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DOE/NV--1461

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 104: Area 7 Yucca Flat Atmospheric Test 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 104: AREA 7 YUCCA FLAT ATMOSPHERIC TEST SITES NEVADA NATIONAL SECURITY SITE, NEVADA

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

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Signature: /s/ Joseph P. Johnston
Date: 08/18/2011

CORRECTIVE ACTION INVESTIGATION PLAN FOR
CORRECTIVE ACTION UNIT 104:
AREA 7 YUCCA FLAT ATMOSPHERIC TEST SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Kevin J. Cabble Date: 08/18/2011

Kevin J. Cabble
Federal Sub-Project Director
Soils Sub-Project

Approved by: /s/ Robert F. Boehlecke Date: 08/18/2011

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project

Table of Contents

Table of Contents *(Continued)*

Table of Contents *(Continued)*

Table of Contents *(Continued)*

List of Figures

List of Figures *(Continued)*

List of Tables

List of Acronyms and Abbreviations

Ac	Actinium
Am	Americium
ASTM	ASTM International
bgs	Below ground surface
BJY	Buster Jangle Y
Ca	Calcium
CAA	Corrective action alternative
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
cm	Centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium
CSM	Conceptual site model
DCG	Derived Concentration Guideline
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective

List of Acronyms and Abbreviations *(Continued)*

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
GPS	Global Positioning System
GZ	Ground zero
HWAA	Hazardous waste accumulation area
I	Iodine
IDW	Investigation-derived waste
in.	Inch
kt	Kiloton
LCS	Laboratory control sample
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mi	Mile
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate

List of Acronyms and Abbreviations *(Continued)*

NAC	*Nevada Administrative Code*
NaI	Sodium iodide
NAD	North American Datum
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
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PET	Potential evapotranspiration
PPE	Personal protective equipment
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
RIDP	Radionuclide Inventory and Distribution Program

List of Acronyms and Abbreviations *(Continued)*

RL	Reporting limit
RMA	Radioactive material area
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMS	Radioactive waste management site
Sm	Samarium
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
T-S	Tumbler-Snapper
TSCA	*Toxic Substances Control Act*
U	Uranium
UCL	Upper confidence limit
UGTA	Underground Test Area
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
µR/hr	Microroentgens per hour
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 104 is located in Area 7 of the Nevada National Security Site, which is approximately 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 104 comprises the 15 corrective action sites (CASs) listed below:

- 07-23-03, Atmospheric Test Site T-7C
- 07-23-04, Atmospheric Test Site T7-1
- 07-23-05, Atmospheric Test Site
- 07-23-06, Atmospheric Test Site T7-5a
- 07-23-07, Atmospheric Test Site - Dog (T-S)
- 07-23-08, Atmospheric Test Site - Baker (T-S)
- 07-23-09, Atmospheric Test Site - Charlie (T-S)
- 07-23-10, Atmospheric Test Site - Dixie
- 07-23-11, Atmospheric Test Site - Dixie
- 07-23-12, Atmospheric Test Site - Charlie (Bus)
- 07-23-13, Atmospheric Test Site - Baker (Buster)
- 07-23-14, Atmospheric Test Site - Ruth
- 07-23-15, Atmospheric Test Site T7-4
- 07-23-16, Atmospheric Test Site B7-b
- 07-23-17, Atmospheric Test Site - Climax

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

The sites will be investigated based on the data quality objectives (DQOs) developed on April 28, 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 104.

The releases at CAU 104 consist of surface-deposited radionuclides from 30 atmospheric nuclear tests. The presence and nature of contamination at CAU 104 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) to the dose-based final action level (FAL). The presence of TED exceeding the FAL is considered a radiological contaminant of concern (COC). Anything identified as a COC will require corrective action. The TED will be calculated as the total of separate estimates of internal and external dose. Results from the analysis of soil samples will be used to calculate internal radiological dose. Thermoluminescent dosimeters will be used to measure external radiological dose.

Based on process knowledge of the releases associated with the nuclear tests and radiological survey information about the location and shape of the resulting contamination plume, it was determined that the releases from the nuclear tests are co-located and will be investigated concurrently. A field investigation will be performed to define areas where TED exceeds the FAL and to determine whether other COCs are present at the site.

The investigation will also collect information to determine the presence and nature of contamination associated with migration and excavation, as well as any potential releases discovered during the investigation.

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 following approval of the plan.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information, including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 104: Area 7 Yucca Flat Atmospheric Test 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 104 is located in Area 7 of the NNSS (formerly the Nevada Test Site), which is approximately 65 miles (mi) northwest of Las Vegas, Nevada. Corrective Action Unit 104 comprises the 15 corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 07-23-03, Atmospheric Test Site T-7C
- 07-23-04, Atmospheric Test Site T7-1
- 07-23-05, Atmospheric Test Site
- 07-23-06, Atmospheric Test Site T7-5a
- 07-23-07, Atmospheric Test Site - Dog (T-S)
- 07-23-08, Atmospheric Test Site - Baker (T-S)
- 07-23-09, Atmospheric Test Site - Charlie (T-S)
- 07-23-10, Atmospheric Test Site - Dixie
- 07-23-11, Atmospheric Test Site - Dixie
- 07-23-12, Atmospheric Test Site - Charlie (Bus)
- 07-23-13, Atmospheric Test Site - Baker (Buster)
- 07-23-14, Atmospheric Test Site - Ruth
- 07-23-15, Atmospheric Test Site T7-4
- 07-23-16, Atmospheric Test Site B7-b
- 07-23-17, Atmospheric Test Site - Climax

These 15 CASs include releases from 30 atmospheric tests conducted in the approximately 1 square mile of CAU 104. Because releases associated with the CASs included in this CAU overlap and individual releases are not separate and distinguishable, these CASs will be addressed jointly at the CAU level. The Corrective Action Investigation (CAI) will include field inspections, radiological surveys, geophysical surveys, sampling of environmental media, analysis of samples, and assessment

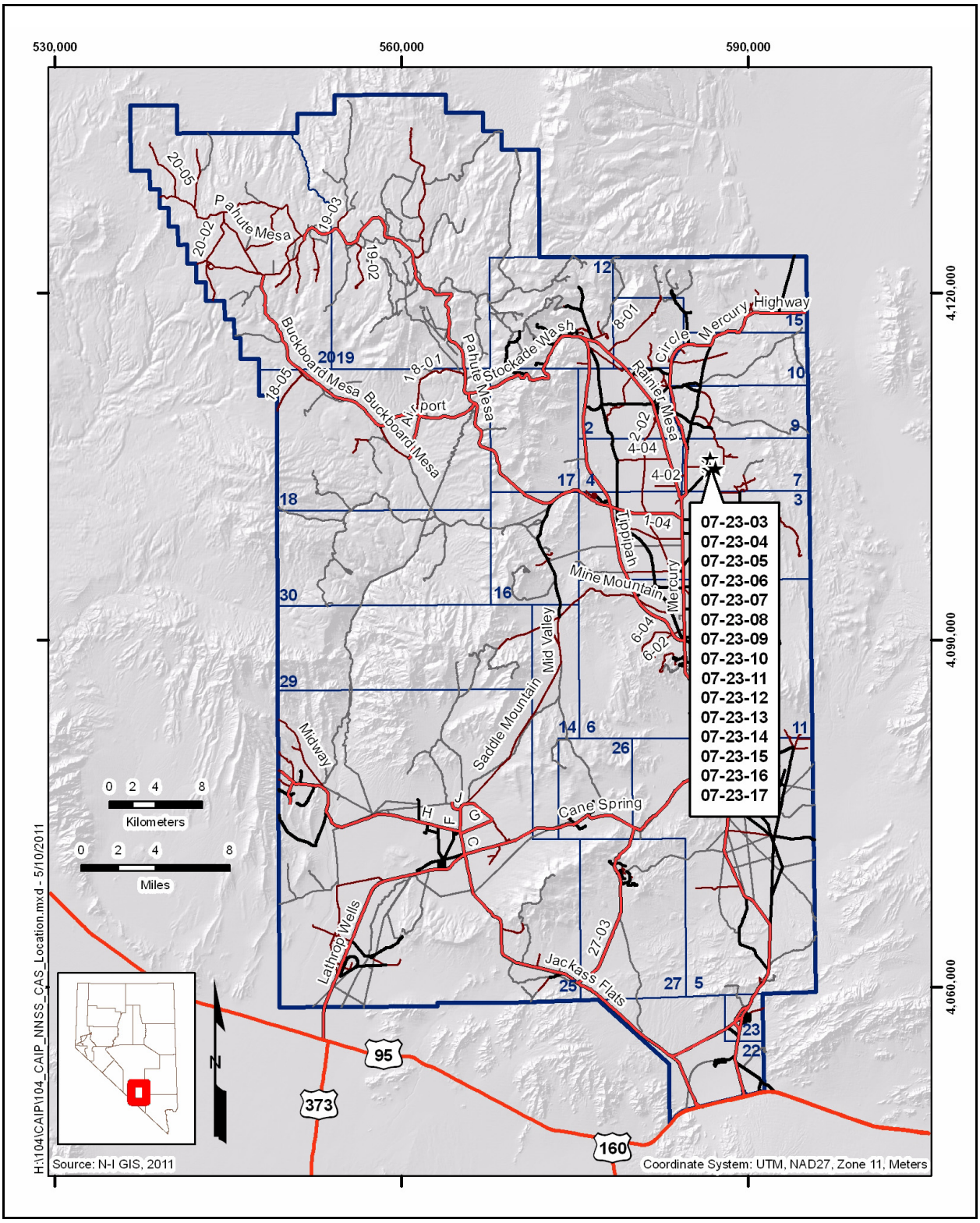

Figure 1-1
CAU 104 CAS Location Map

of investigation results. Data will be obtained to support corrective action alternative (CAA) evaluations and waste management decisions.

1.1 Purpose

Corrective Action Unit 104 is being investigated because hazardous and/or radioactive contaminants may be present in concentrations that exceed risk-based corrective action (RBCA) levels. Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CAU. Additional information will be generated by conducting a CAI before evaluating and selecting CAAs.

1.1.1 CAU 104 History and Description

Corrective Action Unit 104, Area 7 Yucca Flat Atmospheric Test Sites, consists of 15 inactive sites located in the western portion of Area 7. The CAU 104 sites consist of releases of radionuclides to the soil surface from the conduct of atmospheric nuclear testing in the 1950s and subsequent movement of those radionuclides. Operational histories for each CAU 104 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 104. 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 for CAU 104 are presented in Appendix A. A summary of the DQO process is provided below.

The DQO problem statement for CAU 104 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for CAU 104." To address this problem, resolution of the following decision statements is required:

- Decision I: "Is any contaminant of concern (COC) associated with the CAU present in environmental media?" For judgmental sampling decisions, the presence of a COC is defined as any contamination associated with the CAU that is present at concentrations exceeding its corresponding final action level (FAL). 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).

- 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
  - 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 an evaluation of any potential source material (PSM) at the site. Potential source materials are wastes that are present at the site that could cause future contamination of site environmental media at levels exceeding FALs if the wastes were to be released (see Section 3.4).

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in Appendix A. The information necessary to resolve the DQO decisions will be generated for CAU 104 by collecting and analyzing samples generated during a field investigation. The presence of a COC will be determined by collecting and analyzing samples following these two criteria:

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

- To make a probabilistic sampling decision, samples must be collected from unbiased locations that represent contamination within the sampling unit (see Section A.8.1.2).

The DQOs for CAU 104 defined the following two release scenarios to appropriately address the different types of releases that may be present at the CASs:

- The primary release is defined as the initial atmospheric deposition of radiological contaminants from nuclear tests. The initial primary release is generally observed as an annular geometric pattern of contamination from soil particle activation and initial fallout that generally decreases in intensity with distance from the source. Surface deposition of radionuclides that have been distributed at the NNSS from atmospheric nuclear releases has been found to be concentrated in the upper 5 centimeters (cm) of undisturbed soil (Gilbert et al., 1977; Tamura, 1977; McArthur and Mead, 1987; McArthur, 1991). Due to the large amount of surface disturbance at CAU 104, the subsequent movement of radiological contaminants from mechanical displacement is also included in the primary release.

- Other releases are defined as the subsequent movement of radiological contaminants from primary releases through migration and other potential releases of contaminants from site operations (e.g., spills, lead bricks, and PSM).

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 104 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 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 source material, if present, to determine the potential for a release to result in contamination exceeding FALs.

- Collect samples of potential remediation wastes, if present.
- Collect quality control (QC) samples.

Contamination of environmental media originating from activities not identified in the conceptual site model (CSM) 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 104. 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 the CAU, 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 104 comprises 15 CASs that were grouped together based on the geographical location of the sites, technical similarities, and the agency responsible for closure. All CAU 104 CASs are located in Area 7 and are atmospheric test releases.

2.1 Physical Setting

The following sections describe the general physical settings of Area 7 of the NNSS. General background information pertaining to topography, geology, hydrogeology, and climatology is provided for this specific area of the NNSS in the *Geologic Map of the Nevada Test Site, Southern Nevada* (Frizzell and Shulters, 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). Figure 2-1 shows the location of each test included in CAU 104 as well as other site features.

Corrective Action Unit 104 is 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 around CAU 104 is relatively flat, with minimum vegetation over (i.e., grasses) and with gently sloping hills north and west of the site. Most of the area has been disturbed, and non-native soils are present. The general direction of precipitation runoff flow is to the southwest, with a visible drainage exiting the site flowing toward the southwest toward Yucca Flat Dry Lake. Several craters are present at the site and may affect drainage.

The nearest rain gauge to CAU 104 is Buster Jangle Y (BJY) in Area 1, and average annual precipitation at the BJY rain gauge is 16.2 cm (6.4 inches [in.]) (ARL/SORD, 2011). Average annual potential evapotranspiration (PET) has been estimated for the Area 3 Radioactive Waste Management Site (RWMS) as 156.7 cm (61.7 in.) (Yucel, 2009). Rainfall and PET data are presented in Table 2-1.

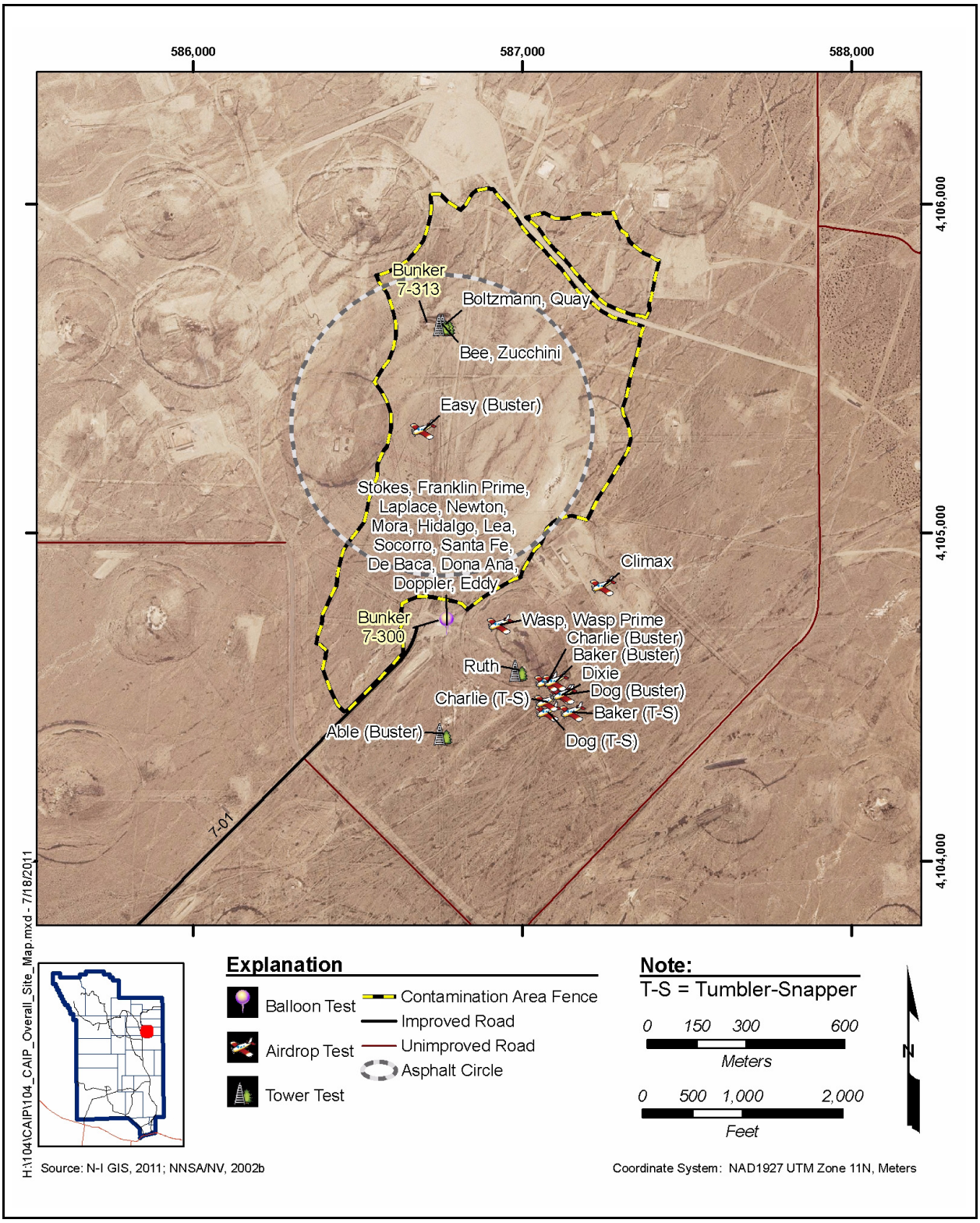

Figure 2-1
CAU 104 Site Map

Table 2-1
Rainfall and PET Information for Yucca Flat

	Area 3 PET 2003-2008 (cm)	BJY Precipitation 1961-2008 (cm)
Minimum	150.2	3.8
Maximum	160.8	37.4
Average	156.7	16.2
95% UCL	159.6	18.1

Source: ARL/SORD, 2011; Yucel, 2009

UCL = Upper confidence limit

The direction of groundwater flow in Yucca Flat generally is from the northeast to southwest. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (Laczniak et al., 1996). The nearest groundwater well to the CAU is ER-7-1, an active well located approximately 2 mi southeast of the site. The most recent recorded depth to the water table is approximately 1,853 feet (ft) below ground surface (bgs) (USGS and DOE, 2011).

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 104 that may have resulted in releases of contaminants to the environment. Thirty atmospheric tests were conducted from 1951 to 1958 in the western portion of Area 7. Because releases associated with these tests overlap and individual releases are not separate and distinguishable, the primary releases at CAU 104 will be addressed as a single release. The CAS-specific summaries are designed to describe the current definition of each CAS and document all significant, known activities. Figure 2-2 shows the chronological order of tests conducted at CAU 104 and also provides a comparison of type, height, and yield.

Several historical documents were reviewed and provide additional information on tests conducted at CAU 104. This includes operational information, details of experiments conducted during testing, and descriptions of structures formerly present at the site. Many of these are referenced through this CAIP as appropriate, and additional information can be found in various documents (Collison, 1955;

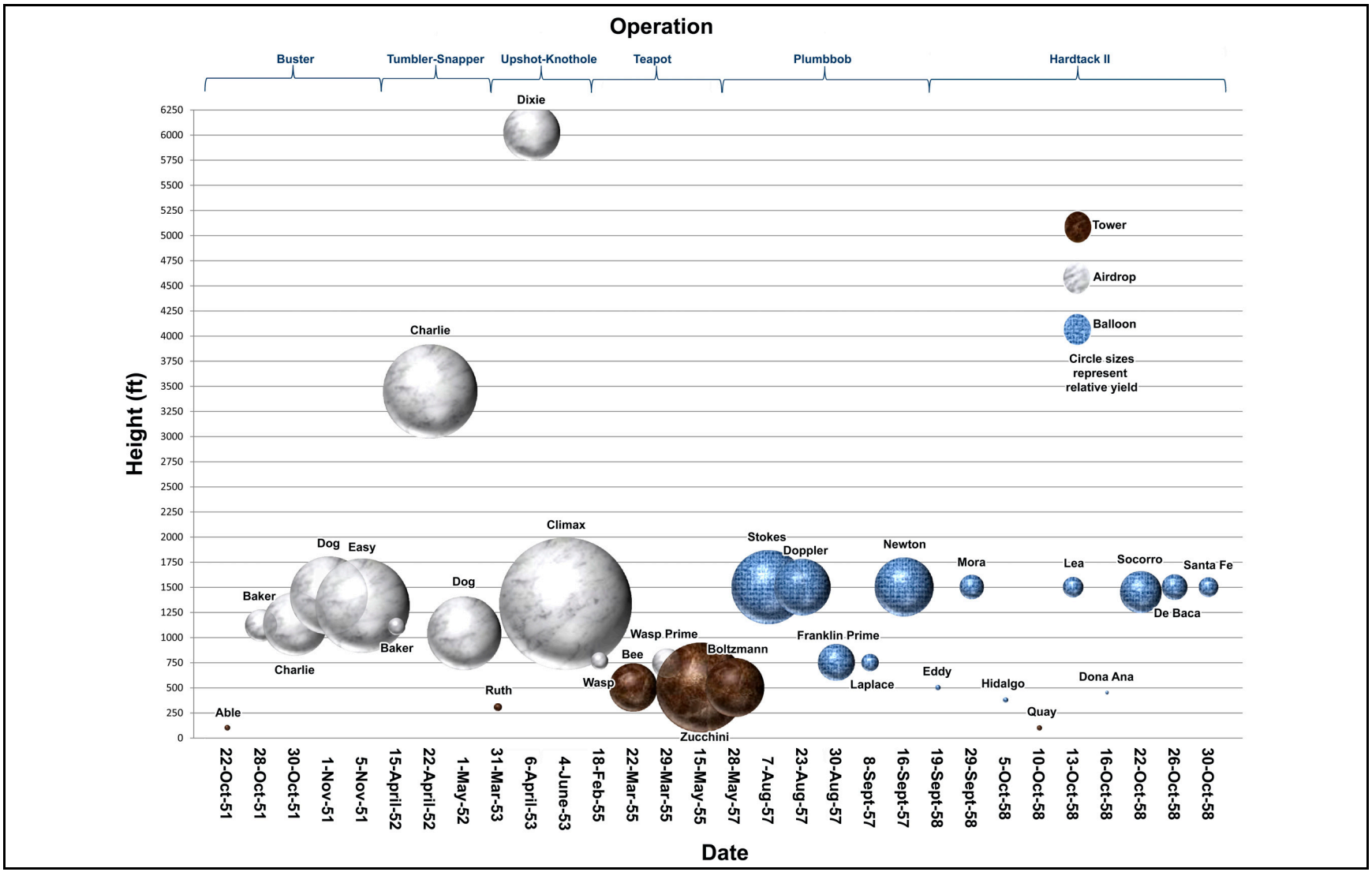

Figure 2-2
Overview of Tests Conducted at CAU 104
Source: DOE/NV, 2000; GE, 1979

Bond et al., 1953; Author Unknown, 1955 and 1960; Holmes & Narver, 1959 and 1960; Malik, 1984; Ponton et al., 1981, 1982a, and 1982b; REECo, Date Unknown and 1958; and Gwynn, 1952).

2.2.1 CAS 07-23-03, Atmospheric Test Site T-7C

Corrective Action Site 07-23-03 consists of a release of radionuclides to surrounding soil from the Boltzmann and Quay weapons-related tower tests. The Boltzmann test was conducted on May 28, 1957, as part of Operation Plumbbob. The device was detonated at 500 ft above ground surface and had a yield of 12 kilotons (kt) (DOE/NV, 2000; GE, 1979). Fallout levels associated with the Boltzmann device were higher than those from similar devices; this was likely due to the addition of 12.5 tons of silica sand in the device cab (Larson et al., 1966). The Quay test was conducted on October 10, 1958, as part of Operation Hardtack II. The device was detonated at 100 ft above ground surface and had a yield of 79 tons (DOE/NV, 2000; GE, 1979).

2.2.2 CAS 07-23-04, Atmospheric Test Site T7-1

Corrective Action Site 07-23-04 consists of a release of radionuclides to surrounding soil from the Easy weapons-related airdrop test. The Easy test was conducted on November 5, 1951, as part of Operation Buster. The device was detonated at 1,314 ft above ground surface and had a yield of 31 kt (DOE/NV, 2000; GE, 1979).

2.2.3 CAS 07-23-05, Atmospheric Test Site

Corrective Action Site 07-23-05 consists of a release of radionuclides to surrounding soil from the Bee and Zucchini weapons-related tower tests. The Bee test was conducted on March 22, 1955, as part of Operation Teapot. The device was detonated at 500 ft above ground surface and had a yield of 8 kt. The Zucchini test was conducted on May 15, 1955, as part of Operation Teapot. The device was detonated at 500 ft above ground surface and had a yield of 28 kt (DOE/NV, 2000; GE, 1979).

2.2.4 CAS 07-23-06, Atmospheric Test Site T7-5a

Corrective Action Site 07-23-06 consists of a release of radionuclides to surrounding soil from the Able weapons-related tower test. The Able test was conducted on October 22, 1951, as part of

Operation Buster. The device was detonated at 100 ft above ground surface and had a yield of less than 0.1 kt (DOE/NV, 2000; GE, 1979).

2.2.5 CAS 07-23-07, Atmospheric Test Site - Dog (T-S)

Corrective Action Site 07-23-07 consists of a release of radionuclides to surrounding soil from the Dog weapons-related airdrop test. The Dog test was conducted on May 1, 1952, as part of Operation Tumbler-Snapper. The device was detonated at 1,040 ft above ground surface and had a yield of 19 kt (DOE/NV, 2000; GE, 1979).

2.2.6 CAS 07-23-08, Atmospheric Test Site - Baker (T-S)

Corrective Action Site 07-23-08 consists of a release of radionuclides to surrounding soil from the Baker weapons-effects airdrop test. The Baker test was conducted on April 15, 1952, as part of Operation Tumbler-Snapper. The device was detonated at 1,109 ft above ground surface and had a yield of 1 kt (DOE/NV, 2000; GE, 1979).

2.2.7 CAS 07-23-09, Atmospheric Test Site - Charlie (T-S)

Corrective Action Site 07-23-09 consists of a release of radionuclides to surrounding soil from the Charlie weapons-related airdrop test. The Charlie test was conducted on April 22, 1952, as part of Operation Tumbler-Snapper. The device was detonated at 3,447 ft above ground surface and had a yield of 31 kt (DOE/NV, 2000; GE, 1979).

2.2.8 CAS 07-23-10, Atmospheric Test Site - Dixie

Corrective Action Site 07-23-10 consists of a release of radionuclides to surrounding soil from the Dixie weapons-related airdrop test. The Dixie test was conducted on April 6, 1953, as part of Operation Upshot-Knothole. The device was detonated at 6,022 ft above ground surface and had a yield of 11 kt (DOE/NV, 2000; GE, 1979).

2.2.9 CAS 07-23-11, Atmospheric Test Site - Dixie

Although "Dixie" appears in the CAS name, CAS 07-23-11 consists of a release of radionuclides to surrounding soil from the Dog weapons-related airdrop test. The Dog test was conducted on

November 1, 1951, as part of Operation Buster. The device was detonated at 1,417 ft above ground surface and had a yield of 21 kt (DOE/NV, 2000; GE, 1979).

2.2.10 CAS 07-23-12, Atmospheric Test Site - Charlie (Bus)

Corrective Action Site 07-23-12 consists of a release of radionuclides to surrounding soil from the Charlie weapons-related airdrop test. The Charlie test was conducted on October 30, 1951, as part of Operation Buster. The device was detonated at 1,132 ft above ground surface and had a yield of 14 kt (DOE/NV, 2000; GE, 1979).

2.2.11 CAS 07-23-13, Atmospheric Test Site - Baker (Buster)

Corrective Action Site 07-23-13 consists of a release of radionuclides to surrounding soil from the Baker weapons-related airdrop test. The Baker test was conducted on October 28, 1951, as part of Operation Buster. The device was detonated at 1,118 ft above ground surface and had a yield of 3.5 kt (DOE/NV, 2000; GE, 1979).

2.2.12 CAS 07-23-14, Atmospheric Test Site - Ruth

Corrective Action Site 07-23-14 consists of a release of radionuclides to surrounding soil from the Ruth weapons-related tower test. The Ruth test was conducted on March 31, 1953, as part of Operation Upshot-Knothole. The device was detonated at approximately 305 ft above ground surface and had a yield of 200 tons (DOE/NV, 2000; GE, 1979).

2.2.13 CAS 07-23-15, Atmospheric Test Site T7-4

Corrective Action Site 07-23-15 consists of a release of radionuclides to surrounding soil from the Wasp and Wasp Prime airdrop tests. The Wasp weapons-effects test was conducted on February 18, 1955, as part of Operation Teapot. The device was detonated at 762 ft above ground surface and had a yield of 1 kt. The Wasp Prime weapons-related test was conducted on March 29, 1955, as part of Operation Teapot. The device was detonated at 739 ft above ground surface and had a yield of 3 kt (DOE/NV, 2000; GE, 1979).

2.2.14 CAS 07-23-16, Atmospheric Test Site B7-b

Corrective Action Site 07-23-16 consists of a release of radionuclides to surrounding soil from 13 balloon tests. Hidalgo, one of the 13 tests conducted at the site, was a safety experiment. The remaining tests were weapons related. Table 2-2 provides additional information on tests conducted at CAS 07-23-16.

Table 2-2
Tests Conducted at CAS 07-23-16

Test	Operation	Date	Height (ft)	Yield
Stokes	Plumbbob	August 7, 1957	1,500	19 kt
Doppler		August 23, 1957	1,500	11 kt
Franklin Prime		August 30, 1957	750	4.7 kt
Laplace		September 8, 1957	750	1 kt
Newton		September 16, 1957	1,500	12 kt
Eddy	Hardtack II	September 19, 1958	500	83 tons
Mora		September 29, 1958	1,500	2 kt
Hidalgo		October 5, 1958	377	77 tons
Lea		October 13, 1958	1,500	1.4 kt
Dona Ana		October 16, 1958	450	37 tons
Socorro		October 22, 1958	1,450	6 kt
De Baca		October 26, 1958	1,500	2.2 kt
Santa Fe		October 30, 1958	1,500	1.3 kt

Source: DOE/NV, 2000; GE, 1979

2.2.15 CAS 07-23-17, Atmospheric Test Site - Climax

Corrective Action Site 07-23-17 consists of a release of radionuclides to surrounding soil from the Climax weapons-related airdrop test. The Climax test was conducted on June 4, 1953, as part of Operation Upshot-Knothole. The device was detonated at 1,334 ft above ground surface and had a yield of 61 kt (DOE/NV, 2000; GE, 1979).

2.3 Waste Inventory

Available documentation, site visits, interviews with former site employees, process knowledge, and general historical NNSS practices were used to identify wastes that may be present.

Solid waste items identified at CAU 104 include miscellaneous debris (e.g., batteries, drums) associated with nuclear testing. Additional wastes may include investigation-derived waste (IDW), decontamination liquids, and contaminated soil. Potential waste types include industrial solid waste, hydrocarbon waste, *Resource Conservation and Recovery Act* (RCRA) hazardous waste, radioactive waste, and mixed waste.

2.4 Release Information

The releases of contamination to CAU 104 are directly or indirectly associated with the 30 atmospheric nuclear tests conducted in the area. The investigation of specific releases at CAU 104 will depend upon the nature of these releases. Therefore, the releases at CAU 104 have been categorized into one of the two release scenarios defined in Section 1.1.2 (i.e., "primary" and "other" releases).

The primary release scenario includes the atmospheric deposition of radioactive contamination onto surface soils from fallout of activated soil and radionuclides from the nuclear tests. The atmospheric releases from all CAU 104 tests were deposited in the same general area, over a period of seven years (October 22, 1951–October 30, 1958). Therefore, it is possible that contamination from earlier tests may be buried under materials released during later tests. Additionally, extensive reworking of soil has occurred at the site, which has likely resulted in further movement of contamination.

The other release scenario includes subsequent migration of radioactivity associated with the primary release scenario, but does not include mechanical movement of radionuclides. The other release scenario for radionuclides includes movement that may occur due to sheet and gully erosion from stormwater runoff.

The other release scenario also includes other potential releases such as spills, or sourced from wastes and debris from activities conducted at the test sites. Four parallel berms run south from Bunker 7-300 along the 7-01 Road for an unknown distance. Partially buried lead-sheathed cable

debris, as shown in Figure 2-3 and described further in Section 2.5.4, is dispersed intermittently across these berms. A large (approximately 0.5-mi-diameter) circle at the center of the site is covered with degraded asphalt, shown in Figure 2-4, will also be addressed as an other release.

Figure 2-3
Lead-Sheathed Cable Present at CAU 104

The primary release contaminants of potential concern (COPCs) for CAU 104 are radionuclides associated with nuclear testing (americium [Am]-241; plutonium [Pu]-238, -239/240, -241; uranium [U]-234, -235, -238; cesium [Cs]-137; and strontium [Sr]-90). Known other release COPCs are lead associated with lead-sheathed piping identified at the site and volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) associated with asphalt at the site. Contaminants of potential concern for any additional other releases identified at the site will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks). Additional information on COPCs can be found in Section 3.2.

Figure 2-4
Degraded Asphalt Present at CAU 104

Exposure routes to receptors include ingestion and inhalation of contaminated media. Site workers may also be exposed to direct radiation by performing activities in proximity to radiologically contaminated materials (i.e., external dose).

Twelve CASs from other CAUs are within a 500-meter (m) radius of the CASs included in CAU 104. Six of these (CASs 07-57-007, 07-57-014, 07-57-016, 07-57-049, 07-57-054, and 07-57-058) consist of Underground Test Area (UGTA) CASs that are currently in Appendix III of the FFACO (1996, as amended) and will not affect the CAU 104 investigation. The other six CASs within a 500-m radius of CAU 104 CASs have been closed and will not affect the CAU 104 investigation.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 104 site. The most recent aerial survey was conducted in 1994 (BN, 1999). The Radionuclide Inventory and Distribution Program (RIDP) conducted an investigation from 1981 through 1986 that estimated the inventory of man-made radionuclides at the NNSS through *in situ* gamma spectroscopy (McArthur

and Mead, 1987; Gray et al., 2007). Additionally, radiological and geophysical walkover surveys were conducted in 2011 to provide additional information for the preparation of this CAIP. Results for all investigations are consistent, showing highest levels of contamination at the northern center of the plume.

2.5.1 Aerial Surveys

Aerial radiological surveys have been conducted at the NNSS measuring the type and intensity of radioactive exposure. Aerial surveys were conducted in 1970, 1978, and 1994 (EG&G, 1972; Fritzche, 1981; BN, 1999). The aerial survey data have not changed significantly from the initial 1970 survey to the most recent 1994 survey; therefore, the data from the most recent aerial survey is referenced. Results for the gross count and americium aerial surveys are shown in Figures 2-5 and 2-6.

2.5.2 Radionuclide Inventory and Distribution Program

As part of an effort to assess the implications of contamination on future uses of the NNSS, the RIDP was established in 1981 to make a comprehensive survey of the important man-made radionuclides of NNSS origin in the NNSS surface soil (McArthur and Mead, 1987). Data collected for the RIDP in the 1980s allowed for estimates of surface soil inventories throughout the NNSS. The RIDP estimated the inventory through *in situ* soil measurements by gamma spectroscopy and limited confirmatory soil sampling (McArthur and Mead, 1987; Gray et al., 2007).

Desert Research Institute reported RIDP measurements from Area 7 near the Quay test area (McArthur and Mead, 1987), which is within the boundaries of CAU 104. This included *in situ* gamma spectroscopy measurements. *In situ* results for Pu-239 are shown in Figure 2-7. To calibrate and verify the *in situ* gamma spectroscopy measurements, seven soil samples were collected, ball-milled and sieved, and analyzed by radiochemical analyses and gamma spectroscopy. Results were reported for Am-241, Cs-137, Pu-238, Pu-239/240, and Sr-90, as shown in Table 2-3. The highest values for Pu using both methods (3,802 picocuries per gram [pCi/g] *in situ* and 4,200 pCi/g radiochemical and gamma spectroscopy) were both collected from the same sample location, near the southwest corner of Bunker 7-313. The report concluded that gamma results and radiochemical

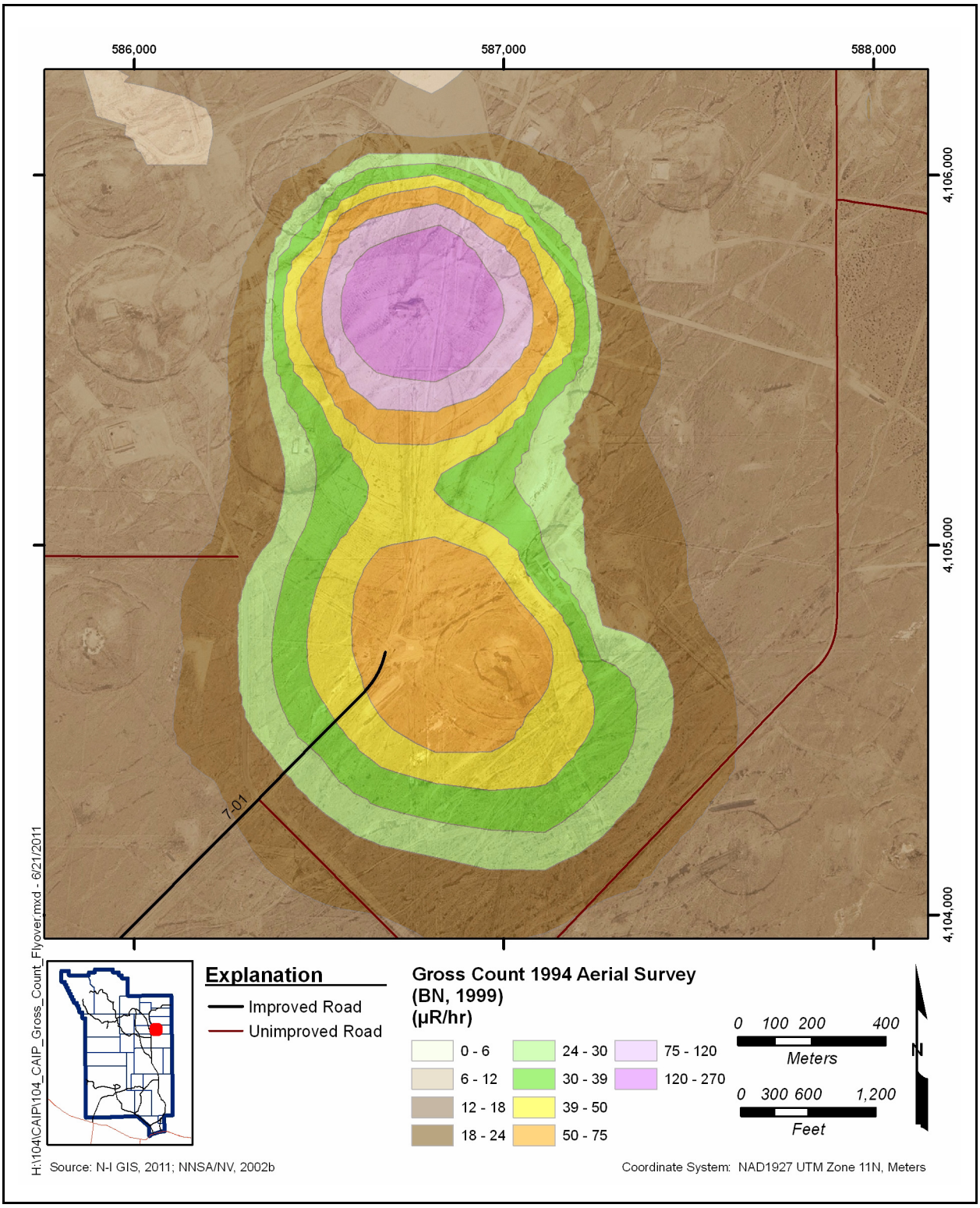

Figure 2-5
CAU 104 Gross Count Aerial Data

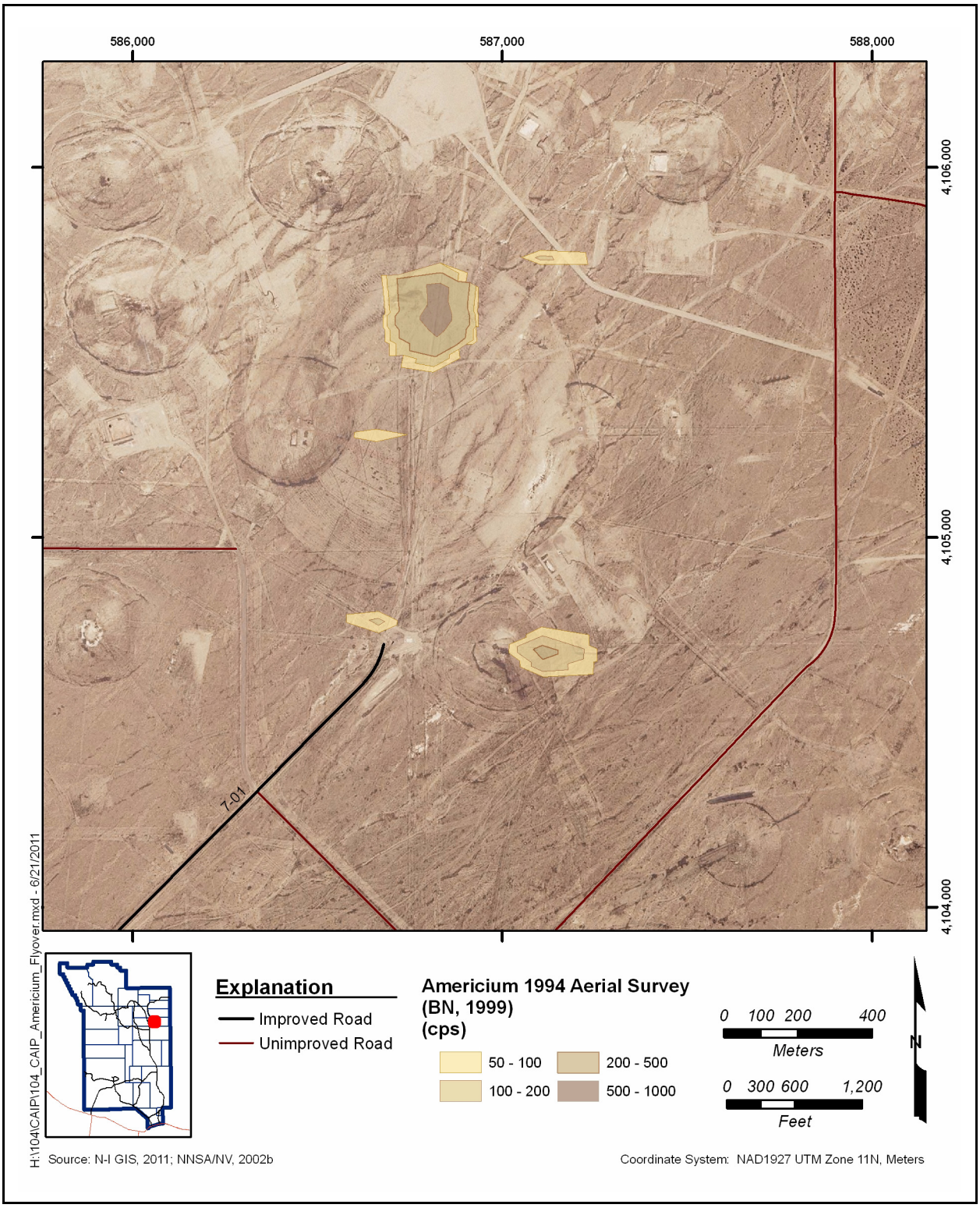

Figure 2-6
CAU 104 Americium Aerial Data

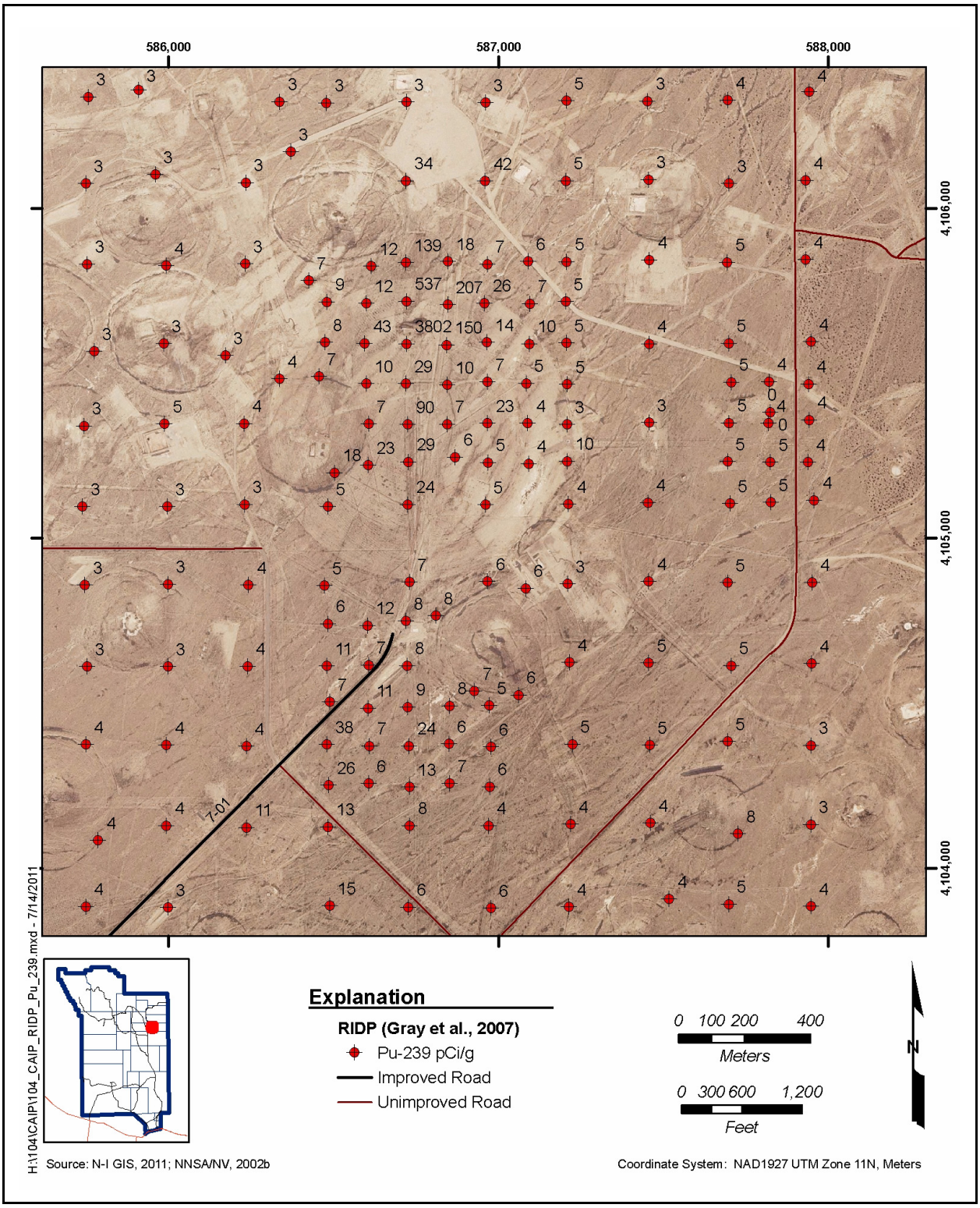

Figure 2-7
CAU 104 RIDP *In Situ* Data

Table 2-3
RIDP Data for CAU 104

Isotope	Maximum (pCi/g)	RRMG Industrial Area (pCi/g)
Am-241	670	2,816
Cs-137	150	140,900
Pu-239/240	4,200	2,215
Pu-238	130	2,423
Sr-90	290	59,470

RRMG = Residual radioactive material guideline

Source: McArthur and Mead, 1987 (Table 8, pg. 53); Anagnostopoulos, 2010

results are both considered reliable and accurate representations of radioactivities in the samples taken (McArthur and Mead, 1987).

2.5.3 Radiological Walkover Surveys

Radiological walkover surveys were performed in 2011 as part of this CAI. The surveys were conducted using a field instrument for the detection of low-energy (gamma) radiation (FIDLER) and sodium iodide (NaI) detectors. The radiological readings, showing a general distribution pattern of radionuclides, were paired with real-time Global Positioning System (GPS) information. Results are shown in Figures 2-8 and 2-9.

2.5.4 Geophysical Surveys

Geophysical surveys were performed in 2011 as part of this CAI. The purpose of the surveys was to identify the extent of lead-sheathed cable present at the site. The survey results are shown in Figure 2-10 and indicate the cable does not run the entire lengths of the soil berms present at the site, but is dispersed intermittently through the berms. These results were verified through use of a metal detector, visual inspection, and shallow (less than 12 in.) excavation. The extent of the lead-sheathed cable is mainly what is visible at the surface, with very little present subsurface within the berms.

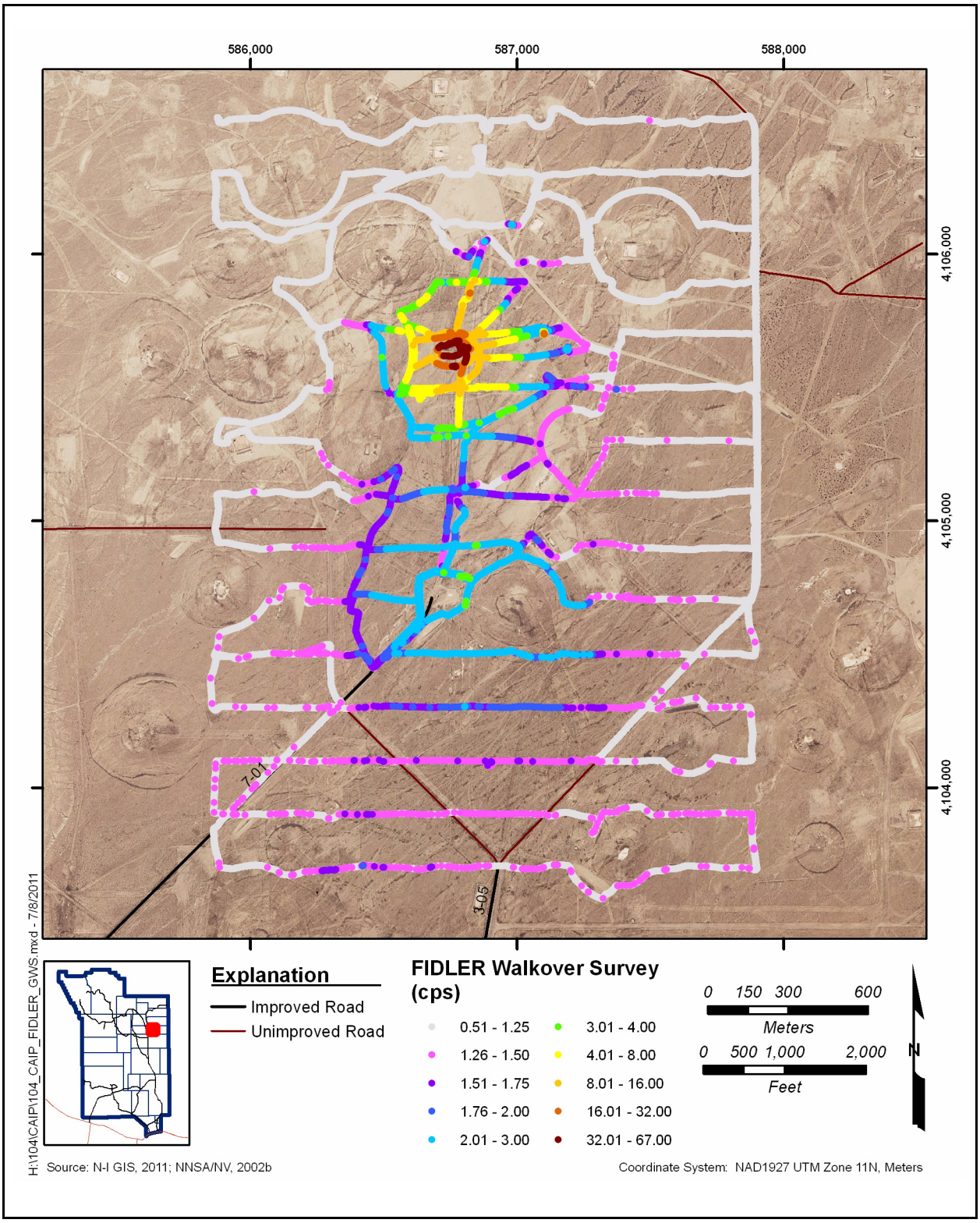

Figure 2-8
CAU 104 FIDLER Survey Results

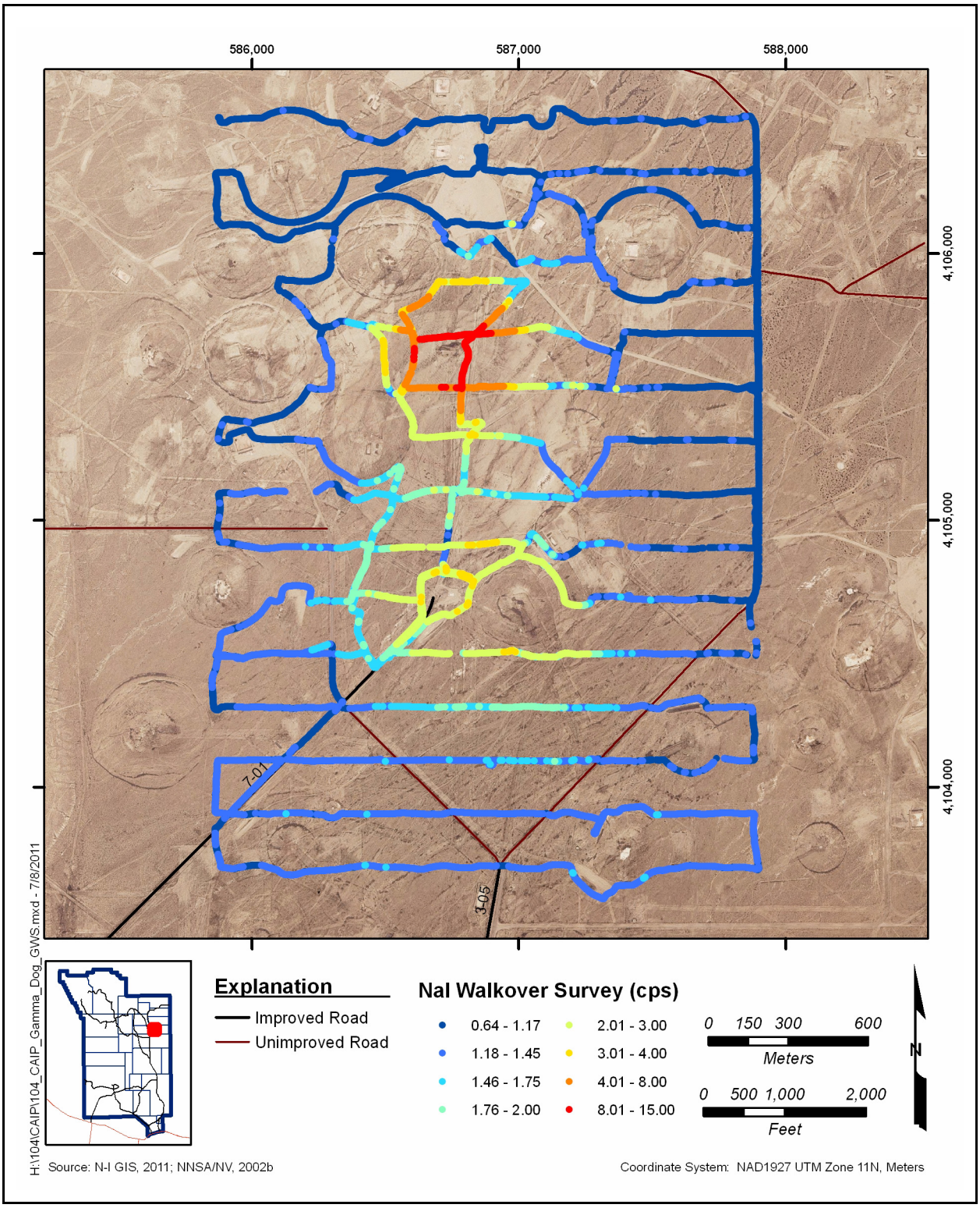

Figure 2-9
CAU 104 Nal Survey Results

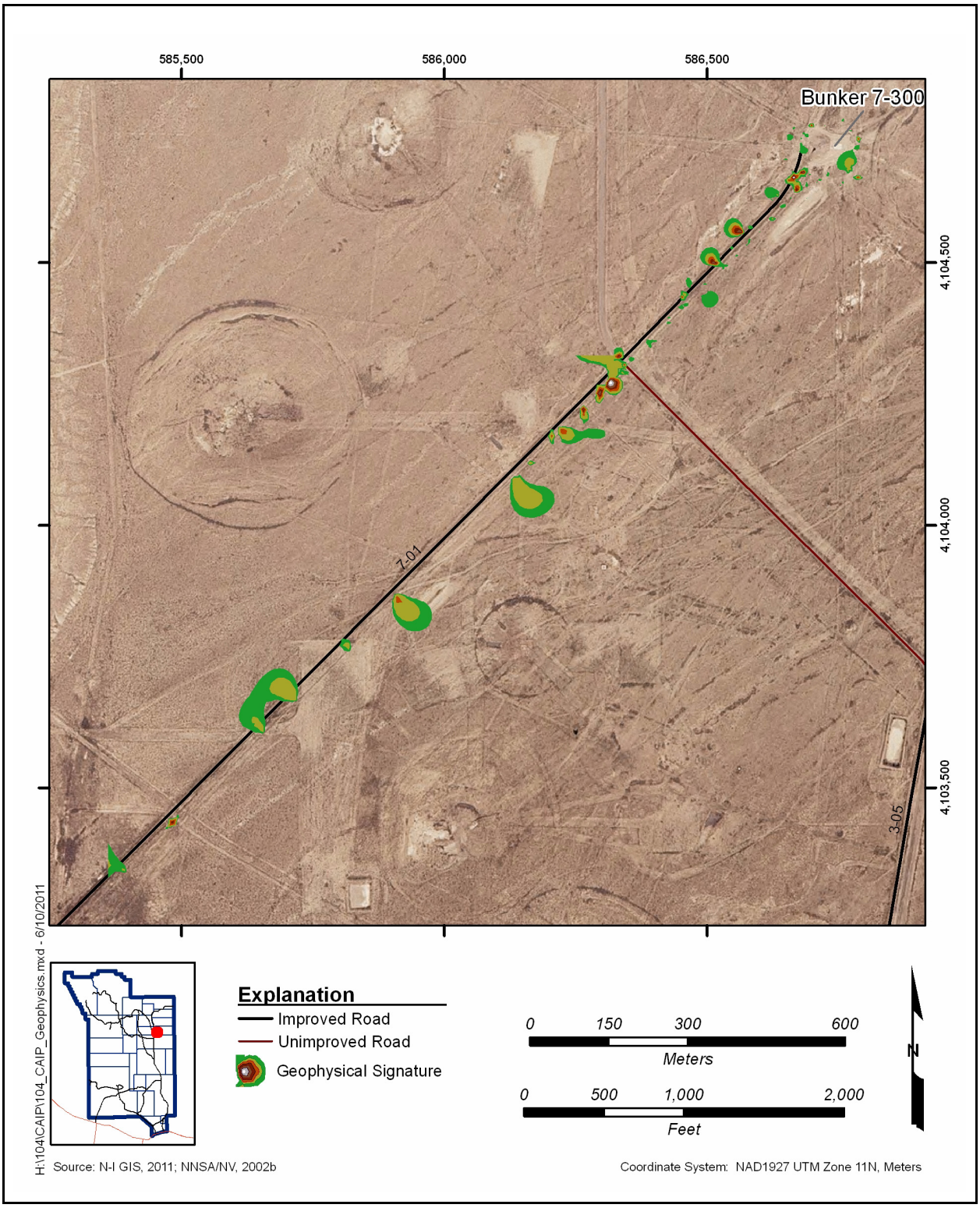

Figure 2-10
CAU 104 Geophysical Survey Results

2.6 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 104.

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 104. 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 104 and formulation of the CSM. Also presented is a summary listing of the COPCs, the preliminary action levels (PALs), and the process used to establish FALs. Additional details and figures depicting the CSM are located in Appendix A.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM was used to develop appropriate sampling strategies and data collection methods. The CSM was developed for CAU 104 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 104 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 for a path to closure. 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 104.

3.1.1 Land Use and Exposure Scenarios

Land-use zones where CAU 104 is located dictate future land use and restrict current and future land use to nonresidential (i.e., industrial) activities.

The dose a receptor could receive from contaminants at CAU 104 would primarily be due to chronic exposure to radionuclides (i.e., receiving a dose over time). Therefore, the dose to a receptor is

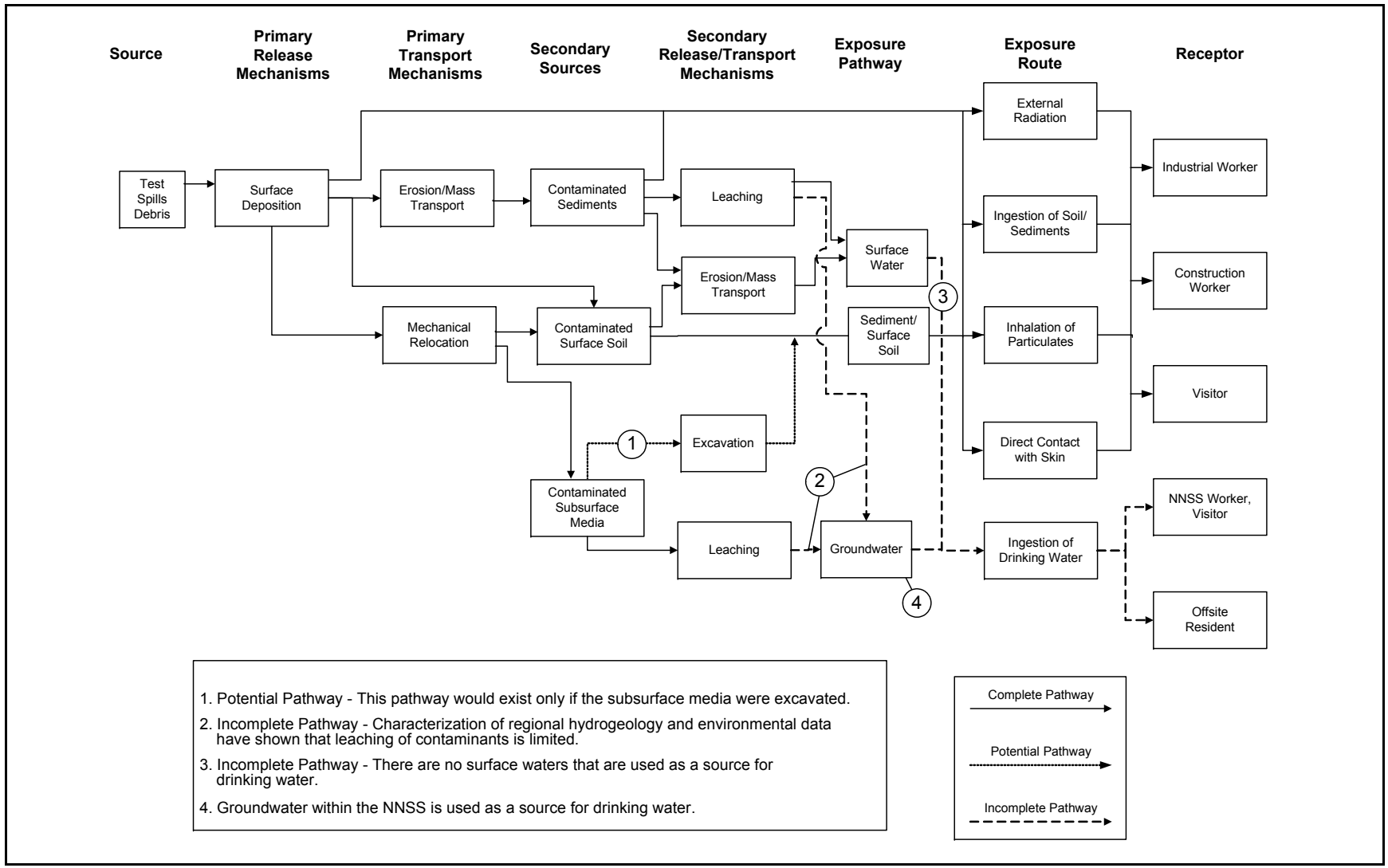

Figure 3-1
Conceptual Site Model Diagram

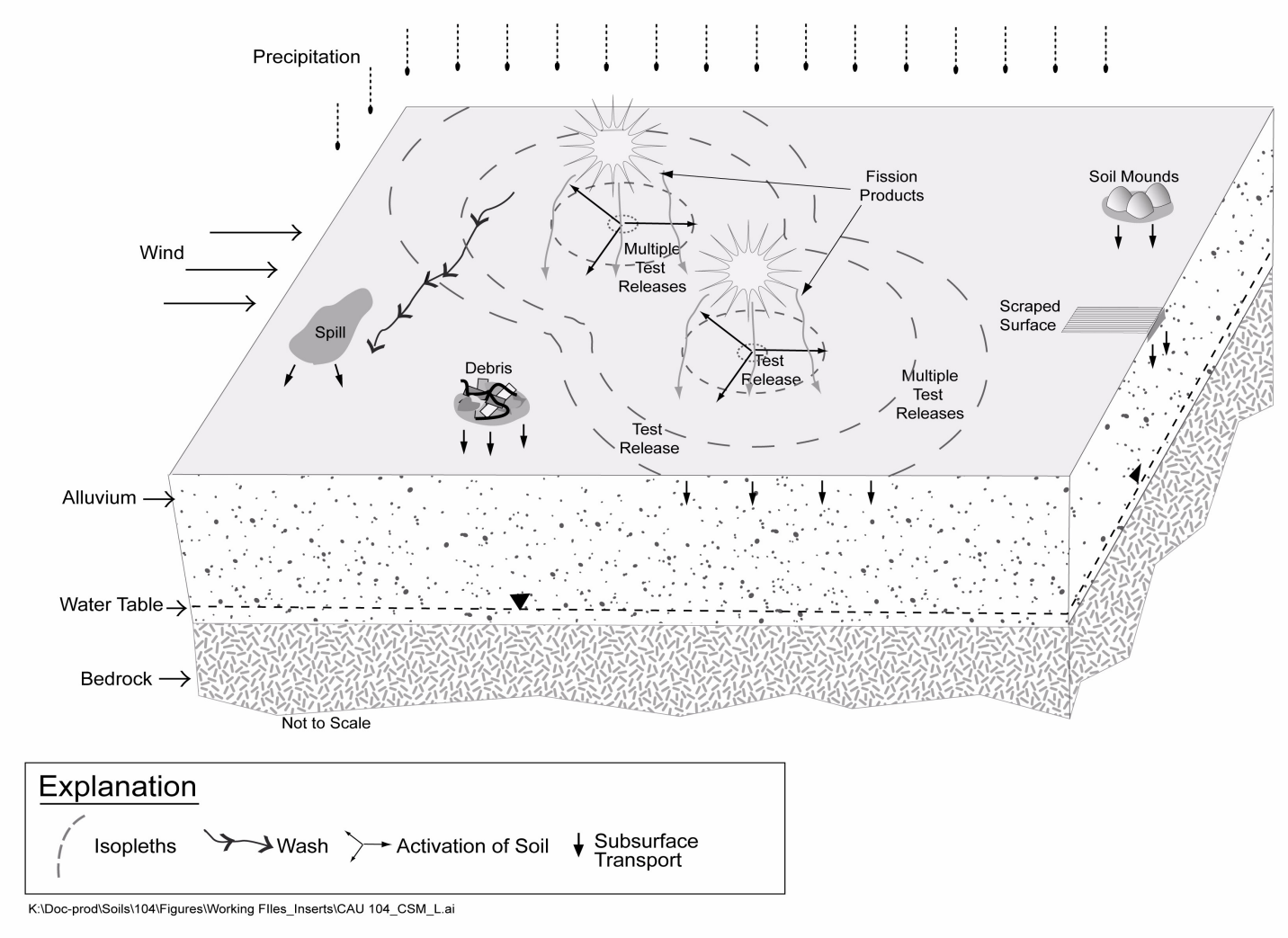

Figure 3-2
CAU 104 Conceptual Site Model

directly related to the amount of time a receptor is exposed to the contaminants. To simplify the calculation and evaluation of dose to receptors, the following exposure scenarios were developed and presented in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006):

- 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 per 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 land-use zone and exposure scenario are based on NNSS current and future land use. Corrective Action Unit 104 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.

Corrective Action Unit 104 is 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).

3.1.2 Contaminant Sources

The contamination sources for CAU 104 are releases of radiological contamination to the atmosphere and soil as a result of 30 atmospheric nuclear tests in the area. The radionuclide contaminants expected to be currently present at any particular test location depend upon the different types of nuclear tests, the amount of nuclear yield that occurred during the test, and the different inherent properties of the radionuclides released. The type of the tests in this CAU are exclusively atmospheric tests that were all detonated above the soil at various elevations. The amount of nuclear yield varied between efficient test devices where most of the nuclear source material reacted during detonation, to tests where the nuclear device was destroyed using conventional explosives resulting in little or no nuclear yield. Different mixtures of radionuclides may be present at these release sites based on the varying composition of the nuclear source material used in the test devices. The radionuclide mixtures at various locations may also vary due to differential fallout patterns where different radionuclides in the airborne plume distill and deposit onto the soil surface over time as they cool following the tests (based on the different melting points of the radionuclides). Contamination on the soil surface may be a source for future migration. Other sources of contamination include lead-sheathed cable debris and a large area of degraded asphalt present at the site, as well as any spills, wastes, and debris that may be identified during the investigation.

3.1.3 Release Mechanisms

Release mechanisms for the primary releases in CAU 104 include the release of fission products and release of unfissioned nuclear fuel from the detonation of nuclear devices as well as neutron activation of soil and debris. Contaminants were released in an annular pattern around ground zero (GZ) for each test conducted at the site. Radionuclides with a low melting point (e.g., iodine [I]) may travel further before condensing and falling out of the plume, while those with higher melting points (e.g., Cs) may condense earlier and be deposited closer to GZ. The nuclear fuel that did not fission (e.g., U-235) is generally found very near to GZ. The atmospheric detonations irradiated the surrounding soil with neutrons, causing the activation of some elements in the soil (e.g., europium [Eu]-152 and -154).

Release mechanisms for other releases included in the CSM are spills and leaks onto surface soils from equipment or stored materials. Materials stored in containers may have leaked or have been spilled. Lead-sheathed cables at the site may release lead to the surrounding soil as they degrade. A large circle of degrading asphalt present at the center of the site may release VOCs and SVOCs as it continues to degrade.

3.1.4 Migration Pathways

Surface migration pathways for CAU 104 include the lateral migration of potential contaminants across surface soils into washes transecting the site. The washes entering and leaving these areas are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical (infiltration) and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas. The area of CAU 104 drains into a small wash located at the southwest corner of the site that flows toward and into Yucca Flat Dry Lake.

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

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 104 (e.g., Pu and Am) have low solubilities and high affinity for media. The physical characteristics of the site generally include soil with medium and high adsorbive capacities, low moisture content, medium water-holding capacity, and relatively great depth to groundwater (e.g., 1,853 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 driving forces for downward migration of contaminants. However, due to high potential evapotranspiration (annual PET at the Area 3 RWMS

has been estimated at 61.7 in. [Yucel, 2009] and limited precipitation for this region [6.4 in./year] [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).

Migration pathways at CAU 104 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 104 CASs is presented in Section 2.1 as it pertains to the investigation. This information has been addressed in the CSM and will be considered during the evaluation of CAAs, as applicable. Climatic and site conditions (e.g., surface and subsurface soil descriptions) as well as specific structure descriptions will be recorded during the CAI. Areas of erosion and deposition within the washes will be qualitatively evaluated to provide additional information on potential offsite migration of contamination.

3.2 Contaminants of Potential Concern

Based on the releases identified in Section 2.4, the suspected contaminants at CAU are radionuclides (Am-241; Pu-238, -239/240, -241; U-234, -235, -238; Cs-137; and Sr-90), lead from lead-sheathed cables, and VOCs and SVOCs associated with hydrocarbons. These COPCs will be reported by the analytical methods gamma spectroscopy, isotopic U, isotopic Pu, isotopic Am, Pu-241, and Sr-90, RCRA metals, VOCs, and SVOCs identified in Table 3-1 for Decision I environmental samples. 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) and may include RCRA metals, VOCs, SVOCs, and polychlorinated biphenyls (PCBs). Other releases identified during preliminary site visits include several intermittent lengths of partially buried lead-sheathed cable and degraded asphalt. The analytes reported for each analytical method are listed in Table 3-2.

Table 3-1
Contaminants of Potential Concern[a]

Analyses	COPCs		
	Primary Release	Lead-Sheathed Cables	Asphalt
Organic COPCs			
VOCs	--	--	x
SVOCs	--	--	x
Inorganic COPCs			
RCRA Metals	--	x	--
Radionuclide COPCs			
Gamma Spectroscopy[b]	x	--	--
Isotopic U	x	--	--
Isotopic Pu	x	--	--
Isotopic Am	x	--	--
Pu-241	x	--	--
Sr-90	x	--	--

[a]The COPCs are the constituents reported from the analytical methods listed.
[b]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.

X = Required analytical method
-- = Not required

Table 3-2
Contaminants of Potential Concern Reported by Analytical Methods

VOCs		SVOCs		PCBs	Metals	Radionuclides
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	2,3,4,6-Tetrachlorophenol	Di-n-octyl phthalate	Aroclor 1016	Arsenic	Am-241
1,1,1-Trichloroethane	Chlorobenzene	2,4,5-Trichlorophenol	Dibenzo(a,h)anthracene	Aroclor 1221	Barium	Pu-238
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,6-Trichlorophenol	Dibenzofuran	Aroclor 1232	Cadmium	Pu-239/240
1,1,2-Trichloroethane	Chloroform	2,4-Dimethylphenol	Diethyl phthalate	Aroclor 1242	Chromium	Pu-241
1,1-Dichloroethane	Chloromethane	2,4-Dinitrotoluene	Dimethyl phthalate	Aroclor 1248	Lead	Sr-90
1,1-Dichloroethene	Chloroprene	2-Chlorophenol	Fluoranthene	Aroclor 1254	Mercury	U-234
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Methylnaphthalene	Fluorene	Aroclor 1260	Selenium	U-235
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylphenol	Hexachlorobenzene	Aroclor 1268	Silver	U-238
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Nitrophenol	Hexachlorobutadiene			
1,2-Dichlorobenzene	Ethyl methacrylate	3-Methylphenol[a] (m-cresol)	Hexachloroethane			**Gamma-Emitting**
1,2-Dichloroethane	Ethylbenzene	4-Methylphenol[a] (p-cresol)	Indeno(1,2,3-cd)pyrene			Ac-228
1,2-Dichloropropane	Isobutyl alcohol	4-Chloroaniline	n-Nitroso-di-n-propylamine			Co-60
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Nitrophenol	Naphthalene			Cs-137
1,3-Dichlorobenzene	Methacrylonitrile	Acenaphthene	Nitrobenzene			Eu-152
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthylene	Pentachlorophenol			Eu-154
1,4-Dioxane	Methylene chloride	Aniline	Phenanthrene			Eu-155
2-Butanone	n-Butylbenzene	Anthracene	Phenol			Nb-94
2-Chlorotoluene	n-Propylbenzene	Benzo(a)anthracene	Pyrene			Th-234
2-Hexanone	sec-Butylbenzene	Benzo(a)pyrene	Pyridine			U-235
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
Co = Cobalt
Nb = Niobium
Th = Thorium

The list of COPCs is intended to encompass all contaminants 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. Additional, 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 (i.e., FALs) or to establish that corrective action is not necessary."

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

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

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

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

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.

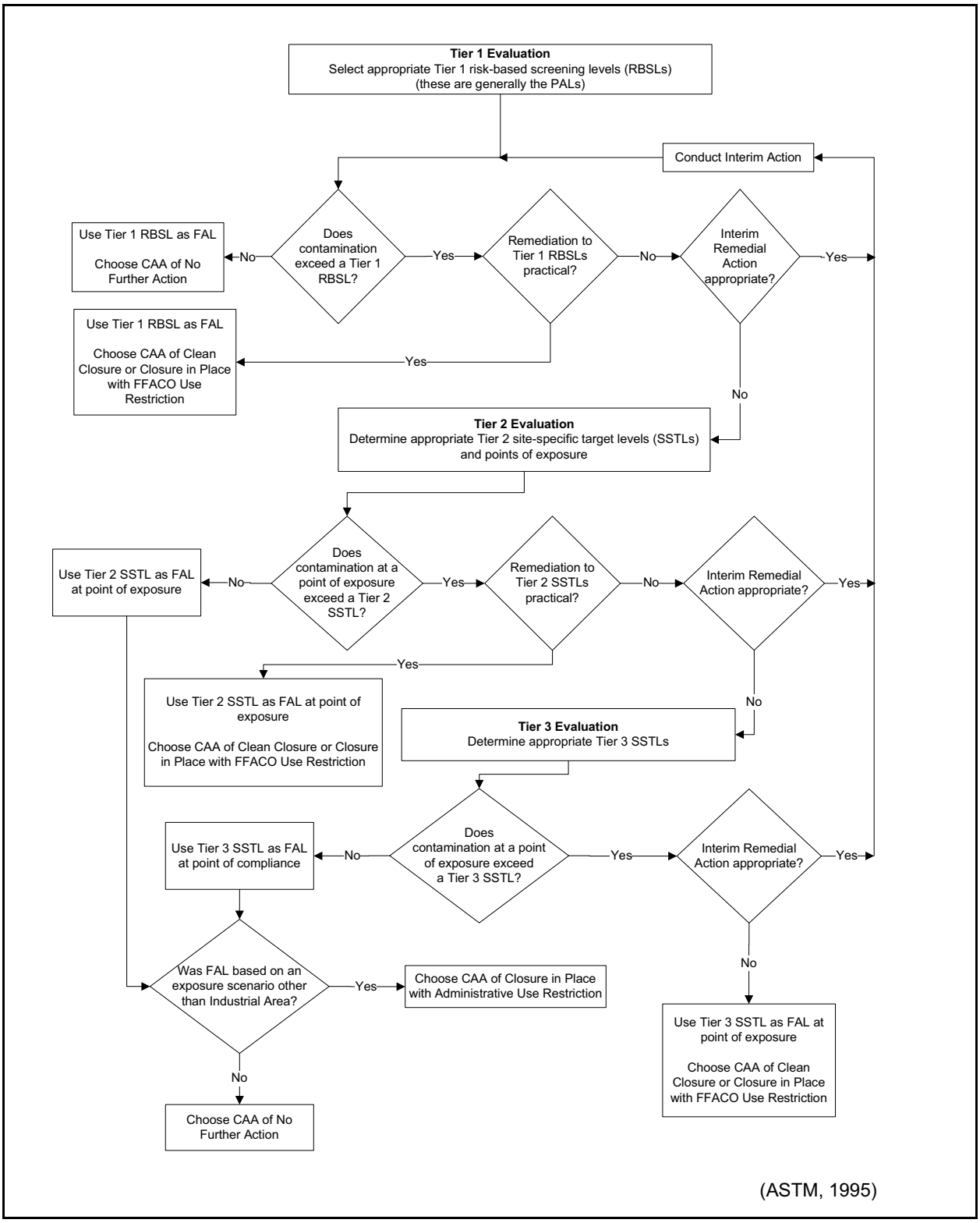

Figure 3-3
Risk-Based Corrective Action Decision Process

If, after implementation of corrective actions, contamination remains in place that is less than the site-specific exposure scenario but exceeds an industrial area exposure scenario, a corrective action of 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 industrial exposure scenario based PALs and site-specific 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 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 millirem-per-year (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 Residual Radioactive (RESRAD) computer code (Murphy, 2004). The RRMGs presented in Table 3-3 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. Specific input parameters are used to calculate the RRMGs for each exposure scenario where the area of contamination is equal to 1,000 square meters (m^2) and depth of contamination equal to 5 cm.

Table 3-3
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	9,741,00l0	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

Source: Anagnostopoulos, 2010

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).

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 104 was developed at a meeting on April 28, 2011. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and to design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 104 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 104." To address this problem statement, resolution of the following decision statements is required:

- Decision I: "Is any COC associated with the CAU present in environmental media?" 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
  - The information needed to determine potential remediation waste types
  - The information needed to evaluate the feasibility of remediation alternatives

The presence of a COC would require a corrective action. For both release scenarios Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. The specific analyses for samples 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 decisions.

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

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

A COC may also be defined as a class of contaminants (i.e., radionuclides, carcinogens, toxins) whose combined effect poses an unacceptable risk (NNSA/NSO, 2006).

Decision I primary release samples will be submitted to analytical laboratories for analyses listed in Section 3.2. For the areas investigated under 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 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 104 COPC are provided in Tables 3-4 and 3-5. The criteria for precision and accuracy listed in Tables 3-4 and 3-5 may vary from information in the QAPP as a result of the laboratory used or updated/new methods (NNSA/NV, 2002a).

Table 3-4
Analytical Requirements for Radionuclides for CAU 104

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]			
Pu-241	Aqueous	Pu-10-RC[h]			
	Non-aqueous	Pu-02-RC[h]			
Sr-90	Aqueous	EPA 905.0[c]			
	Non-aqueous	Sr-02-RC[h]			

[a]A list of constituents reported for each method is provided in Table 3-2.
[b]The MDC is the minimum concentration of a constituent that can be measured and reported with 95% confidence (Standard Methods)[j].
[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]*Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998).

DCG = Derived Concentration Guide
LCS = Laboratory control sample
ND = Normalized difference
RPD = Relative percent difference
%R = Percent recovery

Table 3-5
Analytical Requirements for Chemicals for CAU 104

Analysis[a]	Medium or Matrix	Analytical Method[b]	MDC[c]	Laboratory Precision	Laboratory Accuracy
Organics					
VOCs	All	8260	< FALs	Lab-specific[d]	Lab-specific[d]
TCLP VOCs	Leachate	1311/8260	< Regulatory Levels	Lab-specific[d]	Lab-specific[d]
SVOCs	All	8270	< FALs	Lab-specific[d]	Lab-specific[d]
TCLP SVOCs	Leachate	1311/8270	< Regulatory Levels	Lab-specific[d]	Lab-specific[d]
PCBs	All	8082	< FALs	Lab-specific[d]	Lab-specific[d]
Inorganics					
Metals	All	6010/6020	< 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]
TCLP Metals	Leachate	1311/6010/7470	< Regulatory Levels		

[a]A list of constituents reported for each method is provided in Table 3-2.
[b]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2011b).
[c]The MDC is the minimum concentration of a constituent that can be measured and reported with 99% confidence (SW-846).
[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, 2009).
[e]*Sampling and Analysis Plan Guidance and Template* (EPA, 2000).
[f]*Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004).

MS = Matrix spike
N-I = Navarro-Intera, LLC
RL = Reporting limit
TCLP = Toxicity Characteristic Leaching Procedure

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 104 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for CAU 104 by collecting and analyzing samples generated during a field investigation. The investigation will generate information required to evaluate potential CAAs. For CAU 104, information necessary to evaluate the CAAs of no further action, clean closure, and closure in place will be generated.

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

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

The TED will be determined by summing internal and external dose measurements at each sample 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 a sample plot or grab sample location at a height of 1 m and be left in place for approximately 2,250 hours (equivalent to an annual industrial worker exposure). Each TLD contains three elements from which external dose measurements will be reported. The 95 percent UCL of the average from the TLD elements will be used to represent external dose at each TLD location. For grab sample locations, TED will be represented as the sum of the 95 percent UCL of the external dose and the internal dose calculated from the individual soil sample results. For sample plot locations, TED will be represented as the sum of the 95 percent UCL of the external dose and the 95 percent UCL of the internal dose calculated from all soil sample results collected from the plot.

For chemical contaminants, the DQO decision will be based upon direct comparison of sample results to the FAL.

Modifications to the investigative strategy may be required should unexpected field conditions be encountered. Significant modifications shall be justified and documented before implementation. If an unexpected condition occurs that is 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 104 include site preparation, sample location selection, sample collection, and demobilization.

4.2.1 Site Preparation Activities

Site preparation activities to be conducted before the start of environmental sampling may include relocating or removing surface debris and equipment, constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones, 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.
- Install project-specific environmental monitoring TLDs (see Section 4.2.3 for additional information).
- Perform additional visual surveys 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 subsections.

4.2.2.1 Primary Releases

Decision I will be evaluated by measuring TED within sample plots established within the areas of the highest americium and gross count values as determined from walkover or driveover radiological surveys that will be conducted as part of the investigation. This will be done in an effort to find the location where the internal dose contributes the greatest amount to TED. At least one sample plot will be located in the area with the highest radiological survey values (indicating the area where the maximum dose would most likely be located).

For the determination of the extent of COC contamination, 100 additional sample locations will be established in a grid pattern over the site (see Figure A.8-5). Total effective dose rates at each of these sample locations will be estimated from one grab sample (internal dose) (0 to 5 cm) taken at each location and TLDs (external dose).

To determine whether subsurface (buried) contamination is present at the site, a minimum of 30 subsurface samples will be taken based on judgmental factors that may indicate buried contamination. Subsurface samples will be taken from areas biased toward test locations and elevated radiological surveys. Within these areas, sample locations will be biased toward

- presence of soil mounds,
- evidence of scraping,
- presence of non-native soils, or
- other biasing factors discovered in the field.

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 104, 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, and presence of 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.

Major drainages identified at CAU 104 will be visually surveyed to a distance of up to 1 mi for the presence of sediment accumulation areas, and radiological surveys will be performed. A sampling location will be established at the center of the nearest two sediment accumulation areas or at the location of the highest radiological reading. 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 a Thermo Electra. If the field-screening level (FSL) is exceeded in any depth sample, the 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, the surface sample will be submitted for analysis. If a COC is present at a sedimentation area, additional sedimentation areas will be identified and sampled until at least two sedimentation areas are found that do not contain a COC. Decision II will be resolved by the assumption that the entire volume of the drainage area where a COC is identified contains the COC.

For the lead-sheathed cables identified at the site, it will be assumed that the lead is PSM and requires corrective action. Judgmental samples will be taken at eight locations beneath and around the cables to determine whether lead has migrated to surrounding soil biased to the largest lead pieces. Six surface samples will be taken from the soil above the large asphalt-covered circle to determine whether VOCs and SVOCs have migrated to surrounding soils.

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 will be selected based on the CSM, biasing factors, field-survey results, existing data, and the outer boundary sample locations where COCs are detected. If COCs extend beyond sampled 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 104 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.
- Collect soil samples from locations outside the influence of releases from the CAU, if necessary.
- Perform radiological characterization surveys of construction materials and debris as necessary for disposal purposes.
- Record GPS coordinates for each environmental sample location.

For internal dose soil sampling for the primary release scenario, a probabilistic sampling approach will be implemented for the sampling of 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.8.1.2). External dose will be measured from a TLD installed at the approximate center of the sample plot, or at a TLD and grab sample location, at a height of 1 m and will be left in place for approximately 2,250 hours (equivalent to an annual industrial worker exposure). Additional judgmental samples will be collected to determine whether subsurface contamination is present at the site.

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 may 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.

4.2.4 Sample Management

The analytical program is presented in Section 3.2. 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 and certified that restoration activities have been completed.

5.0 Waste Management

Management of the waste generated during the CAU 104 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 solid waste, low-level radioactive, hazardous, hydrocarbon, *Toxic Substances Control Act* (TSCA) regulated, or mixed wastes.

Disposable sampling equipment, personal protective equipment (PPE), and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or debris (e.g., metal and concrete). 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 and 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 IDW that would otherwise be characterized and disposed as industrial solid 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 or wet decontamination over source locations, and carefully segregating waste streams.

5.2 Potential Waste Streams

The following waste streams have been included as potential waste streams that may require management and disposal:

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

5.3 Investigation-Derived Waste Management

The onsite management of IDW will be determined based on regulations associated with the particular waste type (e.g., industrial solid, 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 Solid Waste

Industrial solid 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. Industrial solid PPE and disposable sampling equipment generated at the CAU will be collected in plastic bags, sealed, labeled with the CAU number where 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 industrial solid 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 Area 9 U10c Industrial Waste Landfill. Additional waste streams characterized as industrial waste will be properly managed on a case by case basis and disposed at the Area 9 U10c Industrial Waste Landfill.

5.3.2 Hydrocarbon Waste

Hydrocarbon solid 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 through other methods 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 (NNSA/NSO, 2010). Potential radioactive waste drums containing soil, PPE, disposable sampling equipment, and/or rinsate may be staged and managed at a designated radioactive material area (RMA).

5.3.4 Hazardous Waste

Suspected 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). Hazardous waste will be characterized in accordance with the requirement of Title 40 CFR 261.

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.

5.3.6 Polychlorinated Biphenyls

Polychlorinated biphenyl contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. 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 CAU 104. 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*. 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 exposure is the standard in radiation safety and serves as the "legal dose of record" when other measurements are available. Specifically, 10 CFR Part 835.402 (CFR, 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:

- Radiological samples:
  - Field duplicates (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)
  - Laboratory QC samples (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)
- Chemical samples (if collected):
  - Trip blanks (1 per sample cooler containing VOC environmental samples)
  - Equipment rinsate blanks (1 per sampling event for each type of decontamination procedure)
  - Source blanks (1 per lot of uncharacterized source material that contacts sampled media)
  - Field duplicates (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)
  - Field blanks (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)
  - Laboratory QC samples (1 per 20 environmental samples or 1 per matrix, if less than 20 collected)

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 and 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 subsections (see Sections 6.2.3 through 6.2.8) discuss each of the DQIs that will be used to assess the quality of laboratory data. The criteria for precision and accuracy in Tables 3-4 and 3-5 may vary from corresponding information in the Industrial Sites QAPP as a result of changes in analytical methodology and laboratory contracts (NNSA/NV, 2002a).

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 104 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 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 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 CAU-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.

The TLDs will be analyzed using automated TLD readers that are calibrated and maintained in accordance with existing QC procedures for TLD processing by a laboratory that is certified through the DOE Laboratory Accreditation Program for dosimetry (Section 6.0). The data from this system meet rigorous data quality requirements and will be assessed for the listed DQIs before inclusion in

the CAU 104 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 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 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 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 3-4 and 3-5.

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 criterion is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants.

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 used for the samples. One LCS will be prepared with each batch of samples for analysis by a specific measurement.

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

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. Factors beyond laboratory control, such as sample matrix effects, can cause the measured

values to be outside of the established criteria. Therefore, the entire sampling and analytical process may be evaluated when determining the usability of the affected data.

The performance metric for assessing the DQI of accuracy on DQO decisions (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 metric is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants.

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 ensured 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 CAU.
- For Decision I probabilistic sampling, having a high degree of confidence that the sample locations selected will represent contamination of the CAU.
- 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 6.2.2, 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 3-4 and 3-5.

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 120 days to complete.

7.2 Records Availability

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

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 104, Area 7 Yucca Flat Atmospheric Test 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 CAU 104 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 104 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 104 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for CAU 104."

A.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO. The DQO planning team met on April 28, 2011, for the DQO meeting.

A.2.2 Conceptual Site Model

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

The CSM was developed for CAU 104 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of 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 CSM for CAU 104 is summarized in Table A.2-1 and discussed below. Table A.2-1 provides descriptions of 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 104 sources. Figure A.2-2 depicts a graphical representation of the CSM.

Table A.2-1
Conceptual Site Model Description of Elements for CAU 104
(Page 1 of 2)

Site Status	Sites are inactive and/or abandoned
Exposure Scenario	Occasional Use
Sources of Potential Soil Contamination	Atmospheric deposition of radionuclides from nuclear testing; spills, waste, infrastructure, and debris associated with testing support
Location of Contamination/ Release Point	Surface soil in annular pattern surrounding GZs; soil directly below debris
Amount Released	Unknown
Affected Media	Surface and shallow subsurface soil; debris such as concrete, metal, and wood
Potential Contaminants	Activation and fission products, unfissioned material; RCRA metals, VOCs, SVOCs

Table A.2-1
Conceptual Site Model Description of Elements for CAU 104
(Page 2 of 2)

Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside the boundaries of the CAU. Infiltration of precipitation through subsurface media serves as a minor driving force for migration of contaminants.
Migration Pathways	Vertical transport is expected to dominate over lateral transport due to infiltration.
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 of the CAU.
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, and dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.

A.2.2.1 Release Sources

Both a primary and other release scenario have been identified to address potential contamination at CAU 104 resulting from 30 atmospheric nuclear test conducted at the site.

The primary release is defined as the initial atmospheric deposition of radiological contaminants from nuclear tests and the subsequent mechanical movement or covering of these contaminants. The atmospheric deposition is generally observed as an annular geometric pattern of contamination from soil particle activation and initial fallout that generally decreases in intensity with distance from the source. Most of the atmospheric tests were conducted around two locations, one in the northern portion of the site and one in the southern portion of the site. As indicated by aerial radiation surveys shown in Figure 2-5, this may have resulted in the formation of two annular contamination plumes that converge at the center of the site.

The following identifies the primary release sources specific to CAU 104 (DOE/NV, 2000; GE, 1979):

- The Able (Buster) source was a weapons-related test with a yield of less than 0.1 kt detonated from a 100-ft tower on October 22, 1951.
- The Baker (Buster) source was a weapons-related test with a yield of 3.5 kt detonated in the air at 1,118 ft above ground surface on October 28, 1951.

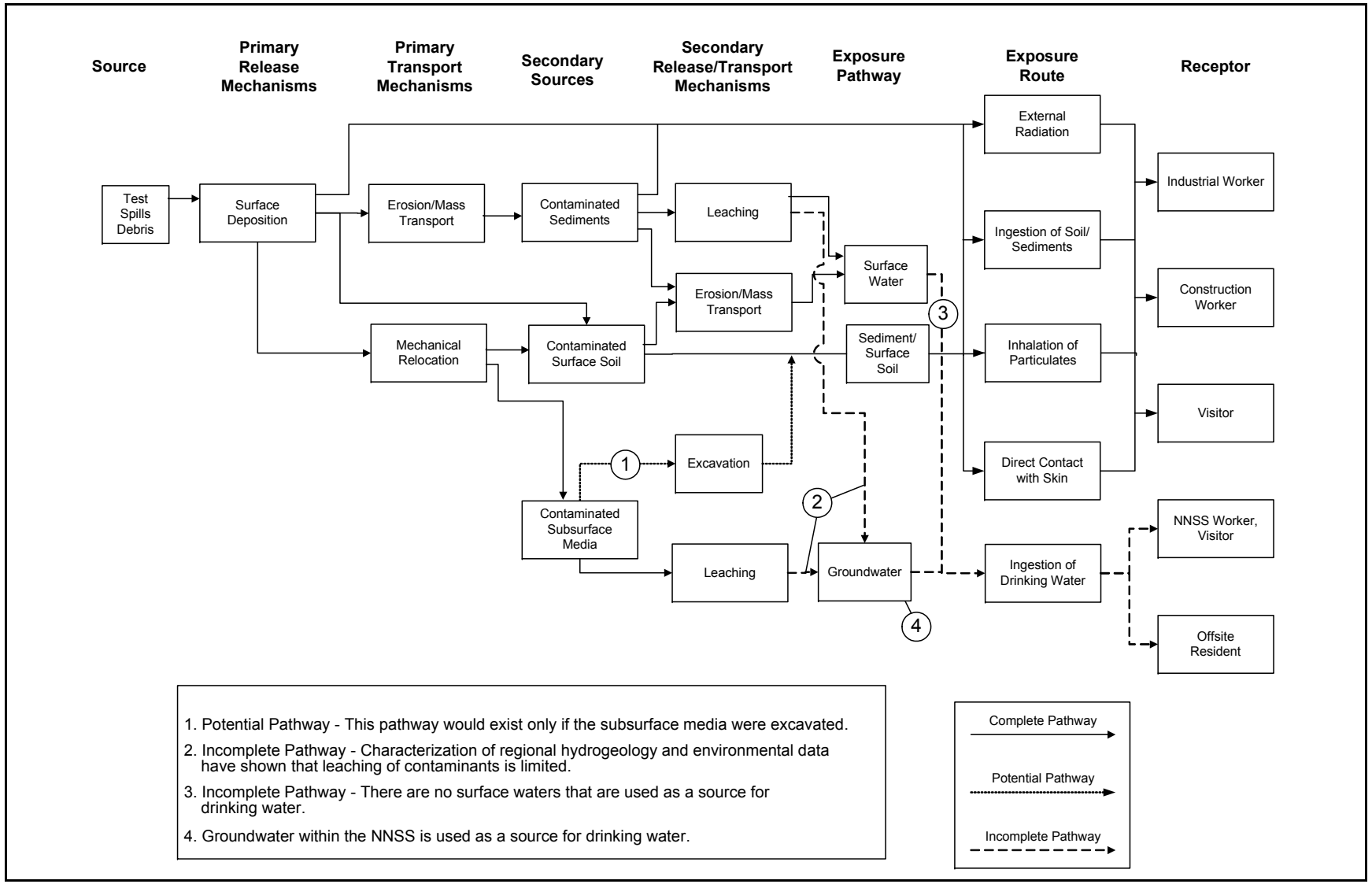

Figure A.2-1
Conceptual Pathways to Receptors

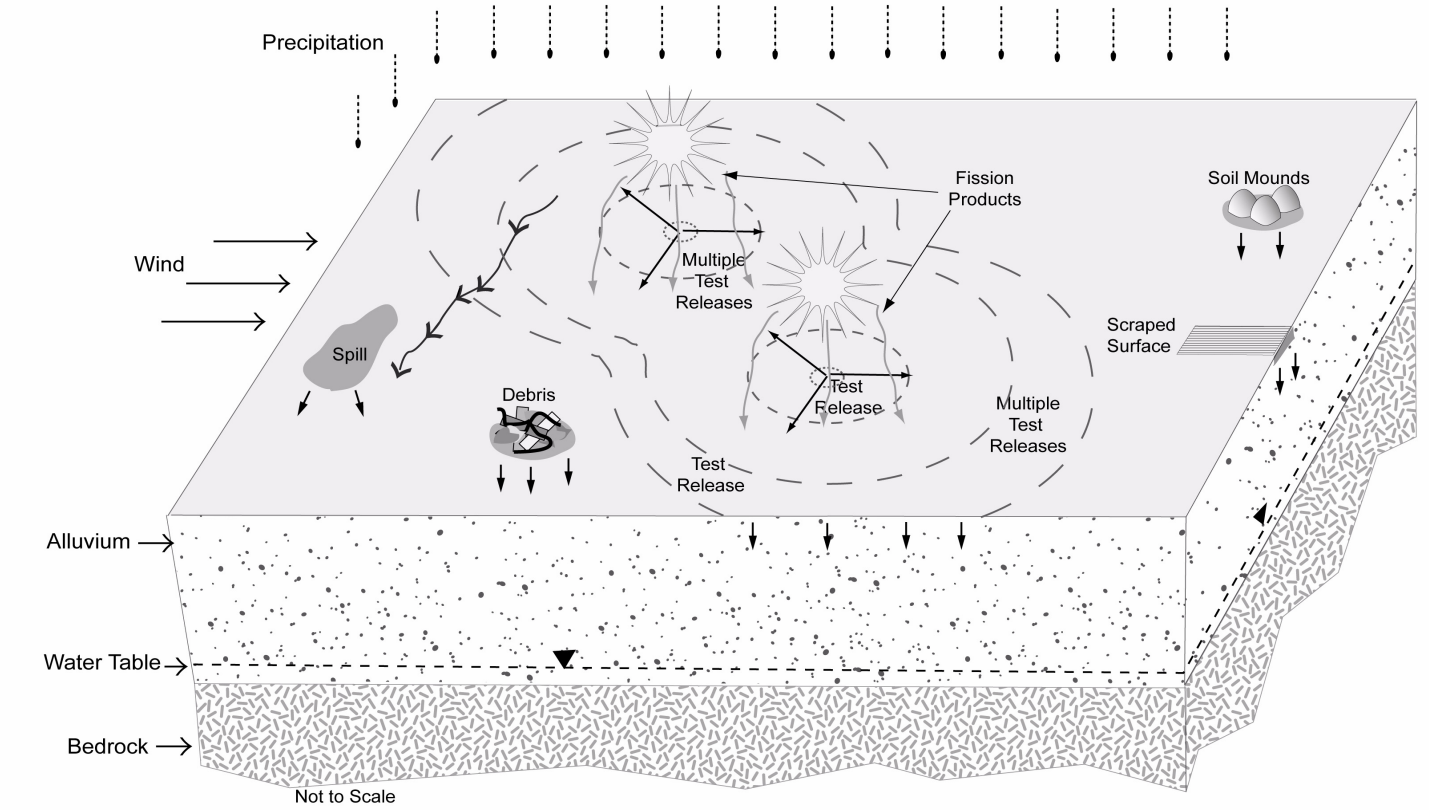

Figure A.2-2
Conceptual Site Model for CAU 104

- The Charlie (Buster) source was a weapons-related test with a yield of 14 kt detonated in the air at 1,132 ft above ground surface on October 30, 1951.

- The Dog (Buster) source was a weapons-related test with a yield of 21 kt detonated in the air at 1,417 ft above ground surface on November 1, 1951.

- The Easy (Buster) source was a weapons-related test with a yield of 31 kt detonated in the air at 1,314 ft above ground surface on November 5, 1951.

- The Baker (Tumbler-Snapper) source was a weapons-effects test with a yield of 1 kt detonated in the air at 1,109 ft above ground surface on April 15, 1952.

- The Charlie (Tumbler-Snapper) source was a weapons-related test with a yield of 31 kt detonated in the air at 3,447 ft above ground surface on April 22, 1952.

- The Dog (Tumbler-Snapper) source was a weapons-related test with a yield of 19 kt detonated in the air at 1,040 ft above ground surface on May 1, 1952.

- The Ruth source was a weapons-related test with a yield of 200 tons detonated from an approximately 305-ft tower on March 31, 1953.

- The Dixie source was a weapons-related test with a yield of 11 kt detonated in the air at 6,022 ft above ground surface on April 6, 1953.

- The Climax source was a weapons-related test with a yield of 61 kt detonated in the air at 1,334 ft above ground surface on June 4, 1953.

- The Wasp source was a weapons-effects test with a yield of 1 kt detonated in the air at 762 ft above ground surface on February 18, 1955.

- The Bee source was a weapons-related test with a yield of 8 kt detonated from a 500-ft tower on March 22, 1955.

- The Wasp Prime source was a weapons-related test with a yield of 3 kt detonated in the air at 739 ft above ground surface on March 29, 1955.

- The Zucchini source was a weapons-related test with a yield of 28 kt detonated from a 500-ft tower on May 15, 1955.

- The Boltzmann source was a weapons-related test with a yield of 12 kt detonated from a 500-ft tower on May 28, 1957.

- The Stokes source was a weapons-related test with a yield of 19 kt detonated from a balloon at 1,500 ft above ground surface on August 7, 1957.

- The Doppler source was a weapons-related test with a yield of 11 kt detonated from a balloon at 1,500 ft above ground surface on August 23, 1957.

- The Franklin Prime source was a weapons-related test with a yield of 4.7 kt detonated from a balloon at 750 ft above ground surface on August 30, 1957.

- The Laplace source was a weapons-related test with a yield of 1 kt detonated from a balloon at 750 ft above ground surface on September 8, 1957.

- The Newton source was a weapons-related test with a yield of 12 kt detonated from a balloon at 1,500 ft above ground surface on September 16, 1957.

- The Eddy source was a weapons-related test with a yield of 83 tons detonated from a balloon at 500 ft above ground surface on September 19, 1958.

- The Mora source was a weapons-related test with a yield of 2 kt detonated from a balloon at 1,500 ft above ground surface on September 29, 1958.

- The Hidalgo source was a safety experiment with a yield of 77 tons detonated from a balloon at 377 ft above ground surface on October 5, 1958.

- The Quay source was a weapons-related test with a yield of 79 tons detonated from a 100-ft tower on October 10, 1958.

- The Lea source was a weapons-related test with a yield of 1.4 kt detonated from a balloon at 1,500 ft above ground surface on October 13, 1958.

- The Dona Ana source was a weapons-related test with a yield of 37 tons detonated from a balloon at 450 ft above ground surface on October 16, 1958.

- The Socorro source was a weapons-related test with a yield of 6 kt detonated from a balloon at 1,450 ft above ground surface on October 22, 1958.

- The De Baca source was a weapons-related test with a yield of 2.2 kt detonated from a balloon at 1,500 ft above ground surface on October 26, 1958.

- The Santa Fe source was a weapons-related test with a yield of 1.3 kt detonated from a balloon at 1,500 ft above ground surface on October 30, 1958.

A large portion of the surface area of CAU 104 has been disturbed, and it is likely there is buried contamination at the site due to site activities throughout the seven years of atmospheric testing and additional site activities after the atmospheric testing. Between tests at the site, different methods were used to lower radioactivity at the site, including scraping and/or covering with clean fill

(Harris et al., 1981). Additional clearing and grading occurred as various structures were constructed and areas were cleared to set up various tests at the site (Preuss, 1953; Richmond, 1953; Jackson, 1993). Review of aerial photos indicates that most of the ground surface shows signs of disturbance, as can be seen in Figure 2-1.

Other releases are defined as any release not included in the primary release, such as those from spills or wastes found at the site during the investigation, or contamination that has migrated as a result of wind or water. Four parallel berms run south from Bunker 7-300 along the 7-01 Road for an unknown distance. Partially buried lead-sheathed cable debris, as shown in Figure 2-3, is dispersed intermittently across these berms and will be addressed as an other release. A large (approximately 0.5-mi-diameter) circle at the center of the site is covered with degraded asphalt, shown in Figure 2-4 will also be addressed as an other release.

A.2.2.2 Potential Contaminants

The CAU-specific COPCs are based on a conservative evaluation of possible site activities considering the incomplete site histories and contaminants found at similar NNSS sites. The COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CAU. The list of COPCs is intended to encompass all of the significant contaminants that could potentially be present at the CAU. Significant contaminants are defined as contaminants that are present at concentrations exceeding the PAL. The COPCs applicable to primary release Decision I environmental samples from CAU 104 are Am-241; Pu-238, -239/240, -241; U-234, -235, -238; Cs-137; and Sr-90. These radionuclides are reported from the analytical methods gamma spectroscopy, isotopic U, isotopic Pu, isotopic Am, Pu-241, and Sr-90 as identified in Table 3-1.

The COPCs applicable to other release Decision I environmental samples for identified other releases at CAU 104 are defined as lead for lead-sheathed cables and VOCs and SVOCs for asphalt as identified in Table 3-1. Additional analyses requested will be determined for other potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks) and may include RCRA metals, VOCs, SVOCs, and PCBs.

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.

As stated in the document *Subsurface Nobel Gas Transport at the Nevada Test Site* (Thompson et al., 1997), the Cambric event at the NNSS was used to study long-term radionuclide migration from the underground detonation of a nuclear device. The Cambric test (with a yield of 750 tons) was conducted below the water table in Frenchman Flat in 1965. A well 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.

Like the Cambric event, the devices used at CAU 104 were plutonium and uranium devices and COPCs include their fission products. Radionuclides associated with these detonations (Am-241; Pu-238, -239/240, -241; U-234, -235, -238; Cs-137; and Sr-90) are generally characterized as having high absorption characteristics and 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. The physical setting of CAU 104, including topography and meteorological data, is presented in Section 2.1.

Corrective Action Unit 104 is located in Area 7 of the NNSS in Yucca Flat. The area is relatively flat, gently sloping to the southeast. The area is sparsely vegetated with native plants. The soil at CAU 104 is made up of sand to cobble-sized alluvium of various lithologies and includes large areas of disturbed and/or non-native soil. No perennial streamflow exists in the region. Ephemeral streams are present and flow in a general southwest direction toward Yucca Flat Dry Lake.

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 referred to as sedimentation areas. Other migration pathways for contamination from the sites include windborne material and materials mechanically displaced from maintenance or construction activities (e.g., moved during road maintenance). Specifically, this can include activities such as decontamination and demolition of facilities, investigation and resolution of CASs, and disassembly and removal of equipment and support structures.

Migration is influenced by the chemical characteristics of the contaminants (Section A.2.2.3) and the physical characteristics of the vadose material (Section A.2.2.4). In general, the contaminants that are reasonably expected to be present at CAU 104 (i.e., radionuclides, RCRA metals, VOCs, SVOCs,

and PCBs) 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, medium water-holding capacity, and relatively long distances to groundwater (e.g., 1,853 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. [Yucel, 2009]) and limited precipitation for this region [6.4 in. per year at Station BJY] [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 104 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 CAU land-use zone and exposure scenario are based on NNSS current and future land use. Corrective Action Unit 104 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.

The Occasional Use Area exposure scenario assumes exposure to industrial workers who are not assigned to the area as a regular work location but may occasionally use the area for intermittent or

short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 8 hours per day, 10 days per year, for 5 years (NNSA/NSO, 2006).

Corrective Action Unit 104 is 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).

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 resolving the problem statement, 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 CAU?" 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 feasibility of remediation alternatives

A corrective action will be determined for any site containing a COC. Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. Decision II samples for both release scenarios will be submitted to define the extent of unbounded COCs. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

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

To evaluate the potential for wastes to result in the introduction of a COC to the surrounding environmental media, the following conservative assumptions were made:

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

If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:

- For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste. 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 (following degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). 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.

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 resolve the problem statement depending on the possible outcomes of the investigation.

A.3.2.1 Alternative Actions to Decision I

If a COC associated with a release from the CAU is not detected, then further assessment of the CAU is not required. If a COC associated with a release from the CAU 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, then additional information will be collected. If sufficient information is not available to evaluate potential CAAs, then additional samples will be collected. Otherwise, collection of additional information is not required.

A.4.0 Step 3 - Identify Information Inputs

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

A.4.1 Information Needs

To resolve Decision I (determine whether a COC is present at a CAU), 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 CAU (probabilistic sampling)
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To resolve Decision II for primary release contamination, samples need to be collected and analyzed to meet the following criterion:

- A decreasing trend of TED rates needs to be established sufficiently to determine a correlation to radiation survey isopleths in such a way that a boundary can be determined around the area posing a more than 25-mrem/yr dose (based on the appropriate exposure scenario).

To resolve Decision II for other release contamination (determine whether sufficient information is available to evaluate potential CAAs), 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 CAU 104 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 CAU (probabilistic). These sample locations, therefore, can be selected by means of either biasing factors used in judgmental sampling (e.g., elevated radiation surveys, stains, spilled substances) or randomly using a probabilistic sampling design. The implementation of a judgmental approach for sample location selection, and of a probabilistic sampling approach, for CAU 104 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 3-4 and 3-5.

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

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

A.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 – 1 ft below original ground surface
- Vertical: Other release – 15 ft bgs
- Horizontal: Primary and other releases – 1 mi from each GZ or location of release

Contamination found beyond these boundaries may indicate a flaw in the CSM and may require reevaluation of the CSM before the investigation could continue. The CAU 104 CASs are considered geographically independent, and intrusive activities are not intended to extend into the boundaries of neighboring CASs included in other CAUs.

A.5.3 Practical Constraints

Practical constraints—such as activities by other organizations at the NNSS, utilities, threatened or endangered animals and plants, unstable or steep terrain, and/or access restrictions—may affect the ability to investigate this site. Practical constraints that have been identified specific to CAU 104 include the presence of unstable subsidence craters from underground testing.

A.5.4 Define the Sampling Units

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

A.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 CAU (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 measured TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the measured TED were significantly different from the true TED, a decision based on the measured 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 measured TED. This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED measurements. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the measured 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 and zinc will be used instead of screening levels when natural background concentrations exceed the screening level (e.g., arsenic on the NNSS). Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by the EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.6.2.2 Radionuclide PALs

The PAL for radioactive contaminants is 25-mrem/yr 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). 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 (Murphy, 2004). 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 will be established using the following equation:

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

Table A.6-1
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

Source: Anagnostopoulos, 2010

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. Specific input parameters are used to calculate the RRMGs for each exposure scenario where the area of contamination is equal to 1,000 m^2 and depth of contamination equal to 5 cm.

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 CAU 104, 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 waste characterization samples, 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 CAU. 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 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 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 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 Sections 6.2.3 through 6.2.8.

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 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 in accordance with established and approved procedures and only clean sample containers will be used. To determine whether a false positive analytical result may have occurred, the following QC samples will be collected as required by the Industrial Sites QAPP (NNSA/NV, 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, additional if field conditions change)

For probabilistic sampling, a 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.7.2.2.

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 subsurface primary releases as described in Section A.8.1.3 and 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 to locate Decision I sample plots for the primary release scenario. Four Decision I sample plots will be placed within the areas of the highest americium or gross count values as determined from additional walkover or driveover radiological surveys. This will be done in an effort to bias locations to areas of the highest internal and external dose. The areas for the additional, more focused radiological surveys were identified based on preliminary surveys and are shown in Figure A.8-1. These locations may change if additional information is received regarding the radiological conditions of the site before sampling.

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.8-2 for an example of this sampling scheme). If sufficient sample material cannot be collected at a specified location (e.g., due to rock, caliche or buried concrete), the sample will be collected from the nearest location that a sample can be obtained.

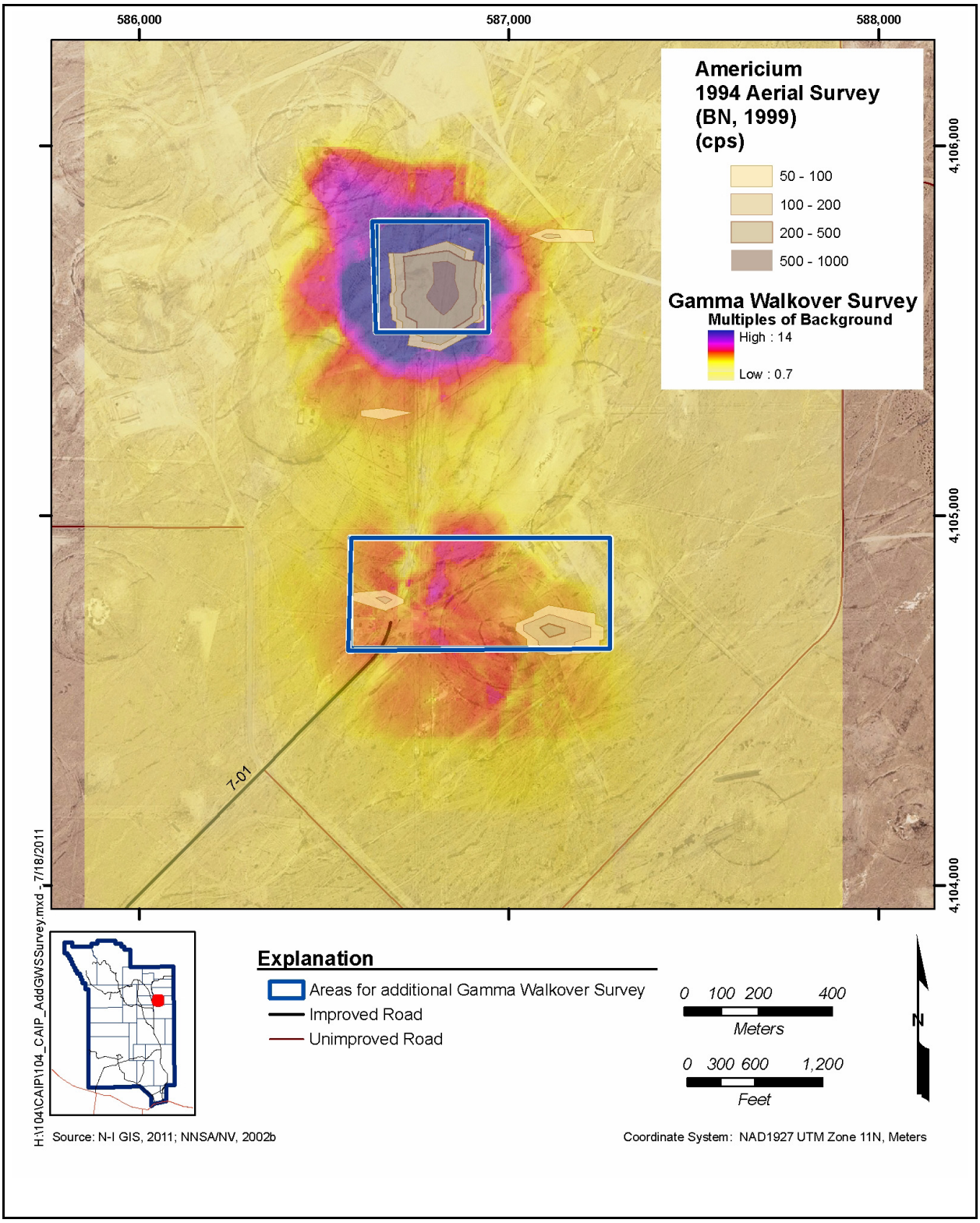

Figure A.8-1
CAU 104 Potential Decision I Sample Plot Locations

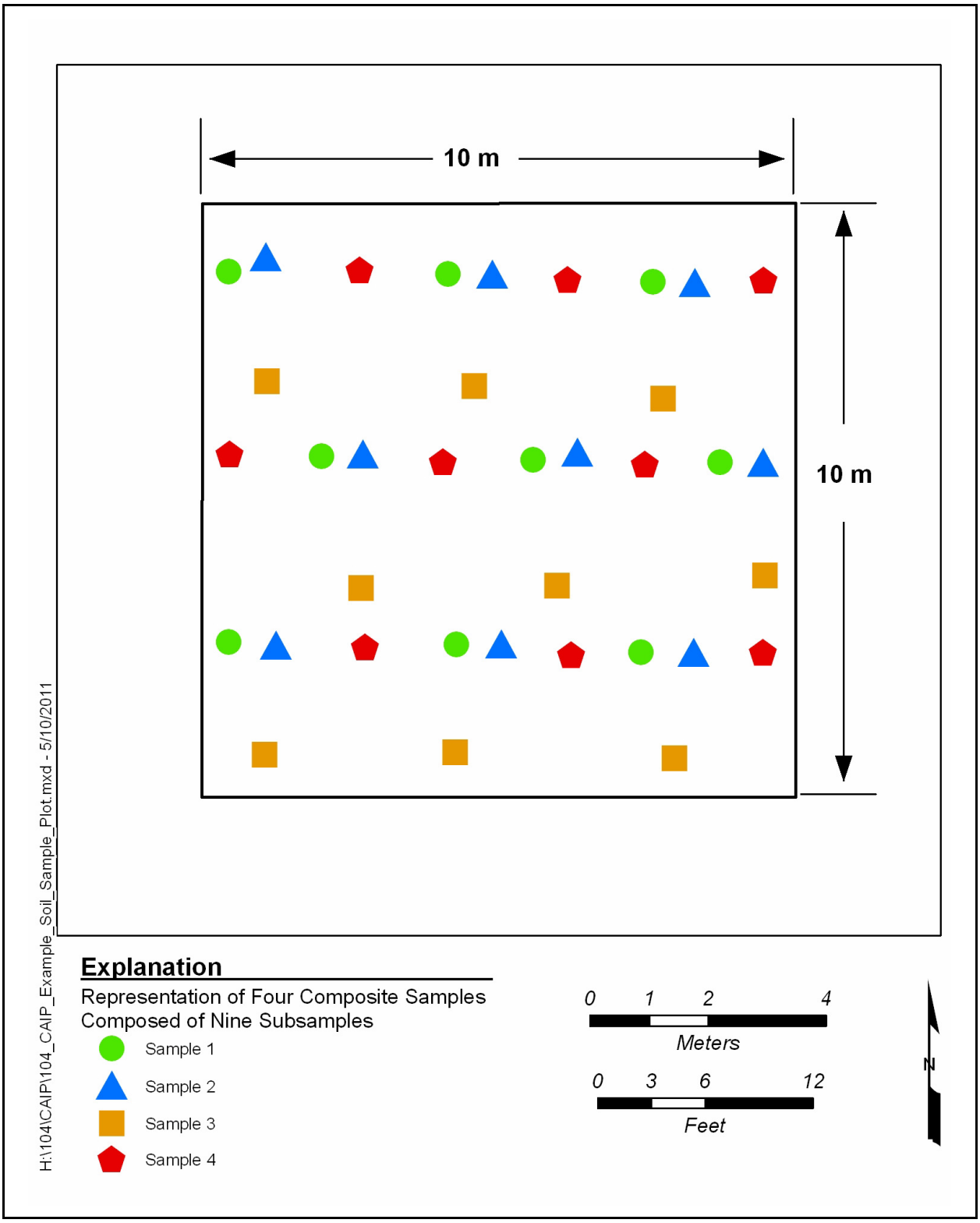

Figure A.8-2
Example Sample Plot

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.
- 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 (e.g., Trinity glass) greater than 0.25-in. diameter that cannot effectively be inhaled or ingested.
- The entire volume of the composited material collected will be submitted to the laboratory for analysis.

An example of the predetermined sample locations at one plot is shown in Figure A.8-2

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 individual internal dose rates associated with each of the composite samples and the external dose rates from the TLD elements. The minimum number of samples required for each sample location will be calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum sample size will be 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 are 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.

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 probabilistic sample location, one of the following actions may be taken:

- Additional sample(s) may be collected.
- Conservatively assume that the TED for the location 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.8.1.3 Determination of Buried Contamination

The CSM includes the possibility of buried contamination in disturbed areas (where the surface soil has been disturbed by excavation or scraping or where it has been covered by asphalt or imported soil) (Section 2.4). Subsurface samples will be collected in these areas to determine whether buried contamination exists. If buried contamination exists, it will be conservatively assumed that the highest level of contamination observed (from surface or subsurface samples) provides dose to site workers. Judgmental screening samples will be taken in disturbed areas at locations biased toward test locations and elevated radiological surveys. Figure A.8-3 shows general areas that have been identified as likely to have higher levels of contamination based on test locations and radiological surveys. Within these general areas, screening sample locations will be identified in disturbed areas based on biasing factors for ground disturbance including soil mounds, evidence of scraping,

presence of non-native soils, or other biasing factors discovered in the field. When screening sample locations have been identified, screening samples will be taken in the following manner:

- Samples will be screened with an alpha/beta radiation meter.
- Six 5-cm intervals will be sampled until 30 cm or native soil is encountered.

If the disturbed soil is not deep enough to allow for six sample intervals (i.e., less than 30 cm), samples will be taken at 5-cm intervals until native soil is encountered. Figure A.8-4 provides example sampling intervals for disturbed ground and soil mounds. If screening results are not significantly different (at least 50 percent difference between samples) from the surface results, it will be assumed that buried contamination does not exist. If screening results are significantly different from the surface results, it will be assumed that buried contamination exists.

A.8.2 External Dose Sampling for Primary Releases

External dose will be determined by collecting in situ measurements using TLDs. External dose measurements will be taken at the approximate center of each sample plot or TLD location at a height of 1 m (3.3 ft). One hundred TLDs will be located in a grid pattern covering the site (Figure A.8-5).

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.

As the FALs are defined as contaminant concentrations or dose from NNSS activities, they do not include concentrations or dose from naturally occurring chemicals or radionuclides (i.e., natural background). Therefore, external dose from NNSS activities will be assumed to be any dose that exceeds background values (i.e., background dose will be subtracted from the total dose recorded on the TLD). Eight TLDs will be placed in background areas (i.e., beyond the influence of the CAU 104 releases). These locations were selected based on background isopleths developed from the 1994 aerial survey (BN, 1999) and are shown in Figure A.8-6. Background dose from control and background TLDs will be subtracted from the total dose from field TLD elements.

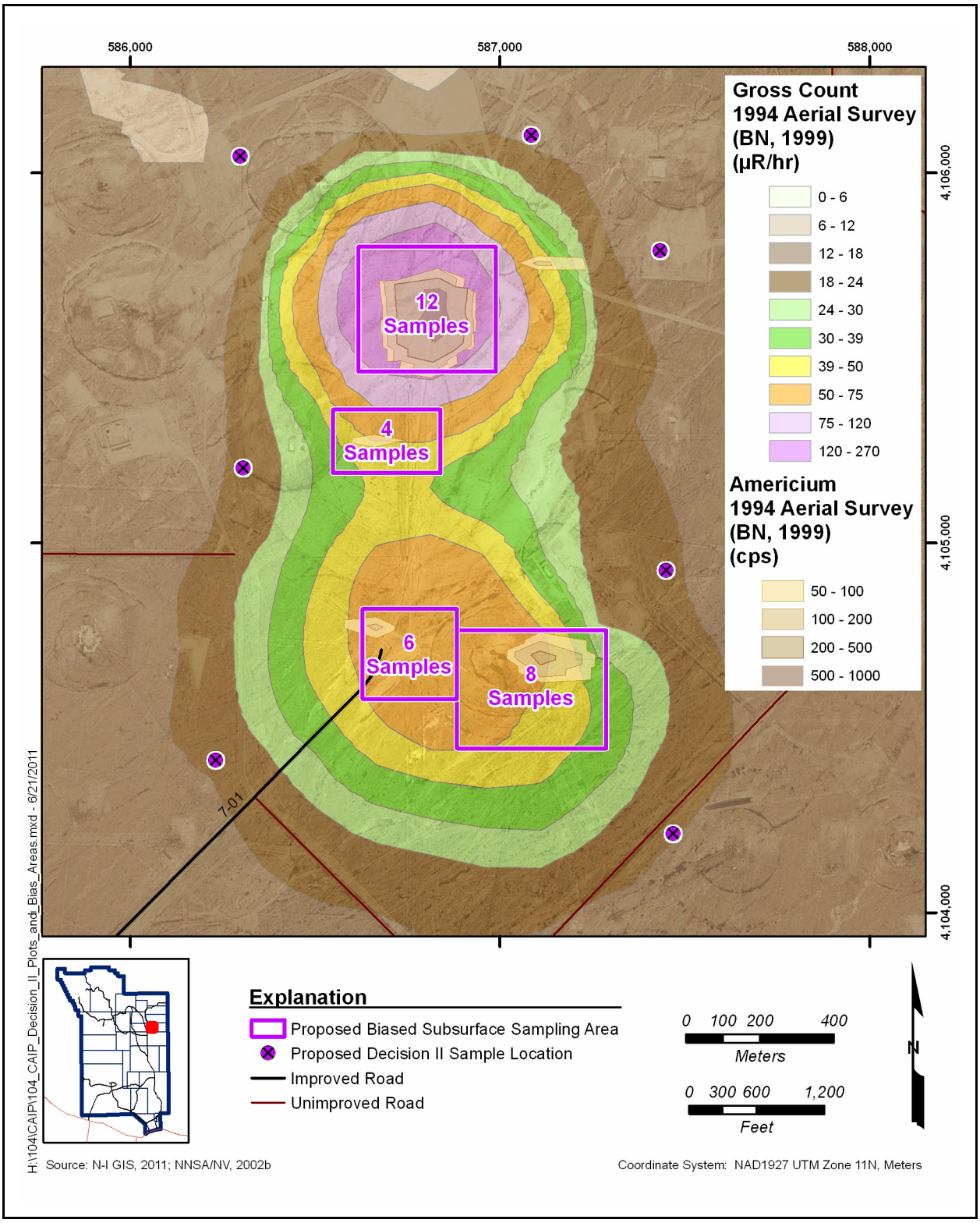

Figure A.8-3
CAU 104 Subsurface Sample Locations

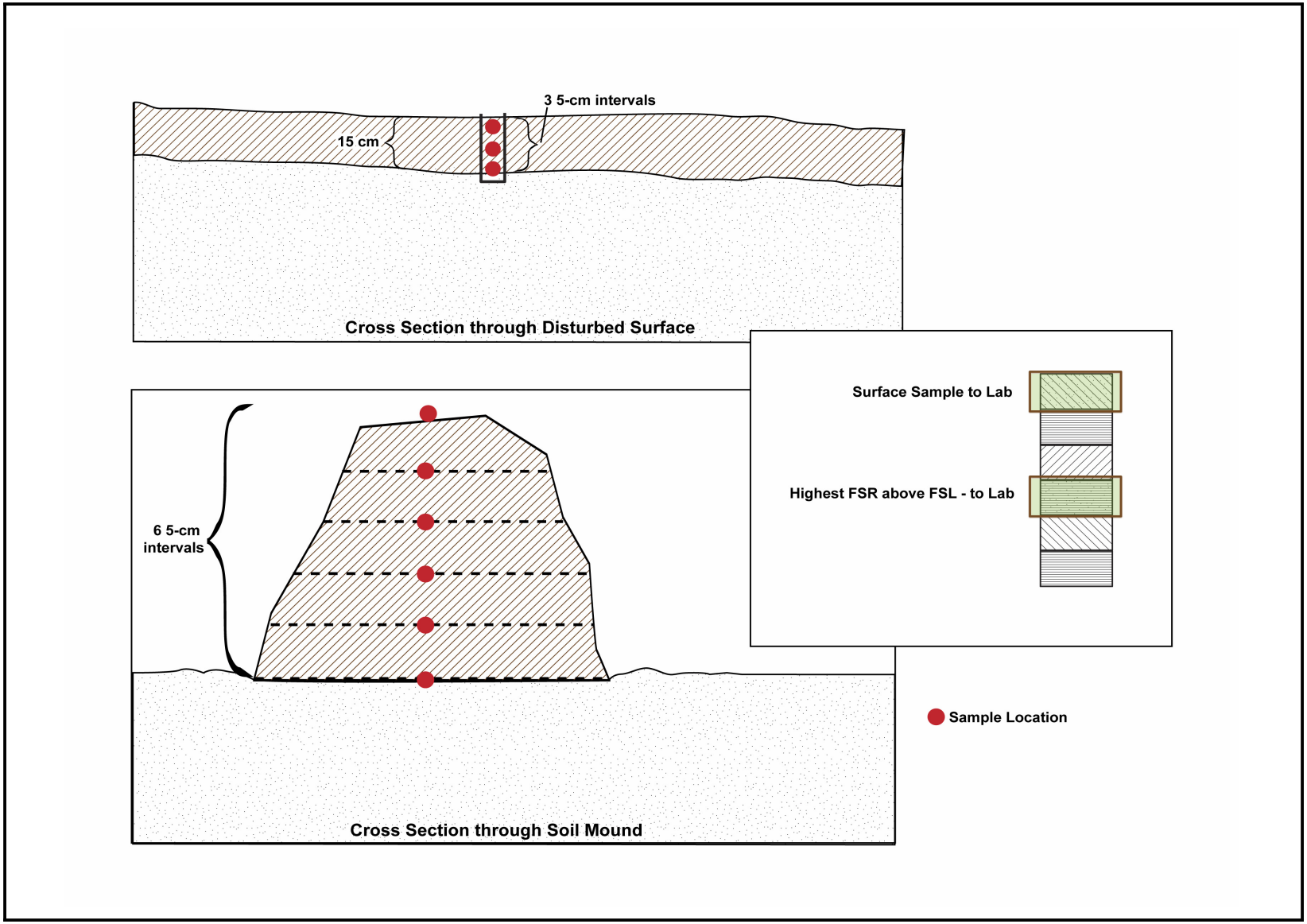

Figure A.8-4
CAU 104 Subsurface Sample Intervals

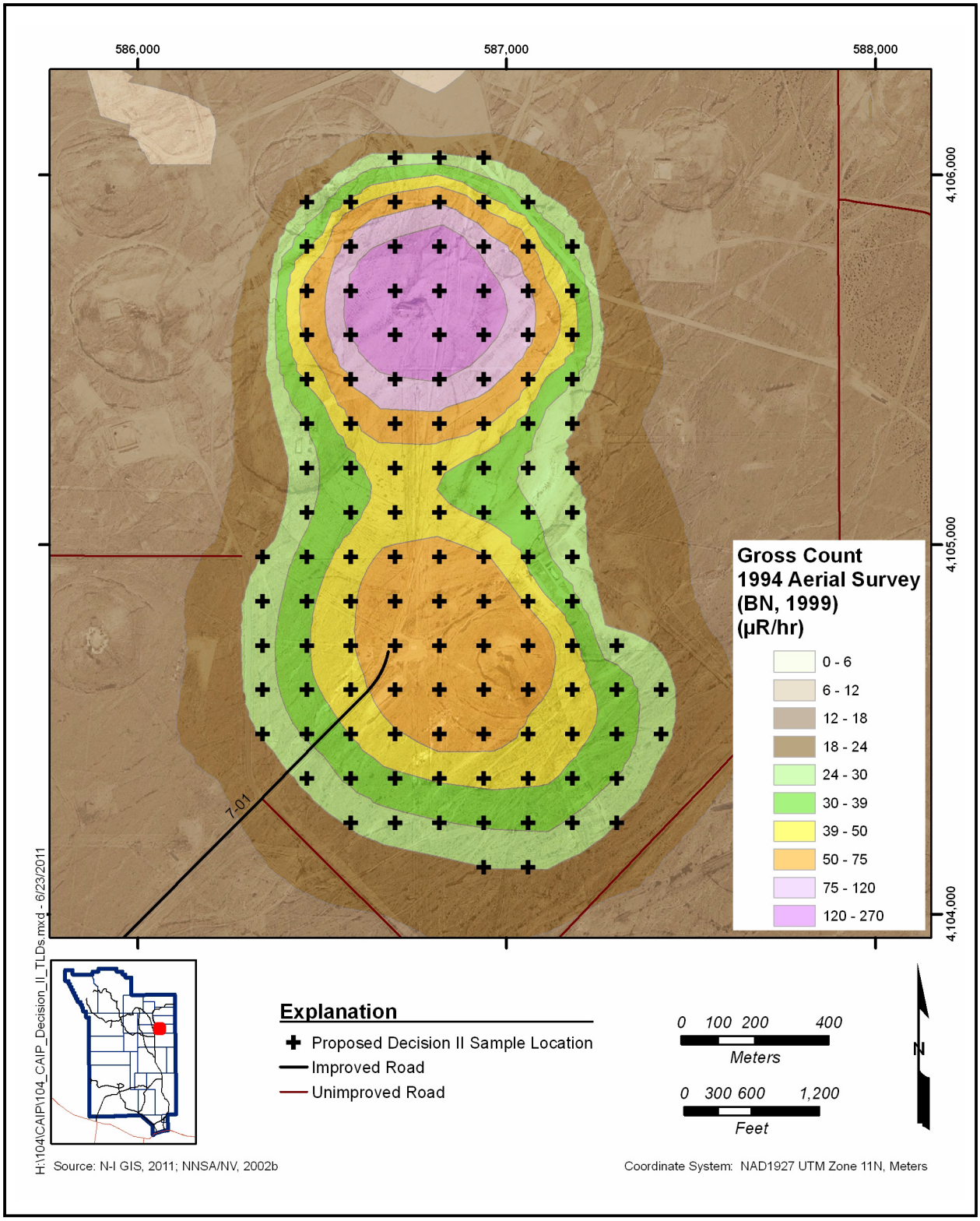

Figure A.8-5
CAU 104 Decision II Sample Locations

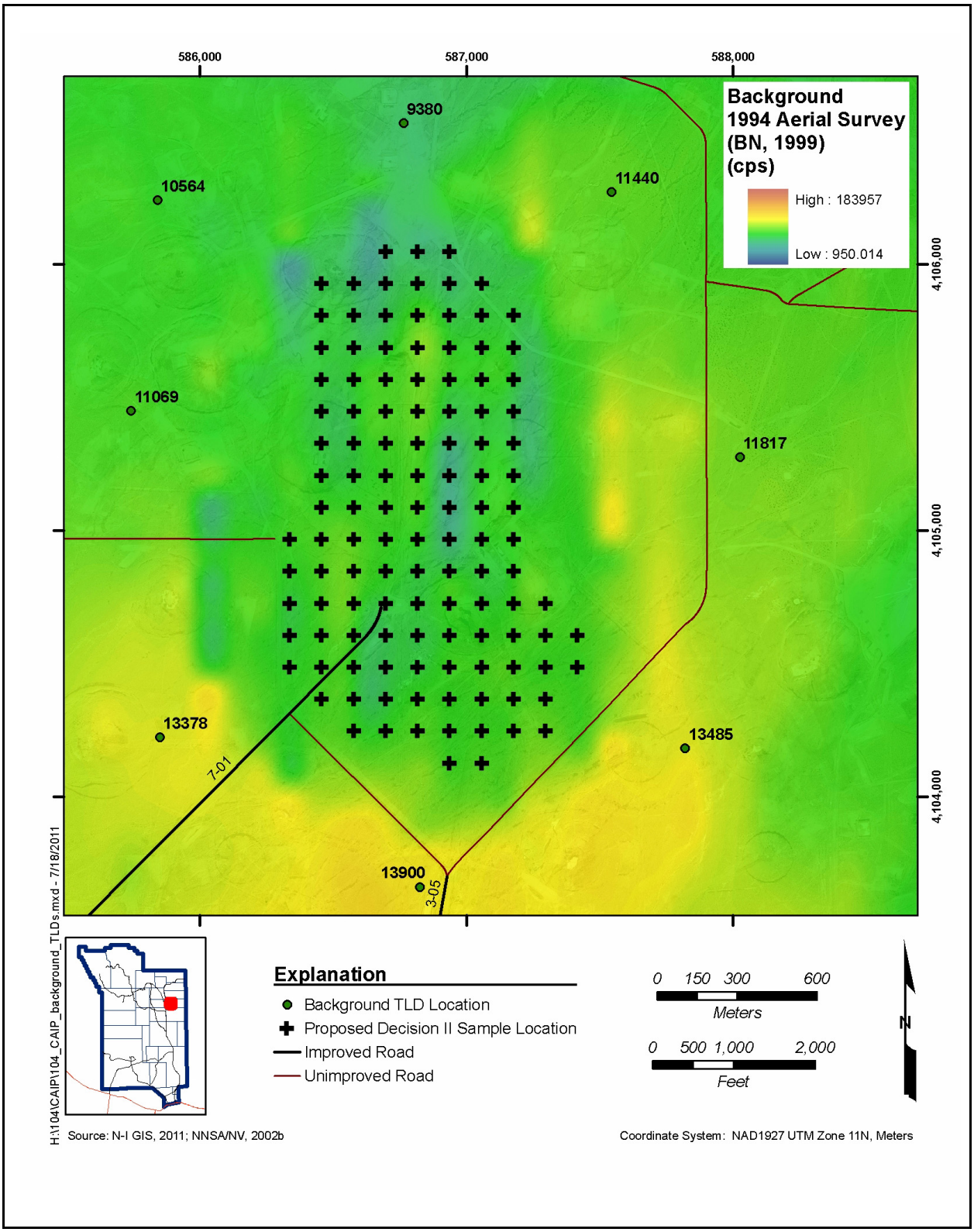

Figure A.8-6
CAU 104 Background TLD Locations

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. External dose at each TLD location is 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.

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

A.8.3 Evaluation of TED for Primary Releases

The 95 percent UCL of the TED from each probabilistic sample location, as discussed in Section A.6.1.2, 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 TED from each sample location and an appropriate gamma radiation survey isopleth. A relationship will be established of the TED with gamma radiation survey values such that a gamma radiation survey value can be established that corresponds 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.

If subsurface contamination is present at levels greater than surface contamination (Section A.8.1.3), a determination of the initial corrective action boundary will be made based on visual observation of disturbed surface area. This determination will be confirmed with Decision II subsurface samples taken at the proposed boundary, as shown in Figure A.8-3.

A.8.4 Sampling for Other Releases

Sample locations for other releases will be determined based upon the likelihood of a contaminant release. These locations will be selected based on the identification of biasing factors during the investigation. For the investigation of drainages, sample locations will be the center of the sediment collection areas or areas with the highest radiological readings. Other releases identified at the site include lead-sheathed cables that will sampled for RCRA metals, and decaying asphalt that will be sampled for VOCs and SVOCs.

For any additional other releases discovered during the investigation, biasing factors such as stains, radiological or geophysical survey results, and presence of 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.

The following factors will also be considered in selecting locations for other release samples at CAU 104:

- Documented process knowledge on source and location of release (e.g., volume of release).
- Stains: Any spot or area on the soil surface that may indicate the presence of a potentially hazardous liquid. Typically, stains indicate an organic liquid, such as an oil, has reached the soil and may have spread out vertically and horizontally.
- Pre-selected areas based on survey data: Locations for which evidence such as the 1994 aerial radiological survey (BN, 1999) provides a basis upon which sample plots can be designated (e.g., man-made gross counts).
- Radiological survey anomalies: Radiological survey results that are significantly higher than the surrounding area.

- Geophysical anomalies: Geophysical survey results that are not consistent with the surrounding area (e.g., results indicating buried concrete or metal, surface metallic objects).

- 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, 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.

- Previous sample results: Locations that may reasonably have been contaminated based upon the results of previous field investigations.

- Experience and data from investigations of similar sites.

- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.

- Odor.

- Other biasing factors: Factors not previously defined for the CAI that become evident once the investigation of the site is under way.

A.8.4.1 Decision I

A judgmental sampling design will be implemented for other releases to establish sample locations and evaluate sample results. For 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 in developing a sampling design. If good prior information about the target site of interest is available, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area (EPA, 2006).

All other release sample locations will be selected to satisfy the DQI of representativeness in that samples collected from selected locations will best represent the populations of interest as defined in Section A.5.1. To meet this criterion for other releases, a biased sampling strategy will be used to target areas with the highest potential for contamination, if it is present anywhere in the CAU. Sample locations will be determined based on process knowledge, previously acquired data, or the 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 this DQO.

A.8.4.1.1 Drainages

The nearest identifiable drainage to CAU 104 flows across the site in a southwest direction toward Yucca Flat Dry Lake. This drainage will be visually surveyed to a distance of 1 mi from the center of CAU 104 for the presence of sediment accumulation areas to identify all sediment collection areas and radiologically surveyed to identify any other areas of high radioactivity. A sampling location will be established at the center of the nearest two sediment accumulation or high radioactivity areas outside the initial corrective action boundary (established using walkover survey data). At each location, samples will be taken as described in Section A.8.1.3.

A.8.4.1.2 Lead-Sheathed Cable

Four parallel berms run south from Bunker 7-300 along the 7-01 Road for an unknown distance. Partially buried lead-sheathed cable debris (Figure 2-3) is dispersed intermittently across these berms. Samples will be taken from eight locations along both exposed and buried sections of the cables to determine whether the lead has leached into the surrounding soil.

A.8.4.1.3 Asphalt

A large (approximately 0.5-mi-diameter) circle at the center of the site is covered with degraded asphalt (Figure 2-4). Six to eight samples will be taken from soils above the asphalt to determine whether VOCs and SVOCs have migrated to the surrounding soil.

A.8.4.1.4 Other Potential Releases

During the course of the CAU 104 investigation, the identification of any biasing factors will be used to determine whether a potential release is present (e.g., stains, spills, debris). Samples will be collected from the material that presents the greatest degree of the biasing factor identified (surface or subsurface as discussed above). Specific analyses requested for these samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

A.8.4.2 Decision II

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

Decision II samples for other releases, including the lead-sheathed buried cables and asphalt, 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 be at least as deep as the vertical extent of contamination defined at the Decision I location and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The Task Manager or Site Supervisor may modify the number, location, and spacing of step-out locations as warranted by site conditions.

A.8.5 Establishment of Final Corrective Action Boundary

The final corrective action boundary will be established to include the initial corrective action boundary and any additional areas that exceed the FAL from the other releases (e.g., spills, waste, or the migration of contamination in drainages).

A.9.0 References

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

ASTM, see ASTM International.

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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 Comments

(1 Page)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: CAU 104, Area 7 Yucca Flat Atmospheric Test Sites, Draft CAIP	2. Document Date: July 2011
3. Revision Number: 0	4. Originator/Organization: N-I
5. Responsible DOE NNSA/NSO Subproject Mgr.: Kevin Cabble	6. Date Comments Due: August 17, 2011
7. Review Criteria: Complete Document	
8. Reviewer/Organization Phone No.: Combined Internal Comments	9. Reviewer's Signature: n/a

10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept/Reject
Multiple		Although not done in response to specific comments from NDEP, changes have been made to a few sections of the document to add to the clarity of the document. These changes have not affected the sampling strategy or approach to closing CAU 104 and have not added or deleted any requirements.	1. The sentence "Specific input parameters used to calculate the RRMGs for each exposure scenario were area of contamination equal to 100 m^2 and depth of contamination equal to 5 cm" appears on page 39 and A-26. This sentence was changed to add clarity, and also to correct 100 m^2 to 1,000 m^2, which was a typographic error. The corrected sentence reads: "Specific input parameters **are** used to calculate the RRMGs for each exposure scenario **where the** area of contamination **is** equal to **1,000** m^2 and depth of contamination equal to 5 cm." 2. Unnecessary detail was removed from Sections 5.3.5 and 5.3.6. No requirements were added or deleted.	

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to NNSA/NSO Environmental Restoration Division, Attn: QAC, M/S 50

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