

Nevada
Environmental
Restoration
Project

DOE/NV--1371-REV 1



Corrective Action Investigation Plan for Corrective Action Unit 106: Areas 5, 11 Frenchman Flat Atmospheric Sites Nevada National Security Site, Nevada

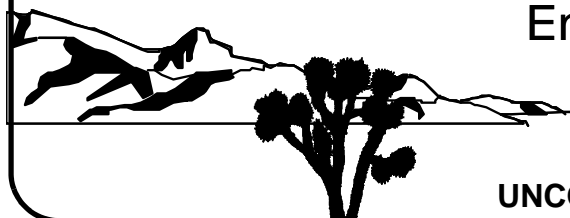
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**CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 106:
AREAS 5, 11 FRENCHMAN FLAT ATMOSPHERIC SITES
NEVADA NATIONAL SECURITY SITE, NEVADA**

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

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Signature: <u>/s/ Joseph P. Johnston</u>
Date: <u>7/29/2011</u>

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AREAS 5, 11 FRENCHMAN FLAT ATMOSPHERIC SITES
NEVADA NATIONAL SECURITY SITE, NEVADA**

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List of Acronyms and Abbreviations

Ac	Actinium
Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
Ca	Calcium
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CFR	<i>Code of Federal Regulations</i>
cm	Centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
Cs	Cesium
CSM	Conceptual site model
DCG	Derived Concentration Guideline
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRI	Desert Research Institute

List of Acronyms and Abbreviations (Continued)

DU	Depleted uranium
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FFACO	<i>Federal Facility Agreement and Consent Order</i>
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
ft ²	Square foot
GPS	Global Positioning System
GZ	Ground zero
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
kt	Kiloton
LCS	Laboratory control sample
m	Meter
m ²	Square meter
MDC	Minimum detectable concentration
mi	Mile
mi ²	Square mile
mrem/IA-yr	Millirem per Industrial Access year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate

List of Acronyms and Abbreviations (Continued)

NAC	<i>Nevada Administrative Code</i>
NAD	North American Datum
NAEG	Nevada Applied Ecology Group
Nb	Niobium
ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
NEPA	<i>National Environmental Policy Act</i>
NNES	Navarro Nevada Environmental Services, LLC
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
Np	Neptunium
NNSS	Nevada National Security Site
NTS	Nevada Test Site
NTSWAC	<i>Nevada Test Site Waste Acceptance Criteria</i>
PAL	Preliminary action level
Pb	Lead
PCB	Polychlorinated biphenyl
pCi	Picocurie
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
PET	Potential evapotranspiration
PPE	Personal protective equipment
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control

List of Acronyms and Abbreviations (Continued)

RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	<i>Resource Conservation and Recovery Act</i>
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
RIDP	Radionuclide and Distribution Program
RL	Reporting limit
RMA	Radioactive material area
RNM	Radionuclide Migration
RPD	Relative percent difference
RRMG	Residual Radioactive Material Guideline
RWMS	Radioactive waste management site
Sm	Samarium
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TED	Total effective dose
Th	Thorium
Tl	Thallium
TPH	Total petroleum hydrocarbons
U	Uranium
URMA	Underground radioactive material area
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 106 is located in Area 5 of the Nevada National Security Site (formerly the Nevada Test Site), which is approximately 65 miles northwest of Las Vegas, Nevada.

Corrective Action Unit 106 comprises the four corrective action sites (CASs) listed below:

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

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 (CAAs). Additional information will be obtained by conducting a corrective action investigation before evaluating CAAs and selecting the appropriate corrective action for each CAS. The results of the field investigation will support a defensible evaluation of viable CAAs that will be presented in the Corrective Action Decision Document.

The sites will be investigated based on the data quality objectives (DQOs) developed on January 19, 2010, by representatives of the Nevada Division of Environmental Protection and the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office. The DQO process was used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 106.

The presence and nature of contamination at CAU 106 will be evaluated based on information collected from a field investigation. The CAU includes land areas impacted by the release of radionuclides from groundwater pumping during the Radionuclide Migration study program (CAS 05-20-02), a weapons-related airdrop test (CAS 05-23-05), and unknown support activities at two sites (CAS 05-45-04 and CAS 05-45-05).

The presence and nature of contamination from surface-deposited radiological contamination from CAS 05-23-05, Atmospheric Test Site - Able, and other types of releases (such as migration and excavation as well as any potential releases discovered during the investigation) from the remaining

three CASs will be evaluated using soil samples collected from the locations most likely containing contamination, if present.

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

The scope of the corrective action investigation for CAU 106 includes the following activities:

- Conduct radiological surveys.
- Collect and submit environmental samples for laboratory analysis to determine internal dose rates and the presence of contaminants of concern.
- If contaminants of concern are present, collect additional samples to define the extent of the contamination and determine the area where the total effective dose at the site exceeds final action levels (i.e., corrective action boundary).
- Collect samples of investigation-derived waste, as needed, for waste management purposes.

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. 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) 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Nevada National Security Site (NNSS) (formerly the Nevada Test Site [NTS]), Nevada. It should be noted that this CAU originally included corrective action sites (CASs) located in Area 11 and Area 5 that have since been moved into other CAUs.

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).

Corrective Action Unit 106 is located in Area 5 of the NNSS, which is approximately 65 miles (mi) northwest of Las Vegas, Nevada ([Figure 1-1](#)). Corrective Action Unit 106 comprises the four CASs shown on [Figure 1-2](#) and listed below:

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

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

1.1 Purpose

The CASs in CAU 106 are being investigated because hazardous and/or radioactive contaminants may be present in concentrations that exceed risk-based corrective action (RBCA) levels. Existing information on the nature and extent of potential contamination is insufficient to evaluate and

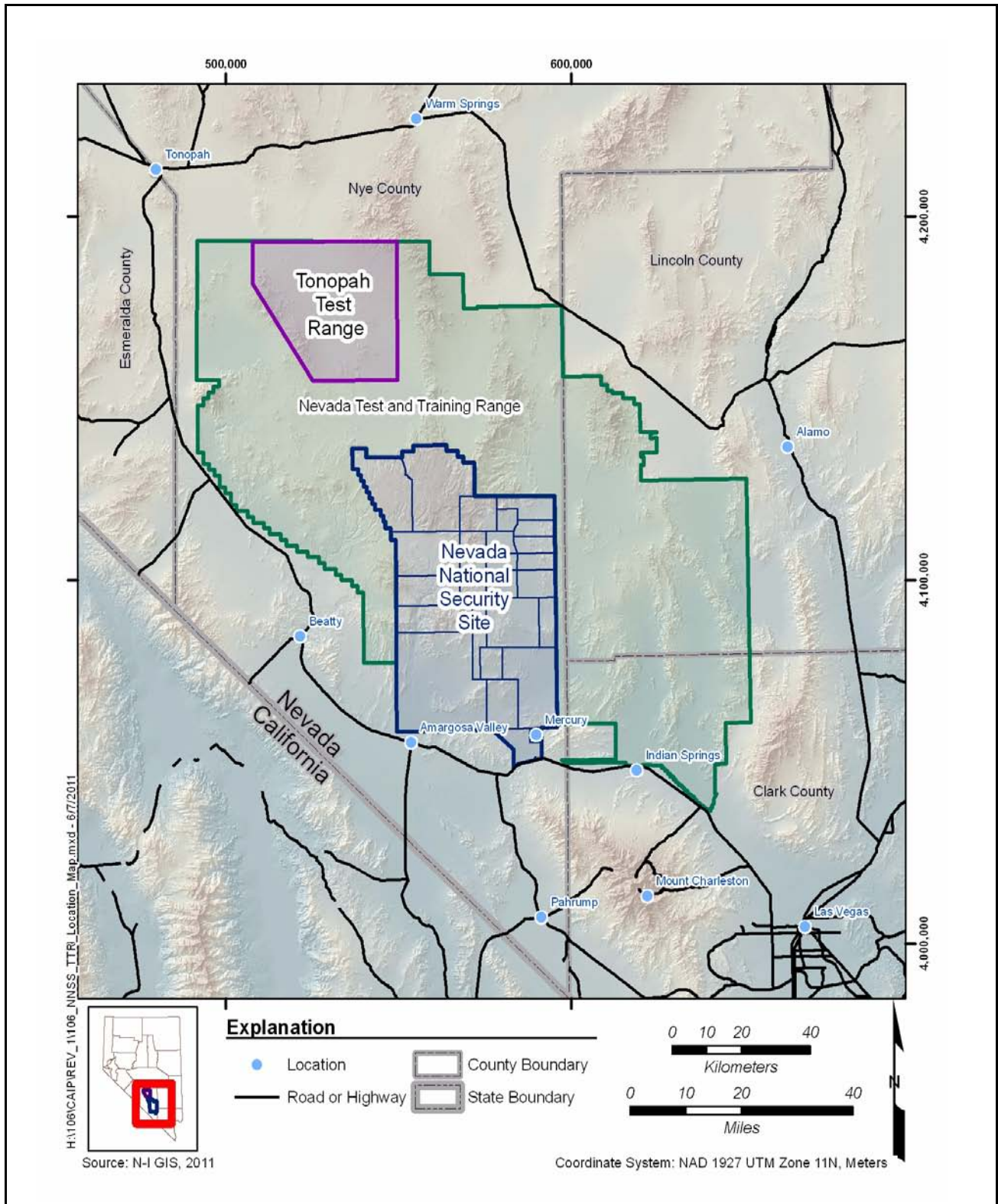


Figure 1-1
Nevada National Security Site

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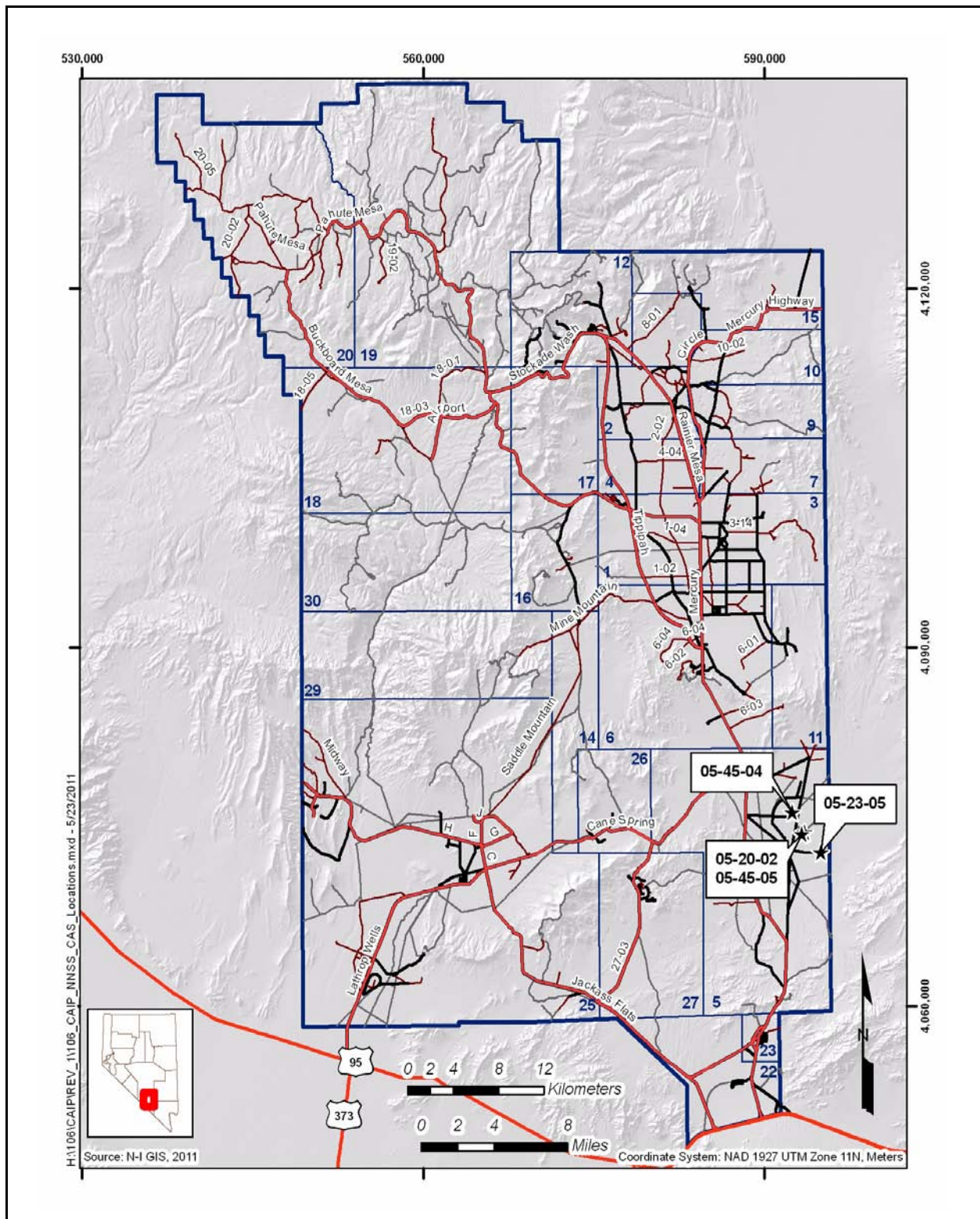


Figure 1-2
CAU 106, CAS Location Map

recommend CAAs for the CASs. Additional information will be generated by conducting a CAI before evaluating and selecting CAAs.

1.1.1 CAU 106 History and Description

Corrective Action Unit 106 consists of four inactive CASs located in Area 5 on Frenchman Flat that will be herein referred to by their associated test and/or common names (Able, Cambric Ditch, 306 GZ, and 307 GZ). Although Evaporation Pond is the FFACO name of CAS 05-20-02, the CAS is more commonly referred to as Cambric Ditch which is the most notable feature of the CAS. Therefore, Cambric Ditch will be the common name used herein. These sites were used to support nuclear testing and other experiments conducted in the Frenchman Flat area, primarily during the 1950s, although the radionuclide migration experiment associated with the Cambric test was performed from 1975 to 1991. The CAU includes land areas impacted by the release of radionuclides from groundwater pumping associated with the Radionuclide Migration (RNM) study (Cambric Ditch), a weapons-related airdrop test (Able), and unknown support activities at two sites (306 GZ and 307 GZ). Hazardous materials may have also been released at 306 GZ and 307 GZ. Operational histories for each CAU 106 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) and the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). 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 106. This CAIP describes the investigative approach developed to collect the necessary data identified in the DQO process. 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 106 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 106.” To address this problem, resolution of the following decision statements is required:

- Decision I: “Is any contaminant of concern (COC) associated with the CAS present in environmental media?” For judgmental sampling decisions, any contaminant of potential concern (COPC) associated with a CAS that is present at concentrations exceeding its corresponding final action level (FAL) will be defined as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006).
- Decision II: “Is sufficient information available to evaluate potential CAAs?” Sufficient information is defined to include:
 - The lateral and vertical extent of COC contamination
 - The information needed to predict potential remediation waste types and volumes
 - Any other information needed to evaluate the feasibility of remediation alternatives

A corrective action will be determined for any site containing a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at the site to cause the future contamination of site environmental media if the wastes were to be released (see [Section 3.4](#)).

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 106 CAS by collecting and analyzing samples generated during a field investigation. The presence of a COC will be determined by collecting and analyzing samples following this criterion:

- To make a judgmental sampling decision, samples must be collected in areas most likely to contain a COC.

The DQOs for CAU 106 defined the following two release scenarios to appropriately address the different types of releases that may be present at the CASs:

- The test release is defined as the initial atmospheric deposition of radiological contaminants from nuclear tests. The initial test release is generally observed as an annular geometric pattern of contamination from soil particle activation and initial fallout that generally decreases in intensity with distance from the source.
- A non-test release is defined as the subsequent movement of radiological contaminants from test releases (either migration or mechanical displacement) and other potential releases of contaminants from site operations (e.g., spills and abandoned materials).

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 106 includes the following activities:

- Perform radiological surveys and field screening.
- Move surface debris and/or materials, as needed, to facilitate sampling and surveys.
- Collect and submit environmental samples for laboratory analysis to determine internal dose rates.
- Collect samples of source material, if present, to determine the potential for a release to result in contamination exceeding FALs.
- Collect samples of potential remediation wastes, if present.
- Collect quality control (QC) samples.
- Collect and submit environmental samples for laboratory analysis to determine the presence and, if present, the nature and extent of COCs.

Contamination of environmental media originating from activities not identified in the conceptual site model (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 106. Objectives of the investigation, including the CSM, 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) is presented in [Section 6.0](#) and in the Industrial Sites Quality Assurance Project Plan (QAPP) (NNSA/NV, 2002a). 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, while [Appendix B](#) contains information on the project organization. [Appendix C](#) contains NDEP comments on the draft version of this document.

2.0 Facility Description

Corrective Action Unit 106 comprises four CASs that were grouped together based on the geographical location of the sites, technical similarities, and the agency responsible for closure. All CASs are located in Area 5 on Frenchman Flat (see [Figures 2-1 through 2-4](#)). The Able (CAS 05-23-05) site is located on the Frenchman Lake dry lake bed and the remaining Cambric Ditch (05-20-02), 306 GZ (CAS 05-45-04), and 307 GZ (CAS 05-45-05) sites are located nearby to the north.

2.1 Physical Setting

This section describes the general physical settings of Frenchman Flat in Area 5, including general background information pertaining to topography, geology, hydrogeology, and climatology. The following subsections are CAS-specific current conditions that pertain to the investigation and CSMs.

All four CASs in CAU 106 are located within the Frenchman Flat Hydrographic Area, which is a 110-square-mile (mi²) closed basin surrounded by low-lying mountains that separate this area from the Mercury Valley Hydrographic Area to the south and from the Yucca Flat Hydrographic Area to the north (USGS, 1996). Erosion of the surrounding mountains has resulted in the accumulation of more than 1,000 feet (ft) of alluvial deposits in some areas of Frenchman Flat (DOE/NV, 1996). The 306 GZ, 307 GZ, and Cambric Ditch sites are located on the alluvial deposits and unconsolidated gravels of Frenchman Flat, and the Able site is located on the ephemeral Frenchman Lake (dry lake bed) that measures approximately 4.5 mi² (DRI, 2000). During the dry season, the ground surface consists of a rough hard-packed silt with a well-defined mud-crack pattern, which is a classic dessication structure of the dry lake environment. During the rainy season, the lake bed may fill with shallow water, especially during wet years.

The principal drainage into the dry lake bed is Nye Canyon from the north, with lesser drainages from the west, including Cane Spring Wash and Barren Wash. Elevations range from 3,080 ft around the lake bed to 4,000 ft around the surrounding hills and mountains.

Groundwater flow beneath the Frenchman Flat area occurs primarily within the carbonate-rock aquifer that flows generally from the northeast to southwest. Within the overlying alluvial and

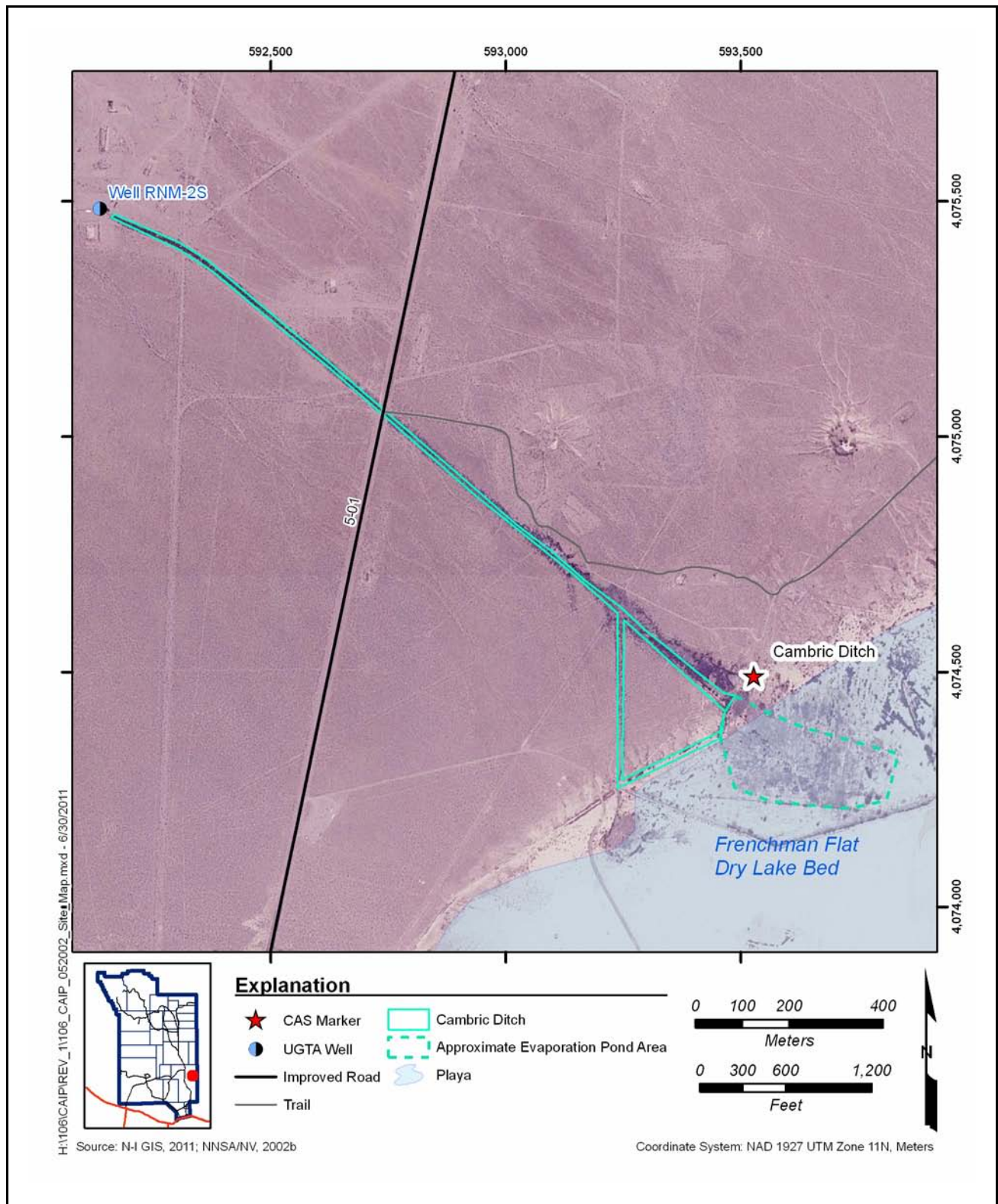


Figure 2-1
Cambric Ditch Physical Setting

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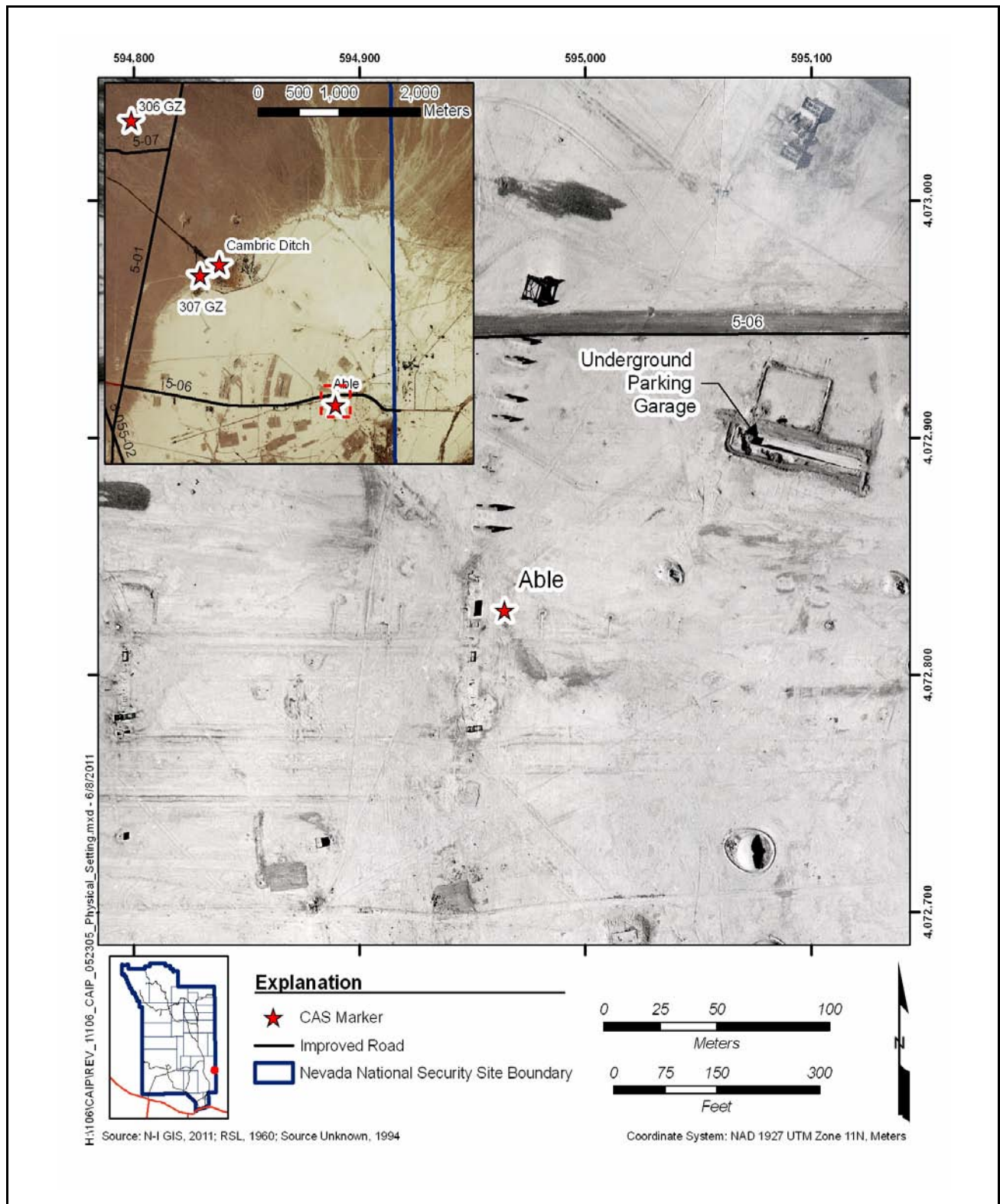


Figure 2-2
Able Physical Setting

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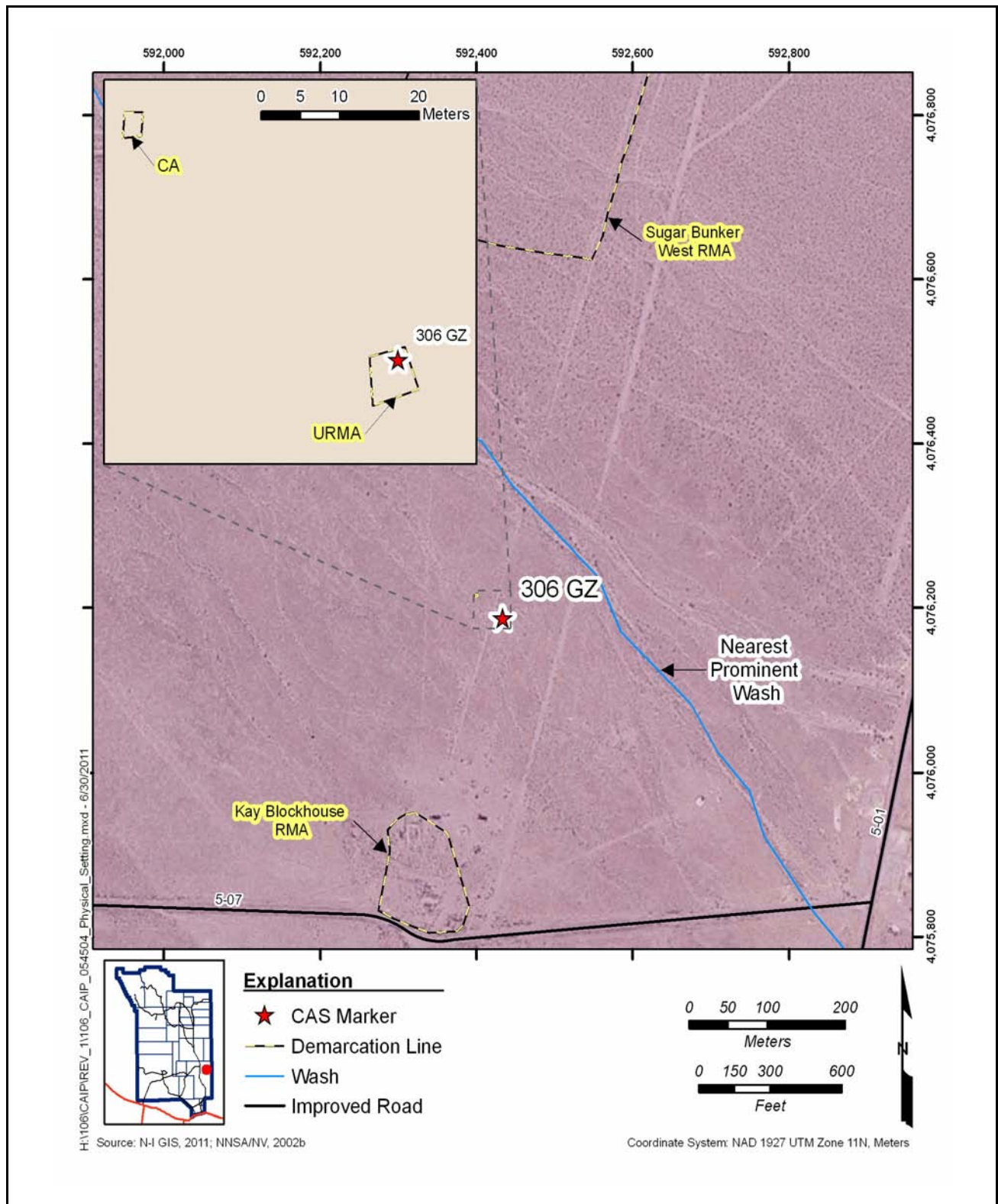


Figure 2-3
306 GZ Physical Setting

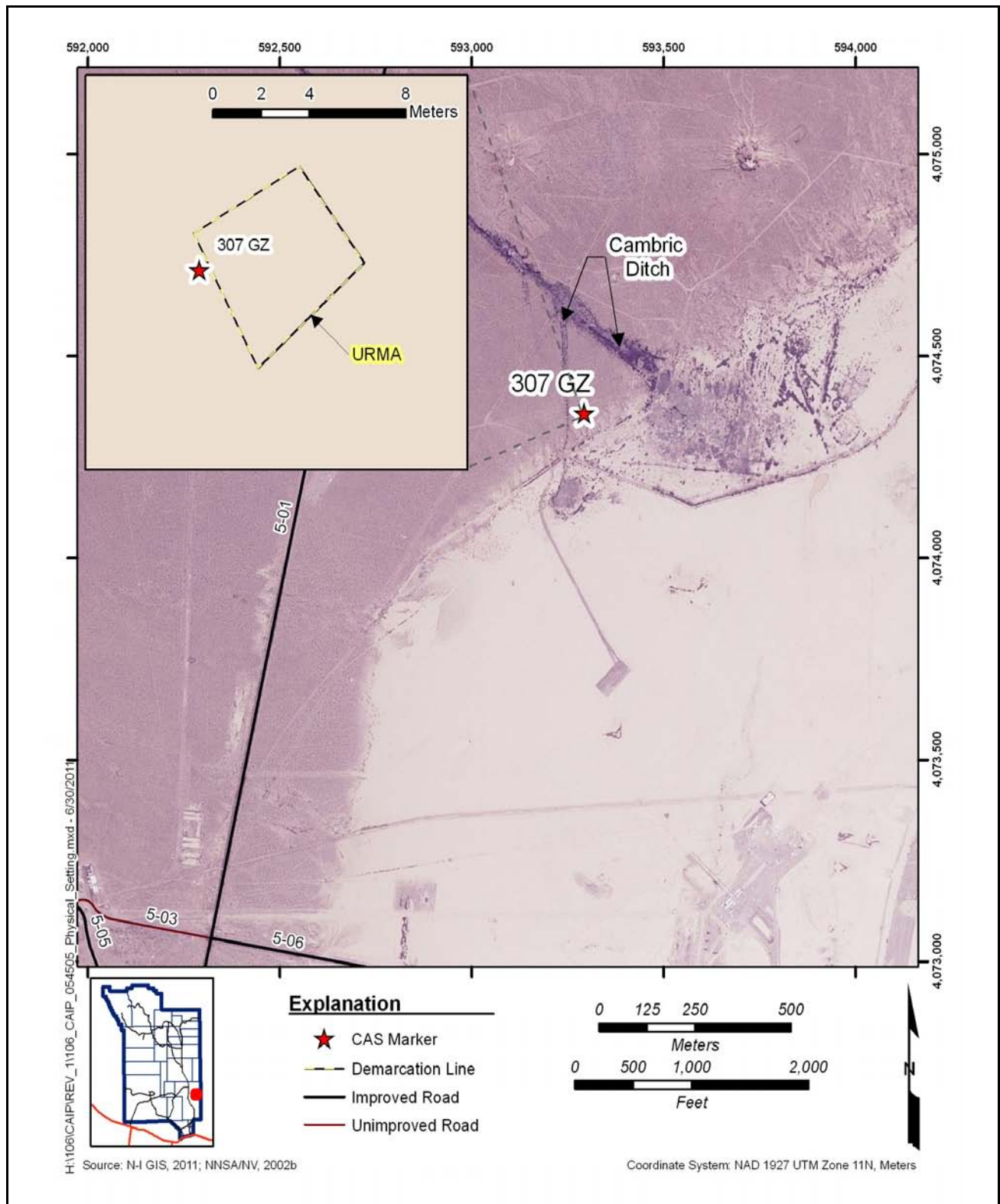


Figure 2-4
307 GZ Physical Setting

volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin, and downward into the carbonate-rock aquifer. The hydraulic gradient in most areas of the alluvial aquifer in Frenchman Flat is relatively flat (less than 1 ft per mile) except near active water wells and/or test wells (USGS, 2003). The nearest wells to the CASs in CAU 106 are UE-5, PW-1, UE-5n, and ER-5-4. The most recent recorded depth to the water table ranges between approximately 700 ft and 775 ft below ground surface (bgs) at these wells (USGS and DOE, 2009).

The average annual precipitation at station Well 5 B, which is located near Frenchman Flat, is 4.51 inches (in.) (ARL/SORD, 2009). Additional rainfall and potential evapotranspiration (PET) information is presented in [Table 2-1](#) (Yucel, 2009).

Table 2-1
Rainfall and PET Information for Frenchman Flat

	PET (in.)	Frenchman Flat Precipitation (in.)
Minimum	62.3	1.14
Maximum	64.8	9.67
Mean	63.5	4.51

2.1.1 Cambric Ditch

The Cambric Ditch site is located at the northwest shore of Frenchman Lake west towards Well RNM-2s east of the 5-01 Road. The access road to the site is off the east side of 5-01 Road, 0.7 mi past the intersection with 5-06 Road ([Figure 2-1](#)). The site consists of a dry wash-like feature known as the Cambric Ditch which runs between the inactive Well RNM-2s and an evaporation pond on the northwestern edge of the Frenchman Lake bed. This feature was excavated to support a portion of the RNM study which involved long-term pumping of Well RNM-2s, in an effort to understand migration of radionuclides within groundwater from the Cambric underground test. The 307 GZ site is located 150 ft west of an extension of the Cambric Ditch.

2.1.2 Able

The Able site is centrally located on Frenchman Lake ([Figure 2-2](#)), approximately 375 ft south of 5-06 Road and 400 ft southwest of the historic Underground Parking Garage associated with the

Priscilla test. Ground zero for the Able test is currently marked by a t-post and metal tag with the markings “Able GZ.” There are no radiological or other postings associated with Able and no debris or vegetation present. The soil of the dry lake bed consists of hard-packed silt. There are many historic structures in the immediate area related to the Frenchman Flat Historic District (DRI, 2000); however, they do not impact the Able site.

2.1.3 306 GZ

The 306 GZ site is located on the gentle slopes of Frenchman Flat approximately 1.25 mi north of Frenchman Lake and 1,200 ft north of 5-07 Road just north of the Kay Blockhouse (CAU 204) (Figure 2-3). The site contains a 20-by-20 ft posted underground radioactive material area (URMA) that is bordered with partially burned wood planks. On the south side of the posted URMA are a group of partially buried cables that appear to extend in the shallow subsurface in the general direction of Kay Blockhouse. However, no association between the two sites has been identified. An adjacent 10-by-10-ft posted contamination area (CA) is located 130 ft to the northwest. Surface debris present includes depleted uranium (DU) and previously melted metal fragments both inside and outside the posted URMA and CA. The soil in this area consists of coarse alluvium and unconsolidated gravels. The nearest prominent wash that drains south to Frenchman Lake is located approximately 500 ft to the east.

2.1.4 307 GZ

The 307 GZ site is located just off of the northwest shore of Frenchman Lake. The access road to the site is off the east side of 5-01 Road, 0.7 mi past the intersection with 5-06 Road. (Figure 2-4). The site contains a 20-by-20-ft posted URMA located behind a Controlled Area posting. Metal and DU debris items are present. The site is also located 150 ft east of an extension of the Cambic Ditch.

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 106 that may have resulted in releases of contaminants to the environment. The CAS-specific summaries are designed to describe the current definition of each CAS and document all significant, known activities.

2.2.1 Cambric Ditch

This CAS consists of the potential releases to the environment from a past study involving groundwater pumping and discharge from Well RNM-2s to the Cambric Ditch. The RNM study was conducted by Lawrence Livermore National Lab to better understand the migration of radionuclides in groundwater from the Cambric test cavity (Bryant, 1992). Cambric was an underground weapons-related shaft test conducted on May 14, 1965 below the water table at the northwest side of Frenchman Lake (DOE/NV, 2000). Well RNM-2s was completed in April 1974 to a depth of 1,156 ft bgs (SNJV, 2004a). This well was continuously pumped during the RNM study between 1975 and 1991 to draw radionuclides from the Cambric test cavity. In 2003, a multiple-well test to quantify hydraulic properties and geochemistry of local hydrostratigraphic units was conducted by pumping groundwater from Well RNM-2s for a period of 75 days (SNJV, 2004a). Groundwater from RNM-2s discharged into the Cambric Ditch and flowed into the evaporation pond on the northwest edge of Frenchman Lake (Thompson et al., 1997). See [Section A.2.2.1](#) for additional information.

2.2.2 Able

This CAS consists of the potential releases to the environment from the Able atmospheric test conducted on April 1, 1952, on Frenchman Lake as part of Operation Tumbler-Snapper (DOE/NV, 2000). Able was a weapons-effect airdrop test (sponsored by Los Alamos National Laboratory and U.S. Department of Defense [DoD]) with the height of burst at 800 ft and a yield of 1 kiloton (kt). The purpose of the Able test was to determine the effects of terrain on air-blast pressure and to check the validity of air-blast gauges used at the earlier tests of Operation Buster-Jangle (DRI, 2000). The test photograph shown in [Figure 2-5](#) suggests that the fireball did not contact the ground. Therefore, trinity glass would not have formed, and a majority of the fission products and unfissioned nuclear material would have been carried away in the fission cloud by the wind. The photograph also indicates some ground disturbance due to the shock wave at the ground zero area.

2.2.3 306 GZ

This CAS consists of the potential surface and subsurface releases to the environment from past activities associated with a posted URMA and an adjacent CA. Releases from debris will be included

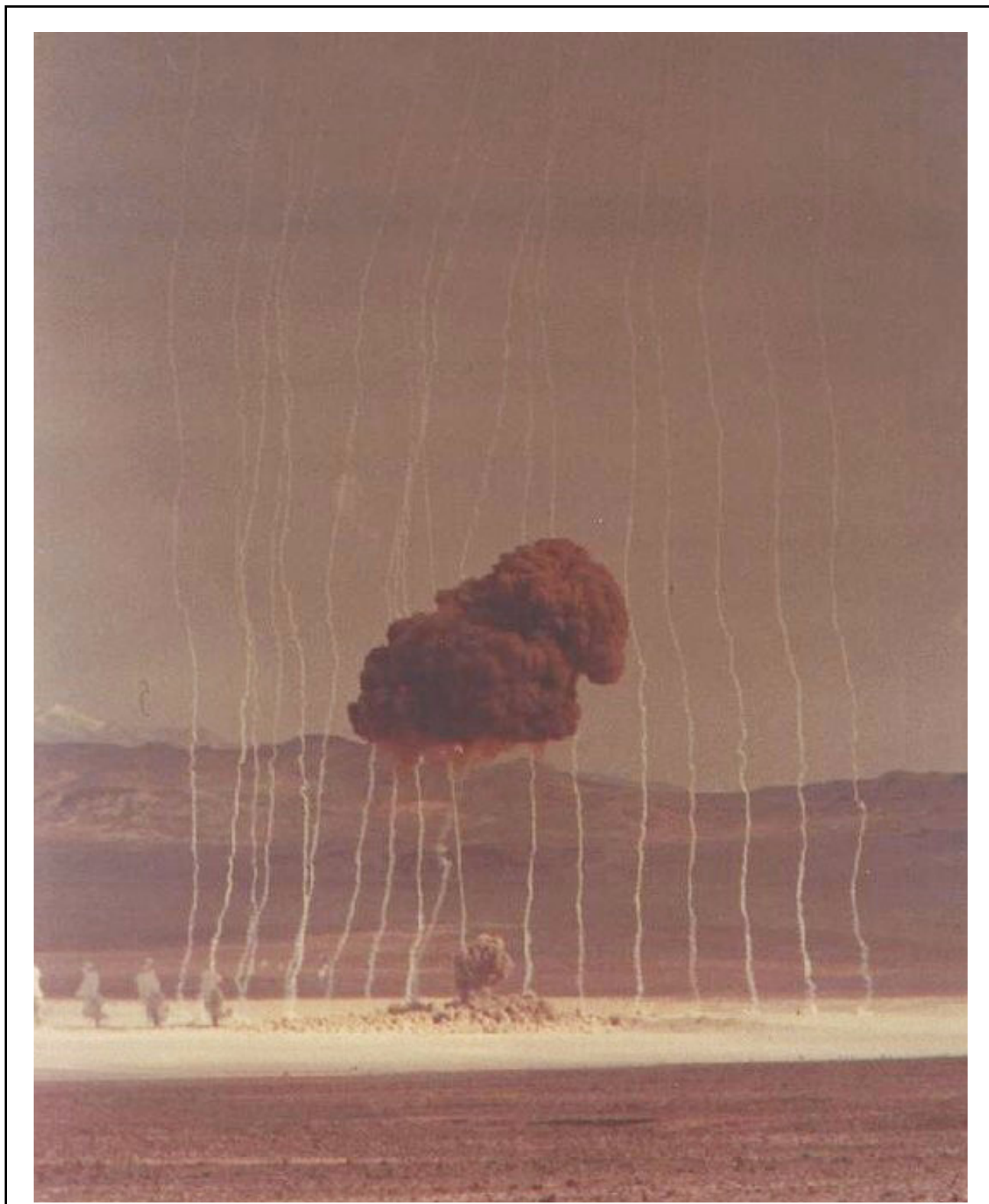


Figure 2-5
Photograph of Able Detonation on April 1, 1952
Source: NWA, 2002

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based on process knowledge of the materials and evidence of a release. The site was first identified in the Contaminated Land Areas Report (DOE/NV, 2000) as “306 GZ”; however, no information has yet been obtained regarding the activities that occurred there. Information about the specific type, number, and dates of experiment or test activities is unknown. Furthermore, it is unknown if anything has been buried within the posted URMA. It should not be assumed that the name “GZ” refers to “ground zero” because it is not believed that large-scale tests occurred at this site. According to interviewees, this site may have been the location of small-scale “test bed” experiments in support of other tests such as GMX.

2.2.4 307 GZ

This CAS consists of the potential surface and subsurface releases to the environment from past activities associated with a posted URMA. The site was first identified in the Contaminated Land Areas Report (DOE/NV, 2000) as “307 GZ”; however, no information has yet been obtained regarding the activities that occurred there, including whether any wastes have been buried as is indicated by the URMA postings. Similar to 306 GZ, it should not be assumed that the name “GZ” refers to “ground zero” because it is not believed that large-scale tests occurred at this site.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NNSC practices were used to identify wastes that may be present. The potential wastes specific to each CAS are listed in the following subsections.

2.3.1 Cambric Ditch

No solid waste items were identified during visual inspections at the site. Investigation-derived waste (IDW) streams including soil, personal protective equipment (PPE), and decontamination rinsate may be generated during the CAI. Potential waste types include industrial waste and low-level radioactive waste.

2.3.2 Able

No solid waste items have been identified at Able. Miscellaneous debris and structures are present in the surrounding area, but are not associated with this CAS. Investigation-derived waste streams including soil, PPE, and decontamination rinsate may be generated during the CAI. Potential waste types include industrial waste and low-level radioactive waste.

2.3.3 306 GZ

Solid waste items identified at 306 GZ include DU, unknown molten metal pieces, and burnt wood. Investigation-derived waste streams including soil, PPE, and decontamination rinsate may be generated during the CAI. Potential waste types that may be identified during the CAI include industrial waste, *Resource Conservation and Recovery Act* (RCRA) hazardous waste, low-level radioactive waste, and mixed waste.

2.3.4 307 GZ

Solid waste items identified at 307 GZ include DU. Investigation-derived waste streams including soil, PPE, and decontamination rinsate may be generated during the CAI. Potential waste types that may be identified during the CAI include industrial waste, RCRA hazardous waste, low-level radioactive waste, and mixed waste.

2.4 Release Information

The releases of contamination to the CASs are directly or indirectly associated with the Able and Cambric weapons-related tests, and unknown activities at 306 GZ and 307 GZ. The investigation of specific releases will depend upon the nature of these releases. Therefore, the releases at CAU 106 have been categorized into either the test release scenario or the non-test release scenario as defined in [Section 1.1.2](#).

The sources of contamination for the test release scenario at CAU 106 are the initial atmospheric deposition of radiological contaminants to surface soil from the Able nuclear weapon test. The sources of contamination for the non-test release scenario at CAU 106 are surface and subsurface wastes (e.g., DU, miscellaneous chemicals and debris items) present at the 306 GZ and 307 GZ sites,

and discharge of contaminated groundwater originating from the Cambic underground nuclear test to the surface and shallow subsurface soils within the Cambic Ditch.

Surface and shallow surface soils are the impacted media at all sites. Exposure routes to receptors include ingestion and inhalation of radionuclides in surface and shallow subsurface soil (internal exposure). Site workers may also be exposed to direct radiation by performing activities in proximity to radiologically contaminated materials (i.e., external dose).

The following subsections contain CAS-specific descriptions of known or suspected releases.

2.4.1 Cambic Ditch

The test release scenario, as defined in [Section 1.1.2](#), does not apply to Cambic Ditch because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear experiment.

The non-test release source for Cambic Ditch is the surface discharge of tritium-contaminated groundwater from Well RNM-2s to the surface of the man-made ditch. The contaminated water released into the ditch emptied into the evaporation pond located on the northwest edge of Frenchman Lake (DOE/NV, 2000; Thompson et al., 1997).

Additional release sources have not been identified at Cambic Ditch; however, there is always a potential to identify additional releases during the CAI.

2.4.2 Able

The test release source at Able is the atmospheric deposition of radionuclides (e.g., fallout of fuel fragments and fission products, and neutron activation of soil) to the surface soil from the detonation of a weapons-effect test with a 1-kt yield at 800 ft above the ground surface. Based on available information from radiological flyover surveys and soil studies, significant quantities of radionuclides were not released to the surface soil surrounding the Able ground zero. Therefore, soil contamination above FALs is not expected at this site. It is possible that the surface soil initially impacted by the Able test has subsequently been buried by lake sedimentation that occurs when the dry lake bed fills with shallow water. However, the initially impacted soil is expected to be near the surface (within the top 15 centimeters [cm] of soil) because of the low sedimentation rates on dry lake beds.

Non-test release sources have not been identified at Able; however, there is always a potential to identify a non-test release during the CAI.

2.4.3 306 GZ

The test release scenario, as defined in [Section 1.1.2](#), does not apply to 306 GZ because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear experiment.

The non-test release source of surface contamination includes abandoned wastes, particularly DU that may have released contaminants to the soil within and surrounding the posted URMA and CA. Other identified surface waste includes solid and molten metal fragments. Because information about the activities conducted at this site is scarce, radioactive and chemical contaminants that have not been identified may have been released to the surface soil. Non-test sources of subsurface contamination include any buried wastes within the boundary of the posted URMA. There is a potential for the subsequent migration of contaminants into nearby washes, although this is not anticipated because the nearest wash is 500 ft to the east.

2.4.4 307 GZ

The test release scenario, as defined in [Section 1.1.2](#), does not apply to 307 GZ because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear experiment.

The non-test release source of surface contamination includes abandoned wastes, particularly DU that may have released contaminants to the soil within and surrounding the posted URMA. Because information about the activities conducted at this site is scarce, radioactive and chemical contaminants that have not been identified may have been released to the surface soil. Non-test sources of subsurface contamination include any buried wastes within the boundary of the posted URMA. The subsequent migration of contaminants into nearby washes is not anticipated at this site.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 106 sites.

As part of an effort to assess the implications of contamination for future uses of the NNSS, the Radionuclide Inventory and Distribution Program (RIDP) was established in 1981 to conduct a comprehensive survey of the important man-made radionuclides of NNSS origin in the NNSS surface soil (DRI, 1989). Data collected for the RIDP and by the Nevada Applied Ecology Group (NAEG) in the 1970s and 1980s allowed for estimates of surface soil inventories throughout the NNSS. The RIDP estimated the inventory through *in situ* soil measurements by gamma spectroscopy and limited confirmatory soil sampling, and the NAEG utilized statistical designs and soil sample analyses to estimate radionuclide inventories for select areas of the NNSS.

An aerial radiological survey flown in 1994 used radiological detection systems to identify gamma radiation (BN, 1999). From the data collected, the gross count rates, man-made radiation, and americium (Am)-241 count rates were published for areas of the NNSS. The field detection of plutonium (Pu) contamination in surface soils can be achieved via the detection of low-energy gamma rays that are emitted from the Am-241 contaminant present in the Pu. The isotopes of Pu primarily emit alpha radiation, which is hard to detect in soils under field conditions. Special radiation detectors that are optimized to sense the low-energy gamma rays and to discriminate against other, higher-energy gamma rays must be used. The most common type is the field instrument for the detection of low-energy radiation (or “FIDLER”) detector.

2.5.1 Cambric Ditch

Previous investigations that produced data relevant to the CAI at Cambric Ditch include the RNM study and the 2003 multiple-well test. There is no coverage of RIDP data for this area, and there are no distinguishable gross count or Am-241 plumes associated with this site.

The maximum tritium concentration measured in groundwater during the RNM study was approximately 3 million picocuries per liter (pCi/L) measured in 1980. The maximum tritium activity measured in 2003 during the year of the multiple-well test ranged from 186,000 to 154,000 pCi/L. Radionuclide data in groundwater discharged from Well RNM-2s has been compiled in the GEOCHEM database developed as part of the UGTA Program (SNJV, 2005). [Table A.8-1](#) provides a summary of the maximum radionuclide concentrations from 1975 through 2003 taken from the results compiled in the GEOCHEM database.

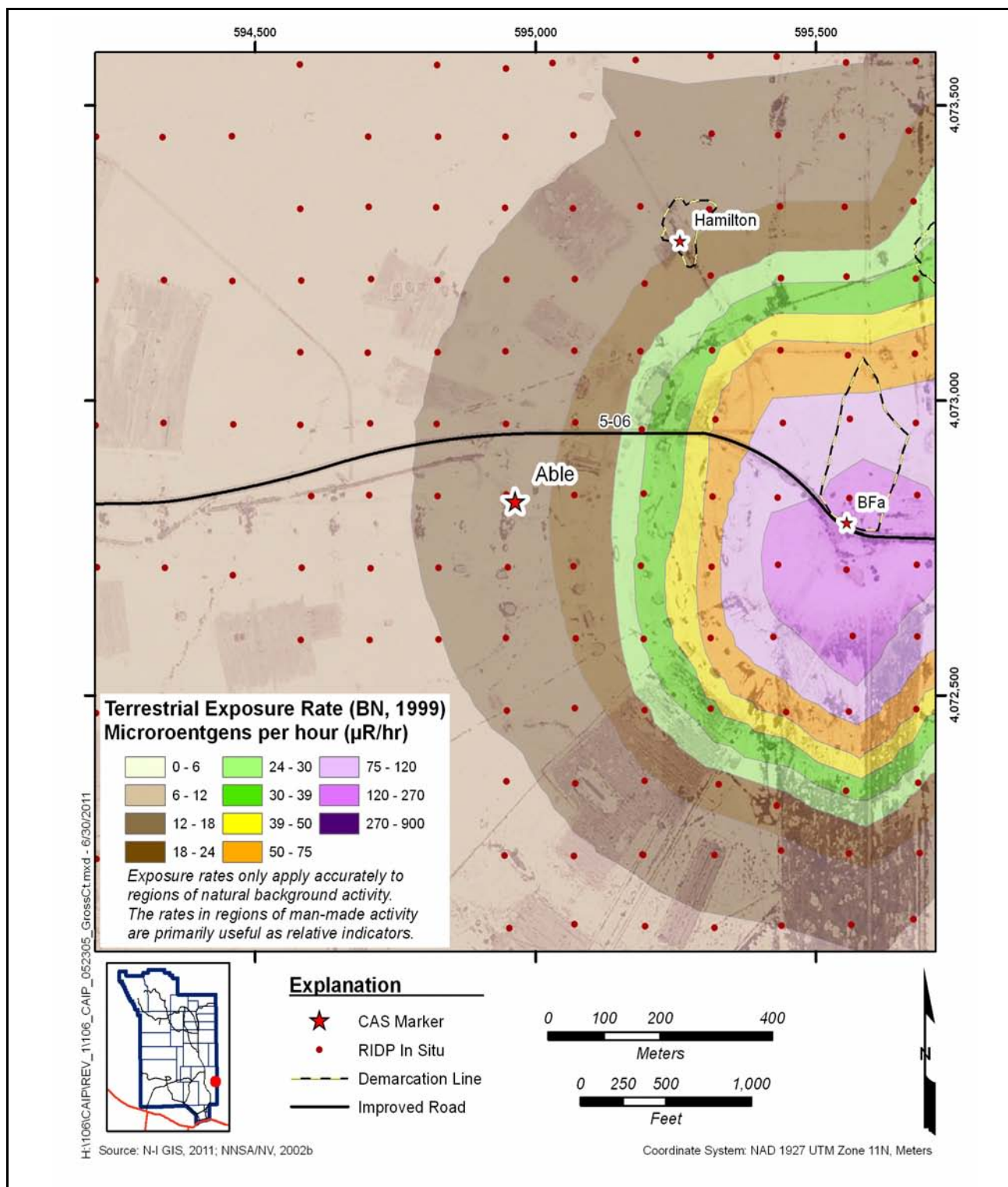
2.5.2 Able

Previous investigations that produced data relevant to the CAI at Able include the surface soil inventory studies by the RIDP and Desert Research Institute (DRI), and aerial radiological surveys.

The Frenchman Lake area was studied intensively as part of the RIDP because a total of 14 aboveground tests were conducted in that area (including Able). [Figure 2-6](#) shows the locations of *in situ* measurements from Frenchman Lake in the vicinity of Able and indicates a low density of data points surrounding the Able site. Soil samples were collected from 29 of the *in situ* measurement locations from Frenchman Lake; however, none of these were collected at Able. The radionuclide inventory estimates for Frenchman Lake are reported (DRI, 1989); however, this information represents a reported 62.4-million-square-foot (ft²) area, and therefore, does not provide value specific to the Able CAI.

In addition to the RIDP data, a radiological characterization study of the Frenchman Lake region was conducted as part of the NTS Radiological Assessment Project and included the Able site (Barnes et al., 1980). Between April 1978 and June 1979, 68 samples were collected at the Able site and analyzed for americium (Am)-241, cesium (Cs)-137, europium (Eu)-155, cobalt (Co)-60, and plutonium (Pu)-239 activities (Barnes et al., 1980). The results are presented on contour maps showing only isopleths of activity for Am-241 (up to 2.5 picocuries per gram [pCi/g]) and Pu-239 (up to 20 pCi/g), indicating that relatively low quantities are present for all analyzed constituents. The isopleths cover the region near Able; however, there are no distinct signatures directly associated with the Able site. Individual sample results are not reported.

The 1994 radiological flyover survey results show no distinguishable gross count or Am isopleths associated with Able ([Figure 2-6](#)). It should be noted that Able is located on the edge of the gross gamma count plume (BN, 1999) associated with the BFa site (CAS 05-23-04), which is being addressed under CAU 541. The BFa site was the location of six tests conducted post-Able in 1953, 1955, and 1957.



**Figure 2-6
 1994 Aerial Radiological Survey Results and RIDP
 In Situ Measurement Locations at Able**

2.5.3 306 GZ

After an extensive search of historical information regarding the 306 GZ, no previous investigations or historical analytical data have been identified. Furthermore, there is no coverage of RIDP data for this area, and there are no distinguishable gross count or Am-241 plumes associated with this site.

2.5.4 307 GZ

After an extensive search of historical information regarding the 306 GZ, no previous investigations or historical analytical data have been identified. Furthermore, there is no coverage of RIDP data for this area, and there are no distinguishable gross count or Am-241 plumes associated with this site.

2.5.5 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, 1996) includes site investigation activities such as those proposed for CAU 106.

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 106. This checklist requires NNSA/NSO project personnel to evaluate their proposed project activities against 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 106 and formulation of the CSM. Also presented is a summary listing of the COPCs, the preliminary action levels (PALs), and the process used to establish FALs. Additional details and figures depicting the CSM are located in [Appendix A](#).

3.1 Conceptual Site Model

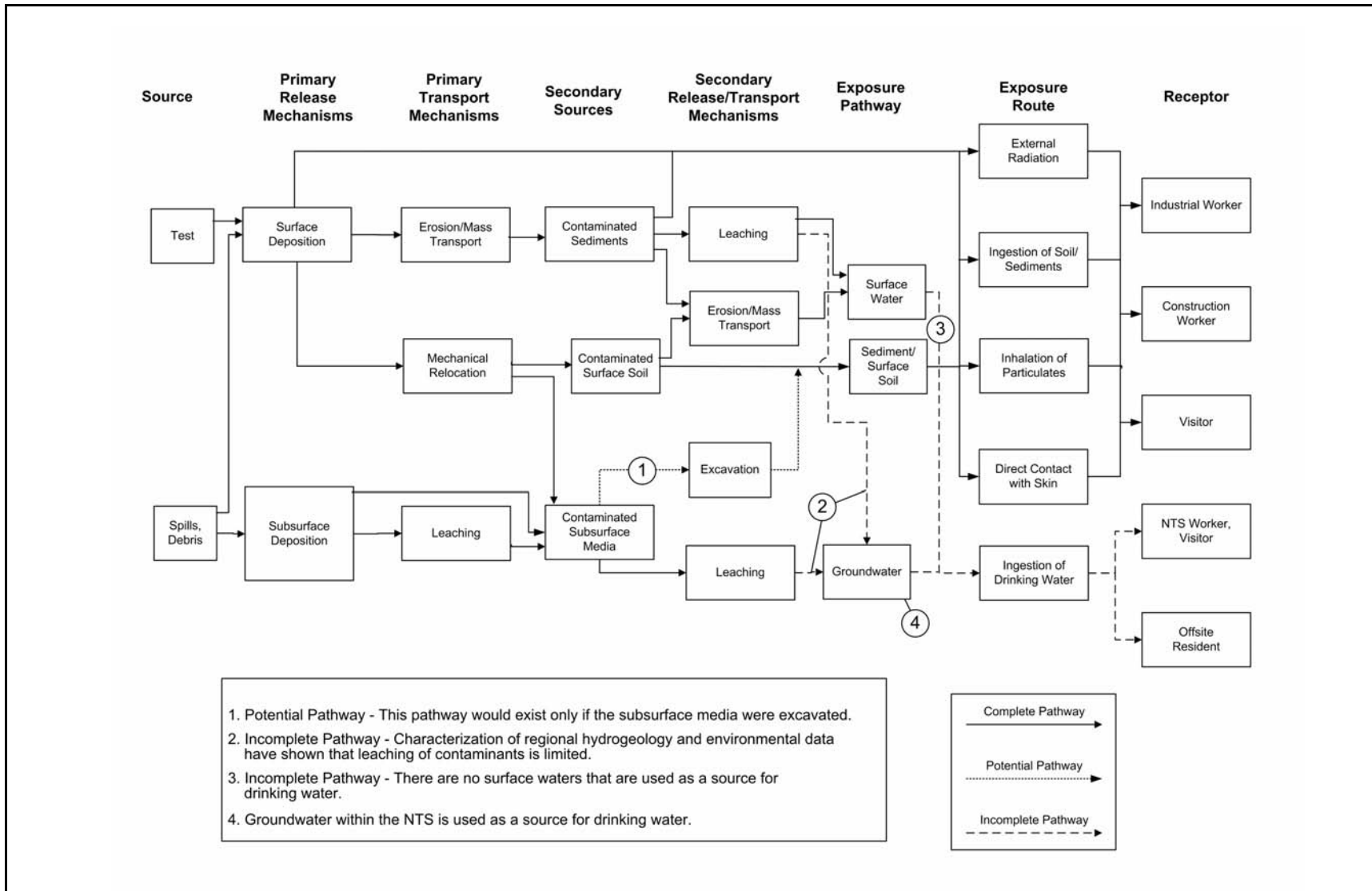
The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM was used to develop appropriate sampling strategies and data collection methods. Site specific CSMs were developed for CAU 106 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 representation of the conceptual pathways to receptors from CAU 106 sources. [Figure 3.2](#) provides schematic representations of the CSMs. If evidence of contamination that is not consistent with the presented CSM is identified during investigation activities, the situation will be reviewed, the CSM will be revised, the DQOs will be reassessed, and a recommendation will be made as to how best to proceed. In such cases, decision-makers listed in [Section A.2.1](#) will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 106.

3.1.1 Land Use and Exposure Scenarios

Land-use zones where the CAU 106 CASs are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

The 306 GZ site is located in the land-use zone described as “Reserved Zone.” This area includes land and facilities that provide widespread flexible support for diverse short-term testing and



**Figure 3-1
 Conceptual Pathways to Receptors**

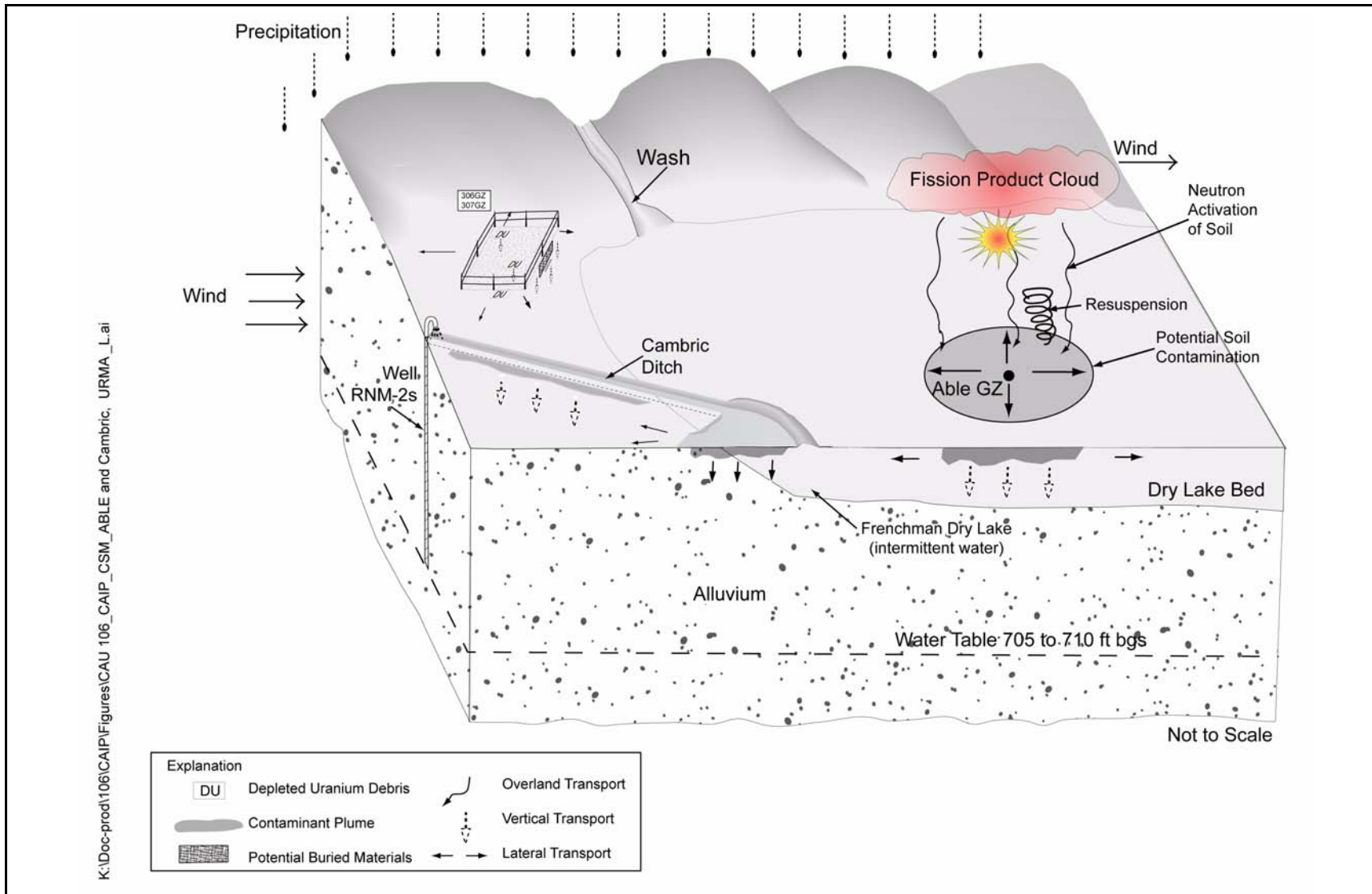


Figure 3-2
Conceptual Site Model for CAU 106

experimentation. The reserved zone is also used for short-duration exercises and training, such as nuclear emergency response, Federal Radiological Monitoring and Assessment Center training, and DoD exercises and training (DOE/NV, 1998).

Able, Cambric Ditch, and 307 GZ are located in the land-use zone described as “Research, Test, and Experiment Zone” within the NNSS. This area is designated for small-scale research and development projects and demonstrations; pilot projects; outdoor tests; and experiments for the development, QA, or reliability of material and equipment under controlled conditions. This zone includes compatible research, development, and testing activities (DOE/NV, 1998).

The exposure scenario for CAU 106 is an Occasional Use Area, based on current and projected future land uses. This exposure scenario assumes exposure to industrial workers who are not assigned to the area as a regular work location but may occasionally use the area for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 8 hours per day, 10 days per year, for 5 years.

These exposure scenarios are used in the calculation of Tier 2 and Tier 3 action levels as described in [Section 3.3](#). Although Tier 2 and Tier 3 FALs may be established on the actual current and projected future land use scenarios, a more conservative land use scenario may also be used. For example, the FAL for a particular CAS categorized as an Occasional Use Area may be based on the Occasional Use Area scenario, or either the Remote Work Area scenario or the Industrial Area scenario may be used for conservatism.

3.1.2 Contaminant Sources

As discussed in [Section 2.4](#), the test release sources at CAU 106 are the initial atmospheric deposition of radiological contaminants to surface soil from the Able test. Contamination on the soil surface may be the source for future migration.

The non-test release sources at CAU 106 are spills or releases from surface and subsurface wastes (e.g., DU, miscellaneous chemicals and debris items) present at the 306 GZ, and 307 GZ sites, and the discharge of contaminated groundwater originating from the Cambric nuclear test to the surface and shallow subsurface soils within the Cambric Ditch and evaporation pond.

See [Table A.2-1](#) for CAS-specific listing of potential contaminant sources.

3.1.3 Release Mechanisms

Test-related release mechanisms include the release of fission products and neutron activation of soil and structural components at Able as well as release of unfissioned nuclear material at Able. The atmospheric detonation at Able may have irradiated the surrounding soil with neutrons, causing the activation of some elements in the soil. However, the absence of gross count and Am-241 activities as shown by radiological flyover surveys and the minimal ground disturbance from the air burst at Able as shown by the test photograph ([Figure 2-5](#)) suggest that the test release of radionuclides to the surface soil was minor.

Non-test release mechanisms for the CSM at all CASs include spills and leaks from abandoned surface waste onto surface soils. Additional non-test release mechanisms include the potential for subsurface releases from wastes at 306 GZ, and 307 GZ. There is a potential for subsequent migration of contaminants into nearby washes at 306 GZ. The non-test release mechanisms for Cambric Ditch includes the mechanical displacement of radionuclides by pumping contaminated groundwater to the surface and subsurface soils within the Cambric Ditch which empties into the evaporation pond.

3.1.4 Migration Pathways

Surface migration pathways include the lateral migration of potential contaminants across surface soils into washes transecting the sites since the original deposition. The washes entering and leaving these areas are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical (infiltration) 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 identified as sedimentation areas. This migration pathway applies to 306 GZ, where a wash approximately 500 ft east of 306 GZ drains to Frenchman Lake; however, migration of contaminants is not expected because of the distance of the wash from the source. Although similar to an ephemeral wash with intermittent stormwater flow events, groundwater discharge events to

Cambric Ditch were longer in duration, maintained a constant volume of discharge, and are assumed to have contained less energy for sediment entrainment than typical stormwater events.

Infiltration and percolation of precipitation serve as a driving force for the potential downward migration of contaminants. However, because of high potential evapotranspiration (annual potential evapotranspiration at the Area 5 Radiological Waste Management Site has been estimated at 63.5 in. [Yucel, 2009]) and limited precipitation for this region (4.85 in. per year [ARL/SORD, 2009]), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992). Although there may be standing water at times on Frenchman Lake, accumulation of fine materials on the lake bed has decreased the hydraulic conductivity of the lake bed to the point where infiltration is not significant (i.e., most of the accumulated water evaporates before it infiltrates the lake bed surface). Reported recharge rates for the Frenchman Flat area range from below 0.1 to 2 millimeters per year (SNJV, 2004b).

Subsurface migration pathways at all 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 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 holding capacity, 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.

3.1.5 Exposure Points

Exposure points for the CSM are expected to be areas of surface contamination where visitors and site workers may come in contact with contaminated surface soil and/or potential source material (PSM). At Able, the initially contaminated surface may have been covered because of subsequent sedimentation on Frenchman Lake; however, the contaminated horizon is expected to be within the top 15 cm of the soil profile. Subsurface exposure points may exist if construction workers come in contact with contaminated media during future excavation activities.

3.1.6 Exposure Routes

Exposure routes to site workers include ingestion and inhalation from disturbance of, or direct contact with, contaminated media. Site workers may also be exposed to direct ionizing radiation by performing activities in proximity to radioactive materials.

3.1.7 Additional Information

Information concerning topography, geology, climatic conditions, hydrogeology, and infrastructure at the CAU 106 CASs is 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 CAAs, as applicable. Climatic and physical site conditions will be recorded during the CAI.

3.2 Contaminants of Potential Concern

Based on the suspected contaminants identified in [Section 2.4](#), the COPCs for CAU 106 are defined as the list of analytes represented by the analytical methods identified in [Table 3-1](#) for Decision I environmental samples taken at each of the CASs. The analytes reported for each analysis are listed in [Table 3-2](#).

The list of COPCs is intended to encompass all 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 and other non-test releases (including those that may be

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

Analyses	Cambric Ditch	Able	306 GZ	307 GZ
Organic COPCs				
PCBs	--	--	X	X
SVOCs	--	--	X	X
VOCs	--	--	X	X
Inorganic COPCs				
RCRA Metals	--	--	X	X
Total Beryllium	--	--	X	X
Hexavalent Chromium	--	--	X	X
Radionuclide COPCs				
Gamma Spectroscopy ^b	--	X	X	X
Isotopic U	--	X	X	X
Isotopic Pu	--	X	X	X
Sr-90	--	X	X	X
Tritium	X	--	--	--

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

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

PCB = Polychlorinated biphenyl
 Sr = Strontium
 SVOC = Semivolatile organic compound
 U = Uranium
 VOC = Volatile organic compound

X = Required analytical method
 -- = Not required

discovered during the investigation). Specific COPCs will be determined for discovered potential releases based on the nature of the potential release (e.g., hydrocarbon stain, DU, lead bricks).

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

**Table 3-2
 COPCs Reported by Analytical Methods**

VOCs		SVOCs		PCBs	Metals	Radionuclides
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	2,3,4,6-Tetrachlorophenol	Di-n-octyl phthalate	Aroclor 1016	Arsenic	Am-241
1,1,1-Trichloroethane	Chlorobenzene	2,4,5-Trichlorophenol	Dibenzo(a,h)anthracene	Aroclor 1221	Barium	Pu-238
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,6-Trichlorophenol	Dibenzofuran	Aroclor 1232	Beryllium	Pu-239/240
1,1,2-Trichloroethane	Chloroform	2,4-Dimethylphenol	Diethyl phthalate	Aroclor 1242	Cadmium	Sr-90
1,1-Dichloroethane	Chloromethane	2,4-Dinitrotoluene	Dimethyl phthalate	Aroclor 1248	Chromium	U-234
1,1-Dichloroethene	Chloroprene	2-Chlorophenol	Fluoranthene	Aroclor 1254	Hexavalent chromium	U-235
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Methylnaphthalene	Fluorene	Aroclor 1260	Lead	U-238
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylphenol	Hexachlorobenzene	Aroclor 1268	Mercury	Tritium
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Nitrophenol	Hexachlorobutadiene		Selenium	
1,2-Dichlorobenzene	Ethyl methacrylate	3-Methylphenol ^a (m-cresol)	Hexachloroethane		Silver	
1,2-Dichloroethane	Ethylbenzene	4-Methylphenol ^a (p-cresol)	Indeno(1,2,3-cd)pyrene			Gamma-Emitting
1,2-Dichloropropane	Isobutyl alcohol	4-Chloroaniline	n-Nitroso-di-n-propylamine			Ac-228 (Th-232)
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Nitrophenol	Naphthalene			Am-241
1,3-Dichlorobenzene	Methacrylonitrile	Acenaphthene	Nitrobenzene			Co-60
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthylene	Pentachlorophenol			Cs-137
1,4-Dioxane	Methylene chloride	Aniline	Phenanthrene			Eu-152
2-Butanone	n-Butylbenzene	Anthracene	Phenol			Eu-154
2-Chlorotoluene	n-Propylbenzene	Benzo(a)anthracene	Pyrene			Eu-155
2-Hexanone	sec-Butylbenzene	Benzo(a)pyrene	Pyridine			Nb-94
4-Isopropyltoluene	Styrene	Benzo(b)fluoranthene				Pb-212
4-Methyl-2-pentanone	tert-Butylbenzene	Benzo(g,h,i)perylene				Pb-214
Acetone	Tetrachloroethene	Benzo(k)fluoranthene				Tl-208
Acetonitrile	Toluene	Benzoic acid				Th-234 (U-238)
Allyl chloride	Total xylenes	Benzyl alcohol				U-235
Benzene	Trichloroethene	Bis(2-ethylhexyl)phthalate				
Bromodichloromethane	Trichlorofluoromethane	Butyl benzyl phthalate				
Bromoform	Vinyl acetate	Carbazole				
Bromomethane	Vinyl chloride	Chrysene				
Carbon disulfide		Di-n-butyl phthalate				

^aMay be reported as 3,4-Methylphenol or m,p-cresol.

Ac = Actinium Th = Thorium
 Nb = Niobium Tl = Thallium
 Pb = Lead

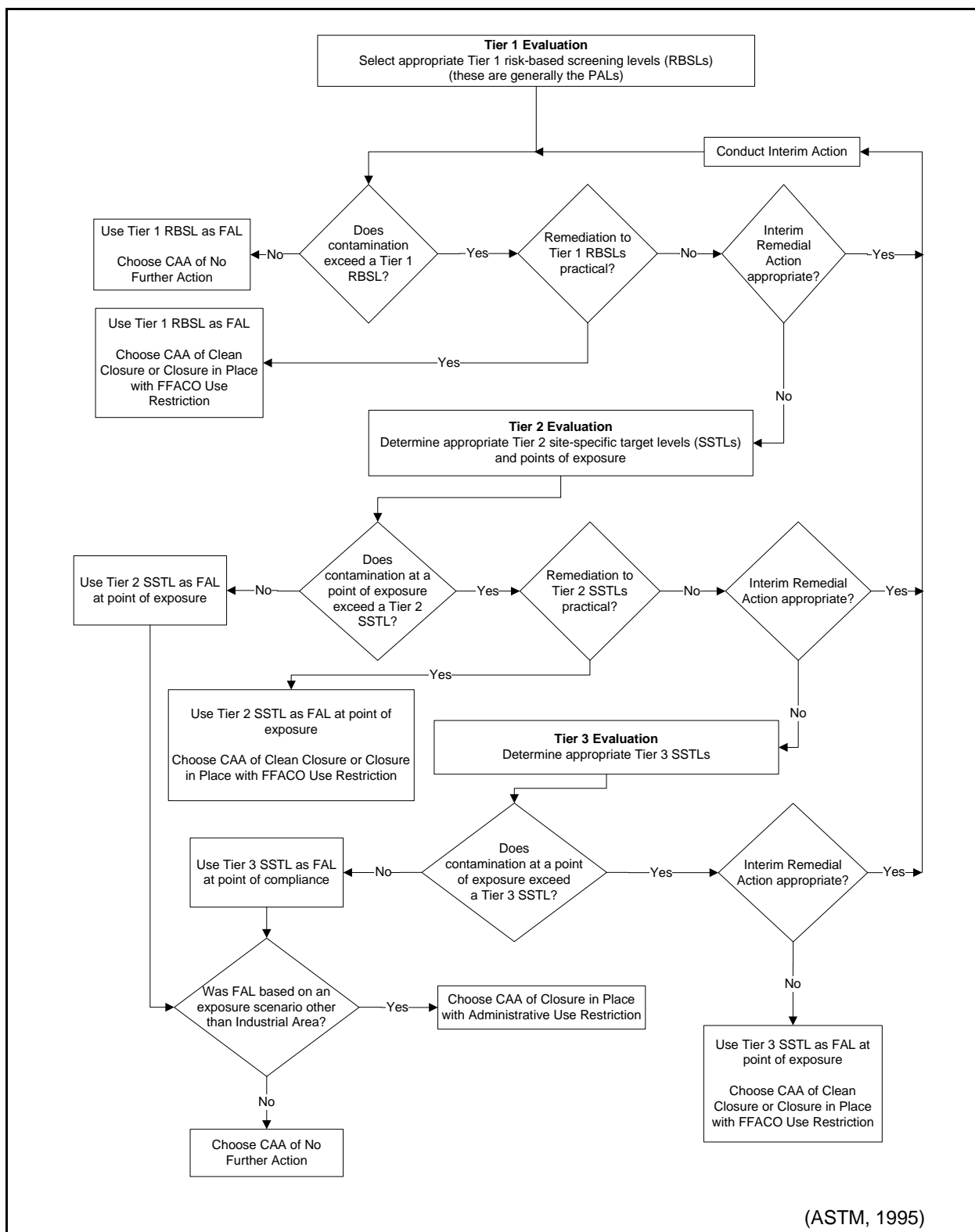
evaluation, therefore streamlining the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with *Nevada Administrative Code* (NAC) Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2008a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2008b) requires the use of American Society for Testing and Materials (ASTM) Method E1739 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (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 chemical constituents of diesel 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 E1739 that consider site-, pathway-, and receptor-specific parameters.

If a Tier 2 or Tier 3 FAL was calculated based on an exposure scenario other than the Industrial Area scenario, a corrective action of closure in place with an administrative use restriction will be required in addition to any other corrective action applied to the CAS to prevent future industrial use of the area. For this reason, contamination at all sites will be evaluated against industrial-exposure-scenario-based FALs, and if applicable, site-specific-exposure-scenario-based FALs. The FALs (along with the basis for their selection) will be proposed in the Corrective Action Decision Document (CADD), where they will be compared to laboratory results in the evaluation of potential corrective actions.

This RBCA 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 of the decision-makers listed in [Section A.2.1](#) 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. Any interim actions conducted will be reported in the CADD.



(ASTM, 1995)

**Figure 3-3
 Risk-Based Corrective Action Decision Process**

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Region 9: Superfund, Preliminary Remediation Goals, Screening Levels for Chemical Contaminants* in industrial soils (EPA, 2009). Background concentrations for RCRA metals will be used instead of screening levels when natural background concentrations exceed the screening level, as is often the case with arsenic on the NNSS. Background is considered the mean plus two standard deviations of the mean 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 screening levels, the protocol used by the EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the CADD.

3.3.2 Radionuclide PALs

The PAL for radioactive contaminants is 25-millirem-per-year (mrem/yr) total effective dose (TED), based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). That document establishes the default exposure conditions and Residual Radioactive (RESRAD) computer code input parameters to be used to calculate the potential radiation dose over a land area. Several input parameters are not specified so that site-specific information can be used.

For test releases, the Industrial Area scenario has been modified by pre-specifying values for several input parameters (such as an area of contamination of 1,000 square meters [m²] and a depth of contamination of 5 cm). In addition, Residual Radioactive Material Guideline (RRMG) values for each individual radionuclide COPC were calculated. The RRMG is the value, in pCi/g for surface soil, for a particular radionuclide, that would result in a dose of 25 mrem/yr. Using RRMGs in site evaluation facilitates the determination of a radiation dose estimate for each soil sample.

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 viable corrective actions (e.g., no further action, clean closure, or closure in place).

As presented in [Section 1.1.2](#), the DQOs address the two types of potential contaminant release scenarios:

- Test releases of contaminants are defined as the initial release of radionuclides from the nuclear test detonations.
- Non-test releases of contamination include the translocation of contamination deposited under the test release scenario (e.g., migration in stormwater runoff, excavated soil, groundwater pumping) and other potential releases (e.g., spills, lead-containing items, and PSM).

The test and non-test releases will be investigated through a judgmental sampling scheme.

The DQO strategy for CAU 106 was developed at a meeting on January 19, 2010, and March 24, 2011, for Cambric Ditch. 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 for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 106 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 106.” To address this problem statement, resolution of the following 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.
- Decision II: “If a COC is present, is sufficient information available to evaluate potential CAAs?” Sufficient information is defined to include:
 - The lateral and vertical extent of COC contamination
 - The information needed to determine potential remediation waste types
 - The information needed to evaluate the feasibility of remediation alternatives

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes (i.e., PSM) that are present at a site to result in the introduction of COCs into site environmental media. To evaluate the potential for wastes to result in the introduction

of a COC to the surrounding environmental media, the following conservative assumptions were made:

- Any containment of waste (e.g., fuel/oil reservoirs, pipe, concrete vaults and walls, drums) would fail at some point, and the waste would be released to the surrounding soil.
- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.
- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
 - For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste.
 - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (following degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004).
 - For liquid wastes, the resulting concentration of contaminants in the surrounding soil would be calculated based on the concentration of contaminants in the wastes and the liquid-holding capacity of the soil.

For the test and non-test release scenarios, Decision I will be resolved by submitting Decision I samples to analytical laboratories to determine the presence of COCs. CAS-specific samples will be submitted for the analyses listed in [Table 3-1](#). The specific analyses for samples from non-test releases identified during the CAI will be selected dependent upon the type and nature of the identified release. Decision II samples for both release scenarios will be submitted as necessary to define the extent of unbounded COCs. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

For the laboratory data, 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 CADD to confirm or refute the CSM. Analytical

methods and target minimum detectable concentrations (MDCs) for each CAU 106 COPC are provided in [Tables 3-3](#) and [3-4](#). The criteria for precision and accuracy listed in [Tables 3-3](#) and [3-4](#) may vary from information in the QAPP as a result of the laboratory used or updated/new methods (NNSA/NV, 2002a).

**Table 3-3
 Analytical Requirements for Radionuclides for CAU 106**

Analysis ^a	Medium or Matrix	Analytical Method	MDC ^b	Laboratory Precision	Laboratory Accuracy
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1 ^c	1/10 DCGs ^d	RPD 35% (non-aqueous) ^e 20% (aqueous) ^e	LCS Recovery (%R) 80-120 ^g
	Non-aqueous	GA-01-R ^h		ND -2<ND<2 ^f	
Other Radionuclides					
Isotopic U	All	U-02-RC ⁿ	1/10 DCGs ^d	RPD 35% (non-aqueous) ^e 20% (aqueous) ^e	Chemical Yield Recovery (%R) 30-105 ⁱ
Isotopic Pu	Aqueous	Pu-10-RC ^h			
	Non-aqueous	Pu-02-RC ^h			
Sr-90	Aqueous	EPA 905.0 ^c		ND -2<ND<2 ^f	LCS Recovery (%R) 80-120 ⁱ
	Non-aqueous	Sr-02-RC ^h			
Gross Alpha/Beta	Aqueous	EPA 900.0 ^c	1/10 DCGs ^d	RPD 35% (non-aqueous) ^e 20% (aqueous) ^e	MS Recovery (%R)
	Non-aqueous	SM 7110 B ^k		ND -2<ND<2 ^f	Lab-specific ^j LCS Recovery (%R) 80-120 ⁱ
Tritium	Aqueous	EPA 906.0 ^c			
	Non-aqueous	Laboratory Procedure ^l			

^aA list of constituents reported for each method is provided in [Table 3-2](#).

^bThe MDC is the minimum concentration of a constituent that can be measured and reported with 95% confidence (Standard Methods)^k.

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

^dThe DCG is the value, in pCi/g of surface soil, for a particular radionuclide that would result in a dose of 25 mrem/IA-yr (e.g., the PAL).

^e*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).

^f*Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997).

^g*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2008).

^h*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).

ⁱProfessional judgment and other industry acceptance criteria are used.

^jAccuracy criteria are developed in-house using approved laboratory standard operating procedures in accordance with industry standards and the NNES Statement of Work requirements.

^k*Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998).

^lLaboratory standard operating procedures in accordance with industry standards and the NNES Statement of Work requirements (NNES, 2009).

DCG = Derived Concentration Guideline

LCS = Laboratory control sample

mrem/IA-yr = Millirem per Industrial Access year

MS = Matrix spike

ND = Normalized difference

NNES = Navarro Nevada Environmental Services, LLC

RPD = Relative percent difference

%R = Percent recovery

**Table 3-4
 Analytical Requirements for Chemicals for CAU 106**

Analysis ^a	Medium or Matrix	Analytical Method	MDC ^b	Laboratory Precision	Laboratory Accuracy
Organics					
VOCs	All	8260 ^c	< FALs	Lab-specific ^d	Lab-specific ^d
SVOCs	All	8270 ^c			
PCBs	All	8082 ^c			
Inorganics					
Metals	All	6010/6020 ^c	< FALs	RPD 35% (non-aqueous) 20% (aqueous) ^e Absolute Difference ±2x RL (non-aqueous) ^f ±1x RL (aqueous) ^f	MS Recovery (%R) 75-125 ^c
Hexavalent Chromium	All	7196 ^c			LCS Recovery (%R) 80-120 ^c
Mercury	Aqueous	7470 ^c			MS Recovery (%R) 85-115 ^c
	Non-aqueous	7471 ^c	LCS Recovery (%R) 80-120 ^c		

^aA list of constituents reported for each method is provided in [Table 3-2](#).

^bThe MDC is the minimum concentration of a constituent that can be measured and reported with 99% confidence (EPA, 2008).

^c*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2008).

^dPrecision and accuracy criteria are developed in-house using approved laboratory standard operating procedures in accordance with industry standards and the NNES Statement of Work requirements (NNES, 2009).

^e*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).

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

RL = Reporting limit

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 106 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for CAU 106 by collecting and analyzing samples generated during a field investigation. The investigation will generate information required to evaluate the potential CAAs of no further action, clean closure, and closure in place.

The presence and nature of contamination for the test and non-test release scenarios will be evaluated using a judgmental approach. Judgmental samples will be collected at all four CASs within CAU 106. Available information indicates that soil contamination above FALs at Able and Cambric Ditch is not expected. Therefore, only individual judgmental samples will be collected for the purpose of confirming that COCs are not present. Non-test releases (e.g., 306 GZ and 307 GZ) will be located, and the associated samples will be analyzed based on judgmental criteria. 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 CAAs.

Sample results for individual radionuclides (at both test and non-test releases) will be compared to the FAL to determine whether COCs are present at any CAS. The FAL (i.e., individual RRMGs) will include both internal and external pathways as external dose is not being measured by thermoluminescent dosimeters.

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

4.2 Field Activities

Field activities at CAU 106 include site preparation, sample location selection, sample collection, and demobilization.

4.2.1 Site Preparation Activities

Site preparation activities to be conducted before the start of environmental sampling may include relocating or removing surface debris and equipment, constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones, constructing decontamination facilities, and moving staged equipment.

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

- Perform radiological surveys and/or scans at Cambric Ditch, Able and potentially at 306 GZ and 307 GZ.
- Perform geophysical surveys at 306 GZ and 307 GZ.
- Perform visual surveys at all CASs within CAU 106 to identify staining or soil discoloration, disturbance of native soils, wastes that may be PSM, or any other indication of potential contamination.

4.2.2 Sample Location Selection

Rationale for selecting areas for sampling is discussed in the following sections.

4.2.2.1 Test Releases

At Able, Decision I will be evaluated by collecting a soil sample at a single judgemental sample location determined based on radiological survey values. This will be done in an effort to find the location where the internal dose contributes the greatest amount to TED.

4.2.2.2 Non-test Releases

For non-test releases at CAU 106, Cambric Ditch, 306 GZ and 307 GZ, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. Biasing factors,

such as stains, geophysical anomalies, radiological survey results, and wastes suspected of containing hazardous or radiological components, will be used to select the most appropriate samples from a particular location for collection and analysis. Biasing factors to be used for selection of sample locations are listed in [Section A.8.3](#). As biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents.

If a COC is present at any non-test release scenario sample location, Decision II sampling will be conducted to define the extent of contamination. Extent (Decision II) sampling locations at each CAS will be selected based on the CSM, biasing factors, field-survey results, existing data, and the outer boundary sample locations where COCs are detected. In general, extent 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 extent locations, additional Decision II samples will be collected from locations farther 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 will be notified, and the investigation strategy will be 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).

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

4.2.3 Sample Collection

The CAU 106 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in [Section 4.2.2](#).
- Collect required QC samples.

- Collect waste management samples as necessary.
- 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, as is feasible.

At Able, a minimum of one sample location will be established. At this location, soil samples will be collected and field screened from various depth intervals (e.g., 0 to 5 cm, 5 to 10 cm, 10 to 15 cm bgs) to determine whether buried contamination exists. The process for determining whether buried contamination exists at Able is described in [Section A.8.1.1](#).

For the non-test release scenario, Decision I samples (0 to 15 cm bgs) will be collected from biased locations as described in [Sections A.8.3.1.1](#) and [A.8.3.1.2](#). If biasing factors are present in soils below locations where Decision I samples were collected, subsurface soil samples will also be collected by augering, backhoe excavation, direct-push, or drilling techniques, as appropriate. Subsurface 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. Decision II sampling of other non-test releases will consist of further defining the extent of contamination where COCs have been confirmed. 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.

4.2.4 Sample Management

The laboratory requirements (i.e., MDCs, precision, and accuracy) to be used when analyzing the COPCs are presented in [Tables 3-3](#) and [3-4](#). The analytical program 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 Industrial Sites QAPP (NNSA/NV, 2002a) and other applicable, approved procedures.

4.3 Safety

A site-specific health and safety document will be prepared and approved before the field effort. This document defines the requirements for protecting the health and safety of the workers and the public. 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, including, but not limited to, radionuclides, chemicals (e.g., heavy metals, VOCs, SVOCs, 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 PPE.
- Occupational exposure monitoring to prevent overexposures 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, and 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.

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 (REOP):

- All equipment, wastes, debris, and materials associated with the CAI will be removed from the site.
- All CAI-related signage and fencing (unless part of a corrective action) will be removed from the site.
- Site will be inspected and certified that restoration activities have been completed.

5.0 Waste Management

Management of the waste generated during the CAU 106 field investigation will be in accordance with all applicable DOE orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP. Wastes will be characterized based on these regulations using process knowledge, field-screening results (FSRs), and analytical results from investigation and waste samples. Waste types that may be generated during the CAI include industrial, low-level radioactive, hazardous, hydrocarbon, or mixed wastes.

Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., metal and concrete). Therefore, these wastes may be characterized based on CAI sample results. 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.

The following sections discuss how the field investigation will be conducted to minimize the generation of waste, the waste streams that are expected to be generated, and the management of IDW.

5.1 Waste Minimization

The CAI will be conducted in a manner that will minimize the generation of wastes by using process knowledge, visual examination, and/or radiological survey and swipe results to avoid collecting uncontaminated media or characterizing uncontaminated IDW as other than industrial or sanitary waste. As appropriate, media and debris will be returned to their original location. To limit unnecessary generation of hazardous or mixed waste, hazardous materials will not be used during the CAI unless required. Other waste minimization practices will include, as appropriate, avoiding contact with contaminated materials, performing dry decontamination or wet decontamination over source locations, and carefully segregating waste streams.

5.2 Potential Waste Streams

The expected waste streams to be generated during the CAU 106 field investigation include industrial and low-level radioactive wastes from the sampling activities. However, because it is uncertain what wastes are present within the CAS boundaries (e.g., lead debris, batteries, historic spills), the following waste streams have been included as potential waste streams that may require management and disposal:

- Disposable sampling equipment and/or PPE
- Environmental media (e.g., soil)
- Surface debris in investigation area (e.g., metal, concrete, batteries)
- Decontamination rinsate

5.3 Investigation-Derived Waste Management

The onsite management of IDW will be determined based on regulations associated with the particular waste type (e.g., industrial, low-level radioactive, RCRA hazardous, hydrocarbon, mixed), or the combination of waste types. The following subsections describe how specific waste types will be managed.

5.3.1 Industrial Waste

Industrial IDW, if generated, will be collected, managed, and disposed of in accordance with the industrial waste management regulations and the permits for operation of the NNSS Waste Landfills.

5.3.2 Hydrocarbon Waste

Hydrocarbon wastes, if generated, 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, an appropriate hydrocarbon waste management facility (e.g., recycling facility) or other method in accordance with the State of Nevada regulations (NDEP, 1997).

5.3.3 Low-Level Radioactive Waste

Low-level radioactive wastes, 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, 2009).

Potential radioactive waste drums containing soil, PPE, disposable sampling equipment, and/or rinsate may be staged and managed at a designated radioactive material area (RMA).

5.3.4 Hazardous Waste

Suspected RCRA hazardous wastes, if generated, will be placed in DOT-compliant containers. All containerized hazardous waste will be handled, inspected, and managed in accordance with Title 40 *Code of Federal Regulations* (CFR) 262.34 (CFR, 2009a).

5.3.5 Mixed Low-Level Waste

Mixed wastes, if generated, shall be managed according to the requirements for hazardous wastes and the requirements for low-level waste.

5.3.6 Polychlorinated Biphenyls

Polychlorinated biphenyl wastes, if generated, will be managed according to 40 CFR 761 (CFR, 2009b), State of Nevada requirements (NAC, 2008a), and DOE guidance.

6.0 Quality Assurance/Quality Control

The overall objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for CASs in CAU 106.

Sections 6.1 and 6.2 discuss the collection of required QC samples in the field and QA requirements for soil samples.

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. As determined in the DQO process, the minimum frequency of collecting and analyzing QC samples for this investigation are:

- For radiological samples:
 - Field duplicates (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)
 - Laboratory QC samples (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)
- For chemical samples:
 - 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 (1 per CAS)
 - Full 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 Industrial Sites QAPP (NNSA/NV, 2002a).

6.2 Laboratory/Analytical Quality Assurance

As stated in the DQOs ([Appendix A](#)), and except where noted, laboratory analytical quality data will be used for making DQO 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 Industrial Sites QAPP (NNSA/NV, 2002a), 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 required samples were appropriately collected, analyzed, and the results met data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether the data 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. Data quality indicators 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
- Completeness
- Comparability
- 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. The criteria for precision and accuracy in Tables 3-3 and 3-4 may vary from corresponding information in the Industrial Sites QAPP as a result of changes in analytical methodology and laboratory contracts (NNSA/NV, 2002a).

**Table 6-1
 Laboratory and Analytical Performance Criteria for CAU 106 DQIs**

DQI	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.	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	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.	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.
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.
Decision I Completeness	80% of the CAS-specific COPCs have valid results.	Cannot support/defend decision on whether COCs are present.
Decision II Completeness	100% of COCs used to define extent have valid results.	Extent of contamination cannot be accurately determined.
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.
Sensitivity	Minimum detectable concentrations are less than or equal to respective FALS.	Cannot determine whether COCs are present or migrating at levels of concern.

6.2.3 Precision

Precision is a measure of the repeatability of the analysis process from sample collection through analysis results and 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 (MSD) and 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 to assess 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) are 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x RL, a control limit of $\pm 1x$ RL and $\pm 2x$ RL for aqueous and soil samples, respectively, is applied to the absolute difference.

The criteria used for the assessment of organic chemical precision are based on professional judgment using laboratory-defined control limits. The criteria used for the assessment of radiological precision when both results are greater than or equal to 5x MDC are 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x MDC, the 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](#).

Any 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 CADD on the impacts to DQO decisions specific to affected contaminants at specific 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 reanalyzing 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: 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.

Any 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 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 CADD 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 CAI 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 Performance or Acceptance Criteria) are:

- For Decision I judgmental sampling, 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 if 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 CADD.

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 is 80 percent. 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 CADD. Additional information will be collected if it is determined that DQO decisions cannot be resolved with the available information.

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 CADD.

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2002). The evaluation criterion for this parameter will be that measurement sensitivity (i.e., MDCs) 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 CADD.

As presented in [Section 3.4](#), the evaluation criterion for this parameter will be that 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. The target MDC for each COPC is provided in [Tables 3-3](#) and [3-4](#).

7.0 *Duration and Records Availability*

7.1 *Duration*

Field and analytical activities will require approximately 120 days to complete.

7.2 *Records Availability*

Historical information and documents referenced in this plan are retained in the DOE project files in Las Vegas, Nevada, and can be obtained through written request to the DOE Federal Sub-Project Director. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the appropriate DOE Federal Sub-Project Director.

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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 106, Areas 5, 11 Frenchman Flat Atmospheric Sites, 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, closure in place, or clean closure). Existing information about the nature and extent of contamination at the CASs in CAU 106 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 106 CAI 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.2.0](#) through [A.8.0](#) were developed in accordance with *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 serves 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 resolving them.
 - 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 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 106 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 106.”

A.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO. The DQO planning team met on January 19, 2010, and March 24, 2011, for the DQO meetings.

A.2.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at a point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. It provides a summary of how and where contaminants are expected to move and what impacts such movement may have. It 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 defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. An accurate CSM is important as it serves as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for CAU 106 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 CAI 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 will be notified and given the opportunity to comment on, or concur with, the recommendation.

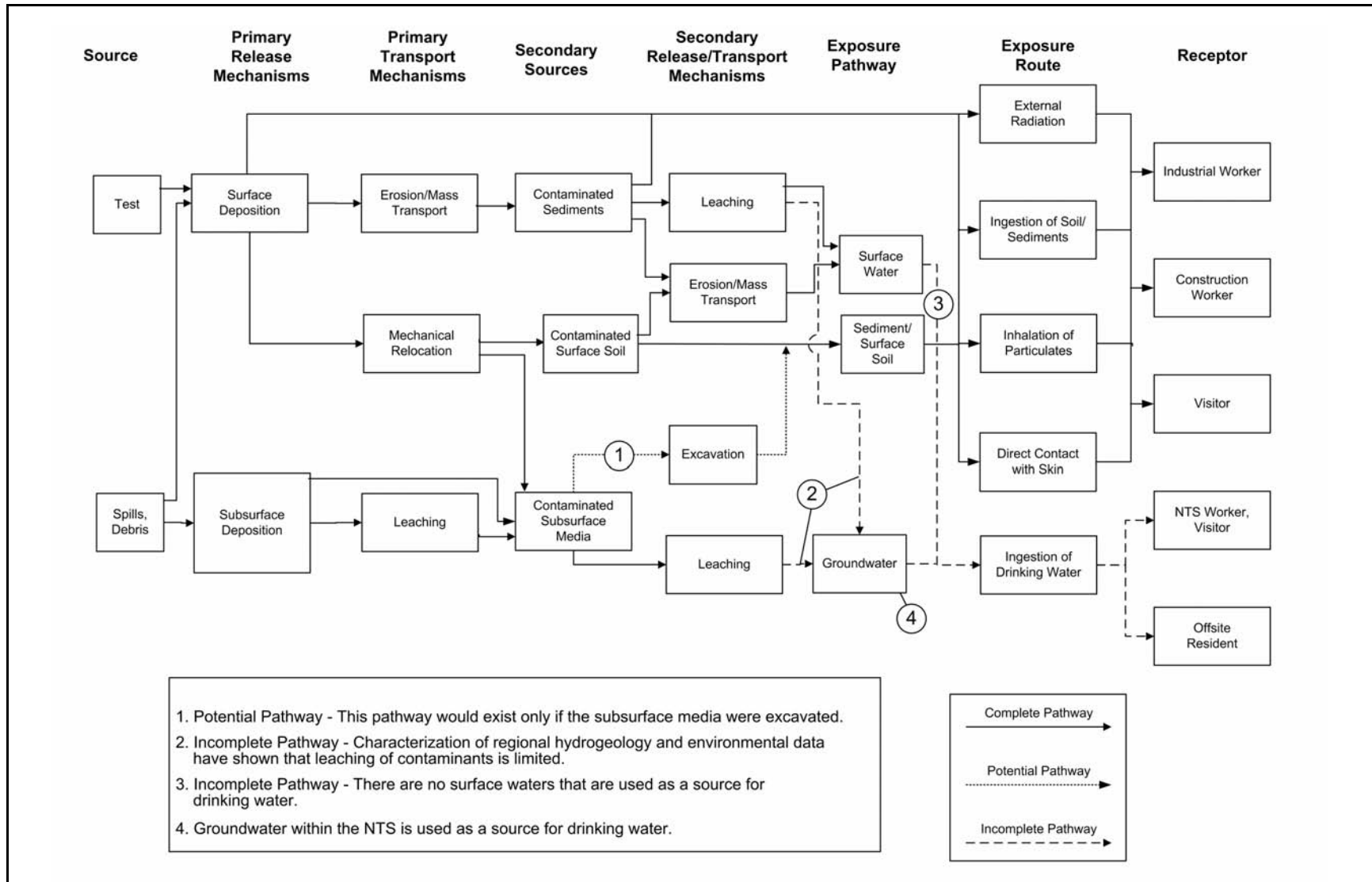
The applicability of the CSM to each CAS is summarized in [Table A.2-1](#), which provides information on CSM elements that will be used throughout the remaining steps of the DQO process. [Figure A.2-1](#) depicts conceptual pathways to receptors from CAU 106 sources. [Figure A.2-2](#) depicts a graphical representation of the CSM.

Table A.2-1
Conceptual Site Model Description of Elements for Each CAS in CAU 106
(Page 1 of 2)

CAS Identifier	05-20-02	05-23-05	05-45-04	05-45-05
CAS Description	Evaporation Pond	Atmospheric Test Site - Able	306 GZ Rad Contaminated Area	307 GZ Rad Contaminated Area
Site Status	Sites are inactive and/or abandoned			
Exposure Scenario	Occasional			
Sources of Potential Soil Contamination	<ul style="list-style-type: none"> • Non-Test Release: surface discharge of tritium contaminated groundwater into the Cambric Ditch 	<ul style="list-style-type: none"> • Test Release: atmospheric deposition of radionuclides from airburst 	<ul style="list-style-type: none"> • Non-Test Release: abandoned surface (e.g., DU) or buried wastes. 	
Location of Contamination/ Release Point	<ul style="list-style-type: none"> • Surface and shallow subsurface soil within the Cambric Ditch and area of the evaporation pond on the northwest edge of Frenchman Lake 	<ul style="list-style-type: none"> • Surface soil surrounding ground zero area • Contaminated soil is potentially buried under thin horizon of accumulated lake sediments 	<ul style="list-style-type: none"> • Surface soil within and surrounding posted URMA's and CA • Surface soil directly below and adjacent to waste items • Shallow subsurface soil within URMA boundary 	
Amount Released	Approximately 17 million cubic meters of groundwater	Unknown		
Affected Media	Surface and shallow subsurface soil	Surface soil	Surface and shallow subsurface soil	
Potential Contaminants	Tritium	Fission products, other potential radionuclides	VOCs, SVOCs, RCRA metals, PCBs, isotopic uranium, and other potential radionuclides	

Table A.2-1
Conceptual Site Model Description of Elements for Each CAS in CAU 106
(Page 2 of 2)

CAS Identifier	05-20-02	05-23-05	05-45-04	05-45-05
CAS Description	Evaporation Pond	Atmospheric Test Site - Able	306 GZ Rad Contaminated Area	307 GZ Rad Contaminated Area
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Percolation of discharged groundwater through subsurface media serves as the major driving force for migration within the Cambric Ditch. Surface water runoff may provide for the transportation of some contaminants within or outside the footprints of the CASs. In the case of Cambric Ditch, continuous surface discharge of groundwater provides for the transportation of tritium-contaminated water along the length of Cambric Ditch to the evaporation pond at the northwest edge of Frenchman Lake. Although there may be standing water at times on Frenchman Lake, accumulation of fine materials on the lake bed has decreased the hydraulic conductivity of the lake bed to the point where infiltration is not significant. Wind may cause resuspension and transport of windborne contaminants; however, this is not a significant mechanism.			
Migration Pathways	Vertical transport expected to dominate over lateral transport due to small surface gradients. However, location of 306 GZ, and 307 GZ on alluvial fan that drains to Frenchman Lake provides potential for overland transport of contaminants. In the case of tritium-contaminated groundwater, vertical transport dominates along the ditch due to the high solubility of the contaminant in geologic media.			
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 for 306 GZ and 307 GZ. Tritium contamination of the vadose zone and groundwater is known to exist under Cambric Ditch; however, the subsurface tritium plume is being addressed under CAU 98 in the Underground Test Area Program. 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, and dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or direct radiation exposure from radioactive materials.			



**Figure A.2-1
 Conceptual Pathways to Receptors**

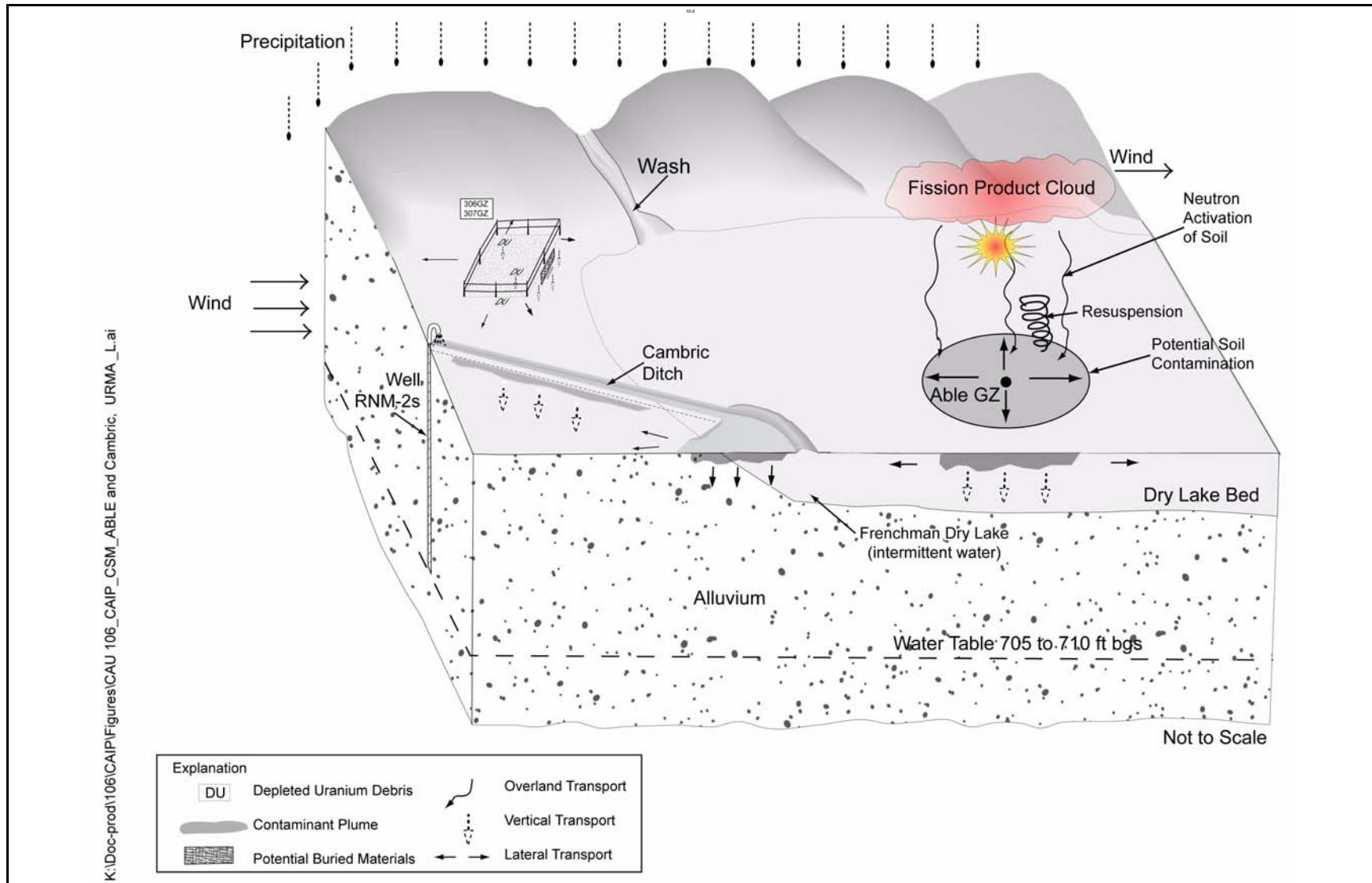


Figure A.2-2
 Conceptual Site Model for CAU 106

A.2.2.1 Release Sources

The following two release scenarios address the different types of releases that may be present at CAU 106. The test release is defined as the initial atmospheric deposition of radiological contaminants from nuclear tests. The initial test release is generally observed as an annular geometric pattern of contamination from soil particle activation and initial fallout that generally decreases in intensity with distance from the source. A non-test release is defined as the subsequent movement of radiological contaminants from test releases (either migration or mechanical displacement) and other potential releases of contaminants from site operations (e.g., spills and abandoned materials).

The sources of contamination for test releases at CAU 106 are the initial atmospheric deposition of radiological contaminants to surface soil from the nuclear weapons-effect (Able) test. The sources of contamination for non-test releases at the Cambric Ditch and the 306 GZ and 307 GZ sites are those resulting from spills or wastes (e.g., DU, miscellaneous chemicals and debris items) found at the sites (i.e., 306 GZ and 307 GZ), and the mechanical displacement (i.e., pumping) of contaminated groundwater to the surface soils within the Cambric Ditch. Contamination on the soil surface may be the source for future migration.

The most likely locations of the contamination and releases to the environment are the soils directly below or adjacent to the CSM's surface and subsurface components (i.e., soils impacted by fallout, wastes present, and other non-test releases). Contamination, if present, is expected to be contiguous to the release points, and concentrations are expected to decrease with horizontal and vertical distance from the source. See [Sections A.2.2.1.1 through A.2.2.1.4](#) for CAS-specific sources of test and non-test releases.

A.2.2.1.1 Cambric Ditch

The test release scenario, as defined in [Section 1.1.2](#), does not apply to the Cambric Ditch because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear test.

The non-test release source for Cambric Ditch is the surface discharge of tritium-contaminated groundwater from Well RNM-2s to the man-made ditch. The contaminated water released into the ditch emptied into the evaporation pond located on the northwest edge of Frenchman Lake. The RNM study was conducted by Lawrence Livermore National Laboratory to better understand the

migration of radionuclides in groundwater from the Cambric test cavity (Bryant, 1992). Cambric was an underground weapons-related test conducted on May 14, 1965, below the water table at the northwest side of Frenchman Lake (DOE/NV, 2000). Well RNM-2s was drilled 91 meters (m) south of the Cambric GZ and was continuously pumped between 1975 and 1991, tested regularly for radionuclides, and discharged approximately 17 million cubic meters of groundwater to Cambric Ditch as part of the RNM study. The maximum tritium concentration measured in groundwater during the RNM study was 2,950,000 pCi/L measured in 1980. In 2003, a multiple-well test to quantify hydraulic properties and geochemistry of local hydrostratigraphic units was conducted. The test involved a constant rate pumpage of 600 gallons per minute from Well RNM-2s for a period of 75 days with groundwater discharged into Cambric Ditch (SNJV, 2004). The maximum tritium activity measured during the same year as the multiple-well test was 186,000 pCi/L (SNJV, 2005).

A.2.2.1.2 Able

The test release source at Able is the atmospheric deposition of radionuclides (e.g., fallout of fuel fragments and fission products, and neutron activation of soil) to the surface soil from the detonation of a weapons-effect test with a 1-kt yield at 800 ft above the ground surface. Based on available information from radiological flyover surveys and soil studies, significant quantities of radionuclides were not released to the surface soil surrounding the Able ground zero. Therefore, soil contamination above FALs is not expected at this site. It is possible that the surface soil initially impacted by the Able test has subsequently been buried by lake sedimentation that occurs when the dry lake bed fills with shallow water. However, the initially impacted soil is expected to be within the top 15 cm of soil because of the low sedimentation rates on dry lake beds.

Non-test release sources have not been identified at Able; however, there is always a potential to identify a non-test release during the CAI.

A.2.2.1.3 306 GZ

The test release scenario, as defined in [Section 1.1.2](#), does not apply to 306 GZ because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear test.

The non-test release source of surface contamination includes abandoned wastes, particularly DU that may have released contaminants to the soil within and surrounding the posted URMA and CA. Other identified surface waste includes solid and previously melted metal fragments. Because information about the activities conducted at this site is limited, it is possible that unknown radioactive and chemical contaminants may have been released to the surface soil. Non-test sources of subsurface contamination include any buried wastes within the boundary of the posted URMA. The subsequent migration of contaminants into nearby washes is possible but not anticipated because the nearest wash is 500 ft to the east.

A.2.2.1.4 307 GZ

The test release scenario, as defined in [Section 1.1.2](#), does not apply to 307 GZ because there is no evidence of atmospheric deposition of radiological contaminants from a nuclear test.

The non-test release source of surface contamination includes abandoned wastes, particularly DU that may have released contaminants to the soil within and surrounding the posted URMA. Because information about the activities conducted at this site is scarce, unknown radioactive and chemical contaminants have potentially been released to the surface soil. Non-test sources of subsurface contamination include any buried wastes within the boundary of the posted URMA. The subsequent migration of contaminants into nearby washes is not anticipated at this site.

A.2.2.2 Potential Contaminants

The CAS-specific 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 NNSS sites. 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. The list of COPCs is intended to encompass all of the significant contaminants that could potentially be present at each CAS. Significant contaminants are defined as contaminants that are present at concentrations exceeding the PAL. The COPCs applicable to Decision I environmental samples from each of the CASs of CAU 106 are defined as the analytes reported from the analytical methods stipulated in [Table A.2-2](#). If previously unknown releases are

**Table A.2-2
Analytical Program^a**

Analyses	Cambric Ditch	Able	306 GZ	307 GZ
Organic COPCs				
PCBs	--	--	X	X
SVOCs	--	--	X	X
VOCs	--	--	X	X
Inorganic COPCs				
RCRA Metals	--	--	X	X
Total Beryllium	--	--	X	X
Hexavalent Chromium	--	--	X	X
Radionuclide COPCs				
Gamma Spectroscopy ^b	--	X	X	X
Isotopic U	--	X	X	X
Isotopic Pu	--	X	X	X
Sr-90	--	X	X	X
Tritium	X	--	--	--

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

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

X = Required analytical method

-- = Not required

identified during the CAI, the specific COPCs will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

A.2.2.3 Contaminant Characteristics

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

As stated in *Subsurface Nobel Gas Transport at the Nevada Test Site* (Thompson et al., 1997), the Cambric test at the NNSS was used to study long-term radionuclide migration from the underground detonation of a nuclear device. The Cambric test (with a yield of 750 tons) was conducted below the water table in Frenchman Flat in 1965. A well (RNM-2s) installed into the groundwater 91 m away from ground zero was continuously pumped from 1975 to 1991 to draw radionuclides from the detonation cavity. The extracted water was tested for radionuclides. None of the adsorbing radionuclides (Am-241, calcium [Ca]-41, Cs-137, Eu-154, Pu-241, samarium [Sm]-151, neptunium [Np]-237, and Sr-90) were detected in the pumped groundwater, attesting to their low solubility and affinity to adsorb to media. This test demonstrated the relative immobility of the adsorbing radionuclides under saturated conditions. These adsorbing radionuclides can be expected to be even less mobile in the vadose zone because the mass flow of water is the predominant driver in contaminant migration and water movement through the vadose zone is much less than in the saturated conditions of the aquifer.

The radionuclide tritium, detected in the pumped groundwater, is considered a conservative tracer in groundwater in that it does not interact with the geologic media through which the water moves. Typically, 99.9 percent of tritium occurs as tritiated water and should, therefore, move at the same velocity as groundwater (Smith, 1995). The RNM study demonstrated the relative mobility of tritium. In the less saturated conditions of the vadose zone, tritium is expected to be less mobile because of the decrease in water movement. However, continuous discharge existed for nearly 16 years in the unlined Cambric Ditch, and tritium is thought to have infiltrated through the unsaturated zone and back into the groundwater (SNJV, 2005; Tompson et al., 2002). Results of an investigation to better understand the movement of radionuclides between the Cambric Ditch and the water table by Tompson et al. (2002) suggest that the transport of tritium through the 200-m vadose zone was relatively fast (3 to 5 years) under flowing conditions of the ditch. The investigation also noted longer residence times were observed in the draining system following ditch shutoff, which supports the earlier inference that relative mobility decreases under less saturated conditions.

Another key characteristic of tritium in developing the CSM for Cambric Ditch is its short half-life of 12.27 years. The maximum concentrations of tritium detected in discharged groundwater from Well RNM-2s were measured from 1979 and 1980. Based on the half-life of tritium, those concentrations have decreased nearly 80 percent over the past 31 years.

Based on this evidence, the target radionuclide elements for Able (Cs, Eu, and Co), 306 GZ (U), and 307 GZ (U) are classified as adsorbing radionuclides with low solubilities located in unsaturated media. Therefore, these contaminants are expected to be found relatively close to release points. Tritium, the target radionuclide for Cambric Ditch, is classified as a mobile radionuclide with a high solubility in unsaturated media and, therefore, is expected to have infiltrated farther away from release points. Additionally, initial concentrations of tritium in soil have significantly decreased over time.

A.2.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Topographical and meteorological properties and attributes include slope stability, precipitation frequency and amounts, precipitation runoff pathways, drainage channels and ephemeral streams, and evapotranspiration potential. Meteorological data are presented in [Section 2.1](#).

All four CASs in CAU 106 are located within the Frenchman Flat Hydrographic Area. Erosion of the surrounding mountains has resulted in the accumulation of more than 1,000 ft of alluvial deposits in some areas of Frenchman Flat (DOE/NV, 1996). The 306 GZ and 307 GZ sites are located on the alluvial deposits and unconsolidated gravels of Frenchman Flat, and the Able test site is located on the ephemeral Frenchman Lake (dry lake bed). The length of Cambric Ditch crosses over both the alluvial deposits and unconsolidated gravels of Frenchman Flat as well as the dry lake bed. During the dry season, the ground surface consists of a rough hard-packed silt with a well-defined mud-crack pattern, which is a classic dessication structure of the dry lake environment. During the rainy season, the lake bed may fill with shallow water (especially during wet years), and this layer of water may be moved around by wind. The principal drainage into the dry lake bed is Nye Canyon from the north, with lesser drainages from the west, including Cane Spring Wash and Barren Wash. Depth to groundwater ranges between approximately 700 ft and 775 ft bgs (USGS and DOE, 2009).

Prominent washes are not present at any of the CASs in CAU 106. The nearest prominent wash to any CAS within CAU 106 is located approximately 500 ft east of 306 GZ. It should be noted that 307 GZ is located 150 ft east of an extension of Cambric Ditch; however, this feature is not expected to impact 307 GZ. The Cambric Ditch itself is not considered a wash because it was excavated for the

purpose of transporting effluent and had a relatively stable configuration; therefore, it is not expected to have impacted other areas of Frenchman Flat before reaching the evaporation pond.

A.2.2.5 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 present in ephemeral washes are subject to much higher transport rates than contaminants present in other surface areas. These ephemeral washes, such as near 306 GZ, are generally dry, but are subject to infrequent 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 as sedimentation areas. The drainages in the Frenchman Flat area ultimately drain to Frenchman Lake dry lake bed. The seasonal filling of Frenchman Lake may provide a hydraulic driver for percolation and migration of contaminants for the Able and Cambric Ditch sites. Although similar to an ephemeral wash with intermittent stormwater flow events, groundwater discharge events to Cambric Ditch were longer in duration, maintained constant volume of discharge, and assumed to contain less energy for sediment entrainment than typical stormwater events.

Other migration pathways for contamination from the sites include transport of contaminated windborne materials and mechanical disturbance due to maintenance or construction activities at the site. Specifically at CAU 106, this can include activities such as decontamination and demolition of facilities, structures, equipment, or materials.

Migration is influenced by the chemical characteristics of the contaminants (presented in [Section A.2.2.3](#)) and the physical characteristics of the vadose media (presented in [Section A.2.2.4](#)). In general, the contaminants that are reasonably expected to be present at CAU 106 (i.e., Cs, Eu, and Co at Able; and U at 306 GZ and 307 GZ) have low solubilities and high affinity for media. The physical characteristics of the vadose media generally include medium to high adsorptive capacities, low moisture contents (i.e., available water-holding capacity), and relatively long distances to groundwater (i.e., over 700 ft bgs). Based on these physical and chemical factors, contamination is expected to be found relatively close to release points. The primary contaminant at Cambric Ditch is

tritium which has a high solubility and low affinity for media. Based on these chemical factors and the physical characteristics of the vadose media, tritium is expected to be found at greater distances from release points.

Infiltration and percolation of precipitation serve as a driving force for downward migration of contaminants. However, because of high PET (mean PET at the Area 5 Radioactive Waste Management Site (RWMS) has been estimated at 63.5 in. [Yucel, 2009]) and limited precipitation for this region (average annual precipitation at station Well 5 B is 4.51 in. [ARL/SORD, 2009]), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992). Although there may be standing water at times on the Frenchman Lake, accumulation of fine materials on the lake bed has decreased the hydraulic conductivity of the lake bed to the point where infiltration is not significant (i.e., most of the accumulated water evaporates before it infiltrates the lake bed surface) (SNJV, 2004).

Subsurface migration pathways at CAU 106 are expected to be predominately vertical, although spills or leaks at the ground surface at 306 GZ and 307 GZ may also have limited lateral migration before infiltration. At Cambric Ditch, lateral migration linearly from the discharge point to the evaporation pond is dominant over vertical migration. However, with the steady-state of discharge and constant driving force of the water, vertical migration is significant for tritium contamination along the length of the ditch into unsaturated media. Previous studies have also shown tritium migrated up to 7 m (21 ft) laterally during the primary release period of the RNM study in the 1980s (Buddemeier, 1988; Tompson et al., 2002). 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).

A.2.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or external irradiation by radioactive materials. The land-use and exposure scenarios for the CAU 106 sites are listed in [Table A.2-3](#). These are based on NNSS current and future land use. All sites are at remote locations without any site improvements and where no regular work is performed; however, there is a potential

**Table A.2-3
 Land-Use and Exposure Scenarios**

Site	Record of Decision Land-Use Zone	Exposure Scenario
306 GZ	<p>Reserved Zone This area includes land and facilities that provide widespread flexible support for diverse short-term testing and experimentation. The reserved zone is also used for short-duration exercises and training, such as nuclear emergency response, Federal Radiological Monitoring and Assessment Center training, and DoD exercises and training.</p>	<p>Occasional Use Area 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>
Able, Cambric Ditch, and 307 GZ	<p>Research Test and Experiment Zone This area is designated for small-scale research and development projects and demonstrations; pilot projects; outdoor tests; and experiments for the development, QA, or reliability of material and equipment under controlled conditions. This zone includes compatible defense and nondefense research, development, and testing projects and activities.</p>	

for site workers to occupy these locations on an occasional and temporary basis, such as a military exercise in the future. Therefore, these sites are classified as occasional work areas.

A.3.0 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.3.1 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 contaminant 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 CAAs?” Sufficient information is defined to include:

- The lateral and vertical extent of COC contamination
- The information needed to determine potential remediation waste types
- The information needed to evaluate the potential for COC migration

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes (i.e., PSM) that are present at a site to result in the introduction of COCs into site environmental media. To evaluate the potential for wastes to result in the introduction of a COC to the surrounding environmental media, the following conservative assumptions were made:

- Any containment of waste (e.g., fuel/oil reservoirs, pipe, concrete vaults and walls, drums) would fail at some point, and the waste would be released to the surrounding soil.
- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.

- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
 - For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste.
 - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (following degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004).
 - For liquid wastes, the resulting concentration of contaminants in the surrounding soil would be calculated based on the concentration of contaminants in the wastes and the liquid-holding capacity of the soil.

For the test and non-test release scenarios, Decision I will be resolved by submitting Decision I samples to analytical laboratories to determine the presence of COCs. The specific analyses for samples from non-test releases identified during the CAI will be selected dependent upon the type and nature of the identified release. Decision II samples for both release scenarios will be submitted as necessary to define the extent of unbounded COCs.

If sufficient information is not available to evaluate potential CAAs, 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.3.2 Alternative Actions to the Decisions

This section identifies actions that may be taken to solve the problem depending on the possible outcomes of the investigation.

A.3.2.1 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 CAAs will be collected.

A.3.2.2 Alternative Actions to Decision II

If the lateral and vertical extent of COC contamination has not been defined by bounding sample results, then additional bounding samples will be collected. If sample analytical results are not sufficient to predict potential remediation waste types, then additional waste characterization samples will be collected. If available information is not sufficient to evaluate the potential for COC migration, additional information will be collected. If sufficient information is not available to evaluate potential CAAs, then additional samples will be collected. Otherwise, collection of additional information is not required.

A.4.0 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.4.1 Information Needs

To resolve Decision I (determine whether a COC is present at a CAS), samples will 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 for test release contamination, samples need to be collected and analyzed to meet the following criteria:

- A decreasing trend of TED rates from more than 25 mrem/IA-yr to less than 25 mrem/IA-yr in at least three directions (vectors) needs to be established sufficiently to determine a correlation to radiation survey isopleths such that a boundary can be determined around the area posing a more-than-25-mrem/yr dose.
- Environmental samples, direct samples of waste, and/or process knowledge is sufficient to predict potential remediation waste types.
- Information is sufficient to determine whether a COC has migrated from the area of original deposition.

The exception to this is Able, where, by definition, a test release occurred; however, available information indicates that soil contamination above FALs is not expected. Therefore, the presence of a COC would be a violation of the CSM. If a COC is present at Able (i.e., a TED greater than the 25-mrem/yr TED is present), then NDEP will be notified and a plan for determining the extent of contamination will be proposed before continuing the CAI at this site.

To resolve Decision II for non-test release contamination (determine whether sufficient information is available to evaluate potential CAAs at each CAS), samples need to be collected and analyzed to meet the following criteria:

- Samples must be collected in areas contiguous to the contamination but where contaminant concentrations are below FALs.
- Samples of the waste or environmental media must provide sufficient information to determine potential remediation waste types.
- Samples of the waste must provide sufficient information to determine whether they contain PSM.
- The analytical suites selected must be sufficient to detect contaminants at concentrations equal to or less than their corresponding FALs.

The exception to this is the Cambric Ditch, where, by definition, a non-test release occurred; however, available information indicates that tritium contamination in soil above FALs is not expected. Therefore, the presence of a COC would be a violation of the CSM. If a COC is present at the Cambric Ditch, then NDEP will be notified and a plan for determining the extent of contamination will be proposed before continuing the CAI at this site.

A.4.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples. 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.4.2.1 Sample Locations

Design of the sampling approaches for the CAU 106 CASs must ensure that the data collected are sufficient for selection of the CAAs (EPA, 2002). To meet this objective, the samples collected from each site should be from locations that most likely contain a COC, if present (judgmental). These sample locations, therefore, can be selected by means of biasing factors used in judgmental sampling

(e.g., a stain or location of elevated radioactivity). The implementation of a judgmental approach for sample location selection for CAU 106 CASs is discussed in [Section A.8.0](#).

A.4.2.2 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) for soil samples are provided in [Tables 3-3](#) and [3-4](#).

A.5.0 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.5.1 Target Populations of Interest

The population of interest to resolve Decision I (“Is any COC present in environmental media within the CAS?”) is any location or area within the site that contains contaminant concentrations exceeding a FAL. The populations of interest to resolve Decision II (“If a COC is present, is sufficient information available to evaluate potential CAAs?”) are:

- Each one of a set of locations bounding contamination in lateral and vertical directions (including migration pathways such as drainages)
- Investigation waste and potential remediation waste

A.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. The CAS-specific Decision II spatial boundaries are listed in [Table A.5-1](#). Contamination found beyond these boundaries may indicate a flaw in the CSM and may 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.5-1
 Spatial Boundaries**

Site	Vertical Boundary (bgs)	Horizontal Boundary
Cambric Ditch	Non-Test Release: 20 ft	Non-Test Release: 50 ft
Able	Test Release: 2 ft	Test Release: 500 ft
306 GZ	Non-Test Release: 15 ft	Non-Test Release: 500 ft
307 GZ		

The spatial boundaries for Cambric Ditch are unique in that any contamination found deeper than the 20-ft boundary specified in [Table A.5-1](#) will be addressed in CAU 98 as part of the tritium groundwater plume associated with the Cambric underground test.

A.5.3 Practical Constraints

No practical constraints were identified that may affect the ability to characterize a site.

A.5.4 Define the Sampling Units

The scale of decision making in Decision I is defined as the CAS. Any COC detected at any location 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 bounding COCs originating from the CAS. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

A.6.0 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.6.1 Population Parameters

Population parameters are defined for the judgmental sampling design in the following sections. Population parameters are the parameters compared to action levels.

A.6.1.1 Judgmental Sampling Design

For judgmental sampling results, 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. A single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS (for Decision I) or that the COC is not bounded (for Decision II).

A.6.2 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 (NAC, 2008a), which lists the requirements for sites with soil contamination. For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2008b) requires the use of ASTM Method E1739 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (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. Total 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 E1739 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 their definition) in the investigation report.

A.6.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the *Region 9: Superfund, Preliminary Remediation Goals, Screening Levels for Chemical Contaminants* in industrial soils (EPA, 2009). Background concentrations for RCRA metals and zinc will be used instead of screening levels when natural background concentrations exceed the screening level (e.g., arsenic on the NNSS). 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 screening levels, the protocol used by the EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.6.2.2 Radionuclide PALs

The PAL for radioactive contaminants is 25 mrem/yr based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). That document establishes the default exposure conditions and RESRAD computer code input parameters to be used to calculate the potential radiation dose over a land area. Several input parameters are not specified so that site-specific information can be used.

For test releases, the Industrial Area scenario has been modified by pre-specifying values for several input parameters (such as an area of contamination of 1,000 m² and a depth of contamination of 5 cm). In addition, RRMG values for each individual radionuclide COPC were calculated. The RRMG is the value, in pCi/g for surface soil, for a particular radionuclide that would result in a dose of 25 mrem/yr. Using RRMGs in site evaluation facilitates the determination of a radiation dose estimate for each soil sample.

A.6.3 Decision Rules

The decision rule applicable to both Decision I and Decision II is:

- If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in [Section A.5.2](#), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

The decision rule 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 will be 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 will be 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 or potential remediation wastes have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.
- If valid analytical results are available for the waste characterization samples defined in [Section A.8.0](#), then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

A.7.0 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.7.1 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:

- Developing a CSM (based on process knowledge) that is agreed to by stakeholder participants during the DQO process.
- Testing the validity of the CSM based on investigation results.
- Evaluating the quality of data based on DQI parameters.

A.7.2 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 the environment.

A.7.2.1 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 sample locations selected will identify COCs if present anywhere within the CAS. For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.
- Having a high degree of confidence that analyses conducted 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 that are most likely contaminated by COCs (supplemented by random samples 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 CSM and selection of sampling locations. The field-screening methods and biasing factors listed in [Section A.4.2.1](#) 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 those locations that best represent the populations of interest as defined in [Section A.5.1](#).

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 all analytical results to ensure that all 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 of soil sample results, as well as individual soil sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the Industrial Sites QAPP (NNSA/NV, 2002) and in [Section 6.2.2](#). The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as 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 analyte 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 all analytical methods used are equivalent to standard EPA methods so that 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 Industrial Sites 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 or 1 per CAS per matrix, if less than 20 collected)

A.7.3 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 in accordance with 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 Industrial Sites 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 per lot)
- Field blanks (minimum of 1 per CAS, additional if field conditions change)

A.8.0 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. Judgmental sampling schemes will be implemented to select sample locations for the test and non-test releases as described in [Section A.2.2.1](#). Investigation results will be compared to FALs to determine the need for corrective action. Potential source material sample results will be evaluated against the PSM criteria listed in [Section A.3.1](#) to determine the need for corrective action.

A.8.1 Sampling for the Test Release at Able

Individual judgmental sample locations will be established at Able because available information indicates that soil contamination above FALs is not expected. These locations will be selected judgmentally based on radiological survey values in an effort to find the location where the internal dose contributes the greatest amount to TED. At least one judgmentally selected sample location will be established, and if no biasing factors are identified, the default sample location will be at the posted ground zero location ([Figure A.8-1](#)).

If buried contamination exists (see [Section A.8.1.1](#)), it will be conservatively assumed that the highest level of contamination observed (from surface or subsurface samples) provides dose to site workers. Therefore, in addition to the surface samples described above, subsurface samples will be collected at each location in 5-cm increments until native soil or buried horizon is encountered and field screened for radioactivity. The subsurface soil sample interval with the highest screening value will be collected and submitted for analysis.

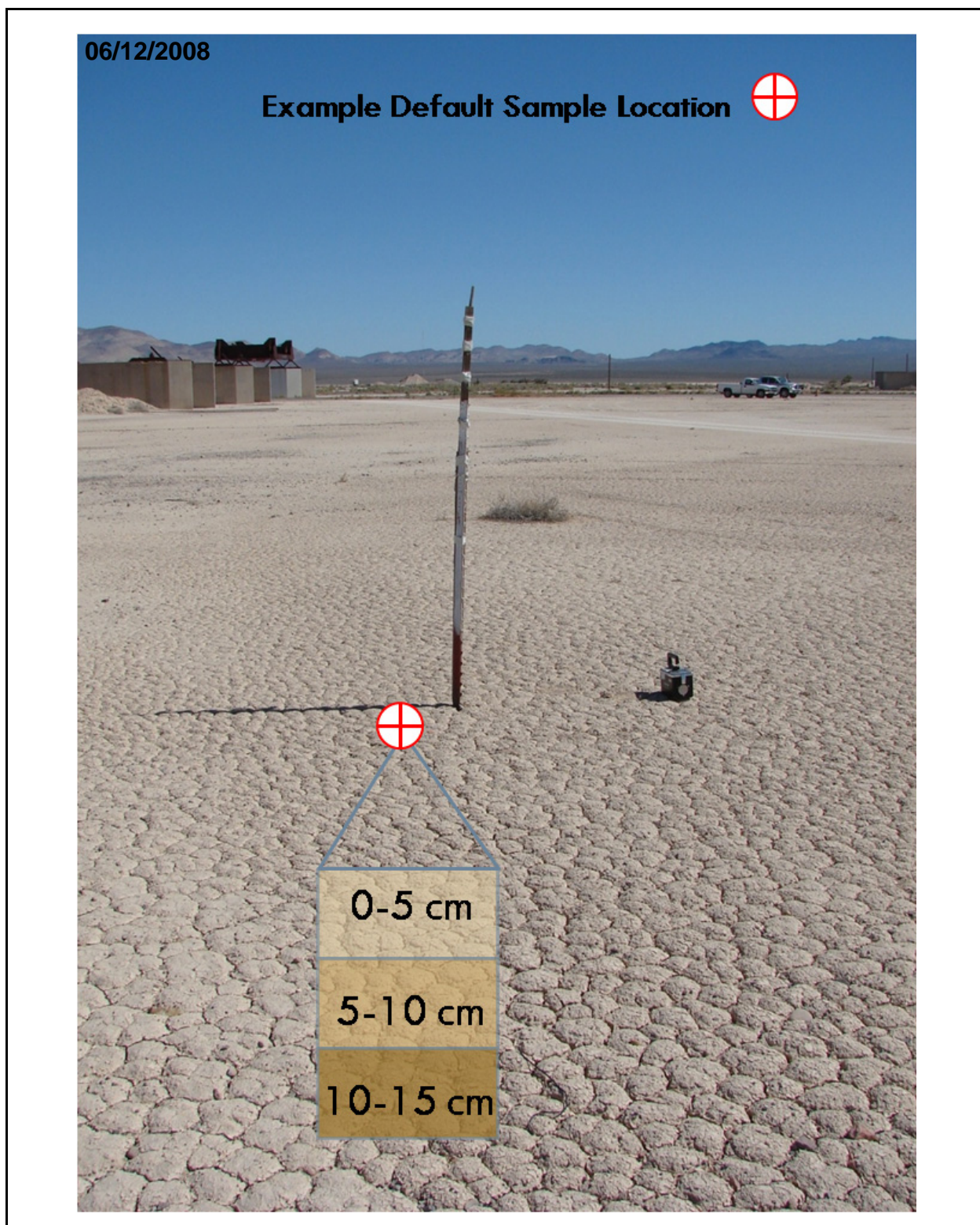


Figure A.8-1
Example Decision I Sample Location at Able

A.8.1.1 Determination of Buried Contamination

As the CSM includes the possibility of buried horizons of contamination at Able, it will be determined whether buried contamination exists before sampling. The initially-impacted soil is expected to be within the top 15 cm of soil because of the low sedimentation rates on dry lake beds.

At Able, the process for determining whether buried contamination exists will be as follows:

- Navigate to the Decision I sample location.
- Collect a 5-cm layer of soil from the surface of the selected sample location.
- Field screen the soil with the appropriate radiation instrument.
- Compare the FSRs of the sample to the established background field-screening levels (FSLs) for the site.
- Continue this process by removing additional 5-cm layers of soil to a depth of at least 15 cm bgs; continue until FSRs are below FSLs.

If all FSRs are below FSLs, it will be assumed that buried contamination does not exist, and only surface samples (from each sampled location) will be collected and submitted for analyses. If FSRs are greater than FSLs from any horizon of soil deeper than 5 cm bgs, it will be assumed that buried contamination exists. If it is decided that buried contamination exists, then Decision I samples at each of the sample locations will be collected and field screened in 5-cm layers. The subsurface sample with the highest screening value at each of the sample locations will be submitted for analysis.

A.8.2 Evaluation of Results for the Test Release at Able

At Able, individual sample locations will be established; therefore, the individual analytical results will be compared to the FAL for each individual radionuclide. If any results exceed the FAL, then additional sample locations will be selected for Decision II.

A.8.3 Sampling for Non-test Releases

Sample locations for non-test releases will be determined based upon the likelihood of a contaminant release at the CAS. These locations will be selected based on biasing factors identified during the investigation. [Sections A.8.3.1.1](#) through [A.8.3.1.3](#) present the judgmental sampling plan for the

Cambric Ditch, 306 GZ, and 307 GZ. The following biasing factors may be used to select the most appropriate samples from a particular location for submittal to the analytical laboratory:

- Process knowledge of the site: Locations for which existing evidence, such as historical photographs, experience from previous investigations, previous sample results, or interviewee's input, suggests that a release of hazardous or radioactive substances may have occurred.
- Process knowledge of the contaminant(s): Locations that are reasonably suspected of contamination based on the chemical and/or physical properties of the contaminant(s) in that environmental setting or knowledge of the source and location of a release.
- Radiological survey results: Locations for which evidence, such flyover and walkover surveys, and radiological field screening, provides a basis upon which sample plots and sample locations can be designated.
- Geophysical anomalies: Geophysical survey results that are not consistent with the surrounding area (e.g., results indicating buried concrete or metal, surface metallic objects).
- Visual indicators such as stains, discoloration, textural discontinuities, ground disturbance of native soils indicating potential buried materials, or any other indication of potential contamination.
- Presence of debris, equipment, or abandoned waste suspected of containing hazardous or radiological components.
- Lithology: Locations where variations in lithology (soil or rock) indicate that different conditions or materials exist.
- Other biasing factors: Factors not previously defined for the CAI that become evident once the investigation of the site is under way.

A.8.3.1 Decision I

A judgmental sampling design will be implemented for the non-test releases to establish sample locations and evaluate sample results. Samples will be submitted for the analyses listed in [Table A.2-2](#). For the non-test releases, individual sample results, rather than an average concentration, will be used to compare to FALs. Therefore, statistical methods to generate site characteristics will not be needed. 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 non-test release 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.5.1](#). To meet this criterion, a biased sampling strategy will be used to target areas with the highest potential for contamination, if it is present anywhere 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.8.3](#). 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.8.3.1.1 Cambric Ditch

To support a limited verification sampling effort, a conservative maximum tritium concentration in soil was calculated based on historical analytical results measured in the groundwater discharged from Well RNM-2s into the Cambric Ditch. [Table A.8-1](#) shows the maximum tritium results reported in groundwater for any given year pumping and discharge occurred as well as the concentration decayed to present time using the following formula:

$$A_f = A_i e^{-(\lambda)(t)}$$

Where: A_f = the final decayed activity

A_i = the initial activity

λ = the radioactive decay constant $\lambda = \frac{\ln(2)}{12.27 \text{ years}}$

t = the elapsed time or the total time of decay in years

As shown in [Table A.8-1](#), the maximum groundwater result was measured on October 17, 1980, at 2,950,000 pCi/L. This maximum concentration decayed to present time (as of 06/07/2011) is now 521,967 pCi/L.

**Table A.8-1
Maximum Tritium Concentrations Measured from Well RNM-2s (pCi/L of water)**

Date	Maximum Concentration	Calculated Current Concentration
12/29/1975	22	3
10/15/1976	329	46
08/05/1977	367	54
12/27/1978	936,000	149,532
12/05/1979	2,690,000	453,174
10/17/1980	2,950,000*	521,967*
03/17/1981	2,863,500	518,642
02/03/1982	2,660,000	506,480
01/05/1983	2,140,000	429,219
01/01/1984	1,700,000	360,562
01/04/1985	1,310,000	294,174
01/28/1986	1,090,000	259,960
01/30/1987	802,000	202,452
01/07/1988	635,000	169,009
01/19/1989	512,000	144,482
01/11/1990	415,000	123,762
02/17/1991	339,000	107,587
04/11/2003	186,000	117,285
07/10/2003	154,000	98,469

Source: GEOCHEM database (SNJV, 2005)

* = Maximum concentration measured

The calculation to determine the maximum soil concentration involves converting the tritium results in pCi/L (decayed to present) into soil-equivalent concentrations in pCi/g. The following conservative assumptions were used in calculating a tritium soil-equivalent concentration:

- All soil water contains tritium at a concentration equivalent to the maximum current concentration from any discharge event (considering the maximum measured concentrations from all discharges decayed to present time).

- No dilution of tritium has occurred from the infiltration of precipitation or flow of stormwater down the ditch.
- The soil contains an amount of tritiated water equivalent to its water holding capacity (estimated to be 15 percent by mass or 0.25 g/cm³ based on a soil bulk density of 1.64 g/cm³).

Using this decay-corrected groundwater concentration of 521,967 pCi/L, the maximum tritium activity in water was converted to activity in soil using the following formula:

$$\frac{521,967 \text{ pCi}}{\text{L water}} \times \frac{\text{L water}}{1,000 \text{ g water}} \times \frac{0.25 \text{ g water}}{\text{g soil}} = \frac{131 \text{ pCi}}{\text{g soil}}$$

The conclusion is that, under worst-case conditions and using unrealistically conservative assumptions, the maximum dose from exposure to tritium-contaminated soil in the Cambric Ditch and the associated evaporation pond is 131 pCi/g of soil. This is significantly less than the FAL for tritium under the Industrial Area exposure scenario of 7,250,000 pCi/g of soil. Therefore, soil contamination above FALs is not expected at this site.

To support this conclusion that the conservative maximum tritium concentration in soil is below the FAL, a verification sample will be collected at a biased location. A radiological scan of the surface will be conducted at the Well RNM-2s discharge area and 30 ft downstream to determine a location of highest radiological dose. If no significantly elevated locations (greater than two times background) are detected in the general area of the discharge area or immediately downstream, then a verification sample will be collected from soil directly below the discharge point from Well RNM-2s (see [Figure A.8-2](#)). A minimum of one judgmental surface sample will be collected from the selected location and submitted for tritium analysis.

A.8.3.1.2 306 GZ and 307 GZ

At 306 GZ and 307 GZ, judgmental sampling is planned for non-test surface releases associated with site activities and subsurface releases associated with buried wastes (if present) within the boundary of the posted URMAs.

For surface releases at each site, a surface sample will be collected from a minimum of two locations of highest radioactivity above the FSLs following removal of identified PSM (e.g., DU, previously melted metal). These biased locations will be based on a radiological walkover survey of the area



Figure A.8-2
Example Decision I Sample Location at Cambric Ditch

within and surrounding the posted URMA (at 306 GZ and 307 GZ) and CA (at 306 GZ only), or based on other biasing factors. These locations may or may not be at locations where PSM was located (see [Figure A.8-3](#)). Potential source material will be removed as it is identified to an extent that is feasible. Geophysical surveys using instruments appropriate for detecting DU may be used. The following approach will be used:

- An initial 100-ft radius of the posted URMA or CA will be surveyed using appropriate geophysical and radiological instruments.
- If PSM is identified within 50 ft of the initial boundary, then the boundary will be extended in 50-ft increments (arcs) from the PSM location until PSM is no longer present. [Figure A.8-3](#)

illustrates how the boundary may extend in a biased direction based on the distribution of PSM on the surface.

For subsurface releases at 306 GZ and 307 GZ, a geophysical survey will be conducted within and surrounding the posted URMA to investigate potential buried wastes. If geophysical anomalies that are consistent with the presence of buried objects/waste are detected, then soil at these locations will be excavated up to 10 ft bgs, or until the object is uncovered (not to exceed 15 ft bgs [CSM boundary]). If no anomalies are detected, then soil will be excavated from the center of the posted URMA. [Figure A.8-4](#) illustrates both scenarios. Judgemental samples will be collected as follows:

- The excavated soil and the soil profile will be continuously monitored for visual biasing factors.
- Soil will be collected a minimum of every 2 ft bgs and field screened for alpha/beta contamination.
- The sample with the highest FSR above the FSL will be submitted for analysis.
- Additional soil samples will be submitted for analysis based on FSRs and visual biasing factors.

A.8.3.1.3 Other Potential Releases

Additional judgmental sample locations may be identified during the CAI if there is evidence of a release. During the course of the CAU 106 investigation, the identification of any biasing factors will be used to determine whether a potential release is present (e.g., stains, spills, debris). Samples will be collected from the material that presents the greatest degree of the biasing factor (surface or subsurface as discussed above). Specific analyses requested for these samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

A.8.3.2 Decision II

Decision II samples for non-test releases will be collected from judgmental sampling locations selected based on locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in [Section A.8.3](#). In general, sample locations will be arranged in a triangular pattern around the area containing COCs at distances based on site conditions, process knowledge,

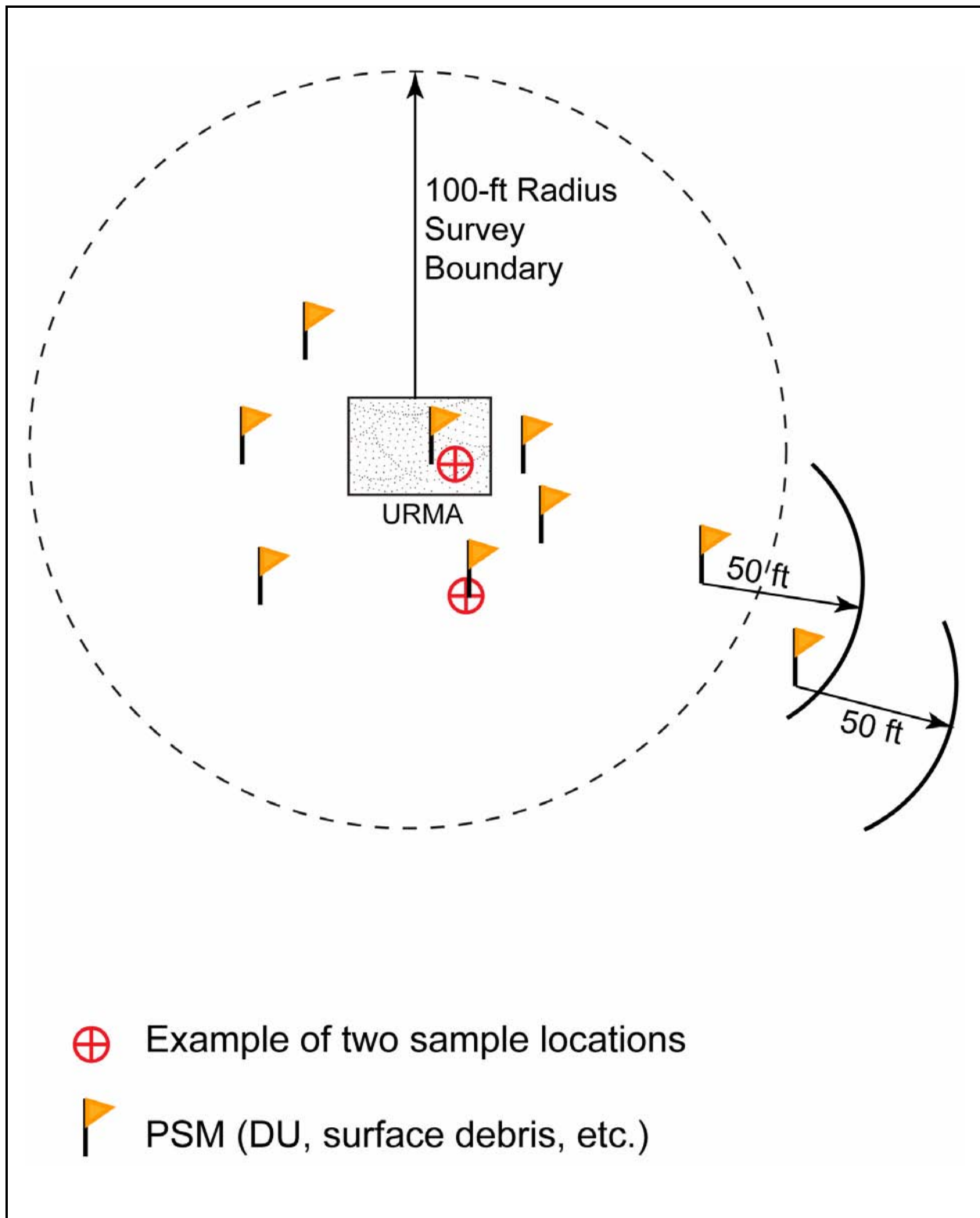


Figure A.8-3
Example Probabilistic Sampling Scheme for Surface Releases at 306 GZ and 307 GZ

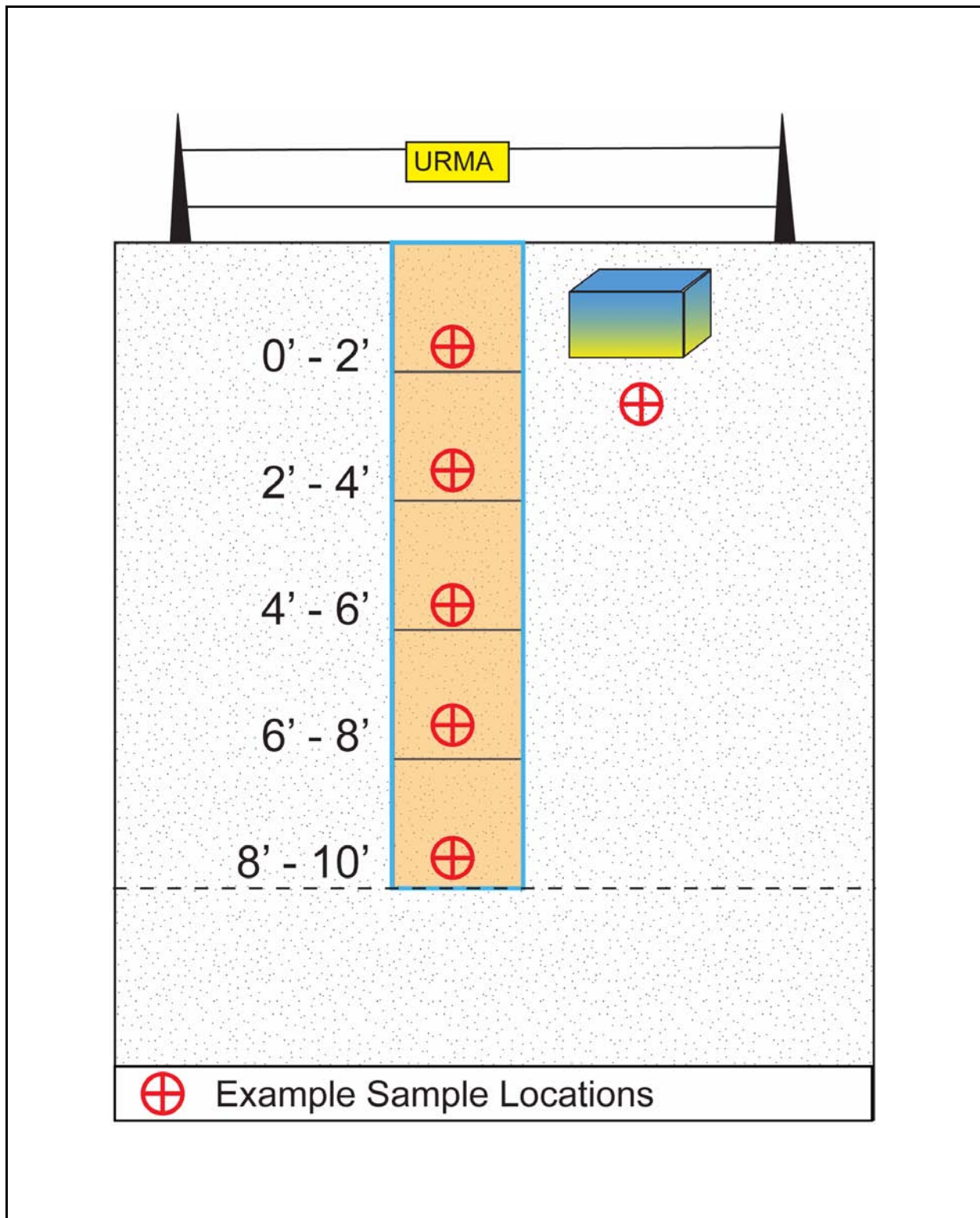


Figure A.8-4
Example Probabilistic Sampling Scheme for URMA at 306 GZ and 307 GZ

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 Task Manager or Site Supervisor may modify the number, location, and spacing of step-outs as warranted by site conditions.

A.8.4 Establishment of Final Corrective Action Boundary

The final corrective action boundary will be established to include the initial corrective action boundary, any additional areas where COCs are expected to migrate in the future, and any COCs identified from the non-test releases.

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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 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 NNSA/NSO 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

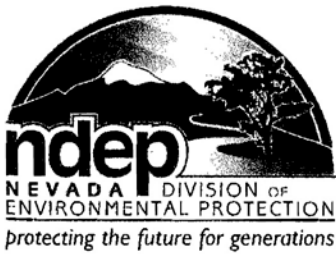
Nevada Division of Environmental Protection Comment Responses

Revision 1 - July 13, 2011

(1 Page)

Revision 0 - March 23, 2010

(2 Pages)



STATE OF NEVADA

Department of Conservation & Natural Resources

DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor

Leo M. Drozdoff, P.E., Director

Colleen Cripps, Ph.D., Administrator

July 13, 2011

Robert F. Boehlecke
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RE: Review of the Draft Revision 1 of the Corrective Action Investigation Plan (CAIP) for Corrective Action Unit (CAU) 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Nevada National Security Site, Nevada
Federal Facility Agreement and Consent Order

Dear Mr. Boehlecke,

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the draft Revision 1 of the CAIP for Corrective Action Unit (CAU) 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Nevada National Security Site, Nevada. NDEP's review of this document did not indicate any deficiencies.

If you have any questions regarding this matter contact me at (702) 486-2850 ext. 233.

Sincerely,

/s/ Jeff MacDougall

Jeff MacDougall, Ph.D., CPM
Supervisor
Bureau of Federal Facilities

ec: JW/KC

cc: K. J. Cabble, ERP, NNSA/NSO, Las Vegas, NV
E. F. Di Sanza, WMP, NNSA/NSO, Las Vegas, NV
J. T. Fraher, DTRA/CXTS, Kirtland AFB, NM
A. L. Primrose NSTec, Las Vegas, NV
T. D. Taylor, N-I, Las Vegas, NV
P. K. Matthews, N-I, Las Vegas, NV
FFACO Group, PSG, NNSA/NSO, Las Vegas, NV





STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

ERD.100329.0001

March 23, 2010

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project
National Nuclear Security Administration
Nevada Site Office
P. O. Box 98518
Las Vegas, NV 89193-8518

RE: Review of Draft Corrective Action Investigation Plan (CAIP) for Corrective Action Unit (CAU) 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Nevada Test Site, Nevada
Federal Facility Agreement and Consent Order

Dear Mr. Boehlecke,

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the draft CAIP for CAU 106: Areas 5, 11 Frenchman Flat Atmospheric Sites. NDEP's review of this document did not indicate any deficiencies.

If you have any questions regarding this matter contact me at (702) 486-2850 ext. 233.

Sincerely,

/s/ Jeff MacDougall

Jeff MacDougall, Ph.D., CPM
Supervisor
Bureau of Federal Facilities

JW/DN/KC

ACTION _____
INFO AMEM
NSO/MGR ✓
COR- _____
File Code _____

MAR 23 2010 10:58



Robert F. Boehlecke

Page 2

March 23, 2010

cc: K. J. Cabble, ERP, NNSA/NSO, Las Vegas, NV
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