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National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 366: Area 11 Plutonium Valley Dispersion Sites Nevada National Security Site, Nevada

Controlled Copy No.: ___
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Environmental Restoration
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U.S. Department of Energy
National Nuclear Security Administration
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CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 366: AREA 11 PLUTONIUM VALLEY DISPERSION SITES NEVADA NATIONAL SECURITY SITE, NEVADA

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

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CORRECTIVE ACTION INVESTIGATION PLAN FOR
CORRECTIVE ACTION UNIT 366:
AREA 11 PLUTONIUM VALLEY DISPERSION SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Kevin J. Cabble Date: 9-26-11

Kevin J. Cabble
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Approved by: /s/ Robert F. Boehlecke Date: 9/26/11

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project

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List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
agl	Above ground level
Am	Americium
ASTM	ASTM International
bgs	Below ground surface
Ca	Calcium
CA	Contamination area
CAA	Corrective action alternative
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CED	Committed effective dose
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
cm	Centimeter
Cm	Curium
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium
CSM	Conceptual site model
CWD	Contaminated waste dump

List of Acronyms and Abbreviations *(Continued)*

CZ	Contamination zone
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DRI	Desert Research Institute
DQI	Data quality indicator
DQO	Data quality objective
E-MAD	Engine Maintenance, Assembly, and Disassembly
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
ft^3	Cubic foot
GPS	Global Positioning System
g/yr	Grams per year
GZ	Ground zero
HCA	High contamination area
HWAA	Hazardous waste accumulation area
ICRP	International Commission on Radiological Protection
IDW	Investigation-derived waste
in.	Inch
LCS	Laboratory control sample

List of Acronyms and Abbreviations *(Continued)*

m	Meter
m^2	Square meter
m/yr	Meters per year
MDC	Minimum detectable concentration
mg/day	Milligrams per day
mi	Mile
mR/hr	Milliroentgens per hour
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Access year
mrem/OU-yr	Millirem per Industrial Access year
mrem/RW-yr	Millirem per Remote Work Area 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
ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
N-I	Navarro-Intera, LLC
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
Np	Neptunium

List of Acronyms and Abbreviations *(Continued)*

NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site
PAH	Polyaromatic hydrocarbon
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PET	Potential evapotranspiration
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
RIDP	Radionuclide Inventory and Distribution Program
RL	Reporting limit
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMS	Radioactive waste management site
Sm	Samarium
Sr	Strontium

List of Acronyms and Abbreviations *(Continued)*

SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
U	Uranium
UCC	Yucca Dry Lake
UCL	Upper confidence limit
URMA	Underground radioactive material area
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
WAC	Waste Acceptance Criteria
μm	Micrometer
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 366 is located in Area 11 of the Nevada National Security Site, which is approximately 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 366 comprises the six corrective action sites (CASs) listed below:

- 11-08-01, Contaminated Waste Dump #1
- 11-08-02, Contaminated Waste Dump #2
- 11-23-01, Radioactively Contaminated Area A
- 11-23-02, Radioactively Contaminated Area B
- 11-23-03, Radioactively Contaminated Area C
- 11-23-04, Radioactively Contaminated Area D

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

The sites will be investigated based on the data quality objectives (DQOs) developed July 6, 2011, 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 366.

The presence and nature of contamination at CAU 366 will be evaluated based on information collected from a field investigation. Radiological contamination will be evaluated based on a comparison of the total effective dose (TED) at sample locations to the dose-based final action level (FAL). The TED will be calculated by summing the estimates of internal and external dose. Results from the analysis of soil samples collected from sample plots will be used to calculate internal radiological dose. Thermoluminescent dosimeters placed at each sample location will be used to measure external radiological dose.

Based on historical documentation of the releases associated with the nuclear tests, it was determined that CASs 11-23-02, 11-23-03, and 11-23-04 will be investigated as one release site. The three test areas associated with these CASs are in close proximity; the devices tested were all composed of plutonium and enriched uranium; and the ground zeroes are all posted high contamination areas (HCAs). Because the device tested at CAS 11-23-01 was composed primarily of enriched uranium and the ground zero is not a posted HCA, the CAS will be investigated as a separate release.

The DQO process also resulted in an assumption that TED within the HCAs and contaminated waste dumps exceeds the FAL and requires corrective action. A field investigation will be performed to define where TED exceeds the FAL and to determine whether other contaminants of concern are present at the site associated with other activities that took place at the site or from spills or waste discovered during the investigation.

The presence and nature of contamination from other types of releases (such as migration and any potential releases discovered during the investigation) will be evaluated using soil samples collected from the locations most likely containing contamination, if present.

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS.

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 after the plan is approved.

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) 366: Area 11 Plutonium Valley Dispersion Sites, Nevada National Security Site (NNSS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) 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.

Corrective Action Unit 366 is located in Area 11 of the NNSS (formerly the Nevada Test Site [NTS]), which is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). Corrective Action Unit 366 comprises the six corrective action sites (CASs) shown on Figure 1-2 and listed below:

- 11-08-01, Contaminated Waste Dump #1
- 11-08-02, Contaminated Waste Dump #2
- 11-23-01, Radioactively Contaminated Area A
- 11-23-02, Radioactively Contaminated Area B
- 11-23-03, Radioactively Contaminated Area C
- 11-23-04, Radioactively Contaminated Area D

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

1.1 Purpose

The CASs in CAU 366 are being investigated because hazardous and/or radioactive contaminants may be present in concentrations that exceed risk-based corrective action (RBCA) levels. Existing information on the nature and extent of potential contamination is insufficient to evaluate and

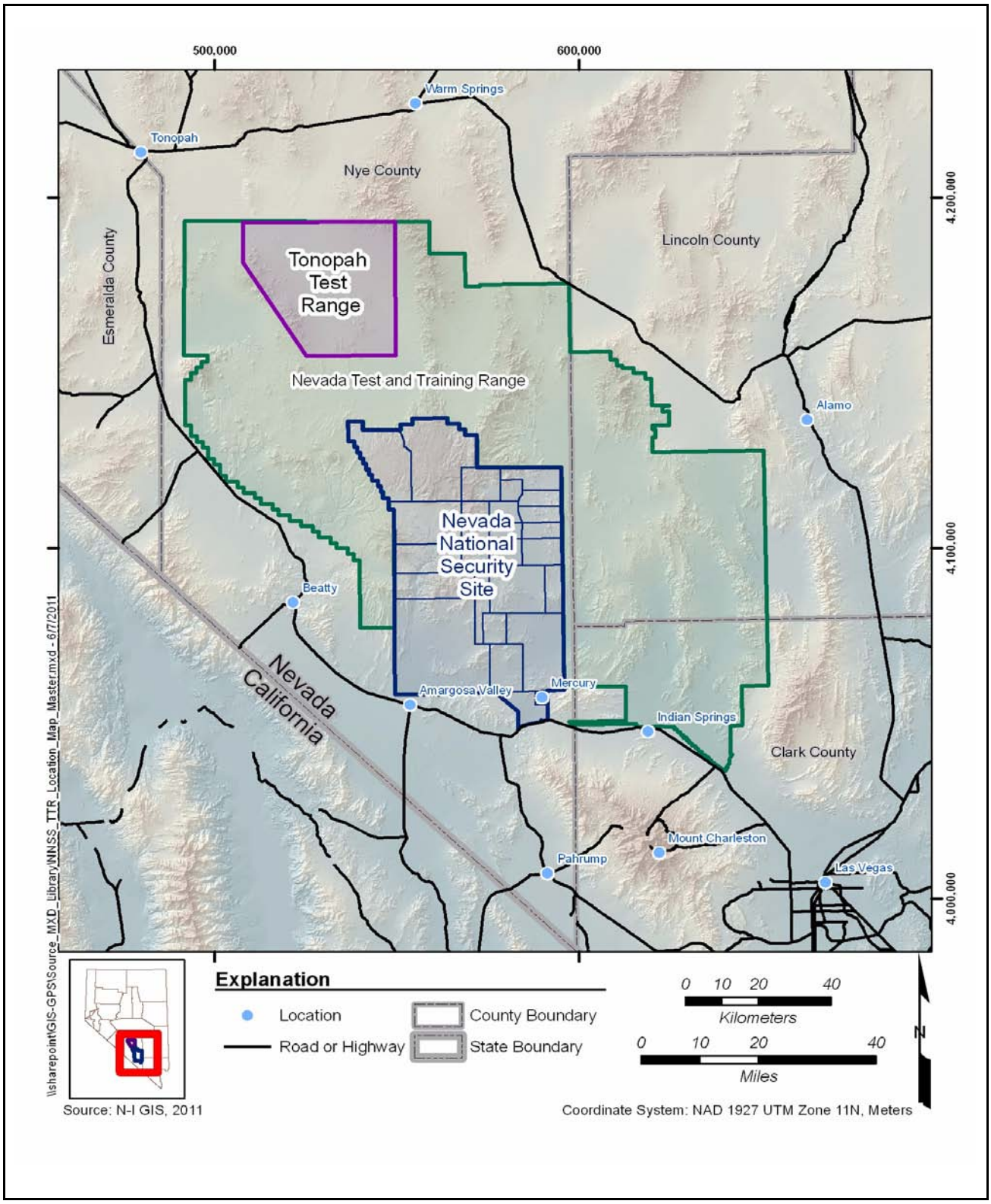

Figure 1-1
Nevada National Security Site

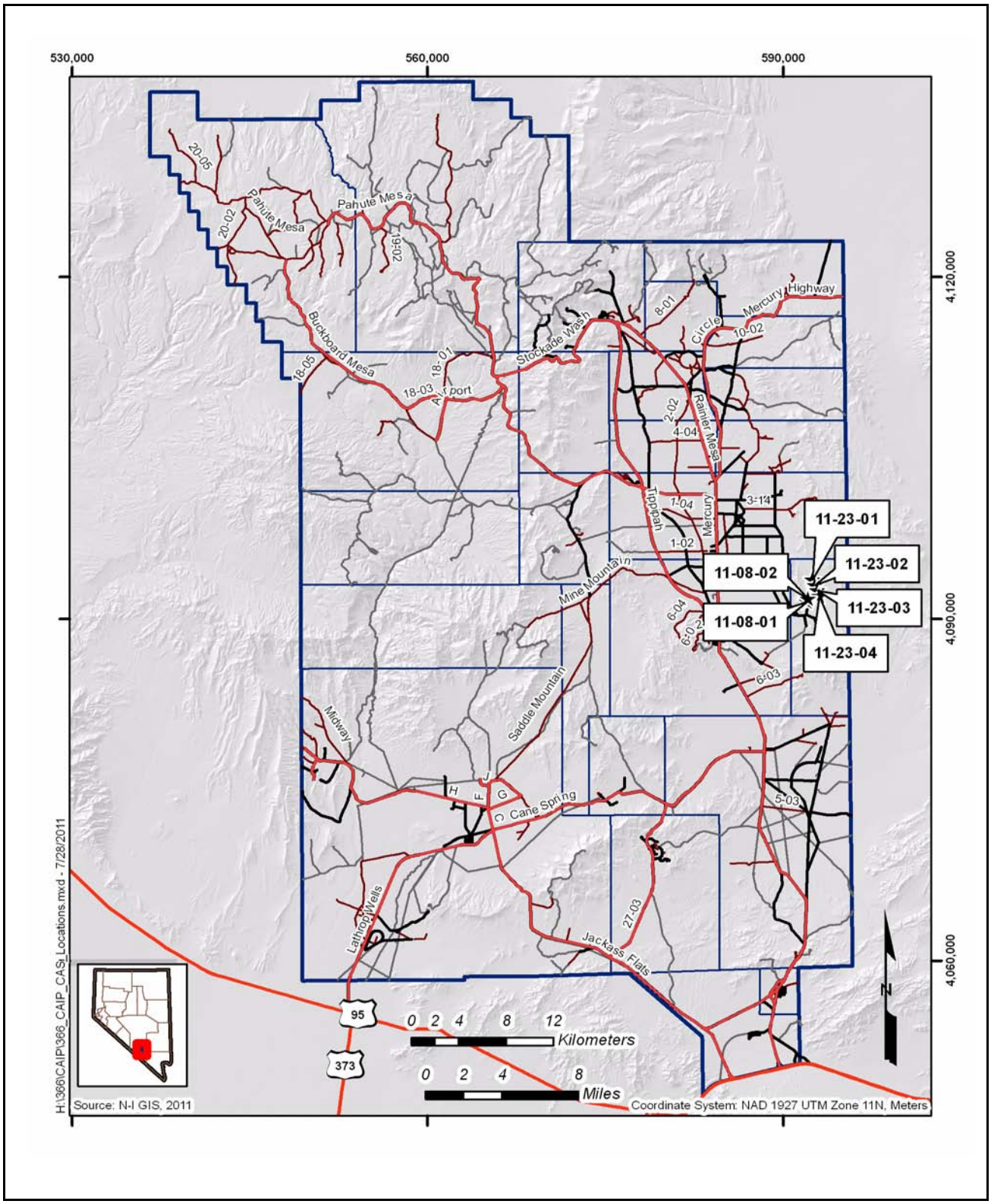

Figure 1-2
CAU 366, CAS Location Map

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

1.1.1 CAU 366 History and Description

Corrective Action Unit 366, Area 11 Plutonium Valley Dispersion Sites, consists of six inactive sites located in the northern portion of Area 11. The CASs consist of four test areas (identified as 11a, 11b, 11c, and 11d) and two contaminated waste dumps (CWDs). The CAU 366 sites were used to support safety experiments associated with Project 56 conducted in the Yucca Flat area in 1955 and 1956. Project 56 was the first test of a full-scale, completely assembled device to verify nuclear safety in the event of an accidental detonation (e.g., handling, fire, electrical discharge). This CAU includes land area that has been impacted by the release of radionuclides from safety experiments and the burial and storage of associated contaminated test materials. Operational histories for each CAU 366 CAS are detailed in Section 2.2.

1.1.2 Data Quality Objective Summary

The sites will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP) and the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). The DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 366. This CAIP describes the investigative approach developed to collect the necessary data identified in the DQO process. Discussion of the DQO methodology and the DQOs specific to each CAS are presented in Appendix A. A summary of the DQO process is provided below.

The DQO problem statement for CAU 366 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 366." 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 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 contaminant 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 to following:

  - The lateral and vertical extent of COC contamination
  - The information needed to predict potential remediation waste types and volumes
  - Any other information needed to evaluate the feasibility of remediation alternatives

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

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in Appendix A. The information necessary to resolve the DQO decisions will be obtained for each CAU 366 CAS by analyzing samples collected 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.5.4).

The DQOs for CAU 366 defined the following two release scenarios to appropriately address the different types of releases that may be present at the CASs:

- **Primary releases** – This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the primary releases is limited to the top 5 centimeters (cm) of soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from aboveground nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CAIP, surface is defined as the upper 5 cm of soil.

- **Other releases** – This release category includes any radionuclide contamination from test activities that is not atmospheric deposition of radionuclides. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have been displaced through subsequent activities. This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition (such as radionuclides being driven into the soil by high explosives at each of the ground zero [GZ] areas). This includes any other chemical or radiological contamination that may be discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release.

As shown in the conceptual site model (CSM) in Section 3.1, it is assumed that surface and subsurface contamination exceeding the FAL is present within the radiologically posted areas at CASs 11-23-02, 11-23-03, 11-23-04, 11-08-01, and 11-08-02 and that corrective action is required (see Section A.2.2.1). Each of these posted high contamination areas (HCAs) and/or underground radioactive material areas (URMAs) will be defined as a default contamination boundary (see Section 3.4) and require corrective action.

The primary releases and other releases will be investigated outside the default contamination boundaries. Investigation of primary releases will be accomplished through measurements of surface soil radioactivity using a combination of judgmental and probabilistic sampling schemes. Investigation of other releases will be accomplished using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that radioactivity is present at depth based on process knowledge (e.g., buried material).

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 366 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Conduct geophysical surveys.
- Perform field screening.

- Measure *in situ* external dose rates using thermoluminescent dosimeters (TLDs) or other dose-measurement devices.
- Collect and submit environmental samples for laboratory analysis to determine the internal dose and whether any COC is present.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of any COCs that are present.
- Collect samples of waste materials, if there is 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).

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

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS, while Appendix B contains information on the project organization. Appendix C contains NDEP comments on the draft version of this document.

2.0 Facility Description

Corrective Action Unit 366 comprises six CASs that were grouped together because all of the CASs are located in close proximity to one another and are directly related to the Project 56 safety experiments. They are all located in the portion of Area 11 referred to as Plutonium Valley.

2.1 Physical Setting

The following sections describe the general physical settings of Area 11 of the NNSS. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for these specific areas of the NNSS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (USGS, 1990); *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996).

All of the CASs in CAU 366 are located within the Yucca Flat Hydrographic Area of the NNSS. Yucca Flat is a closed basin, which is slowly being filled with alluvial deposits eroding from the surrounding mountains (Laczniak et al., 1996).

Local topography immediately east of the CASs consists of low-lying mountains. The CASs are located in a relatively flat area, with a gentle slope to the west. Several washes flow through Plutonium Valley. Precipitation runoff flow from the CASs is generally to the southwest. The most notable wash in the area travels through CAS 11-23-04 (11d) and flows into a historical detention basin in the southwest portion of the contamination area (CA). However, the detention basin has filled in over time, and the basin can overflow in flood events. This wash and the other ephemeral channels that flow through Plutonium Valley ultimately flow toward the Yucca Flat dry lake (Figure 2-1).

Groundwater flow in Yucca Flat is generally 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 (Laczniak et al., 1996). The nearest rain gauge to CAU 366 is the Yucca Dry Lake (UCC) rain gauge. The average annual precipitation recorded at this

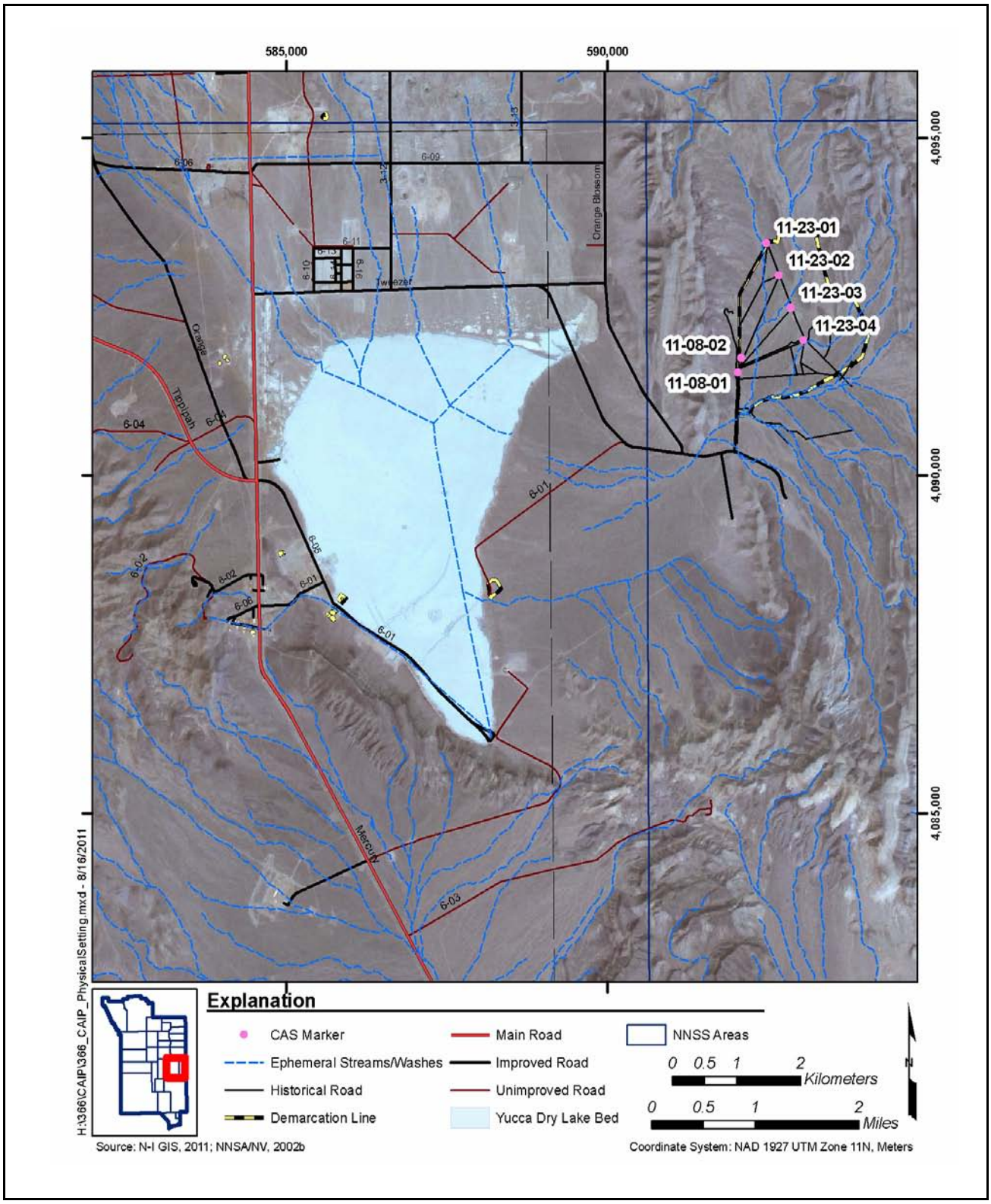

Figure 2-1
CAU 366 Physical Setting

location is 6.61 inches (in.) (ARL/SORD, 2011). Average annual potential evapotranspiration (PET) has been estimated for the Area 3 Radioactive Waste Management Site (RWMS) as 61.7 in. Additional rainfall and PET data are presented in Table 2-1.

Table 2-1
Rainfall and PET Information for Yucca Flat

	Area 3 PET (cm)	UCC Precipitation (cm)
Minimum	150.2	2.90
Maximum	160.8	41.17
Mean	157	16.03
95% UCL	160.2	19.35

Source: ARL/SORD, 2011

The nearest groundwater well to the CASs is ER-6-1-2 main, located approximately 1.8 mi west of test area 11a and 2.3 mi northwest of test area 11d. The most recent recorded depth to the water table is approximately 1,544 feet (ft) below ground surface (bgs) (USGS/DOE, 2011).

The thickness of the unsaturated zone extends to more than 600 ft bgs (Hevesi et al., 2003). Therefore, it is expected that vertical migration of contaminants would be very limited.

The vegetation in the area is fairly dense and consists of joshua trees, blackbrush, and other desert vegetation. The soil in this area consists of sandy alluvium with bedrock surfacing along the eastern portion of the site.

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 366 that may have resulted in releases of contaminants to the environment. The CAS-specific summaries are designed to describe the current definition of each CAS and document all significant, known activities.

Several historical documents were reviewed that provided operational information, details of the nuclear tests and associated activities, as well as activities that took place in the area after Project 56

came to a close. Many of these documents are referenced through the CAIP as appropriate; however, additional supporting information is available in the documents listed in Section 8.0.

2.2.1 CAS 11-08-01, Contaminated Waste Dump #1; and CAS 11-08-02, Contaminated Waste Dump #2

These CASs are defined as the release of contaminants to the environment from stored and buried drums containing sand and ashed wood, cables, metal, and other miscellaneous debris. The areas where the CWDs are located were excavated sometime before November 1955, when the first of the four tests that were completed as part of Project 56 took place. Historical documentation refers to them as "rad-safe burial pits" that were to be 12 ft long, 6 ft deep, and 3 ft wide (Lyon, 1955). As a result of the tests, the wooden cabs that the devices were placed in and sand that surrounded the test beds became radiologically contaminated as well as other items such as cable, metal, and various items associated with the test activities. The two CWDs were used to dispose of this material as well as any contaminated clothing or equipment (Lyon, 1955). The area contained within the radiologically posted fence lines for the CAS 11-08-01, CWD #1, measures 105 by 93 ft and is a posted URMA. Corrective Action Site 11-08-02, CWD #2, measures 78 by 92 ft and is a posted HCA and URMA. Two drums filled with debris and partially buried cable are visible in the boundary of CWD #2; these items were investigated as CAU 214, Bunkers and Storage Areas; CAS 11-22-03, Drum (see Section 2.5.5). The two CWDs are located southwest of the four GZ areas and are situated within the large site-encompassing CA posting. Figure 2-2 shows the location of CASs 11-08-01 and 11-08-02.

2.2.2 CAS 11-23-01, Radioactively Contaminated Area A; CAS 11-23-02, Radioactively Contaminated Area B; CAS 11-23-03, Radioactively Contaminated Area C; and CAS 11-23-04, Radioactively Contaminated Area D

These CASs are defined as the release of contaminants to the environment from four surface safety experiments in the Project 56 test series conducted at four separate, close proximity test areas. Project 56 was the first test of a full-scale, completely assembled device to verify the nuclear safety in

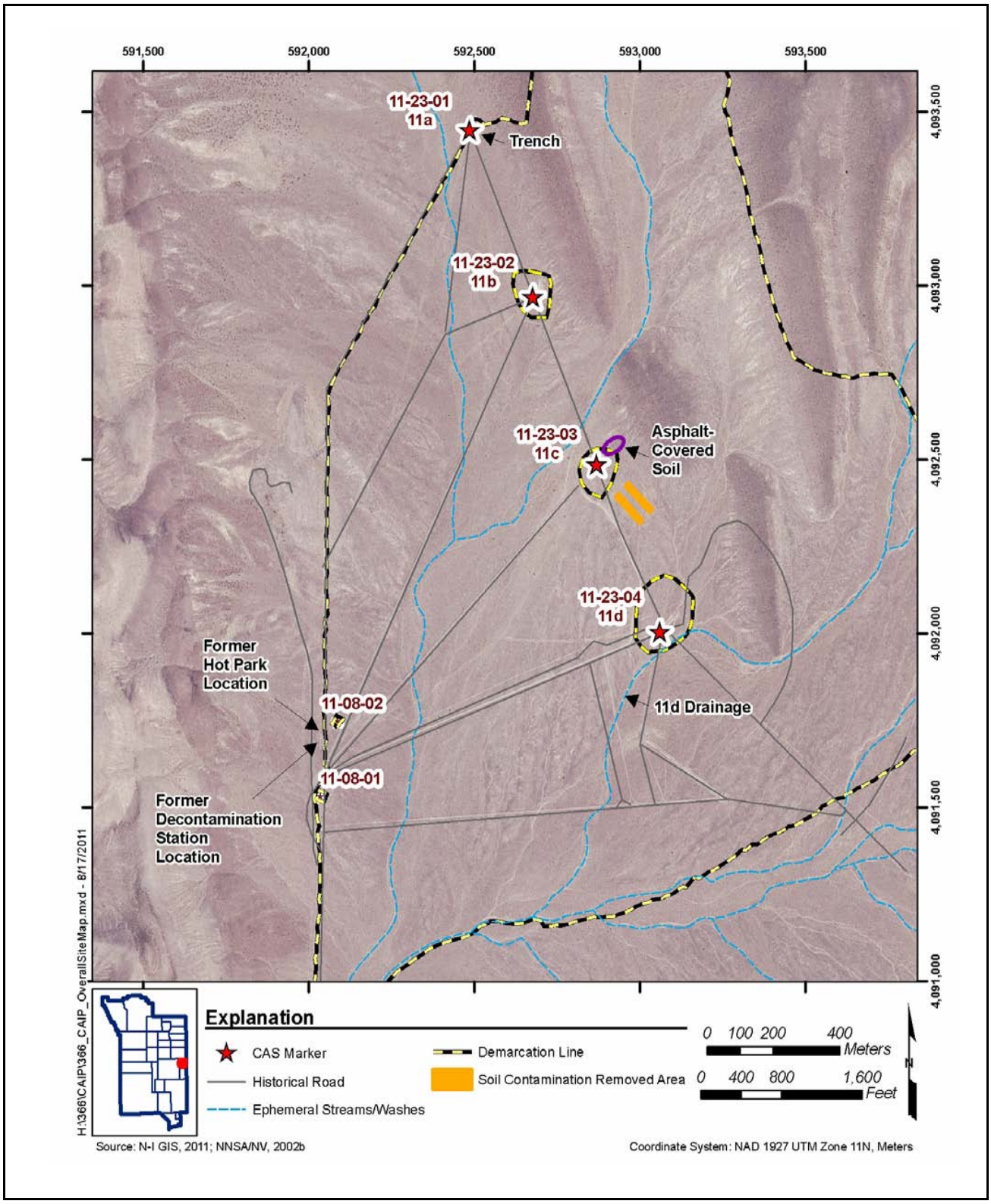

Figure 2-2
CAU 366 Site Map

the event of an accidental detonation (e.g., handling, fire, electrical discharge). The following discusses the specifics of each CAS (DOE/NV, 2000):

- CAS 11-23-01, Radioactively Contaminated Area A, consists of the soil impacted as a result of safety experiment Project 56 No. 1. The safety experiment was detonated at test area 11a on November 1, 1955, with a result of zero yield.

- CAS 11-23-02, Radioactively Contaminated Area B, consists of the soil impacted as a result of safety experiment Project 56 No. 2. The safety experiment was detonated at test area 11b on November 3, 1955, with a result of zero yield.

- CAS 11-23-03, Radioactively Contaminated Area C, consists of the soil impacted as a result of safety experiment Project 56 No. 3. The safety experiment was detonated at test area 11c on November 5, 1955, with no yield.

- CAS 11-23-04, Radioactively Contaminated Area D, consists of the soil impacted as a result of safety experiment Project 56 No. 4. The safety experiment was detonated at test area 11d on January 18, 1956, with a very slight yield.

The test conducted at 11a was primarily an enriched uranium device, while each of the other three tests were of plutonium and enriched uranium devices. Each test area consisted of a test bed specifically designed for the recovery of unconsumed nuclear material. A test bed consisted of a wooden cab positioned in the center of a 100-ft-diameter asphalt pad that was covered with sand (Figure 2-3). The wooden cabs used for the first three tests were lined with metal, while the metal was taken out of the design for the fourth test. On the final experiment, the wooden cab was slightly altered, a better quality of sand was used, and the amount of sand was reduced from the 3 in. used during the previous test to 1/2 in. These modifications were made for the final experiment to ensure that the most nuclear material possible was recovered (AEC, 1957).

After the four tests were completed, there was a nuclear materials recovery effort. As a result of these activities, much of the sand and debris generated from the test activities were packaged and either shipped off for nuclear recovery or placed in two CWDs (CASs 11-08-01 and 11-08-02) located east of the four test areas (Allaire, 1958; Johnson, 1956). However, a small amount of debris—including metal, lead bricks, and batteries—is present throughout the test area and within open trenches located adjacent to the east side of the GZ at each test location. The CAS 11-23-01 (11a) GZ and trench is not within an HCA. The GZ and trenches at CASs 11-23-02 (11b), 11-23-03 (11c), and 11-23-04 (11d) are located within a posted HCA fence line. Additional debris is present within the three HCAs.

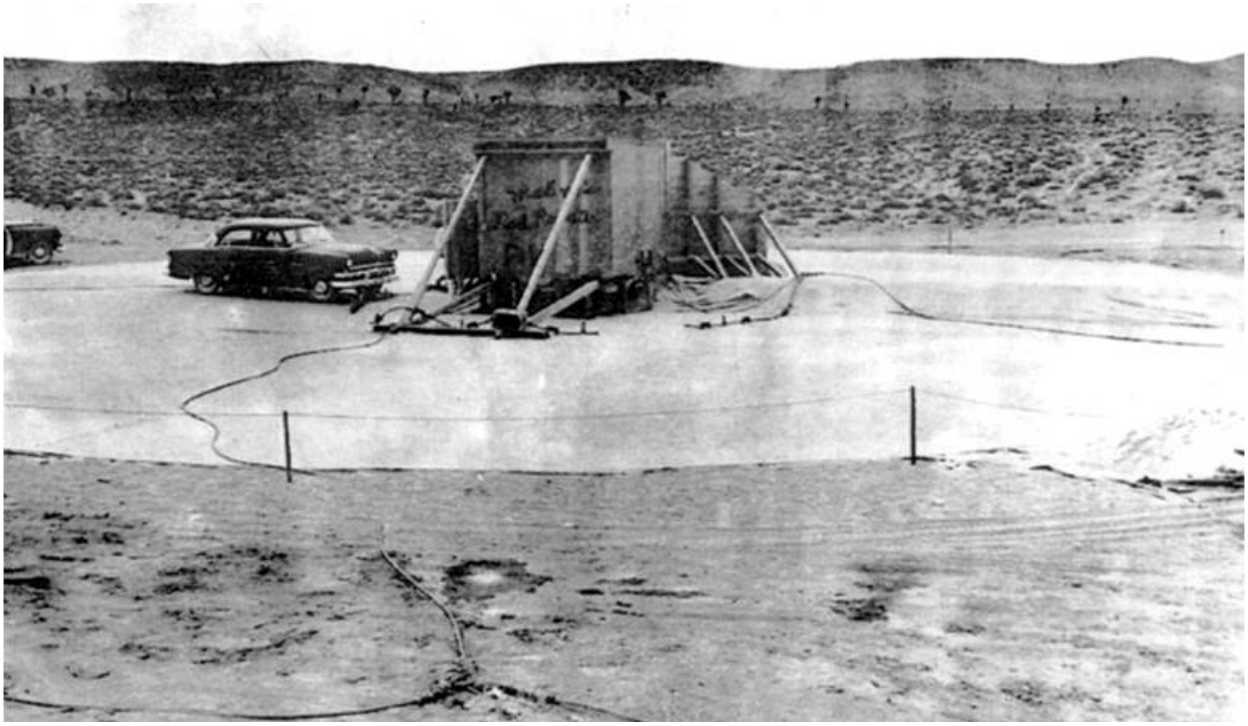

Figure 2-3
CAU 366 Test Bed
Source: Author Unknown, Date Unknown

Although most of the debris is expected to be a result of the test activities, some debris was left behind from activities that took place after the Project 56 tests. As part of a training exercise to simulate a plane accident, an XF-90A plane was broken in half and the front and back ends placed in the 11b and 11c GZs, respectively (Seals, 2004). After the plane was decontaminated for removal, waste from the decontamination effort as well as small plane parts were left in the 11b GZ (Friedrichs, 2011). All four CASs are located within a site-encompassing CA posted area.

Just outside the CA, west of the test areas, a decontamination station and hot park were present. The decontamination station was used to decontaminate personnel, while the hot park was used to park "hot" vehicles and to store and decontaminate drums containing material to be shipped for nuclear recovery (Johnson, 1956; LASL, Date Unknown). Documentation states that water and soap was used during decontamination (Page, 1956).

Figure 2-2 shows the location of the four test areas: 11a trench, asphalt-covered soil near 11c, the former decontamination station, and the former hot park.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NNSS practices were used to identify wastes that may be present. The potential wastes inside the CA but outside the HCAs and the CWDs consist of debris such as metal, cables, wood, lead bricks, batteries, drums, and other various potentially radiologically contaminated debris. Debris located on the surface of CWD #2 includes cable, drums, filters, and other miscellaneous radiologically contaminated debris (NNSA/NSO, 2004). Waste located in the subsurface of both CWDs consist of drums containing sand, wood, and metal; contaminated clothing; equipment; and other radiologically contaminated debris. Inside the three HCA-posted GZs, there is the material used in the decontamination of the XF-90A plane; small parts left behind from the XF-90A plane; and wood, metal, cables, and other miscellaneous radiologically contaminated debris (Friedrichs, 2011).

Investigation-derived waste (IDW) streams may include soil, personal protective equipment (PPE), sampling equipment, decontamination rinsate, and debris. Potential waste types include industrial waste, low-level radioactive, hazardous, hydrocarbon, or mixed wastes.

2.4 Release Information

The release of contamination to the CAU 366 CASs is directly or indirectly associated with the four Project 56 safety experiments. The investigation of specific releases at CAU 366 will depend upon the nature of these releases. Therefore, the releases at CAU 366 have been categorized into one of the two release scenarios defined in Section 1.1.2.

The primary release scenario includes the atmospheric dispersion of radioactive materials to the soil surrounding the four test areas. The other release scenario includes subsequent migration of radioactive materials associated with atmospheric deposition under the primary release scenario. This may occur due to sheet and gully erosion from stormwater runoff. This scenario also includes other potential releases from the burial or storage of debris in waste dumps and trenches as well as from discharges, spills, wastes, or debris from activities conducted at the test areas.

Surface and subsurface soils are the impacted media at all sites. Exposure routes to receptors include ingestion and inhalation of radionuclides in the soil (internal dose). Site workers may also be exposed

to direct radiation by performing activities in proximity to radiologically contaminated materials (i.e., external dose).

The following subsections contain CAS-specific descriptions of known or suspected releases associated with CAU 366.

2.4.1 CAS 11-08-01, Contaminated Waste Dump #1; CAS 11-08-02, Contaminated Waste Dump #2

The potential releases are from the presence of buried material, which was generated during any of the four Project 56 tests. The buried material consists of sand, ashed wood, and metal along with other debris and associated test materials that may contain radionuclides and hazardous materials. Additionally, surface debris is present within the fence line of CAS 11-08-02. That debris was investigated as a part of CAU 214, CAS 11-22-03 (see Section 2.5.5).

2.4.2 CAS 11-23-01, Radioactively Contaminated Area A

Contamination at the site is from scattered nuclear material and fallout from the initial detonation of a device at test area 11a that was composed of primarily enriched uranium. Other potential releases associated with this site may include debris in a trench east of the GZ, contamination migrated with stormwater runoff, and spills or wastes associated with this test.

2.4.3 CAS 11-23-02, Radioactively Contaminated Area B; CAS 11-23-03, Radioactively Contaminated Area C; and CAS 11-23-04, Radioactively Contaminated Area D

Contamination at these sites is from scattered nuclear material and fallout from the initial detonation of a plutonium and enriched uranium device at each of the test areas 11b, 11c, and 11d. A known area of asphalt-covered soil near 11c is considered a release and will be investigated. Additionally, a decontamination station and hot park used to decontaminate personnel, materials, and vehicles may have released contaminants to surface soil. The potential exists for deposited contamination to have migrated with stormwater runoff. Other potential releases such as spills or wastes associated with any of these three tests may also be present.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 366 Project 56 test area.

2.5.1 Radiological Flyover Surveys

Radiological flyover surveys have been conducted at the NNSS to characterize the radiation exposure. The following details three surveys conducted in the Project 56 test area:

- An aerial radiological survey was conducted in 1982 by flying a regular grid of 96 parallel flight lines spaced 150 ft apart at 100 ft above ground level (agl). The principal products of the analysis of the survey data are isopleth contour maps of the total terrestrial exposure rate and soil concentrations for americium (Am)-241, uranium (U)-235, and cesium (Cs)-137 (Clark, 1983).

- An aerial radiological survey was conducted in 1994 by flying along a set of parallel flight lines spaced 500 ft apart at 200 ft agl. The purpose of the survey was to provide a more detailed measurement of the NTS gamma radiation natural background and areas of man-made activity (BN, 1999a).

- An aerial radiological survey was conducted in 1999 by flying along a set of parallel flight lines spaced 75 ft apart at 50 ft agl. The purpose of the survey was to measure, map, and define the areas of Am-241 activity to determine the areas of plutonium contamination. The values of the areas surveyed ranged from less than 70 counts per second (cps) to more than 32,000 cps (BN, 1999b). It should be noted that no Am-241 was detected at test area 11a.

The 1999 aerial radiological survey will be referenced consistently because the method of flying at a lower altitude with closer spaced flight lines provided the most useful data. Figure 2-4 shows the results of the radiological survey.

2.5.2 Soil Measurements and Sampling

Data collected for the Radionuclide Inventory and Distribution Program (RIDP) and by the Nevada Applied Ecology Group (NAEG) in the 1980s allowed for estimates of surface soil inventories throughout the NTS. The RIDP estimated the inventory through *in situ* soil measurements by gamma spectroscopy and limited confirmatory soil sampling (McArthur and Mead, 1989; Gray et al., 2007). The locations of the *in situ* soil measurements and soil sampling that took place throughout the Project 56 test area, relative to the 1999 aerial radiological survey, are shown on Figure 2-5.

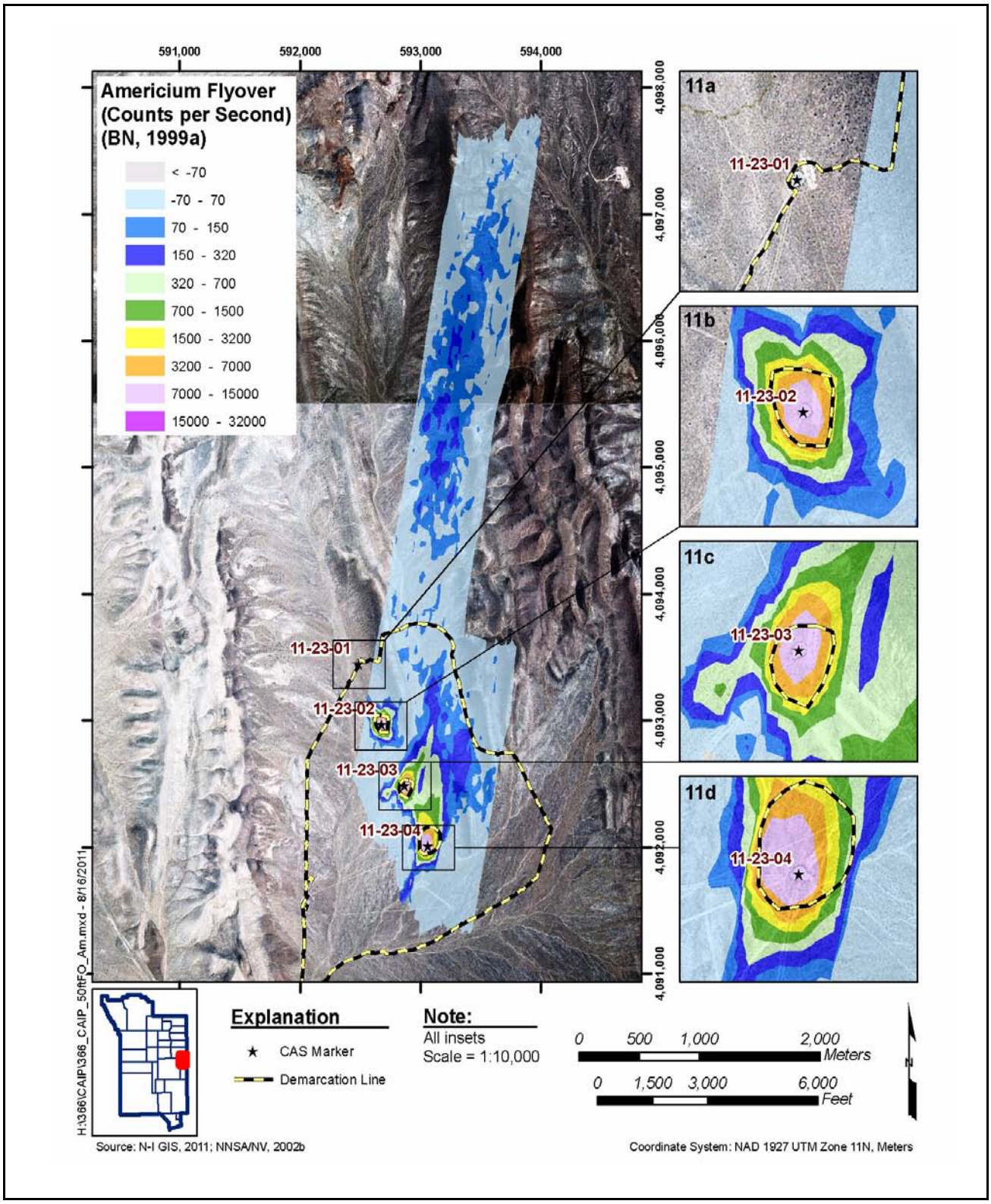

Figure 2-4
Radiological Flyover Survey of the Project 56 Test Area

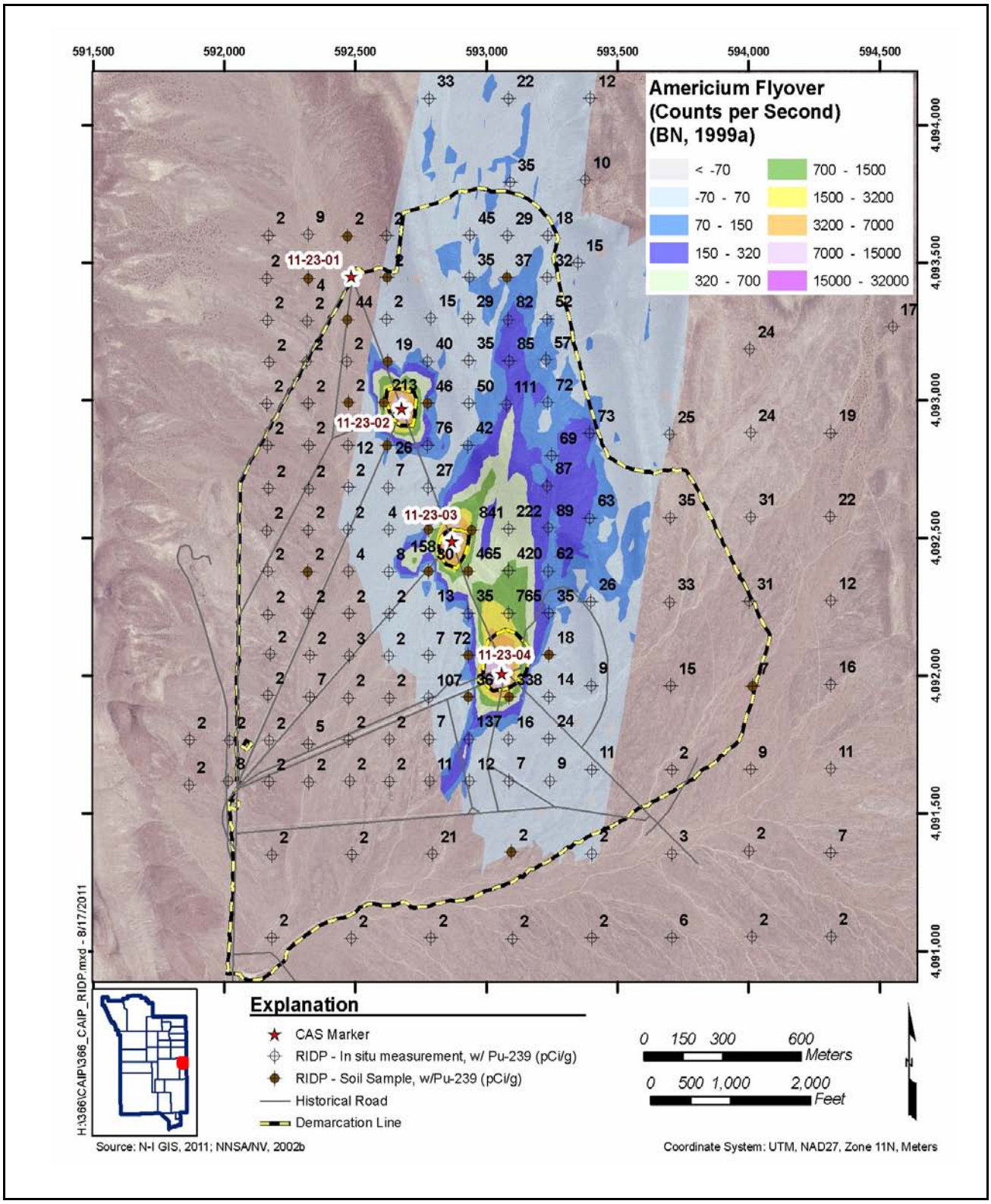

Figure 2-5
CAU 366 RIDP *In Situ* Measurements and Soil Sample Locations

2.5.3 Project 56 Soil Removal Activities

Several activities took place in the Project 56 test area that resulted in the removal of contaminated soil. One such effort was completed in 1982 to determine the effectiveness of removing soil contamination using a large truck-mounted vacuum unit rather than conventional earth-moving equipment, particularly in terms of volume reduction. The equipment testing area was selected based on the results of previous NAEG documentation that indicated an area near 11c and 11d where contamination overlapped. Two plots, each measuring 39 by 335 ft, were selected 98 ft apart from each other (see "Soil Contamination Removed Area" on Figure 2-2). Desert pavement surface and profile pre-cleanup and post-cleanup soil samples were collected within the two plots using various sampling methods. Most of the samples were analyzed for Am-241, with a few samples being analyzed for plutonium (Pu)-239/240 as well. The majority of activity was associated with the surface (0- to 1-in.) increment. The highest values for pre-cleanup desert pavement sampling were 74.8 +/- 11.9 picocuries per gram (pCi/g) of Am-241 and 377 +/- 33.9 pCi/g of Pu-239/240. The Pu-239/240 to Am-241 activity ratio was established as 5.69. Additional data were presented for sampling in washes and blow sand mounds. Soil was removed from the two plots to an average depth of 6.4 in., and an estimated 685 cubic feet (ft^3) of contaminated soil was removed and disposed of at the U3axbl crater. The two plots were decontaminated to less than 10 pCi/g of Am-241 contamination in surface soil (Orcutt, 1982).

In 1987, 40 barrels of soil were removed from an area outside the 11c GZ to test a soil cleanup process that was formerly used at Johnston Island in the north Pacific. The soil was removed from the area and transported to the Engine Maintenance, Assembly, and Disassembly (E-MAD) facility, where the soil cleanup equipment was set up as a pilot plant. A figure showing the relative soil removal area is present in the report (Sunderland, 1987). The process of removing the soil is not discussed in the report. It appears the soil was removed from areas adjacent to the plots established during the 1982 soil cleanup effort, directly adjacent to the 11c GZ fence line, and in a wash near 11c.

According to radiological survey reports and photographs, another soil removal effort took place in 1992. One of the reports is labeled "Large Volume Soil Collection A-11" and dated April 1992. The report lists barrels 36 to 41, so it is believed that a minimum of 41 barrels of soil were removed. The date on the report corresponds to photographs taken that show personnel shoveling soil into drums.

Other survey reports show that solid waste from 11b was swiped in November 1992 (Author unknown, 1992).

These historical documents indicate that soil was removed from the Project 56 test area, rather than contaminated material being mounded or scraped into piles and left on site. Because of the various soil removal activities, there may be areas of decontaminated land adjacent to areas potentially contaminated from the primary releases. Therefore, these disturbed areas will not be included in the sampling location selection because they are not areas most likely to contain a COC.

2.5.4 Desert Research Institute Sampling

Desert Research Institute (DRI) conducted a sampling effort in May 2010 to determine whether radionuclides were being transported down washes flowing through test areas 11c and 11d. Two washes (the western wash associated with 11c and the eastern wash associated with 11d), a detention basin that the washes drain into, and the sediment just outside the detention basin were sampled. Ten surface samples (depths ranging from 0 to 5 in.) and one shallow subsurface sample (3 to 7 in.) were collected and analyzed for Am-241, Pu-238, and Pu-239/240 activity concentrations in two different size fractions (less than 63 micrometers [μm] and 63 μm to 250 μm). The highest activity concentrations for all samples were in the smaller size fraction. The highest single sample value was detected in the sample located along the eastern wash and closest to 11d with a result of Pu-239/240 at 949 pCi/g, Pu-238 at 8.99 pCi/g, and Am-241 at 211 pCi/g (Miller et al., 2011).

Results from this sampling and any future DRI activities conducted in this area will be taken into consideration and applied, as appropriate, in the closure report.

2.5.5 CAU 214 Investigation

The debris present on the surface of CAS 11-08-02 (CWD #2) was investigated as part of CAU 214, CAS 11-22-03. The CAS consists of two drums containing debris and two braided-wire cable piles. Five swipes and one paper filter sample were collected as part of the investigation. The highest Pu-239/240 result was 2,430,000 +/- 340,000 pCi/ per swipe from debris in one of the drums. It was determined that the contamination associated with the debris was a result of the Project 56 experiments and, therefore, not a release from CAS 11-22-03. There was no further action regarding

the CAS components because there was a higher risk to human health from removing the contaminated debris than from leaving it in place (NNSA/NSO, 2004).

2.5.6 CAU 366 Preliminary Investigation

In 2011, a preliminary field investigation was completed in the Project 56 test area. This effort included visual and radiological walkover surveys. During the visual survey, which included walking the area inside of the CA fence line, photographs were taken and site conditions were noted. Radiological surveys were completed around the four test areas, two CWDs, northeastern plume inside the CA, northern plume outside the CA, and a portion of the former decontamination station location. The appropriate radiological instruments were used to detect the suspected contaminants at a particular location. Specifically, the Ludlum model 44-21 was used at test area 11a, while the PRM-470 and field instrument for the detection of low-energy radiation (FIDLER) were used at test areas 11b, 11c, and 11d. Because the PRM-470 did not show any areas of significantly elevated gamma activity above background, the FIDLER results were used to show the elevated areas of Am-241. Figures 2-6 and 2-7 show the results of the radiological walkover survey from the Ludlum 44-21 and FIDLER radiological instruments, respectively.

Concurrently, a debris sweep was conducted in the area of 11a; adjacent to but outside the HCAs associated with 11b, 11c, and 11d; and adjacent to the two CWDs. Seventy-nine pieces of debris were surveyed using an NE Electra instrument and photographed, and a Global Positioning System (GPS) coordinate was collected. One piece of surveyed debris exceeded the instrument's detection limit of 10,000,000 disintegrations per minute (dpm). Additionally, some debris was swiped and the swipes were then field screened to determine the level of removable alpha contamination. Although 79 pieces of debris were documented, this is not a comprehensive inventory of the debris within the Project 56 test area. Figure 2-8 shows the location of the surveyed debris.

2.5.7 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 366.

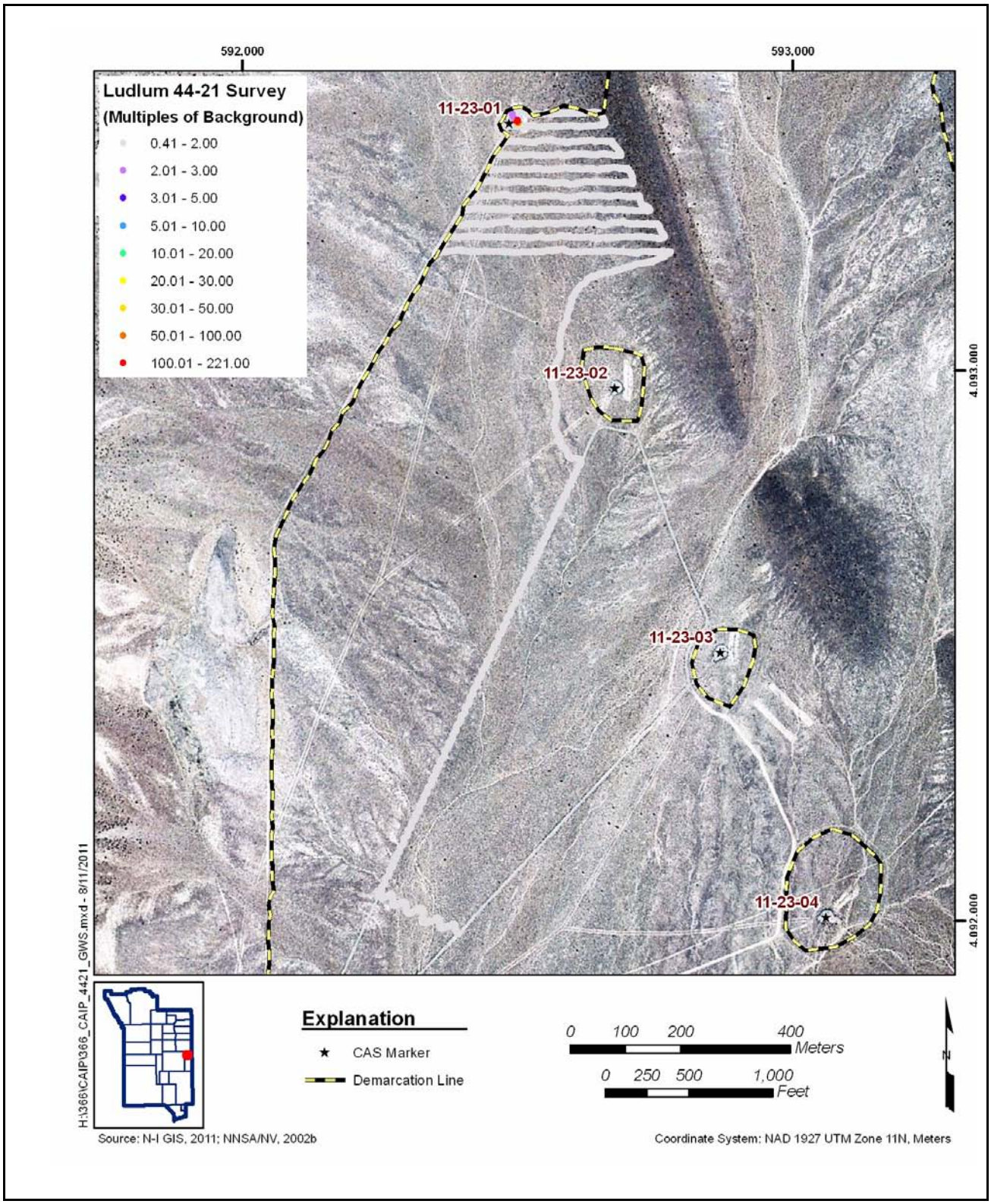

Figure 2-6
CAU 366 Preliminary Investigation, Radiological Walkover Survey (Ludlum 44-21)

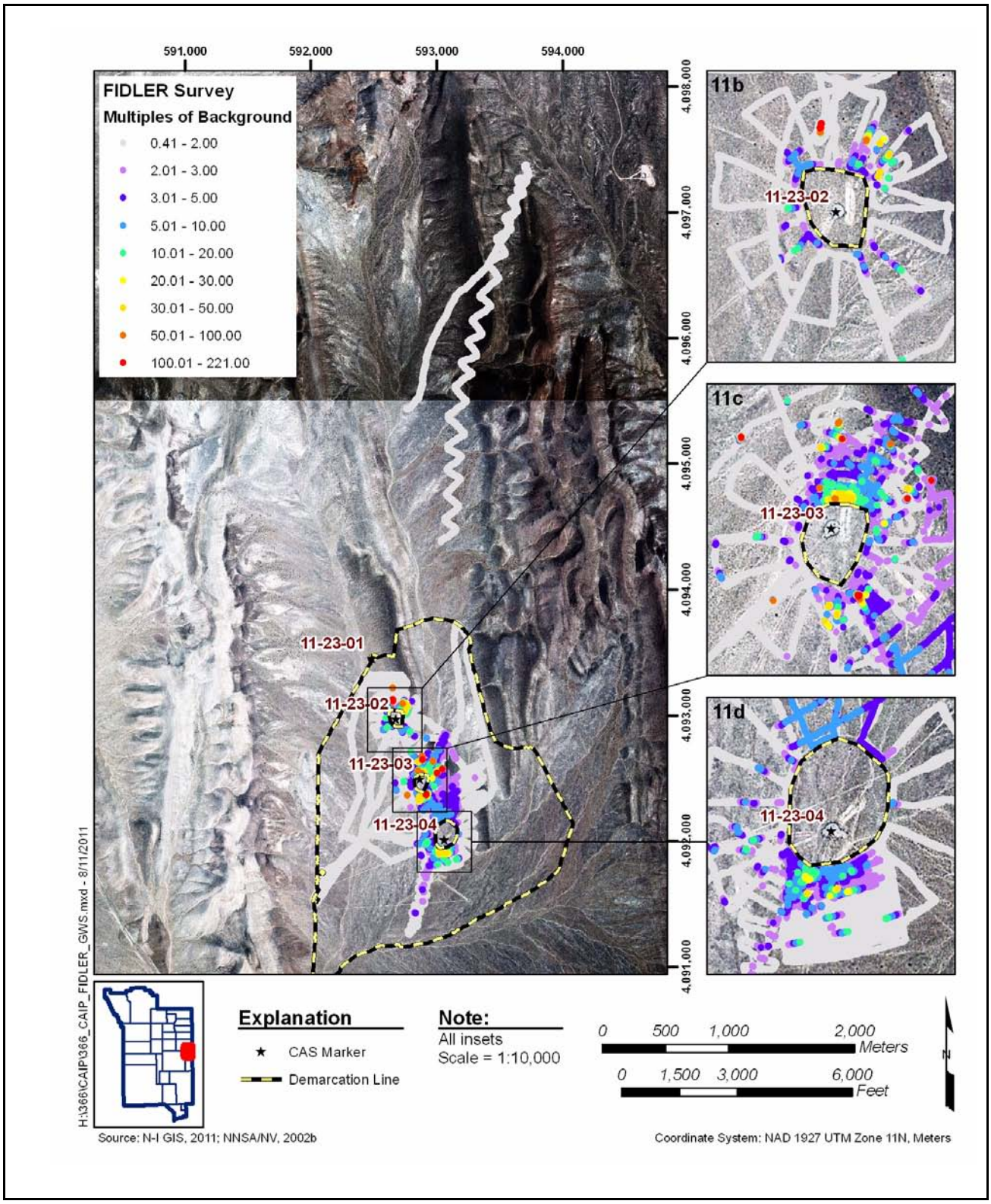

Figure 2-7
CAU 366 Preliminary Investigation, Radiological Walkover Survey (FIDLER)

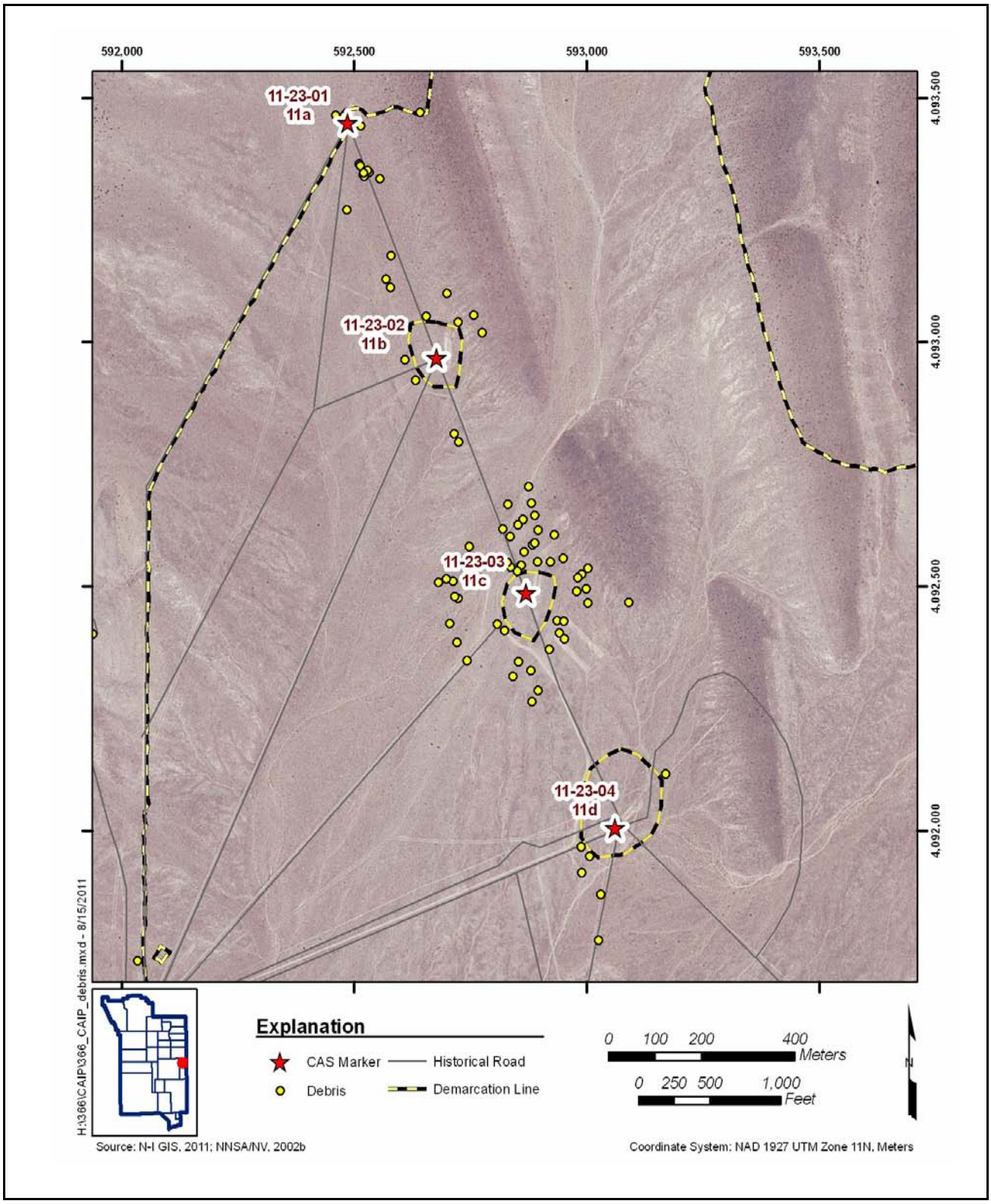

Figure 2-8
CAU 366 Preliminary Investigation, Debris Survey

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 366. 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 366 and formulation of the CSM. Also presented is a summary listing of the contaminants of potential concern (COPCs), the preliminary action levels (PALs), and the process used to establish FALs. Additional details and figures depicting the CSM are located in Appendix A.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM was used to develop appropriate sampling strategies and data collection methods. The CSM was developed for CAU 366 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 366 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.2.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 366.

3.1.1 Land Use and Exposure Scenarios

Land-use zones where the CAU 366 CASs are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

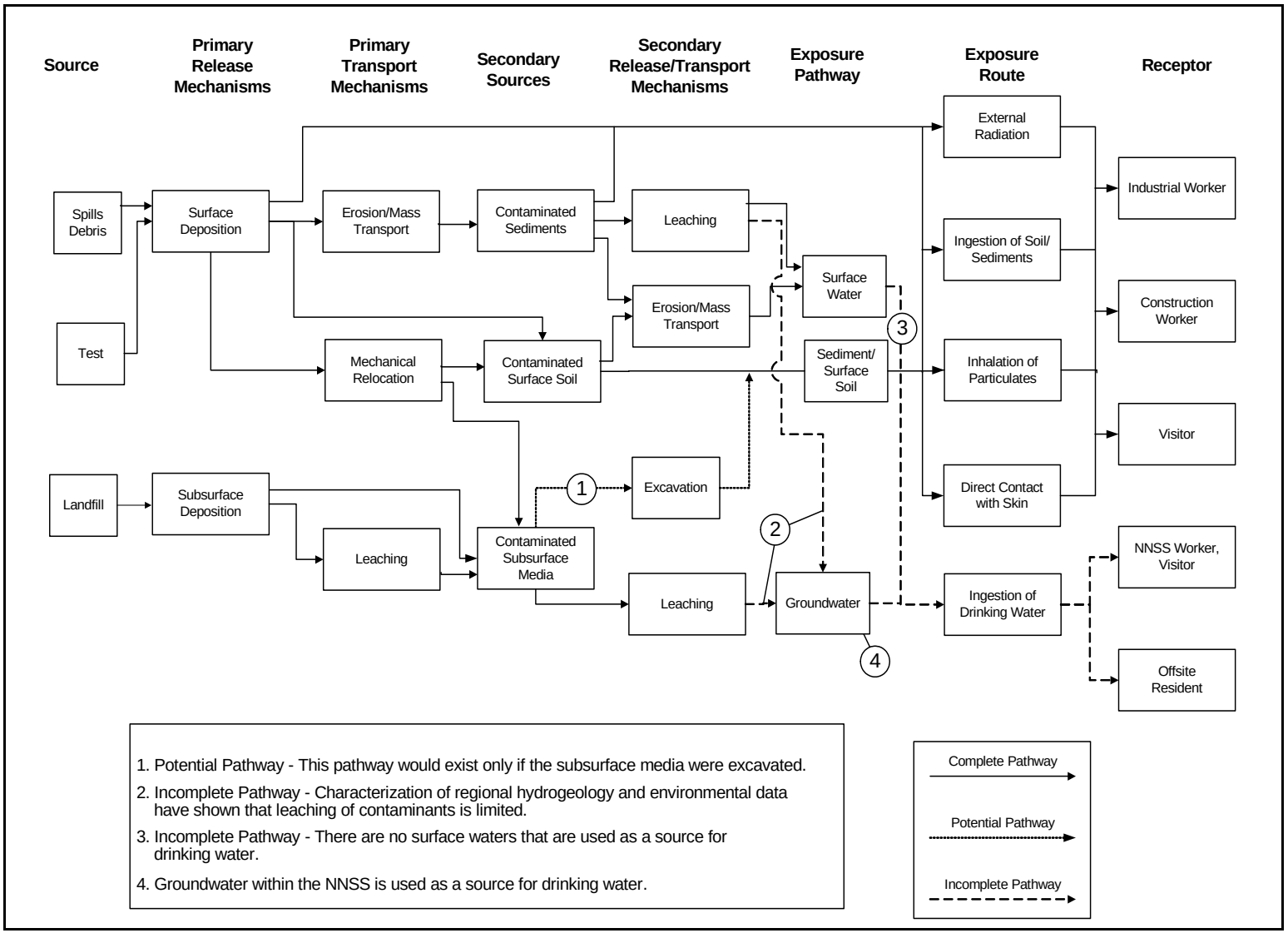

Figure 3-1
Conceptual Site Model Diagram

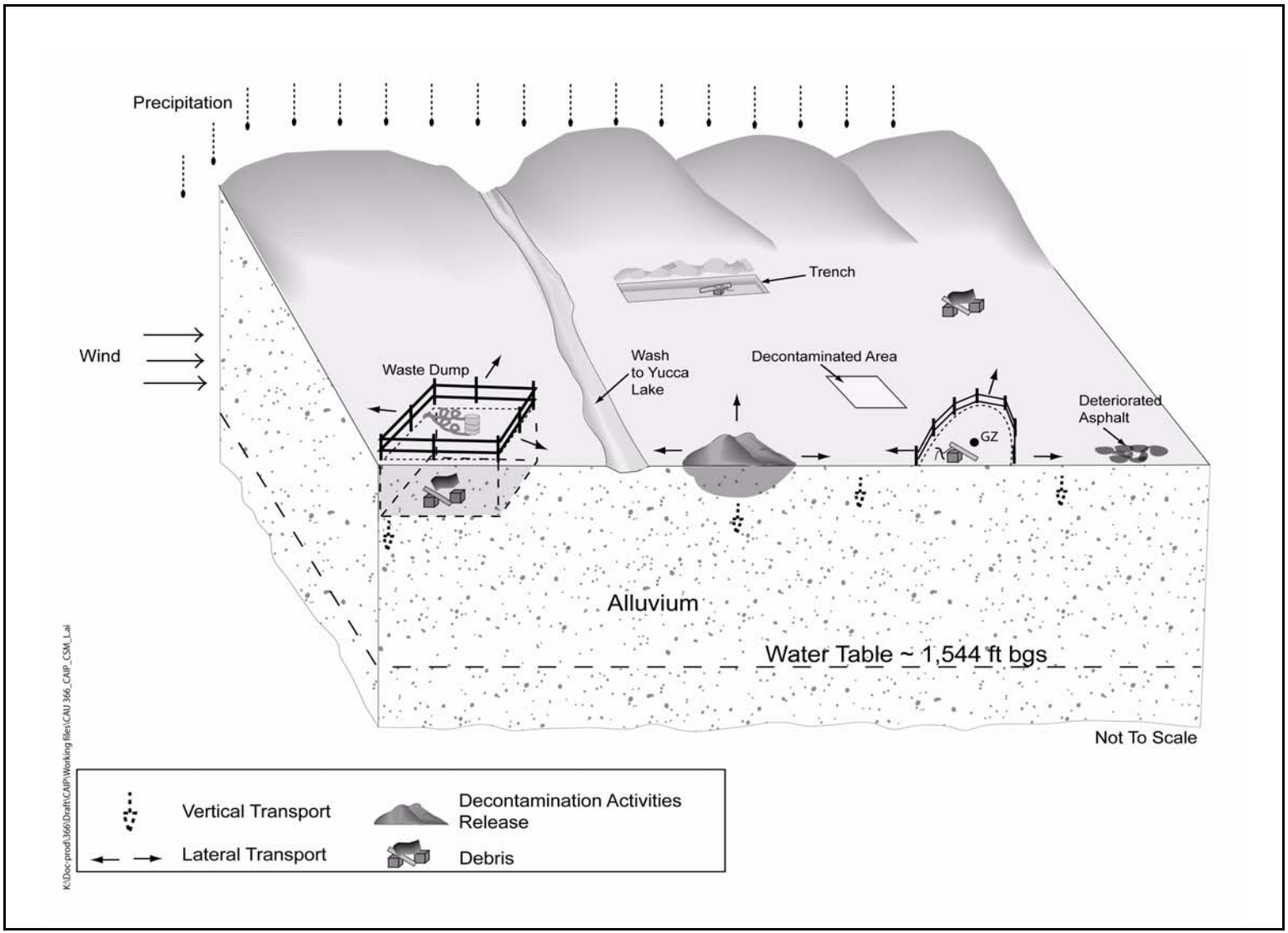

Figure 3-2
CAU 366 Conceptual Site Model

The CAU 366 CASs are located in the land-use zone described as "Nuclear Test Zone" within the NNSS. This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

Exposure scenarios for the CAU 366 CASs have been categorized into the following three types based on current and projected future land uses:

- Industrial Area – This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (225 days per year, 10 hours per day, for 25 years). The total effective dose (TED) calculated using this exposure scenario is the TED an industrial worker receives during 2,250 hours of annual exposure to site contaminants and is expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- Remote Work Area – This exposure scenario assumes noncontinuous work activities at a site. This scenario addresses exposure to industrial workers exposed to contaminants in soil during a portion of an average workday. This scenario assumes that this is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be on the site for an equivalent of 336 hours (or 42 days) per year for an entire career (25 years). The TED calculated using this exposure scenario is the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and is expressed in terms of millirem per Remote Work Area year (mrem/RW-yr).

- Occasional Use Area – This exposure scenario assumes occasional work activities at a site. This scenario addresses exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site. This scenario assumes that this is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hours (or 10 days) per year for 5 years. The TED calculated using this exposure scenario is the TED an occasional use area worker receives during 80 hours of annual exposure to site radioactivity and is expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

The CAU 366 land-use zone and exposure scenario are based on NNSS current and future land use. Corrective Action Unit 366 is a remote location 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, this site is classified as an Occasional Use Area.

3.1.2 Contaminant Sources

The contamination sources for CAU 366 CASs are releases of radiological contamination to the atmosphere and soil as a result of the four Project 56 tests and the associated test activities. These test activities include decontamination efforts, use of a hot park, burial of debris at two CWDs, spills, and scatter of test-related debris. Contamination on the soil surface from the primary and other releases may be a source for future migration. See Section 2.4 and Table A.2-1 for a CAS-specific listing of potential contaminant sources.

3.1.3 Release Mechanisms

Release mechanisms for the primary releases in CAU 366 include the release of unfissioned nuclear fuel at all four test areas and the limited release of fission products at 11d from nuclear testing. The high explosives used in the devices would have scattered nuclear components radially from the GZs.

Release mechanisms for the other releases include the potential release of decontamination effluent from the activities conducted at the decontamination station and hot park, spills or leaks from stored drums or equipment at the hot park, and releases from debris or waste stored on the surface and in the subsurface soil of the two CWDs. Additionally, there may be spills or leaks from various debris located throughout the test area (e.g., drums, batteries).

3.1.4 Migration Pathways

Surface migration pathways for CAU 366 include the lateral migration of potential contaminants across surface soils into washes transecting the site since the original deposition. The washes entering and leaving these areas are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical (infiltration) and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas. Several small washes and two prominent washes flow through Plutonium Valley to a detention basin located just

outside the northwestern corner of the CA. This detention basin (date of installation unknown) has begun to fill with sediment and overflows during heavy storm events. Beyond the basin, the wash flows toward the Yucca Flat Dry Lake.

Contaminants may also be moved through mechanical disturbance and release of effluents. Specifically, this includes the removal of soil contamination as a result of several nuclear recovery and cleanup efforts. There were no piles of scraped material or mounds identified that would indicate that soil contamination has been buried; rather, the contaminants have been removed in some locations. Additionally, contaminants may have been moved as a result of repeated release of decontamination effluent from the decontamination station and hot park.

Migration is influenced by the chemical characteristics of the contaminants (presented in Section A.2.2.3) and the physical characteristics of the vadose material (presented in Section A.2.2.4). In general, the contaminants that are reasonably expected to be present at CAU 366 (i.e., plutonium and americium) have low solubilities and high affinity for media. The physical characteristics of the vadose material generally include medium and high adsorbive capacities, low moisture contents (i.e., available water-holding capacity), and relatively long distances to groundwater (e.g., approximately 1,544 ft bgs). Based on these physical and chemical factors, contamination is expected to be found relatively close to release points.

Infiltration and percolation of precipitation serve as driving forces for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 RWMS has been estimated at 61.7 in.) and limited precipitation for this region (6.61 in. per year), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways 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).

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 366 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 will be recorded during the CAI.

3.2 Contaminants of Potential Concern

Based on the suspected contaminants identified in Section 2.4, the COPCs for CAU 366 have been identified (see Table A.2-2). The list of COPCs is intended to encompass all contaminants reasonably expected to be at the site which may contribute to dose or risk. These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs and other releases (including those that may be discovered during the investigation). Specific COPCs (and subsequently the analyses requested) will be determined for discovered potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

3.3 Preliminary Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further

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 ASTM International (ASTM) Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

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

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- Tier 2 evaluation – Conducted by calculating Tier 2 site-specific target levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total concentrations of total petroleum hydrocarbons (TPH) will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemical constituents of diesel will be compared to the SSTLs.

- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

This RBCA process includes a provision for conducting an interim remedial action if necessary and appropriate. The decision to conduct an interim action may be made at any time during the investigation and at any level (tier) of analysis. Concurrence of the decision-makers listed in Section A.2.1 will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site following completion of any interim actions. Any interim actions conducted will be reported in the investigation report.

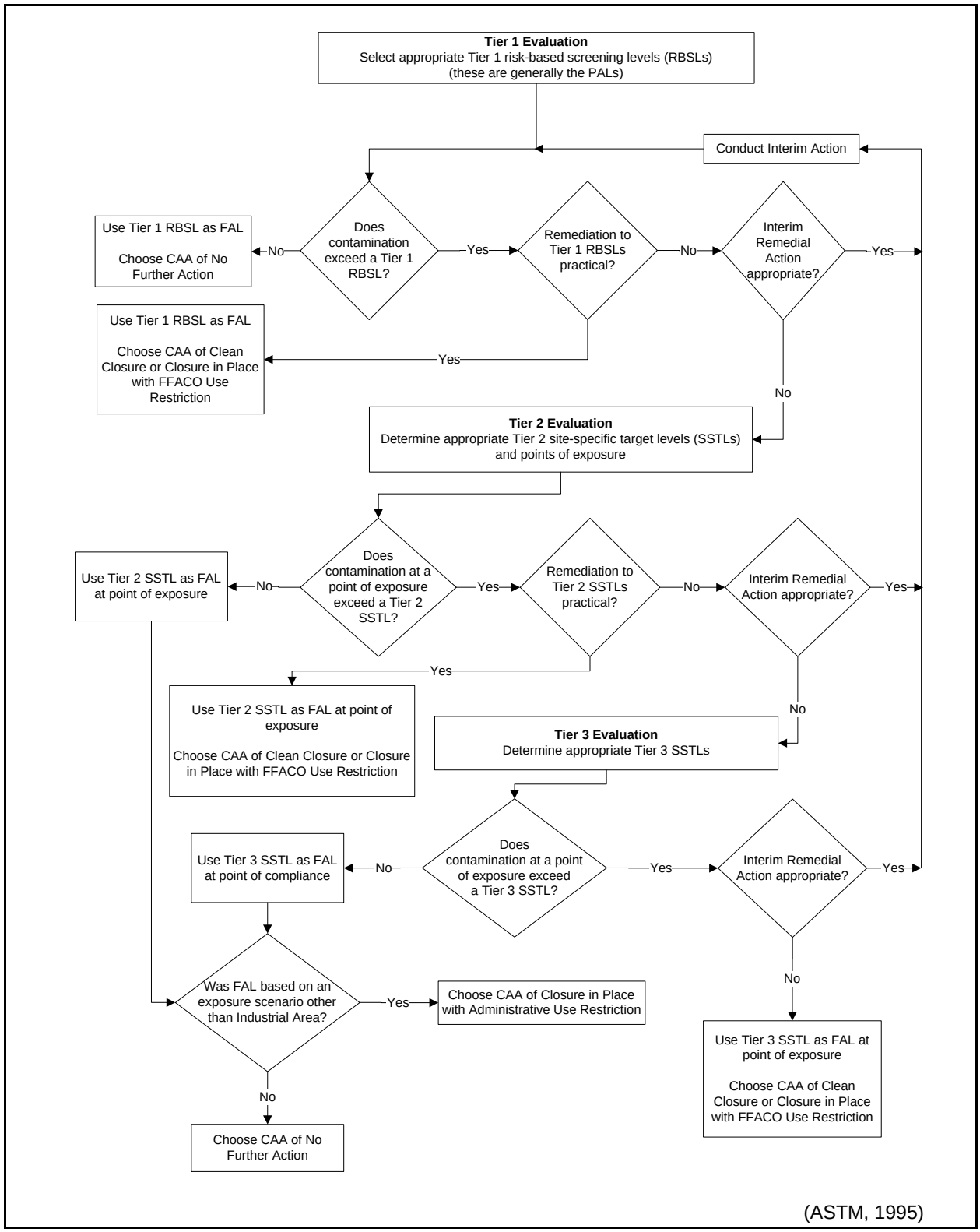

Figure 3-3
Risk-Based Corrective Action Decision Process

If, following implementation of corrective actions, contamination remains in place that is less than the site-specific exposure scenario based FAL but exceeds 25 millirem per year (mrem/yr) based on the Industrial Area exposure scenario, an administrative use restriction will be implemented to prevent future industrial use of the area. For this reason, contamination at all sites will be evaluated against the industrial exposure scenario based FALs. The FALs (along with the basis for their selection) will be proposed in the investigation report, where they will be compared to laboratory results in the evaluation of potential corrective actions.

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants* in industrial soils (EPA, 2011a). Background concentrations for *Resource Conservation and Recovery Act* (RCRA) metals will be used instead of screening levels when natural background concentrations exceed the screening level, as is often the case with arsenic on the NNSS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by the EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

3.3.2 Radionuclide PALs

The PAL for radioactive contaminants is 25-mrem/yr TED, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). For primary releases, the TED is calculated as the sum of external dose and internal dose. External dose is determined directly from TLD measurements. Internal dose is determined by comparing analytical results from soil samples to residual radioactive material guidelines (RRMGs) that were established using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001). The RRMGs presented in Table 3-1 are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram of surface soil, for a particular radionuclide, that would result in an internal dose of 25 mrem/yr to a receptor (under the

appropriate exposure scenario) independent of any other radionuclide (assumes that no other radionuclides contribute dose). The internal dose associated with any specific radionuclide would be established using the following equation:

Internal dose (mrem/yr) = [Analytical result (pCi/g) / RRMG] x 25 mrem/yr

When more than one radionuclide is present, the internal dose will be calculated as the sum of the internal doses for each radionuclide. In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used. The default and site-specific input parameters used in the RESRAD calculation of RRMGs for each exposure scenario are listed in Attachment A-1 in Appendix A.

Table 3-1
Residual Radioactive Material Guideline Values

Radionuclide	Exposure Scenario (pCi/g)		
	Industrial Area	Remote Work Area	Occasional Use Area
Am-241	2,816	16,120	45,550
Co-60	551,300	7,229,000	74,210,000
Cs-137	140,900	1,955,000	27,560,000
Eu-152	1,177,000	13,240,000	81,740,000
Eu-154	846,900	9,741,000	63,530,000
Eu-155	5,588,000	66,450,000	475,100,000
Nb-94	3,499,000	39,660,000	249,200,000
Pu-238	2,423	13,880	39,220
Pu-239/240	2,215	12,680	35,820
Sr-90	59,470	807,500	9,949,000
Th-232	2,274	13,410	38,520
U-234	19,600	137,900	447,000
U-235	20,890	149,600	492,200
U-238	21,200	155,400	336,100

Co = Cobalt
Eu = Europium
Nb = Niobium
Sr = Strontium
Th = Thorium

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 4.1, it is assumed that TED within the default contamination boundaries (i.e., HCAs encompassing the GZ at 11b, 11c, 11d; and the fence lines encompassing the two CWDs) exceed the FAL. Figure 3-4 shows the default contamination boundaries associated with CAU 366. For these areas, the DQO decisions are resolved and corrective action is required. The DQO decisions will be resolved for the areas outside the default contamination boundaries.

As presented in Section 1.1.2, the DQOs address two types of potential contaminant release scenarios. The primary releases will be investigated through a combination of probabilistic and judgmental sampling, and the other releases will be investigated through judgmental sampling. Therefore, discussions related to these two release scenarios are presented separately.

The DQO strategy for CAU 366 was developed at a meeting on July 6, 2011. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 366 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 366." 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 following:
  - The lateral and vertical extent of COC contamination

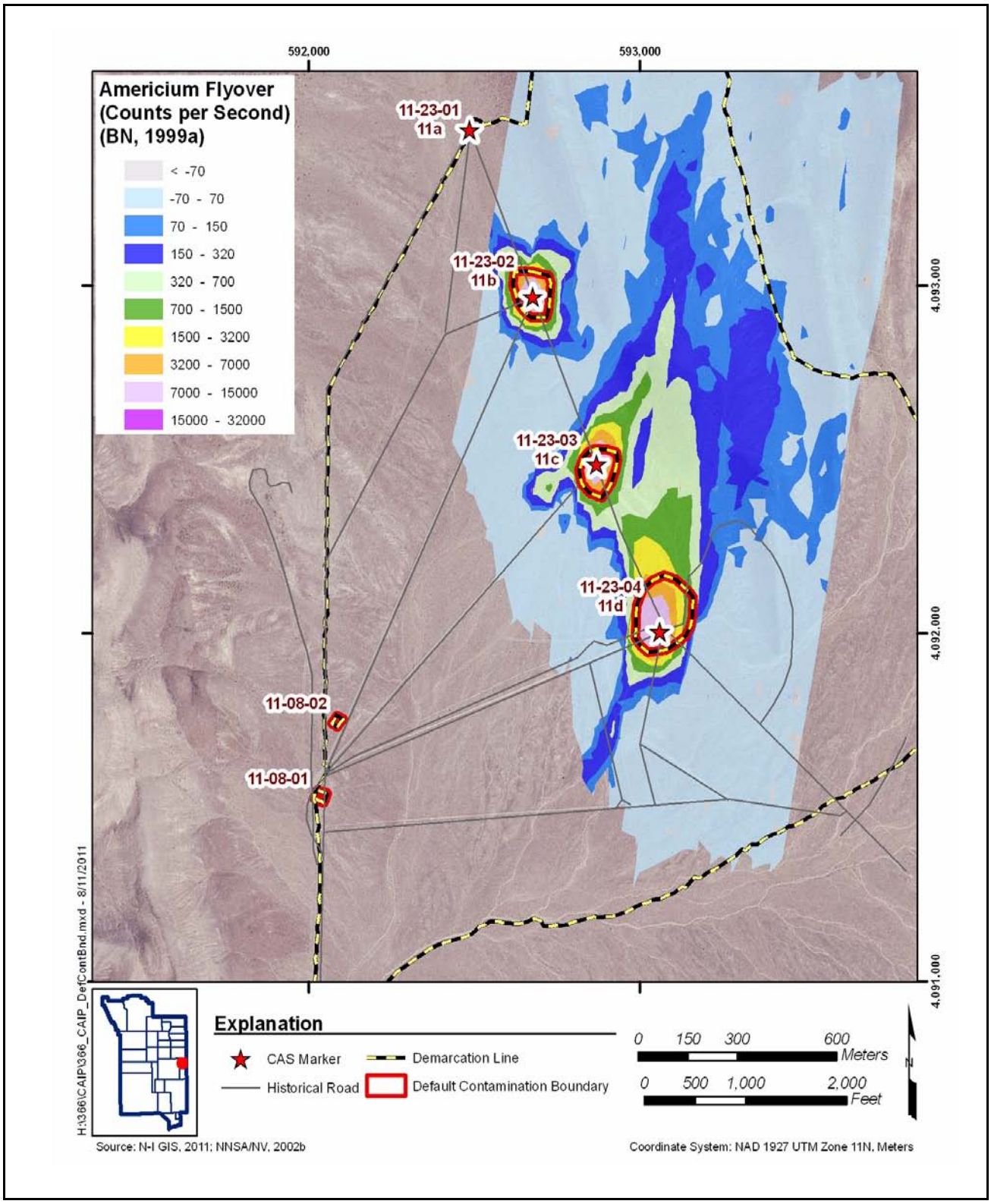

Figure 3-4
CAU 366 Default Contamination Boundaries

- The information needed to determine potential remediation waste types
- The information needed to evaluate the feasibility of remediation alternatives

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes (i.e., potential source material [PSM]) that are present at a site to introduce COCs into site environmental media. Several conservative assumptions were made to evaluate the potential for wastes to introduce a COC to the surrounding environmental media. These assumptions are detailed in Section A.3.1.

For the primary release scenario, it is unknown whether COCs are present outside the default contamination boundaries and Decision I sampling for the primary release scenario will be conducted. If COCs are identified, Decision II must be resolved for the primary releases at CAU 366.

For the other release scenario, Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. The specific analyses for samples from other 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.

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 investigation report to confirm or refute the CSM and determine whether the DQO data needs were met.

Analytical methods and target minimum detectable concentrations (MDCs) for each CAU 366 COPC are provided in Tables 3-2 and 3-3. The criteria for precision and accuracy listed in Tables 3-2 and 3-3 may vary from information in the QAPP as a result of the laboratory used or updated/new methods (NNSA/NV, 2002a).

Table 3-2
Analytical Requirements for Radionuclides for CAU 366

Analysis[a]	Medium or Matrix	Analytical Method	MDC[b]	Laboratory Precision	Laboratory Accuracy
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1[c]	10% of DCGs[d]	RPD 35% (non-aqueous)[e] 20% (aqueous)[e] ND -2<ND<2[f]	LCS Recovery (%R) 80-120[g]
	Non-aqueous	GA-01-R[h]			
Other Radionuclides					
Isotopic U	All	U-02-RC[h]	10% of DCGs[d]	RPD 35% (non-aqueous)[e] 20% (aqueous)[e] ND -2<ND<2[f]	Chemical Yield Recovery (%R) 30-105[i] LCS Recovery (%R) 80-120[i]
Isotopic Pu	Aqueous	Pu-10-RC[h]			
	Non-aqueous	Pu-02-RC[h]			
Isotopic Am	Aqueous	Am-03-RC[h]			
	Non-aqueous	Am-01-RC[h]			
Gross Alpha/Beta	Aqueous	EPA 900.0[c]			MS Recovery (%R) Lab-specific[j] LCS Recovery (%R) 80-120[i]
	Non-aqueous	SM 7110 B[k]			
Tritium	Aqueous	EPA 906.0[c]			
	Non-aqueous	Laboratory Procedure[l]			

[a]A list of constituents reported for each method is provided in Table A.2-4.
[b]The MDC is the minimum concentration of a constituent that can be measured and reported with 95% confidence (Standard Methods)[k].
[c]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).
[d]The DCG is the value, in picocuries per gram of surface soil, for a particular radionuclide that would result in a dose of 25 mrem/IA-yr (e.g., the PAL).
[e]*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).
[f]*Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997).
[g]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2011b).
[h]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[i]Professional judgment and other industry acceptance criteria are used.
[j]Accuracy criteria are developed in-house using approved laboratory standard operating procedures in accordance with industry standards and the N-I Statement of Work requirements (NNES, 2010).
[k]*Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998).
[l]Laboratory standard operating procedures in accordance with industry standards and the N-I Statement of Work requirements (NNES, 2010).

DCG = Derived Concentration Guide
LCS = Laboratory control sample
MS = Matrix spike
ND = Normalized difference
N-I = Navarro-Intera, LLC
RPD = Relative percent difference
%R = Percent recovery

Table 3-3
Analytical Requirements for Chemicals for CAU 366

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]
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]

[a]A list of constituents reported for each method is provided in Table A.2-4.
[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, 2011b).
[d]Precision and accuracy criteria are developed in-house using approved laboratory standard operating procedures in accordance with industry standards and the N-I Statement of Work requirements (NNES, 2010).
[e]*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).
[f]*Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004).

RL = Reporting limit
SVOC = Semivolatile organic compound
VOC = Volatile organic compound

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 366 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for CAU 366 by collecting and analyzing samples generated during a field investigation. However, the investigation will not include the HCAs associated with the 11b, 11c, and 11d GZs or the two CWDs (see Section A.2.2.1), as contamination exceeding FALs is assumed to be present within these areas. For the HCAs at the three GZs, this assumption is based on the documented presence of readily removable alpha contamination exceeding HCA criteria; the potential for a receptor in these areas to inhale, ingest, and transport this removable contamination; and the potential presence of buried contamination near the GZs. The two CWDs are assumed to contain contamination exceeding FALs based on available process knowledge that they were used to dispose of contaminated material from Project 56 (see Section 2.2.1) and the impracticality of characterizing a heterogeneous landfill. Default contamination boundaries have been established at these locations, and corrective actions are required. For the area outside the default contamination boundaries, information will be generated during a site investigation to resolve DQO decisions.

The presence and nature of contamination for primary releases will be evaluated using a combination of judgmental and probabilistic approaches. The sample plots will be selected and evaluated judgmentally, and the samples collected within the sample plots will be collected and evaluated probablistically. All other releases will be located and samples analyzed based on judgmental criteria.

If it is determined that a COC is present at any CAS, that CAS will be further addressed by determining the extent of contamination before evaluating CAAs.

For primary releases, DQO decisions will be based on the 95 percent UCL of the average TED for each sample plot. The TED will be determined by summing internal and external dose measurements at each sample plot location. 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 TLD. The TLD will be installed at the approximate center of the sample plot at a height of 1 meter (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. The 95 percent UCL of the average TED for each plot will be the sum of the 95 percent UCL of the three TLD element estimates of external dose and the 95 percent UCL of the four estimates of internal dose from the soil samples.

Modifications to the investigative strategy may be required if unexpected field conditions are encountered at any CAS. Significant modifications shall be justified and documented before implementation. If an unexpected condition indicates that conditions are significantly different than the CSM, the activity will be rescoped and the identified decision-makers will be notified.

4.2 Field Activities

Field activities at CAU 366 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; constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones; providing sanitary facilities; constructing decontamination facilities; and moving staged equipment.

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

- Perform additional radiological surveys, as necessary.
- Perform geophysical surveys at CASs 11-08-01, 11-08-02, and 11-23-01.

- Install project-specific environmental monitoring TLDs (see Section 4.2.3 for additional information).

- Perform additional visual surveys, as necessary, at all CASs within CAU 366 to identify any staining, discoloration, disturbance of native soils, or any other indication of potential contamination.

4.2.2 Sample Location Selection

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

4.2.2.1 Primary Releases

As presented in Section 4.1, it is assumed that TED within the default contamination boundaries (i.e., HCAs encompassing the GZ at 11b, 11c, 11d; and the fence lines encompassing the two CWDs) exceed the FAL. For these areas, Decision I is resolved and corrective action is required.

Outside the default contamination boundaries, Decision I will be evaluated by calculating TED in a sample plot established within the area of the highest uranium values (11a) or americium values (11b, 11c, 11d) as determined from the results of a radiological survey.

At test area 11a, the radiological instrument to survey the area was primarily the Ludlum model 44-21 to detect uranium that was released from a device composed primarily of enriched uranium. A FIDLER was used on the area between 11a and 11b to determine whether a plutonium plume overlapped 11a. Based on the results of these surveys, only one area of elevated Ludlum 44-21 readings was identified near the 11a GZ. One sample plot is planned at this location for the collection of soil samples to determine internal dose. A TLD will be placed in the sample plot to determine the external dose. Outside the sample plot, the radiological readings in test area 11a are very near background, so no Decision II sample plot locations were selected. If the 95 percent UCL of the TED at the Decision I sample plot exceeds the FAL, additional sample plot locations will be selected.

Test areas 11b, 11c, and 11d all were impacted by the testing of an enriched uranium and plutonium device. The FIDLER and PRM-470 radiological instruments were used for the radiological surveys. A review of the PRM-470 survey data indicated no areas of significantly elevated gamma activity above background. Therefore, assuming a correlation between the presence of Am-241, as detected by the FIDLER, and the presence of Pu-239, the results of the FIDLER survey were used to

determine the locations where the internal dose contributes the greatest amount to TED. Plutonium and americium (which contribute significantly to the internal dose) are the main radionuclides present and are present in a configuration in which they are readily inhaled or ingested (e.g., not in refractory form). Therefore, at least two sample plots will be located in the areas with the highest radiological survey values outside the default contamination boundaries. Additionally, a sample plot will be placed in an area of asphalt-covered soil near the 11c GZ because it is unknown what the true surface radiological conditions are at this location. A TLD will be placed in each of the sample plots to determine the external dose.

If the 95 percent UCL of the TED at the Decision I sample plots associated with test areas 11b, 11c, and 11d exceeds 25 mrem/IA-yr, three Decision II sample plot locations will be established judgmentally along a vector (minimum of two vectors total) that is approximately normal to the gamma radiation survey isopleths. A TLD will be placed in each of the Decision II sample plots to determine the external dose.

All soil samples collected at each sample plot and all TLDs placed at each sample plot will be sampled as described in Section 4.2.3.

4.2.2.2 Other Releases

For other releases at CAU 366, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. Biasing factors—such as stains, radiological survey results, presence of drainages, and wastes suspected of containing hazardous or radiological components—will be used to select the most appropriate samples from a particular location for collection and analysis.

A radiological walkover survey will be conducted for the investigation of the decontamination station and hot park. The survey will be completed in the former location of these structures (based on a historical map). A sample plot will be placed in the area with the most widespread elevated radiological readings from the survey (i.e., sample plot will not be placed around a single elevated reading but rather an area of elevated readings). If additional biasing factors such as spills or PSM are identified in the former locations of the decontamination station and hot park, additional sample locations may be selected.

A geophysical survey will be conducted at the trench adjacent to the 11a GZ. If buried material is identified, it will be noted as an area requiring possible corrective action. No samples will be collected based on the geophysical survey results. However, if biasing factors such as spills or PSM are identified in the trench, additional sample locations may be selected.

The easternmost drainage that travels through 11d will be visually and radiologically surveyed from outside the 11d HCA to the detention basin located just outside the southwestern corner of the CA. The visual survey will be conducted to identify sediment accumulation areas. A sampling location will be established at the center of the nearest two sediment accumulation areas outside the default contamination boundary, which may include the detention basin. 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 an alpha/beta contamination meter. The surface sample will submitted for analysis. Additionally, if the field-screening level (FSL) for any depth sample exceeds the FSL of the surface sample by greater than 20 percent, the depth sample with the highest screening value at each sample location will be submitted for analysis. If the FSL is not exceeded in any depth sample, only the surface sample will be submitted for analysis. A radiological survey will be conducted to identify elevated readings where additional judgmental sample locations may be selected. Information (such as sample results and the results of the radiological survey) needed to assess the potential for future migration of the 25-mrem/yr boundary will be obtained during the field investigation and addressed in the closure report.

Decision II will be resolved for drainages by the assumption that the entire volume of sediment in each sediment accumulation area where a COC is identified contains the COC. Additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain a COC. This may require investigating sediment accumulation areas beyond the detention basin.

If a COC is present at any other release scenario sample location, Decision II sampling will be conducted to define the extent of contamination where COCs have been confirmed. Extent (Decision II) sampling locations at each CAS will be selected based on the CSM, biasing factors, field-survey results, existing data, and the outer boundary sample locations where COCs are detected. In general, extent sample locations will be arranged in a triangular pattern around areas containing a

COC at distances based on site conditions, COC concentrations, process knowledge, and biasing factors. If COCs extend beyond extent locations, additional Decision II samples will be collected from locations further from the source.

If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be reevaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be reevaluated. A minimum of one analytical result less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination. The lateral and vertical extent of COCs will only be established based on validated laboratory analytical results (i.e., not field screening).

The sampling strategy and the estimated 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 investigation report.

4.2.3 Sample Collection

The CAU 366 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in Section 4.2.2.
- Collect required QC samples.
- Collect waste management samples as necessary.
- Collect external dose measurements by hanging TLDs at the sample plots, or collect instrument dose readings at extent locations.
- Collect soil samples from locations outside the influence of releases from the CAS, if necessary.
- Perform radiological characterization surveys of construction materials and debris as necessary for disposal purposes.
- Record GPS coordinates for each environmental sample location.

4.2.3.1 Primary Releases

To determine internal dose for the primary release scenario, a probabilistic sampling approach will be implemented for collecting composite samples within the sample plots. Each composite sample will consist of soil collected from nine randomly located subsample locations within the plot. For each composite sample, the first location will be selected randomly; the remaining eight subsample locations will be established on a systematic triangular grid (see Section A.8.0). External dose will be sampled from a TLD 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).

4.2.3.2 Other Releases

Decision I other 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 of other releases will consist of further defining the extent of contamination where COCs have been confirmed. Although the decontamination station and hot park are considered other releases, the samples will be collected from the sample plot in the same manner as the primary release sample plots.

4.2.4 Sample Management

The laboratory requirements (i.e., MDCs, precision, and accuracy) to be used when analyzing the COPCs are presented in Tables 3-2 and 3-3. The analytical program is presented in Tables A.2-2 through A.2-4. 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 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 to ensure restoration activities have been completed.

5.0 Waste Management

Waste generated during the CAU 366 field investigation will be managed in accordance with all applicable DOE orders, federal and state regulations, and agreements and permits between DOE and NDEP. Wastes will be characterized based on these regulations using process knowledge, field-screening results (FSRs), and analytical results from investigation and waste samples. Waste types that may be generated during the CAI include industrial, low-level radioactive, hazardous, hydrocarbon, or mixed wastes.

Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., metal, lead brick). These wastes may be characterized based on CAI sample results of associated samples, process knowledge, or directly sampled. Chemicals were not known to be used or present at this CAU in a manner that would generate listed hazardous waste; therefore, wastes will be characterized based on their chemical characteristics. The waste will be managed and disposed of accordingly.

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 using process knowledge, segregation, visual examination, and/or field screening (e.g., radiological survey and swipe results) to avoid cross-contaminating uncontaminated media or uncontaminated IDW that would otherwise be characterized and disposed of as industrial 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 and approved by

Environmental Compliance and Safety and Health. 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 366 field investigation include industrial and low-level radioactive IDW from the sampling activities. However, because of the uncertainty about what debris are present within the CAS boundaries (e.g., lead debris, batteries, historical 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, batteries, lead, drums)
- Decontamination rinsate

5.3 Investigation-Derived Waste Management

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

5.3.1 Industrial Waste

Industrial IDW, if generated, will be collected, managed, and disposed of in accordance with the solid waste regulations and the permits for operation of the NNSS Solid Waste Disposal Sites. The IDW generated at each CAS will only be collected in clear plastic bags, sealed, labeled with the CAS number from each site in which it was generated, and dated. The waste will then be placed in a roll-off box located in Mercury, or other approved roll-off box location. The number of bags of IDW placed in the roll-off box will be counted as they are placed in the roll-off box, noted in a log, and documented in the field activity daily log. These logs will provide necessary tracking information for ultimate disposal in the U10c Industrial Waste Landfill.

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 NNSS Waste Acceptance Criteria (WAC) (NNSA/NSO, 2010). Potential radioactive waste drums 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 U.S. Department of Transportation (DOT)-compliant containers. All containerized hazardous waste will be managed in accordance with Title 40 *Code of Federal Regulations* (CFR) 262.34 (CFR, 2011b).

5.3.5 Mixed Low-Level Waste

Mixed waste, if generated, shall be managed and dispositioned according to the requirements of RCRA (CFR, 2011b), agreements between NNSA/NSO and the State of Nevada, and DOE requirements for radioactive waste. Waste characterized as mixed will not be stored for a period of time that exceeds the requirements of RCRA unless subject to agreements between NNSA/NSO and the State of Nevada. The mixed waste shall be transported via an approved hazardous waste/radioactive waste transporter to the NNSS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituent concentrations below Land Disposal Restrictions may be disposed of at the NNSS Area 5 Radioactive Waste Management Site if the waste meets the requirements of the NNSS WAC (NNSA/NSO, 2010), the NNSS NDEP permit for the Hazardous Waste Management Unit (NEV HW0101, issued December 2010), and the RCRA Part B Permit. Mixed waste constituent concentrations exceeding Land Disposal Restrictions will require development of a treatment and disposal plan that is subject to NDEP review and approval.

5.3.6 Polychlorinated Biphenyls

The management of polychlorinated biphenyls (PCBs) is governed by the *Toxic Substances Control Act* (USC, 2009) and its implementing regulations at 40 CFR 761 (CFR, 2011c), and agreements between EPA and NDEP. Polychlorinated biphenyl contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA "characteristic" waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). The IDW will initially be evaluated using analytical results for media samples from the CAI. If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2011c) as well as State of Nevada requirements (NAC, 2008b), guidance, and agreements with NNSA/NSO.

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 366. 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 NNSS. This group is responsible for a routine environmental monitoring program at the NNSS. The program includes a campaign of TLDs that are emplaced at pre-established locations across the NNSS 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* (Wills, 2007). The TLDs will be submitted to the Environmental Technical Services group for inclusion in their routine quarterly read of the NNSS 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 QC procedures for TLD processing. A summary of the routine environmental monitoring TLD QC efforts and results can be found in Section 5.2.1 of the *Nevada Test Site Environmental Report 2006* (Wills, 2007). 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 of the following factors:

1. The TLDs will be exposed at the sample plots for the 2,250 hours of exposure time used for the Industrial Area exposure scenario. This eliminates errors in reading dose-rate meter scale graduations and needle fluctuations that 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 dose 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, 2011a) 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 as follows:

- For radiological samples:
  - field duplicates (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected),
  - laboratory QC samples (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected).
- For chemical samples (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 CAS per matrix, if less than 20 collected),
  - field blanks (minimum of 1, possibly more depending on site conditions),
  - laboratory QC samples (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected).

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

6.2 Laboratory/Analytical Quality Assurance

As stated in the DQOs (see 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 investigation report. 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

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 366 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.

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 3-2 and 3-3 may vary from corresponding information in the Industrial Sites QAPP as a result of changes in analytical methodology and laboratory contracts (NNSA/NV, 2002a).

The TLDs will be analyzed using automated TLD readers that are calibrated and maintained in accordance with existing QC procedures for TLD processing (Section 6.0) by a laboratory that is certified through the DOE Laboratory Accreditation Program for dosimetry. The data from this system meet rigorous data quality requirements and will be assessed for the listed DQIs before inclusion in the CAU 366 datset. Therefore, a separate evaluation of the TLD data against the DQIs will not be conducted.

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 Tables 3-2 and 3-3.

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 (Table 6-1) is that at least 80 percent of sample results for each measured contaminant are not qualified due to duplicates exceeding the criteria. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants at specific CASs.

6.2.4 Accuracy

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

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

The criteria used for the assessment of inorganic chemical accuracy are 75 to 125 percent for MS recoveries and 80 to 120 percent for LCS recoveries. For organic chemical accuracy, MS and LCS laboratory-specific percent recovery criteria developed and generated in-house by the laboratory according to approved laboratory procedures are applied. The criteria used for the assessment of radiochemical accuracy are 80 to 120 percent for LCS and MS recoveries.

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

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

6.2.5 Representativeness

Representativeness is the degree to which sample characteristics accurately and precisely represent characteristics of a population or an environmental condition (EPA, 2002). Representativeness is assured by carefully developing the 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 as follows:

- 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 investigation report.

6.2.6 Completeness

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

For the judgmental sampling approach, the completeness goal 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 investigation report. Additional samples will be collected if it is determined that the available information is not sufficient to resolve DQO decisions.

6.2.7 Comparability

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

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2002). If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives. This assessment will be presented in the investigation report.

As presented in Section 3.4, the evaluation criterion for this parameter will be that the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. The target MDCs for each COPC are provided in Tables 3-2 and 3-3.

Although the data quality for TLD measurements is assessed via the routine environmental monitoring program (Section 6.0), the sensitivity evaluation criterion for TLD measurements is 50 percent of the FAL (i.e., 12.5 net mrem/yr).

7.0 Duration and Records Availability

7.1 Duration

Field and analytical activities will require approximately 160 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 facilities located in Las Vegas and Carson City, Nevada, or by contacting the appropriate DOE Federal Sub-Project Director.

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic process used to plan data collection activities and define performance criteria for the CAU 366, Area 11 Plutonium Valley Dispersion Sites, field investigation. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the CASs in CAU 366 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 366 CAI will be based on the DQOs presented in this appendix as developed by representatives of the NDEP and the NNSA/NSO. The seven steps of the DQO process presented in Sections A.2.0 through A.8.0 were developed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

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

- 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, and
  - an analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings.
- Acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data.

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

A.2.0 Step 1 - State the Problem

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

The problem statement for CAU 366 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 366."

A.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO. The team met on July 6, 2011, for the DQO meeting.

A.2.2 Conceptual Site Model

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

The CSM was developed for CAU 366 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 COPCs and the potentially affected media.

The CSM consists of the following:

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

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

The applicability of the CSM to each CAS is summarized in Table A.2-1 and discussed below. Table A.2-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure A.2-1 depicts a representation of the conceptual pathways to receptors from CAU 366 sources. Figure A.2-2 depicts a graphical representation of the CSM.

Table A.2-1
Conceptual Site Model Description of Elements for Each CAS in CAU 366

CAS Identifier	11-08-01	11-08-02	11-23-01	11-23-02	11-23-03	11-23-04
CAS Description	**Contaminated Waste Dump #1**	**Contaminated Waste Dump #2**	**Radioactively Contaminated Area A**	**Radioactively Contaminated Area B**	**Radioactively Contaminated Area C**	**Radioactively Contaminated Area D**
Site Status	Sites are inactive and/or abandoned					
Exposure Scenario	Occasional Use Area					
Sources of Potential Soil Contamination	Stored and buried radioactively contaminated debris (metal, cables, wood), sand, and soil		Primary Release: Atmospheric deposition of radionuclides from four safety experiments Other Releases: Radioactively contaminated debris, effluent from decontamination/hot park activities, drainages			
Location of Contamination/ Release Point	Surface and subsurface soil within the CWDs		Surface soil surrounding the four GZ locations; soil directly below or adjacent to contaminated debris; sediment in washes; and surface/shallow subsurface soil from decontamination/hot park activities			
Amount Released	Unknown					
Affected Media	Surface, shallow, and subsurface soil; wash sediments					
Potential Contaminants	Isotopic Pu, Isotopic U, Isotopic Am, other potential radionuclides, and fission products; RCRA metals; VOCs and SVOCs (asphalt near 11c)					
Transport Mechanisms	Surface water runoff serves as the major driving force for lateral migration of contaminants while percolation of precipitation or runoff through subsurface media provides a driver for vertical transport of contaminants. Wind may cause limited resuspension and transport of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding FALs.					
Migration Pathways	Vertical transport is expected to dominate over lateral transport due to small surface gradients. However, the CASs are located on an alluvial fan that drains to Yucca Flat, so there is some potential for lateral transport.					
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.					
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, and dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or direct radiation exposure by radioactive materials.					

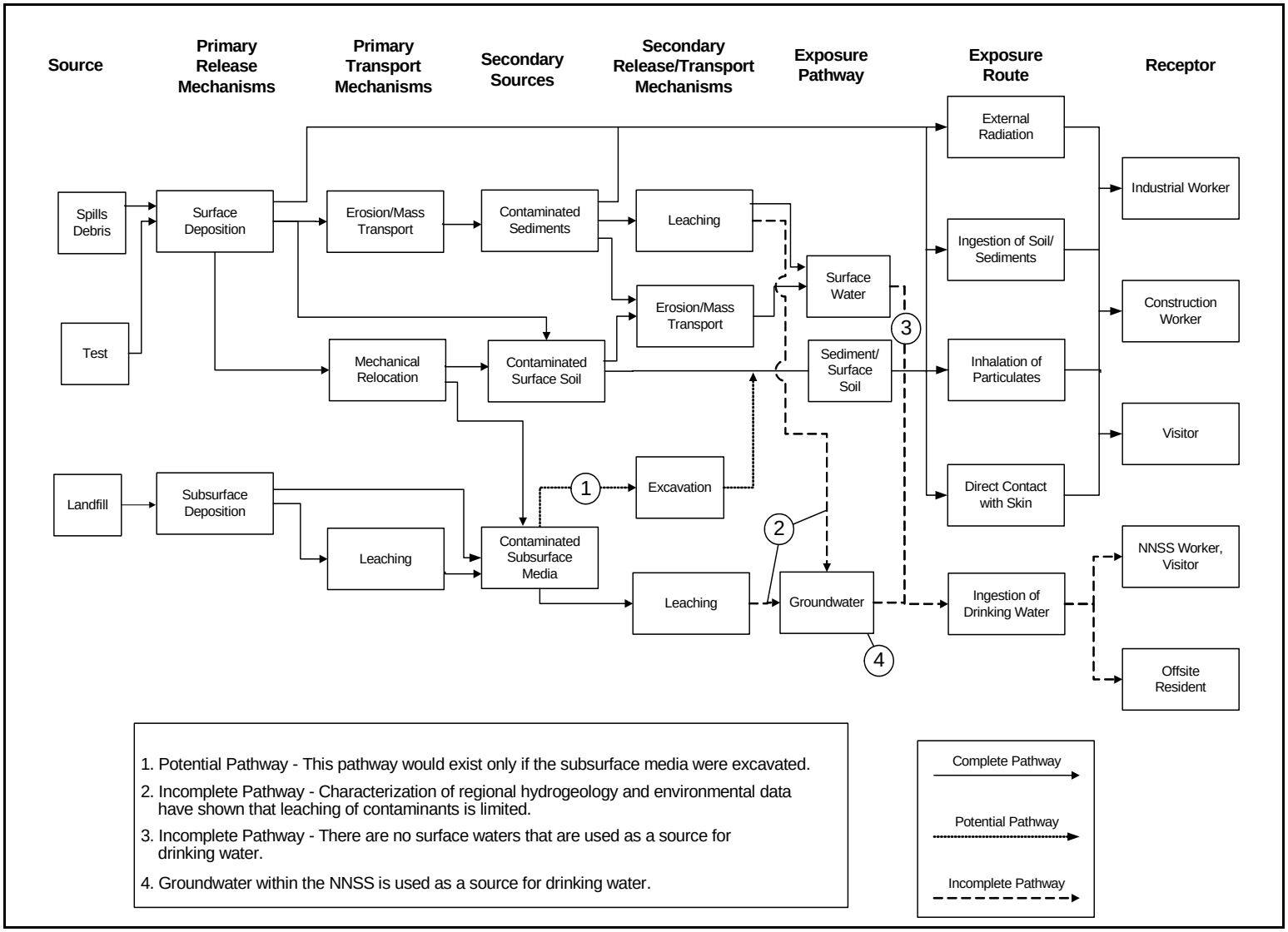

Figure A.2-1
Conceptual Site Model Diagram

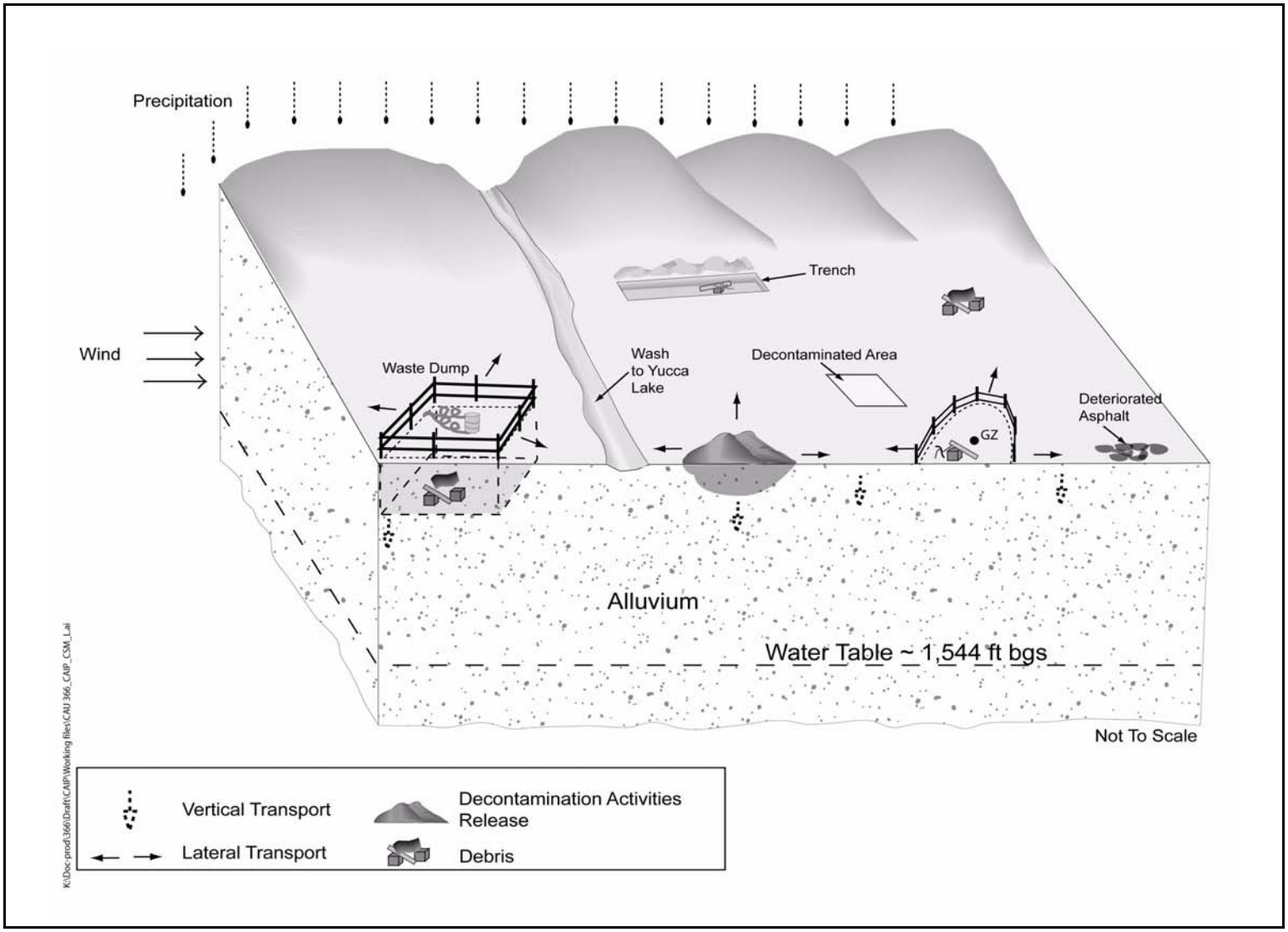

Figure A.2-2
CAU 366 Conceptual Site Model

A.2.2.1 Release Sources

The releases of contamination to CAU 366 are directly or indirectly associated with the four Project 56 safety experiments. The primary release scenario consists of the initial atmospheric deposition of radiological contamination to surface soil and debris present in the area at the time of the experiments. Contamination of the surface soil may be the source for future migration. The following identifies the primary release sources specific to four CASs in CAU 366 (DOE/NV, 2000):

- The Project 56 No. 1 (CAS 11-23-01) source was a surface safety experiment with zero yield that was detonated at location 11a on November 1, 1955. The experiment included the use of a device containing primarily enriched uranium.

- The Project 56 No. 2 (CAS 11-23-02) source was a surface safety experiment with zero yield that was detonated at location 11b on November 3, 1955. The experiment included the use of a device containing plutonium and enriched uranium.

- The Project 56 No. 3 (CAS 11-23-03) source was a surface safety experiment with no yield that was detonated at location 11c on November 5, 1955. The experiment included the use of a device containing plutonium and enriched uranium.

- The Project 56 No. 4 (CAS 11-23-04) source was a surface safety experiment with a very slight yield that was detonated at location 11d on January 18, 1956. The experiment included the use of a device containing plutonium and enriched uranium.

Other releases are defined as all other types of releases resulting in soil contamination from spills or wastes found at the site during the investigation, or contaminated materials that have migrated as a result of wind, water, excavation, or some other influence. Corrective Action Sites 11-08-01 and 11-08-02 are waste dumps containing various types of debris (e.g., cable, drums containing contaminated ashed wood and sand, metal scraps) present on the surface and buried in the subsurface. The items were contaminated as a result of the primary release (four safety experiments) but are now considered an other release due to the potential release of contamination to the soil within the boundaries of the waste dumps. A decontamination station and hot park were used to decontaminate personnel and drums or other materials and equipment by using water and soap. The water and any removed contamination was presumably discharged to the surrounding soil. The trench at 11a may contain wastes and debris that could be a source of an other release. Additionally, washes flowing through the CA, particularly the 11d test area, are potential other releases associated with Project 56.

The most likely locations of the contamination and releases to the environment are the soils directly below or adjacent to the CSM's surface and subsurface components (i.e., soils impacted by fallout and other releases).

A.2.2.2 Potential Contaminants

The CAS-specific COPCs are based on a conservative evaluation of possible site activities identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Additional COPCs for other releases 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). The list of COPCs is intended to encompass all of the significant contaminants that could potentially be present at each CAS. Significant contaminants are defined as contaminants that are present at concentrations exceeding the PAL. The COPCs applicable to Decision I environmental samples from each of the CASs of CAU 366 are listed in Table A.2-2. Table A.2-3 lists the analyses required for these COPCs while Table A.2-4 lists all the analytes that are reported for those analyses.

Table A.2-2
Contaminants of Potential Concern[a]
(Page 1 of 2)

COPCs	CASs 11-08-01 and 11-08-02	CAS 11-23-01	CASs 11-23-02, 11-23-03, 11-23-04
Organic COPCs			
PAHs	--	--	X[b]
Inorganic COPCs			
Lead	--	--	X
Radionuclide COPCs			
U-234	X	X	X
U-235/236	X	X	X
U-238	X	X	X
Pu-238	X	X	X
Pu-239/240	X	X	X

Table A.2-2
Contaminants of Potential Concern[a]
(Page 2 of 2)

COPCs	CASs 11-08-01 and 11-08-02	CAS 11-23-01	CASs 11-23-02, 11-23-03, 11-23-04
Cs-137	X	X	X
Am-241	X	X	X

[a]The COPCs are the constituents that, based on process knowledge and historical documentation, are likely to be present.
[b]Analyses for PAHs will only be run on the sample plot in the asphalt area.

PAH = Polyaromatic hydrocarbon
X = COPC associated with this CAS
-- = COPC not associated with this CAS

Table A.2-3
Analytical Method[a]

Analyses	CASs 11-08-01 and 11-08-02	CAS 11-23-01	CASs 11-23-02, 11-23-03, 11-23-04
Organic COPCs			
SVOCs	--	--	X[b]
VOCs	--	--	X[b]
Inorganic COPCs			
RCRA Metals	--	--	X
Radionuclide COPCs			
Gamma Spectroscopy[b]	X	X	X
Isotopic U	X	X	X
Isotopic Pu	X	X	X

[a]The analytical method has been determined based on the site specific COPCs.
[b]Analyses for SVOCs and VOCs will only be run on the sample plot in the asphalt area.

X = Analytical method required for this CAS
-- = Analytical method not required for this CAS

A.2.2.3 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.2-4
Analytes Reported for Required Analyses

VOCs		SVOCs		Metals	Radionuclides
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	2,3,4,6-Tetrachlorophenol	Di-n-octyl phthalate	Arsenic	**Gross Alpha/Beta**
1,1,1-Trichloroethane	Chlorobenzene	2,4,5-Trichlorophenol	Dibenzo(a,h)anthracene	Barium	Pu-238
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,6-Trichlorophenol	Dibenzofuran	Beryllium	Pu-239/240
1,1,2-Trichloroethane	Chloroform	2,4-Dimethylphenol	Diethyl phthalate	Cadmium	U-234
1,1-Dichloroethane	Chloromethane	2,4-Dinitrotoluene	Dimethyl phthalate	Chromium	U-235
1,1-Dichloroethene	Chloroprene	2-Chlorophenol	Fluoranthene	Lead	U-238
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Methylnaphthalene	Fluorene	Mercury	
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylphenol	Hexachlorobenzene	Selenium	**Gamma-Emitting**
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Nitrophenol	Hexachlorobutadiene	Silver	Ac-228
1,2-Dichlorobenzene	Ethyl methacrylate	3-Methylphenol[a] (m-cresol)	Hexachloroethane		Am-241
1,2-Dichloroethane	Ethylbenzene	4-Methylphenol[a] (p-cresol)	Indeno(1,2,3-cd)pyrene		Co-60
1,2-Dichloropropane	Isobutyl alcohol	4-Chloroaniline	n-Nitroso-di-n-propylamine		Cs-137
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Nitrophenol	Naphthalene		Eu-152
1,3-Dichlorobenzene	Methacrylonitrile	Acenaphthene	Nitrobenzene		Eu-154
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthylene	Pentachlorophenol		Eu-155
1,4-Dioxane	Methylene chloride	Aniline	Phenanthrene		Nb-94
2-Butanone	n-Butylbenzene	Anthracene	Phenol		Th-234
2-Chlorotoluene	n-Propylbenzene	Benzo(a)anthracene	Pyrene		U-235
2-Hexanone	sec-Butylbenzene	Benzo(a)pyrene	Pyridine		
4-Isopropyltoluene	Styrene	Benzo(b)fluoranthene			
4-Methyl-2-pentanone	tert-Butylbenzene	Benzo(g,h,i)perylene			
Acetone	Tetrachloroethene	Benzo(k)fluoranthene			
Acetonitrile	Toluene	Benzoic acid			
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

As stated in the document *Subsurface Nobel Gas Transport at the Nevada Test Site* (Thompson et al., 1997), the Cambric test at the NTS was used to study long-term radionuclide migration from the underground detonation of a nuclear device. The Cambric test (with a yield of 750 tons) was conducted below the water table in Frenchman Flat in 1965. A well installed into the groundwater 91 m away from GZ was continuously pumped from 1975 to 1991 in order to draw radionuclides from the detonation cavity. The extracted water was tested for radionuclides. None of the adsorbing radionuclides (Am-241, calcium [Ca]-41, Cs-137, Eu-154, Pu-241, samarium [Sm]-151, neptunium [Np]-237, and Sr-90) were detected in the pumped groundwater (attesting to their low solubility and affinity to adsorb to media). The radionuclides tritium and krypton detected in the pumped groundwater are considered to be conservative tracers in groundwater (i.e., they do not interact with the geologic media through which the water moves). This test demonstrated the relative immobility of the adsorbing radionuclides under saturated conditions. As the mass flow of water is the

predominant driver in contaminant migration, these adsorbing radionuclides can be expected to be even less mobile in the vadose zone as water movement through the vadose zone is much less than in the saturated conditions of the aquifer.

Based on this evidence, the target radionuclide elements (plutonium and uranium) are classified as adsorbing radionuclides with low solubilities that are located within unsaturated media. Therefore, these contaminants are expected to be found relatively close to release points.

A.2.2.4 Site Characteristics

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

All six CASs in CAU 366 are located in Area 11 of the NNSS in Yucca Flat. Erosion of the surrounding mountains has resulted in the accumulation of alluvial deposits. The soil in and around the CASs is made up of sandy silt to cobble-sized alluvium of various lithologies. The area is moderately vegetated with native plants. The area is generally flat, but slopes gently toward the west. Prominent washes flow through the test areas (especially 11d) and deposit into a detention basin that ultimately flows toward Yucca Lake. The nearest groundwater well to the CASs is ER-6-1-2 main located approximately 1.8 mi west of test area 11a and 2.3 mi northwest of test area 11d. The most recent recorded depth to the water table is approximately 1,544 ft bgs (USGS/DOE, 2011).

A.2.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils. Contaminants present in ephemeral washes are subject to much higher transport rates than contaminants present in other surface areas. These ephemeral washes 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 accumulation areas. Several washes flow through the area where these CASs are located. The washes flow to a detention basin and ultimately toward Yucca Lake. Contaminants from the sites may also migrate via windborne material, or move through mechanical disturbance due to the decontamination activities and movement of contaminated material to the hot park location and waste dumps.

Migration is influenced by the chemical characteristics of the contaminants (presented in Section A.2.2.3) and the physical characteristics of the vadose material (presented in Section A.2.2.4). In general, the contaminants that are reasonably expected to be present at CAU 366 (i.e., plutonium and uranium) have low solubilities and high affinity for media. The physical characteristics of the vadose material generally include medium and high adsorbive capacities, low moisture contents (i.e., available water-holding capacity), and relatively long distances to groundwater (e.g., 1,544 ft). Based on these physical and chemical factors, contamination is expected to be found relatively close to release points.

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 61.7 in.) and limited precipitation for this region (6.61 in. [ARL/SORD, 2011]), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at CAU 366 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.2.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or external irradiation by radioactive materials. The land-use for CAU 366 is "Nuclear Test Zone," which means the area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. This zone includes compatible defense and nondefense research, development, and testing activities. The exposure scenario for CAU 366 is "Occasional Use Area." These CASs are in a remote location 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 (up to 80 hours per year for five years) such as a military exercise. Therefore, these sites are classified as an Occasional Use Area.

A.3.0 Step 2 - Identify the Goal of the Study

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

A.3.1 Decision Statements

The Decision I statement is as follows: "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. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NSO, 2006). If a COC is detected, then Decision II must be resolved.

The Decision II statement is as follows: "If a COC is present, is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

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

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

For the primary release scenario, the DQO process resulted in an assumption that TED within the radiologically posted HCAs exceeds the FAL and requires corrective action. Therefore, a default contamination boundary will be established for each HCA (Section 3.4). Figure 3-4 shows the default contamination boundaries for CASs 11-23-02, 11-23-03, and 11-23-04.

For the other release scenario at CASs 11-08-01 and 11-08-02, the DQO process resulted in an assumption that TED within the radiologically posted fence lines of both CWDs exceeds the FAL and requires corrective action. Therefore, a default contamination boundary will be established for each

CWD (Section 3.4). Figure 3-4 shows the default contamination boundaries for CASs 11-08-01 and 11-08-02.

Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. Decision II samples for both primary and other 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.

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and the contaminants would be released to the surrounding media. The following will be used as the criteria for determining whether a waste is PSM:

- 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 (after 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. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (after 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). If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For liquid wastes, the resulting concentration of contaminants in the surrounding soil will be calculated based on the concentration of contaminants in the waste and the liquid holding capacity of the soil. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

The radiation surveys conducted at CAU 366 identified anomalous radiation values associated with discrete debris items. If these items provided a potential to cause a receptor to receive a dose exceeding the FAL, they would be considered to be PSM. To evaluate the TED associated with these items (and determine whether these items could be PSM), TED will be calculated for two locations of maximum radiation survey values. This will be accomplished at each location by measuring external dose using a TLD and internal dose using a portable low volume air sampler to collect airborne radioactive particles that could be inhaled or ingested. A net TED value will be calculated by subtracting background radiation and TED from soil in the surrounding area. The resulting TED values from these two locations should provide the maximum TED from any debris item at CAU 366. If the resulting TED values are less than the FAL, it will be determined that debris items do not require corrective action. If the resulting TED values exceed the FAL, it will be determined that debris items require corrective action, and an additional radiation survey will be conducted to identify additional debris items that meet this criterion of PSM.

A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk (NNSA/NSO, 2006).

If sufficient information is not available to evaluate potential CAAs, then site conditions will be reevaluated and additional samples will be collected (as long as the scope of the investigation is not exceeded and any CSM assumption has not been shown to be incorrect).

A.3.2 Alternative Actions to the Decisions

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

A.3.2.1 Alternative Actions to Decision I

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

A.3.2.2 Alternative Actions to Decision II

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

A.4.0 Step 3 - Identify Information Inputs

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

A.4.1 Information Needs

Decision I has been resolved for the areas inside the default contamination boundaries as these areas have already been identified as requiring corrective action. Therefore, Decision I sampling only applies to those areas outside the default contamination boundaries. To resolve Decision I (determine whether a COC is present at a CAS), samples will be collected and analyzed following these two criteria:

- Samples must 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.

Decision II for the primary release contamination within the HCAs has been established as the existing fence line which serves as the default contamination boundary. To resolve Decision II for primary release contamination outside the default contamination boundaries, TED rates need to be established at locations that bound the FAL dose rate and provide sufficient information to establish a high (greater than 0.8) correlation to radiation survey isopleths. A boundary will then be determined around the radiation survey isopleth that correlates to the 25-mrem/yr FAL.

Decision II for the two CWDs is a geophysical survey to determine whether all buried material is captured within the existing fence line that serves as the default contamination boundary. To resolve Decision II for other 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.4.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples. These samples will be submitted to analytical laboratories meeting the quality criteria stipulated in the Industrial Sites QAPP (NNSA/NV, 2002a). The TLDs will be submitted to the Environmental Technical Services group at the NNSS, 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.4.2.1 Sample Locations

Design of the sampling approaches for the CAU 366 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., debris or location of elevated radioactivity) or (b) randomly using a probabilistic sampling design. The implementation of a judgmental approach for sample location selection, and of a probabilistic sampling approach, for CAU 366 are discussed in Section A.8.0.

A.4.2.2 Analytical Methods

Analytical methods are available to provide the data needed to resolve the decision statements. The analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) for soil samples are provided in Tables 3-2 and 3-3.

A.5.0 Step 4 - Define the Boundaries of the Study

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

A.5.1 Target Populations of Interest

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

- For the primary releases - locations where TED varies from above the FAL to below the FAL
- For the other releases - each one of a set of locations bounding contamination in lateral and vertical directions
- Investigation waste and potential remediation waste

A.5.2 Spatial Boundaries

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

- Vertical: Primary release - 5 cm below original ground surface
- Vertical: Other release - 15 ft bgs
- Horizontal: Primary and other release - 4 mi from GZ

Contamination found beyond these boundaries may indicate a flaw in the CSM and may require reevaluation of the CSM before the investigation can continue. Each CAS is considered geographically independent, and intrusive activities are not intended to extend into the boundaries of neighboring CASs.

A.5.3 Practical Constraints

There are no practical constraints identified for this CAU.

A.5.4 Define the Sampling Units

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

A.6.0 Step 5 - Develop the Analytic Approach

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

A.6.1 Population Parameters

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

A.6.1.1 Judgmental Sampling Design

For judgmental sampling results, the population parameter is the observed concentration of each contaminant from each individual analytical sample. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II. A single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS (for Decision I), or that the COC is not bounded (for Decision II).

A.6.1.2 Probabilistic Sampling Design

For probabilistic sampling results, the population parameter is the true 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 TED at the site in question exceeds the FAL. Because a calculated TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the calculated TED were significantly different than the true TED, a decision based on the calculated TED could result in a decision error. To reduce the probability of making a false negative decision error, a conservative estimate of the true TED is used to compare to the FAL instead of the calculated TED. This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED values. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED.

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 each of the calculated TED averages requires the following:

- A minimum number of samples are collected.
- 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.6.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, 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 E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

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

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- Tier 2 evaluation – Conducted by calculating Tier 2 SSTLs using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total TPH concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

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

A.6.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants* in industrial soils (EPA, 2011). Background concentrations for RCRA metals will be used instead of screening levels when natural background concentrations exceed the screening level (e.g., arsenic on the NNSS). Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by the EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.6.2.2 Radionuclide PALs

The PAL for radioactive contaminants is 25-mrem/yr TED, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). For primary releases, the TED is calculated as the sum of external dose and internal dose. External dose is determined directly from TLD measurements. Internal dose is determined by comparing analytical results from soil samples to RRMGs that were established using the RESRAD computer code (Yu et al., 2001). The RRMGs presented in Table A.6-1 are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram for surface soil, for a particular radionuclide, that would result in an internal dose of 25 mrem/yr to a receptor (under the appropriate exposure scenario) independent of any other radionuclide (assumes that no other radionuclides contribute dose). The internal dose associated with any specific radionuclide would be established using the following equation:

Internal dose (mrem/yr) = [Analytical result (pCi/g) / RRMG] x 25 mrem/yr

When more than one radionuclide is present, the internal dose will be calculated as the sum of the internal doses for each radionuclide. In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used. The default and site-specific input parameters used in the RESRAD calculation of RRMGs for each exposure scenario are listed in Attachment A-1.

Table A.6-1
Residual Radioactive Material Guideline Values
(Page 1 of 2)

Radionuclide	Exposure Scenario (pCi/g)		
	Industrial Area	Remote Work Area	Occasional Use Area
Am-241	2,816	16,120	45,550
Co-60	551,300	7,229,000	74,210,000
Cs-137	140,900	1,955,000	27,560,000
Eu-152	1,177,000	13,240,000	81,740,000
Eu-154	846,900	9,741,000	63,530,000
Eu-155	5,588,000	66,450,000	475,100,000
Nb-94	3,499,000	39,660,000	249,200,000

Table A.6-1
Residual Radioactive Material Guideline Values
(Page 2 of 2)

Radionuclide	Exposure Scenario (pCi/g)		
	Industrial Area	Remote Work Area	Occasional Use Area
Pu-238	2,423	13,880	39,220
Pu-239/240	2,215	12,680	35,820
Sr-90	59,470	807,500	9,949,000
Th-232	2,274	13,410	38,520
U-234	19,600	137,900	447,000
U-235	20,890	149,600	492,200
U-238	21,200	155,400	336,100

A.6.3 Decision Rules

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

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

The decision rules for Decision I are as follows:

- 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 as follows:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL or potential remediation wastes have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

- If valid analytical results are available for the waste characterization samples defined in Section A.8.0, then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

A.7.0 Step 6 - Specify Performance or Acceptance Criteria

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

A.7.1 Decision Hypotheses

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

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

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

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

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

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

A.7.2 False Negative Decision Error

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

A.7.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 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 unbiased samples where appropriate). Decision II samples must be collected in areas that represent the lateral and vertical extent of contamination (above FALs). The following characteristics must be considered to control decision errors for the first criterion:

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

These characteristics were considered during the development of the CSM and selection of sampling locations. The field-screening methods and biasing factors listed in Section A.4.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section A.5.1.

To satisfy the second criterion, Decision I soil samples will be analyzed for the chemical and radiological parameters listed in Section 3.2. Decision II soil 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.7.2.2 False Negative Decision Error for Probabilistic Sampling

The false negative decision error rate goal was established by the DQO meeting participants at 5 percent. Upon validation of the analytical results, statistical parameters will be calculated for each

significant COPC identified at each site. Protection against a false negative decision error is contingent upon the following:

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

Control of the false negative decision error for probabilistic sampling designs is accomplished by ensuring that the following requirements 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.7.3 False Positive Decision Error

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

False positive results are typically attributed to laboratory and/or sampling/handling errors that could cause cross contamination. To control against cross contamination, decontamination of sampling equipment will be conducted 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 for the sampling effort, additional if field conditions change)

For probabilistic sampling, false positive decision error rate goal was established by the DQO meeting participants at 0.20 (or 20 percent probability). Protection against this decision error is also afforded by the controls listed in Section A.7.2 for probabilistic sampling designs.

A.8.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. Judgmental sampling schemes will be implemented to select sample plot locations for the primary 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 other releases as described in Section A.2.2.1. Investigation results will be compared to FALs to determine the need for corrective action. Potential source material sample results will be evaluated against the PSM criteria listed in Section A.3.1 to determine the need for corrective action.

A.8.1 Internal Dose Sampling for Primary Releases

A.8.1.1 Judgmental Sample Plot Locations

A judgmental sampling design will be implemented for locating Decision I sample plots for the primary release scenario outside the default contamination boundaries. These sample locations have been determined judgmentally based on the highest results of the radiological walkover surveys and the presence of asphalt-covered soil at one location. This will be done in an effort to find the location where the internal dose contributes the greatest amount to TED.

Because the device tested at 11a was composed of primarily enriched uranium compared to plutonium and uranium devices tested at 11b, 11c, and 11d, two sets of Decision I sample plots will be selected. Therefore, CAS 11-23-01 (11a) will be investigated individually, while CASs 11-23-02 (11b), 11-23-03 (11c), and 11-23-04 (11d) will be investigated as a group.

For the primary release at 11a, one Decision I sample plot will be located south of and partially within the 11a trench. This location was selected based on the highest results of the radiological survey conducted during the preliminary investigation. The proposed Decision I sampling plot location is depicted on Figure A.8-1.

Three Decision I sample plots have been selected (outside the default contamination boundaries) for the primary release associated with the tests conducted at 11b, 11c, and 11d. Two of the sample plots

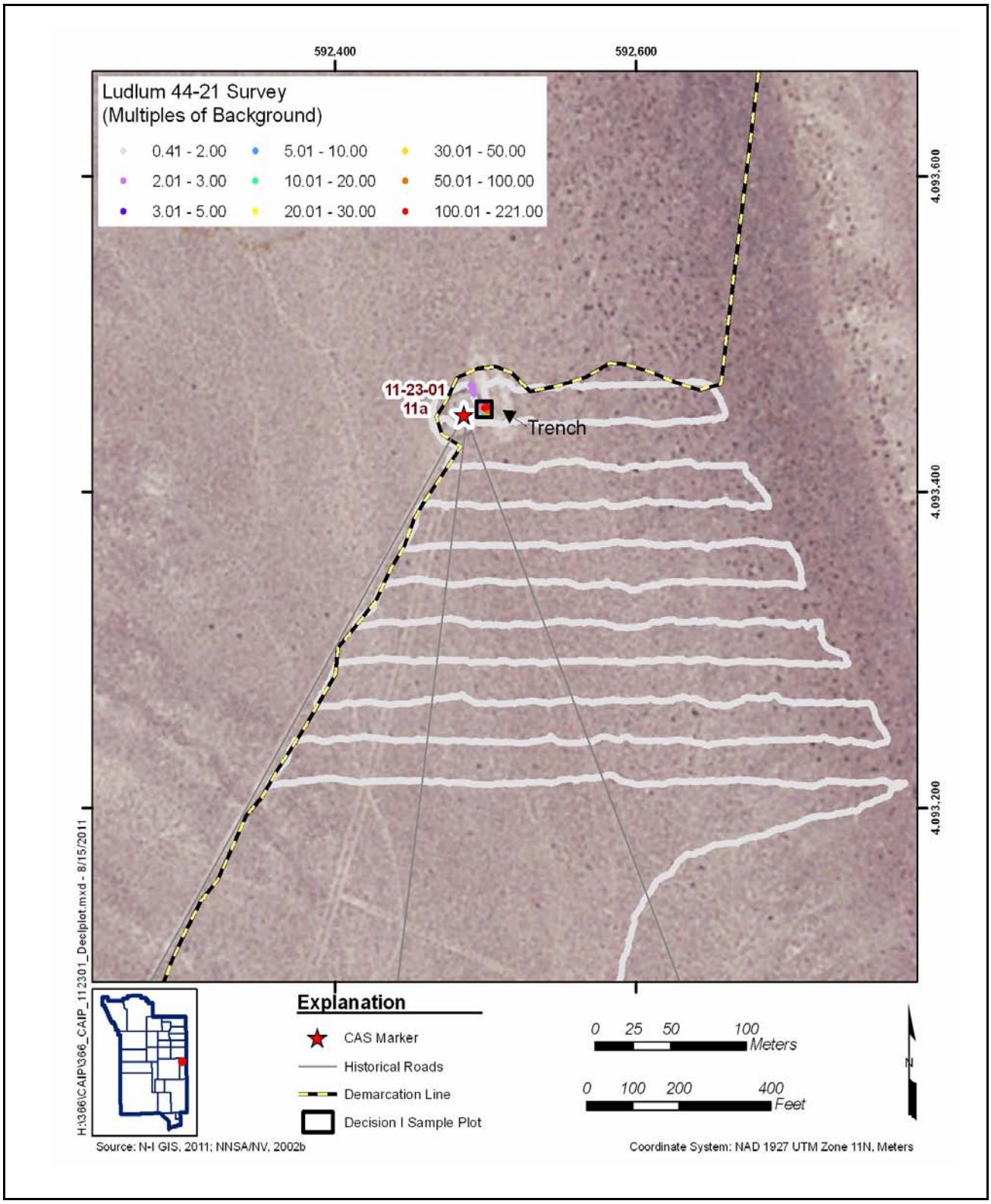

Figure A.8-1
Decision I Sample Plot - Test Area 11a

have been selected at locations with the most elevated radiological readings resulting from the walkover survey. There will be one sample plot north of the 11c HCA and one sample plot south of the 11d HCA. Because the radiological readings are not as elevated near 11b, there will not be any Decision I sample plots near the 11b HCA. The third sample plot selected for the primary release associated with 11b, 11c, and 11d was selected in the asphalt-covered soil area near the 11c HCA. This area was selected because it is unknown what the true radiological conditions are at this location. The proposed Decision I sampling plot locations are depicted on Figures A.8-2 and A.8-3.

A judgmental sampling design will also be implemented for locating Decision II sample plots. Sample plot locations have been selected judgmentally based on radiological surveys and aerial radiological surveys. These data will be used to establish patterns of contaminant distribution. Six initial Decision II sample plots will be established for the 11b, 11c, and 11d primary release. Three sample plots will be judgmentally established along each of two vectors that are approximately normal to the radiation survey isopleths with the constraint that, on each vector, at least one sample plot will present a TED less than the FAL. The approximate proposed sampling vectors and sample plots are shown on Figures A.8-4 and A.8-5.

A.8.1.2 Sampling of Sample Plots

The probabilistic sampling scheme will be implemented to select sample locations within the sample plots and evaluate the analytical results. For each sample collected within the sample plot, randomly selected subsample locations will be chosen using a random start, triangular pattern (see Figure A.8-6). 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.

Statistical methods that generate site characteristics will be used to establish internal dose estimates that represent the sample plot as a whole. Composite samples will be collected at each sample plot in the following manner:

- At least four composite samples will be collected from each established sample plot.

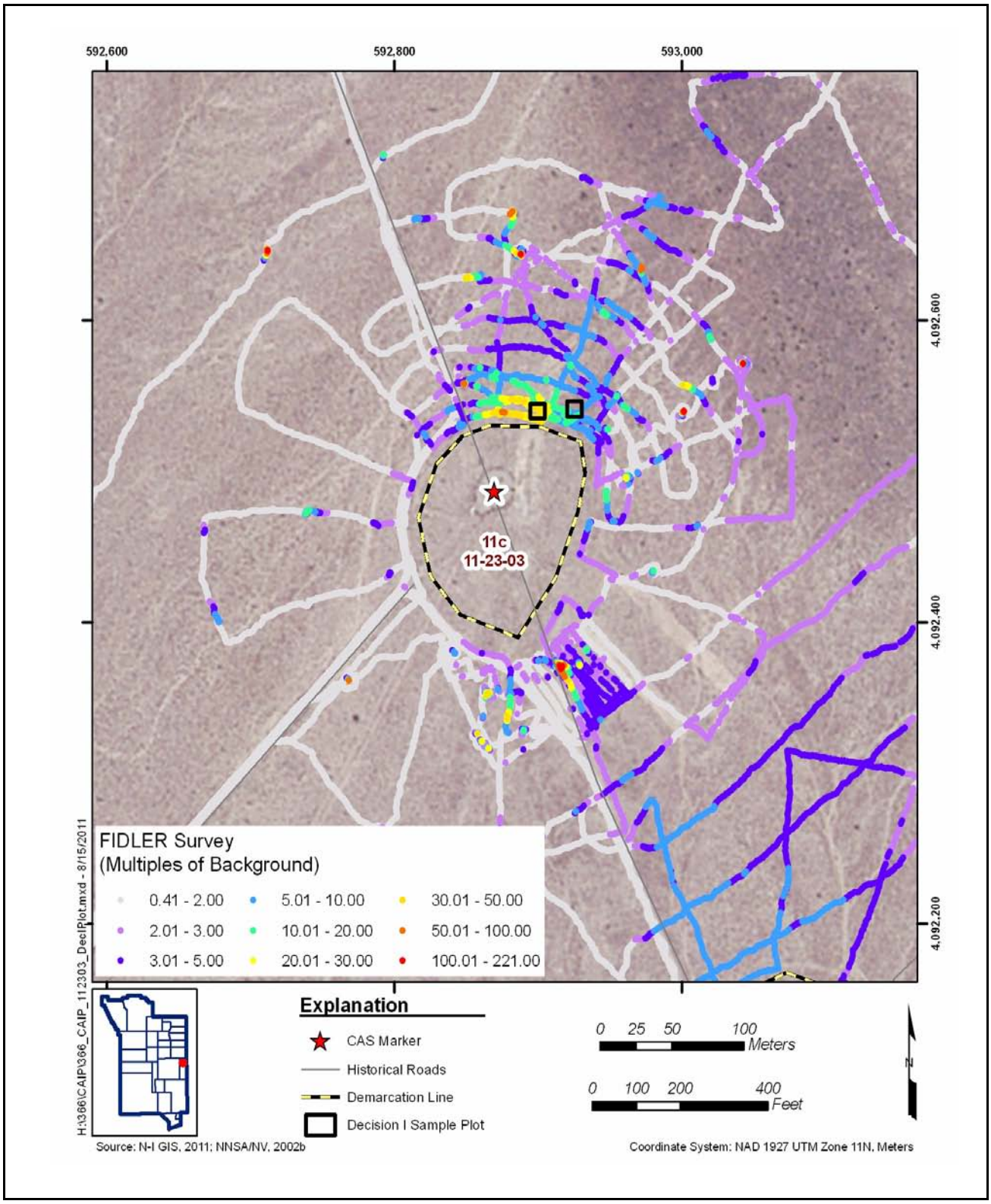

Figure A.8-2
Decision I Sample Plots for Test Areas 11b, 11c, and 11d - View 1

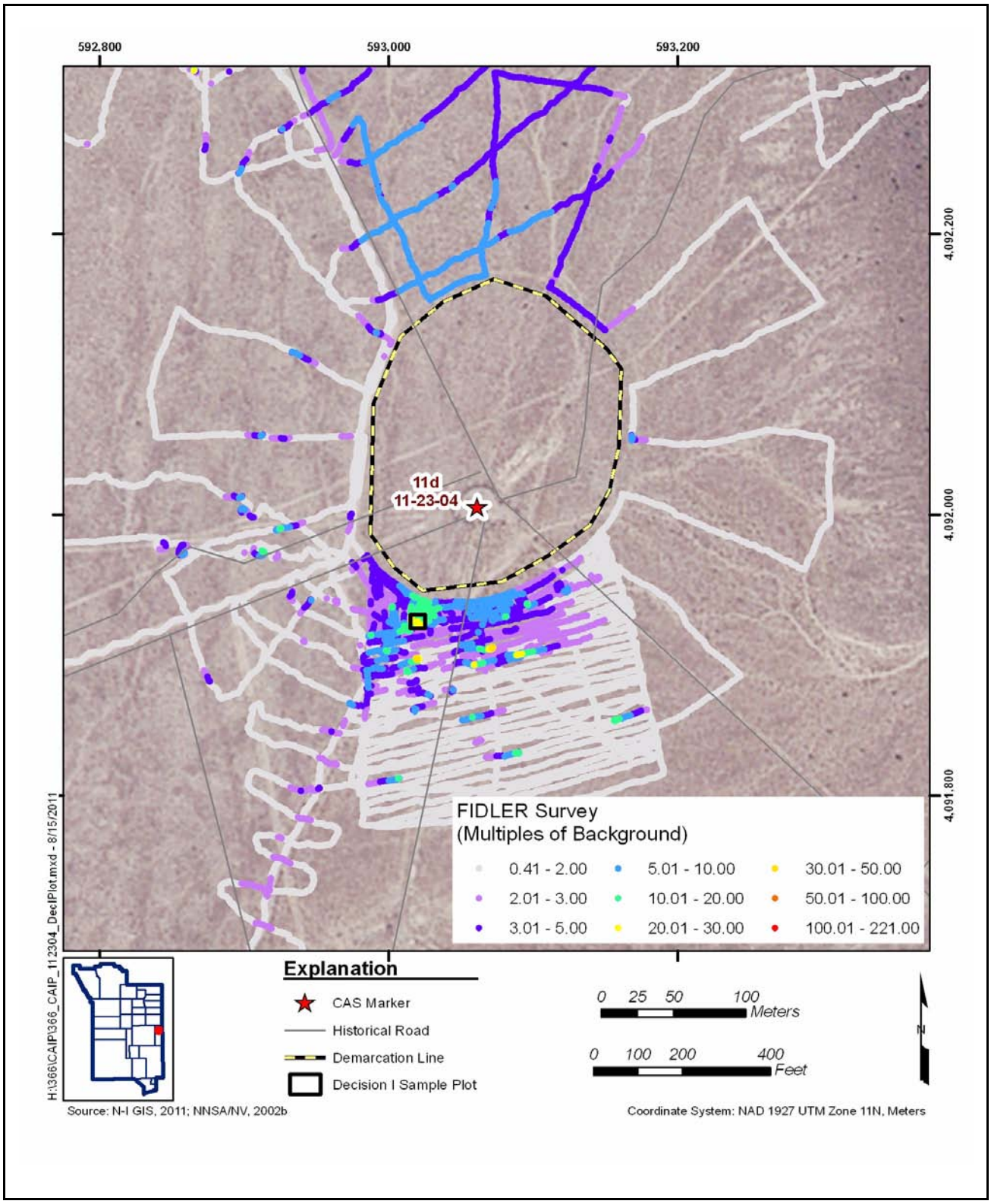

Figure A.8-3
Decision I Sample Plots for Test Areas 11b, 11c, and 11d - View 2

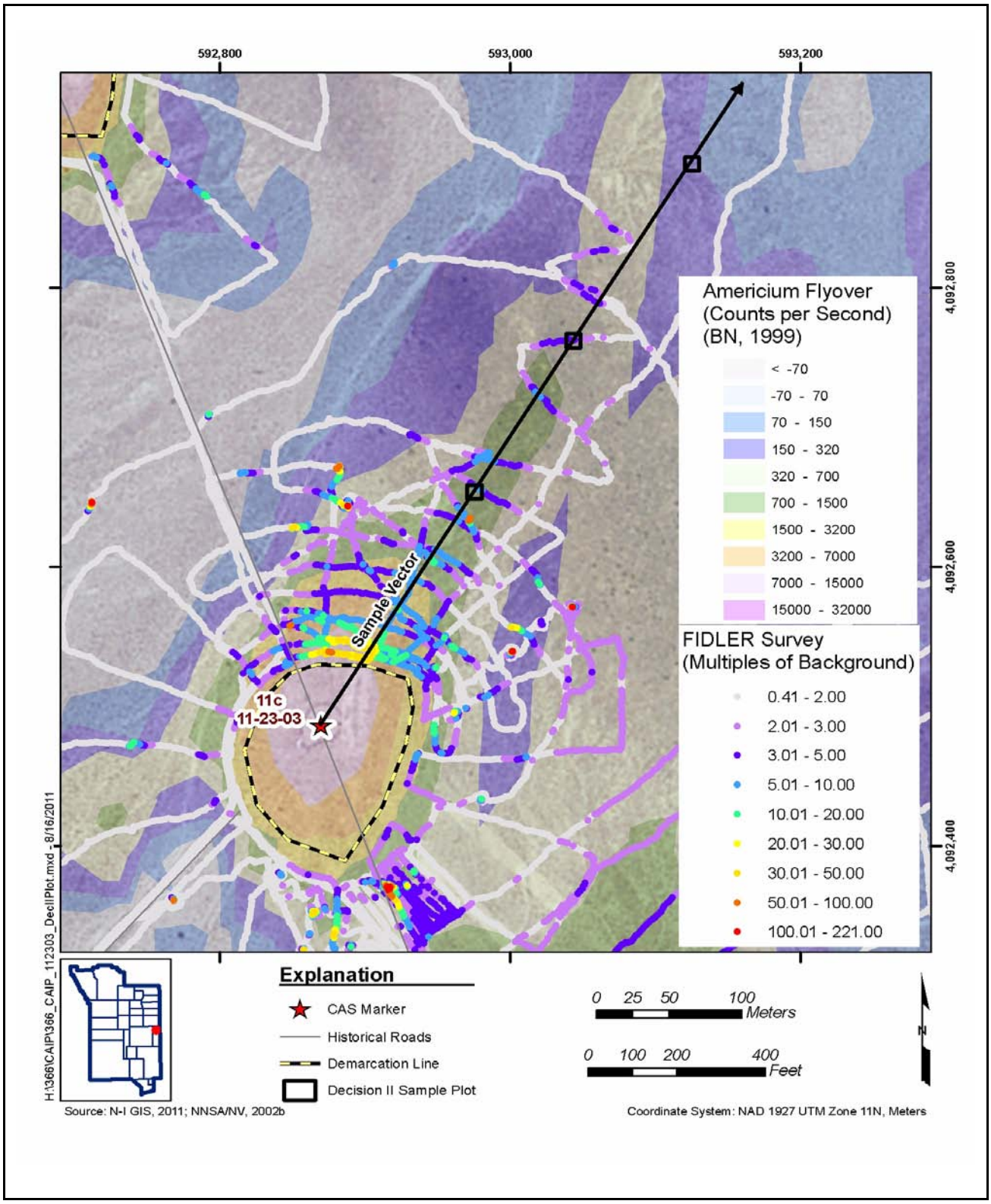

Figure A.8-4
Decision II Sample Plots and TLD Locations for Test Areas 11b, 11c, and 11d - View 1

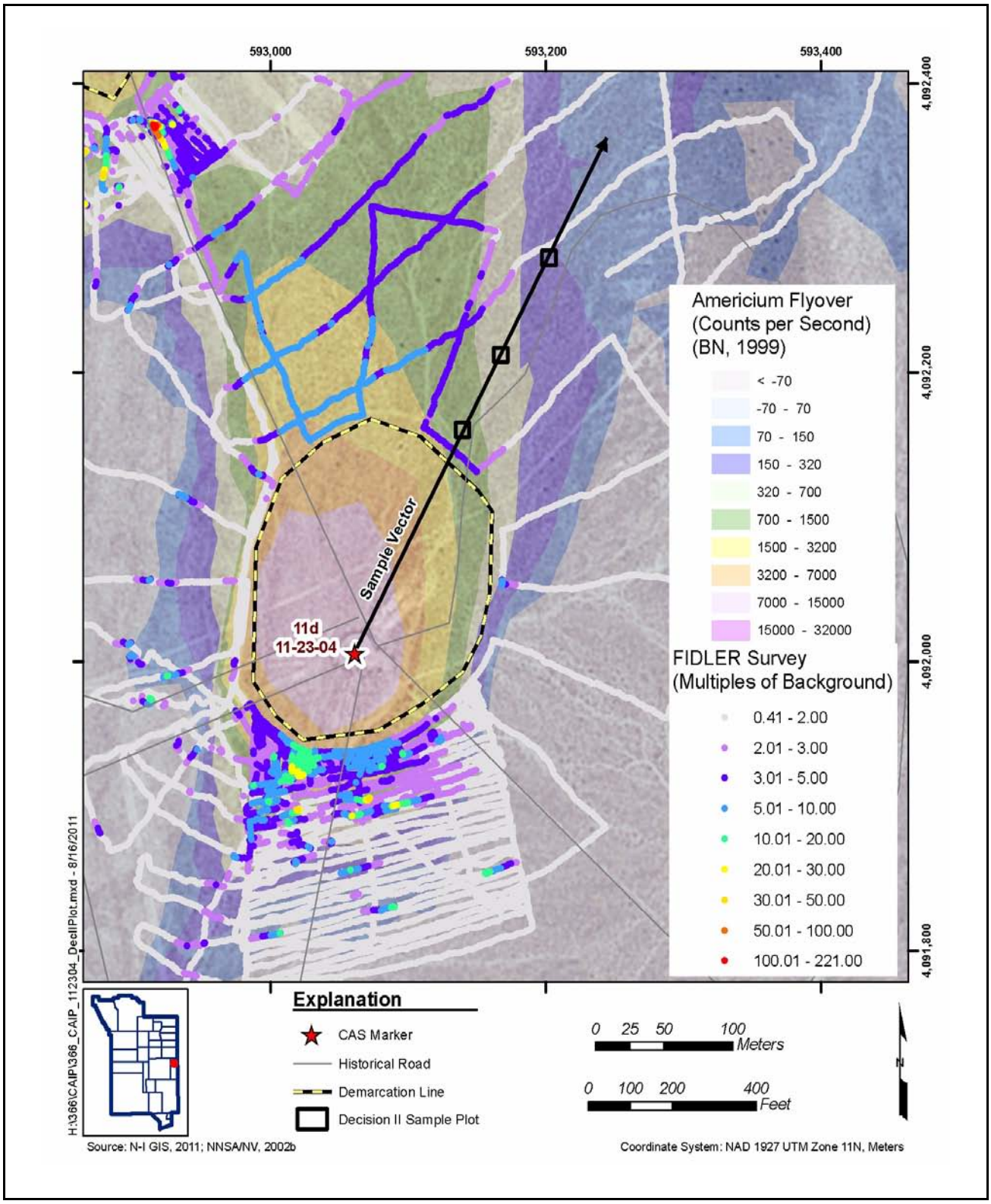

Figure A.8-5
Decision II Sample Plots and TLD Locations for Test Areas 11b, 11c, and 11d - View 2

- Each composite sample will comprise nine aliquots taken from randomly selected locations within each plot. These locations will be predetermined using a random start with a triangular grid pattern.

- Samples will be sieved to eliminate material 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.

An example of the predetermined sample locations at one plot is shown on Figure A.8-6.

As determination of the minimum sample size cannot be accomplished until after the data have been generated, the sufficiency of the number of samples collected will be evaluated. This will be evaluated based on TED results (composed of individual internal dose rates associated with each of the four composite samples added to the external dose rates from the TLD elements). The minimum number of samples required for each sample plot was calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum sample size was calculated using the following EPA sample size formula (EPA, 2006):

$$n \geq \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z_{.95}^2}{2}$$

where:

s = standard deviation
$z_{.95}$ = z score associated with the false negative rate of 5 percent
$z_{.80}$ = z score associated with the false positive rate of 20 percent
μ = dose level where false positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples is required to calculate these statistical values and as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required.

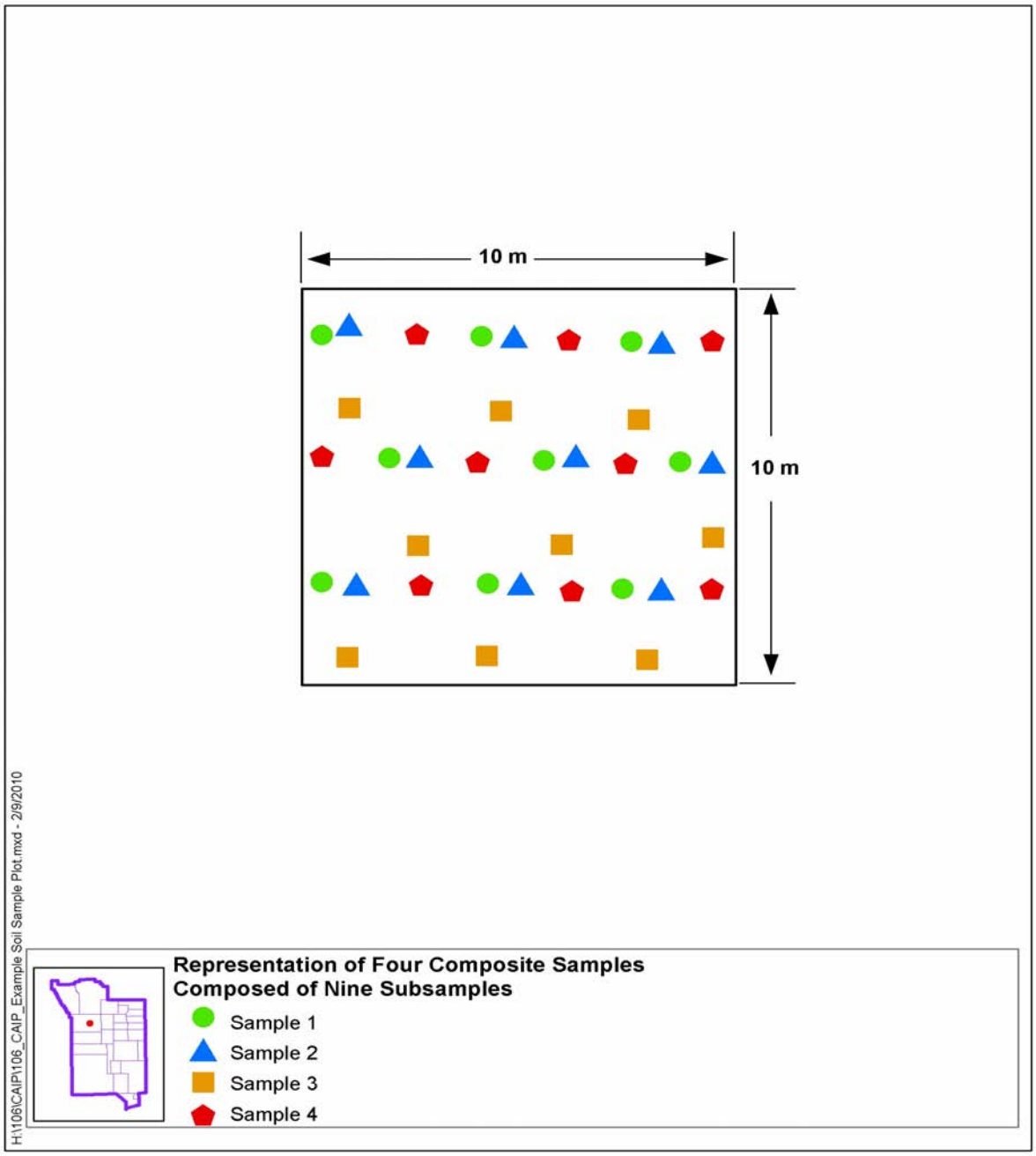

Figure A.8-6
Example Probabilistic Sampling Scheme at a Sample Plot

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

- 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.

All calculations for the determination of sample size sufficiency will be provided in the investigation report. If the criteria established in this section result 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 these criteria cannot be met, justifications for use of the resulting TED without meeting the criteria will be made in the investigation report.

A.8.2 External Dose Sampling for Primary 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 a single sample location or 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* (BN, 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 mrem/IA-yr, will be presented as net values (e.g., a background has been subtracted from the raw result). Naturally occurring terrestrial and cosmic radiation (i.e., background) will be registered on a TLD. These background radiation values can be comparable to the value of the FAL. Therefore, the FAL is only applicable to radiation dose from man-made sources at the NNSS 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 dose to be subtracted from the TLD results will be obtained from an area determined to be unaffected by man-made activities at the NNSS. Ten such areas are identified in Section 5.0 of the *Nevada Test Site Environmental Report 2006* (Wills, 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 NNSS environmental monitoring TLDs, as described in Section 6.0. The Panasonic UD-814 TLD used in the NNSS 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.8.3 Evaluation of TED for Primary Releases

As discussed in Section A.6.1.2, the 95 percent UCL of the TED from each sample location will be used to establish the corrective action boundary. The 95 percent UCL of the TED for each sample location 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 external dose measurements from the TLD and the 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 sample location and a corresponding measurement from an appropriate radiation survey. These paired values will be used to establish a correlation for each radiation survey and identify the radiation survey that has the best correlation to TED. This correlation will be used to establish a radiation survey value corresponding to the 25-mrem/yr FAL (using the appropriate exposure scenario). An isopleth of this value from the radiological survey will be used as the initial corrective action boundary.

A.8.4 Sampling for Other Releases

Sample locations for other 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 the decontamination station and hot park, a sample plot will be selected based on the highest radiological readings identified from a radiological walkover survey. The survey will be conducted in the areas most likely for a release associated with these two facilities to have occurred. For the investigation of drainages, sample locations will be selected from the center of the sediment collection areas or at locations of elevated radiological readings.

The following factors will also be considered in selecting locations for analytical samples at CAU 366:

- Drums, containers, equipment, or debris: Materials that contain or may have contained hazardous or radioactive substances.
- Lithology: Locations where variations in lithology (soil or rock) indicate that different conditions or materials exist.
- Preselected areas based on process knowledge of the site: Locations for which evidence such as historical photographs or maps, experience from previous investigations, or interviewee's input exists that a release of hazardous or radioactive substances may have occurred.
- Preselected areas based on process knowledge of the contaminant(s): Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.
- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.
- Other biasing factors: Factors not previously defined for the CAI that become evident once the investigation of the site is under way.

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. As biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents. A TLD will be placed at all sample locations.

A.8.4.1 Decision I

A judgmental sampling design will be implemented for the other releases for establishing sample locations and evaluating sample results. For radiological other releases (i.e., decontamination

station), the primary release sampling scheme will be implemented (Sections A.8.1.1 and A.8.1.2). For chemical other 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).

A biased sampling strategy will be used to target areas with the highest potential to contain a COC, if it is present anywhere in the CAS. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in Section A.8.4. 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 DQOs.

Previously identified other releases associated with CAU 366 are the two CWDs, 11a trench, 11d drainage, and former decontamination station and hot park (Figure A.8-7). The following sections describe the sampling plan developed for these other releases.

A.8.4.1.1 Contaminated Waste Dumps #1 and #2

It has been determined that the area within the radiological posted fence line encompassing CASs 11-08-01 and 11-08-02 will require corrective action (Section 4.1). However, to ensure that the waste dumps are contained within this boundary, a geophysical survey will be conducted inside and outside the fence at CAS 11-08-01 (posted URMA) and outside the fence at CAS 11-08-02 (posted HCA and URMA). No soil samples will be collected at either CAS.

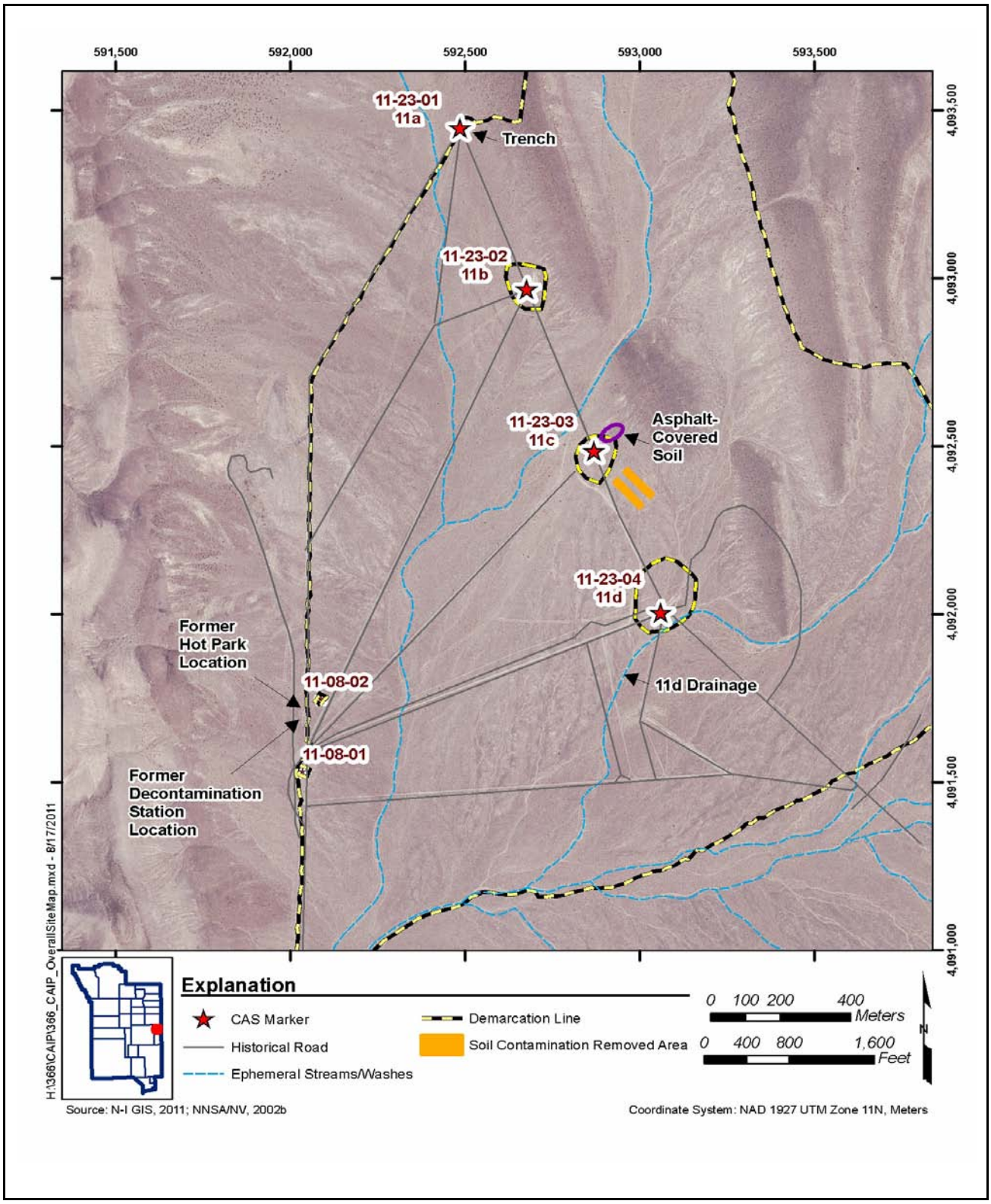

Figure A.8-7
CAU 366, Site Map

A.8.4.1.2 11a Trench

A geophysical survey will be conducted over the accessible portions of the trench, to include the excavated area as well as the spoils pile. If buried debris is detected, that area will require corrective action, and a default contamination boundary will be established to encompass all of the buried material. If other biasing factors are identified during the investigation of the trench (i.e., stains, waste), judgmental soil samples will be collected and analyzed for the appropriate constituents. A TLD will be placed at all sample locations.

A.8.4.1.3 11d Drainage

This drainage will be visually surveyed from outside the 11d HCA to the detention basin for the presence of sediment accumulation areas within the wash. A sampling location will be established at the center of the nearest two sediment accumulation areas (which may include the detention basin) outside the default corrective action boundary of 11d. Judgmental samples will be collected as follows:

- At each sample location within the sediment accumulation area, a sample will be collected from each 5-cm depth interval until native material is encountered.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent difference) than the FSR of the surface sample, then only the surface sample will be submitted for analysis. If the FSR is greater than 20 percent higher than the surface sample, then both the surface sample and the depth sample with the elevated FSR will be submitted for analysis.
- If the FSL is not exceeded in any depth sample, then only the surface sample will be submitted for analysis.

Figure A.8-8 shows an example of this sampling scheme.

It will be conservatively assumed that the highest TED from either surface or subsurface samples will be used to resolve DQO decisions. If a subsurface sample results in a higher internal dose than a surface sample, a TLD-equivalent external dose will be calculated for the subsurface sample. This will be accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the RESRAD-calculated external dose from the subsurface samples. This

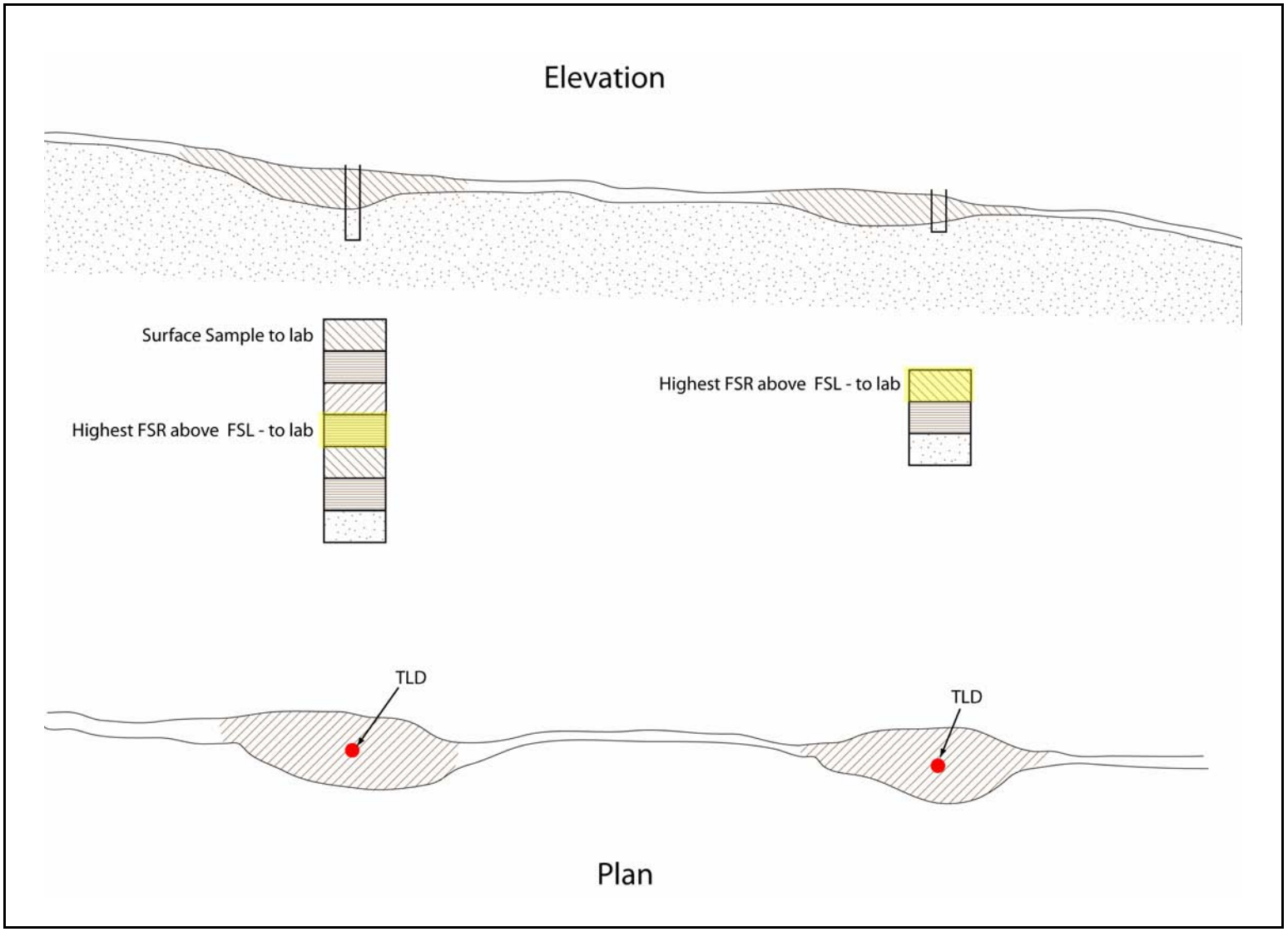

Figure A.8-8
Judgmental Sampling at Drainages

surface TLD reading will be increased by this proportion to estimate a TLD-equivalent external dose for the subsurface soil.

A radiological survey was completed in the upper portion of the wash that included the active channel, overbank deposits, and the younger and older terraces. There were no elevated readings identified that would require a sample to be collected. A radiological survey will be completed on the remainder of the wash. If elevated readings are identified in the active channel, additional samples may be collected using the previously discussed drainage sample scheme. If there are elevated readings in the overbank or terraces, judgmental surface samples may be collected at the location of the most elevated radiological reading. A TLD will be placed at each sample location.

All drainage samples will be submitted for the analyses listed under CAS 11-23-04 in Table A.2-3 because the wash being sampled flows through the 11d test area.

Information (such as sample results and the results of the radiological survey) needed to assess the potential for future migration of the 25-mrem/yr boundary will be obtained during the field investigation and addressed in the closure report.

A.8.4.1.4 Decontamination Station and Hot Park

The former locations of the decontamination station and hot park will be investigated for potential releases that may have occurred as a result of the activities that took place there. The area encompassing the station and park will be visually and radiologically surveyed. A sample plot will be placed in the area with the most widespread elevated radiological readings. A probabilistic sampling approach (such as for a primary release) will be used to collect the samples within the plot. Because there is no evidence that additional COPCs have been introduced, the samples will be analyzed for the same contaminants associated with the primary release. If biasing factors (i.e., stains, a discharge area) are identified during the visual survey, additional judgmental soil samples will be collected. A TLD will be placed in the center of the sample and at all additional sample locations (if selected).

A.8.4.1.5 Other Potential Releases

During the course of the CAU 366 investigation, the identification of any biasing factors (e.g., stains, spills, debris) will be used to determine whether a potential release is present. Samples will be collected from the material that presents the greatest degree of the biasing factor (surface or subsurface as discussed in Section A.8.4). Specific analyses requested for these samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

A.8.4.2 Decision II

Decision II samples for other releases identified during the investigation will be collected from judgmental sampling locations selected based on locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in Section A.8.4. 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 include samples from 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.

If a COC is found in the 11d drainage at a sediment accumulation 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 accumulation area where a COC was identified contains the COC. If a COC is identified as being associated with the drainage but is located outside a sediment accumulation area, Decision II step-out samples will be collected as discussed previously.

A.8.5 Establishment of Final Corrective Action Boundary

The final corrective action boundary will be established to include the default contamination boundaries, the initial corrective action boundary, and any additional areas that exceed the FAL.

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Attachment A-1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil

(10 Pages)

Introduction

This appendix promulgates tables of Residual Radioactive Material Guidelines (RRMGs) for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios, for use in the evaluation of Soils Project sites. These exposure scenarios are described in the document *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). Two sets of RRMGs were calculated for each of the three exposure scenarios: one set using only the inhalation and ingestion pathways (e.g., internal dose), and one set that added the external gamma pathway (e.g., internal and external dose). The second set is needed to evaluate "other release" soil samples where thermoluminescent dosimeters (TLDs) were not emplaced to measure the external dose.

Background

The *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006), provides a Nevada Division of Environmental Protection (NDEP)-approved process for the derivation of soil sampling final action levels that are congruent with the risk-based corrective action process. This document is used by the Navarro-Intera, LLC, Soils Project as well.

The Residual Radioactive (RESRAD) computer code, version 6.5 (Yu et al., 2001), and the guidance provided in NNSA/NSO (2006) were used to derive RRMGs for use in the Soils Project. The RRMGs are radionuclide-specific values for radioactivity in surface soils, expressed in units of picocuries per gram (pCi/g). A soil sample with a radionuclide concentration that is equal to the RRMG value for that radionuclide would present a potential dose of 25 millirem per year (mrem/yr) to a receptor under the conditions described in the exposure scenario. When more than one radionuclide is present, the potential dose must be evaluated by summing the fractions for each radionuclide (i.e., the measured concentration divided by the RRMG for the radionuclide). The resultant sum of the fractions value is then multiplied by 25.0 to obtain an estimate of the dose.

The RRMGs are specific to a particular exposure scenario. The dose estimates obtained from the use of RRMGs are valid only when the assumptions provided in the exposure scenario for the intended land-use hold true. In most cases at the Nevada National Security Site (NNSS), the Industrial Area exposure scenario is quite conservative and is bounding for most anticipated future land uses.

A recent revision to 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2011) had adopted new, more sophisticated, dosimetric models and new dosimetric terms. Internal dose is now to be expressed in terms of the Committed Effective Dose (CED), and International Commission on Radiological Protection (ICRP) 72 dose conversion factors are to be used.

Methods

Calculations were performed using the RESRAD code, version 6.5 (Yu et al., 2001). The ICRP 72 dose conversion factors were used. The RESRAD input parameters were verified and checkprinted.

The radionuclide niobium (Nb)-94 was previously added to the RRMGs to accommodate work in Area 25 that is related to the Nuclear Rocket Development Station (NRDS). The radionuclides silver (Ag)-108m, curium (Cm)-243, and Cm-244 were recently detected on one or more Soils Project sites, and RRMGs were calculated to demonstrate that their contribution to the total effective dose (TED) is negligible.

The RESRAD calculations have identified that for all radionuclides evaluated, with one exception: The maximum potential dose occurs at time-zero. The RRMGs provided in this memorandum do reflect those for time-zero. The exception previously mentioned is the radionuclide thorium (Th)-232, which has several daughters with short half-lives. Because the daughter activity "grows in," and because RRMGs include the contributions from daughters, the maximum potential dose for Th-232 actually occurs at 10.21 years. A RRMG for Th-232 at 10.21 years was not selected, and the RRMG for time-zero was used, for the following reasons:

- RESRAD suggests a set of RRMGs for use when the overall total dose is at its maximum. Considering the contributions from all radionuclide contaminants of potential concern (COPCs), this would be at time-zero.
- The additional dose from the in-growth of Th-232 daughters is offset by the radioactive decay of other radionuclides that would be present (e.g., cesium [Cs]-137).
- The additional dose from the in-growth of Th-232 daughters is very small when compared to the basic dose limit of 25 mrem/yr. For example, if Th-232 were found at a concentration of 100 pCi/g, the increase in potential dose from time-zero to 10.21 years would only be 0.52 millirem (mrem). To date, Th-232 has only been seen on Soils Project sites at environmental levels of about 1.5 to 3 pCi/g.

Assumptions and Default Parameters

Appendix B to DOE/NV--1107 (NNSA/NSO, 2006) lists the RESRAD code variables (i.e., input parameters) for the three exposure scenarios. These pre-determined values were used to calculate the RRMGs, with a few exceptions as described in Table 1.

Results

The RRMGs are presented in Tables 2 to 7. The abbreviation "RRMG" in each of the six tables includes a subscript to indicate the scenario and the exposure pathways that are activated. When referencing a set of RRMGs, the subscripts should be included to avoid confusion and a potential misapplication of the RRMGs.

Table 1: RESRAD Input Parameters

Item #	RESRAD Parameter	Industrial Area	Remote Work Area	Occasional Use Area	Explanation
1	Area of CZ (m^2)	1,000			Appendix B states "Site Specific." Previously, 100 m^2 was selected to conform to the maximum area of contamination limitation in DOE Order 458.1 (DOE, 2011). Going forward, 1,000 m^2 has been selected to add conservatism and realism to the RRMGs. The 1,000 m^2 RRMGs will be applied to 100-m^2 evaluation areas.
2	Thickness of CZ (m)	0.05			Appendix B states "Site Specific." This depth encompasses the bulk of the potential contamination and includes the maximum concentration.
3	Cover Depth	0.00			Appendix B states "Site Specific." Cover depth only affects the time delay before contamination becomes available for erosion and airborne suspension. Increasing the cover depth, in some cases, may lead to lower dose estimates.
4	Precipitation (m/yr)	0.144			Appendix B states "Site Specific." The selected value is the average annual rainfall as recorded at Camp Desert Rock.
5	Indoor Time Fraction	**[0.1712]**	**[0.0256]**	0	The stated value was 0, conservatively assuming no time is spent indoors. The new value more accurately reflects the Industrial Area scenario in which 66% of the time is spent indoors. $\left(\frac{2250\ hrs\ on-site}{8760\ hrs\ in\ a\ year}\right) 0.6666\ indoors = 0.1712$ The same correction was made for the Remote Work Area scenario.
6	Soil Ingestion Rate (g/yr)	**[43.43]**	20.2	4.8	The stated value was 108, assuming that all time is spent outdoors under a 480-mg/day soil ingestion rate. The new value more accurately reflects the soil ingestion rate of 193 mg/day when both indoor and outdoor time fractions are considered. Refer to page 14 of DOE/NV--1107 (NNSA/NSO, 2006).
7	Indoor Dust Filtration Factor	**[0.4]**	**[0.4]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
8	Shielding Factor External Gamma	**[0.7]**	**[0.7]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
9	Pathway 1 – External Gamma	Suppressed	Suppressed	Suppressed	In general, external dose at Soils Projects will be evaluated via TLDs or direct measurement with a dose-rate meter. Soil samples and RRMGs are used to determine the internal dose component only. The pathway was activated for the second set of RRMGs for each scenario to allow the evaluation of biased sample locations where TLDs were not emplaced.

Note 1: Items 1–4 above are site-specific default values that were selected for the Soils Project.
Note 2: Table B.1-1 in Appendix B contains several errors. The bold and bracketed values are corrections to those values.

CZ = Contamination zone
m^2 = Square meter
g/yr = Grams per year
m/yr = Meters per year
m = Meter
mg/day = Milligrams per day

Table 2: Soils Project – Industrial Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(IA-I)}$** (pCi/g)
Ag-108m	2.737E+06
Am-241	2.816E+03
Cm-243	3.852E+03
Cm-244	4.735E+03
Co-60	5.513E+05
Cs-137	1.409E+05
Eu-152	1.177E+06
Eu-154	8.469E+05
Eu-155	5.588E+06
Nb-94	3.499E+06
Pu-238	2.423E+03
Pu-239/240	2.215E+03
Sr-90	5.947E+04
Th-232	2.274E+03
U-234	1.960E+04
U-235	2.089E+04
U-238	2.120E+04

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Industrial Area exposure scenario.

Table 3: Soils Project – Industrial Area Exposure Scenario – Internal & External Dose

Radionuclide	**RRMG$_{(IA-IE)}$** (pCi/g)
Ag-108m	9.281E+01
Am-241	1.503E+03
Cm-243	3.155E+02
Cm-244	4.713E+03
Co-60	1.833E+01
Cs-137	7.290E+01
Eu-152	3.826E+01
Eu-154	3.571E+01
Eu-155	9.583E+02
Nb-94	9.653E+01
Pu-238	2.416E+03
Pu-239/240	2.207E+03
Sr-90	7.714E+03
Th-232	5.067E+02
U-234	1.865E+04
U-235	2.555E+02
U-238	1.423E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Industrial Area exposure scenario.

Table 4: Soils Project – Remote Work Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(RWA-I)}$** (pCi/g)
Ag-108m	3.389E+07
Am-241	1.612E+04
Cm-243	2.223E+04
Cm-244	2.716E+04
Co-60	7.229E+06
Cs-137	1.955E+06
Eu-152	1.324E+07
Eu-154	9.741E+06
Eu-155	6.645E+07
Nb-94	3.966E+07
Pu-238	1.388E+04
Pu-239/240	1.268E+04
Sr-90	8.075E+05
Th-232	1.341E+04
U-234	1.379E+05
U-235	1.496E+05
U-238	1.554E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Remote Work Area exposure scenario.

Table 5: Soils Project – Remote Work Area Exposure Scenario – Internal & External Dose

Radionuclide	**$RRMG_{(RWA-IE)}$** (pCi/g)
Ag-108m	6.204E+02
Am-241	9.239E+03
Cm-243	2.083E+03
Cm-244	2.715E+04
Co-60	1.225E+02
Cs-137	4.874E+02
Eu-152	2.557E+02
Eu-154	2.387E+02
Eu-155	6.406E+03
Nb-94	6.452E+02
Pu-238	1.390E+04
Pu-239/240	1.269E+04
Sr-90	5.522E+04
Th-232	3.292E+03
U-234	1.314E+05
U-235	1.709E+03
U-238	9.572E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Remote Work Area exposure scenario.

Table 6: Soils Project – Occasional Use Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(OUA-I)}$** (pCi/g)
Ag-108m	2.762E+08
Am-241	4.555E+04
Cm-243	6.307E+04
Cm-244	7.68E+04
Co-60	7.421E+07
Cs-137	2.756E+07
Eu-152	8.174E+07
Eu-154	6.353E+07
Eu-155	4.751E+08
Nb-94	2.492E+08
Pu-238	3.922E+04
Pu-239/240	3.582E+04
Sr-90	9.949E+06
Th-232	3.852E+04
U-234	4.470E+05
U-235	4.922E+05
U-238	3.361E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Occasional Use Area exposure scenario.

Table 7: Soils Project – Occasional Use Area Exposure Scenario - Internal & External Dose

Radionuclide	**$RRMG_{(OUA-IE)}$** (pCi/g)
Ag-108m	2.087E+03
Am-241	2.797E+04
Cm-243	6.886E+03
Cm-244	7.653E+04
Co-60	4.122E+02
Cs-137	1.640E+03
Eu-152	8.604E+02
Eu-154	8.031E+02
Eu-155	2.156E+04
Nb-94	2.171E+03
Pu-238	3.915E+04
Pu-239/240	3.573E+04
Sr-90	1.955E+05
Th-232	1.062E+04
U-234	4.252E+05
U-235	5.749E+03
U-238	3.219E+04

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Occasional Use Area exposure scenario.

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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

(1 Page)

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

September 21, 2011

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) 366: Area 11 Plutonium Valley Dispersion Sites, Nevada National Security Site, Nevada
Federal Facility Agreement and Consent Order

Dear Mr. Boehlecke,

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the draft CAIP for Corrective Action Unit (CAU) 366: Area 11 Plutonium Valley Dispersion Sites, Nevada National Security Site, Nevada. NDEP's review of this document did not indicate any deficiencies.

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

Sincerely,

/s/ Jeff MacDougall

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

JJM/JW/KC:*jjm*

cc: K. J. Cabble, ERP, NNSA/NSO, Las Vegas, NV
E. F. Di Sanza, WMP, NNSA/NSO, Las Vegas, NV
J. T. Fraher, DTRA/CXTS, Kirtland AFB, NM
A. L. Primrose NSTec, Las Vegas, NV
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