures for field activities:

- Potential hazards to site personnel and the public include, but are not limited to: radionuclides, chemicals (e.g., heavy metals, volatile organic compounds [VOCs], semivolatile organic compounds, and petroleum hydrocarbons), adverse and rapidly changing weather, remote location, and motor vehicle and heavy equipment operations.
- 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 use of appropriate personal protective equipment (PPE).

- Occupational exposure monitoring to prevent overexposure to hazards such as radionuclides, chemicals, and physical agents (e.g., heat, cold, and high wind).
- Radiological surveying for alpha/beta and gamma emitters to minimize and/or control personnel exposures; use of the “as-low-as-reasonably-achievable” principle when addressing radiological hazards.
- Emergency and contingency planning to include medical care and evacuation, decontamination, spill control measures, and appropriate notification of project management. The same principles apply to emergency communications.
- If presumed asbestos-containing material is identified (CFR, 2006c; NAC, 2006a), inspection and/or samples collection will be performed by trained personnel.

4.4 Site Restoration

Upon completion of CAI and waste management activities, the following actions will be implemented before closure of the site Real Estate/Operations Permit:

- Removal of equipment, wastes, and materials associated with the CAI.
- Removal of signage and fencing (unless part of a corrective action) installed to complete the CAI.
- Grading of site to pre-investigation condition (unless changed condition is necessary under a corrective action).
- Inspection of site to certify that site restoration activities have been completed.

5.0 Waste Management

Management of IDW will be based on regulatory requirements, field observations, process knowledge, and laboratory results from CAU 546 investigation samples.

Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or debris (e.g., construction materials). Therefore, sampling and analysis of IDW, separate from analyses of site investigation samples, may not be necessary for all IDW. However, if associated investigation samples are found to contain contaminants above regulatory levels, conservative estimates of total waste contaminant concentrations may be made based on the mass of the waste, the amount of contaminated media contained in the waste, and the maximum concentration of contamination found in the media. Direct samples of IDW may also be taken to support waste characterization.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with applicable DOE orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP.

5.1 Waste Minimization

Investigation activities are planned to minimize IDW generation. This will be accomplished by incorporating the use of process knowledge, visual examination, and/or radiological survey and swipe results. When possible, disturbed media (such as soil removed during trenching) or debris will be returned to its original location. Contained media (e.g., soil managed as waste) as well as other IDW will be segregated to the greatest extent possible to minimize generation of hazardous, radioactive, or mixed waste. Hazardous material used at the sites will be controlled in order to limit unnecessary generation of hazardous or mixed waste. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during investigations.

5.2 Potential Waste Streams

Waste generated during the investigation activities will include the following potential waste streams:

- Personal protective equipment and disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, bowls)
- Decontamination rinsate
- Environmental media (e.g., soil)
- Hazardous surface debris or debris in the investigation area to be removed as a best management practice (e.g., drum at CAS 09-20-01)

5.3 Investigation-Derived Waste Management

The onsite management and ultimate disposition of IDW will be determined based on the waste type (e.g., sanitary, low-level, hazardous, hydrocarbon, mixed), or the combination of waste types. A determination of the waste type will be guided by several factors, including, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, and/or radiological survey/swipe results.

Table 4-2 of the RadCon Manual (NNSA/NSO, 2004) shall be used to determine whether such materials may be declared nonradioactive. Onsite IDW management requirements by waste type are detailed in the following sections. Applicable waste management regulations and requirements are listed in [Table 5-1](#).

**Table 5-1
Waste Management Regulations and Requirements**

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	N/A	NRS ^a 444.440 - 444.620 NAC ^b 444.570 - 444.7499 NTS Landfill Permit SW13.097.04 ^c NTS Landfill Permit SW13.097.03 ^d
Liquid/Rinsate (nonhazardous)	N/A	Water Pollution Control General Permit GNEV93001, Rev. 3iii ^e
Hazardous	RCRA ^f , 40 CFR 260-282	NRS ^a 459.400 - 459.600 NAC ^b 444.850 - 444.8746 POC ^g
Low-Level Radioactive	N/A	DOE Orders and NTSWAC ^h
Mixed	RCRA ^f , 40 CFR 260-282	NTSWAC ^h POC ^g
Hydrocarbon	N/A	NTS Landfill Permit SW13.097.02 ⁱ NAC ^b 445A.2272
Polychlorinated Biphenyls	TSCA ^j , 40 CFR 761	NRS ^a 459.400 - 459.600 NAC ^b 444.940 - 444.9555
Asbestos	TSCA ^j , 40 CFR 763	NRS ^a 618.750 - 618.840 NAC ^b 444.965 - 444.976

^aNevada Revised Statutes (NRS, 2003a, b, c)

^bNevada Administrative Code (NAC, 2006a and e)

^cArea 23 Class II Solid Waste Disposal Site (NDEP, 1997a)

^dArea 9 Class III Solid Waste Disposal Site (NDEP, 1997c)

^eNevada Test Site Sewage Lagoons (NDEP, 1999)

^fResource Conservation and Recovery Act (CFR, 2006a)

^gNevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste (BN, 1995)

^hNevada Test Site Waste Acceptance Criteria, Rev. 6-02 (NNSA/NSO, 2006b)

ⁱArea 6 Class III Solid Waste Disposal Site for hydrocarbon waste (NDEP, 1997b)

^jToxic Substance Control Act (CFR, 2006b and c)

DOE = U.S. Department of Energy

N/A = Not applicable

NAC = Nevada Administrative Code

NRS = Nevada Revised Statutes

NTS = Nevada Test Site

NTSWAC = Nevada Test Site Waste Acceptance Criteria

POC = Performance Objective for the Certification of
Nonradioactive Hazardous Waste

RCRA = Resource Conservation and Recovery Act

TSCA = Toxic Substance Control Act

5.3.1 Sanitary Waste

Sanitary IDW generated at each CAS will be collected, managed, and disposed of in accordance with the sanitary waste management regulations and the permits for operation of the NTS 10c Industrial Waste Landfill.

Sanitary IDW generated at each CAS will only be collected in plastic bags, sealed, labeled with the CAS number from each site in which it was generated, and dated. The waste will then be placed in a roll-off box located in Mercury, or other approved roll-off box location. The number of bags of sanitary IDW will be counted as they are placed in the roll-off box, noted in a log, and documented in the Field Activity Daily Log. These logs will provide necessary tracking information for ultimate disposal in the 10c Industrial Waste Landfill.

5.3.2 Low-Level Radioactive Waste

Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting a radiologically controlled area (RCA). This allows for the immediate segregation of radioactive waste from waste that may be unrestricted regarding radiological release. Removable contamination limits, as defined in Table 4-2 of the RadCon Manual (NNSA/NSO, 2004), will be used to determine whether such waste may be declared unrestricted regarding radiological release versus radioactive waste. Direct sampling of the waste may be conducted to aid in determining whether a particular waste unit (e.g., drum of soil) contains low-level radioactive waste, as necessary. Waste determined to be below the values of Table 4-2, either by direct radiological survey/swipe results or process knowledge, will not be managed as potential radioactive waste but managed in accordance with the appropriate section of this document. Wastes in excess of Table 4-2 values will be managed as potential radioactive waste and in accordance with this section.

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE orders, and the requirements of the current version of the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (NNSA/NSO, 2006b). Potential radioactive waste drums containing soil, PPE, disposable sampling equipment, and/or rinsate may be staged at a designated radioactive material area (RMA) or RCA when full, or at the end of an investigation phase. The waste drums will remain at the RMA pending certification and disposal under NTSWAC requirements (NNSA/NSO, 2006b).

5.3.3 Hazardous Waste

Waste accumulation areas at CAU 546 will be established according to project needs. Satellite accumulation areas and HWAAs will be managed according to requirements of federal and state regulations (CFR, 2006a; NAC, 2006b). The HWAAs will be properly controlled for access, and equipped with spill kits and appropriate spill containment. Suspected hazardous wastes will be placed in DOT-compliant containers. All containerized hazardous waste will be handled, inspected, and managed in accordance with Title 40 CFR 265 Subpart I (CFR, 2006a). These provisions include managing the waste in containers compatible with the waste type, and segregating incompatible waste types so that in the event of a spill, leak, or release, incompatible wastes shall not contact one another. The HWAAs will be covered under a site-specific emergency response and contingency action plan until such time that the waste is determined nonhazardous or all containers of hazardous waste have been removed from the storage area. Hazardous waste will be characterized in accordance with the requirement of Title 40 CFR 261 (CFR, 2006a). No RCRA-“listed” waste has been identified at CAU 546. Hazardous waste will be managed and transported in accordance with RCRA and DOT requirements to a permitted treatment, storage, and disposal facility (CFR, 2006a).

5.3.4 Hydrocarbon Waste

Hydrocarbon soil waste containing more than 100 milligrams per kilogram (mg/kg) of TPH will be managed on site in a drum or other appropriate container until fully characterized. Hydrocarbon waste may be disposed of at a designated hydrocarbon landfill (NDEP, 1997b), an appropriate hydrocarbon waste management facility (e.g., recycling facility), or other method in accordance with Nevada regulations.

5.3.5 Mixed Low-Level Waste

Mixed waste, if generated, shall be managed and dispositioned according to RCRA requirements (CFR, 2006a) or subject to agreements between NNSA/NSO and the State of Nevada, as well as DOE requirements for radioactive waste. The waste will be marked with the words “Hazardous Waste Pending Analysis and Radioactive Waste Pending Analysis.” Waste characterized as mixed will not be stored for a period of time that exceeds RCRA requirements unless subject to agreements between NNSA/NSO and the State of Nevada. The mixed waste shall be transported via an approved

hazardous waste/radioactive waste transporter to the NTS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituent concentrations below Land Disposal Restrictions may be disposed of at the NTS Area 5 Radioactive Waste Management Site if the waste meets the requirements of the NTSWAC (NNSA/NSO, 2006b), the NTS *Hazardous Waste Management Facility Draft Permit* (NEV HW0009 [NDEP, 2000]), and the *RCRA Part B Permit Application for Waste Management Activities at the Nevada Test Site* (DOE/NV, 1999). Mixed waste constituent concentrations exceeding Land Disposal Restrictions will require treatment and disposal plan development under the requirements of the Mutual Consent Agreement between DOE and the State of Nevada (NDEP, 1995).

5.3.6 Polychlorinated Biphenyls

The management of polychlorinated biphenyls (PCBs), if present at concentrations greater than 50 mg/kg, is governed by the *Toxic Substances Control Act* (USC, 1976) and its implementing regulations at 40 CFR 761 (CFR, 2006b). Polychlorinated biphenyl contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA “characteristic” waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). The IDW will initially be evaluated using analytical results for media samples from the investigation. If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2006b) as well as State of Nevada requirements (NAC, 2006a), guidance, and agreements with NNSA/NSO.

5.4 Management of Specific Waste Streams

5.4.1 Personal Protective Equipment

Personal protective equipment and disposable sampling equipment will be inspected visually for stains, discoloration, and gross contamination as the waste is generated; and evaluated for radiological contamination. Staining and/or discoloration will be assumed to be the result of contact with potentially contaminated media such as soil, sludge, or liquid. Gross contamination is the visible contamination of an item (e.g., clumps of soil/sludge on a sampling spoon or free liquid smeared on a glove). While gross contamination can often be removed through decontamination methods, removal

of gross contamination from small items, such as gloves or booties is not typically conducted. If IDW meets this description, it will be segregated and managed as potentially “characteristic” hazardous waste. This segregated population of waste will either: (1) be assigned the characterization of the soil/sludge that was sampled, (2) be sampled directly, or (3) undergo further evaluation using the soil/sludge sample results to determine how much soil/sludge would need to be present in the waste to exceed regulatory levels. Waste that is determined hazardous will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements, or subject to agreements between NNSA/NSO and the State of Nevada. The PPE and equipment that is not visibly stained, discolored, or grossly contaminated and that is within the radiological free-release criteria will be managed as nonhazardous sanitary waste.

5.4.2 *Management of Decontamination Rinsate*

Rinsate at CAU 546 will not be considered hazardous waste unless there is evidence that the rinsate may display a RCRA characteristic. Evidence may include the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. Decontamination rinsate that is potentially hazardous (using associated sample results and/or process knowledge) will be managed as characteristic hazardous waste (CFR, 2006a). The regulatory status of the potentially hazardous rinsate will be determined through the application of associated sample results or direct sampling. If the associated samples do not indicate the presence of hazardous constituents, then the rinsate will be considered nonhazardous.

The disposal of nonhazardous rinsate will be consistent with guidance established in current NNSA/NSO Fluid Management Plans for the NTS as follows:

- Rinsate that is determined to be nonhazardous and contaminated to less than 5x Safe Drinking Water Standards (SDWS) is not restricted as to disposal. Nonhazardous rinsate that is contaminated at 5x to 10x SDWS will be disposed of in an established infiltration basin or solidified and disposed of as sanitary waste or low-level waste.
- Nonhazardous rinsate that is contaminated at greater than 10x SDWS will be disposed of in a lined basin or solidified and disposed of as sanitary waste or low-level waste.

5.4.3 *Management of Soil*

This waste stream consists of soil removed for disposal during soil sampling, excavation, and/or drilling. This waste stream will be characterized based on laboratory analytical results from representative locations. If the soil is determined to potentially contain COCs, the material will be managed either onsite or containerized for transportation to an appropriate disposal site.

Onsite management of the soil waste will be allowed only if it is managed within an area of concern, and it is appropriate to defer the management of the waste until the final site remediation. If this option is chosen, the waste soil shall be protected from run-on and run-off using appropriate protective measures based on the type of contaminant(s) (e.g., covered with plastic and bermed).

Management of soil waste for disposal consists of placing the waste in containers, labeling the containers, temporarily storing the containers until shipped, and shipping the waste to a disposal site. The containers, labels, management of stored waste, transport to the disposal site, and disposal shall be appropriate for the type of waste (e.g., hazardous, hydrocarbon, mixed).

Note that soils placed back into a borehole, or excavation in the same approximate location from which it originated, is not considered to be waste.

5.4.4 *Management of Debris*

Debris waste stream(s) can vary depending on site conditions. Debris that requires removal for the investigation activities (soil sampling, excavation, and/or drilling) must be characterized for proper management and disposition. Historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, radiological survey/swipe results and/or the analytical results of samples, either directly or indirectly associated with the waste, may be used to characterize the debris. Debris will be inspected visually for stains, discoloration, and gross contamination. Debris may be deemed reusable, recyclable, sanitary waste, hazardous waste, PCB waste, or low-level waste. Waste that is not sanitary will be entered into an approved waste management system where it will be managed and dispositioned according to federal and state requirements, and agreements between NNSA/NSO and the State of Nevada. The debris will be managed either onsite by berming and covering next to the excavation, by placement in a

container(s), or left on the footprint of the CAS; and its disposition deferred until implementation of corrective action at the site.

6.0 *Quality Assurance/Quality Control*

The overall characterization activities objective described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for each CAU 546 CAS. [Sections 6.1](#) and [6.2](#) discuss the collection of required QC samples in the field and QA requirements for laboratory/analytical data to achieve closure. Unless otherwise stated in this CAIP, or required by the results of the DQO process (see [Appendix A](#)), this investigation will adhere to the QAPP (NNSA/NV, 2002).

6.1 *Quality Control Sampling Activities*

Field QC samples will be collected in accordance with established procedures. Field QC samples are collected and analyzed to aid in determining the validity of environmental sample results. The number of required QC samples depends on the types and number of environmental samples collected. The minimum frequency of collecting and analyzing QC samples for this investigation, as determined in the DQO process, include:

- Trip blanks (1 per sample cooler containing VOC environmental samples)
- Equipment rinsate blanks (1 per sampling event for each type of decontamination procedure)
- Source blanks (1 per lot of uncharacterized source material that contacts sampled media)
- Field duplicates (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)
- Field blanks (may be 1 per 20 environmental samples, 1 per day, or 1 per CAS depending on site conditions and agreement of DQO participants)
- Laboratory QC samples (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

Additional QC samples may be submitted based on site conditions at the discretion of the Task Manager or Site Supervisor. Field QC samples shall be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the QAPP (NNSA/NV, 2002).

6.2 Laboratory/Analytical Quality Assurance

Criteria for the investigation, as stated in the DQOs ([Appendix A](#)) and where noted, require laboratory analytical quality data be used for making critical decisions. Rigorous QA/QC will be implemented for all laboratory samples including documentation, data verification and validation of analytical results, and an assessment of DQIs as they relate to laboratory analysis.

6.2.1 Data Validation

Data verification and validation will be performed in accordance with the QAPP (NNSA/NV, 2002), except where otherwise stipulated in this CAIP. All chemical and radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all samples were appropriately collected, analyzed, and the results passed data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether they meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

The DQIs are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. The DQIs are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance). The quality and usability of data used to make DQO decisions will be assessed based on the following DQIs:

- Precision
- Accuracy/bias
- Representativeness
- Comparability
- Completeness
- Sensitivity

[Table 6-1](#) provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The following

subsections discuss each of the DQIs that will be used to assess the quality of laboratory data. Due to changes in analytical methodology and changes in analytical laboratory contracts, criteria for precision and accuracy in [Tables 3-4](#) and [3-5](#) that varies from corresponding QAPP information will supersede the QAPP (NNSA/NV, 2002).

Table 6-1
Laboratory and Analytical Performance Criteria for
CAU 546 Data Quality Indicators
(Page 1 of 2)

Data Quality Indicator	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Precision	At least 80% of the sample results for each measured contaminant are not qualified for precision based on the criteria for each analytical method-specific and laboratory-specific criteria presented in Section 6.2.3 .	If the performance metric is not met, the affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Accuracy/Bias	At least 80% of the sample results for each measured contaminant are not qualified for accuracy based on the method-specific and laboratory-specific criteria presented in Section 6.2.4 .	If the performance metric is not met, the affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Sensitivity	Minimum detectable concentrations are less than or equal to respective FALs.	Cannot determine whether COCs are present or migrating at levels of concern.
Comparability	Sampling, handling, preparation, analysis, reporting, and data validation are performed using standard methods and procedures.	Inability to combine data with data obtained from other sources and/or inability to compare data to regulatory action levels.
Representativeness	Samples contain contaminants at concentrations present in the environmental media from which they were collected.	Analytical results will not represent true site conditions. Inability to make appropriate DQO decisions.
Completeness	80% of the CAS-specific COPCs have valid results. 100% of CAS-specific targeted contaminants have valid results.	Cannot support/defend decision on whether COCs are present.
Extent Completeness	100% of COCs used to define extent have valid results.	Extent of contamination cannot be accurately determined.

Table 6-1
Laboratory and Analytical Performance Criteria for
CAU 546 Data Quality Indicators
 (Page 2 of 2)

Data Quality Indicator	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Clean Closure Completeness	100% of targeted contaminants have valid results.	Cannot determine whether COCs remain in soil.

CAS = Corrective action site
 COC = Contaminant of concern
 COPC = Contaminant of potential concern

DQO = Data quality objective
 FAL = Final action level

6.2.3 Precision

Precision is a measure of the repeatability of the analysis process from sample collection through analysis results. It is used to assess the variability between two equal samples.

Determinations of precision will be made for field duplicate samples and laboratory duplicate samples. Field duplicate samples will be collected simultaneously with samples from the same source under similar conditions in separate containers. The duplicate sample will be treated independently of the original sample in order to assess field impacts and laboratory performance on precision through a comparison of results. Laboratory precision is evaluated as part of the required laboratory internal QC program to assess performance of analytical procedures. The laboratory sample duplicates are an aliquot (or subset) of a field sample generated in the laboratory. They are not a separate sample but a split, or portion, of an existing sample. Typically, laboratory duplicate QC samples may include matrix spike duplicate and laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

Precision is a quantitative measure used to assess overall analytical method and field-sampling performance as well as the need to “flag” (qualify) individual parameter results when corresponding QC sample results are not within established control limits.

The criteria used for the assessment of inorganic chemical precision when both results are greater than or equal to 5x reporting limit (RL) is 20 and 35 percent, respectively, for aqueous and soil

samples. When either result is less than 5x RL, a control limit of ± 1 x RL and ± 2 x RL for aqueous and soil samples, respectively, is applied to the absolute difference.

The criteria used for the assessment of organic chemical precision is based on professional judgment using laboratory derived control limits.

The criteria used for the assessment of radiological precision is 20 and 35 percent, respectively, for aqueous and soil samples, when both results are greater than or equal to 5x MDC. When either result is less than 5x MDC, the normalized difference (ND) should be between -2 and +2 for aqueous and soil samples. The parameters to be used for assessment of precision for duplicates are listed in [Table 3-4](#).

Values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. The performance metric for assessing the DQI of precision on DQO decisions (see [Table 6-1](#)) is that at least 80 percent of sample results for each measured contaminant are not qualified due to duplicates exceeding the criteria. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants and CASs.

6.2.4 Accuracy

Accuracy is a measure of the closeness of an individual measurement to the true value. It is used to assess the performance of laboratory measurement processes.

Accuracy is determined by analyzing a reference material of known parameter concentration or by re-analyzing a sample to which a material of known concentration or amount of parameter has been added (spiked). Accuracy will be evaluated based on results from three types of spiked samples: matrix spike (MS), LCS, and surrogates (organics). The LCS sample is analyzed with the field samples using the same sample preparation, reagents, and analytical methods employed for the samples. One LCS will be prepared with each batch of samples for analysis by a specific measurement.

The criteria used for the assessment of inorganic chemical accuracy are 75 to 125 percent for MS recoveries and 80 to 120 percent for LCS recoveries. For organic chemical accuracy, MS and LCS

laboratory-specific percent recovery criteria developed and generated in-house by the laboratory according to approved laboratory procedures are applied. The criteria used for the assessment of radiochemical accuracy are 80 to 120 percent for LCS and MS recoveries.

Values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. Factors beyond laboratory control, such as sample matrix effects, can cause the measured values to be outside of the established criteria. Therefore, the entire sampling and analytical process may be evaluated when determining the usability of the affected data.

The performance metric for assessing the DQI of accuracy on DQO decisions (see [Table 6-1](#)) is that at least 80 percent of the sample results for each measured contaminant are not qualified for accuracy. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants and CASs.

6.2.5 Representativeness

Representativeness is the degree to which sample characteristics accurately and precisely represent characteristics of a population or an environmental condition (EPA, 2002). Representativeness is assured by carefully developing the sampling strategy during the DQO process such that false negative and false positive decision errors are minimized. The criteria listed in DQO Step 6 – Specify the Tolerable Limits on Decision Errors are:

- For Decision I, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.

These are qualitative measures that will be used to assess measurement system performance for representativeness. The assessment of this qualitative criterion will be presented in the investigation report.

6.2.6 Completeness

Completeness is defined as generating sufficient data of the appropriate quality to satisfy the data needs identified in the DQOs. For judgmental sampling, completeness will be evaluated using both a quantitative measure and a qualitative assessment. The quantitative measurement to be used to evaluate completeness is presented in [Table 6-1](#) and is based on the percentage of measurements made that are judged to be valid.

For the judgmental sampling approach, the completeness goal for targeted contaminants and the remaining COPCs is 100 and 80 percent, respectively. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions.

The qualitative assessment of completeness is an evaluation of the sufficiency of information available to make DQO decisions. This assessment will be based on meeting the data needs identified in the DQOs and will be presented in the investigation report. Additional samples will be collected if it is determined that the number of samples do not meet completeness criteria.

6.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 2002). The criteria for the evaluation of comparability will be that all sampling, handling, preparation, analysis, reporting, and data validation were performed and documented in accordance with approved procedures that are in conformance with standard industry practices. Analytical methods and procedures approved by DOE will be used to analyze, report, and validate the data. These methods and procedures are in conformance with applicable methods used in industry and government practices. An evaluation of comparability will be presented in the investigation report.

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses that represent different levels of the variable of interest (EPA, 2002). The evaluation criteria for this parameter will be that measurement sensitivity (detection limits) will be less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed

for usability and potential impacts on meeting site characterization objectives. This assessment will be presented in the investigation report.

7.0 Duration and Records Availability

7.1 Duration

Table 7-1 is a tentative duration of activities (in calendar days) for the CAI.

7.2 Records Availability

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

Table 7-1
Corrective Action Investigation Activity Durations

Duration (days)	Activity
10	Site Preparation
76	Fieldwork Preparation and Mobilization
55	Sampling
160	Data Assessment
180	Waste Management

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 546, Injection Well and Surface Releases, field investigation. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., No Further Action, Close in Place, or Clean Closure). Existing information about the nature and extent of contamination at the CASs in CAU 546 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 546 investigation will be based on the DQOs presented in this appendix as developed by representatives of the NDEP and the NNSA/NSO. The seven steps of the DQO process presented in [Sections A.3.0](#) through [A.9.0](#) were developed in accordance with *EPA Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

The DQO process presents a judgmental sampling approach. In general, the procedures used in the DQO process provide:

- A method to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.
- Criteria that will be used to establish the final data collection design such as:
 - The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
 - The decisions or estimates that need to be made and the order of priority for resolution.
 - The type of data needed.
 - An analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings.
- Acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data.

- A data collection design that will generate data meeting the quantitative and qualitative criteria specified. A data collection design specifies the type, number, location, and physical quantity of samples and data, as well as the QA and QC activities that will ensure that sampling design and measurement errors are managed sufficiently to meet the performance or acceptance criteria specified in the DQOs.

A.2.0 Background Information

The following two CASs that comprise CAU 546 are located in Areas 6 and 9 of the NTS, as shown in [Figure A.2-1](#):

- 06-23-02, U-6a/Russet Testing Area
- 09-20-01, Injection Well

The following sections ([Sections A.2.1](#) through [A.2.2](#)) provide a CAS description, physical setting and operational history, release information, and previous investigation results for each CAS in CAU 546. The CAS-specific COPCs are provided in the following sections. Many of the COPCs are based on a conservative evaluation of possible site activities considering the incomplete site histories of the CASs and considering contaminants found at similar NTS sites. Targeted contaminants are defined as those contaminants that are known or that could be reasonably suspected to be present within the CAS based on previous sampling or process knowledge.

A.2.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

Corrective Action Site 06-23-02 consists of potential release of contaminants to the soil in the overall Russet testing area, two muckpiles, a discharge pit, a posted vent line, a posted soil pile, and an unidentified subsurface anomaly. The CAS is located approximately 1 mi north of the intersection of Mercury Highway and Tippipah Highway. [Figure A.2-2](#) shows a site sketch of the CAS.

Two muckpiles are present at CAS 06-23-02. The northern muckpile is oval with a fairly flat top and is approximately 675 ft in circumference and approximately 25 ft thick at its highest point. The muckpile is compact and the material seems to be consistent throughout. The southern muckpile is approximately 670 ft in circumference and is about 12 ft thick at its highest point. This muckpile is irregularly shaped with fingers of muck extending from the overall muckpile. Both muckpiles have debris protruding from and buried within the piles. [Figures A.2-3](#) and [A.2-4](#), respectively, show the two muckpiles.

The discharge pit is 50 by 25 by 12 ft and has two inlet pipes that are 4 inches (in.) in diameter. The perimeter of the pit is bermed approximately 4 ft high above the ground surface, and the inside of the pit was excavated to a depth of approximately 8 ft below grade. Therefore, the total depth of the

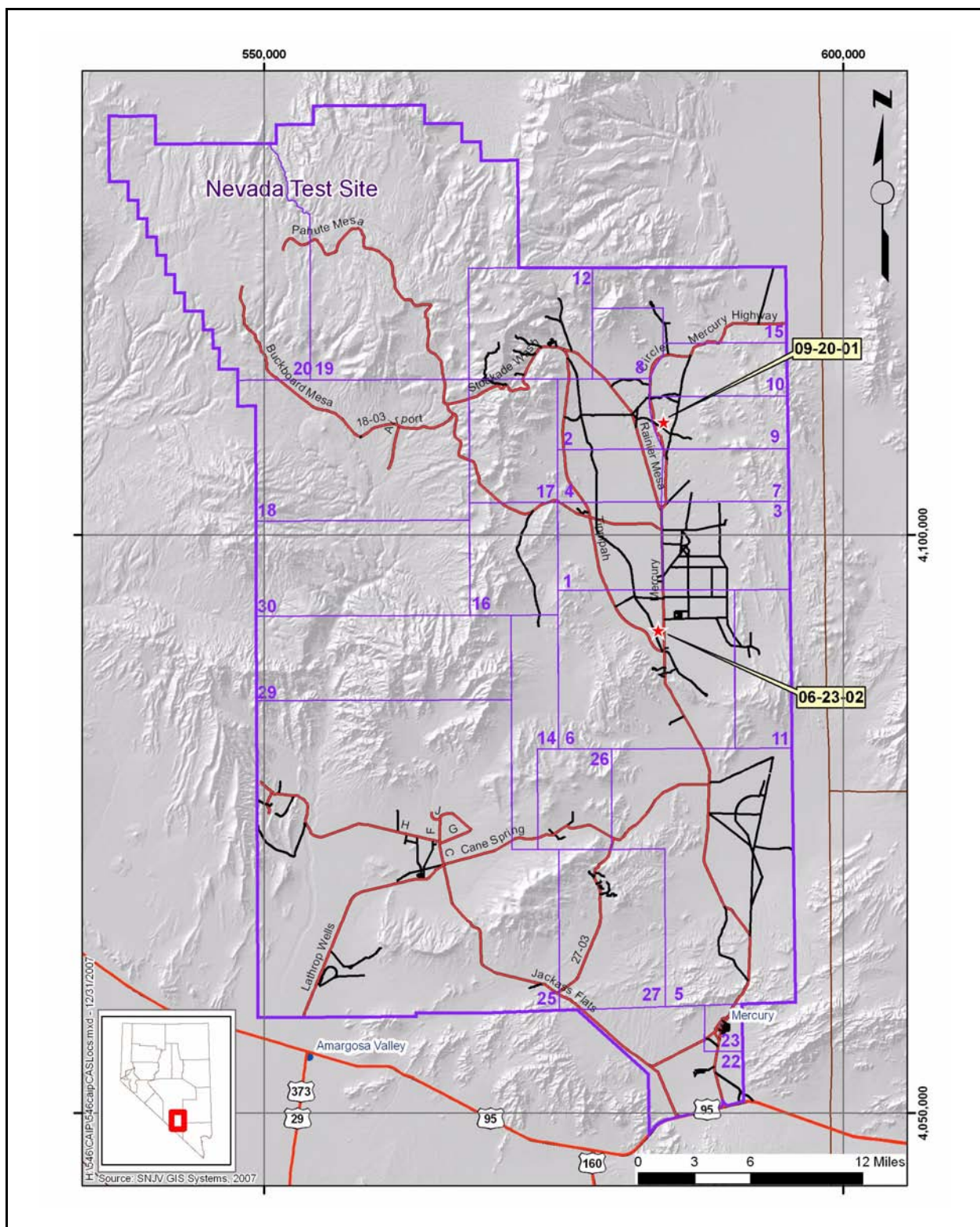


Figure A.2-1
Corrective Action Unit 546, CAS Location Map

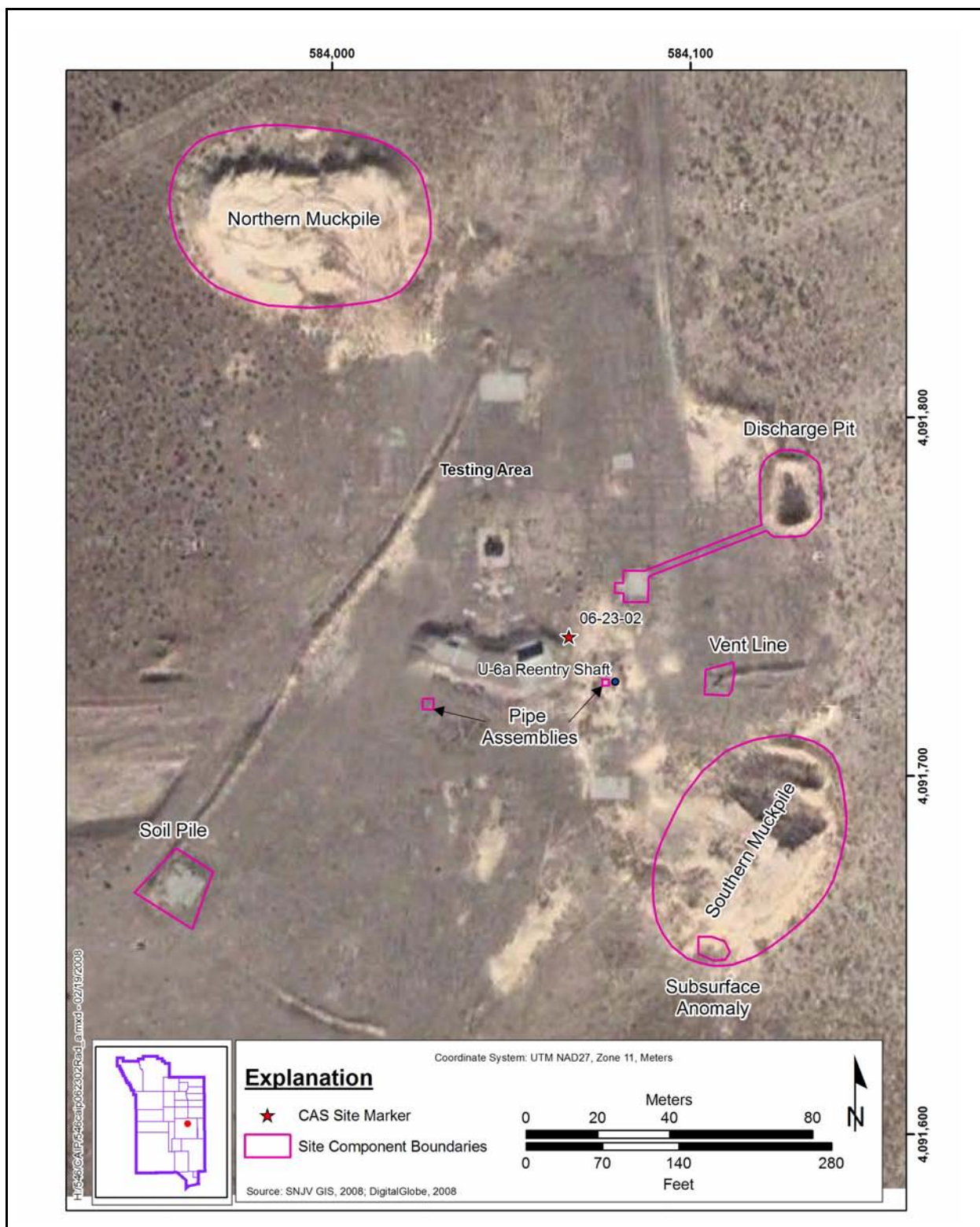


Figure A.2-2
Site Sketch of CAS 06-23-02



Figure A.2-3
Photograph of the Northern Muckpile at CAS 06-23-02



Figure A.2-4
Photograph of the Southern Muckpile at CAS 06-23-02

discharge pit is 12 ft. The inlet pipe on the eastern side of the berm extends underground approximately 115 ft to a concrete pad where the pipe becomes visible again. There is an open connection on the end of the pipe. The pipe on the western berm extends through the berm with one end angled downward inside the discharge pit and the other end open to daylight on the outside of the berm. There is slight soil discoloration in the pit; the extent is unknown because the pit floor is mostly covered with tumbleweed. [Figure A.2-5](#) shows an overview of the discharge pit.

The soil pile is partially located on a concrete pad that is fenced and posted “Underground Radioactive Material.” The pile is approximately 4.5 ft high and 60 ft in circumference. There is debris such as wood, metal, and cables in the soil pile. [Figure A.2-6](#) is a photograph of the soil pile.

The vent line is also fenced and posted “Underground Radioactive Material.” The vent line comes out of the ground at a 45 degree angle and is 6 ft high and 10 ft long. The opening of the pipe is 1 ft in diameter and is closed with a lid that has been secured with a metal band and bolt. The lid may also be welded in place. The vent line is approximately 105 ft east of the re-entry shaft. Adjacent and west of the re-entry shaft are two pipe assemblies that may be associated with gas sampling. The vent line is shown in [Figure A.2-7](#). The piping assemblies will be assessed during the field investigation to determine whether they are a potential source of release.

The testing area where various trailers, vehicles, heavy equipment, and drill rigs were present over time and where all of the pre- and post-test activities took place is approximately 6.3 acres. There is various debris scattered throughout the testing area such as piping, concrete, wood, metal, cables, and wires. There are several structures and boreholes in the testing area that, along with the debris, are not included in the scope of this CAS, as they have not been identified as a source of potential environmental contamination. Also located within the testing area is a diversion ditch that is assumed to have been used to divert runoff water away from activities in the area. The ditch runs diagonally from west to north. An overview of the testing area is shown in [Figure A.2-8](#).

A subsurface anomaly is present along the southern edge of the southern muckpile. The anomaly was identified on a geophysical survey as being 43 by 33 ft with the surface of the anomaly being no deeper than 13 ft. It is not known what object or group of objects are causing this anomaly.

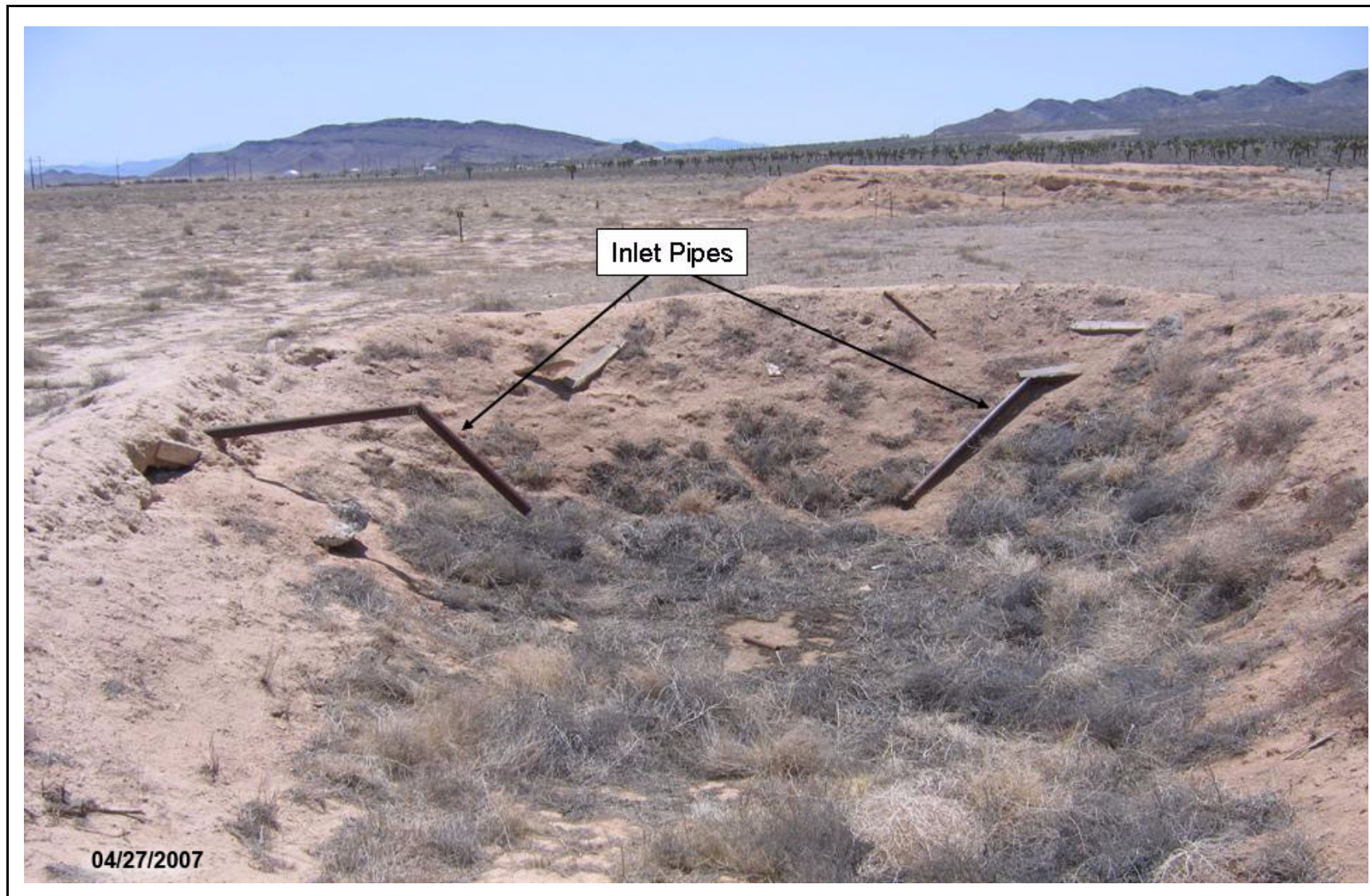


Figure A.2-5
Photograph of the Discharge Pit at CAS 06-23-02



Figure A.2-6
Photograph of the Soil Pile at CAS 06-23-02



Figure A.2-7
Photograph of the Vent Line at CAS 06-23-02



Figure A.2-8
Photograph of the Testing Area at CAS 06-23-02

Physical Setting and Operational History – Corrective Action Site 06-23-02 is located on Yucca Flat in Area 6. This CAS is the location of the Russet test that was conducted on March 5, 1968. Russet was a nuclear test conducted by the Los Alamos National Laboratory and U.S. Department of Defense as a part of Operation Crosstie. The test was conducted in an extensive network of subsurface tunnels and drift systems. The underground test had a yield of less than 20 kilotons and resulted in a surface release of radioactivity that was confined to the NTS. There are several posted “Underground Radioactive Material” areas present at the site as a result of the subsurface test. The Russet test area was the location of pre- and post-test activities.

A historical aerial photograph shows that the northern muckpile was being created during the pre-test activities in 1968 ([Figure A.2-9](#)) (AAS, 1968). None of the other components included in the work scope, other than the overall testing area, were present at this time and were likely created as a result of post-test or re-entry activities. Although the posted soil pile is not present in the photograph, the building whose foundation the soil pile currently overlaps is visible. The purpose of the building and the source of the resulting soil pile is unknown. According to a photograph for re-entry activities, the vent line intercepts the U-6a re-entry shaft. Additionally, some piping is present in the vicinity of the re-entry shaft that could be gas sampling assemblies. Line of site piping was mentioned as being present during testing activities but, according to the configuration shown in a photograph and information provided by interviewees, the LOS piping has been removed and the holes sealed. Although the discharge pit is not shown on the photograph, a shower trailer is shown in the vicinity where the discharge pit has been identified in the field. The southern muckpile is located in close proximity to the U-6a re-entry shaft and is non-existent in the pre-test photograph, which indicates that this muckpile is associated with post-test activities. No details regarding the subsurface anomaly have been identified.

Corrective Action Site 06-23-02 is located in the central northern region of Area 6 in the Yucca Flat hydrographic region. Mean precipitation for Area 6 is 6.7 in./yr as measured at the Yucca Dry Lake climatological rain gauge (ARL/SORD, 2007). The CAS is located within the Aqueduct Mesa drainage basin, approximately 659 ft west of the nearest wash, which drains south to Yucca Lake. The nearest well (UE-6d) to CAS 06-23-02 is approximately 3,000 ft northwest. The depth to groundwater at this well is 1,514 ft (USGS and DOE, 2007). The soil at CAS 06-23-02 is native and consists of silt to cobble-sized alluvium of various lithologies. Although the soil is native, the area



Figure A.2-9
Historical Aerial Photograph of CAS 06-23-02

has been disturbed and extensively reworked. Also present onsite is a diversion ditch along the western edge of the site. It appears to have been created to divert surface water around the active portion of the site. The thickness of alluvium at this site is unknown; however, the entire 425 ft of the U-6a borehole was drilled in alluvium.

Release Information – There is the potential for a release to have occurred to the soil within the muckpiles, discharge pit, posted soil pile, the vent line, and in the testing area. Investigation of the subsurface anomaly may identify an additional release.

Previous Investigation Results – Previous investigations at this CAS include a radiological walkover and geophysical survey. The geophysical survey identified several anomalies within the two muckpiles that are indicative of debris. Additionally, a subsurface anomaly measuring 43 by 33 ft was identified in the southern portion of the southern muckpile. It is unknown at what depth this anomaly occurs; however, it is known based on the precision of the survey that the surface of the object, or objects, is no deeper than approximately 13 ft. The interference from the fence posts and surface debris in the posted soil pile made it impossible to know if anything is buried below the surface features of the soil pile. A shallow pipe that leads from the discharge pit to a concrete pad west of the pit was also identified.

The preliminary radiological survey results indicate that the readings at the site were 1.44 times the background levels. The survey was conducted of all the components in the CAS with the exception of the overall testing area. The remainder of the area is in the process of being surveyed.

A.2.2 Corrective Action Site 09-20-01, Injection Well

Corrective Action Site 09-20-01 consists of a potential release of contaminants to the soil surrounding the injection well and below a drum located in an excavation pit near the injection well. The CAS is located within the U-9u crater, which is located approximately 0.5 mi north of 9-01 Road.

Figure A.2-10 shows an aerial photograph of the CAS.

Although this CAS is called an injection well in the FFACO, it has been determined that the CAS was used as a disposal hole. However, because the CAS description is injection well, it will be referred to as such.

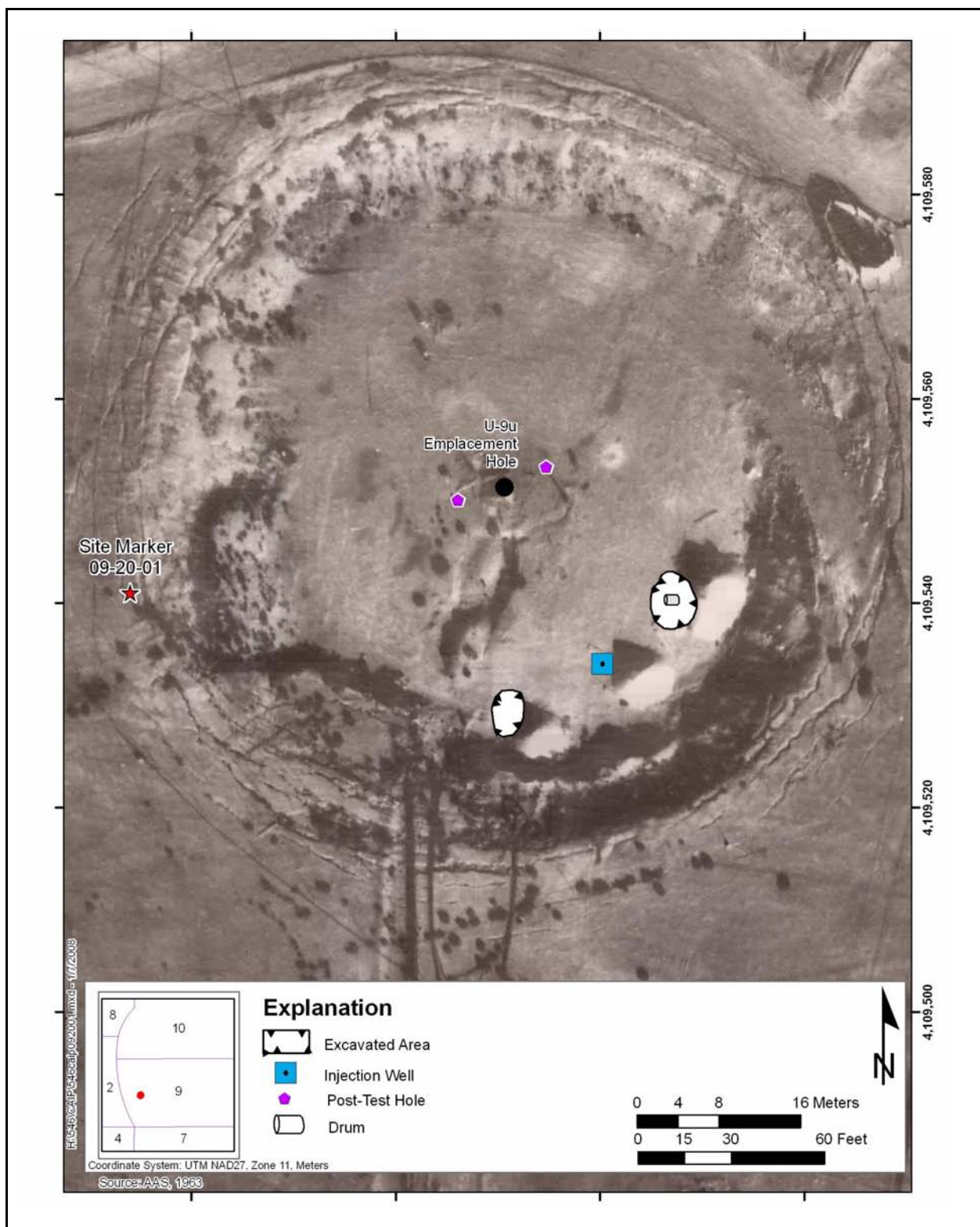


Figure A.2-10
Aerial Photograph of CAS 09-20-01

The injection well is located approximately 50 ft south of the U-9u emplacement hole, within the U-9u crater. There is a steel plate measuring 3 by 3 ft that covers the injection well. In the center of the steel plate is an 18-in. diameter injection well cover that is padlocked. The depth of the injection well has not been determined. An empty 55-gallon drum is located in a small excavated area approximately 10 ft northeast of the injection well. The pit is partially filled with tumbleweed. The drum was found upside down with an open bung. The injection well and drum are shown in [Figure A.2-11](#).

There are posts connected by yellow rope present inside the crater from recent activities that were conducted by the Borehole Management Program. Additionally, there is some debris present within the crater such as wood, steel, and cables but are not a part of this work scope.

Physical Setting and Operational History – Corrective Action Site 09-20-01 is located on Yucca Flat in Area 9. This CAS is located within the U-9u crater, which was created as a result of the Raritan test. The low yield test was conducted at a depth of 595 ft by LLNL on September 6, 1962, as a part of Operation Storax. A crater 23 ft deep and 220 ft in diameter was created. A stability study was conducted in 2007 by LLNL. It was determined that complete collapse occurred quickly after detonation, and the current configuration is stable (LLNL, 2007).

The injection well was used to dispose of classified core and solidified and liquid decontamination waste. Specific information about volumes and contaminants in the disposed material has not been identified. Drilling records could not be identified for this CAS. According to historical photographs, the injection well was present in 1963. A document written in 1988 stated that the injection well was still active (DOE, 1988). Based on this information, it is assumed that this well received core and/or waste from other locations other than U-9u. A small excavated area with an open drum is present near the injection well. It is unknown when the drum appeared and if it was empty when discarded in the borrow pit.

Corrective Action Site 09-20-01 is located in the central western region of Area 9 in the Yucca Flat hydrographic region. Mean precipitation for Area 9 is 6.4 in./yr as measured at the Buster Jangle climatological rain gauge near the intersection of Mercury Highway and Rainier Mesa Road (ARL/SORD, 2007). The CAS is located within the Aqueduct Mesa drainage basin, approximately 659 ft west of the nearest wash, which drains south to Yucca Lake. The nearest well (ER-2-1) to

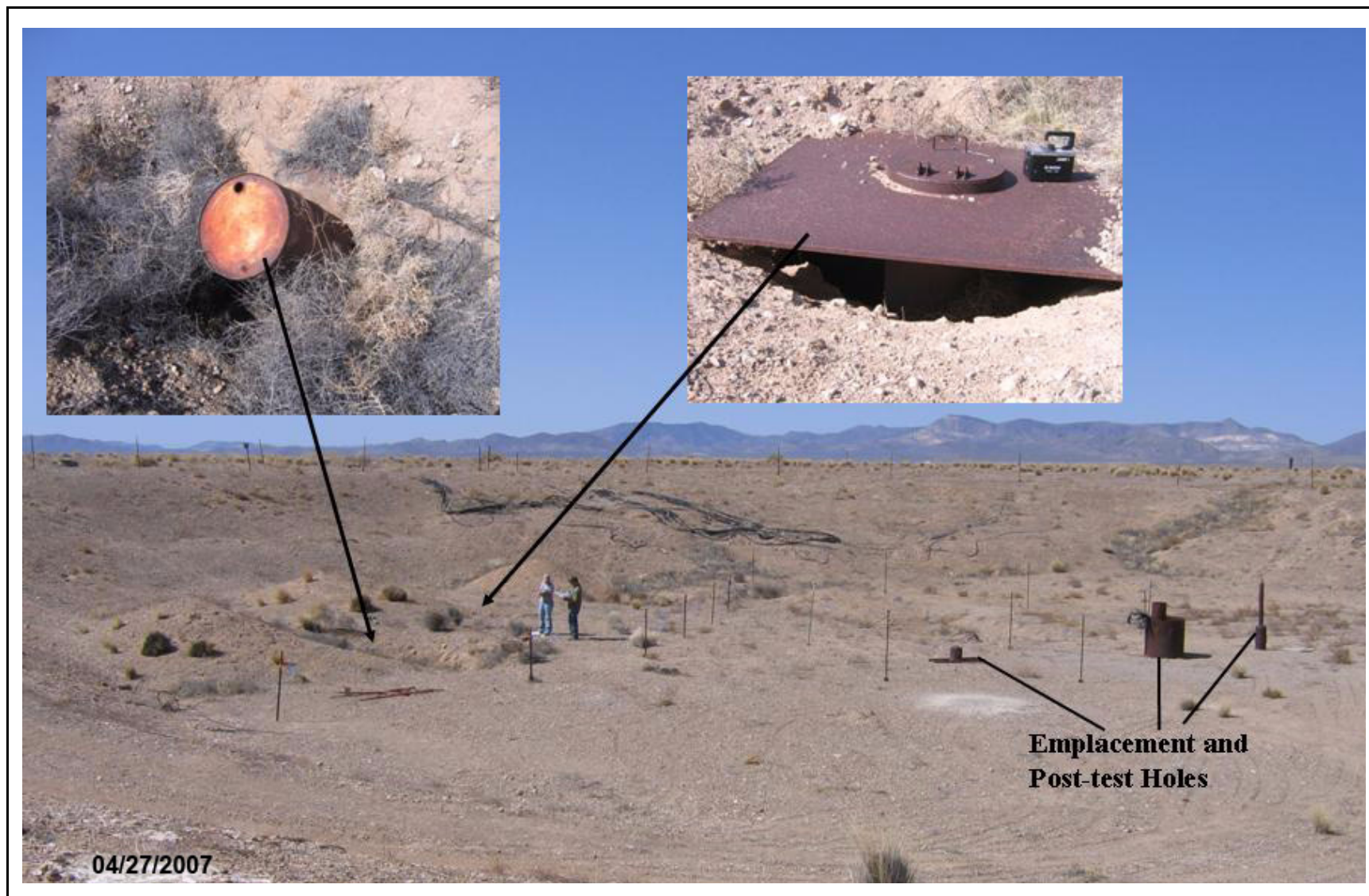


Figure A.2-11
Photograph of Injection Well and Drum at CAS 09-20-01

CAS 09-20-01 is approximately 5,260 ft southwest. The depth to groundwater at this well is 1,725 ft (USGS and DOE, 2007). The soil at CAS 09-20-01 is native and consists of silt to cobble-sized alluvium of various lithologies. Although the depth to alluvium at CAS 09-20-01 is unknown, the Raritan test was detonated in alluvium at a working point of 515 ft (LLNL, 2007).

Release Information – There is the potential for a release of potential contaminants to have occurred to the soil surrounding the surface and subsurface components of the injection well and below the drum. The only visible staining is below the drum as the drum has rusted over time and some soil staining has resulted from this.

Previous Investigation Results – Previous investigations at this CAS include site visits and a radiological survey. A radiological walkover survey was completed at this CAS and no elevated readings were identified. The maximum survey point is approximately 0.998 times the mean undisturbed background radiation emission rate (SNJV, 2007). Therefore, no radiological constituents within the CAS could be distinguished from the surrounding area. Additionally, the drum was swiped for surface radiological contamination, but no elevated readings were noted.

Classified core and decontamination wastes (both liquid and solidified) were disposed of in the injection well at CAS 09-20-01. It can be expected that these wastes would include mixed fission products, plutonium, uranium, and potentially metals and/or organic solvents at levels above FALs. For safety reasons, any new sampling borehole at this CAS would have to be drilled at some distance from the injection well. Therefore, sample results could not be used reliably to disprove the presence of COCs around the injection well. Because of this, it is assumed that COCs are present at CAS 09-20-01, and a corrective action of Close in Place with a use restriction will be implemented for the subsurface contamination. The collection of subsurface samples by drilling would present significant risks to workers; may not provide useful additional information on the nature and extent of contamination; and would not affect the selected corrective action of Close in Place. The area of the use restriction will be presented in the CADD. Investigation of disposal holes within CAU 542 with similar histories and similar CSMs revealed that contamination had not migrated more than 15 ft from the release point at the bottom of the well.

A.3.0 Step 1 - State the Problem

Step 1 of the DQO process defines the problem that requires study; identifies the planning team, and develops a conceptual model of the environmental hazard to be investigated.

The problem statement for CAU 546 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 546.”

A.3.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NSO, SNJV, and NSTec. The DQO planning team met on November 8, 2007, for the DQO meeting. The primary decision-makers are the NDEP and NNSA/NSO representatives.

A.3.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at any point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. It provides a good summary of how and where contaminants are expected to move; what impacts such movement may have, and is the basis for assessing how contaminants could reach receptors both in the present and future. The CSM describes the most probable scenario for current conditions at each site and define the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. Accurate CSMs are important as they serve as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for CAU 546 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of:

- Potential contaminant releases including media subsequently affected.

- Release mechanisms (the conditions associated with the release).
- Potential contaminant source characteristics including contaminants suspected to be present and contaminant-specific properties.
- Site characteristics including physical, topographical, and meteorological information.
- Migration pathways and transport mechanisms that describe the potential for migration and where the contamination may be transported.
- The locations of points of exposure where individuals or populations may come in contact with a COC associated with a CAS.
- Routes of exposure where contaminants may enter the receptor.

If additional elements are identified during the investigation that are outside the scope of the CSM, the situation will be reviewed and a recommendation will be made as to how to proceed. In such cases, NDEP and NNSA/NSO will be notified and given the opportunity to comment on or concur with the recommendation.

The applicability of the CSM to each CAS is summarized in [Table A.3-1](#) and discussed below.

[Table A.3-1](#) provides information on CSM elements that will be used throughout the remaining steps of the DQO process. [Figure A.3-1](#) represents site conditions applicable to the CSM.

A.3.2.1 Contaminant Release

The most likely locations of the contamination and releases to the environment are the soils directly below or adjacent to the surface and subsurface components of the CSM (e.g., muckpiles, discharge pit, subsurface anomaly, vent line, testing area, posted soil pile, injection well, and drum). The CSM accounts for potential releases resulting from overflow of system components that are present at the ground surface (e.g., piping in the discharge pit and the injection well) and surface spills.

Contaminants migrating from the CASs, regardless of physical or chemical characteristics, are expected to exist at interfaces and in the soil adjacent to the various features in lateral and vertical directions. Concentrations are expected to decrease with horizontal and vertical distance from the source.

Table A.3-1
Conceptual Site Model
Description of Elements for Each CAU 546 CAS

CAS Identifier	06-23-02	09-20-01
CAS Description	U-6a/Russet Testing Area	Injection Well
Site Status	Sites are inactive and/or abandoned	
Exposure Scenario	Occasional Use Area	
Sources of Potential Soil Contamination	Discarded muck and soil, discharged effluent, releases from testing activities, and unknown buried objects	Injection well and drum
Location of Contamination/Release Point	Surface and shallow subsurface soil at or near location(s) of potential environmental concerns	Surface and shallow subsurface soil below the drum, surface and subsurface soil near the injection well
Amount Released	Unknown	
Affected Media	Surface and shallow subsurface soil	Surface, shallow subsurface, and subsurface soil
Potential Contaminants	VOCs, SVOCs, TPH-DRO, PCBs, RCRA Metals, Radionuclides	
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Surface water runoff may provide the transportation of some contaminants within or outside of the footprints of the CASs. The discharge pit is believed to have received effluent and the liquid discharged could have served as a driving source for the migration of contaminants. Additionally, unsolidified waste was likely discharged to the injection well, which could have assisted the transport of contaminants, if the bottom of the injection well is not contained.	
Migration Pathways	Vertical transport is expected to dominate over lateral transport in all of the features, except the muckpiles, due to small surface gradients.	
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.	
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.	

COC = Contaminant of concern
COPC = Contaminant of potential concern
DRO = Diesel-range organic
PCB = Polychlorinated biphenyl

SVOC = Semivolatile organic compound
TPH = Total petroleum hydrocarbons
RCRA = *Resource Conservation and Recovery Act*
VOC = Volatile organic compound

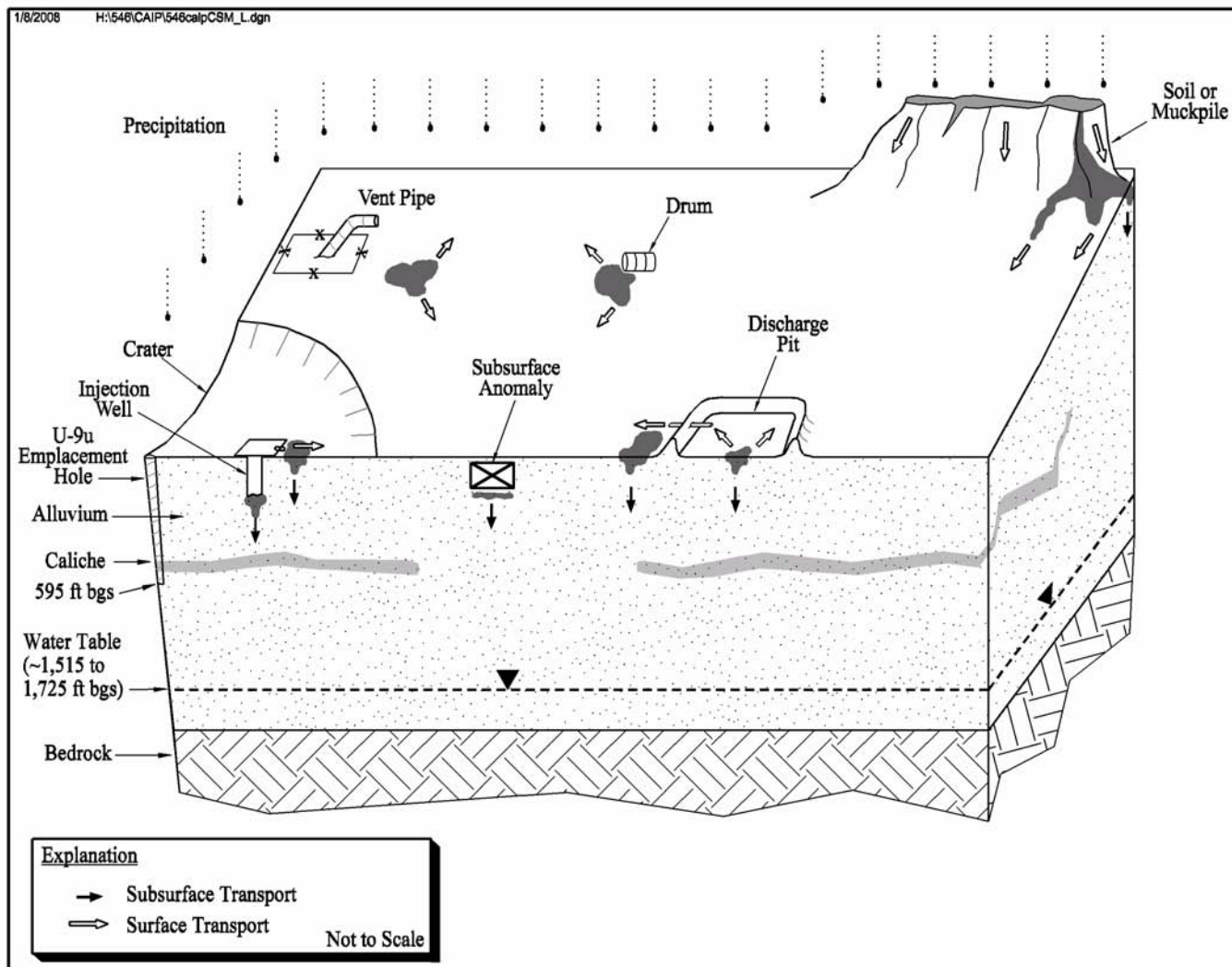


Figure A.3-1
Conceptual Site Model for CAU 546

A.3.2.2 Potential Contaminants

The COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Because complete information regarding activities performed at the CAU 546 sites is not available, contaminants detected at similar NTS sites were included in the contaminant lists to reduce uncertainty. The list of COPCs is intended to encompass all of the contaminants that could potentially be present at each CAS. The COPCs applicable to Decision I environmental samples from each of the CASs of CAU 546 are defined as the constituents reported from the analytical methods stipulated in [Table A.3-2](#).

Table A.3-2
Analytical Program^a
(Includes Waste Characterization Analyses)

Analyses	CAS 06-23-02	CAS 09-20-01
Organic Contaminants of Potential Concern (COPCs)		
Total Petroleum Hydrocarbons-Diesel-Range Organics	X	X
Polychlorinated Biphenyls	X	X
Semivolatile Organic Compounds	X	X
Volatile Organic Compounds	X	X
Inorganic COPCs		
<i>Resource Conservation and Recovery Act Metals</i>	X	X
Radionuclide COPCs		
Gamma Spectroscopy	X	X
Isotopic Uranium	X	X
Isotopic Plutonium	X	X
Strontium-90	X	X
Waste Characterization Analyses		
Gross Alpha	X	X
Gross Beta	X	X
Tritium	X	X

^aThe COPCs are the constituents reported from the analytical methods listed.

X = Required analytical method

During the review of site history documentation, process knowledge information, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs, some of the COPCs were identified as targeted contaminants at specific CASs. Targeted contaminants are those COPCs for which evidence in the available site and process information suggests a reasonably suspected presence at a given CAS. The targeted contaminants are required to meet a more stringent completeness criteria than other COPCs thus providing greater protection against a decision error (see [Section 6.2.6](#)). Targeted contaminants for each CAU 546 CAS are identified in [Table A.3-3](#).

**Table A.3-3
Targeted Contaminants for CAU 546**

Corrective Action Site	Chemical Targeted Contaminant(s)	Radiological Targeted Contaminant(s)
06-23-02	None Identified	Plutonium-238, Plutonium-239/240, Uranium-235, Uranium-238
09-20-01	None Identified	None Identified

A.3.2.3 Contaminant Characteristics

Contaminant characteristics include, but are not limited to: solubility, density, and adsorption potential. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with small particle size, high solubility, low density, and/or low affinity for media are found further from release points or in low areas where evaporation of ponding will concentrate dissolved contaminants.

A.3.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Physical properties include permeability, porosity, hydraulic conductivity, degree of saturation, sorting, chemical composition, and organic content. Topographical and meteorological properties and attributes include slope stability, precipitation frequency and amounts, precipitation runoff pathways, drainage channels and ephemeral streams, and evapotranspiration potential.

A.3.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils.

Contaminants released to a wash, or a diversion ditch in the case of CAS 06-23-02, are subject to higher transport mechanisms than contaminants released to other surface areas. Washes, such as those in the Yucca Flat area, are generally dry but subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events could be ultimately carried by the streamflow to Yucca Lake or interim locations where the flowing water loses energy and the sediments drop out. These locations are readily identifiable by hydrologists as sedimentation areas.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (potential evapotranspiration at the Area 3 Radiological Waste Management Site has been estimated at 62.6 in./yr [Shott et al., 1997]) and limited precipitation for this region (average of 6.67 in./yr [ARL/SORD, 2007]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

A.3.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation (dust), dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials. The land-use and exposure scenarios for the CAU 546 CASs are listed in [Table A.3-4](#) and are based on NTS current and future land use. These CASs are at remote locations without site improvements and where no regular work is performed. There is still the possibility, however, that site workers could occupy these locations on an occasional and temporary basis (e.g., a military exercise). Therefore, these sites are classified as occasional work areas.

Table A.3-4
Land-Use and Exposure Scenarios

Corrective Action Site	Record of Decision Land-Use Zone	Exposure Scenario
06-23-02, 09-20-01	<p style="text-align: center;">Nuclear Test</p> <p>This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. This zone includes compatible defense and nondefense research, development, and testing activities.</p>	<p style="text-align: center;">Occasional Use Area</p> <p>Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.</p>

A.4.0 Step 2 - Identify the Goal of the Study

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statement(s), and considers alternative outcomes or actions that can occur upon answering the question(s).

A.4.1 Decision Statements

The Decision I statement is: “Is any COC present in environmental media within the CAS?” For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). If a COC is detected, then Decision II must be resolved.

The Decision II statement is: “If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?” Sufficient information is defined to include:

- Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
- The information needed to determine potential remediation waste types.
- The information needed to evaluate the feasibility of remediation alternatives (geotechnical data if construction or evaluation of barriers is considered).

A corrective action will be determined for any site containing a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released. To evaluate the potential for a future release from source material introducing a COC to the surrounding environmental media, the following conservative assumptions were made:

- The vent line or possibly piping assemblies would fail at some point and contaminants would be released to the surrounding media.
- The muck or potentially contaminated soil in the pile will release contaminants to the surrounding media.

- The resulting concentration of contaminants in the surrounding media would be greater than applicable action levels.

If sufficient information is not available to evaluate potential corrective action alternatives then site conditions will be re-evaluated and additional samples will be collected (as long as the scope of the investigation is not exceeded and any CSM assumption has not been shown to be incorrect).

A.4.2 Alternative Actions to the Decisions

In this section, the actions that may be taken to solve the problem are identified depending on the possible outcomes of the investigation.

A.4.2.1 Alternative Actions to Decision I

If no COC associated with a release from the CAS is detected, then further assessment of the CAS is not required. If a COC associated with a release from the CAS is detected, then the extent of COC contamination will be determined and additional information required to evaluate potential corrective action alternatives will be collected.

A.4.2.2 Alternative Actions to Decision II

If sufficient information is available to evaluate potential corrective action alternatives, then no further assessment of the CAS is required. If sufficient information is not available to evaluate potential corrective action alternatives, then additional samples will be collected.

A.5.0 Step 3 - Identify Information Inputs

Step 3 of the DQO process identifies the information needed, determines sources for information, and identifies sampling and analysis methods that will allow reliable comparisons with FALs.

A.5.1 Information Needs

To resolve Decision I (determine whether a COC is present at a given CAS), samples need to be collected and analyzed following these two criteria:

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

To resolve Decision II (determine whether sufficient information is available to evaluate potential corrective action alternatives at each CAS), samples will be collected and analyzed to meet the following criteria:

- Sample collection must be collected in areas contiguous to the contamination but where contaminant concentrations are below FALs.
- Sample collection from waste or environmental media must provide sufficient information to determine potential remediation waste types.
- Appropriate samples must be submitted to evaluate the feasibility of remediation alternatives (e.g., geotechnical data if construction or evaluation of barriers is considered).
- The analytical suites selected must be sufficient to detect contaminants at concentrations equal to or less than their corresponding FALs.

A.5.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples using grab sampling, hand augering, direct push, backhoe excavation, or other appropriate sampling methods. These samples will be submitted to analytical laboratories meeting the quality criteria stipulated in the Industrial Sites QAPP (NNSA/NV, 2002). Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

A.5.2.1 Sample Locations

Design of the sampling approaches for the CAU 546 CASs must ensure that the data collected are sufficient for selection of appropriate corrective action alternatives (EPA, 2002). To meet this objective, the samples should be collected from locations at each site most likely to contain a COC, if present.

Decision I sample locations at CASs 06-23-02 and 09-20-01 will be determined based upon the likelihood of the soil containing a COC, if present at the CAS. These locations will be selected based on field-screening techniques, biasing factors, the CSM, and existing information. Analytical suites for Decision I samples will include all COPCs identified in [Table A.3-2](#).

Field-screening techniques may be used to select appropriate sampling locations by providing semiquantitative data that can be used to comparatively select samples to be submitted for laboratory analyses from several screening locations. Field screening may also be used for health and safety monitoring and to assist in making certain health and safety decisions. The following field-screening methods may be used to select analytical samples at CAU 546:

- Walkover surface area radiological surveys – A radiological survey will be conducted over the CAS area, as permitted by terrain and field conditions, to detect locations of elevated radioactivity.
- Alpha and beta/gamma radiation – A radiological survey instrument will be used.
- Gamma emitting radionuclides – A radiological dose rate measurement instrument will be used.

Biasing factors will primarily be used to select samples to be submitted for laboratory analyses based on existing site information and site conditions discovered during the investigation. The following factors will also be considered in selecting locations for analytical samples at CAU 546:

- Documented process knowledge on source and location of release (e.g., volume of release).
- Stains: Any spot or area on the soil surface that may indicate the presence of a potentially hazardous liquid. Typically, stains indicate an organic liquid such as an oil has reached the soil, and may have spread out vertically and horizontally.

- Elevated radiation: Any location identified during radiological surveys that had alpha/beta/gamma levels significantly higher than surrounding background soil.
- Geophysical anomalies: Any location identified during geophysical surveys that had results indicating surface or subsurface materials existed, and were not consistent with the natural surroundings (e.g., buried concrete or metal, surface metallic objects).
- Drums, containers, equipment or debris: Materials of interest that may have been used at, or added to, a location, and that may have contained or come in contact with hazardous or radioactive substances at some point during their use.
- Lithology: Locations where variations in lithology (soil or rock) indicate that different conditions or materials exist.
- Preselected areas based on process knowledge of the site: Locations for which evidence such as historical photographs, experience from previous investigations, or interviewee input, exists that a release of hazardous or radioactive substances may have occurred.
- Preselected areas based on process knowledge of the contaminant(s): Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.
- Experience and data from investigations of similar sites.
- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or other indication of potential contamination.
- Presence of debris, waste, or equipment.
- Odor.
- Other biasing factors: Factors not previously defined for the CAI, but become evident once the investigation of the site is under way.

Because there may not be distinct biasing factors within a CAS component (i.e., muckpiles), the sample locations within a component may be selected randomly.

Decision II sample step-out locations will be selected based on the CSM, biasing factors, and existing data. Analytical suites will include those parameters that exceeded FALs (i.e., COCs) in prior samples. Biasing factors to support Decision II sample locations include Decision I biasing factors plus available analytical results.

A.5.2.2 Analytical Methods

Analytical methods are available to provide the data needed to resolve the decision statements. The analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) are provided in [Tables 3-4](#) and [3-5](#).

A.6.0 Step 4 - Define the Boundaries of the Study

Step 4 of the DQO process defines the target population of interest and its relevant spatial boundaries, specifies temporal and other practical constraints associated with sample/data collection, and defines the sampling units on which decisions or estimates will be made.

A.6.1 Target Populations of Interest

The population of interest to resolve Decision I (“Is any COC present in environmental media within the CAS?”) is at any location within the site that is contaminated with any contaminant above a FAL. The populations of interest to resolve Decision II (“If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?”) are:

- Each one of a set of locations bounding contamination in lateral and vertical directions.
- Potential remediation waste.
- Environmental media where natural attenuation or biodegradation or construction/evaluation of barriers is considered.

A.6.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination at each CAS, as shown in [Table A.6-1](#). Contamination found beyond these boundaries may indicate a flaw in the CSM and require re-evaluation of the CSM before the investigation could continue. Each CAS is considered geographically independent and intrusive activities are not intended to extend into the boundaries of neighboring CASs.

**Table A.6-1
Spatial Boundaries of CAU 546 CASs**

Corrective Action Site	Spatial Boundaries
06-23-02	The testing area, including all of the components (e.g., muckpiles, discharge pit), plus a 100-foot (ft) lateral buffer; 15 ft below ground surface (bgs) vertically.
09-20-01	The lateral buffer for the injection well and drum is the crater boundary; 15 ft bgs vertically.

A.6.3 Practical Constraints

Practical constraints such as military activities at the NTS, weather (i.e., high winds, rain, lightning, extreme heat), utilities, threatened or endangered animal and plants, unstable or steep terrain, and/or access restrictions may affect the ability to investigate this site. The practical constraints associated with the investigation of the CAU 546 CASs are summarized in [Table A.6-2](#).

Table A.6-2
Practical Constraints for the CAU 546 Field Investigation

Corrective Action Site	Practical Constraints
06-23-02	Weather (i.e., high winds, rain, lightning, extreme heat), underground utilities and buried cables, debris within muckpiles and posted soil pile, located within the habitat range of the desert tortoise ^a , the vent line (and possibly the piping assemblies) being under pressure, and loose and unconsolidated terrain
09-20-01	Weather (i.e., high winds, rain, lightning, extreme heat), U-9u Crater fence boundary, buried cables, location within a crater, proximity of the injection well to the U-9u cavity, and loose and unconsolidated terrain

^aMojave Desert population of the desert tortoise is listed as a threatened species by the U.S. Fish and Wildlife Service (DOE/NV, 1996).

A.6.4 Define the Sampling Units

The scale of decision-making for CAS 06-23-02 in Decision I is defined as the various components within CAS 06-23-02. These individual components are the northern muckpile, southern muckpile, discharge pit, posted soil pile, vent line, subsurface anomaly, and the remaining testing area. Any COC detected at any location within the individual component will cause the determination that the component is contaminated and needs further evaluation. The scale of decision-making for CAS 09-20-01 in Decision I is the surface soil around the injection well and drum. Any COC detected at these locations within the CAS will cause the determination that the CAS is contaminated and needs further evaluation. The scale of decision-making for Decision II is defined as a contiguous area contaminated with any COC originating from either the CAS or the CAS components. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

A.7.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates an “If ... then ... else” decision rule that involves it.

A.7.1 Population Parameters

The population parameter is the observed concentration of each contaminant from each individual analytical sample. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II. For Decision I, a single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS.

The Decision II population parameter is an individual analytical result from a bounding sample. For Decision II, a single bounding sample result for any contaminant exceeding a FAL would cause a determination that the contamination is not bounded.

A.7.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006b) requires the use of ASTM Method E 1739-95 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary.”

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels or the FALs may be calculated using a Tier 2 evaluation.
- Tier 2 evaluation – Conducted by calculating Tier 2 SSTLs using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. The TPH concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.
- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

The comparison of laboratory results to FALs and the evaluation of potential corrective actions will be included in the investigation report. The FALs will be defined (along with the basis for definition) in the investigation report.

A.7.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the EPA *Region 9 Risk-Based Preliminary Remediation Goals (PRGs)* for chemical contaminants in industrial soils (EPA, 2004). Background concentrations for RCRA metals will be used instead of PRGs when natural background concentrations exceed the PRG, which is often the case with arsenic on the NTS. Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.7.2.2 Total Petroleum Hydrocarbon PALs

The PAL for TPH is 100 ppm as listed in NAC 445A.2272 (NAC, 2006c).

A.7.2.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25 mrem/yr dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land-use scenario as presented in [Section A.3.2](#).

Solid media such as concrete and/or structures may pose a potential radiological exposure risk to site workers if contaminated. The radiological PAL for solid media will be defined as the unrestricted-release criteria defined in the RadCon Manual (NNSA/NSO, 2004).

A.7.3 Decision Rules

The decision rules applicable to both Decision I and Decision II are:

- If COC contamination is inconsistent with the CSM, or extends beyond the spatial boundaries identified in [Section A.6.2](#), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

The decision rules for Decision I are:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.
- If a COC exists at any CAS, then a corrective action will be determined, else no further action is necessary.
- If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, else no further action is necessary.

The decision rules for Decision II are:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL, in any bounding direction, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.
- If analytical results are available to characterize IDW and estimate potential remediation waste types/volume, then the decision will be that sufficient information exists to evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

A.8.0 Step 6 - Specify Performance or Acceptance Criteria

Step 6 of the DQO process defines the decision hypotheses, specifies controls against false rejection and false acceptance decision errors, examines consequences of making incorrect decisions from the test, and places acceptable limits on the likelihood of making decision errors.

A.8.1 Decision Hypotheses

The baseline condition (i.e., null hypothesis) and alternative condition for Decision I are:

- Baseline condition – A COC is present.
- Alternative condition – A COC is not present.

The baseline condition (i.e., null hypothesis) and alternative condition for Decision II are as follows:

- Baseline condition – The extent of a COC has not been defined.
- Alternative condition – The extent of a COC has been defined.

Decisions and/or criteria have false negative or false positive errors associated with their determination. The impact of these decision errors and the methods that will be used to control these errors are discussed in the following subsections. In general terms, confidence in DQO decisions based on judgmental sampling results will be established qualitatively by:

- The development and concurrence of CSMs (based on process knowledge) by stakeholder participants during the DQO process.
- Validity testing of CSMs based on investigation results.
- Evaluation of the data quality based on DQI parameters.

A.8.2 False Negative Decision Error

The false negative decision error would mean deciding that a COC is not present when it actually is (Decision I), or deciding that the extent of a COC has been defined when it has not (Decision II). In both cases, the potential consequence is an increased risk to human health and environment.

A.8.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 2002).

Judgmental sampling conclusions about the target population depend upon the validity and accuracy of professional judgment.

The false negative decision error (where consequences are more severe) for judgmental sampling designs is controlled by meeting these criteria:

- For Decision I, having a high degree of confidence that the selected sample locations will identify COCs if present anywhere within the CAS. For Decision II, having a high degree of confidence that the selected sample locations will identify the extent of COCs.
- Having a high degree of confidence that analyses will be sufficient to detect any COCs present in the samples.
- Having a high degree of confidence that the dataset is of sufficient quality and completeness.

To satisfy the first criterion, Decision I samples must be collected in areas most likely to be contaminated by COCs (supplemented by random samples within specific components, where appropriate). Decision II samples must be collected in areas that represent the lateral and vertical extent of contamination (above FALs). The following characteristics must be considered to control decision errors for the first criterion:

- Source and location of release
- Chemical nature and fate properties
- Physical transport pathways and properties
- Hydrologic drivers

These characteristics were considered during the development of the CSMs and selection of sampling locations. The field-screening methods and biasing factors listed in [Section A.5.2.1](#) will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from locations that best represent the populations of interest as defined in [Section A.6.1](#).

To satisfy the second criterion, Decision I samples will be analyzed for the chemical and radiological parameters listed in [Section 3.2](#). Decision II samples will be analyzed for those chemical and radiological parameters that identified unbounded COCs. The DQI of sensitivity will be assessed for analytical results to ensure that sample analyses had measurement sensitivities (detection limits) that were less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed (for usability and potential impacts on meeting site characterization objectives) in the investigation report.

To satisfy the third criterion, the entire dataset, as well as individual sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the QAPP (NNSA/NV, 2002) and [Section 6.2.2](#). The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially “flag” (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the constituent performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that the analytical methods used are equivalent to standard EPA methods. This is so results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in [Section 6.2.2](#).

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the QAPP (NNSA/NV, 2002):

- Field duplicates (minimum of 1 per matrix per 20 environmental samples)
- Laboratory QC samples (minimum of 1 per matrix per 20 environmental samples)

A.8.3 False Positive Decision Error

The false positive decision error would mean deciding that a COC is present when it is not, or a COC is unbounded when it is not; resulting in increased costs for unnecessary sampling and analysis.

False positive results are typically attributed to laboratory and/or sampling/handling errors that could cause cross contamination. To control against cross contamination, decontamination of sampling equipment will be conducted according to established and approved procedures and only clean sample containers will be used. To determine whether a false positive analytical result may have occurred, the following QC samples will be collected as required by the QAPP (NNSA/NV, 2002):

- Trip blanks (1 per sample cooler containing VOC environmental samples)
- Equipment blanks (1 per sampling event)
- Source blanks (1 per uncharacterized source lot)
- Field blanks (minimum of 1 per CAS, additional if field conditions change)

A.9.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. A judgmental sampling scheme will be implemented to select sample locations and evaluate analytical results for CAU 546. [Sections A.9.1](#) through [A.9.2](#) contain general information about collecting Decision I and Decision II samples under a judgmental sampling design, while the subsequent sections provide CAS-specific sampling activities, including proposed sample locations.

A.9.1 Decision I Sampling

A judgmental sampling design will be implemented for both CAS 06-23-02 and CAS 09-20-01. Because individual sample results, rather than an average concentration, will be used to compare to FALs, statistical methods to generate site characteristics will not be used. Adequate representativeness of the entire target population may not be a requirement to developing a sampling design. If good prior information is available on the target site of interest, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area (EPA, 2006).

All sample locations will be selected to satisfy the DQI of representativeness in that samples collected from selected locations will best represent the populations of interest as defined in [Section A.6.1](#). To meet this criterion for judgmentally sampled sites, a biased sampling strategy will be used for Decision I samples to target areas with the highest potential for contamination, if it is present in the CAS. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in [Section A.5.2.1](#). If biasing factors are present in soils below locations where Decision I samples were removed, additional Decision I soil samples will be collected at depth intervals, selected by the Site Supervisor, based on biasing factors to a depth where the biasing factors are no longer present. The Site Supervisor has the discretion to modify the judgmental sample locations, but only if the modified locations meet the decision needs and criteria stipulated in this DQO.

A.9.1.1 Corrective Action Site 06-23-02, U-6a/Russet Testing Area

During Decision I sampling, the features discussed in the following sections will be sampled.

Northern and Southern Muckpiles – On the northern and southern muckpiles, four locations on the top of each muckpile will be selected based on the radiological walkover survey or other biasing factors present. If there are no biasing factors, then the sample locations will be randomly selected. One surface sample (0.0 to 0.5 ft bgs) will be collected at each location using a scoop and pan.

A trench will be dug in four locations around each of the muckpiles using a backhoe or excavator to look for biasing factors within the muckpiles. The trenches will be dug between 10 and 20 ft from the outer edge of the muckpile. This depth from the edge of the muckpile may vary based on the presence or lack of biasing factors. The samples may be collected directly from the backhoe bucket or, depending on the stability and configuration of the trenched area, directly from an area with biasing factors. If there is a lack of visual biasing factors, then a bucket of soil from 3-ft intervals will be surveyed for elevated readings. A minimum of four samples will be collected at each trenched area. Additional samples may be submitted based on the presence of biasing factors. If there are more than four biasing factors in each trenched area, additional samples will be collected. If there are no biasing factors present within a trenched area, then the four sample locations will be spaced evenly from the top to the bottom of the muckpile ([Figure A.9-1](#)).

Discharge Pit – Five sample locations were selected in the discharge pit: one at the lowest point of the discharge pit, one in the discolored soil, one at each of the two pipe inlets, and one at the pipe outlet. These locations were selected because these are the areas that are most likely to contain a COC, if present. One surface sample (0.0 to 0.5 ft bgs) will be collected at each location using a scoop and pan ([Figure A.9-2](#)).

Soil Pile – A minimum of six sample locations were selected at the posted soil pile. Samples will be accessed using a shovel, or similar tool, and collected using a scoop and pan from locations with biasing factors. If there are no biasing factors, samples will be collected from three, equally spaced, randomly selected, locations within the soil pile and from the soil pile/native interface (directly below the sample locations) within the soil pile ([Figure A.9-3](#)).

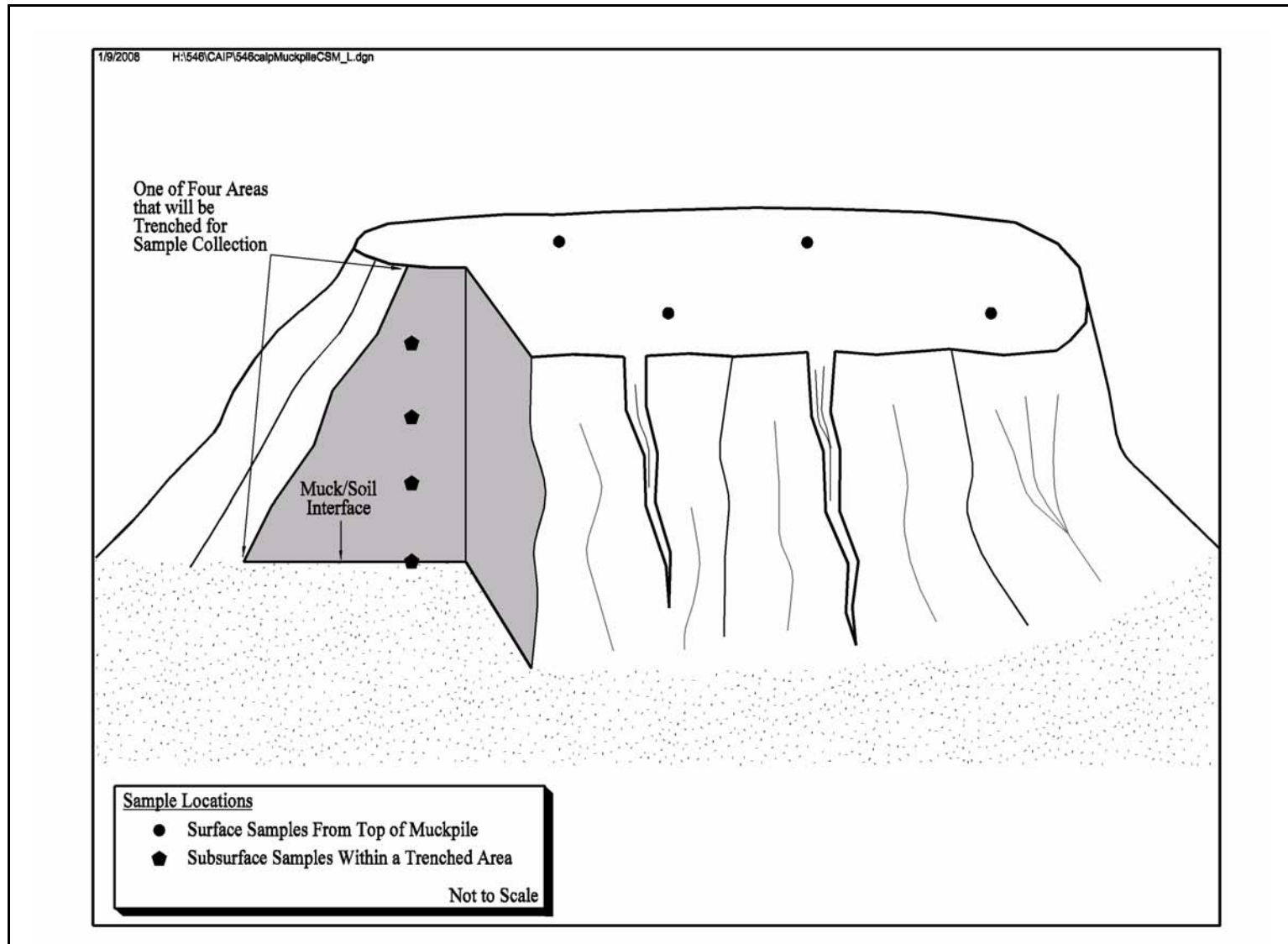


Figure A.9-1
Proposed Sample Locations at the CAS 06-23-02 Muckpiles

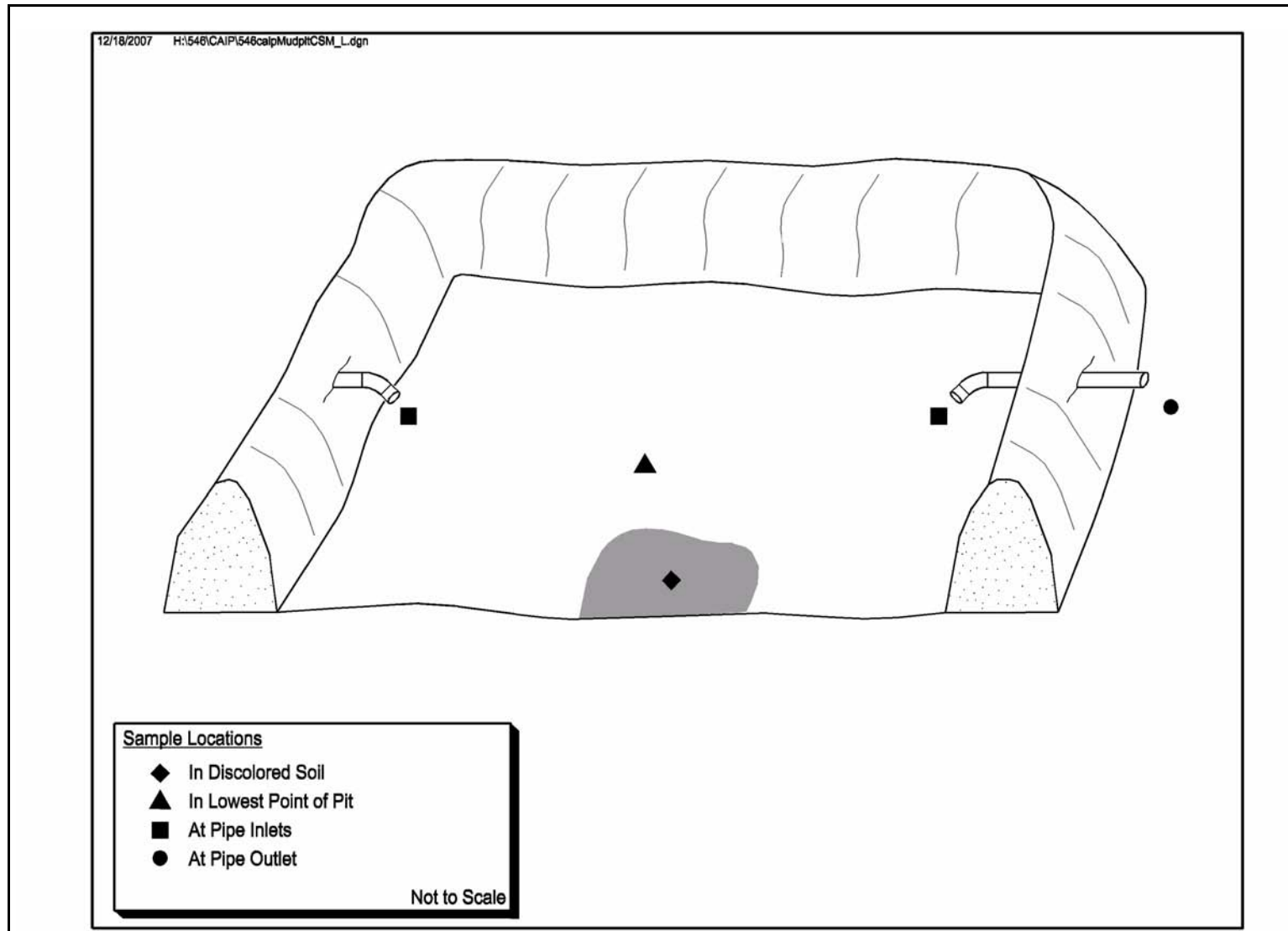


Figure A.9-2
Proposed Sample Locations at the CAS 06-23-02 Discharge Pit

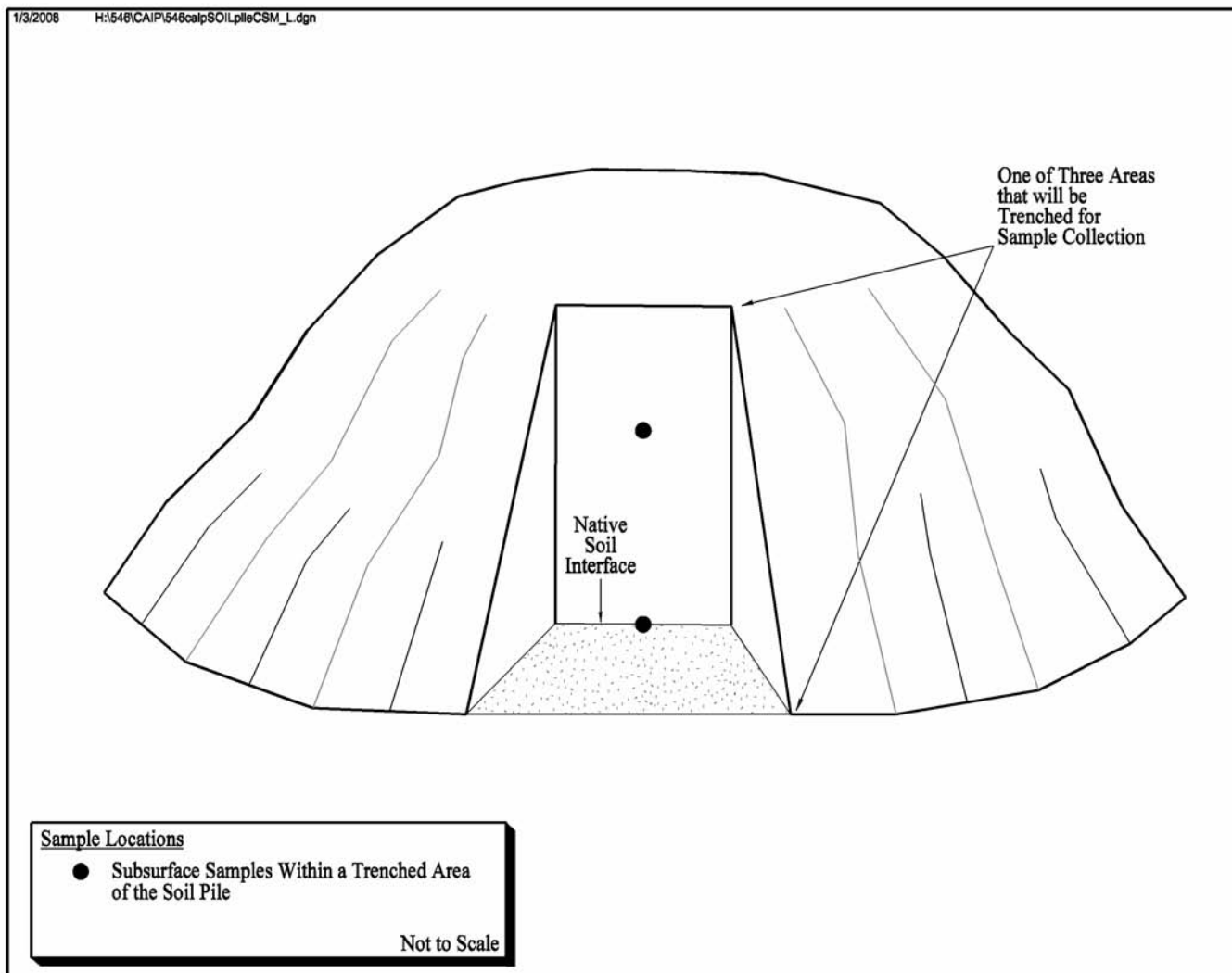


Figure A.9-3
Proposed Sample Locations at the CAS 06-23-02 Soil Pile

Vent Line – A minimum of three sample locations have been selected at the vent line. Surface samples (0.0 to 0.5 ft bgs) will be collected directly below the vent line and at two locations at a distance east of the vent line ([Figure A.9-4](#)). The samples will be collected using a scoop and pan. The sample locations will be collected based on a radiological walkover survey. If there are no biasing factors identified on the survey, then the locations will be randomly selected. Additionally, swipes will be taken of the inside and outside of the vent line. Other piping assemblies in the area that may be associated with the vent line will be evaluated during field activities, and samples will be collected based on the judgment of the Site Supervisor.

Testing Area – The entire testing area will be walked and inspected visually to identify biasing factors, if present. The area has been mapped out in transects that are spaced approximately 25 ft apart ([Figure A.9-5](#)). This survey along with the radiological walkover survey will be used to identify sample locations. If no biasing factors are identified, no samples will be collected. At pieces of debris that are potentially hazardous or have elevated radiological readings, one surface sample (0.0 to 0.5 ft bgs) will be collected below the debris.

Subsurface Anomaly – A backhoe, or similar equipment, will be used to access the anomaly. The sampling strategy for the subsurface anomaly will be determined once the anomaly has been exposed, because there is no information presently available to develop a strategy.

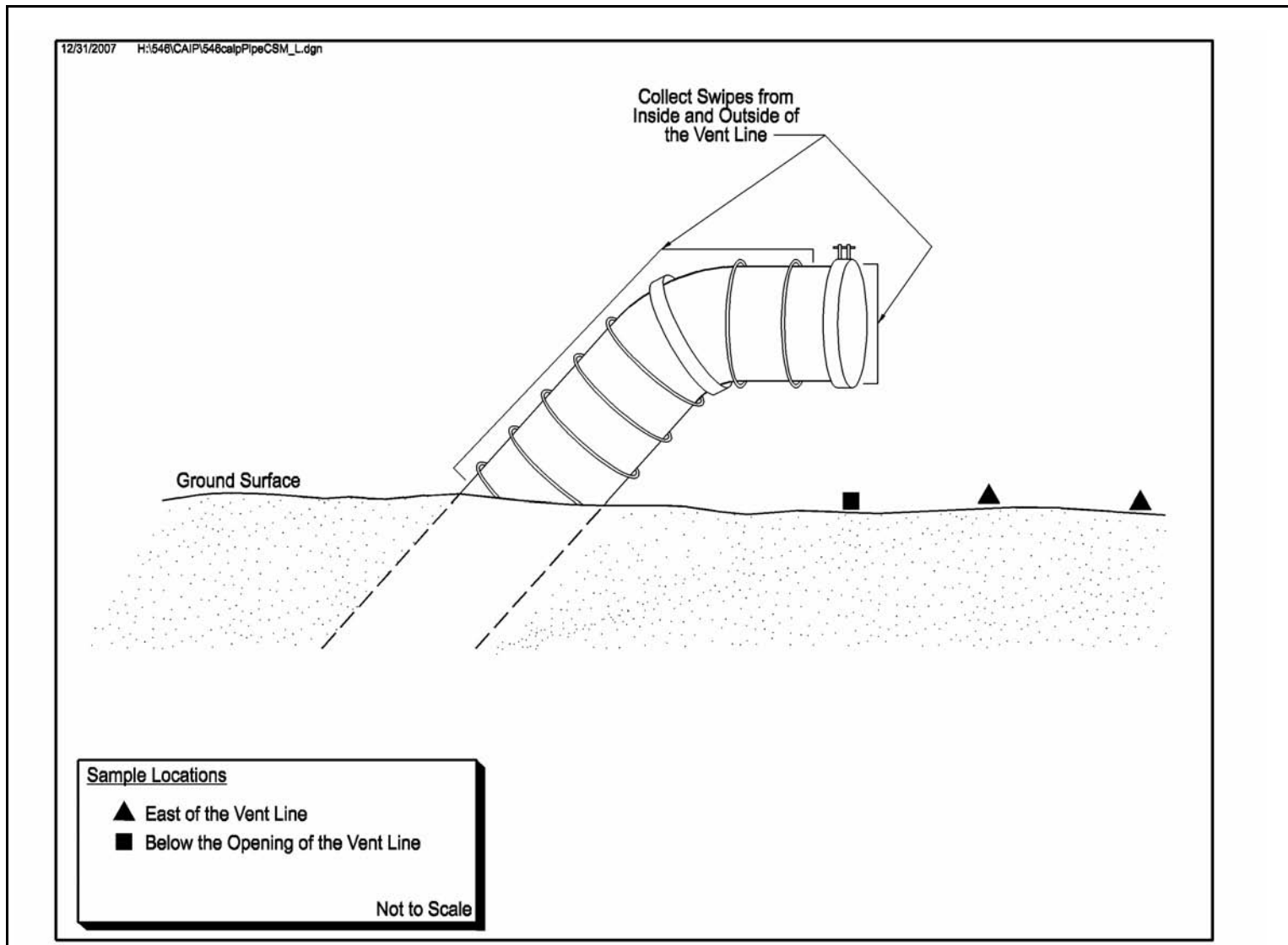


Figure A.9-4
Proposed Sample Locations at the CAS 06-23-02 Vent Line



Figure A.9-5
Transect Map of the CAS 06-23-02 Testing Area

A.9.1.2 Corrective Action Site 09-20-01, Injection Well

During Decision I sampling, the features discussed in the following sections will be sampled.

Injection Well – Three surface (0.0 to 0.5 ft bgs) samples will be collected surrounding the injection well. The samples will be collected using a scoop and pan. The locations will be selected based on biasing factors; if there are no biasing factors, the sample locations will be selected randomly. The Site Supervisor will use his professional judgment to select locations that would most likely be contaminated, if a COC is present.

Drum – One surface (0.0 to 0.5 ft bgs) sample will be collected from below the drum, at the lowest point of the excavated area. The sample will be collected using hand sampling tools such as a scoop and pan. A pitchfork or shovel will be used to remove tumbleweed from the pit. The area will be surveyed for biasing factors. If there are additional biasing factors, additional samples may be taken. Swipes will be taken of the inside and outside of the drum.

Proposed Decision I sample locations are shown in [Figure A.9-6](#).

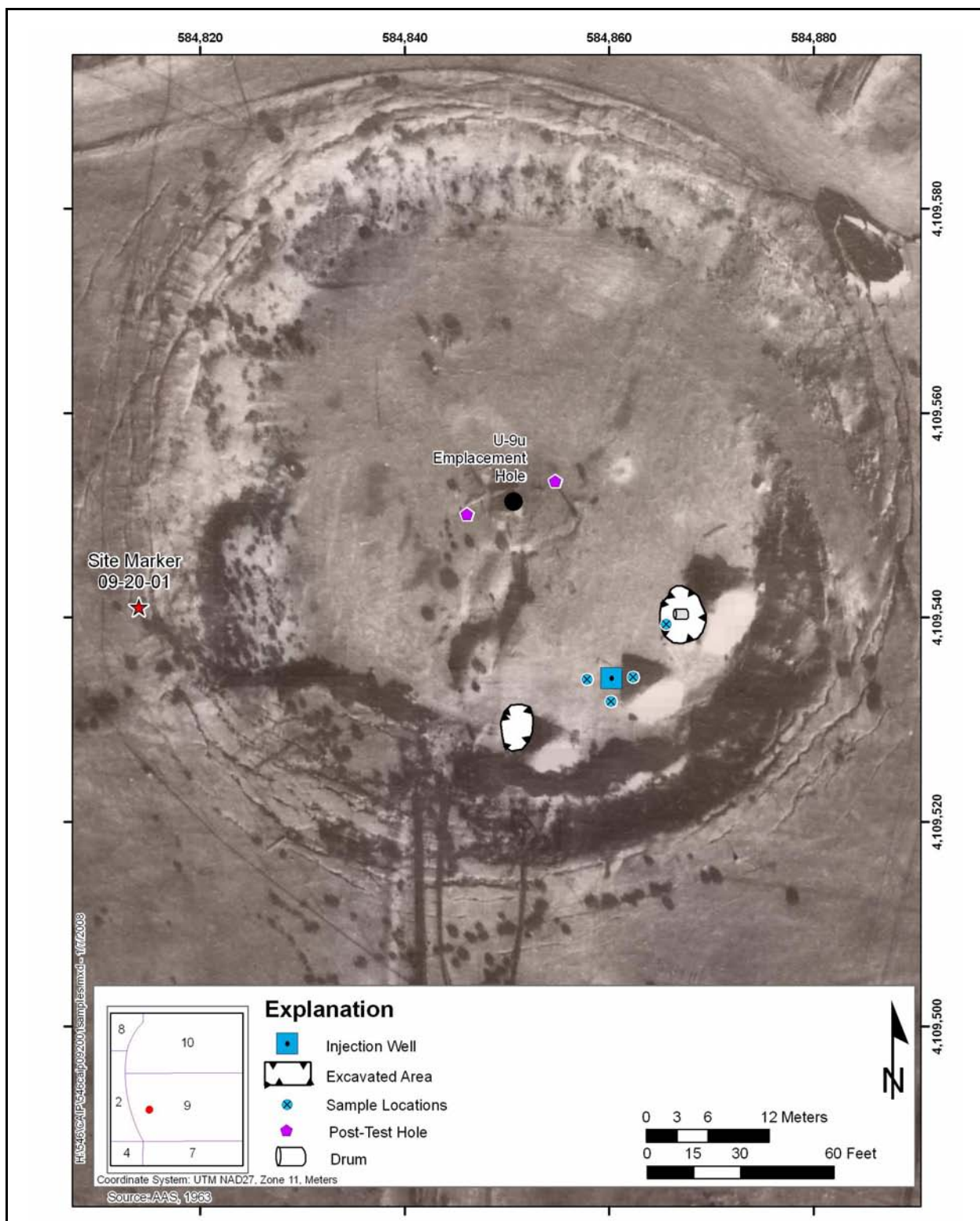


Figure A.9-6
Proposed Sample Locations at CAS 09-20-01

A.9.2 Decision II Sampling

To meet the DQI of representativeness for Decision II samples (that Decision II sample locations represent the population of interest as defined in [Section A.6.1](#)), judgmental sampling locations at each CAS will be selected based on the outer boundary sample locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in [Section A.5.2.1](#). In general, sample locations will be arranged in a triangular pattern around the Decision I location or area at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location, and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The number, location, and spacing of step-out samples may be modified by the Site Supervisor as warranted by site conditions.

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Appendix B

Project Organization

B.1.0 Project Organization

The NNSA/NSO Federal Sub-Project Director is Kevin Cabble. He can be contacted at (702) 295-5000. The NNSA/NSO Task Manager is Janis Romo. She can be contacted at (702) 295-0838.

The identification of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change, and it is suggested that the DOE Federal Sub-Project Director be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report before the start of field activities.

Appendix C

Nevada Division of Environmental Protection Comment Responses

(1 Page)

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Investigation Plan for Corrective Action Unit 546: Injection Well and Surface Releases, Nevada Test Site, Nevada	2. Document Date: 02/07/2008
3. Revision Number: 0	4. Originator/Organization: Stoller-Navarro
5. Responsible NNSA/NV ERP Project Manager: Kevin J. Cabble	6. Date Comments Due: 02/08/2008
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No: Don Elle and Ted Zaferatos, NDEP, 486-2850	9. Reviewer's Signature:

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) General	Mandatory	The report follows acceptable procedures and guidelines but does not appear to have been reviewed for completeness and clarity. Some sentences and paragraphs are incomplete and hinder the understanding of proposed actions. Contaminant findings are critical to the cleanup decision making process. The entire report should be proofread and corrected.	The document has undergone a complete editorial review.	

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