Nevada
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Project

DOE/NV--1359

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 367: Area 10 Sedan, Ess and Uncle Unit Craters Nevada Test Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

December 2009

Environmental Restoration
Project

U.S. Department of Energy
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CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 367: AREA 10 SEDAN, ESS AND UNCLE UNIT CRATERS NEVADA TEST SITE, NEVADA

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

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CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 367: AREA 10 SEDAN, ESS AND UNCLE UNIT CRATERS NEVADA TEST SITE, NEVADA

Approved by: /s/ Kevin Cabble Date: 12/09/2009

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List of Acronyms and Abbreviations

Ac	Actinium
Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
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
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
cm	Centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium
CSM	Conceptual site model
DCG	Derived Concentration Guideline
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Eu	Europium

List of Acronyms and Abbreviations (Continued)

FAL	Final action level
FFACO	*Federal Facility Agreement and Consent Order*
ft	Foot
GPS	Global Positioning System
GZ	Ground zero
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
K	Potassium
kt	Kiloton
LCS	Laboratory control sample
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mi	Mile
mm/yr	Millimeters per year
mR/hr	Milliroentgens per hour
mrem/IA-yr	Millirem per Industrial Access year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NAD	North American Datum
NAEG	Nevada Applied Ecology Group
Nb	Niobium
NBMG	Nevada Bureau of Mines and Geology

List of Acronyms and Abbreviations *(Continued)*

ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNES	Navarro Nevada Environmental Services, LLC
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
PAL	Preliminary action level
Pb	Lead
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PET	Potential evapotranspiration
PPE	Personal protective equipment
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
R/hr	Roentgens per hour
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
Rh	Rhodium
RIDP	Radionuclide and Distribution Program
RL	Reporting limit
RPD	Relative percent difference

List of Acronyms and Abbreviations *(Continued)*

RWMS	Radioactive waste management site
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TED	Total effective dose
Th	Thorium
Tl	Thallium
TLD	Thermoluminescent dosimeter
U	Uranium
UCC	Yucca Dry Lake
UCL	Upper confidence limit
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
VSP	Visual Sample Plan
μR/hr	Microroentgens per hour
%R	Percent recovery

Executive Summary

Corrective Action Unit 367 is located in Area 10 of the Nevada Test Site, which is approximately 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 367 comprises the four corrective action sites (CASs) listed below:

- 10-45-01, U-10h Crater (Sedan)
- 10-45-02, Ess Crater Site
- 10-09-03, Mud Pit
- 10-45-03, Uncle Crater Site

The CAS 10-09-03, Mud Pit, is located at the bottom of the CAS 10-45-02 crater and is addressed in this document in association with CAS 10-45-02. 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. Therefore, additional information will be obtained by conducting a corrective action investigation. The results of the field investigation will support a defensible evaluation of viable corrective action alternatives that will be presented in the Corrective Action Decision Document.

The sites will be investigated based on the data quality objectives (DQOs) developed on September 30, 2009, 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 367.

Based on process knowledge of the releases associated with the nuclear tests and radiological survey information about the location and shape of the resulting contamination plume, it was determined that the releases from the nuclear tests are co-located and will be investigated as one release site. The DQO process also resulted in an assumption that total effective dose (TED) within the areas of the craters, crater rims, and related mounding around the craters exceeds the final action level (FAL) and requires corrective action. A field investigation will be performed to define a single area where TED exceeds the FAL and to determine whether other contaminants of concern (COCs) are present at the site (such as in the mud pit associated with CAS 10-09-03, or associated with stains or waste discovered during the investigation).

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 367 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Collect and submit environmental samples for laboratory analysis to determine the area where TED at the site exceeds FALs (i.e., corrective action boundary).
- Evaluate TED to potential receptors in areas along Mercury Highway that have been impacted by a release of radionuclides from the Sedan test.
- Collect and submit environmental samples for laboratory analysis related to the drilling mud within CAS 10-09-03, Mud Pit, and any encountered stains or waste as necessary to determine whether COCs are present.
- If COCs are present, collect additional step-out samples to define the extent of the contamination.
- Collect samples of investigation-derived waste, as needed, for waste management purposes.

Total effective dose will be calculated as the sum of external dose and internal dose measured at each 100-square-meter sampling plot. External dose will be measured using thermoluminescence dosimeters (or equivalent method), and internal dose will be calculated by the Residual Radioactive computer code using analytical results of radionuclide activities from soil samples.

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) 367: Area 10 Sedan, Ess and Uncle Unit Craters.

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 February 2008).

Corrective Action Unit 367 is located in Area 10 of the Nevada Test Site (NTS), which is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). Corrective Action Unit 367 comprises the four corrective actions sites (CASs) shown on Figure 1-2 and listed below:

- 10-45-03, Uncle Crater Site
- 10-45-02, Ess Crater Site
- 10-09-03, Mud Pit
- 10-45-01, U-10h Crater (Sedan)

The Corrective Action Investigation (CAI) will include field inspections, radiological surveys, sampling of environmental media, sample analysis, 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 367 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 recommend CAAs for the CASs. Additional information will be generated by conducting a CAI before evaluating and selecting CAAs.

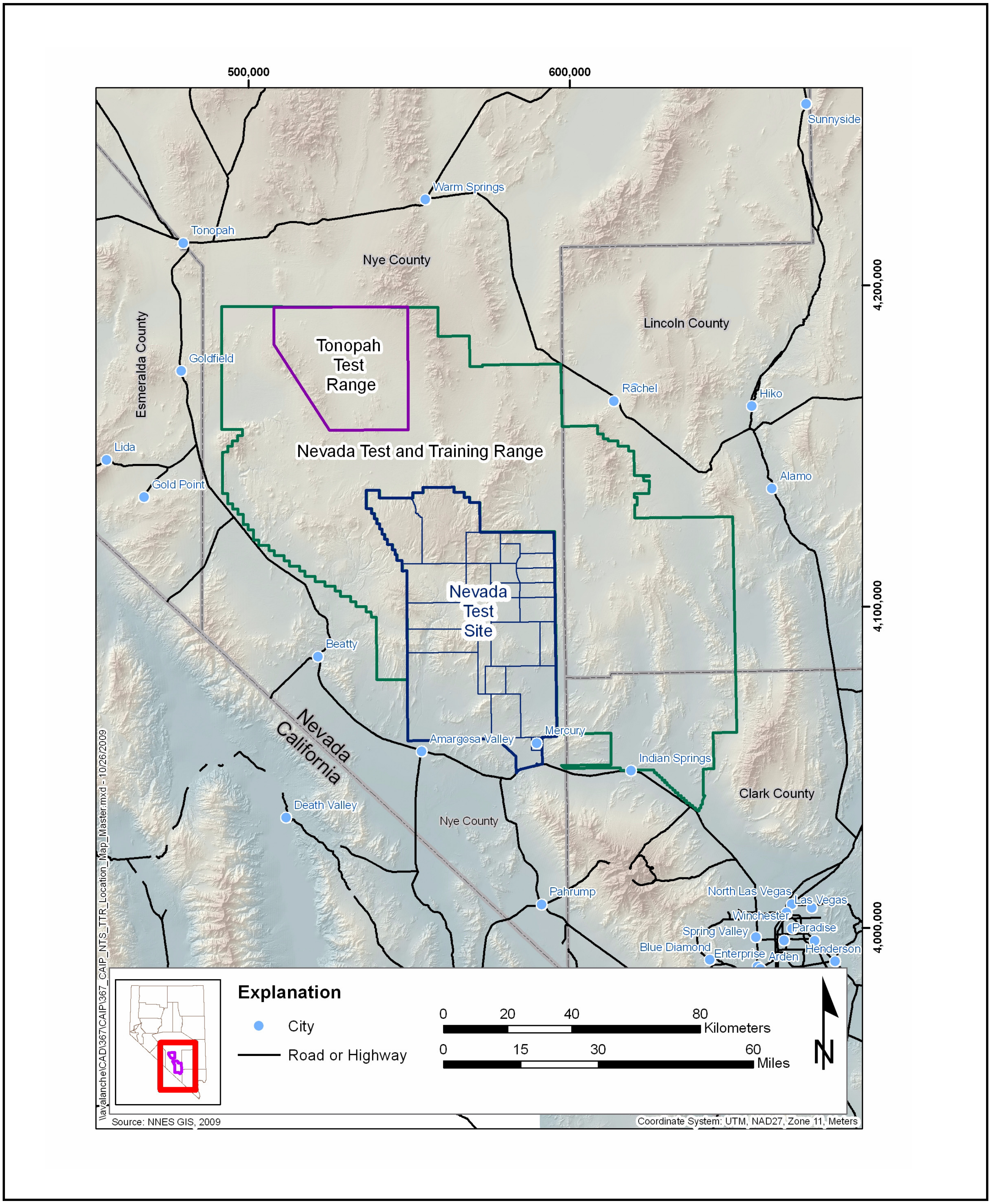

Figure 1-1
Nevada Test Site

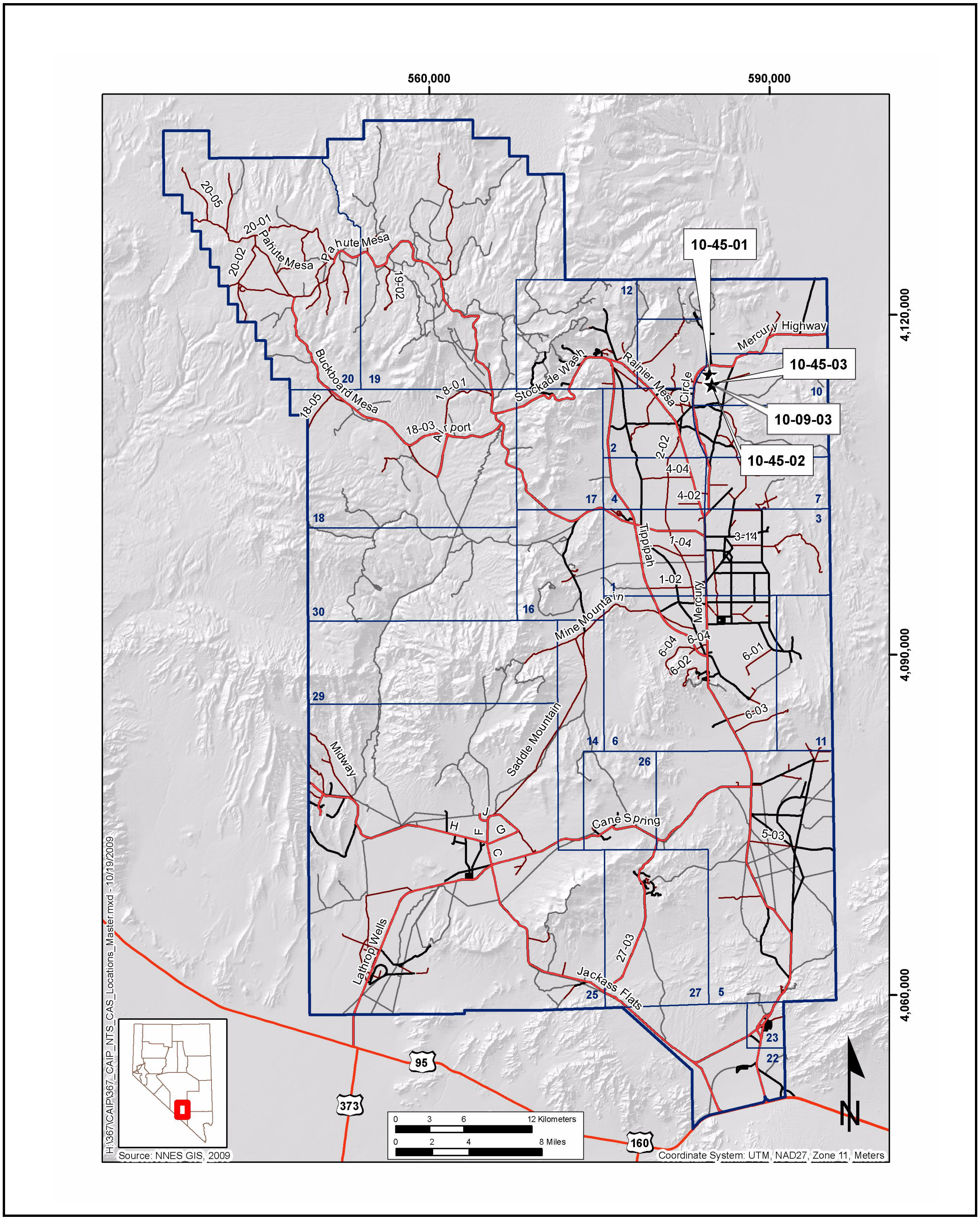

Figure 1-2
CAU 367, CAS Location Map

1.1.1 CAU 367 History and Description

Corrective Action Unit 367, Area 10 Sedan, Ess and Uncle Unit Craters, consists of four inactive sites located in the western portion of Area 10. The CAU 367 sites were used to support nuclear testing conducted in the Yucca Flat area from the 1950s through the early1960s. Operational histories for each of the CAU 367 CASs are detailed in Section 2.2. The CAU 367 sites consist of the following releases:

- CAS 10-45-03: Radioactive material from Uncle test
- CAS 10-45-02: Radioactive material from Ess test
- CAS 10-09-03: Mud Pit in Ess crater
- CAS 10-45-01: Radioactive material from Sedan test

Throughout this document, the CASs are discussed in chronological order of detonation with the exception of CAS 10-09-03 which will be discussed in combination with CAS 10-45-02. Uncle (CAS 10-45-03) was detonated in 1951; Ess (CAS 10-45-02) was detonated in 1955; and Sedan (CAS 10-45-01) was detonated in 1962.

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 367. 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 CAU 367 are presented in Appendix A. A summary of the DQO process is provided below.

The DQO problem statement for CAU 367 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 367.” 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. For probabilistic sampling decisions, any COPC for which the 95 percent upper confidence limit (UCL) of the mean exceeds its corresponding FAL will be defined as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/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 determine potential remediation waste types
  - 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 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 CAU 367 by collecting and analyzing samples generated during a field investigation. The presence of a COC will be determined by collecting and analyzing samples following these two criteria:

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

- To make a probabilistic sampling decision, samples must be collected from random locations that represent contamination within the sampling unit (see Section A.6.4).

The DQOs for CAU 367 defined 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 such as the CAS 10-09-03 drilling mud).

As shown in the conceptual site model (CSM) in Section 3.1.1, it is assumed that there is an area within and surrounding the craters that contains much of the radioactivity released from the subsurface detonation of the test device.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 367 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Measure *in situ* external dose rates using thermoluminescent detectors (TLDs) or other dose-measurement devices.
- Collect and submit environmental samples for laboratory analysis to determine internal dose rates.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of any COCs, if present.
- 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.

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

Contamination from the nearby Ceres, Oberon, and Titania safety experiments in Area 8 (CAU 105) may impact the northwest portion of the CAU 367 plume. In this region, contamination areas have been delineated that are associated with these experiments. These contamination areas and any contamination that can be attributed to these experiments will be excluded from the scope of CAU 367 and will be included in the corrective action evaluation of these releases (currently CAU 105).

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 367. 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 CAU 367, 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 367 comprises four CASs that were grouped together based on the geographical location of the sites, technical similarities, and the agency responsible for closure. The CASs are located in Area 10 of the NTS.

2.1 Physical Setting

The following sections describe the physical settings of Area 10 of the NTS. Geological and hydrological setting descriptions for the CAU 367 CASs are detailed in the following subsections.

2.1.1 Yucca Flat

Corrective Action Sites 10-45-01, 10-45-02, 10-09-03 and 10-45-03 are located within the Yucca Flat Hydrographic Area of the NTS. Yucca Flat is a closed basin, which is slowly being filled with alluvial deposits eroding from the surrounding mountains (USGS, 1996).

Local topography around the CASs is relatively flat, with gently sloping hills east and west of the site. The general direction of precipitation runoff flow is to the east, into an ephemeral channel that generally flows to the south into the Yucca Flat dry lake.

The direction of groundwater flow in Yucca Flat generally is from the northeast to southwest. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (USGS, 1996). The average annual precipitation at Station UCC on the Yucca Flat dry lake is 16.03 centimeters (cm) (6.31 inches [in.]) (ARL/SORD, 2009). Average annual potential evapotranspiration (PET) has been estimated for the Area 3 Radioactive Waste Management Site (RWMS) as 157 cm (61.81 in.). The nearest rain gauge to CAU 367 is located at the EPA Farm in Area 15. Rainfall and PET data are presented in Table 2-1. The recharge rate to the Yucca Flat area is relatively low (1.76 millimeters per year [mm/yr]), and the thickness of the unsaturated zone extends to more than 600 feet (ft) below ground surface (bgs) (USGS, 1996; Nordyke and Williamson, 1965). Therefore, it is expected that vertical migration of contaminants would be very limited.

Table 2-1
Rainfall and PET Information for Yucca Flat

	Area 3 PET (cm)	Station UCC (Yucca Dry Lake) Precipitation (cm)	EPA Farm Precipitation (cm)
Minimum	150.2	2.90	5.64
Maximum	160.8	41.17	39.78
Mean	157	16.03	19.18
95% UCL	160.2	19.35	22.48
Years reported	2003-2008	1959-2008	1965-2008

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 367. The CAS-specific summaries are designed to describe the current definition of each CAS and document all significant, known activities.

2.2.1 CAS 10-45-03, Uncle Crater Site

Corrective Action Site 10-45-03 consists of a release of radionuclides to surrounding soil from the Uncle test, conducted on November 29, 1951. This detonation was the first underground test at the NTS. The test device was buried 5.2 meters (m) bgs and had a yield of 1.2 kilotons (kt) (DOE/NV, 2000). This test resulted in formation of a crater measuring 78.4 m in diameter and 16.2 m deep. The detonation deposited “almost all” of the total activity as fallout (Nordyke, 1961). The test was part of Operation Jangle, to test weapons effects from a specific type of weapon system. Figure 1-2 shows the location of CAS 10-45-03.

2.2.2 CAS 10-45-02, Ess Crater Site

Corrective Action Site 10-45-02 consists of a release of radionuclides to surrounding soil from the Ess test, conducted on March 23, 1955. The test device was buried at a depth of 20 m and had a yield of 1 kt (DOE/NV, 2000). This test resulted in formation of a crater measuring 88 m in diameter and 29 m deep. The detonation deposited approximately 70 percent of the total activity as fallout

(Nordyke, 1961). The test was part of Operation Teapot weapons-effects test. Figure 1-2 shows the location of CAS 10-45-02.

2.2.3 CAS 10-09-03, Mud Pit

Corrective Action Site 10-09-03 is in Ess crater and consists of waste drilling mud that is likely the result of post-test drilling. It was identified in the *Compliance Assessment of the Nevada Test Site* (DOE, 1990). This CAS was formerly in CAU 544; it was transferred to CAU 367 in 2009. The mud pit measures approximately 79 m by 15 m. Figure 1-2 shows the location of CAS 10-09-03.

2.2.4 CAS 10-45-01, U-10h Crater (Sedan)

Corrective Action Site 10-45-01 consists of a release of radionuclides to surrounding soil from the Sedan test, conducted on July 6, 1962. The test device was buried at a depth of 193.5 m and had a yield of 104 kt (DOE/NV, 2000). This test resulted in formation of a crater measuring 390 m in diameter and 98 m deep. The test was part of the Plowshare excavation experiment to explore application of nuclear explosives for peaceful uses of atomic energy. The crater was placed on the National Register of Historic Places in 1994. Figure 1-2 shows the location of CAS 10-45-01.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. Wastes generated during the CAI may include debris, investigation-derived waste (IDW), decontamination liquids, and contaminated soils. Potential waste types include sanitary waste, *Resource Conservation and Recovery Act* (RCRA) hazardous waste, radioactive waste, and mixed waste.

Solid waste identified includes debris and drilling mud at the bottom of Ess crater and debris in and around the crater (SNJV, 2008).

2.4 Release Information

The releases of contamination to the CAU 367 CASs are directly or indirectly associated with the Uncle, Ess, and Sedan nuclear tests. The investigation of specific releases at CAU 367 will depend upon the nature of these releases. Therefore, the releases at CAU 367 have been categorized into one of the two release scenarios defined in Section 1.1.2.

The test release scenario includes the prompt injection of radionuclides and activated material into the geological formation around the test devices that resulted in contamination below and around the crater and rim (see Section 3.1.3). This scenario also includes the atmospheric deposition of radioactive contamination onto surface soils from fallout of activated soil ejected from the crater and radionuclides from the fireball. The atmospheric releases from the Uncle, Ess, and Sedan nuclear tests were deposited in the same general area, with the Uncle release being the first deposition (1951), followed by the Ess (1955) and Sedan release (1962). Therefore, it is possible that contamination from earlier tests may be buried under the ejecta of later tests. However, it is likely that contamination associated with the Uncle, Ess, and Sedan nuclear tests is co-located and mixed together such that the individual releases are not distinguishable. Visual evidence from the Sedan test film (AEC, 1962) shows the dramatic effects of the base surge following detonation of the test. The base surge is shown scouring surface soil out to a diameter of 5 mi from ground zero (GZ). This film demonstrates mixing of the existing surface soil into the plume of ejected material from the Sedan test (Figure 2-1).

The non-test release scenario includes the drilling mud in the bottom of the Ess crater that comprises CAS 10-09-03. The source of this drilling mud is not known but is suspected to be the result of post-test drilling in the Ess crater as there is no trail of drilling mud down the slope of the crater that would indicate dumping of the mud from an external source. Contamination associated with this mud is also unknown, but radioactivity from drilling into the contaminated crater and petroleum hydrocarbons that were commonly used as lubricants in drilling mud may be present.

The non-test release scenario also includes subsequent migration of radioactivity associated with atmospheric deposition under the test release scenario. This may occur due to sheet and gully erosion from stormwater runoff. The non-test release scenario also includes subsequent movement of surface-deposited radionuclides through excavation or grading associated with entry into the craters for recovering samples or drilling, and clearing of contaminated surfaces to provide a clean work area. The non-test scenario also includes other potential releases such as spills, wastes, or debris from activities conducted at the test sites.

Figure 2-1
Sedan Base Surge
Source: AEC, 1962

Exposure routes to receptors include ingestion and inhalation of radionuclides in surface 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 identifies the release sources specific to each CAS (DOE/NV, 2000):

- The Uncle source was a weapons-effects test with a yield of 1.2 kt buried at a depth of 5.2 m that was detonated on November 29, 1951.
- The Ess source was a weapons-effects test with a yield of 1 kt buried at a depth of approximately 20 m that was detonated on March 23, 1955.
- The Sedan source was a Plowshare test with a yield of 104 kt buried at a depth of 193.5 m that was detonated on July 6, 1962.
- The CAS 10-09-03, Mud Pit, source is drilling mud expected to contain radionuclides and hydrocarbons from post-test drilling activities.

Thirty CASs are within a 500-m radius of CASs 10-45-02 and 10-45-03. Three of these (CASs 10-22-05, 10-22-34, and 10-22-38) consist of housekeeping wastes that have not yet been scheduled for closure. All other CASs within a 500-m radius of Sedan have been closed.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 367 site. Aerial surveys were conducted in 1970, 1978, and 1994. The americium (Am)-241 results from the 1994 survey were unusable due to rapidly changing results and high count rates (BN, 1999). The Radionuclide and Distribution Program (RIDP) conducted an investigation from 1981 through 1986, which estimated the inventory of man-made radionuclides at the NTS through *in situ* gamma spectroscopy (DRI, 1987). These RIDP data were extrapolated to estimate levels of plutonium (Pu) across CAU 367 as shown on Figure 2-2.

2.5.1 CAS 10-45-03, Uncle Crater Site

Onsite fallout from the Uncle test was mainly to the north of GZ. Nineteen hours after the test, radiation exposure 3 kilometers northeast of GZ ranged from 0.01 roentgens per hr (R/hr) to 2.0 R/hr (DNA, 1951).

The 1994 aerial radiological survey showed gross count rates from 75 to 120 counts per second (cps) within 125 m of Uncle (BN, 1999). These results are shown on Figure 2-3.

2.5.2 CAS 10-45-02, Ess Crater Site

A helicopter survey was performed approximately two hours following the Ess test. A reading from 4.5 m into the crater recorded an exposure of 2,500 R/hr. Follow-up surveys measured 4,500 milliroentgens per hour (mR/hr) two weeks after the test and 550 mR/hr six weeks after the test (U.S. Army, 1955).

Results from the 1994 aerial survey showed gross count at this CAS ranged from 50 to 120 cps within 125 m of Ess crater (BN, 1999). These results are shown on Figure 2-3.

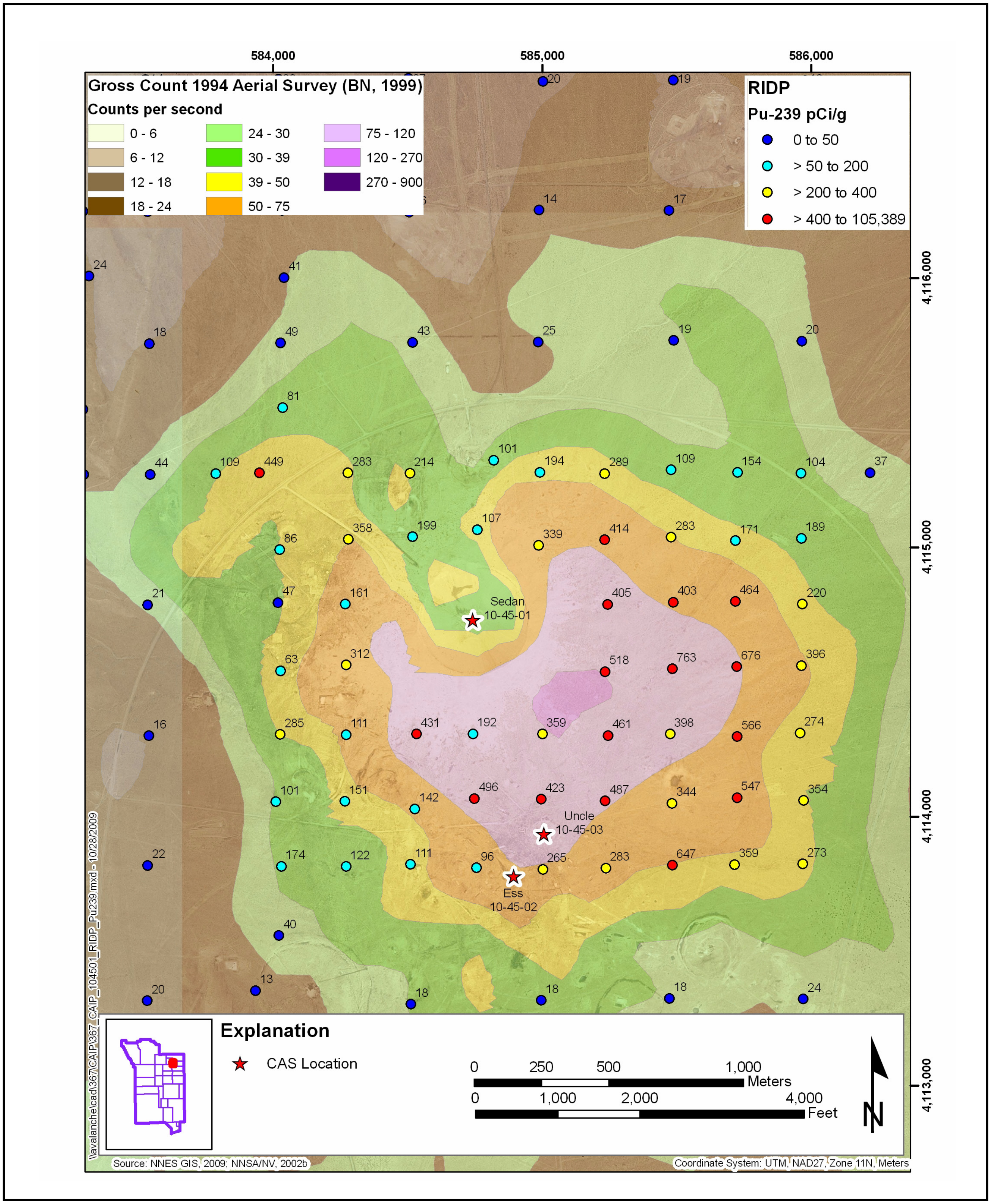

Figure 2-2
CAU 367 Plutonium-Inferred RIDP Data

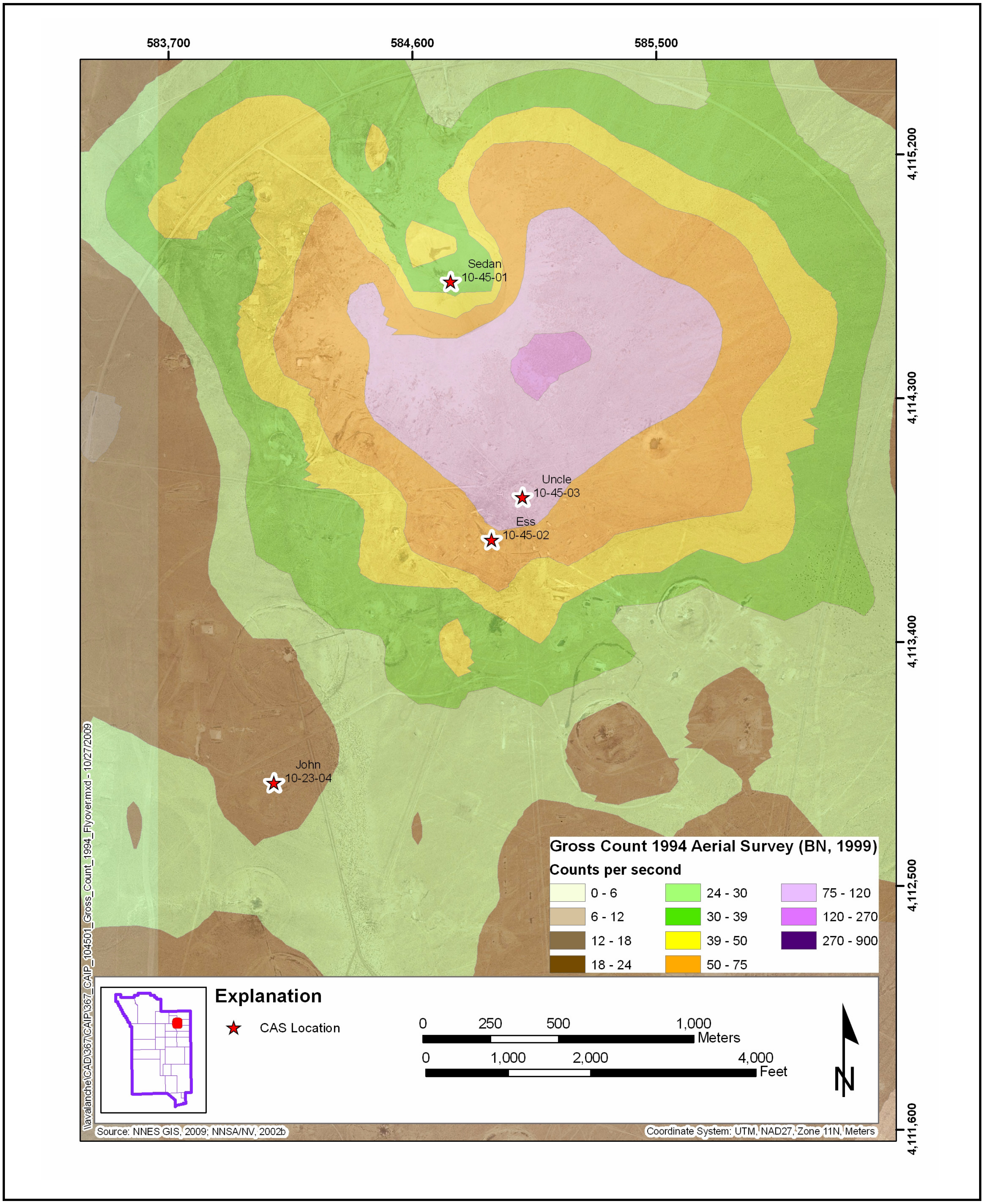

Figure 2-3
CAU 367 1994 Aerial Survey Gross Count

2.5.3 CAS 10-09-03, Mud Pit

During a site visit on January 9, 2002 high gamma readings were detected, but no additional information is available (IT Corporation, 2002). The report noted that Radiological Work Permits may be necessary for entry into the mud pit. No geophysical surveys or analytical results were identified for this site.

2.5.4 CAS 10-45-01, U-10h Crater (Sedan)

The 1970 survey detected one large area with a gamma exposure-rate maximum of 450 microroentgens per hour (μR/hr). This survey was limited to Sedan crater and did not include the northern or western edges. The 1978 aerial survey covered the western portion of Area 10. Sedan crater area had elevated activity and three other locations south of Sedan also had elevated activity. A third aerial radiological survey was conducted at the NTS in 1994. The gross counts at Sedan ranged from 30 to 75 cps within 300 m of Sedan crater. The plume extends across Mercury Highway to the north and northwest (BN, 1999). Results of the 1994 aerial survey are shown on Figure 2-3.

The Nevada Applied Ecology Group (NAEG) began investigating the Sedan crater in 1981 by sampling surface soils within two 300-m-wide transects east and southeast of GZ (Essington, 1985). Soil samples from 10 evenly spaced plots were collected to evaluate vertical distribution of radionuclides (Am-241; cesium [Cs]-137; cobalt [Co]-60; europium [Eu]-152, -154, -155; and rhodium [Rh]-101, -102) and to provide data to calibrate aerial survey results from units of exposure to radionuclide concentrations. Soil samples were not sieved or ball-milled.

All of the radionuclides showed a similar distribution in the top 20 cm of the profile, which indicated a significant decrease in activity below a depth of 5 cm. Depth of ejecta at these locations was estimated at 20 cm based on visual observation (Essington, 1985).

Desert Research Institute reported RIDP measurements from Area 10 at Sedan crater (DRI, 1987), which included 15 *in situ* gamma spectroscopy measurements. This inventory of man-made radionuclides was extrapolated to estimate levels of Pu across CAU 367. To calibrate and verify the *in situ* gamma spectroscopy measurements, five soil samples were collected, ball-milled and sieved, and analyzed by radiochemical analyses and gamma spectroscopy. The soil sample results were reported for Am-241, Cs-137, Pu-238 Pu-239/240, and strontium (Sr)-90, as shown in Table 2-2.

Table 2-2
RIDP Data from Sedan Crater

Isotope	Minimum (pCi/g)	Maximum (pCi/g)	Average (pCi/g)
Am-241	8	36	20
Cs-137	33	87	62
Pu-239/240	44	190	113
Pu-238	8.8	35	21
Sr-90	25	77	51

pCi/g = Picocuries per gram

Source: DRI (1987) Table 4, pg. 20

These samples were analyzed for Am-241 by both gamma spectroscopy, radio separation, and alpha spectroscopy. The report concluded that gamma results and radiochemical results are both considered reliable and accurate representations of radioactivities in the samples taken (DRI, 1987).

In June 1964, researchers drilled four holes near the bottom of the Sedan crater (Hansen, 1966). Punch core samples were recovered periodically during the drilling, and several different types of geophysical logs were run in the holes. Depths of hole ranged from 76 to 211 m. Conclusions from the study are summarized as follows:

- True crater surface lies approximately 58.5 m below GZ.
- A zone of compacted alluvium exists outside the true crater surface and may be 200 ft thick or more.
- Fractures (concentric and radiating) developed in the medium below and around the crater.

In 2009, gamma count-rate measurements were performed with a PRM-470B plastic scintillator. In addition, existing TLDs around Sedan crater were read and the results converted to millirem per Industrial Access year (mrem/IA-yr). The PRM-470B readings were taken at the site of each TLD. The TLD data were correlated to PRM-470 radiation survey readings, resulting in a coefficient of determination (r^2) of 0.99 as shown in Figure A.2-3. (Note: r is a very good measure of the linear correlation between two variables. When r = 1, all data points lie on a straight line, indicating perfect correlation.) Initial conclusions from this effort indicate that external radiation dose is approximately equal to 25 mrem/IA-yr at locations when PRM-470 values are 403 cps (Anagnostopoulos, 2009).

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 367.

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 367. 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 367 and formulation of the CSM. Also presented is a summary listing of the COPCs, the PALs for the CAU 367 CAI, 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 the 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. The CSM was developed for CAU 367 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 367 sources. Figure 3-2 depicts a graphical representation of the CSM. 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.3.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 367.

3.1.1 Land Use and Exposure Scenarios

Land-use zones where the CAU 367 CASs are located dictate future land use and restrict current and future land use to nonresidential (i.e., industrial) activities. The CAU 367 site is located in the land-use zone described as “Nuclear Test Zone” within the NTS. This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests. This

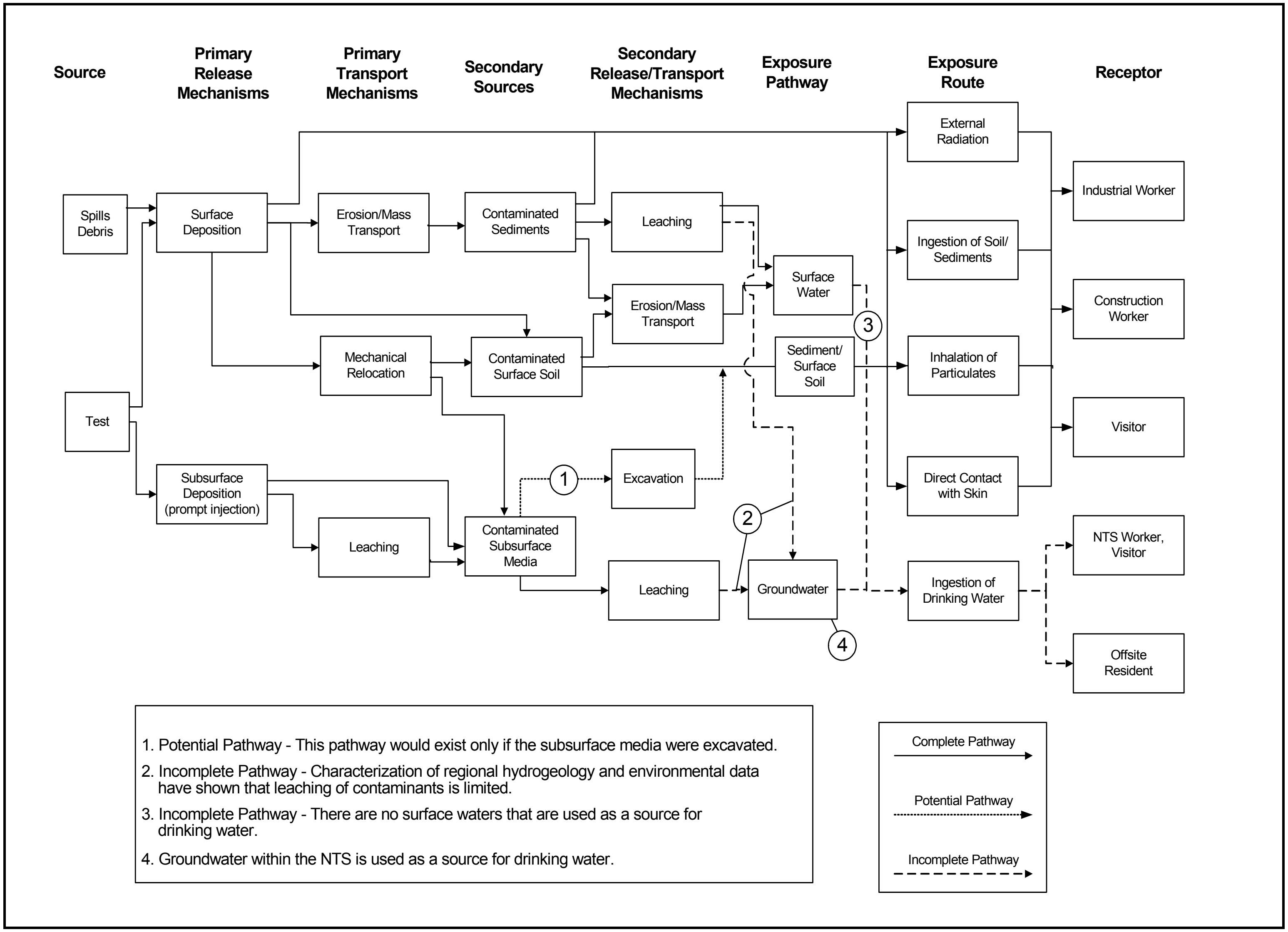

Figure 3-1
Conceptual Site Model Diagram

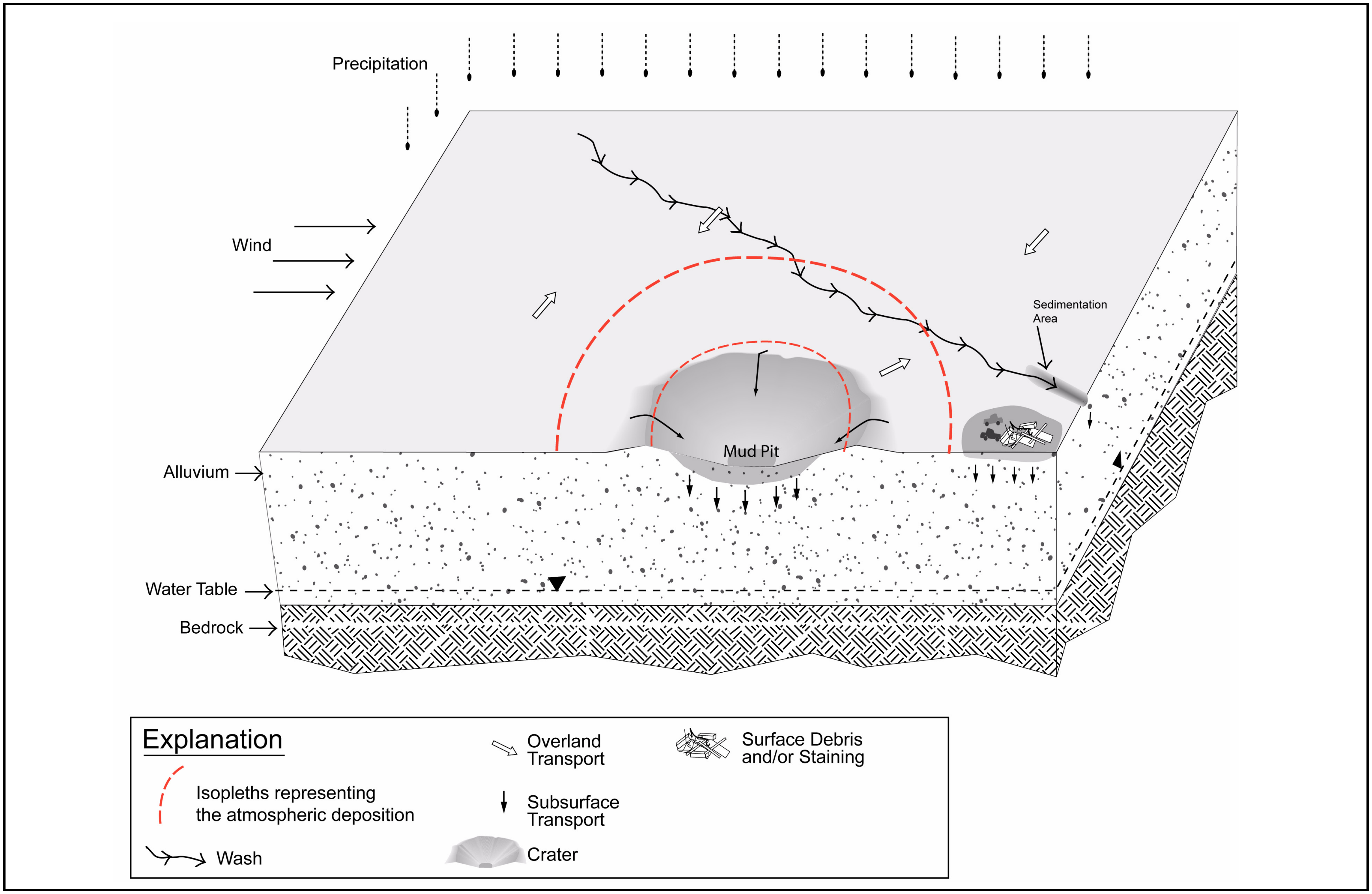

Figure 3-2
CAU 367 Conceptual Site Model

zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

The exposure scenario for the CAU 367 CASs based on current and projected future land uses is the Occasional Use Area. This exposure scenario assumes exposure to industrial workers who are not assigned to the area as a regular 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 10 hours per day, 10 days per year, for 5 years.

3.1.2 Contaminant Sources

The contamination sources for CAU 367 CASs are releases of radiological contamination to the atmosphere and soil as a result of Plowshare (CAS 10-45-01) and weapons-effects (CASs 10-45-02 and 10-45-03) tests, and contamination in the mud pit (CAS 10-09-03). Contamination in craters and on the soil surface may be sources for future migration.

3.1.3 Release Mechanisms

Release mechanisms for the test releases in CAU 367 include the release of fission products and release of unfissioned nuclear fuel from the detonation of nuclear devices as well as neutron activation of soil and debris. The radionuclides resulting from the neutron activation of soil are primarily Eu-152 and Eu-154.

As discussed in Section 2.4, the sequential detonations and ejecta from the Uncle, Ess, and Sedan tests create the possibility that surface contamination from the three tests have been mixed into a layer of contamination that is not distinguishable to any test. Film from the Sedan test shows the dramatic effects of the detonation’s base surge (AEC, 1962). The base surge is shown scouring and lifting surface soil into the ejecta out to a diameter of 5 mi from GZ (Figure 2-1). The concept of surface contamination mixing is also supported by post-Sedan soil sampling that showed contamination generally decreased with depths greater than 5 cm.

The CSM for the distribution of surface contamination from the three tests is that surface deposition of contaminants from the Uncle and Ess tests occurred mainly with a bias toward the prevailing wind direction (north) at the time of detonation, and surface deposition of contaminants from the Sedan test occurred mainly to the southeast. This resulted in an area with overlapping contamination from all three tests. Film from the Sedan test shows significant initial blowout to the southeast of Sedan GZ followed by a smaller blowout to the northwest (AEC, 1962) (Figure 3-3). These blowouts contained a higher concentration of fission material and activated soil than the remaining material displaced by the detonation, and resulted in a surface contamination plume that is not centered around the crater (Figure 3-3) and is not concentric with the pattern of total ejecta (see Figure A.9-1).

Figure 3-3
Sedan Blowouts
Source: AEC, 1962

3.1.4 Migration Pathways

Potential migration pathways include the lateral migration of contaminants across the soil surface and accumulation in drainages and craters, and vertical migration of potential contaminants into subsurface soils. Contaminants may also be moved through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include activities such as construction of viewing and parking areas, removal of surface contamination through scraping or grading, and construction and maintenance of roadways (e.g., shoulder grading of Mercury Highway).

Surface migration pathways for CAU 367 include the lateral migration of potential contaminants across surface soils into washes transecting the site since the original deposition. Contaminants released into ephemeral washes within the site are potentially subject to much higher transport rates than contaminants released to areas outside the drainages. 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. The area near CAU 367 drains into a small wash located east of the site that flows toward and into Yucca Flat dry lake. Other migration pathways for contamination from the site include wind-borne material and material displaced from roads in the vicinity (e.g., moved during road maintenance).

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.

Infiltration and percolation of precipitation serve as a driving force for downward migration of contaminants. However, due to high PET (annual PET at the Area 3 RWMS has been estimated at 157 cm [Shott et al., 1997]) and limited precipitation for this region (annual average of 16.03 cm at Station UCC [ARL/SORD, 2009]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at CASs at CAU 367 are expected to be predominantly 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).

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. Subsurface exposure points may exist if construction workers come in contact with contaminated media during excavation activities.

3.1.6 Exposure Routes

Exposure routes to site workers include ingestion 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, floodplains, and infrastructure at the CAU 367 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 site conditions (e.g., surface and subsurface soil descriptions) will be recorded during the CAI. Areas of erosion and deposition within the washes will be qualitatively evaluated to provide additional information on potential offsite migration of contamination. Movement of ephemeral stream channels may be identified based on a comparison of historical photographs and visual observations where erosion and deposition have occurred within the washes.

3.2 Contaminants of Potential Concern

Based on the suspected contaminants, the potential COPCs for CAU 367 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 analytical method are listed in Table 3-2.

Table 3-1
Analytical Program[a]

Analyses	Test Release	Non-Test Release[b]	Mud Pit
Organic COPCs			
PCBs	--	X	--
SVOCs	--	X	X
VOCs	--	X	X
Inorganic COPCs			
RCRA Metals	--	X	--
Beryllium	--	X	--
Radionuclide COPCs			
Gamma Spectroscopy[c]	X	X	X
Isotopic U	X	X	--
Isotopic Am	X	X	--
Sr-90	X	X	--
Isotopic Pu	X	X	--

[a]The COPCs are the constituents reported from the analytical methods listed.
[b]Selection based on type of release, indicators, process knowledge, etc.
[c]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.

PCB = Polychlorinated biphenyl
SVOC = Semivolatile organic compound
VOC = Volatile organic compound
X = Required analytical method
-- = Not required

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 Mud Pit and other potential non-test releases that may be discovered during the investigation. Specific COPCs (and subsequently the analyses requested) will be determined for other potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

3.3 Preliminary Action Levels

The preliminary action levels (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,

Table 3-2
Constituents 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	Pu-238
1,1,1-Trichloroethane	Chlorobenzene	2,4,5-Trichlorophenol	Dibenzo(a,h)anthracene	Aroclor 1221	Barium	Pu-239/240
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,6-Trichlorophenol	Dibenzofuran	Aroclor 1232	Beryllium	Sr-90
1,1,2-Trichloroethane	Chloroform	2,4-Dimethylphenol	Diethyl Phthalate	Aroclor 1242	Cadmium	U-234
1,1-Dichloroethane	Chloromethane	2,4-Dinitrotoluene	Dimethyl Phthalate	Aroclor 1248	Chromium	U-235
1,1-Dichloroethene	Chloroprene	2-Chlorophenol	Fluoranthene	Aroclor 1254	Lead	U-238
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Methylnaphthalene	Fluorene	Aroclor 1260	Mercury	Am-241
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylphenol	Hexachlorobenzene	Aroclor 1268	Selenium	
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Nitrophenol	Hexachlorobutadiene		Silver	**Gamma-Emitting**
1,2-Dichlorobenzene	Ethyl methacrylate	3-Methylphenol[a] (m-cresol)	Hexachloroethane			Ac-228 (Th-232)
1,2-Dichloroethane	Ethylbenzene	4-Methylphenol[a] (p-cresol)	Indeno(1,2,3-cd)pyrene			Am-241
1,2-Dichloropropane	Isobutyl alcohol	4-Chloroaniline	n-Nitroso-di-n-propylamine			Co-60
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Nitrophenol	Naphthalene			Cs-137
1,3-Dichlorobenzene	Methacrylonitrile	Acenaphthene	Nitrobenzene			Eu-152
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthylene	Pentachlorophenol			Eu-154
1,4-Dioxane	Methylene chloride	Aniline	Phenanthrene			Eu-155
2-Butanone	n-Butylbenzene	Anthracene	Phenol			K-40
2-Chlorotoluene	n-Propylbenzene	Benzo(a)anthracene	Pyrene			Nb-94
2-Hexanone	sec-Butylbenzene	Benzo(a)pyrene	Pyridine			Pb-212
4-isopropyltoluene	Styrene	Benzo(b)fluoranthene				Pb-214
4-Methyl-2-pentanone	tert-Butylbenzene	Benzo(g,h,i)perylene				Tl-208
Acetone	Tetrachloroethene	Benzo(k)fluoranthene				Th-234 (U-238)
Acetonitrile	Toluene	Benzoic Acid				U-235
Allyl chloride	Total Xylenes	Benzyl Alcohol				
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				

[a]May be reported as 3,4-Methylphenol or m,p-cresol.

Ac = Actinium
K = Potassium
Nb = Niobium
Pb = Lead
Th = Thorium
Tl = Thallium
U = Uranium

they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation, therefore streamlining the consideration of remedial alternatives. The 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 E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

This RBCA process, summarized in Figure 3-4, 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.

- Tier 3 evaluation - Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

This 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.3.1 will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site following completion of any interim actions. Any interim actions conducted will be reported in the Corrective Action Decision Document (CADD).

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

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Region 9: 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 the case with arsenic on the NTS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology (NBMG) throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range)

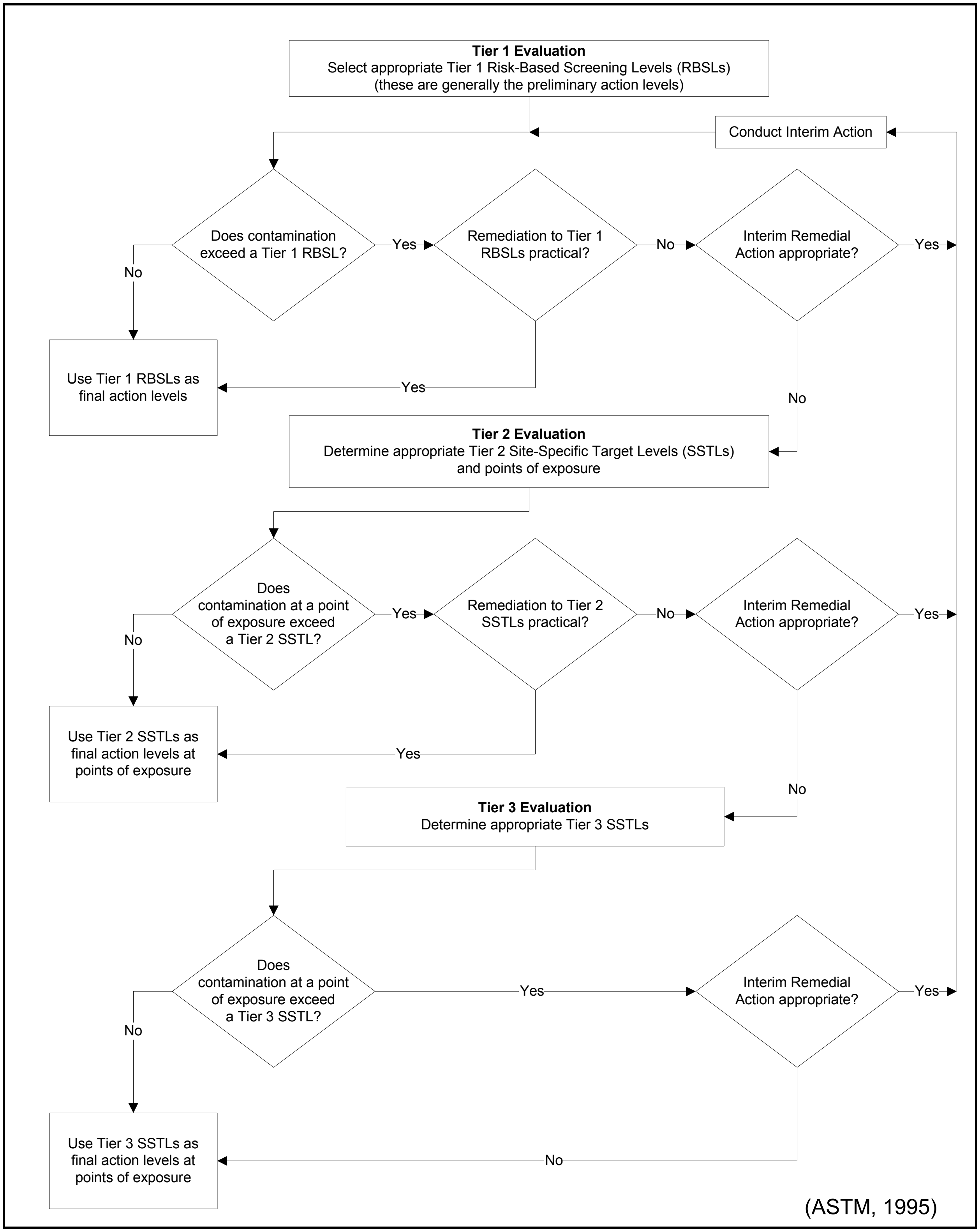

Figure 3-4
Risk-Based Corrective Action Decision Process

(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) 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 100 square meters (m^2) and a depth of contamination of 5 cm). In addition, Derived Concentration Guideline (DCG) values for each individual radionuclide potential COPC were calculated. The DCG is the value, in picocuries per gram for surface soil, for a particular radionuclide, that would result in a dose of 25 mrem/yr. Using DCGs 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 two types of potential contaminant releases:

- Test releases of contaminants are defined as the initial deposition 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, and grading of roads) and other potential releases (e.g., spills, lead bricks, and potential source material [PSM]) such as the drilling mud that comprises CAS 10-09-03.

The test releases will be investigated through a combination of probabilistic and judgmental sampling, and the non-test releases will be investigated through judgmental sampling. Therefore, discussions related to these two release scenarios are presented separately.

The DQO strategy for CAU 367 was developed at a meeting on September 30, 2009. 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 and data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 367 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 367." 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: "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.

For the test release scenario, the DQO process resulted in an assumption that TED within the areas of the craters, crater rims, and related mounding around the craters exceeds the FAL and requires corrective action. Process knowledge from test data indicate that much of the radioactivity associated with the test was captured within the craters and in fractures around the crater. The extent of the subsurface contamination in and around the craters has not been determined but has been conservatively estimated through the establishment of a default contamination boundary for each crater that includes the area of the craters and ejecta mounds at the crater rims. Figure 3-5 shows an example of a default contamination boundary. Also, radiological results from the PRM-470 radiological survey reported in Section 2.5.4 indicate that external dose will exceed the PAL outside the default contamination boundary. Therefore, Decision I for the test release scenario is resolved, corrective action is necessary, and Decision II must be resolved for the test releases at CAU 367.

For the non-test release scenario, Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. Samples from CAS 10-09-03, Mud Pit, will be submitted for the analyses listed in Table 3-1. Samples from around the Mercury Highway will be submitted for the same analyses as listed for the test release scenario. The specific analyses for samples from other non-test releases 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.

A corrective action may also be necessary if there is a potential for wastes that are present at a site to result in the introduction of COCs into site environmental media (PSM). 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 example, a small contaminant mass contained in a large mass such as a concrete wall would not be considered to be PSM, whereas that same mass of contaminant lying directly on soil would be considered to be PSM.

Figure 3-5
Default Contamination Boundary for Sedan Crater
Source: RSL, 1991

- 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 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 and determine whether the DQO data needs were met.

To satisfy the DQI of sensitivity (presented in Section 6.2.8), the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. Analytical methods and target minimum detectable concentrations (MDCs) for each CAU 367 COPC are provided in Tables 3-3 and 3-4. The MDC is the lowest concentration of a chemical or radionuclide parameter that can be detected in a sample within an acceptable level of error. 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 367
(Page 1 of 2)

Analysis[a]	Medium or Matrix	Analytical Method	MDC[b]	Laboratory Precision	Laboratory Accuracy
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1[c]	< FALs	RPD 35% (non-aqueous)[d] 20% (aqueous)[d] ND -2<ND<2[e]	LCS Recovery (%R) 80-120[f]
	Non-aqueous	GA-01-R[g]			

Table 3-3
Analytical Requirements for Radionuclides for CAU 367
(Page 2 of 2)

Analysis[a]	Medium or Matrix	Analytical Method	MDC[b]	Laboratory Precision	Laboratory Accuracy
Other Radionuclides					
Isotopic U	All	U-02-RC[g]	< FALs	RPD 35% (non-aqueous)[d] 20% (aqueous)[d] ND -2<ND<2[e]	Chemical Yield Recovery (%R) 30-105[h] LCS Recovery (%R) 80-120[h]
Isotopic Pu	Aqueous	Pu-10-RC[g]			
	Non-aqueous	Pu-02-RC[g]			
Isotopic Am	Aqueous	Am-03-RC[g]			
	Non-aqueous	Am-01-RC[g]			
Sr-90	Aqueous	EPA 905.0[c]			
	Non-aqueous	Sr-02-RC[g]			

[a]A list of constituents reported for each method is provided in Table 3-2.
[b]The MDC is the minimum concentration of a constituent that can be measured and reported with 95% confidence (Standard Methods)[i].
[c]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).
[d]*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).
[e]*Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997).
[f]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2008).
[g]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[h]Professional judgment and other industry acceptance criteria are used.
[i]*Standard Methods for the Examination of Water and Wastewater* (Clesceri, et al., 1998).

LCS = Laboratory control sample
ND = Normalized difference
RPD = Relative percent difference
%R = Percent recovery

Table 3-4
Analytical Requirements for Chemical COPCs for CAU 367

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]	< FALs	Lab-specific[d]	Lab-specific[d]
PCBs	All	8082[c]	< FALs	Lab-specific[d]	Lab-specific[d]
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] LCS Recovery (%R) 80-120[c]
Mercury	Aqueous Non-aqueous	7470[c] 7471[c]			

[a]A list of constituents reported for each method is provided in Table 3-2.
[b]The MDC is the minimum concentration of a constituent that can be measured and reported with 99% confidence (SW-846).
[c]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2008).
[d]Precision 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).

MS = Matrix spike
NNES = Navarro Nevada Environmental Services, LLC
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 367 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated by collecting and analyzing samples collected during a field investigation. The investigation will produce the information required to evaluate potential CAAs. However, due to the prompt injection of radionuclides from the nuclear tests (Section A.3.2.1), a large mass of subsurface contamination is present within each of the craters at a depth that would be technically infeasible to remove under the corrective action of clean closure. This contamination is effectively contained in unsaturated media beneath and around the craters and is covered by less contaminated material, which has eroded into the craters. This provides a stable configuration for the contamination in the craters. Therefore, the information that is required to evaluate the corrective action of clean closure (e.g., the extent of crater contamination) will not be collected during the investigation. Instead, the extent of contamination associated with the craters will be assumed by defining a default contamination boundary around each crater (Section 3.1.3).

Modifications to the investigative strategy may be required should unexpected field conditions be encountered. 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 367 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, equipment, and structures; constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones; providing sanitary facilities; constructing decontamination facilities; and temporarily moving staged equipment.

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

- Perform radiological surveys at CAU 367 (see Sections 2.5 and A.5.2.1.1 for additional information).
- Install project-specific environmental monitoring TLDs (see Section 4.2.3 for additional information).

4.2.2 Sample Location Selection

The following sections discuss the rationale for selecting areas for sampling.

4.2.2.1 Test Releases

As presented in Section 3.4, it is assumed that Decision I for test releases is resolved and that dose exceeds the FAL within and around the default contamination boundary. Therefore, sampling for the test releases will focus on resolving Decision II.

For the test releases at CAU 367, four Decision II sample plot locations will be determined judgmentally along each of four vectors that are approximately normal to the gamma radiation survey isopleths. The sample plot locations will be selected based on preliminary estimates of the location along each vector where TED would equal 25 mrem/IA-yr. The Decision II sample plot locations must meet the criterion that at least one sample plot will be located within the 25 mrem/IA-yr boundary and at least one sample plot will be located outside this boundary. A probabilistic sampling approach will be implemented for the selection of composite sample locations within each sample plot at the CASs. At each plot, each composite sample will consist of soil collected from nine sample locations within the plot. For each composite sample, the first location will be selected randomly; the remaining eight sample locations will be established on a systematic triangular grid (see Section A.9.0). Selection of probabilistic sample locations at these CASs, including an example of the predetermined sample locations at one plot (see Figure A.9-2), are presented in Sections A.5.2.1.2 and A.9.1. Section A.5.2.1.2 also briefly reviews the methodology and computation approach for the probabilistic sampling, while Section A.9.1 describes the sample location selection process.

4.2.2.2 Non-test Releases

For non-test releases at CAU 367, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. For CAS 10-09-03, the drilling mud in the bottom of Ess crater will be sampled from the center of the crater. For the investigation of contamination along the shoulders of Mercury Highway, sample locations will be based on the highest readings from a radiological survey for Am-241 (either ground based or aerial). For the investigation of drainages, sample locations will be the center of the sediment collection areas. For the other non-test releases, biasing factors such as stains, 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 submittal to the analytical laboratory. Biasing factors to be used for selection of sampling locations are listed in Section A.5.2.1. As biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents.

The sampling strategy and the estimated locations of biased samples are presented in Appendix A. The Task Manager or Site Supervisor may modify the number, location, and spacing of step-outs 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 367 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described Section 4.2.2.
- Collect required QC samples.
- Collect waste management samples as necessary.

- Collect external dose measurements by hanging TLDs at the sample plots, or collect instrument dose readings at extent locations.
- Record Global Positioning System (GPS) coordinates for each environmental sample location.

Decision I non-test release samples (0 to 15 cm bgs) will be collected from the locations described in Section 4.2.2.2. 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 will not be conducted for CAS 10-09-03 (non-test release) as the drilling mud is contained within the Ess crater. If a COC is present at CAS 10-09-03, the entire volume of drilling mud will be assumed to contain the COC and will be included in the corrective action determined for the default contamination boundary for the Ess crater.

Decision II sampling will also not be conducted for the drainage sedimentation areas (non-test release). If a COC is present in the sediment, the entire volume of the sediment will be assumed to contain the COC and will require corrective action.

If the TED near Mercury Highway exceeds the FAL, Decision II sampling will be conducted for the investigation of contamination along the shoulders of the highway. Decision II sampling will consist of further defining the extent of the area where corrective actions will be necessary to protect motorists and highway maintenance workers.

For other non-test releases, Decision II sampling will consist of further defining the extent of contamination where COCs have been confirmed. Extent (Decision II) sampling locations will be selected based on the CSM, biasing factors, field-survey results, existing data, and the outer boundary sample locations where COCs were 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 sample 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).

Decision II sampling for test releases will consist of collecting four samples from each plot. Each composite sample will be comprised of nine surface subsamples collected from 0 to 5 cm bgs at the locations described in Section 4.2.2. This depth of sampling is sufficient to capture the maximum radionuclide concentration as explained in Sections 2.5.4, 3.1.3, and A.2.2.4. Data collected will be used to estimate the TED for each sample. The TED will be determined for each sample by summing the internal and external dose components. Sample results for individual radionuclides will be used to calculate internal dose using RESRAD computer code (Yu et al., 2001). External dose will be determined by collecting *in situ* measurements using a dose measurement device (e.g., TLDs). These TLDs will be installed at the approximate center of the sample plot at a height of 1 m and be left in place for approximately 2,250 hours (equivalent to an annual industrial worker exposure). Each TLD contains three elements from which external dose measurements will be reported. Decision criteria are based on the 95 percent UCL of the average TED for each plot based on the four soil samples and the three TLD elements.

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 personal protective equipment (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; 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 367 field investigation will be managed 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, and analytical results from investigation and waste samples. Waste types that may be generated during the CAI include sanitary, 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 367 field investigation include sanitary and low-level radioactive wastes from the sampling activities. However, because of the uncertainty about what is 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., sanitary, low-level, hazardous, hydrocarbon, mixed) or the combination of waste types. The following subsections describe how specific waste types will be managed.

5.3.1 Industrial and Sanitary Waste

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

5.3.2 Hydrocarbon Waste

Hydrocarbon soil 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, 2006).

5.3.3 Low-Level 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* (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.

5.3.4 Hazardous Waste

Suspected 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) 265 Subpart I (CFR, 2009b).

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, 2009c), 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 367. The data from the TLD measurements will also meet rigorous data quality requirements. The TLDs will be obtained from, and measured by, the Environmental Technical Services group at the NTS. This group is responsible for a routine environmental monitoring program at the NTS. The program includes a campaign of TLDs that are emplaced at pre-established locations across the NTS for the monitoring of external dose. The TLDs are replaced and read quarterly. Details of this campaign can be found in the *Nevada Test Site Environmental Report 2006* (NNSA/NSO, 2007). The TLDs will be submitted to the Environmental Technical Services group for inclusion in their routine quarterly read of the NTS environmental monitoring TLDs. The TLDs will be analyzed using automated TLD readers that are calibrated and maintained by the National Security Technologies, LLC, Radiological Control Department in accordance with existing quality control procedures for TLD processing. A summary of the routine environmental monitoring TLD quality control efforts and results can be found in Section 5.2.1 of the *Nevada Test Site Environmental Report 2006* (NNSA/NSO, 2007). In general, the average relative percent difference between pairs of environmental TLDs was 2.5 percent for the year 2006. Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

The determination of the external dose component of the TED by TLDs was determined to be the most accurate method because:

1. The TLDs will be exposed at the sample plots for the entire 2,250 hours of the Industrial Area exposure scenario, which eliminates errors in dose-rate meter scale graduations and needle fluctuations. These errors would be magnified when as-read meter values are multiplied from units of “per-hour” to 2,250 hours.

2. The use of a TLD to determine an individual's external exposure is the standard in radiation safety and serves as the “legal dose of record” when other measurements are available. Specifically, 10 CFR Part 835.402 (CFR, 2009a) indicates that personal dosimeters shall be provided to

monitor individual exposures and that the monitoring program that uses the dosimeters shall be accredited in accordance with a DOE Laboratory Accreditation Program.

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 matrix, if less than 20 collected)
  - Laboratory QC samples (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)
- For chemical samples (if collected):
  - 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 matrix, if less than 20 collected)
  - Field blanks (may be 1 per 20 environmental samples, 1 per day, or 1 per CAU depending on site conditions and agreement of DQO participants)
  - Laboratory QC samples (1 per 20 environmental samples or 1 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 367 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 ±1x RL and ±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 of the established criteria. Therefore, the entire sampling and analytical process may be evaluated when determining the usability of the affected data.

The performance metric for assessing the DQI of accuracy on DQO decisions (see Table 6-1) is that at least 80 percent of the sample results for each measured contaminant are not qualified for accuracy.

If this performance is not met, an assessment will be conducted in the CADD on the impacts to DQO decisions specific to affected contaminants and the CAU.

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.
- For Decision I probabilistic sampling, having a high degree of confidence that the sample locations selected will represent contamination of 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 for COPCs is 80 percent. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions. For the probabilistic sampling approach, the completeness goal is a calculated minimum sample size required to produce a valid statistical comparison of the sample mean to the FAL.

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 samples will be collected if it is determined that the number of samples do not meet completeness criteria.

6.2.7 Comparability

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

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 NNSA/NSO project files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Federal Sub-Project Director. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the appropriate NNSA/NSO Federal Sub-Project Director.

8.0 References

AEC, see Atomic Energy Commission.

ARL/SORD, see Air Resources Laboratory/Special Operations and Research Division.

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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 367, Area 10 Sedan, Ess and Uncle Unit Craters 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 367 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 367 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.3.0 through A.9.0 were developed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

The DQO process presents a combination of probabilistic and judgmental sampling approaches. In general, the procedures used in the DQO process provide:

- A method to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.
- Criteria that will be used to establish the final data collection design, such as:
  - The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
  - The decisions or estimates that need to be made, and the order of priority for 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 Background Information

The following four CASs that comprise CAU 367 are located in Area 10 of the NTS, as shown in Figure A.2-1:

- 10-45-03, Uncle Crater Site
- 10-45-02, Ess Crater Site
- 10-09-03, Mud Pit
- 10-45-01, U-10h Crater (Sedan)

The following sections provide background information for CAU 367. Sections A.2.2.1 through A.2.2.4 provide the CAS description, physical setting, operational history, release information, and previous investigation results for each CAS in CAU 367.

Throughout this document, the crater CASs are discussed in chronological order of detonation. Uncle (CAS 10-45-03) was detonated in 1951; Ess (CAS 10-45-02) was detonated in 1955; and Sedan (CAS 10-45-01) was detonated in 1962.

A.2.1 CAU 367 Information

Physical Setting and Operational History

Corrective Action Unit 367 is located on Yucca Flat, which is relatively flat, with gently sloping hills to the east and west; topography is typical of disturbed desert area. It is arid with sparse vegetation. The general direction of precipitation runoff is to the east, into an ephemeral channel that generally flows to the south into Yucca Flat dry lake. Precipitation is infrequent, and annual average precipitation is 16.03 cm at Station UCC on Yucca Flat dry lake (ARL/SORD, 2009). Annual average PET has been estimated as 157 cm. It is expected that vertical migration of contaminants would be very limited due to the low annual rate of precipitation and high annual PET rate at the site. Intermittent streams, which cross the CAU 367 plumes, are present flowing in a general southwest direction. At the nearest borehole, UE-10 ITS3, depth to groundwater is 570 m (USGS, 2009).

Release Information

The releases of contamination to the CAU 367 CASs are directly or indirectly associated with the Uncle, Ess, and Sedan nuclear tests. However, the investigation of specific releases at CAU 367 will

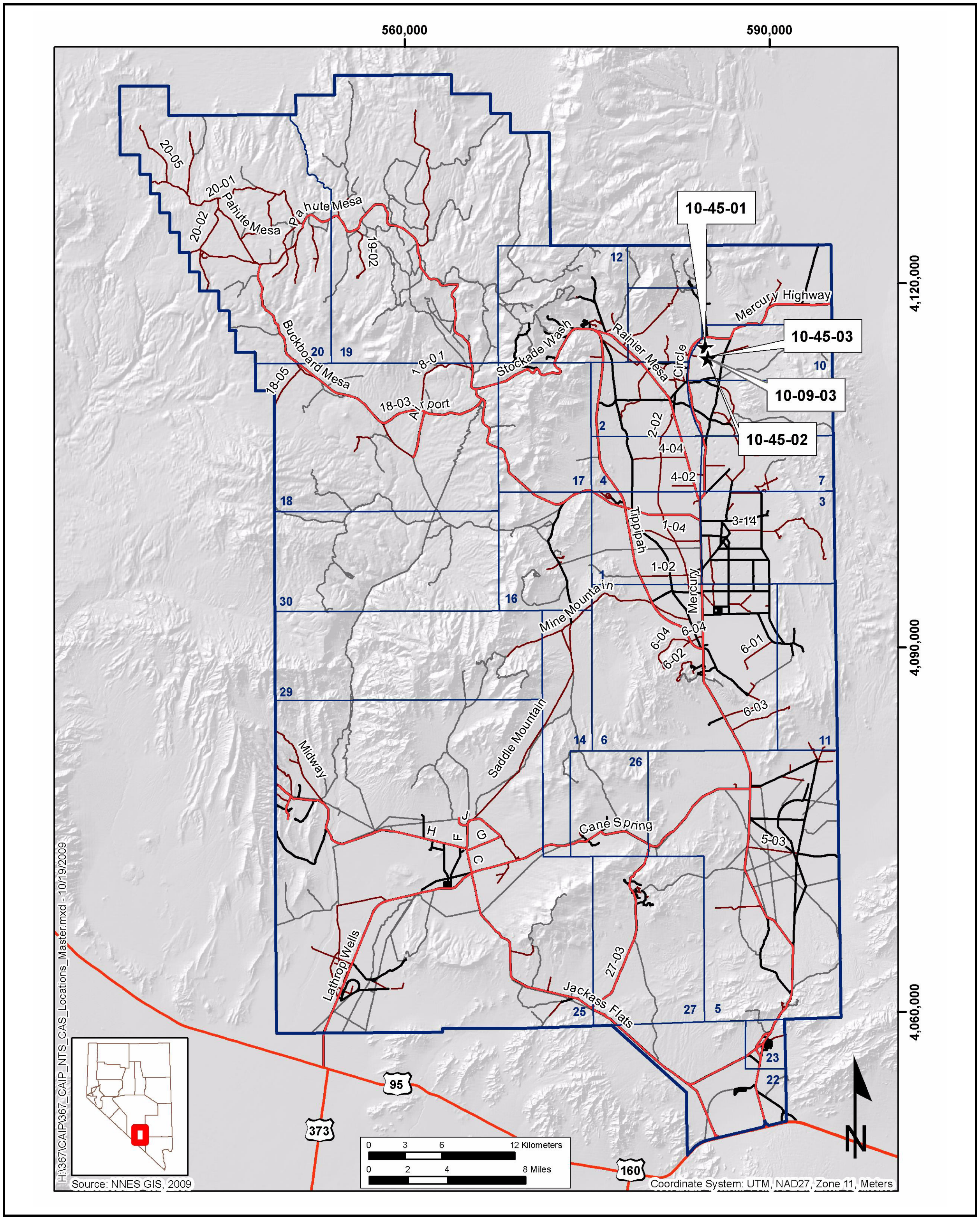


Figure A.2-1
CAU 367, CAS Location Map

depend upon the nature of these releases. Therefore, the releases at CAU 367 have been categorized into one of the following two release scenarios (i.e., release mechanisms):

- The test release scenario consists of the initial deposition of radioactivity to surrounding soils from prompt injection of nuclear material, neutron activation of soils and debris, and the atmospheric deposition of fuel fragments and fission products.
- The non-test release scenario consists of the subsequent movement of radiological contaminants from test releases (either by migration or mechanical displacement) and other potential releases of contaminants from site operations (e.g., spills and abandoned materials such as the CAS 10-09-03 drilling mud).

The test release scenario includes the prompt injection of radionuclides and activated material into the geological formation around the test devices that resulted in contamination below and around the crater and rim. This scenario also includes the atmospheric deposition of radioactive contamination onto surface soils from fallout of activated soil ejected from the crater and radionuclides from the fireball. The atmospheric releases from the Uncle, Ess, and Sedan nuclear tests were deposited in the same general area, with the Uncle release being the first deposition (1951), followed by the Ess release (1955) and the Sedan release (1962). Therefore, it is possible that contamination from earlier tests may be buried under the ejecta of later tests. However, it is likely that contamination associated with the Uncle, Ess, and Sedan nuclear tests is co-located and mixed together such that the individual releases are not distinguishable. Visual evidence from the Sedan test film (AEC, 1962) shows the dramatic effects of the base surge following detonation of the test. The base surge is shown scouring surface soil out to a diameter of 5 mi from GZ. This film demonstrates mixing of the existing surface soil into the plume of ejected material from the Sedan test. For these reasons, the contamination associated with the test release scenarios for the Uncle, Ess, and Sedan nuclear tests will be addressed as one release.

The non-test release scenario includes the drilling mud in the bottom of the Ess crater that comprises CAS 10-09-03. The source of this drilling mud is not known but is suspected to be the result of post-test drilling in the Ess crater as there is no trail of drilling mud down the slope of the crater that would indicate dumping of the mud from an external source. Any contamination associated with this mud is also unknown but may contain radioactivity from drilling into the contaminated crater and petroleum hydrocarbons that were commonly used as lubricants in drilling mud.

The non-test release scenario also includes subsequent migration of radioactivity associated with atmospheric deposition under the test release scenario. This may occur due to sheet and gully erosion from stormwater runoff. Surface water drainages are not apparent in the immediate vicinity of the Uncle, Ess, and Sedan nuclear tests. A minor drainage is distinguishable to the west of the site that flows toward and into the Yucca Dry Lake. The non-test release scenario also includes subsequent movement of surface-deposited radionuclides through excavation or grading associated with entry into the craters for recovering samples or drilling; clearing of contaminated surfaces to provide a clean work area; and construction or maintenance of roadways. The non-test scenario also includes contamination identified as spills and wastes from activities conducted at the test sites (such as CAS 10-09-03, Mud Pit) or debris from the nuclear test structures.

Exposure pathways to receptors include ingestion and inhalation of radionuclides in surface soil and small particles of activated soil (internal exposure). Site workers also may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials (i.e., external exposure).

The following identifies the test release sources specific to each CAS (DOE/NV, 2000):

- The Uncle source was a weapons-effects test with a yield of 1.2 kt buried at a depth of 5.2 meters (m) that was detonated on November 29, 1951.
- The Ess source was a weapons-effects test with a yield of 1 kt buried at a depth of approximately 20 m that was detonated on March 23, 1955.
- The Sedan source was a Plowshare test with a yield of 104 kt buried at a depth of 193.5 m that was detonated on July 6, 1962.

There is no information on the specific potential release of CAS 10-09-03, Mud Pit, located in the Ess crater. However, many similar mud pits at the NTS have been characterized, and the nature of contamination associated with mud pits is generally limited to radionuclides from post-test drilling activities and petroleum hydrocarbons used in the drilling muds.

A.2.2 CAU 367 CAS-Specific Information

A.2.2.1 CAS 10-45-03, Uncle Crater Site

Corrective Action Site 10-45-03 consists of release of radionuclides to surrounding soil from the Uncle Test. Figure A.2-2 shows the location of this CAS and the distances between Sedan, Uncle, and Ess craters.

Release Information

The detonation at CAS 10-45-03 deposited approximately "almost all" of the total activity as prompt injection of radionuclides and activated material into the geologic formation around the test device (Nordyke, 1961). Release of contamination at the site includes fallout due to the crater test as well as Eu and Co isotopes in the soil as a result of neutron activation.

Previous Investigation Results

An aerial radiological survey was conducted at the NTS in 1994. The exposure rate from man-made sources in the area of Uncle crater ranged from 45 to 85 mR/hr (BN, 1999). Gross count data were also mapped. Gross counts are shown on Figure A.2-2.

The RIDP conducted an investigation from 1981 through 1986 in which the inventory of some man-made radionuclides at the NTS through *in situ* gamma spectroscopy was estimated (DRI, 1987). Using these results, data were extrapolated to estimate levels of Pu across CAU 367. These results are shown on Figure 2-2.

A.2.2.2 CAS 10-45-02, Ess Crater Site

Corrective Action Site 10-45-02 consists of release of radionuclides to surrounding soil from the Ess Crater Site test. Figure A.2-2 shows the location of this CAS and the distances between Sedan, Uncle, and Ess craters.

Release Information

Release of contamination at the site includes fallout due to the test as well as Eu and Co isotopes in the soil as a result of neutron activation.

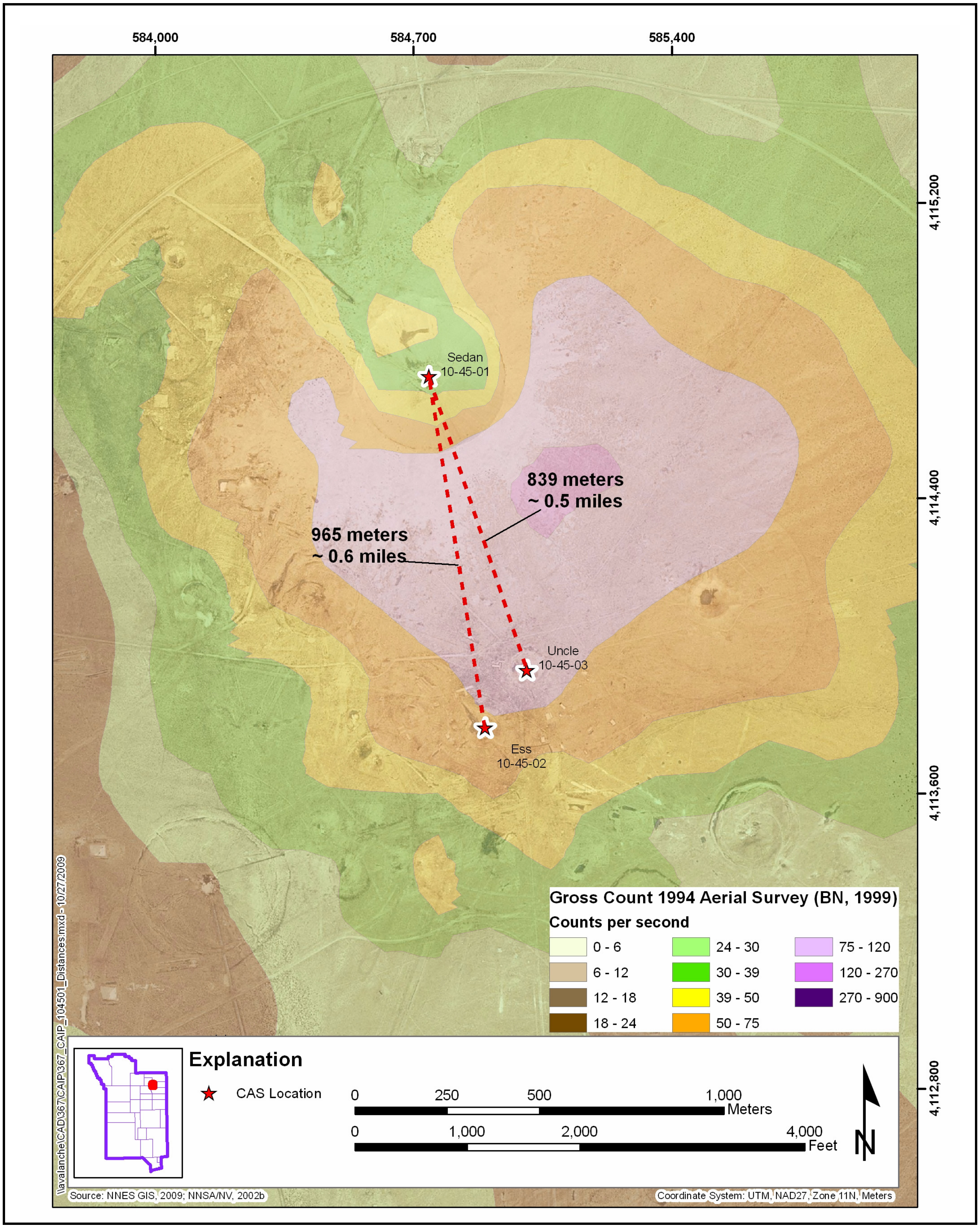


Figure A.2-2
Distances between Sedan, Uncle, and Ess Craters

Previous Investigation Results

An aerial radiological survey was conducted at the NTS in 1994. The exposure rate from man-made sources and gross count were measured at this CAS (BN, 1999). There results are shown on Figure A.2-2.

The RIDP conducted an investigation from 1981 through 1986, which estimated the inventory of man-made radionuclides at the NTS through *in situ* gamma spectroscopy (DRI, 1987). Using these results, data were extrapolated to estimate levels of Pu across CAU 367. These results are shown on Figure 2-2.

A.2.2.3 CAS 10-09-03, Mud Pit

Corrective Action Site 10-09-03 consists of a release of drilling mud into Ess crater.

Physical Setting and Operational History

Corrective Action Site 10-09-03 is located in Ess crater. It was identified in the *Compliance Assessment of the Nevada Test Site* (DOE, 1990). The mud pit is approximately 79 m by 15 m.

Release Information

No information is available on potential release of contamination from this CAS.

Previous Investigation Results

A field crew visited this site on January 9, 2002. High gamma readings were detected, but no specific information is available (IT Corporation, 2002). No other investigation results are available.

A.2.2.4 CAS 10-45-01, U-10h Crater (Sedan)

Corrective Action Site 10-45-01 consists of a release of radionuclides to surrounding soil from the Sedan test. Figure A.2-2 shows the location of this CAS and the distances between Sedan, Uncle, and Ess craters.

Release Information

Release of contamination at the site includes fallout due to the Plowshare test as well as Eu and Co isotopes in the soil as a result of neutron activation.

Previous Investigation Results

The NAEG began investigating the Sedan crater in 1981 by sampling surface soils within two 300-m-wide transects east and southeast of GZ (Essington, 1985). These areas were determined not to interfere with testing activities at NTS and could be maintained undisturbed for the duration of the studies. Soil samples from 10 evenly spaced plots were evaluated for vertical distribution of radionuclides (Am-241; Cs-137; Co-60; Eu-152, -154, -155; and Rh-101, -102) and to provide data to calibrate aerial survey results from units of exposure to radionuclide concentrations. Soil samples were not sieved or ball-milled.

All of the radionuclides show a similar distribution in the top 20 cm of the profile, which is a significant increase at 2.5 and 5 cm followed by a general decrease continuing to about 30 cm. Depth of ejecta at this location was estimated at 20 cm based on visual observation. Only 40 percent of Cs-137 and 50 percent of other gamma-emitting radionuclides were located in the top 5 cm of soil (Essington, 1985).

Desert Research Institute reported RIDP measurements from Area 10 at Sedan crater (DRI, 1987). Five soil samples were collected, ball-milled and sieved, and analyzed by radiochemical analyses and gamma spectroscopy. Results were reported for Am-241, Cs-137, Pu-239/240, Pu-238, and Sr-90, as shown in Table A.2-1. These samples were analyzed for Am-241 by both gamma spectroscopy, radio separation, and alpha spectroscopy. The report concluded that gamma results and radiochemical results are both considered reliable and accurate representations of radio activities in the samples taken (DRI, 1987).

The RIDP estimated exposure from man-made radionuclides at the NTS through *in situ* gamma spectroscopy. Using these results, data were extrapolated to estimate levels of Pu across CAU 367. These results are shown on Figure 2-2.

In June 1964, researchers drilled four holes near the bottom of the Sedan crater (Hansen, 1966). Punch core samples were recovered periodically during the drilling, and several different types of

Table A.2-1
RIDP Data from Sedan Crater

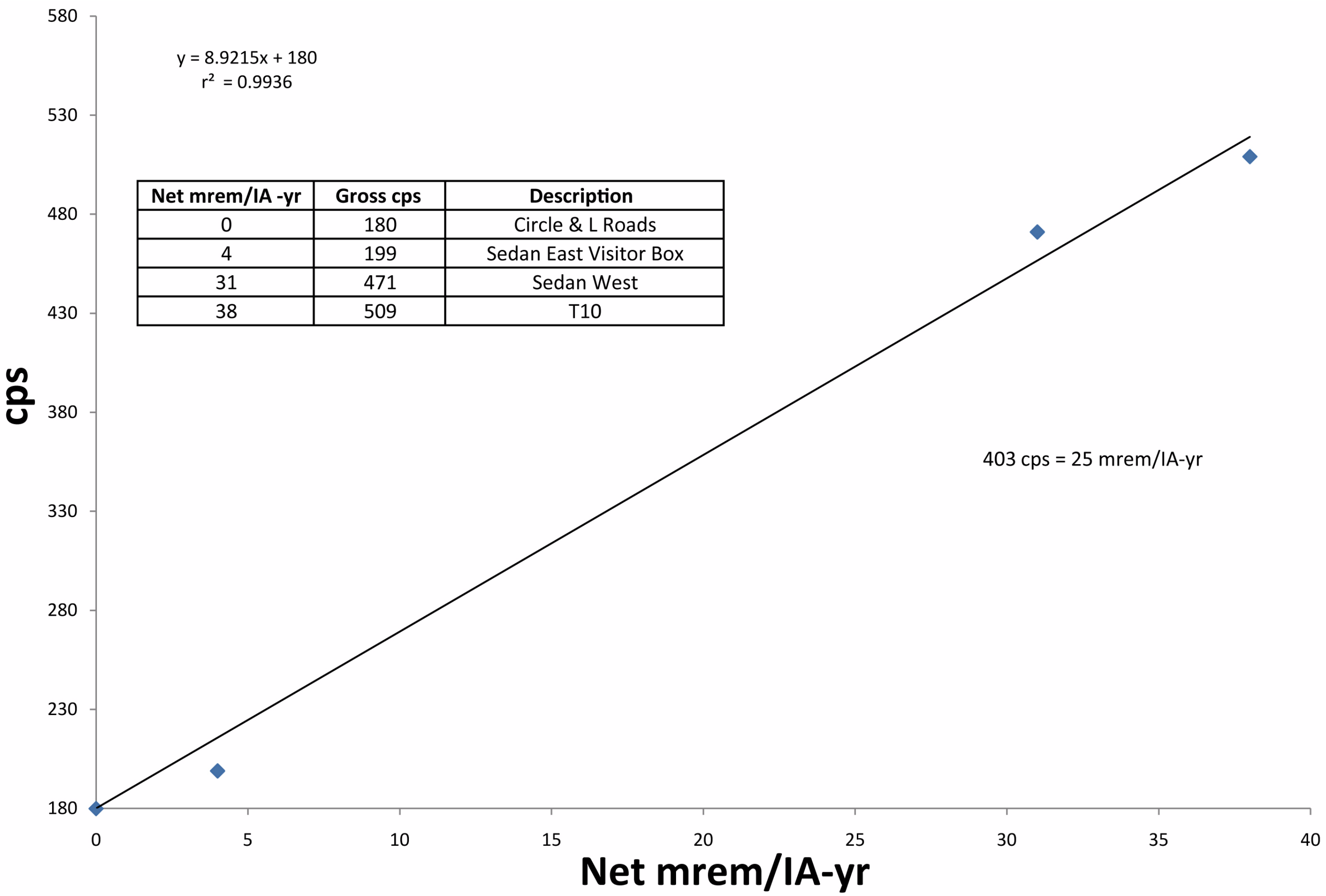
Isotope	Minimum (pCi/g)	Maximum (pCi/g)	Average (pCi/g)
Am-241	8	36	20
Cs-137	33	87	62
Pu-239/240	44	190	113
Pu-238	8.8	35	21
Sr-90	25	77	51

Source: DRI (1987) Table 4, pg. 20

geophysical logs were run in the holes. Depths of hole ranged from 250 to 692 ft. Conclusions from the study are summarized as follows:

- True crater surface lies approximately 192 ft below GZ.
- A zone of compacted alluvium exists outside the true crater surface and may be 200 ft thick or more.
- Fractures (concentric and radiating) developed in the medium below the true crater boundary.

In 2009, gamma walkover surveys were performed with a PRM-470B plastic scintillator. In addition, existing TLDs around Sedan crater were read and the results converted to mrem/IA-yr. The PRM-470B readings were taken at the site of each TLD. When the TLD data were correlated to PRM-470 radiation survey readings, a very good fit was obtained ($r^2 = 0.99$) as shown in Figure A.2-3. This approach allows an estimate of external dose rates very early in the investigation, and helps focus more rigorous sampling and selection of sampling sites. Initial conclusions from this effort indicate that external radiation doses will be approximately 25 mrem/IA-yr when PRM-470 readings equal 403 cps (Anagnostopoulos, 2009).



Net mrem/IA -yr	Gross cps	Description
0	180	Circle & L Roads
4	199	Sedan East Visitor Box
31	471	Sedan West
38	509	T10

Figure A.2-3
PRM-470B Versus Net Dose (mrem/IA-yr) for Sedan Crater
Source: Anagnostopoulos, 2009

A.3.0 Step 1 - State the Problem

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

The problem statement for CAU 367 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 367."

A.3.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO. The DQO planning team met on September 30, 2009, for the DQO meeting.

A.3.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at 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 the 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 367 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 by which 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.

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

A.3.2.1 Release Sources

The releases of contamination to CAU 367 are directly or indirectly associated with the Uncle, Ess, and Sedan nuclear tests. The test release scenario consists of the initial deposition of radioactivity to surrounding soils from prompt injection of nuclear material, neutron activation of soils and debris, and the atmospheric deposition of fuel fragments and fission products. A typical cross-section of a crater, including crater nomenclature, is shown in Figure A.3-2. The visible crater is bounded by material that may be classified into three categories: fallback and ejecta zone, rupture zone, and elastic zone (Fleming et al., 1970).

Table A.3-1
Conceptual Site Model Description of Elements for CAU 367

Site Status	Sites are inactive.
Exposure Scenario	Occasional.
Sources of Potential Soil Contamination	Fallout and soil activation from belowground nuclear tests.
Location of Contamination/ Release Point	Location generally related to location of 1994 aerial survey isopleths. Contamination also present within and around craters.
Amount Released	The total amount of radioactivity released to the surface is unknown.
Affected Media	Surface and shallow subsurface soil; debris.
Potential Contaminants	Gamma and isotopic radionuclides.
Transport Mechanisms	Surface water runoff may provide for transportation of some contaminants. Percolation of precipitation through subsurface media serves as a minor driving force for migration of contaminants to groundwater. Wind may also transport contamination but is considered a minor pathway.
Migration Pathways	Vertical and lateral transport with stormwater.
Lateral and Vertical Extent of Contamination	Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, and dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.

The following identifies the test release sources specific to each CAS (DOE/NV, 2000):

- The Uncle source was a weapons-effects test with a yield of 1.2 kt buried at a depth of 5.2 m that was detonated on November 29, 1951.
- The Ess source was a weapons-effects test with a yield of 1 kt buried at a depth of approximately 20 m that was detonated on March 23, 1955.
- The Sedan source was a Plowshare test with a yield of 104 kt buried at a depth of 193.5 m that was detonated on July 6, 1962.

There is no information on the specific potential release of CAS 10-09-03, Mud Pit, other than the presence of drilling mud in the bottom of the Ess crater. However, many similar mud pits at the NTS have been characterized, and the nature of contamination associated with mud pits is generally

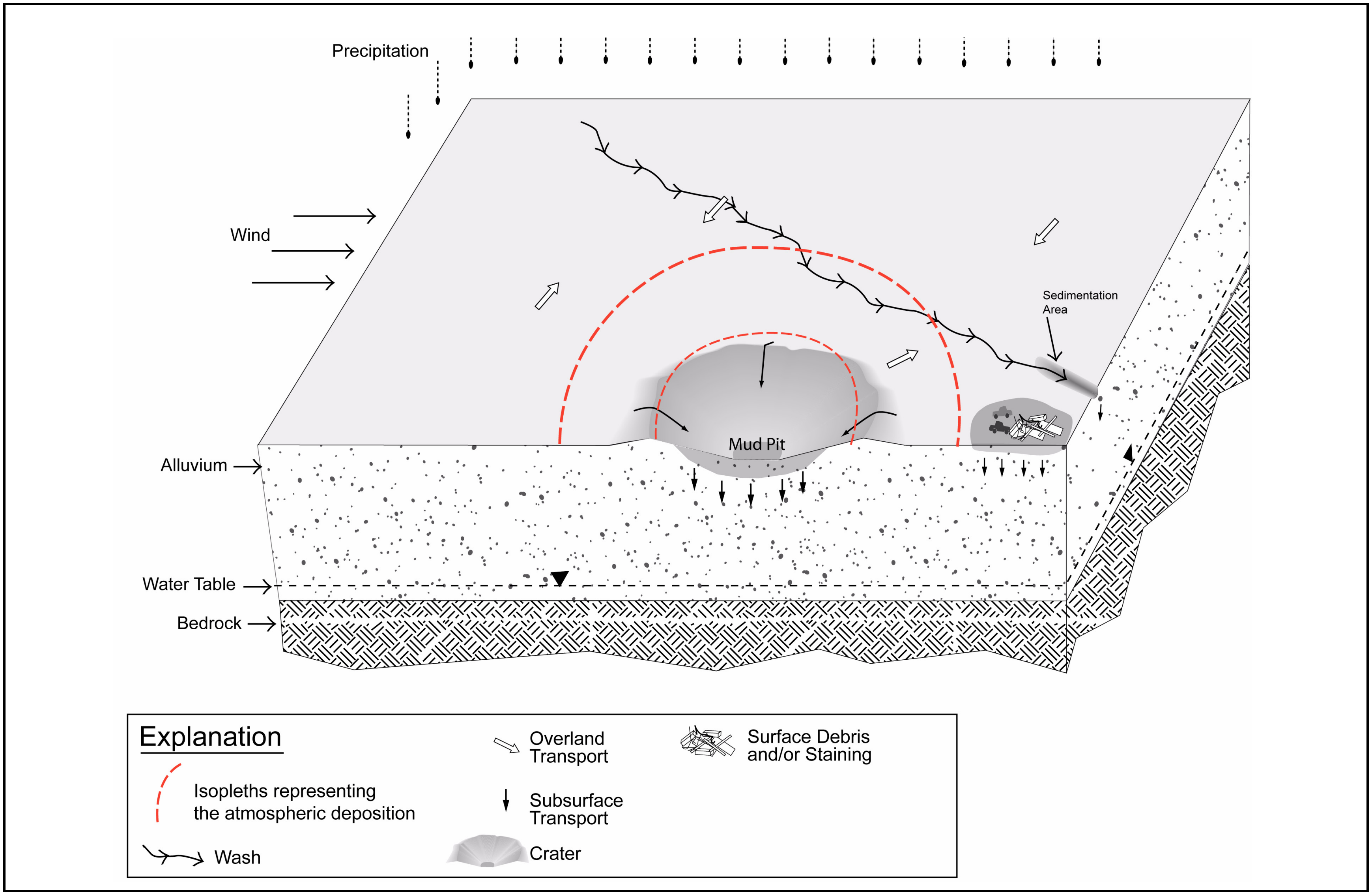


Figure A.3-1
CAU 367 Conceptual Site Model

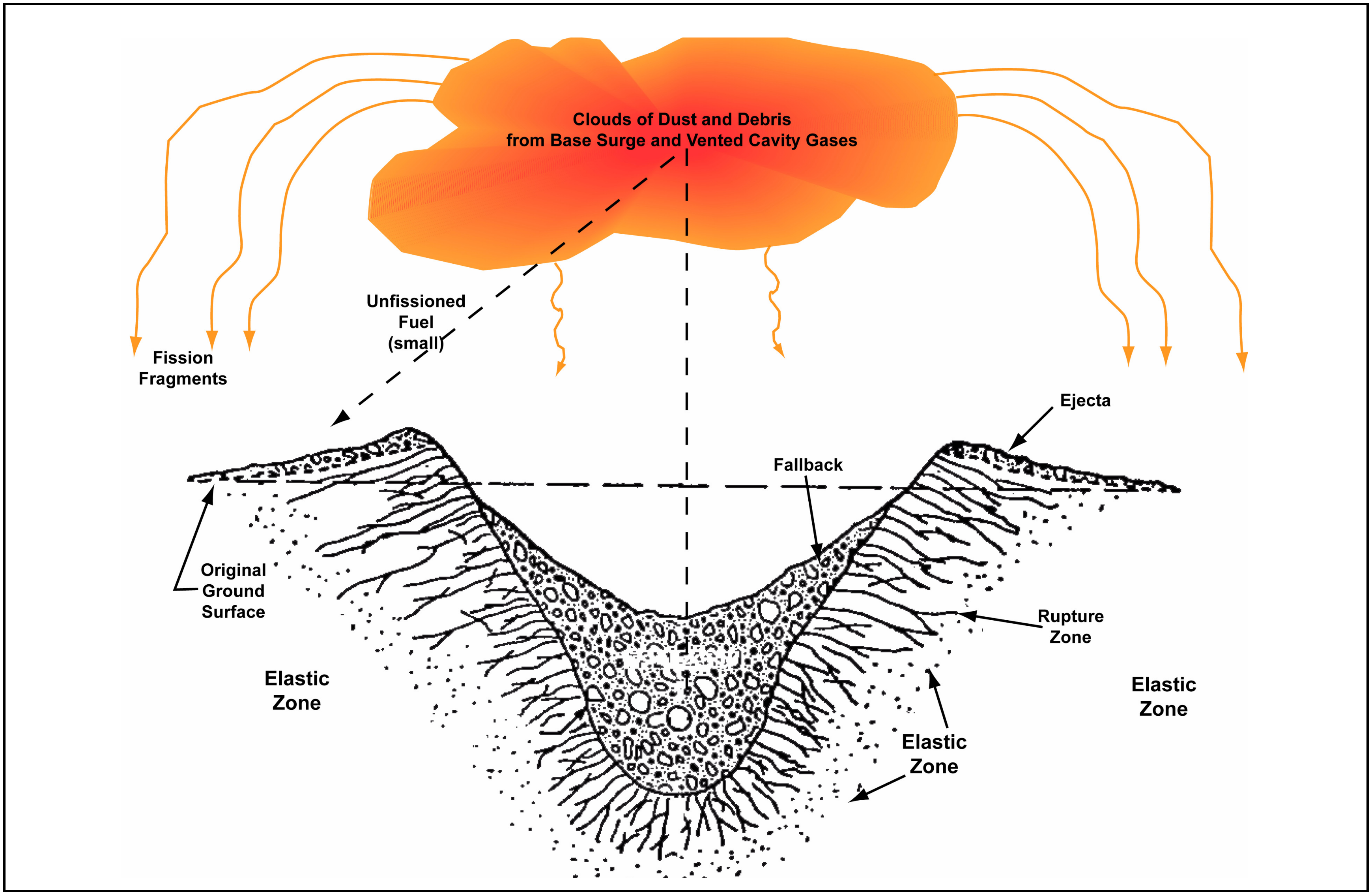


Figure A.3-2
CAU 367 Conceptual Site Model: Release

limited to radionuclides from post-test drilling activities and petroleum hydrocarbons used in the drilling muds.

A.3.2.2 Potential Contaminants

The COPCs are based on a conservative evaluation of possible site activities considering the incomplete site histories and considering contaminants found at similar NTS 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. The list of COPCs is intended to encompass all of the significant contaminants that could potentially be present. Significant contaminants are defined as contaminants that are present at concentrations exceeding the PAL.

Based on the suspected contaminants, the potential COPCs for CAU 367 are defined as the list of analytes reported from the analytical methods identified in Table A.3-2 for Decision I environmental samples taken at each of the CASs. 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 mud pit (CAS 10-09-03) and other potential non-test releases that may be discovered during the investigation. Specific COPCs (and subsequently the analyses requested) will be determined for other potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

A.3.2.3 Contaminant Characteristics

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

Table A.3-2
Analytical Program[a]

Analyses	Test Release	Non-Test Release[b]	Mud Pit
Organic COPCs			
PCBs	--	X	--
SVOCs	--	X	X
VOCs	--	X	X
Inorganic COPCs			
RCRA Metals	--	X	--
Beryllium	--	X	--
Radionuclide COPCs			
Gamma Spectroscopy[c]	X	X	X
Isotopic U	X	X	--
Isotopic Am	X	X	--
Sr-90	X	X	--
Isotopic Pu	X	X	--

[a]The COPCs are the constituents reported from the analytical methods listed.
[b]Selection based on type of release, indicators, process knowledge, etc.
[c]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.

X = Required analytical method
-- = Not required

A.3.2.4 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 A.2.1.

A.3.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils. Contaminants present in ephemeral washes are subject to much higher transport rates than contaminants present in other surface areas. These ephemeral washes 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 area near CAU 367 drains into a small wash located to the east of the site that flows toward and into Yucca Flat dry lake. Other migration pathways for contamination from the site include wind-borne material and material displaced from roads in the vicinity (e.g., moved during road maintenance).

Contaminants may also be moved through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include activities such as construction of viewing and parking areas, removal of surface contamination through scraping or grading, and the construction and maintenance of roadways (e.g., shoulder grading of Mercury Highway).

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.

Infiltration and percolation of precipitation serve as a driving force for downward migration of contaminants. However, due to high PET (annual PET at the Area 3 RWMS has been estimated at 157 cm) and limited precipitation for this region (annual average of 16.03 cm at Station UCC [ARL/SORD, 2009]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at CAU 367 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).

A.3.2.6 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. Corrective Action Sites 10-45-01, 10-45-02, 10-45-03, and 10-09-03 are at remote locations without any site improvements and where no regular work is performed. There is still the possibility, however, that site workers could occupy these locations on an occasional and temporary basis, such as a military exercise. Therefore, these sites are classified as occasional work areas.

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

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

A.4.1 Decision Statements

The Decision I statement is: "Is any COC present in environmental media within the CAS?" For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NSO, 2006). Decision I has been resolved, and it has been determined that Decision II must be resolved (see Section 3.4).

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 feasibility of remediation alternatives (bioassessment if natural attenuation or biodegradation is considered, and geotechnical data if construction or evaluation of barriers is considered)

A corrective action will be determined for any site containing a COC.

For the test release scenario, the DQO process resulted in an assumption that TED within the areas of the craters, crater rims, and related mounding around the craters exceeds the FAL and requires corrective action. A default contamination boundary will be established for each crater that will include the area of the craters and ejecta mounds at the crater rims (see Section 3.4). Figure 3-5 shows an example of a default contamination boundary. Also, radiological results from the PRM-470 radiological survey reported in Section 2.5.4 indicate that external dose will exceed the PAL outside the default contamination boundary. Therefore, Decision I for the test release scenario is resolved, corrective action is necessary, and Decision II must be resolved for the test releases at CAU 367.

For the non-test scenario, Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. Decision II samples for both release scenarios will be submitted 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.

The evaluation of the need for corrective action will include the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released. To evaluate the potential for 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.

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.4.2 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.4.2.1 Alternative Actions to Decision I

If no COC associated with a non-test release from the CAS is detected, then further assessment of non-test releases from 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.4.2.2 Alternative Actions to Decision II

If sufficient information is available to evaluate potential CAAs, then further assessment of the CAS is not required. If sufficient information is not available to evaluate potential CAAs, then additional samples will be collected.

A.5.0 Step 3 - Identify Information Inputs

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

A.5.1 Information Needs

To resolve Decision I (determine whether a COC is present at a CAS), for non-test release contamination, samples will be collected and analyzed following these two criteria:

- Samples must either (a) be collected in areas most likely to contain a COC (judgmental sampling) or (b) properly represent contamination at the CAS (probabilistic sampling).
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

Samples will not be required to resolve Decision I for the test release scenario as the DQO process resulted in a decision that Decision I is resolved, corrective action is necessary, and Decision II must be resolved for the test releases at CAU 367. This is based on the process knowledge from the nuclear tests that the craters, crater rims, and related mounding around the craters are contaminated at levels that would exceed the dose-based FAL (i.e., the default contamination boundary as defined in Section A.4.1). Therefore, Decision I for the test release scenario is resolved, corrective action is necessary, and Decision II must be resolved for the test releases at CAU 367.

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/yr to less than 25 mrem/yr in four 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.

Decision II sampling will not be conducted for CAS 10-09-03 (non-test release) as the drilling mud is contained within the Ess crater. If a COC is present at CAS 10-09-03, the entire volume of drilling mud will be assumed to contain the COC and will be included in the corrective action determined for the default contamination boundary for the Ess crater.

Decision II sampling will also not be conducted for the drainage sedimentation areas (non-test release). If a COC is present in the sediment, the entire volume of the sediment will be assumed to contain the COC and will require corrective action.

Decision II sampling will be conducted for the investigation of contamination along the shoulders of Mercury Highway. If the TED near the highway exceeds the FAL, Decision II sampling will consist of further defining the extent of the area where corrective actions will be necessary to protect motorists and highway maintenance workers.

To resolve Decision II for other 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.

A.5.2 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, 2002a). The TLDs will be submitted to the Environmental Technical Services group at the NTS, which is certified by the DOE Laboratory Accreditation Program for dosimetry. Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

A.5.2.1 Sample Locations

Design of the sampling approaches for the CAU 367 CASs must ensure that the data collected are sufficient for selection of the CAAs (EPA, 2002b). To meet this objective, the samples collected from each site should either be from locations that most likely contain a COC, if present (judgmental), or from locations that properly represent overall contamination at the CAS (probabilistic). These sample locations, therefore, can be selected by means of either (a) biasing factors used in judgmental sampling (e.g., a stain, likely containing a spilled substance) or (b) randomly using a probabilistic sampling design.

A.5.2.1.1 Judgmental Approach for Sample Location Selection

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 the identification of biasing factors during the investigation. For CAS 10-09-03, the drilling mud in the bottom of Ess crater will be sampled from the center of the crater. For the investigation of contamination along the shoulders of Mercury Highway, sample locations will be based on the highest readings from a radiological survey (either ground-based or aerial). For the investigation of drainages, sample locations will be the center of the sediment collection areas. For the other non-test releases, biasing factors such as stains, 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 submittal to the analytical laboratory. Biasing factors to be used for selection of sampling locations are listed in Section A.5.2.1. As biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents.

For the test releases at CAU 367, four Decision II sample plot locations will be determined judgmentally along each of four vectors that are approximately normal to the gamma radiation survey isopleths. The sample plot locations will be selected based on preliminary estimates of the location along each vector where TED would equal 25 mrem/IA-yr. The Decision II sample plot locations must meet the criterion that at least one sample plot will be located within the 25 mrem/yr boundary and at least one sample plot will be located outside this boundary.

The following biasing factors may be considered in selecting locations for analytical samples at CAU 367:

- Documented process knowledge on source and location of release (e.g., volume of release).
- Stains: Any spot or area on the soil surface that may indicate the presence of a potentially hazardous liquid. Typically, stains indicate an organic liquid such as an oil has reached the soil, and may have spread out vertically and horizontally.
- Pre-selected areas based on process knowledge of the site: Locations for which evidence such as 1994 aerial radiological survey provides a basis upon which sample plots can be designated (e.g., man-made gross counts).
- Radiological survey anomalies: Radiological survey results that are significantly higher than the surrounding area.
- Lithology: Locations where variations in lithology (soil or rock) indicate that different conditions or materials exist.
- Presence of debris, waste, or equipment.
- Other biasing factors: Factors not previously defined for the CAI that become evident once the investigation of the site is under way.

A.5.2.1.2 Probabilistic Approach for Test-Release Sample Location Selection

A probabilistic sampling approach will be implemented for the selection of composite sample locations within each sample plot at the CASs. At each plot, each composite sample will consist of soil collected from nine random subsample locations within the plot. For each composite sample, the first subsample location will be selected randomly; the remaining eight subsample locations will be established on a systematic triangular grid (see Section A.9.0). Selection of probabilistic subsample locations at these CASs, including an example of the predetermined sample locations at one plot (see Figure A.9-2), are presented in Section A.9.1. Section A.9.1 also describes the subsample location selection process.

Computation of Minimum Sample Size

The minimum number of samples required to compute a UCL for each sample plot will be calculated from the estimated TEDs to verify that sufficient samples were collected. Visual Sample Plan (VSP) software will be used to calculate minimum sample sizes (PNNL, 2005). This software was developed by Pacific Northwest National Laboratory for the DOE and EPA to determine the minimum number of samples needed to characterize a site based on the type of test to be performed, the distribution of the data, the variability of the data, and the acceptable false positive and false negative error rates.

The input parameters to be used in calculating the minimum sample size are:

- A confidence level, set at 95 percent, that a false negative error will not occur
- A confidence level, set at 80 percent, that a false positive error will not occur
- A gray region width of 50 percent of the FAL
- The average TED
- The standard deviation of the average TED

The sufficiency of the number of samples collected will be evaluated after the CAI based on a recalculation of the sample size based on the actual data. All calculations for the determination of sample size sufficiency will be provided in the investigation report.

A.5.2.2 Analytical Methods

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

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

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

A.6.1 Target Populations of Interest

The population of interest to resolve Decision I ("Is any COC present in environmental media within the CAS?") is 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
- Investigation waste and potential remediation waste
- Environmental media where natural attenuation or biodegradation or construction/evaluation of barriers is considered.

A.6.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM at CAU 367. Decision II spatial boundaries are as follows:

- Vertical: Test release - 2 ft below original ground surface
- Vertical: Non-test release - 15 ft bgs
- Horizontal: Test- and non-test release - 3 mi from GZ

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.

A.6.3 Practical Constraints

Practical constraints such as military activities at the NTS, utilities, threatened or endangered animals and plants, unstable or steep terrain, and/or access restrictions may prevent the ability to investigate this site.

A.6.4 Define the Sampling Units

The scale of decision making in Decision I is defined as the CAU. Any COC detected at any location will cause the determination that the CAU is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area contaminated with any COC originating from the CAU. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

A.7.0 Step 5 - Develop the Analytic Approach

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

A.7.1 Population Parameters

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

A.7.1.1 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. For Decision I, a single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS.

A.7.1.2 Probabilistic Sampling Design

For probabilistic sampling results, the population parameter is the true average TED over the area of the sample plot. Resolution of DQO decisions associated with the probabilistic sampling design requires determining, with a specified degree of confidence, whether the true average TED at the site in question exceeds the FAL. Because the averages from sample results are estimates of the true (unknown) average contaminant concentrations, it is uncertain how well the sample averages represent the true averages. If an average contaminant concentration were directly compared to the FAL, a significant difference between the true average and the sample average could lead to making decision errors. To reduce the probability of making a false negative decision error, a conservative estimate of the true average is used to compare to the FAL. This conservative estimate (overestimation) of the true contaminant concentration averages will be calculated as the 95 percent UCLs of the respective TED averages. By definition, there will be a 95 percent probability that the true average TED is less than the 95 percent UCL of the sample average.

The computation of appropriate UCLs depends upon the data distribution, the number of samples, the variability of the dataset, and the skewness associated with the dataset. A statistical package will be used to determine the appropriate probability distribution (e.g., normal, lognormal, gamma) and/or a suitable non-parametric distribution-free method and then to compute appropriate UCLs. To ensure that the appropriate UCL computational method is used, the sample data will be tested for goodness-of-fit to all of the parametric and non-parametric UCL computation methods described in *Calculating the Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA, 2002a).

Computation of an appropriate UCL for TED requires that:

- The data originate from a symmetric, but not necessarily normally distributed, population.
- The estimation of the variability is reasonable and representative of the population being sampled.
- The population values are not spatially correlated.

A.7.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2008a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2008b) requires the use of ASTM Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

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

- Tier 1 evaluation - Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.
- Tier 2 evaluation - Conducted by calculating Tier 2 SSTLs using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis.
- Tier 3 evaluation - Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

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

A.7.2.1 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, such as arsenic on the NTS. Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the NBMG 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.7.2.2 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 100 m^2 and a depth of contamination of 5 cm). In addition, DCG values for each individual radionuclide COPC were calculated. The DCG is the value, in picocuries per gram for surface soil, for a particular radionuclide, that would result in a dose of 25 mrem/yr. Using DCGs in site evaluation facilitates the determination of a radiation dose estimate for each soil sample.

A.7.3 Decision Rules

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

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

The decision rules for Decision I are:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.
- If a COC exists at any CAS, then a corrective action will be determined, else no further action 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 in any bounding direction 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.9.0, 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.8.0 Step 6 - Specify Performance or Acceptance Criteria

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

A.8.1 Decision Hypotheses

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

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

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

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

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

- 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.8.2 False Negative Decision Error

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

A.8.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 2002b). 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 most likely to be 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.5.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section A.6.1.

To satisfy the second criterion, Decision I samples will be analyzed for the chemical and radiological parameters listed in Section 3.2. Decision II samples will be analyzed for those chemical and radiological parameters that identified unbounded COCs. The DQI of sensitivity will be assessed for 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, 2002a) and in Section 6.2.2. The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the 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, 2002a):

- 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.8.2.2 False Negative Decision Error for Probabilistic Sampling

Upon validation of the analytical results, statistical parameters will be calculated for each significant COC identified at each site. Protection against a false negative decision error is contingent upon:

- Population distribution
- Sample size
- Actual variability
- Measurement error

Control of the false negative decision error, therefore, for probabilistic sampling designs is accomplished by ensuring that the following requirement are met for each of the significant COPCs:

- The population distributions fit the applied UCL determination method.
- A sufficient sample size was collected.
- The actual standard deviation is calculated.
- Analyses conducted were sufficient to detect contamination exceeding FALs.

A.8.3 False Positive Decision Error

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

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

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

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. Judgmental sampling schemes will be implemented to select the Decision II sample plot locations for the test releases. Probabilistic sampling schemes will be implemented to select the sample locations within each of the sample plots. Judgmental sampling will also be used to investigate any non-test releases as described in Section A.5.2.1.1. 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 3.4 to determine the need for corrective action.

A.9.1 Internal Dose Sampling for Test Releases

A.9.1.1 Sample Plot Locations

A judgmental sampling design will be implemented for locating Decision II sampling plots for the test release. Sample plot locations will be selected judgmentally based on radiological surveys and applicable historical sampling results. These data include existing or new aerial radiological surveys, GPS-assisted gamma walkover surveys, NAEG data, and RIDP data. These data will be used to establish patterns of contaminant distribution. Initial Decision II sample plots will be established based on gross count gamma radiation survey data, and additional Decision II sample plots may need to be established based on Am-241 radiation survey results. At least four sample plots will be established on each of four vectors that are approximately normal to the gamma radiation survey isopleths with the constraint that on each vector at least one sample plot will present a TED greater than the FAL and at least one sample plot will present a TED less than the FAL (Figure A.9-1). To meet this constraint, it was necessary to determine a preliminary estimate of the locations where TED may be equal to the FAL. This was accomplished by plotting the estimates of external dose from the correlation of existing NTS environmental monitoring TLD dose measurements to the radiological readings collected with the PRM-470 radiation meter as presented in Section A.2.2.4. When compared to the 1994 gross count-rate aerial data (BN, 1999), it was estimated that external dose alone would exceed 25 mrem/IA-yr at approximately the 30-cpm isopleth. Therefore, the first sample plot on each vector will be located inside this isopleth. The approximate proposed sampling vectors

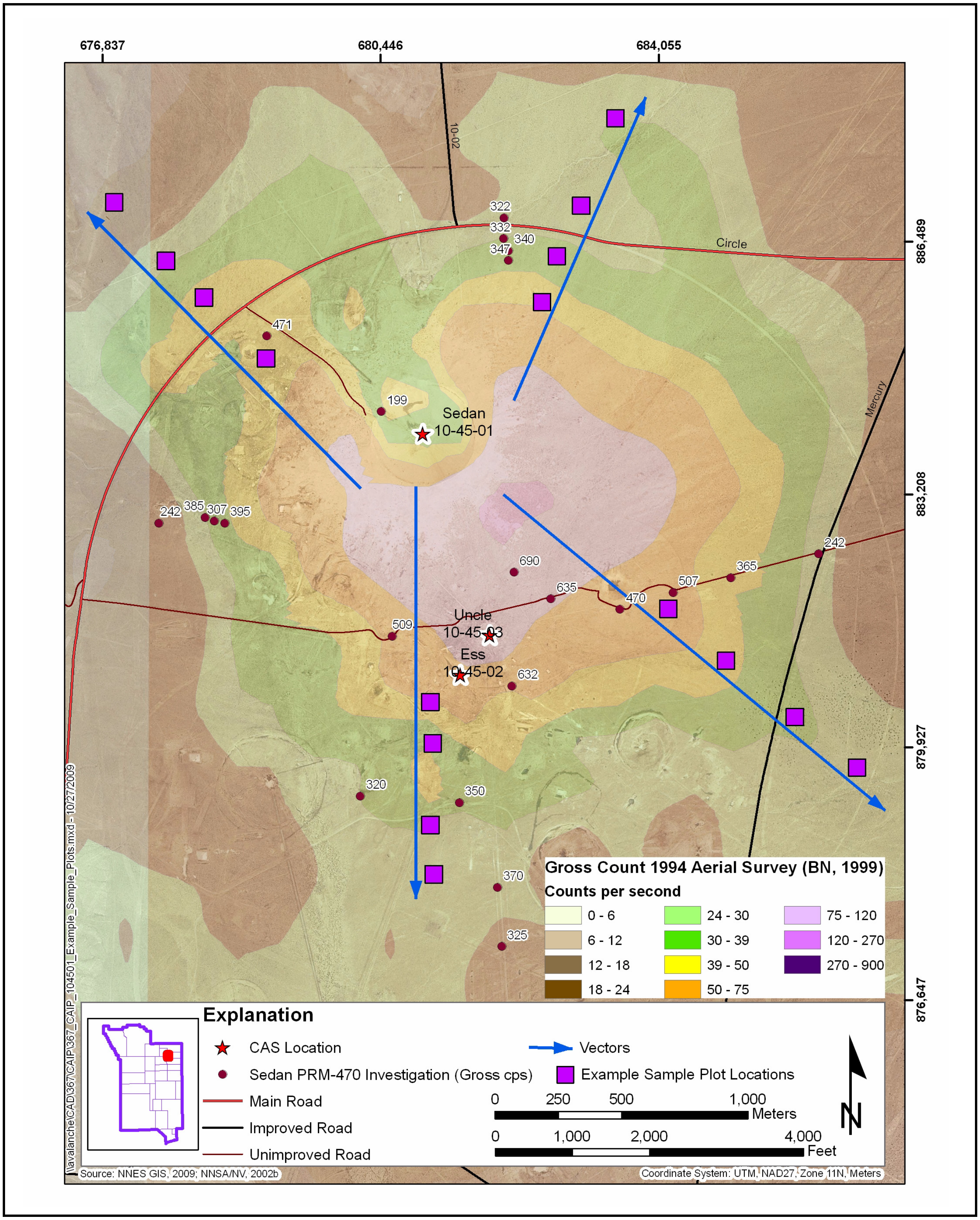


Figure A.9-1
Sedan Example Sample Plot Location Map

and sample plots are shown in Figure A.9-1. Figure A.9-2 shows an example of the predetermined sample locations at one plot.

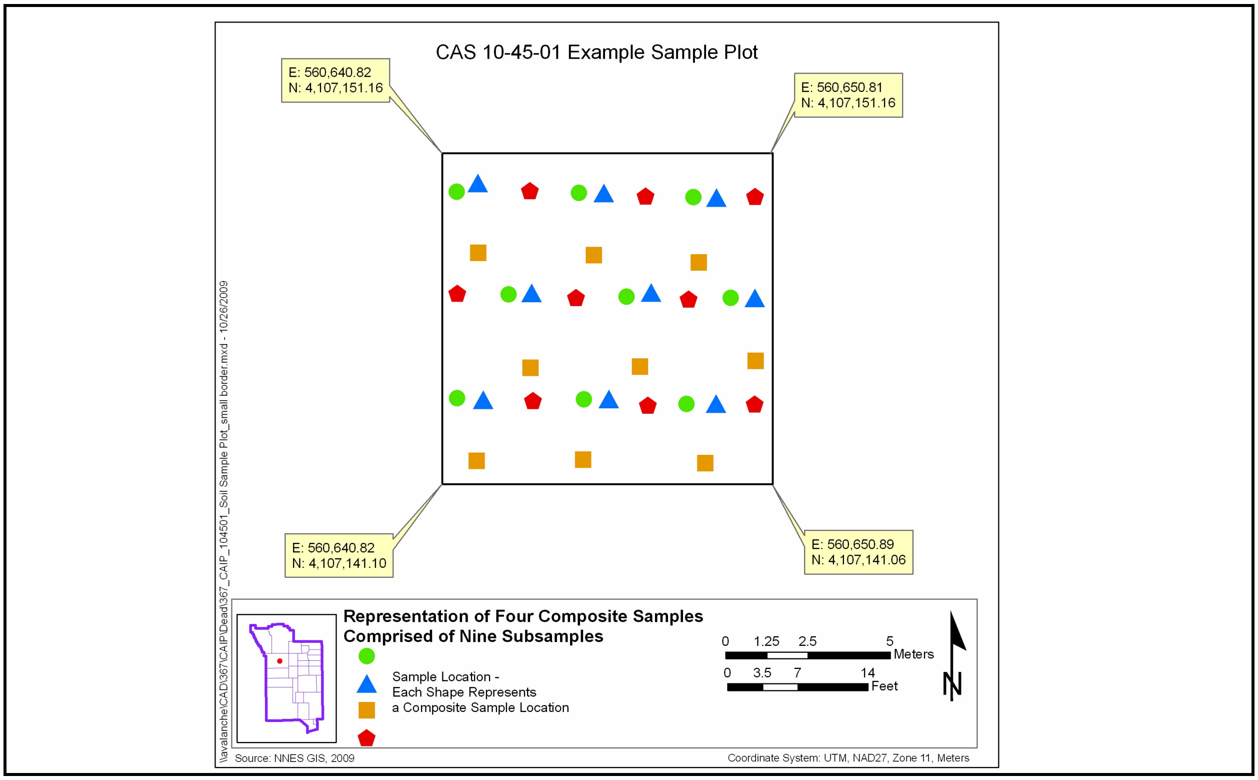


Figure A.9-2
CAU 367 Example Sample Plot

An additional aerial Am-241 radiological survey will be performed to identify Pu distribution patterns at the site. At least one sample plot will be located based on the highest Am-241 survey results outside the default contamination boundary. If an Am-241 signature is detected outside the initial corrective action boundary (see Section A.9.4), additional sample plots will be established based on the highest Am-241 survey results outside the initial corrective action boundary to verify that the boundary encompasses all locations where the TED exceeds the FAL. Sample plots based on Am-241 survey results will be sampled in the same manner as the initial sample plots.

A.9.1.2 Sample Locations

The probabilistic sampling scheme will be implemented to select sample locations within the sample plots and evaluate the analytical results. For each sample plot, randomly selected sample locations will be chosen with locations specified by the VSP software (PNNL, 2005) based on a random start, triangular pattern (see Figure A.9-2 for an example of this sampling scheme). If sufficient sample material cannot be collected at a specified location (e.g., rock, caliche or buried concrete), the Site Supervisor will establish the location at the nearest place that a surface sample can be obtained.

A.9.1.3 Determination of Buried Contamination

As the CSM includes the possibility of buried horizons of contamination, it will be determined whether buried contamination exists before sampling. As the most probable locations for buried contamination are where the deposited ejecta layer from the Sedan test are deeper, a screening plot for determining the presence of buried contamination will be established next to the first sample plot on each of the vectors nearest to the Uncle and Ess sites in the following manner:

1. The surface sample will be screened with alpha/beta contamination meter.
2. A 5-cm layer of soil will then be removed from the screening plot.
3. Steps 1 and 2 will be repeated until native soil is encountered.

If screening results are not significantly different (at least 50 percent difference between samples) than the surface results, it will be assumed that buried contamination does not exist, and only surface samples will be collected and submitted for analyses. If screening results are significantly different than the surface results, it will be assumed that buried contamination exists.

A.9.1.4 Sample Collection

Statistical methods that generate site characteristics will be used for establishing TED values that represent the sample plot as a whole. Composite samples will be collected at each sample plot in the following manner:

- Each composite sample will be comprised of nine aliquots taken from randomly selected locations within each plot. These locations will be predetermined using a random start with a triangular grid pattern as described in Section A.9.1.2.

- Samples will be sieved to eliminate material (e.g., Trinity glass) greater than 0.25 in. diameter that cannot effectively be inhaled or ingested.

- The entire volume of the composited material collected will be submitted to the laboratory for analysis.

If buried contamination exists, 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 composite location in 5-cm increments until native soil or buried horizon is encountered. The subsurface soil subsample with the highest screening value at each composite location will be composited into a sample submitted for analysis.

A minimum number of samples (i.e., composite samples) is required to compute the UCL. This number will be calculated based on the TED results (comprised of individual internal dose rates associated with each of the four composite samples added to the external dose rates from each plot). Determination of the minimum sample size cannot be accomplished until after the data has been generated. After the data evaluation is complete, the required number of samples will be calculated.

The input parameters to be used in calculating the minimum sample size are:

- A confidence level that a false negative error will not occur will be set at 95 percent.
- A confidence level that a false positive error will not occur will be set at 80 percent.
- A gray region width equal to 50 percent of the FAL (12.5 mrem/yr).
- The standard deviation of the TEDs at each plot.

If the criteria established in this section results in a determination that the minimum sample size was not met for a plot, one of the following actions may be taken:

- Additional composite sample(s) may be collected.
- Conservatively assume that the TED for the plot exceeds the FAL.

If this criteria cannot be met, justifications for use of the resulting TED without meeting the criteria will be made in the CADD.

A.9.2 External Dose Sampling for Test Releases

External dose (penetrating radiation dose for the purposes of this document) will be determined by collecting *in situ* measurements using TLDs. External dose measurements will be taken at the approximate center of each sample plot at a height of 1 m (3.3 ft).

The TLD placement and processing will follow the protocols established in *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (NNSA/NSO, 2003). The TLDs will be in place for a targeted total exposure time of 2,250 hours, or the resulting data will be adjusted to be equivalent to an exposure time of 2,250 hours.

Estimates of external dose, in millirem per Industrial Access year, will be presented as net values (e.g., a background has been subtracted from the raw result). Naturally occurring terrestrial and cosmic radiation will be registered on a TLD, and the values can be significant in comparison to the FAL. In addition, the FAL is only applicable to radiation exposure from man-made sources at the NTS and is a value in excess of what would be present if there were no nuclear activities at the site.

The value for the natural background to be subtracted from the TLD results will be obtained from an area determined to be unaffected by man-made activities at the NTS. Ten areas are identified in Section 5 of the *Nevada Test Site Environmental Report 2006* (NNSA/NSO, 2007) and are routinely monitored for external radiation exposure via environmental monitoring TLDs.

The project-specific TLDs are subjected to the same QA checks as the routine NTS environmental monitoring TLDs, as described in Section 6.0. The Panasonic UD-814 TLD used in the NTS environmental monitoring program contains four individual elements. The readings from each element are compared as part of the routine QA checks during the TLD processing. External dose at each TLD location is then determined using the readings from TLD elements 2, 3, and 4. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose.

A.9.3 Evaluation of TED

If buried contamination exists, it will be conservatively assumed that the highest level of contamination observed (from surface or subsurface samples) provides dose to site workers. Therefore, the samples with the highest dose (surface or subsurface) at each plot will be used for the internal dose estimate. If subsurface samples contain higher levels of contamination (that would result in a higher dose), a TLD-equivalent external dose will be calculated for the sample plot based on the subsurface sample results. This will be accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The

RESRAD-calculated external dose from the subsurface samples will then be adjusted to TLD-equivalent values using this correlation.

As discussed in Section A.7.1.2, the 95 percent UCL of the TED from each sample plot will be used to establish the corrective action boundary. The 95 percent UCL of the TED for each sample plot will be established as the sum of the 95 percent UCL of the internal dose and the 95 percent UCL of the external dose. These 95 percent UCL dose estimates will be calculated using the three external dose measurements from the TLD and the four RESRAD-calculated internal dose estimates from the soil samples.

The initial corrective action boundary area will be calculated using the 95 percent UCL of the TED from each plot along each vector and an appropriate gamma radiation survey isopleth. A relationship will be established of the 95 percent UCL of the TED with gamma radiation survey values along each vector such that a gamma radiation survey value along each vector can be established that corresponds to the 25-mrem/yr FAL (using the appropriate exposure scenario). An isopleth from the radiological survey that encompasses the lowest value corresponding to the 25-mrem/yr FAL will be chosen as the initial corrective action boundary.

A.9.4 Sampling for Non-Test Releases

A.9.4.1 Decision I

A judgmental sampling design will be implemented for the non-test releases for establishing sample locations and evaluating sample results. 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.6.1. To meet this criterion for non-test releases, 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.5.2.1. If biasing factors are present in soils below locations where Decision I samples were removed, additional Decision I soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. The Site Supervisor has the discretion to modify the judgmental sample locations, but only if the modified locations meet the decision needs and criteria stipulated in this DQO.

A.9.4.1.1 CAS 10-09-03, Mud Pit

For CAS 10-09-03, Mud Pit, samples will be collected from the center of the crater. A surface sample (0 to 15 cm) will be collected at this location as well as a depth sample from just below the drilling mud and crater interface. These samples will be submitted for the analyses listed in Table A.3-2.

A.9.4.1.2 Drainages

The nearest identifiable drainage to CAU 367 is located to the east of the Sedan crater and flows toward and into the Yucca Flat dry lake. This drainage will be visually surveyed to a distance of 1 mi from Sedan GZ for the presence of sediment accumulation areas to identify all sediment collection areas. A sampling location will be established at the center of the nearest two sediment accumulation areas outside the initial corrective action boundary (established using gamma survey data). At each location, a sample will be collected from each 5-cm depth interval until native material is encountered. Each sample will be screened with alpha/beta contamination meter, and the sample with the highest screening value at each sample location will be submitted for analysis. If differences in the screening result values are not significantly different, the surface sample will be submitted for analysis.

A.9.4.1.3 Mercury Highway

The investigation of contamination along the shoulders of Mercury Highway will investigate the potential TED from short-term activities such as road maintenance. Samples will be collected from two areas based on the highest readings from a radiological survey for Am-241 (either ground based or aerial) along Mercury Highway to the north and northwest of the Sedan crater (the areas indicated by the highest readings from the 1994 aerial survey) (BN, 1999). At each area, the sampling location will be further refined using a Fidler (or equivalent) radiation survey instrument to determine the location of highest radioactivity. Samples will be collected at each location from the 0- to 5-cm, 5- to 10-cm, and 10- to 15-cm depth increments. These samples will be submitted for the same analyses as listed for the test release scenario. The RESRAD code will be used to calculate TED from sample analytical results for individual radionuclides under a most exposed worker scenario.

A.9.4.1.4 Other Potential Releases

During the course of the CAU 367 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.9.4.2 Decision II

If a COC is present at a sediment collection area sampling location, additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain COCs, and other drainages will be assessed for the potential to have sediment collection areas that contain a COC. Decision II will be resolved by the assumption that the entire volume of sediment in each sediment collection area where a COC was identified contains the COC.

Decision II sampling will not be conducted for CAS 10-09-03 (non-test release) as the drilling mud is contained within the Ess crater. If a COC is present at CAS 10-09-03, the entire volume of drilling mud will be assumed to contain the COC and will require corrective action.

If the TED near the highway exceeds the FAL, Decision II sampling will be conducted for the investigation of contamination along the shoulders of Mercury Highway. Decision II sampling will consist of further defining the extent of the area where corrective actions will be necessary to protect motorists and highway maintenance workers.

Decision II samples for non-test releases, other than CAS 10-09-03 and the drainage areas, 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.5.2. In general, sample locations will be arranged in a triangular pattern around the area containing COCs at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The Task Manager or Site Supervisor may modify the number, location, and spacing of step-outs as warranted by site conditions.

A.9.5 Establishment of Final Corrective Action Boundary

The final corrective action boundary will be established to include the default contamination boundary, the initial corrective action boundary, any additional areas that exceed the FAL based on Pu contamination (sample plots based on the Am-241 survey), and any COCs identified from the non-test releases (e.g., from CAS 10-09-03, spills, waste, or the migration of contamination in drainages).

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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

(2 Pages)

December 08, 2009

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) 367: Area 10 Sedan, Ess and Uncle Unit Craters, 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 Corrective Action Investigation Plan (CAIP) for Corrective Action Unit (CAU) 367: Area 10 Sedan, Ess and Uncle Unit Craters. 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,

Jeff MacDougall, CPM, PhD.
Supervisor
Bureau of Federal Facilities

JJM/JW/DN/KC

cc: J. T. Fraher, DTRA/CXTS, Kirtland AFB, NM
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