Nevada
Environmental
Management
Operations Activity

DOE/NV--1486

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

September 2012

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

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
Telephone: 800.553.6847
Fax: 703.605.6900
E-mail: *orders@ntis.gov*
Online Ordering: *http://www.ntis.gov/help/ordermethods.aspx*

Available electronically at *http://www.osti.gov/bridge*

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Phone: 865.576.8401
Fax: 865.576.5728
Email: *reports@adonis.osti.gov*

DOE/NV--1486

CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 105: AREA 2 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

Controlled Copy No.: ___

Revision No.: 0

September 2012

CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 105:
AREA 2 YUCCA FLAT ATMOSPHERIC TEST SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 9/17/2012

Tiffany A. Lantow
Soils Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 9/17/12

Robert F. Boehlecke
Environmental Management Operations Manager

Table of Contents

***Table of Contents** (Continued)*

Table of Contents (Continued)

Table of Contents *(Continued)*

List of Figures

List of Tables

List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
agl	Above ground level
Al	Aluminum
Am	Americium
ASTM	ASTM International
bgs	Below ground surface
BJY	Buster Jangle Y
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
Ci	Curie
cm	Centimeter
Cm	Curium
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy

List of Acronyms and Abbreviations *(Continued)*

DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
GPS	Global Positioning System
GZ	Ground zero
HASL	Health and Safety Laboratory
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
in./yr	Inches per year
K	Potassium
keV	Kiloelectron volt
kt	Kiloton
LCS	Laboratory control sample
m	Meter
mi	Mile
mL/g	Milliliters per gram
mm/yr	Millimeters per year
mrem/IA-yr	Millirem per Industrial Area year
mrem/OA-yr	Millirem per Occasional Use Area year

List of Acronyms and Abbreviations *(Continued)*

mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NAD	North American Datum
Nb	Niobium
nCi/m^2	Nanocuries per square meter
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
NNSSWAC	*Nevada National Security Site Waste Acceptance Criteria*
Np	Neptunium
Pa	Proactinium
PAH	Polyaromatic hydrocarbon
PAL	Preliminary action level
Pb	Lead
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PET	Potential evapotranspiration
PPE	Personal protective equipment
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan

List of Acronyms and Abbreviations *(Continued)*

QC	Quality control
RAD	Radiation
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
R/hr	Roentgens per hour
RIDP	Radionuclide Inventory and Distribution Program
RMA	Radioactive material area
RRMG	Residual radioactive material guideline
RSL	Remote Sensing Laboratory
RWMS	Radioactive waste management site
SG	Study group
SOW	Statement of Work
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
Tc	Technetium
TED	Total effective dose
Th	Thorium
Tl	Thallium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
TSCA	*Toxic Substances Control Act*
U	Uranium

List of Acronyms and Abbreviations (Continued)

UCL	Upper confidence limit
USGS	U.S. Geological Survey
UST	Underground storage tank
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
yd^3	Cubic yard
μR/hr	Microroentgens per hour

Executive Summary

Corrective Action Unit (CAU) 105 is located in Area 2 of the Nevada National Security Site, which is approximately 65 miles northwest of Las Vegas, Nevada. CAU 105 is a geographical grouping of sites where there has been a suspected release of contamination associated with atmospheric nuclear testing. This document describes the planned investigation of CAU 105, which comprises the following corrective action sites (CASs):

- 02-23-04, Atmospheric Test Site - Whitney
- 02-23-05, Atmospheric Test Site T-2A
- 02-23-06, Atmospheric Test Site T-2B
- 02-23-08, Atmospheric Test Site T-2
- 02-23-09, Atmospheric Test Site - Turk

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 30, 2012, 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 105. The site investigation process will also be conducted in accordance with the *Soils Activity Quality Assurance Plan*, which establishes requirements, technical planning, and general quality practices to be applied to this activity.

The potential contamination sources associated with all CAU 105 CASs are from atmospheric nuclear testing activities. The presence and nature of contamination at CAU 105 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 at sample locations to the dose-based final action level. The total effective dose 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 placed at the center of each sample location will be used to measure external radiological dose.

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

This Corrective Action Investigation Plan has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada; DOE, Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Fieldwork will be conducted after the plan is approved.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains activity-specific information, including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 105: Area 2 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.

CAU 105 is located in Area 2 of the NNSS, which is approximately 65 miles (mi) northwest of Las Vegas, Nevada. CAU 105 comprises the five corrective action sites (CASs) at three separate locations (sites) shown on Table 1-1 and Figure 1-1.

Table 1-1
CAU 105 CASs

CAS Number	CAS Name	Associated Tests	Site	Site Name
02-23-04	Atmospheric Test Site - Whitney	Whitney	T-2	T-2
02-23-08	Atmospheric Test Site T-2	Badger, How	T-2	T-2
02-23-09	Atmospheric Test Site - Turk	Turk	T-2	T-2
02-23-05	Atmospheric Test Site T-2A	Shasta	T-2A	Shasta
02-23-06	Atmospheric Test Site T-2B	Diablo	T-2B	Diablo

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

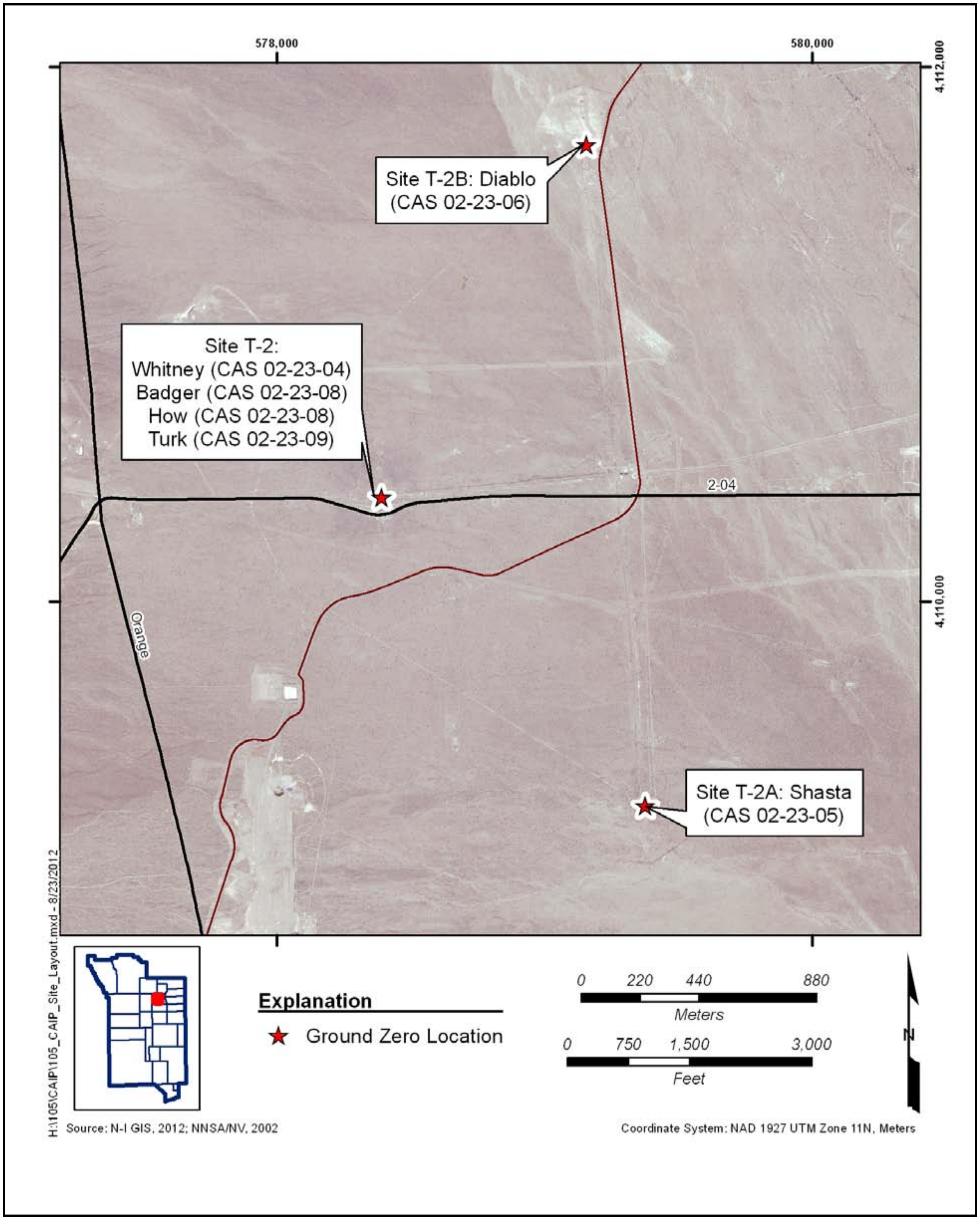

Figure 1-1
CAU 105, CAS Location Map

1.1 Purpose

The CASs in CAU 105 are being investigated because hazardous and/or radioactive contaminants may be present in concentrations that exceed risk-based corrective action (RBCA) levels. Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs. Additional information will be generated by conducting a CAI before evaluating and selecting CAAs.

1.1.1 CAU 105 History and Description

CAU 105, Area 2 Yucca Flat Atmospheric Test Sites, consists of five CASs at three inactive sites located in Area 2. The CAU 105 sites were used to support atmospheric nuclear testing conducted at the Yucca Flat area between 1952 and 1957. Operational histories for CAU 105 sites 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). DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 105. This CAIP describes the investigative approach developed to collect the necessary data identified in the DQO process. Discussions of the DQO methodology and the DQOs specific to each site are presented in Appendix A. A summary of the DQO process is provided below.

The DQO problem statement for CAU 105 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 105.” To address this problem, resolution of the following decision statements is required:

- **Decision I.** “Is any contaminant of concern (COC) associated with the CAS present in environmental media?” For judgmental sampling decisions, any contaminant associated with a CAS that is present at concentrations exceeding its corresponding final action level (FAL) will be defined as a COC. For probabilistic sampling decisions, any contaminant for which the 95 percent upper confidence limit (UCL) of the mean exceeds its corresponding FAL will be defined as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2012c).

- **Decision II.** "Is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include to following:
  - The lateral and vertical extent of COC contamination
  - The information needed to predict potential remediation waste types and volumes
  - Any other information needed to evaluate the feasibility of remediation alternatives

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

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in Appendix A. The information necessary to resolve the DQO decisions will be generated for each CAU 105 CAS by collecting and analyzing samples generated during a field investigation. The presence of a COC will be determined by collecting and analyzing samples following 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.5.4).

The DQOs for CAU 105 defined similarities in conceptual site model (CSM) properties of several releases that would allow a common investigative approach (e.g., surface deposition of relatively immobile contaminants, migration and mixing of contaminants in drainage channels, excavation of contaminated surface soil, or similarities in release sources such as weapons tests on towers). Based on these similarities, study groups (SGs) were established to simplify the planning and investigation of CAU 105 releases. The DQOs for CAU 105 defined the following SGs to appropriately address the different types of releases that may be present at the CASs:

- **SG 1 (Atmospheric Tests)**. This release category is specific to the atmospheric deposition of radionuclide contamination from nuclear weapons testing (comprised mainly of fission and activation products) onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the this type of release is limited to the top 5 centimeters (cm) of soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CAIP, surface is defined as the upper 5 cm of soil.

- **SG 2 (Excavation)**. This release category is specific to the mechanical disturbance and relocation of contaminated surface soil (from an SG 1 type of release).
- **SG 3 (Debris/Spills)**. This group investigates any chemical or radiological contamination associated with debris and/or spills. The debris will be evaluated for potential source material (PSM), and spills will be evaluated based on the presence of biasing factors such as discoloration or elevated instrument readings or available process knowledge.
- **SG 4 (Migration)**. This group investigates the translocation of contaminated surface soil (from an SG 1 type of release) by stormwater runoff into drainages.
- **SG 5 (Landfills)**. This group investigates potential subsurface soil contamination resulting from the burial of waste.

Investigation of SGs 1 and 2 will be accomplished through measurements of surface soil radioactivity using a combination of judgmental and probabilistic sampling schemes. Investigation of SGs 3, 4, and 5 will be accomplished using a judgmental sampling scheme dependent upon the nature of the release.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 105 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.
- Evaluate analytical results to determine whether any COC is present.
- Determine the nature and extent of any COCs that are present.

- Collect samples of waste material, if present, to determine the potential for a release to result in contamination exceeding FALs.
- Collect samples of potential remediation wastes, if present.
- Collect quality control (QC) samples.

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

1.3 CAIP Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about CAU 105. 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 activity 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 Soils Quality Assurance Plan (QAP) (NNSA/NSO, 2012b). The activity schedule and records availability are discussed in Section 7.0. Section 8.0 provides a list of references.

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

2.0 Facility Description

CAU 105 comprises five CASs that were grouped together based on the geographical location of the sites and technical similarities (atmospheric testing). The five CASs are located within three sites in Area 2 of the NNSS. Four tests (Whitney, Badger, How, and Turk) encompassing three CASs (02-23-04, 02-23-08, and 02-23-09) were conducted at Site T-2; Badger and How are included together in CAS 02-23-08. One test, Shasta (CAS 02-23-05), was performed at Site T2-A; and one test, Diablo (CAS 02-23-06), was performed at Site T2-B.

2.1 Physical Setting

The following sections describe the general physical settings of Area 2 of the NNSS. General background information pertaining to topography, geology, hydrogeology, and climatology is provided for these specific areas of the NNSS region 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).

CASs 02-23-04, 02-23-05, 02-23-06, 02-23-08, and 02-23-09 are located within the Yucca Flat Hydrographic Area of the NNSS. Yucca Flat is a closed basin, which is slowly being filled with alluvial deposits eroding from the surrounding mountains (Laczniak et al., 1996).

Local topography around the three physical sites is relatively flat, with gently sloping hills to the west. Precipitation runoff flow from the area is generally to the south and east, into an ephemeral channel that generally flows to the south into the Yucca Flat dry lake.

CAU 105 is located within the Yucca Flat Tributary Flow System, a part of the regional carbonate aquifer flow system that moves generally from northeast to southwest (Fenelon et al., 2010). Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (Laczniak et al., 1996). The nearest rain gauge to CAU 105 is Buster Jangle Y (BJY) in Area 1 where precipitation averages 6.3 inches per year (in./yr). Average annual potential evapotranspiration (PET) has been estimated for the Area 3 Radioactive Waste Management Site (RWMS) as 61.8 inches (in.). Rainfall and PET data are presented in Table 2-1.

Table 2-1
Rainfall and PET Information for Yucca Flat

	Area 3 PET (in.)	BJY Precipitation (in.)
Minimum	59.1	1.5
Maximum	63.3	14.7
Mean	61.8	6.3
95% UCL	63.1	7.4

Source: ARL/SORD, 2012

The nearest groundwater well to all CASs is U.S. Geological Survey (USGS) Water Well UE-2ce, an active well located approximately 1.3 mi west of the site (USGS, 2012). The most recent recorded depth to the water table is approximately 1,452 feet (ft) below ground surface (bgs).

2.2 Operational History

The following subsections provide a description of the use and history of each site in CAU 105 that may have resulted in releases of contaminants to the environment. The site-specific summaries are designed to describe the current definition of each site and document all significant, known activities.

The atmospheric testing of nuclear weapons at CAU 105 was performed between 1952 and 1957. Limited areas of contaminated soils exist from the testing performed at this CAU, and test-related debris remains. As these were atmospheric tests performed on steel towers, no craters are observed at any of the three sites. However, radioactive material areas (RMAs) are present around ground zero (GZ) at each of the three sites as depicted in Figure 2-1.

In 1989, the Radioactive Waste Consolidation Project was initiated at each of the CAU 105 sites to determine the feasibility of remediating contaminated surface soils and debris (REECo, 1988; Johnston, 2012). As part of this project, surface soil was graded into mounds and removed from the northern section of Site T-2B, Diablo. Efforts also included the removal of large steel tower debris and some lead debris from all sites.

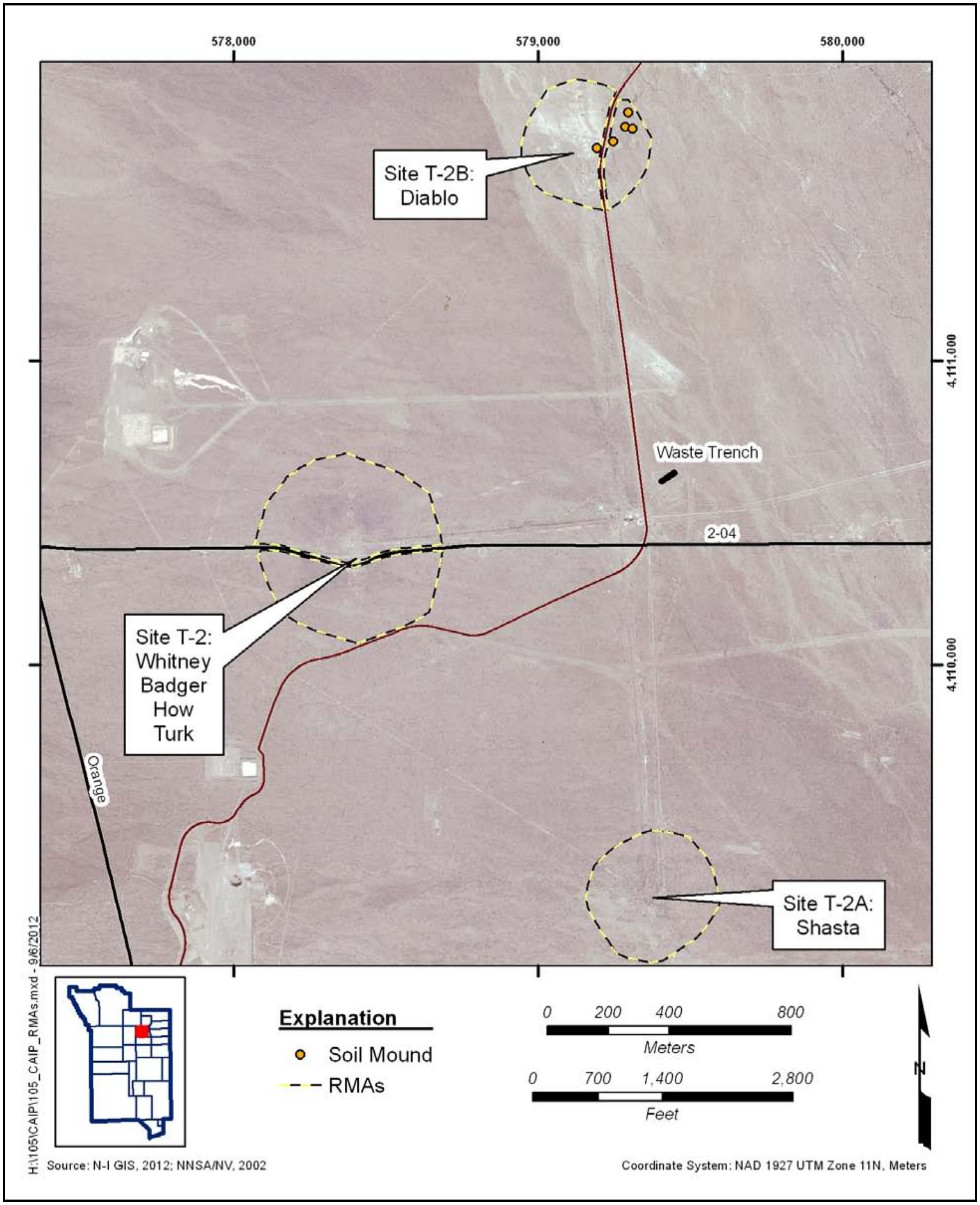

Figure 2-1
CAU 105 Site Features

2.2.1 Site T-2: CAS 02-23-04, Atmospheric Test Site - Whitney; CAS 02-23-08, Atmospheric Test Site T-2; and CAS 02-23-09, Atmospheric Test Site - Turk

These three CASs are defined as the release of contaminants associated with atmospheric testing of nuclear weapons at Site T-2. The following discusses the specifics of each CAS (DOE/NV, 2000):

- CAS 02-23-04, Atmospheric Test Site - Whitney, was part a weapons-related test of Operation Plumbbob with a yield of 19 kilotons (kt). The test was performed on September 23, 1957, from a 500-ft tower. Whitney was the last of four tests performed at this site.
- CAS 02-23-08, Atmospheric Test Site T-2, consists of the two weapons-related tests, Badger and How. Badger was a weapons-related test with a yield of 23 kt and was part of Operation Upshot-Knothole. The test was performed on April 18, 1953, from a 300-ft tower. Atmospheric test How was a weapons-related test with a yield of 14 kt performed as part of Operation Tumbler-Snapper. The test was performed on June 5, 1952, from a 300-ft tower.
- CAS 02-23-09, Atmospheric Test Site - Turk, was a weapons-related test as part of Operation Teapot with a yield of 43 kt. The test was performed on March 7, 1955, from a 500-ft tower. The yield for Turk was the largest observed for CAU 105.

Efforts from the 1989 Radioactive Waste Consolidation Project resulted in the removal of 1,044 cubic yards (yd^3) of debris from the T-2 Site (Johnston, 2012).

In addition to the five CASs at the three locations, a previously unidentified waste trench and potential landfills were identified approximately 0.7 mi east of Site T-2 as depicted on Figure 2-1. An open trench measuring approximately 60 by 15 ft contains metal and wood debris from an unknown source. Aerial photographs and visual surveys reveal disturbed linear areas south of the open trench, indicating potential buried landfills.

2.2.2 Site T-2A, Shasta: CAS 02-23-05, Atmospheric Test Site T-2A

This CAS is defined as a release of contaminants associated with the atmospheric test of one nuclear weapon at Site T-2A, Shasta. This atmospheric detonation was part of Operation Plumbbob designed as a weapons-related test with a yield of 17 kt. The test was performed on August 18, 1957, from a 500-ft tower (DOE/NV, 2000). The 1989 Radioactive Waste Consolidation Project resulted in the remediation of 372 yd^3 of large steel tower debris and some lead debris (Johnston, 2012).

2.2.3 Site T-2B, Diablo: CAS 02-23-06, Atmospheric Test Site T-2B

This CAS is defined as the release of contaminants associated with an atmospheric test of nuclear weapons at Site T-2B, Diablo. This weapons-related test was performed as part of Operation Plumbbob with a yield of 17 kt. The test was performed on July 15, 1957, from a 500-ft tower (DOE/NV, 2000).

Low profile soil berms approximately 10 in. in height and 2 ft wide are observed at the Diablo site along the road and south fence line. The berms are located inside the RMA demarcation fence and are observed to affect surface runoff on and off the site.

The 1989, the Radioactive Waste Consolidation Project (REECo, 1988; Johnston, 2012) was reported to have removed more than 600 shipments of soil from the north and northwest section of Site T-2B, Diablo to the Area 3 RWMS. In the northern area of the site, soil and debris have been mounded in preparation of shipment; however, they were not removed because the project was discontinued. These soil and debris mounds are currently observed at the site. Steel tower debris and some lead debris was also removed during consolidation project efforts. Concrete tower anchor foundations were removed from Site T-2B, Diablo during consolidation project activities. Foundations measuring 8 ft deep, 20 ft long, and 8 ft across were removed using explosives and are currently expressed as depressions in the ground with some steel reinforcement bars remaining. Debris containing concrete, soil, and reinforcement bars is presently mounded around the depressions (Johnston, 2012).

2.3 Waste Inventory

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

Solid waste items identified at these CASs include miscellaneous debris such as metal pieces, batteries, and lead bricks/piping. Solid waste is also identified at a waste trench approximately 0.7 mi east of Site T-2 GZs. Additional wastes may include investigation-derived waste (IDW), decontamination liquids, and soils. Potential waste types include sanitary, hydrocarbon, *Resource Conservation and Recovery Act* (RCRA) hazardous, radioactive, and mixed waste.

2.4 Release Information

The releases of contamination at the CAU 105 sites are directly or indirectly associated with atmospheric testing. The investigation of specific releases at CAU 105 will depend upon the nature of these releases. Therefore, the releases at CAU 105 have been categorized into one of the five SGs defined in Section 1.1.2.

Exposure routes to receptors include ingestion and inhalation of radionuclides in surface soil (internal exposure). Site workers may also be exposed to direct radiation by performing activities in proximity to radiologically contaminated materials (i.e., external dose). Exposure to chemical contaminants may result from spills, wastes, and debris to include lead exposure from observed bricks and piping. Therefore, the CSM will include the potential for receptors to receive an internal dose from contaminated soil and an external dose from contaminated soil and debris.

Fourteen CASs are within a 3,000-ft radius of CAU 105 (see Table 2-3 and Figure 2-6). Of specific note is CAS 02-26-01 from CAU 5000 that is located within the Site T-2B, Diablo RMA. This lead-lined concrete box is an archived CAS and has been identified as historically significant (FFACO; 1996, as amended). All CASs within the 3,000-ft radius of CAU 105 have been closed or have been deferred based on historical significance.

2.4.1 Study Group 1, Atmospheric Tests

A release of radioactive contamination to the soil as a result of atmospheric nuclear weapons testing from 300- and 500-ft towers was observed at all CAU 105 sites. Releases include fallout of fission products and the neutron activation of soils and debris to include Trinity glass. Releases may also be attributed to the historical use of radionuclides as tracers and/or surrogates. Radionuclides with a low melting point (e.g., iodine) traveled significant distances before condensing and falling out of the plume, while those with higher melting points (e.g., cesium) condensed earlier and were deposited closer to respective GZs. The nuclear fuel that did not fission (e.g., uranium or plutonium isotopes) has a very high melting point and is generally found very near to GZ. Different mixtures of radionuclides may be present at these release sites based on the varying composition of the nuclear source material used in the weapons related test devices. The fission and activation products released from these tests were distributed in a roughly annular pattern around GZ.

The atmospheric tests also irradiated the surrounding soil with neutrons, causing the activation of some elements in the soil. The activated soil is expected to contain activation products (i.e., europium and cobalt isotopes) distributed in an annular pattern concentrated closest to GZ. The annular pattern of contamination is shifted to the south at Site T-2B, Diablo due to the cleanup efforts performed in the northern part of the site (Johnston, 2012).

2.4.2 Study Group 2, Excavations

The subsequent excavation of soil and debris at Site T-2B, Diablo was performed in the late 1980s. Soil and debris were mechanically graded into mounds as staging areas for disposal as part of surface contamination consolidation efforts. The project was terminated before all mounds were disposed of, and existing soil piles remain at the site at locations depicted on Figure 2-1.

2.4.3 Study Group 3, Debris/Spills

Other sources of contamination include spills, wastes, and debris. During the preliminary investigations at the CAU, debris, lead-acid batteries, and lead bricks/piping were identified. The batteries and lead bricks/piping are identified as a potential source of lead that may be released to the soil. Stained soil was identified at the waste trench during preliminary investigations and at a localized location near GZ at Shasta. Other stained soil and debris may be identified during site characterization activities and will be investigated as appropriate.

2.4.4 Study Group 4, Migration

Contamination on the soil surface may also be a source for future migration. The potential exists for deposited contamination to have migrated with stormwater runoff into drainage channels located at the sites.

2.4.5 Study Group 5, Landfills

During the preliminary investigation, a previously unidentified waste trench was discovered approximately 0.7 mi east of Site T-2. As a potential source of contamination, this trench contains wood and metal debris from unknown sources. Aerial photographs and visual surveys reveal disturbed areas south of the open trench indicating potential buried landfills. The potential releases associated with these locations will be assessed as part of site investigation activities.

2.4.6 Concrete Box with Lead Lining

One source of potential contamination include a lead-lined concrete box located at Site T-2B, Diablo. This concrete box is designated as a separate CAS, 02-26-01, Lead (Concrete Box w/Lining). This CAS within CAU 5000 is an archived CAS and is designated as a historical site. Due to the archived status and historical significance, the potential releases associated with this locations will not be assessed as part of site investigation activities.

2.5 Investigative Background

All available historical investigation data are assessed in the planning phase as biasing information for selecting appropriate sampling locations. Aerial and ground-based radiation surveys were conducted in the CAU 105 area. Table 2-2 lists the methods, advantages, limitations, spatial and spectral resolutions, measurement dates, and applied use for the radiation survey methods. Details of the surveys are discussed in Sections 2.5.1 and 2.5.3.

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), the quality required for a dataset will be determined by its intended use in decision making. Ground-based and aerial radiological survey data are classified as decision supporting, and are not used, by themselves, to make corrective action decisions. For defining corrective action boundaries, the radiation surveys will be used only in terms of defining a relative spatial distribution of contamination.

The aerial radiation surveys provided spectral information that was used to differentiate specific isotopic signatures. This allowed the separate mapping of Am-241 contamination, man-made gamma activity, and gross gamma activity within the surveyed areas.

The radionuclide activity in this area is due to a combination of fission products (primarily high-energy gamma radiation) and unfissioned nuclear material (primarily low-energy gamma, beta, and alpha radiation). Physical and chemical properties of the radionuclides associated with fission products and unfissioned material affect the spatial distribution of the radionuclides as discussed in Section A.2.2.3.

Table 2-2
Comparison of Radiation Survey Methods

	Gamma Drive-Over Survey	Aerial Radiological Survey (200 ft agl)
Method Description Summary	Ground-based towed array sodium iodide scintillator instrument that detects gamma emissions	Helicopter-mounted thallium-activated sodium iodide, gamma-ray scintillation detectors
Advantages and Limitations	**Advantages:** Towed array can cover more area quickly. Array has multiple detectors for increased reliability. **Limitations:** Does not distinguish between the radionuclides emitting the gamma emissions.	**Advantages:** Gives a wide area of view (as opposed to ground-based surveys); can survey large areas quickly. **Limitations:** Because it is elevated and moving at a fast rate, does not distinguish small localized areas of contamination or materials that are contaminated.
Spatial Resolution	Held at ~12 in. agl, has a larger field than hand-held instruments with multiple detectors	Altitude: 60 m Line Spacing: 150 m 120-m diameter window
Spectral Resolution	All gamma emitters	38 to 3,026 keV
Measurement Date	June 27 to July 20, 2011	1994
Applied Use	Nondiscriminatory gamma count used to identify contamination from nuclear testing	**For Am-241:** Processed for energies in the 57- to 70-keV range (Am-241) relative to the 38- to 50-keV and 70- to 82-keV background windows. Used to identify Am-241 contamination as an indicator of plutonium contamination. **For man-made:** Processed for energies in the 38- to 1,294-keV window relative to the 1,394- to 3,026-keV background window. Used to identify contamination from nuclear testing.

agl = Above ground level
Am = Americium
m = Meter
keV = Kiloelectron volt

Source: BN, 1999

The following subsections summarize the investigations conducted at the CAU 105 site. These investigations include the 1994 flyover survey (BN, 1999) and the Radionuclide Inventory and Distribution Program (RIDP) (McArthur and Mead, 1987; Gray et al., 2007).

2.5.1 Aerial Radiological Surveys

The Remote Sensing Laboratory (RSL) conducted an aerial radiological survey in 1994 by flying along a set of parallel flight lines spaced 500 ft apart at 200 ft agl. The purpose of the survey was to provide a more detailed measurement of the gamma radiation natural background and areas of man-made activity at the site (BN, 1999). These flyover data were processed to produce gross count, man-made contamination, and americium concentration data layers (BN, 1999; N-I GIS, 2012). Figure 2-2 displays the results of the aerial survey depicting the man-made radiological activity for CAU 105. Elevated concentrations are observed concentrically around each of the three sites with the highest levels of up to 450 roentgens per hour (R/hr) at the Site T-2 GZ (BN, 1999). Results from the 1994 aerial survey show the highest gross count radiological activity at Site T-2 of up to 900 microroentgens per hour (μR/hr). Elevated concentrations are also observed at GZ for each of the three sites as shown in Figure 2-3. There are no detectable Am-241 signatures significantly above the minimum detectable activity for the sensor configuration and signal processing method used to produce this aerial survey. Therefore, this method is not able to reliably determine the presence or absence of Am-241.

Each of the sites is related to high-yield testing that resulted in the deposition of cesium, europium, and other fission-related contaminants. Gross gamma and man-made spectra are of the greatest use in delineating the spatial distribution of contaminants. Therefore, the 1994 man-made flyover survey was used as biasing information in projecting sample locations for the three sites (see Section A.8.1).

2.5.2 Radionuclide Inventory and Distribution Program

The 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). These RIDP data were decay-corrected to estimate levels of radionuclides across CAU 105 as shown on Figure 2-4 and discussed in this section. RIDP data are provided as they present a general distribution of data used as background information during the DQO process as discussed in Appendix A.

At Site T-2 and Site T-2A, Shasta, 173 *in situ* measurements and 17 soil profile samples were collected. At Site T-2B, Diablo, 53 *in situ* measurements and 12 soil profile samples were collected.

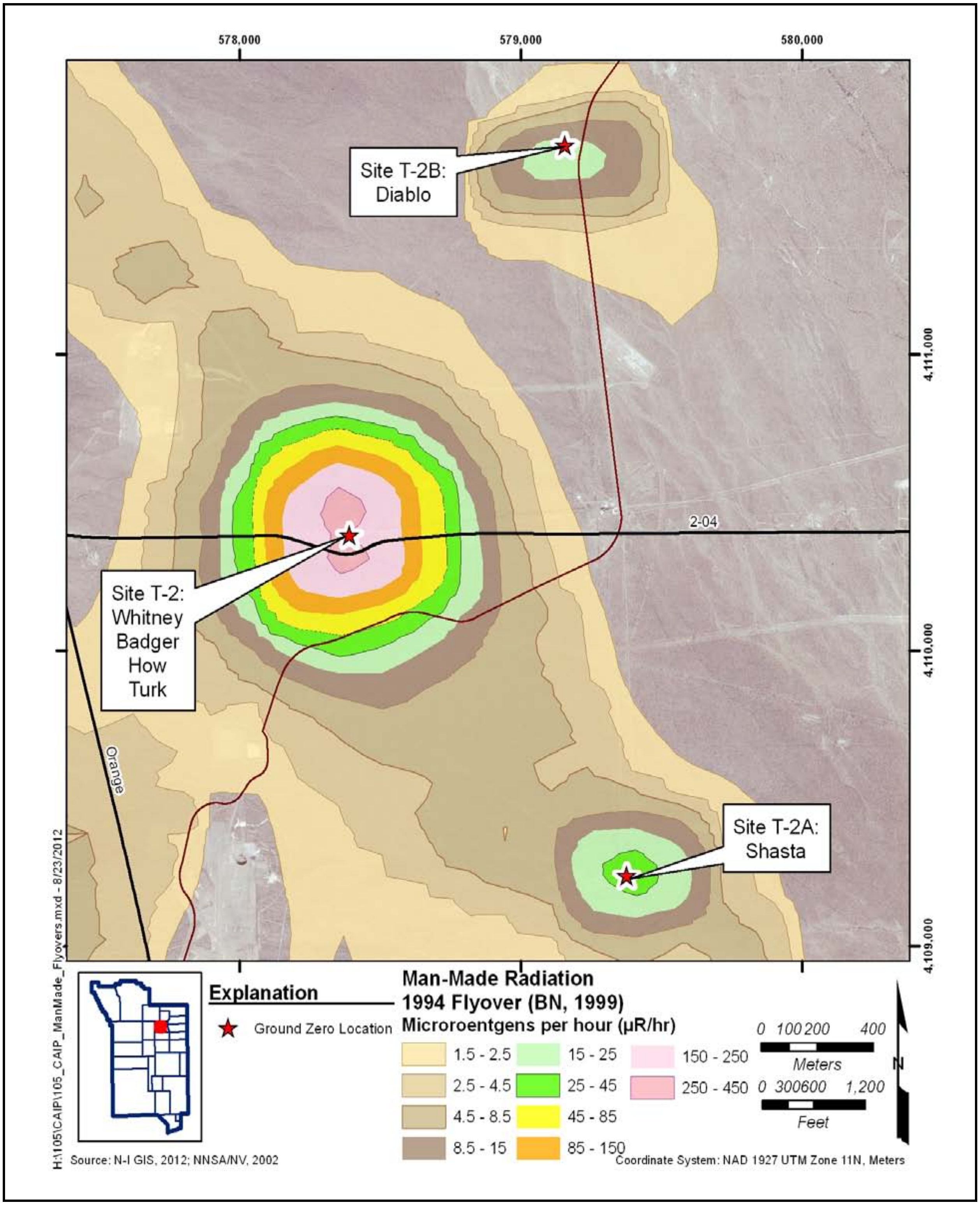

Figure 2-2
CAU 105 Aerial Man-Made Radiation Survey

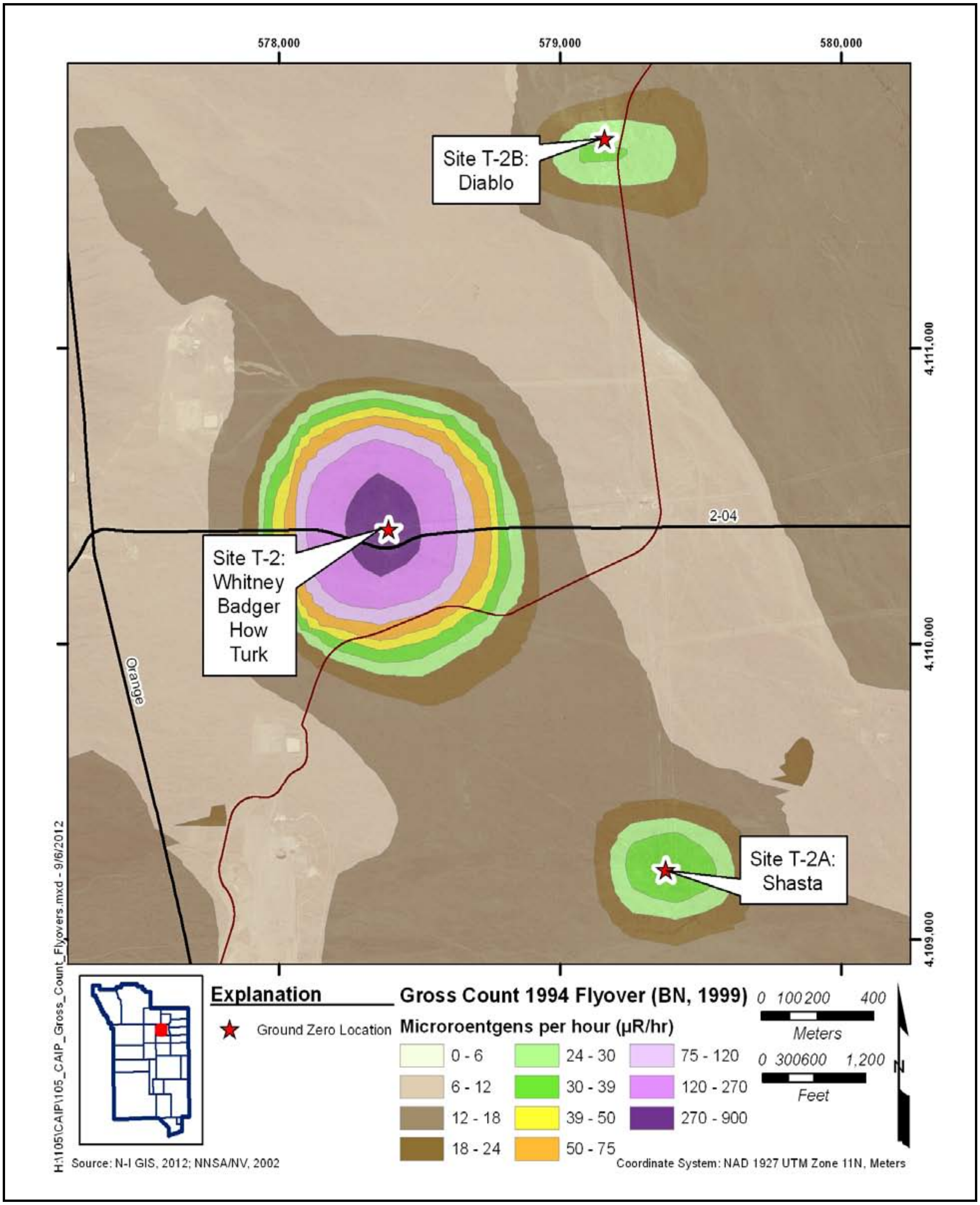

Figure 2-3
CAU 105 Aerial Gross Count Radiation Survey

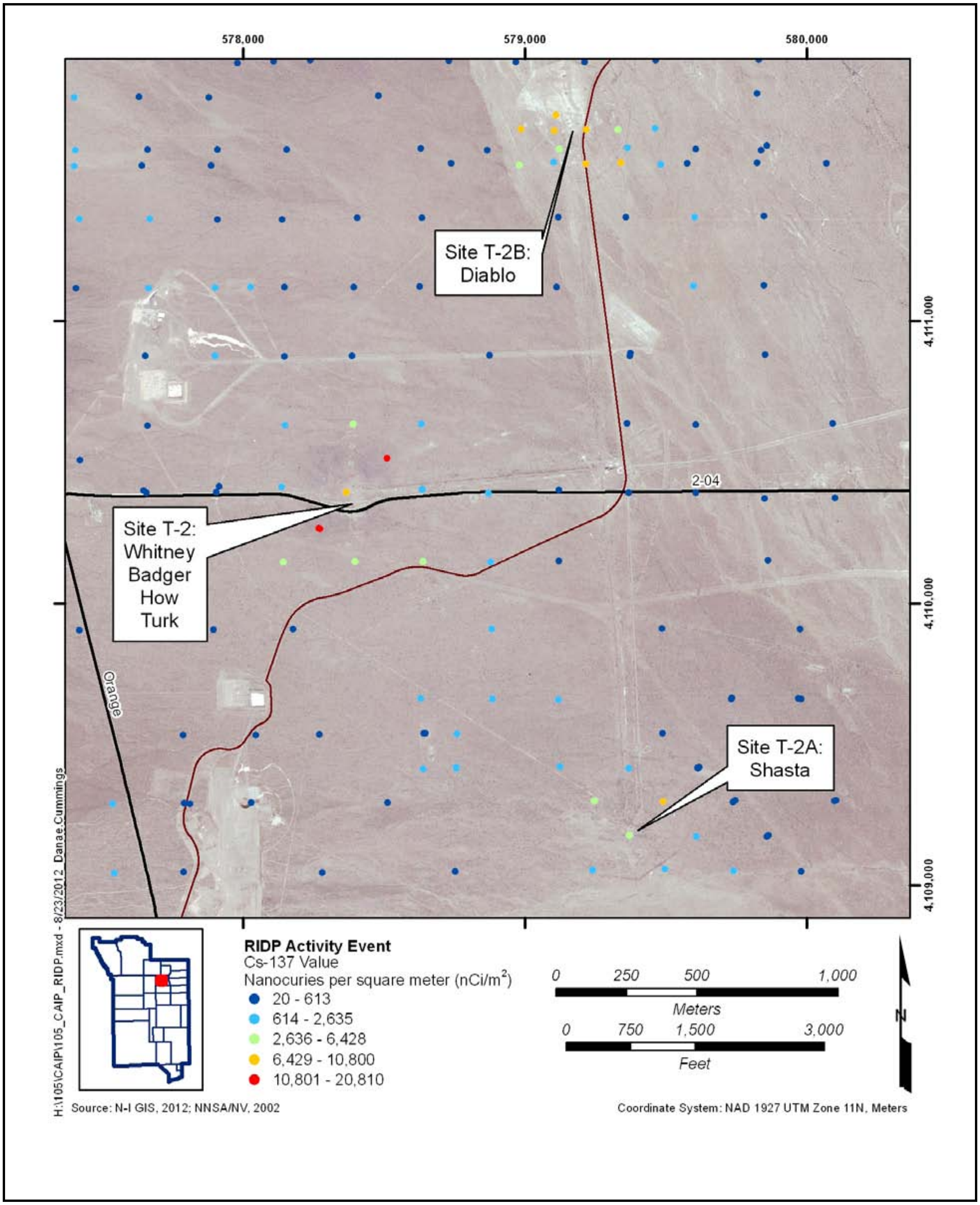

Figure 2-4
CAU 105 RIDP In Situ Data

Estimates of the contaminant radionuclides released to local surface soils at CAU 105 are as follows: plutonium (Pu)-238 at 5.3 curies (Ci), Am-241 at 2.1 Ci, cobalt (Co)-60 at 0.1 Ci, cesium (Cs)-137 at 14.0 Ci, strontium (Sr)-90 at 32.7 Ci, and europium (Eu)-152 at 6.4 Ci. The total inventory of radionuclides remaining in the soils in this area is estimated at 60.7 Ci.

At locations where soil samples were collected, four increments to a total sampling depth of 15 cm were collected (McArthur and Kordas, 1985; Gray et al., 2007). Results for the sampling at depth at all sites shows that the radiological activity decreases with depth, with the highest activity found within the top 0 to 5 cm.

Although the RIDP data present a general distribution of contamination, there is not sufficient resolution for biasing sample locations. In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), RIDP data are classified as decision supporting and will not be used for sample location planning and preliminary corrective action boundary identification. The RIDP *in situ* measurements for Cs-137 within the boundaries of CAU 105 are shown in Figure 2-4. The data show elevated readings centered around the GZ for SG 1 at each of the three sites.

2.5.3 CAU 105 Preliminary Investigation

In 2011, preliminary visual and radiological survey field investigations were completed in the CAU 105 area. Visual surveys included walking the area inside and immediately outside the RMAs. Debris, disturbed areas, and test-related remains were identified and their locations recorded using the Global Positioning System (GPS). During this effort, a previously unidentified waste trench was identified approximately 0.7 mi east of the Site T-2 GZs as shown on Figure 2-1. Photographs, location, and site conditions were documented as part of the visual survey. Results from the visual survey will be used in determining sample locations for SG 3.

Radiological surveys were completed at Site T-2; Site T-2A, Shasta; Site T-2B, Diablo; and the waste trench using gamma drive-over radiological instrumentation. The gamma drive-over survey is a vehicle-towed array of multiple radiation detectors connected to a GPS and computer for data collection. The system is designed to monitor gamma radiation levels from soil as described in Table 2-2. Elevated gamma activity above background is observed at all test sites as shown in Figure 2-5. The 2011 gamma drive-over survey is used to identify bias used in the selection of sample locations for SGs 1 and 2, and will be evaluated for use in defining corrective action boundaries in the Corrective Action Decision Document (CADD). Gamma activity at the identified waste trench is not observed to be elevated.

2.5.4 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 105.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed before site investigation activities begin at CAU 105. This checklist requires NNSA/NSO activity personnel to evaluate their proposed 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.

2.5.5 Other Surrounding CASs

Other investigations were performed in the vicinity of CAU 105 at surrounding CASs as summarized in Table 2-3 and as presented on Figure 2-6.

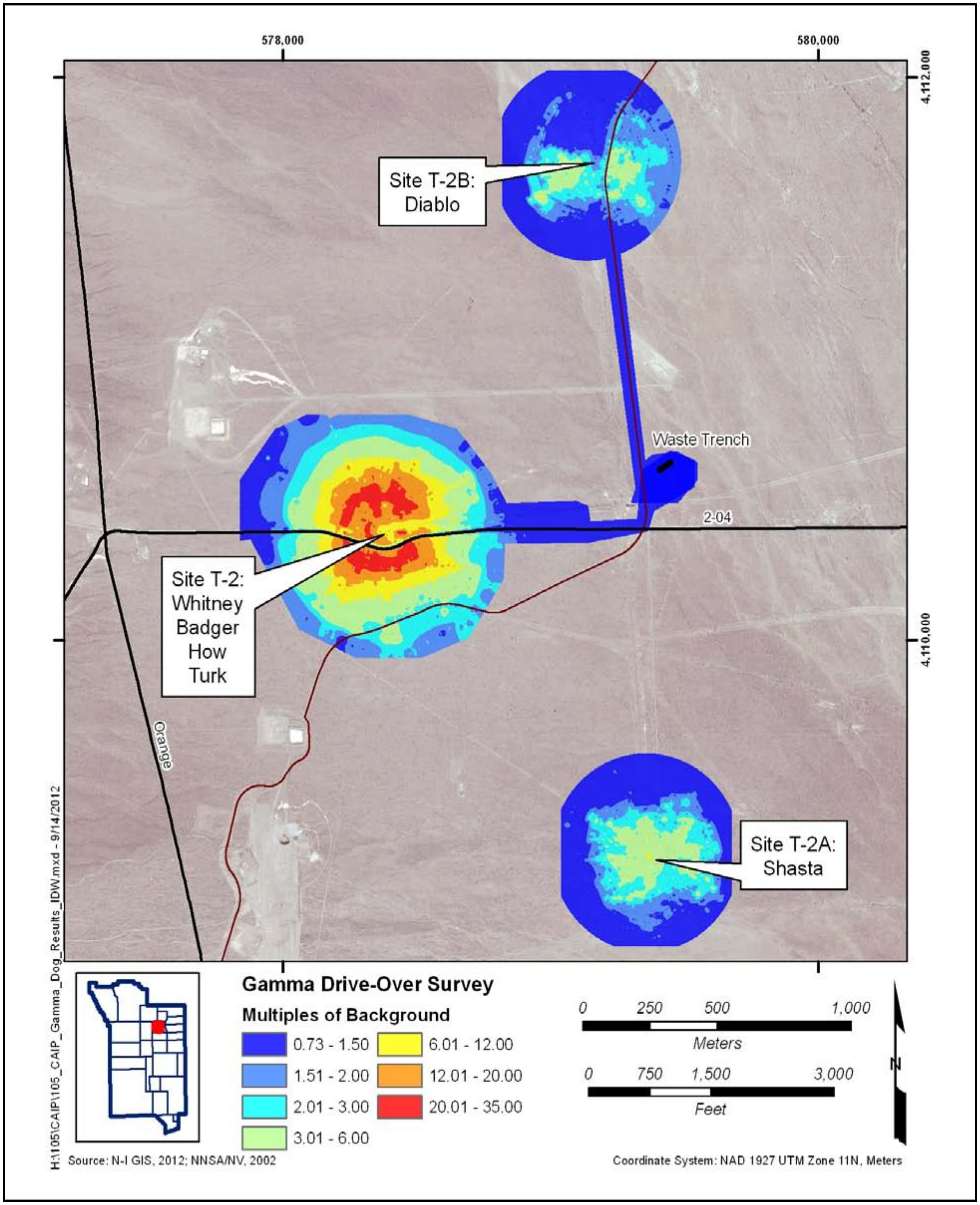

Figure 2-5
CAU 105 Gamma Drive-Over Survey

Table 2-3
Surrounding CASs to CAU 105

Description	CAS #	CAU #	Closure Strategy	Functional Category
UST 2-300-1	02-02-03	464	Closure in Place - Administrative Controls	Underground Storage Tank
U-2cw Mud Pit (1)	02-09-23	532	No Further Action	Mud Pit
U-2cv Mud Pit (1)	02-09-26	532	No Further Action	Mud Pit
UE-2ad Mud Pit (1)	02-09-46	534	No Further Action	Mud Pit
UE-2ac Mud Pit (1)	02-09-47	534	No Further Action	Mud Pit
Drums	02-22-11	76	Clean Closure	Housekeeping Waste
Battery	02-24-01	14	Clean Closure	Housekeeping Waste
Battery	02-24-09	382	Clean Closure	Housekeeping Waste
Lead (Concrete Box w/Lining)	02-26-01	5000	Archived Corrective Action Site; CAS is a historical site	Lead
Lead Pipes/RAD Area	02-26-02	286	Clean Closure	Lead
Gun Turret w/Lead in Barrel	02-26-07	5000	Archived Corrective Action Site; CAS is a historical site	Lead
Lead Bricks (100)	02-26-09	386	Clean Closure	Housekeeping Waste
Instrument Bunker	02-34-01	204	Closure in Place - Administrative Controls	Magazine/Bunker
U-2cr Cavity	02-57-069	97	Closure in Place	Underground Test/Detonation Cavity

RAD = Radiation
UST = Underground storage tank

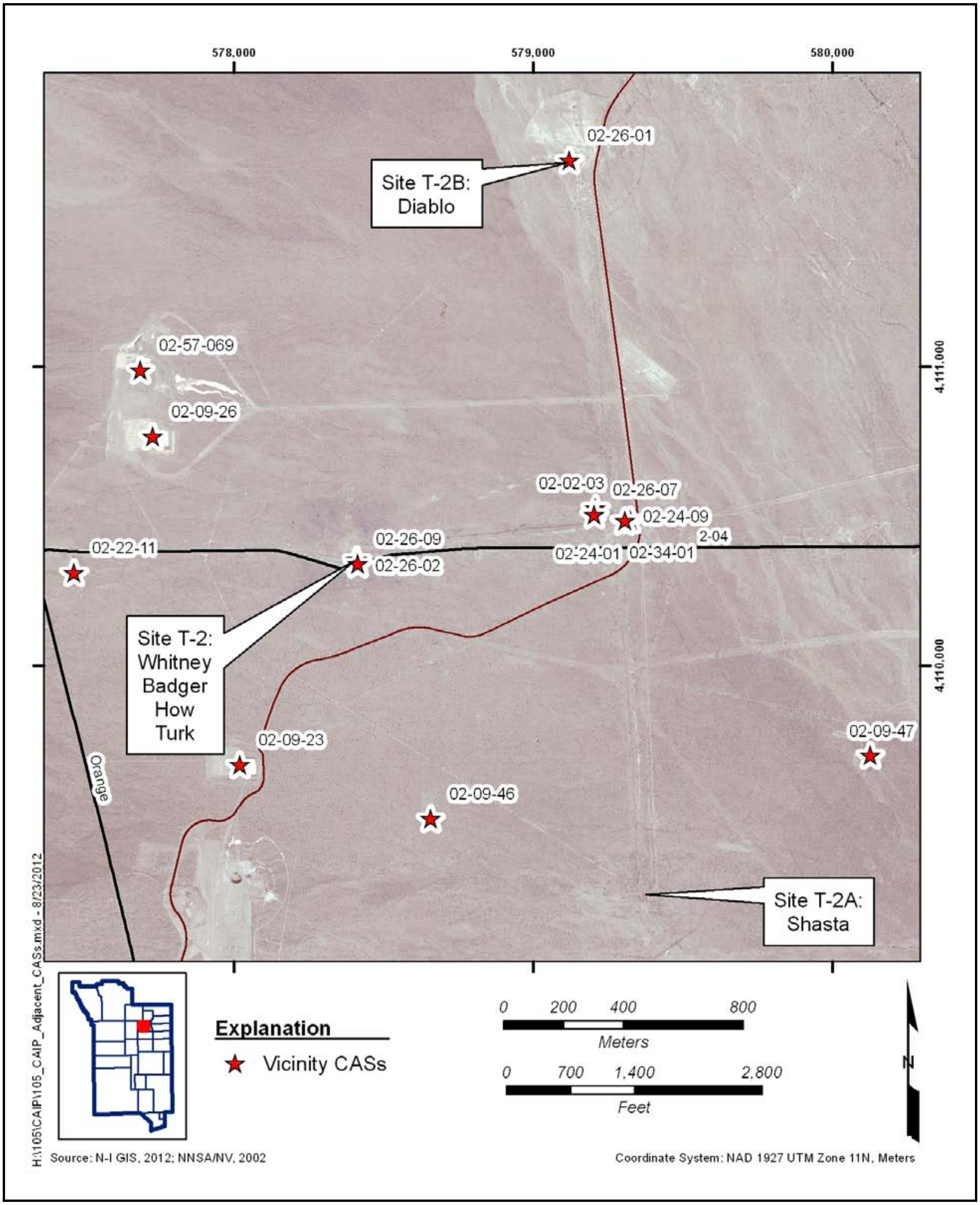

Figure 2-6
CAU 105 Surrounding CAS Locations

3.0 Objectives

This section presents an overview of the DQOs for CAU 105 and formulation of the CSM. Also presented is a summary listing of the contaminants of potential concern (COPCs), the preliminary action levels (PALs), and the process used to establish FALs. Additional details and figures depicting the CSM are located in Appendix A.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM was used to develop appropriate sampling strategies and data collection methods. The CSM was developed for CAU 105 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 105 sources. Figure 3-2 depicts a graphical representation of the CSM. If evidence of contamination that is not consistent with the presented CSM is identified during investigation activities, the situation will be reviewed, the CSM will be revised, the DQOs will be reassessed, and a recommendation will be made as to how best to proceed. In such cases, decision makers listed in Section A.2.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 105.

3.1.1 Land-Use and Exposure Scenarios

Land-use zones where the CAU 105 sites are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

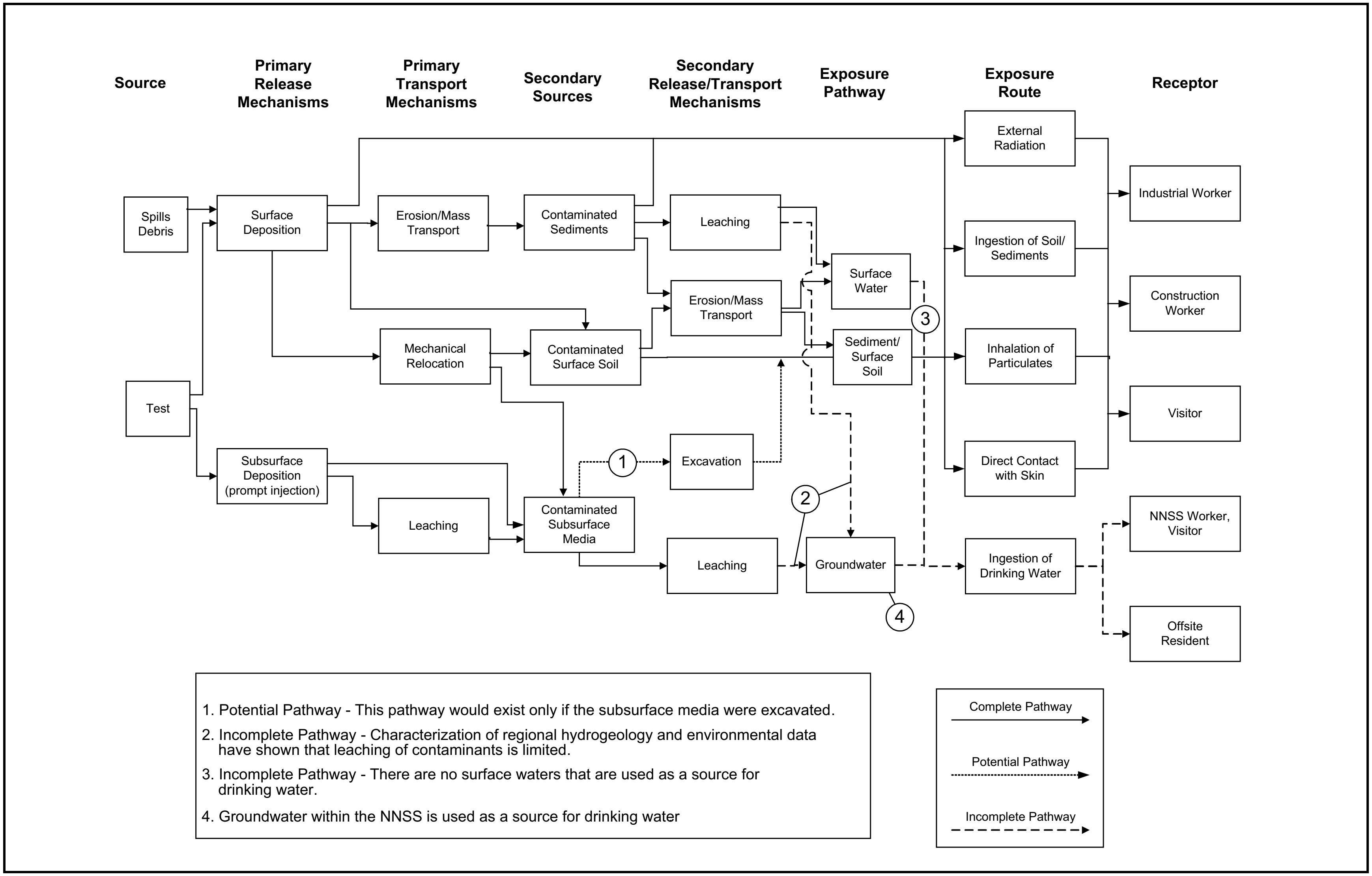

Figure 3-1
CSM Diagram

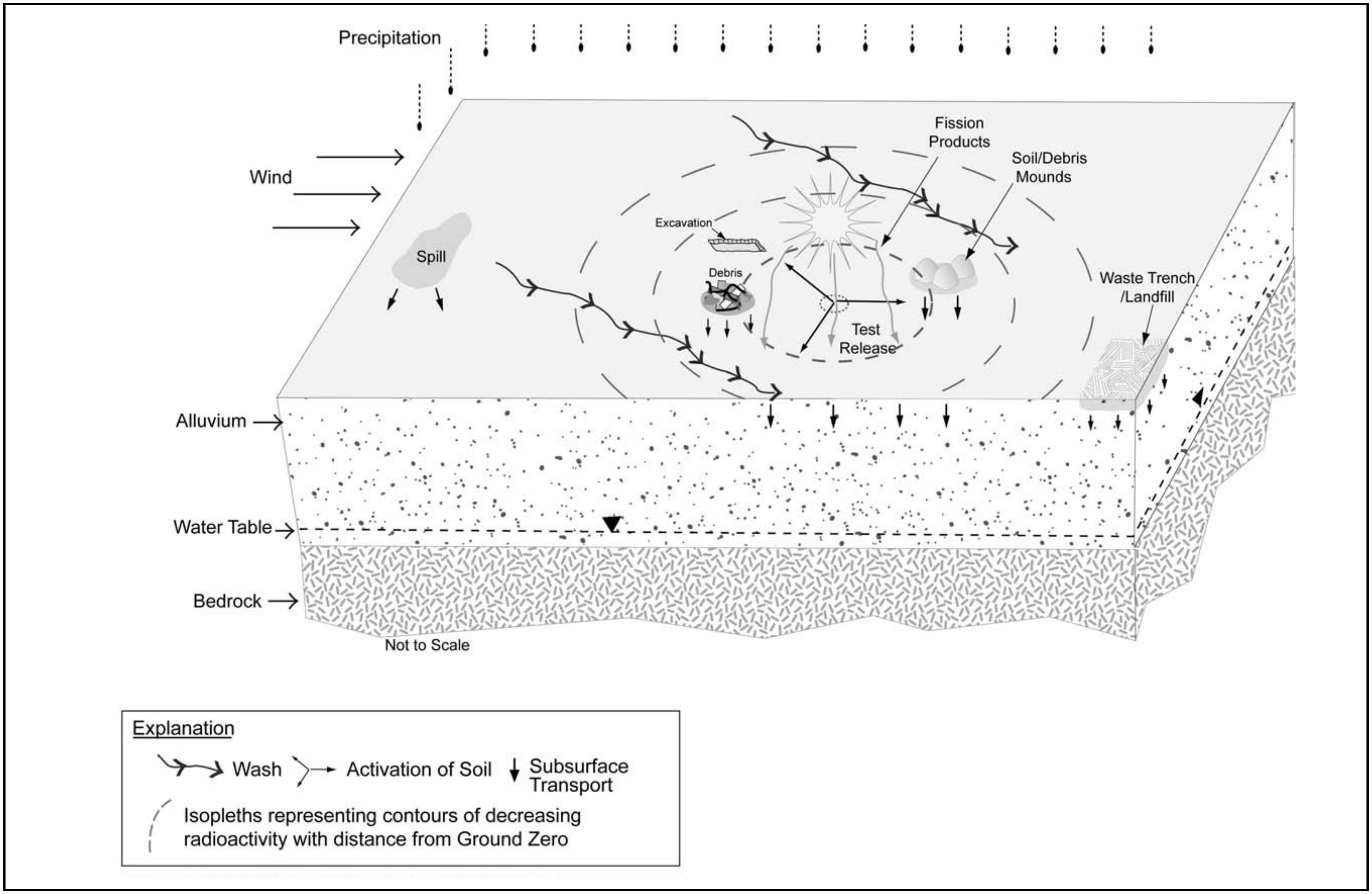

Figure 3-2
CAU 105 CSM

The CAU 105 sites are located in the land-use zone described as "Nuclear and High Explosives Test Zone" within the NNSS. This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high explosives tests. This zone includes compatible defense and nondefense research, development, and testing activities. The "Nuclear Test Zone" is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests (DOE/NV, 1998).

Exposure scenarios for the CAU 105 sites have been categorized into the following three types based on current and projected future land uses:

- **Industrial Area.** This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (250 days per year, 8 hours per day, for 25 years). The total effective dose (TED) calculated using this exposure scenario is the TED an industrial worker receives during 2,000 hours of annual exposure to site contaminants and is expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

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

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

The CAU 105 land-use zone and exposure scenario are based on current and future land use at the NNSS. CAU 105 is a remote location without any site improvements and where no regular work is performed. There is still the possibility, however, that site workers could occupy these locations on an occasional and temporary basis such as a military exercise. Therefore, this site is classified as an Occasional Use Area.

3.1.2 Contaminant Sources

Contaminant sources for CAU 105 CASs are the releases identified in Section 2.4 of radiological contamination to the atmosphere and soil as a result of weapons-related nuclear tests. Other sources of contaminants includes spills and leaks from site activities to include discarded debris.

3.1.3 Release Mechanisms

Release mechanisms for the releases in CAU 105 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. Release mechanisms for the atmospheric test-related releases at these three sites were the detonation of a nuclear device at a tower-height elevation of 300 or 500 ft. This released fission products and produced neutron activated soils and debris. The distribution of surface contamination from the test releases generally occurred concentric with the GZ.

As discussed in Section 2.4, the multiple detonations from the same Site T-2 release location have overlapping depositions resulting in a layer of contamination that is not traceable to any test. Subsequent consolidation efforts at the Diablo site have resulted in the removal of surface soil and consolidation of contaminated soil into piles that have affected the concentric distribution of radionuclides at this site.

Mechanisms for other releases includes spills and leaks onto surface soils from site activities to include discarded debris. An open waste trench has been identified at this CAU and has been identified as a potential release of contaminants. Debris, lead-acid batteries, and lead bricks have been identified at the sites. The batteries and lead bricks are identified as a potential source of lead that may be released to the soil. Stained soil was identified at the waste trench during preliminary investigations and at a localized location near GZ at Shasta.

3.1.4 Migration Pathways

Surface migration pathways for CAU 105 include the lateral migration of potential contaminants across surface soils into washes transecting the site since the original deposition. The washes entering and leaving these areas are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical (infiltration) and lateral transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas. The area near CAU 105 drains to the east and southeast toward and into Yucca Flat Dry Lake. Other migration pathways for contamination from the site include wind-borne materials.

Potential migration pathways also include contaminant movement through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include removal of surface contamination through scraping or grading, and construction and maintenance of roadways (e.g., grading of gravel roads through the RMAs at Site T-2 and Site T-2B, Diablo).

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

Infiltration and percolation of precipitation serve as driving forces for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 RWMS has been estimated at 61.8 in. [Shott et al., 1997]) and limited precipitation for this region (6.3 in./yr [Winograd and Thordarson, 1975]), 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 105 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 lateral transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

For surface contamination to reach the water table, the contaminants would have to be dissolved in infiltrating precipitation and then be transported through the vadose zone alluvium that extends through the 1,452-ft unsaturated zone observed at the nearest groundwater well discussed in Section 2.1.

The vertical penetration distance of infiltrating precipitation in 1,000 years would be the groundwater recharge rate (in millimeters per year [mm/yr]) divided by the volumetric moisture content (cubic centimeters per cubic centimeter) of the subsurface vadose alluvium times 1,000 years. The groundwater recharge rate in the vicinity of CAU 105 has been estimated to range from less than 0.1 mm/yr to 2.5 mm/yr based on regional infiltration studies (SNJV, 2006). The moisture content observed in the subsurface alluvium in shallow boreholes near the Area 3 RWMS indicates moisture contents in the range of 0.05 to 0.1 (Kwicklis et al., 2006). Based on these observations, penetration distances of infiltrating precipitation may be as much as 50 m in 1,000 years (using the maximum groundwater recharge rate of 2.5 mm/yr and the minimum moisture content of 0.05).

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 105 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 drainages will be qualitatively evaluated to provide additional information on potential offsite migration of contamination. Movement of ephemeral drainage channels may be identified based on a comparison of historical photographs and visual observations where erosion and deposition have occurred within the washes.

3.2 Contaminants of Potential Concern

The COPCs for CAU 105 are defined as the contaminants reasonably expected at each site that could contribute to a dose or risk exceeding the FAL. Based on the nature of the releases identified in Section 2.4, and previous investigation results presented in Section 2.5, the contaminants that could reasonably be suspected to be present at CAU 105 are the isotopes of uranium, plutonium, americium, and europium in addition to Cs-137. These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs and other releases (including those that may be discovered during the investigation). Specific COPCs (and subsequently the analyses requested) will be determined for discovered potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks/piping). Although not suspected to be present, analysis for other COPCs will be performed to eliminate the possibility of their presence due to an incomplete history of site testing operations as discussed in Section A.2.2.2.

These COPCs will be reported by the analytical methods identified in Table A.2-3 for environmental samples taken at each of the CASs. The analytes reported for each analytical method are listed in Table A.2-4.

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 *Soils Risk-Based Corrective Action Evaluation Process* (NNSA/NSO, 2012c). This process conforms with *Nevada Administrative Code* (NAC) 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012b) requires the use of ASTM International (ASTM) Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

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

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

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

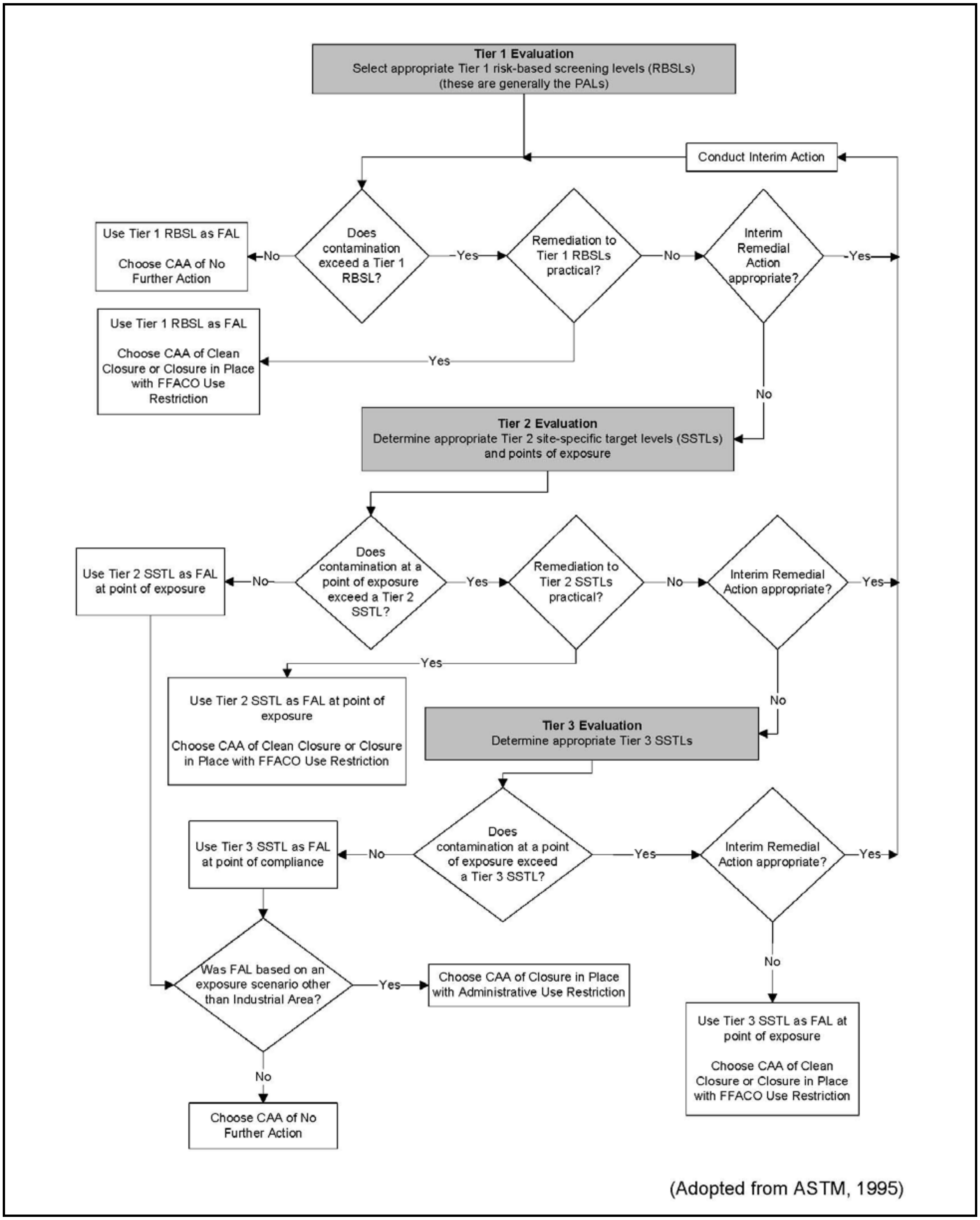

Figure 3-3
RBCA Decision Process

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 after any interim actions are completed. Any interim actions conducted will be reported in the CADD.

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

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) Region 9 Regional Screening Levels for chemical contaminants in industrial soils (EPA, 2012). 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 EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the CADD.

3.3.2 Radionuclide PALs

The PAL for radioactive contaminants is a TED of 25 mrem/yr, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in *Soils Risk-Based Corrective Action Evaluation Process* (NNSA/NSO, 2012c). 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 the residual radioactive material guidelines (RRMGs) that were established using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001). The RRMGs are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram (pCi/g) of surface soil, for a particular radionuclide that would result in an internal dose of 25 mrem/yr to a receptor (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used. The default and site-specific input parameters used in the RESRAD calculation of RRMGs for each exposure scenario are listed in the Soils RBCA process (NNSA/NSO, 2012c).

3.4 DQO Process Discussion

This section contains a summary of the DQO process that is presented in Appendix A. The DQO process is a strategic planning approach based on the scientific method that is designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommendation of viable corrective actions (e.g., no further action, clean closure, or closure in place).

As presented in Section 1.1.2, the DQOs address the releases associated with five SGs.
The atmospheric test and excavation releases (SGs 1 and 2) 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 105 was developed at a meeting on April 30, 2012. 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 105 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 105.” To address this problem statement, resolution of the following decision statements is required:

- **Decision I.** “Is any COC present in environmental media within the CAS?” If a COC is detected, then Decision II must be resolved.
- **Decision II.** “Is sufficient information available to evaluate potential CAAs?” Sufficient information is defined to include the following:
    - The lateral and vertical extent of COC contamination
    - The information needed to determine potential remediation waste types
    - The information needed to evaluate the feasibility of remediation alternatives

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

For the atmospheric test and excavation (SGs 1 and 2) release scenario, it is unknown whether COCs are present and Decision I sampling will be conducted. If COCs are identified, Decision II must be resolved for these releases at CAU 105.

For the other release scenarios (SGs 3, 4, and 5), Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. The specific analyses for samples from these releases will be selected dependent upon the type and nature of the identified release. Decision II samples for these release scenarios will be submitted as necessary to define the extent of unbounded COCs. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

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

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 105 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for CAU 105 by collecting and analyzing samples generated during a field investigation. Information will be generated during the field investigation to resolve DQO decisions.

The presence and nature of contamination for SGs 1 and 2 will be evaluated using a combination of judgmental and probabilistic approaches. The location of the sample plots will be selected and evaluated judgmentally, and the samples collected within the sample plots will be collected and evaluated probablistically. Sampling areas for SGs 3, 4, and 5 will be located and sample results evaluated based on judgmental criteria.

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

For probabilistic sampling of radiological contamination, DQO decisions will be based on the 95 percent UCL of the average TED for each sample plot. For judgmental sampling, DQO decisions will be based on a direct comparison of sample results to the FAL.

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 the RRMGs presented in Section 3.3.2. 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.

The TED rates at each TLD location where soil samples are not collected will be estimated by adding an estimate of internal dose to the TLD results. The conservative estimate of internal dose for each of these locations will be calculated based on a ratio of internal dose to external dose. This ratio will be conservatively established from the measured internal and external doses at the sample plot with the maximum internal dose rate. Use of this ratio will overestimate internal dose (and therefore TED) at all locations with lower dose rates. The TED for each of these TLD locations will be calculated as the total of the external dose measured by the TLD and the internal dose estimated using internal/external dose ratio from the selected sample plot or sample.

External dose will be determined by collecting *in situ* measurements using a TLD. The TLD will be installed at the approximate center of the sample plot at a height of 1 m and be left in place for approximately 2,000 hours (equivalent to an annual industrial worker exposure). Each TLD contains three elements from which external dose measurements will be reported. The 95 percent UCL of the average TED for each plot will be the sum of the 95 percent UCL of the TLD element results for external dose and the 95 percent UCL of the sample results for internal dose.

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

4.2 Field Activities

Field activities at CAU 105 include site preparation, sample location selection, sample collection, sample management, 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; and constructing decontamination facilities.

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

- Perform radiological surveys of the area around site GZs and identified washes to provide biasing information used in selecting sample locations.
- Install activity-specific environmental monitoring TLDs (see Section 4.2.3 for additional information).
- Perform visual surveys at all sites within CAU 105 to identify debris, any staining, discoloration, disturbance of native soils, or any other indication of potential contamination.

4.2.2 Sample Location Selection

The selection of sampling areas will be conducted in accordance with the following rationale for the five SGs. If, during the investigation, 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.

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 any step-outs as warranted by site conditions to achieve DQO criteria stipulated in Appendix A. Where sampling locations are modified, the justification for these modifications will be documented in the CADD.

4.2.2.1 Study Group 1, Atmospheric Tests

Decision I will be evaluated by measuring TED at sample locations established in a selected pattern for each site as presented in Figures A.8-1 through A.8-3.

One soil sample plot is planned at each of the three sites based on the locations with the highest readings from the 2011 gamma drive-over survey. The selection of this plot will be performed in an effort to find the location where the internal dose contributes the greatest amount to TED. A TLD will be placed in the approximate center of each sample plot to determine the external dose.

TLDs will be placed in a vector or grid pattern at each site to measure external dose. A vector pattern is proposed at Site T-2 and Site T-2A, Shasta because isotopes released from the tests consist of fission and activation products distributed in a roughly annular pattern around GZ. Sample vectors are designed to provide greater sample coverage closer to GZ. A grid pattern is proposed at Site T-2B, Diablo because the annular pattern has been affected by consolidation efforts performed in 1989. The annular pattern of contamination is generally shifted to the south at Site T-2B, Diablo due to consolidation efforts performed in the northern part of the site (Johnston, 2012). As a result of these efforts affecting the annular pattern, a sample grid is selected to provide uniform coverage without the bias toward greater sample locations closer to GZ.

4.2.2.2 Study Group 2, Excavations

The excavated soil and debris piles observed at Site T-2B, Diablo will be investigated to determine content and dose. A partial excavation of one soil pile will be performed to document content and estimate the TED within the soil pile. Soil from the excavation will be leveled and placed on the ground adjacent to the excavation. Internal dose will be determined by grab sample analysis and external dose by TLD measurement.

4.2.2.3 Study Group 3, Debris/Spills

For releases associated with debris/spills at CAU 105, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. The Decision I evaluation for this SG will be performed to investigate the presence of COCs based upon visual surveys and sampling. Biasing factors such as stains, radiological survey results, and wastes suspected of containing hazardous or radiological components will be used to select the most appropriate samples from a particular location for collection and analysis. The presence of lead bricks/piping and broken lead-acid batteries are wastes suspected of containing hazardous or radiological components.

If a COC is present, Decision II sampling will be conducted to define the extent of contamination based on validated laboratory analytical results where COCs have been confirmed. In general, extent sample locations will be arranged in a triangular pattern around areas containing a COC at distances based on site conditions, COC concentrations, process knowledge, and biasing factors. If COCs extend beyond extent locations, additional Decision II samples will be collected from locations farther from the source. A minimum of one analytical result less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination.

4.2.2.4 Study Group 4, Migration

The migration of contaminants in drainages for Decision I will be evaluated by measuring TED at individual sample locations. Sample locations will be selected at identified downstream sediment accumulation areas. Gamma drive-over surveys performed as part of preliminary investigations efforts (Figure 2-5) in 2011 at all sites will be used to determine sample locations. As needed, additional radiological surveys may be conducted to identify elevated readings to select a minimum of two sedimentation areas within each drainage identified for further study in the DQOs. Samples will be collected from each of the identified sedimentation areas. Three drainages have been selected for further evaluation at both Site T-2 and Site T-2B, Diablo. One drainage has been selected for evaluation at Site T-2A, Shasta.

Sample locations will be established at the center of the nearest two sediment accumulation areas outside the initial corrective action boundary. At each location, a sample will be collected from each 10-cm depth interval until native material is encountered. Each sample will be screened with an alpha/beta contamination meter and samples collected in accordance with Section A.8.6. Decision II will be resolved for drainages by the assumption that the entire volume of sediment in each sediment accumulation area where a COC is identified contains the COC. Additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain a COC. This may require investigating sediment accumulation areas beyond those initially selected.

4.2.2.5 Study Group 5, Landfills

An investigation will be conducted at the previously unidentified waste trench located approximately 0.7 mi east of Site T-2. Stained soil has been observed at the site and is a biasing factor for sampling. If other biasing factors such as spills or PSM are identified at the trench, additional sample locations may be selected.

If a COC is present, 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. In general, extent sample locations will be arranged in a triangular pattern around areas containing a COC at distances based on site conditions, COC concentrations, process knowledge, and biasing factors. If COCs extend beyond extent locations, additional Decision II samples will be collected from locations farther from the source. Additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain a COC. This may require investigating sediment accumulation areas beyond those initially selected.

Geophysical surveys will be conducted at the waste trench and surrounding area to the south. Surveys will be performed at the ends of the linear open trench to determine extent. Surveys will also be performed in the area south of the trench where aerial photography has identified potentially disturbed areas in a linear pattern parallel to the open waste trench. If buried material is identified, then corrective actions will be required.

4.2.3 Sample Collection

The CAU 105 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in Section 4.2.2.
- Collect required QC samples.
- Collect waste management samples as necessary.
- Collect external dose measurements by hanging TLDs at the sample plots.
- Collect soil samples from locations outside the influence of releases from the CAS, if necessary.
- Record GPS coordinates for each environmental sample location.

To determine internal dose for the SG 1 release scenario, a probabilistic sampling approach will be implemented for collecting composite samples within the sample plots. Each composite sample will consist of soil collected from nine randomly located subsample locations within the plot. For each composite sample, the first location will be selected randomly; the remaining eight subsample locations will be established on a systematic triangular grid (see Section A.8.0). External dose will be sampled from a TLD installed at the approximate center of the sample plot at a height of 1 m and be left in place for approximately 2,000 hours (equivalent to an annual industrial worker exposure).

Decision I for SGs 2, 3, 4, and 5 release samples will be collected from the locations described in Section 4.2.2. If biasing factors are present in soils below locations where Decision I samples were collected, subsurface soil samples will also be collected by augering, backhoe excavation, direct-push, or drilling techniques, as appropriate. Subsurface soil samples will be collected based on biasing factors to a depth where the biasing factors are no longer present.

The internal dose rate at each site within CAU 105 will be determined by sampling within one plot for each site established at the location of the highest radiological values as determined from the 2011 gamma drive-over survey. This will be done in an effort to find the location where the internal dose contributes the greatest amount to TED. A TLD will be placed in the approximate center of each sample plot to determine the external dose. In addition to the TLD placed with each sample plot, TLDs will be installed in a vector or grid pattern at each site as presented in Figures A.8-1 through A.8-3 to measure external dose.

4.2.4 Sample Management

The laboratory requirements (i.e., precision, accuracy, and analytical program) to be used when analyzing the COPCs are presented in the Soils QAP (NNSA/NSO 2012b). The analytical program is presented in Tables A.2-2 through A.2-4. All sampling activities and QC requirements for field and laboratory environmental sampling will be conducted in compliance with the Soils QAP.

4.3 Site Restoration

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

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

5.0 Waste Management

Waste generated during the CAU 105 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, hazardous, hydrocarbon, *Toxic Substances Control Act* (TSCA) regulated (e.g., polychlorinated biphenyls [PCBs], asbestos), low-level radioactive, 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 potentially contaminated debris (e.g., lead). These wastes may be characterized based on associated environmental sample results, waste characterization results, FSRs, or process knowledge.

Chemicals were not known to be used or present at this CAU in a manner that would generate listed hazardous waste; therefore, wastes will be characterized based on their chemical characteristics. The waste will be managed and disposed of accordingly.

Conservative estimates of total waste contaminant concentrations may be made based on the mass of the waste, the amount of contaminated media contained in the waste, and the maximum concentration of contamination found in the media.

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

5.1 Waste Minimization

The CAI will be conducted in a manner that will minimize the generation of wastes using process knowledge, segregation, visual examination, and/or field screening (e.g., radiological survey and swipe results) to avoid cross-contaminating uncontaminated media or uncontaminated IDW that would otherwise be characterized and disposed of as industrial waste. As appropriate, media and debris will be returned to their original location. To limit unnecessary generation of hazardous or mixed waste, hazardous materials will not be used during the CAI unless required and approved by Environmental Compliance and Health and Safety. Other waste minimization practices will include, as appropriate, avoiding contact with contaminated materials, performing dry decontamination or wet decontamination over source locations, and carefully segregating waste streams.

5.2 Potential Waste Streams

The following is a list of common waste streams that may be generated during the field investigation and that may require management and disposal:

- Disposable sampling equipment and field screening waste
- PPE
- Environmental media (e.g., soil)
- Surface debris (e.g., lead bricks, batteries, scrap metal)
- Decontamination rinsate

5.3 IDW Management

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

5.3.1 Industrial Waste

Industrial solid waste, if generated, will be collected, managed, and disposed of in accordance with the solid waste regulations and the permits for operation of the NNSS Solid Waste Disposal Sites. The most commonly generated industrial solid waste includes disposable sampling equipment and PPE that will be collected in plastic bags, and marked in accordance with requirements. This waste, and other waste generated such as debris or soil that is characterized as industrial waste, may be placed in the roll-off box located adjacent to Building 23-153 in Mercury or in another approved container (e.g., drum).

5.3.2 Hazardous Waste

Suspected hazardous waste, if generated, will be containerized and managed in waste accumulation areas in accordance with 40 *Code of Federal Regulations* (CFR) 262.34 (CFR, 2012b).

5.3.3 Hydrocarbon Waste

Suspected hydrocarbon solid waste, if generated, will be managed on site in a drum or other appropriate container until fully characterized and in accordance with the State of Nevada regulations (NDEP, 2006).

5.3.4 Polychlorinated Biphenyls

PCB management is governed by TSCA and its implementing regulations at 40 CFR 761 (CFR, 2012c), and agreements between EPA and NDEP. PCB contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA “characteristic” waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). 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 in accordance with 40 CFR 761 (CFR, 2012c) as well as State of Nevada requirements (NAC, 2012b), guidance, and agreements with NNSA/NSO.

5.3.5 Low-Level Waste

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE orders, and the requirements of the current version of the *Nevada National Security Site Waste Acceptance Criteria* (NNSSWAC) (NNSA/NSO, 2012a). Containers filled with potential radioactive waste will be staged and managed at a designated RMA.

5.3.6 Mixed Low-Level Waste

Mixed waste, if generated, will be managed in accordance with the RCRA requirements (CFR, 2012b), permits between NNSA/NSO and the State of Nevada, and DOE requirements for radioactive waste. The mixed waste must be transported via an approved hazardous waste/radioactive waste transporter to the permitted NNSS mixed waste storage pad pending treatment and/or disposal.

6.0 Quality Assurance/Quality Control

The overall objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for CASs in CAU 105. Characterization activities, including those related to TLD measurements, will be conducted in accordance with the Soils QAP (NNSA/NSO, 2012b).

The data from TLD measurements will meet rigorous data quality requirements. 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. TLDs are replaced and read quarterly. Details of this campaign can be found in the *Nevada Test Site Environmental Report 2006* (Wills, 2007). TLDs will be submitted to the Environmental Technical Services group for inclusion in their routine quarterly read of the NNSS environmental monitoring TLDs. 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. *TLDs will be exposed at the sample plots for an extended period of time that approximates the 2,000 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 2,000 hours.

2. *The use of a TLD to determine an individual's external dose is the standard in radiation safety and serves as the "legal dose of record" when other measurements are available.* Specifically, 10 CFR Part 835.402 (CFR, 2012a) indicates that personal dosimeters must be provided to monitor individual exposures and that the monitoring program that uses the dosimeters must 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 QC 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 is as follows:

- **Radiological samples**
    - Field duplicates (1 per 20 environmental grab samples, or 1 per site per matrix if less than 20 collected)
    - Laboratory QC samples (1 per 20 environmental samples, or 1 per site 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 site per matrix if less than 20 collected)
    - Field blanks
    - Laboratory QC samples (1 per 20 environmental samples, or 1 per site 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 must be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the Soils QAP (NNSA/NSO, 2012b).

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 Soils QAP (NNSA/NSO, 2012b), 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 in accordance with company-specific procedures. The data will be reviewed to ensure that all required samples were appropriately collected and analyzed, and that the results met data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether the data meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

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). Significant DQI criteria variations from the Soils QAP (NNSA/NSO, 2012b) will be reported in the CADD. The quality and usability of data used to make DQO decisions will be assessed based on the following DQIs:

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

Table 6-1 provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The following subsections discuss each of the DQIs that will be used to assess the quality of laboratory data. The criteria for precision and accuracy in the Soils QAP (NNSA/NSO, 2012b) may change as a result of changes in analytical methodology and laboratory contracts.

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 105 DQIs

DQI	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Precision	At least 80% of the sample results for each measured contaminant are not qualified for precision based on the criteria for each analytical method-specific and laboratory-specific criteria presented in Section 6.2.3.	The affected analytical results from each affected site will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Accuracy	At least 80% of the sample results for each measured contaminant are not qualified for accuracy based on the method-specific and laboratory-specific criteria presented in Section 6.2.4.	The affected analytical results from each affected site 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 site-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.

TLDs will be analyzed using automated TLD readers that are calibrated and maintained in accordance with existing QC procedures for TLD processing (Section 6.0) by a laboratory that is certified through the DOE Laboratory Accreditation Program for dosimetry. The data from this system meet rigorous data quality requirements and will be assessed for the listed DQIs before inclusion in the CAU 105 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 laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

Precision is a quantitative measure used to assess overall analytical method and field-sampling performance as well as the need to “flag” (qualify) individual parameter results when corresponding QC sample results are not within established control limits. The validation criteria for precision are defined in the Soils QAP (NNSA/NSO, 2012b).

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 CADD on the impacts to DQO decisions specific to affected contaminants at specific CASs.

6.2.4 Accuracy

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

Accuracy is determined by analyzing a reference material of known parameter concentration or by reanalyzing a sample to which a material of known concentration or amount of parameter has been added (spiked). Accuracy will be evaluated based on results from three types of spiked samples: matrix spike (MS), LCS, and surrogates (organics). The LCS 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 validation criteria for accuracy are defined in the Soils QAP (NNSA/NSO, 2012b).

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

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

6.2.5 Representativeness

Representativeness is the degree to which sample characteristics accurately and precisely represent characteristics of a population or an environmental condition (EPA, 2002). Representativeness is 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 site.

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

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

6.2.6 Completeness

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

For the judgmental sampling approach, the completeness goal is 80 percent. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions. For the probabilistic sampling approach, the completeness goal is a calculated minimum sample size required to produce a valid statistical comparison of the sample mean to the FAL.

The qualitative assessment of completeness is an evaluation of the sufficiency of information available to make DQO decisions. This assessment will be based on meeting the data needs identified in the DQOs and will be presented in the CADD. Additional samples will be collected if it is determined that the 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 CADD.

6.2.8 Sensitivity

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

As presented in Section 3.4, the evaluation criterion for this parameter will be that the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs.

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

7.0 Duration and Records Availability

7.1 Duration

Field and analytical activities will require approximately 160 days to complete.

7.2 Records Availability

Historical information and documents referenced in this plan are retained in the NNSA/NSO activity files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Soils Activity Lead. This document is available in the DOE public reading facilities located in Las Vegas and Carson City, Nevada, or by contacting the appropriate DOE Soils Activity Lead.

8.0 References

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

ASTM, see ASTM International.

Air Resources Laboratory/Special Operations and Research Division. 2012. "Nevada Test Site (NTS) Climatological Rain Gauge Network." As accessed at http://www.sord.nv.doe.gov/home_climate_rain.htm on 17 April.

ASTM International. 1995 (reapproved 2002). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739 - 95(2002). West Conshohocken, PA.

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site,* DOE/NV/11718--324. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2012a. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2012b. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management System." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2012c. Title 40 CFR, Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." Washington, DC: U.S. Government Printing Office.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

DRI, see Desert Research Institute.

Desert Research Institute. 1988. *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas*. April. Las Vegas, NV.

EPA, see U.S. Environmental Protection Agency.

ERDA, see Energy Research and Development Administration.

Energy Research and Development Administration. 1977. *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada*, ERDA-1551. Washington, DC.

FFACO, see *Federal Facility Agreement and Consent Order.*

Fenelon, J.M., D.S. Sweetkind, and R.J. Laczniak. 2010. *Groundwater Flow Systems at the Nevada Test Site, Nevada: A Synthesis of Potentiometric Contours, Hydrostratigraphy, and Geologic Structures*, Professional Paper 1771. Reston, VA: U.S. Geological Survey.

Federal Facility Agreement and Consent Order. 1996 (as amended March 2010). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Soils Sites Strategy, was last modified May 2011, Revision No. 4.

Frizzell, V.A., and J. Shulters. 1990. *Geologic Map of the Nevada Test Site, Southern Nevada*, Map I-2046. Denver, CO: U.S. Geological Survey.

Gilbert, R.O., E.H. Essington, D.N. Brady, P.G. Doctor, and L.L Eberhardt. 1977. "Statistical Activities during 1976 and the Design and Initial Analysis of Nuclear Site Studies." In *Transuranics in Desert Ecosystems*, NVO-181. pp. 331–366. November. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

Gray, K.J., D.S. Shafer, K. Self, C. Martin, and R. McArthur. 2007. *Radionuclide Inventory and Distribution Program (RIDP) Database*, Rev. 2. April. Las Vegas, NV: Desert Research Institute, Water Resources Center.

Johnston, J., Navarro-Intera, LLC (N-I). 2012. Memorandum to S. Mergenmeier (N-I) titled "CAU 105 Sites T-2, T-2A, and T-2B Radioactive Waste Consolidation Project Information," 31 January. Las Vegas, NV.

Kwicklis, E.M., A.V. Wolfsberg, P.H. Stauffer, M.A. Walvoord, and M. Sulley. 2006. *Numerical Evaluation of Liquid and Vapor Fluxes at the Nevada Test Site Area 3 Radioactive Waste Management Site Using Hydrologic Data and Natural Environmental Tracers*, LA-UR-06-1212. Los Alamos, NM: Los Alamos National Laboratory.

Laczniak, R.J., J.C. Cole, D.A. Sawyer, and D.A. Trudeau. 1996. *Summary of Hydrogeologic Controls on Ground-Water Flow at the Nevada Test Site, Nye County, Nevada*, Water-Resources Investigations Report 96-4109. Carson City, NV: U.S. Geological Survey.

McArthur, R.D., and J.F. Kordas. 1983. *Radionuclide Inventory and Distribution Program: The Galileo Area*, DOE/NV/10162-14; Publication No. 45035. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2. Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and S.W. Mead. 1987. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #3. Areas 3, 7, 8, 9, and 10*, DOE/NV/10384-15; Publication No. 45056. Las Vegas, NV: Desert Research Institute, Water Resources Center.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M. Todd (SAIC) titled "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV: IT Corporation.

NAC, see *Nevada Administrative Code*.

NBMG, see Nevada Bureau of Mines and Geology.

NDEP, see Nevada Division of Environmental Protection.

N-I GIS, see Navarro-Intera Geographic Information Systems.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro-Intera Geographic Information Systems. 2012. ESRI ArcGIS Software.

Nevada Administrative Code. 2012a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 May.

Nevada Administrative Code. 2012b. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 May.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Reno, NV.

Nevada Division of Environmental Protection. 2006 (as amended August 2000). *Class III Solid Waste Disposal Site for Hydrocarbon Burdened Soils, Area 6 of the NTS*, Permit SW 13-097-02, Rev. 7. Carson City, NV.

REECo, see Reynolds Electrical & Engineering Co., Inc.

Reynolds Electrical & Engineering Co., Inc. 1988. *Nevada Test Site Radioactive Waste Consolidation Project, Fiscal Year 1989 Plan*. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV.

SNJV, see Stoller-Navarro Joint Venture.

Shott, G.J., V. Yucel, M.J. Sully, L.E. Barker, S.E. Rawlinson, and B.A. Moore. 1997. *Performance Assessment/Composite Analysis for the Area 3 Radioactive Waste Management Site at the Nevada Test Site, Nye County, Nevada*, Rev. 2.0. Las Vegas, NV.

Stoller-Navarro Joint Venture. 2006. *Phase I Hydrologic Data for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 97: Yucca Flat/Climax Mine, Nevada Test Site, Nye County, Nevada*, Rev. 0, S-N99205--077. Las Vegas, NV.

Tamura, T. 1977. “Plutonium Distribution in a Desert Pavement–Desert Mound Soil System in Area 11.” In *Environmental Plutonium on the Nevada Test Site and Environs*, NVO-171. June. Las Vegas, NV: Energy Research and Development Administration, Nevada Applied Ecology Group.

USGS, see U.S. Geological Survey.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Nevada Test Site Orthophoto Site Atlas,* DOE/NV/11718--604. Aerial photos acquired Summer 1998. Prepared by Bechtel Nevada. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Nevada National Security Site Waste Acceptance Criteria*, DOE/NV-325-Rev. 9. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012c. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1992. *Remedial Investigation and Feasibility Study for the Plutonium Contaminated Soils at Nevada Test Site, Nellis Air Force Range and Tonopah Test Range*. April. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1998. *Nevada Test Site Resource Management Plan*, DOE/NV--518. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV--209-Rev 15. Las Vegas, NV.

U.S. Environmental Protection Agency. 2002. *Guidance for Quality Assurance Project Plans*, EPA QA/G5, EPA/240/R-02/009. Washington, DC: Office of Environmental Information.

U.S. Environmental Protection Agency. 2012. *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants*. As accessed at http://www.epa.gov/region9/superfund/prg on 3 May. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

U.S. Geological Survey. 2012. "Groundwater Levels for Nevada." As accessed at http://nwis.waterdata.usgs.gov/nv/nwis/gwlevels on 18 April.

Wills, C.A. 2007. *Nevada Test Site Environmental Report 2006*, DOE/NV 25946--259. Prepared for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. Las Vegas, NV: National Security Technologies, LLC.

Winograd, I.J., and W. Thordarson. 1975. *Hydrology and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site*, USGS Professional Paper 712-C.

Yu, C., A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.5 released in October 2009.)

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 105, Area 2 Yucca Flat Atmospheric Test Sites, field investigation. DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the sites in CAU 105 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 105 CAI will be based on the DQOs presented in this appendix as developed by NDEP and NNSA/NSO representatives. 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 105 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the sites in CAU 105."

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 30, 2012, 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 105 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 site
- Routes of exposure where contaminants may enter the receptor

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

The applicability of the CSM to each release source is summarized in Table A.2-1 and discussed below. Table A.2-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure A.2-1 depicts a representation of the conceptual pathways to receptors from CAU 105 sources. Figure A.2-2 depicts a graphical representation of the CSM.

A.2.2.1 Release Sources

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following SGs:

- **SG 1 (Atmospheric Tests)**. This release category is specific to the atmospheric deposition of radionuclide contamination from nuclear weapons testing (comprised mainly of fission and activation products) onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the this type of release is limited to the top 5 cm of soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CAIP, surface is defined as the upper 5 cm of soil.
- **SG 2 (Excavation**). This release category is specific to the mechanical disturbance and relocation of contaminated surface soil (from an SG 1 type of release).

Table A.2-1
CSM Description of Elements for Each SG at CAU 105

CAS Identifier	All CASs				
SG	1 Atmospheric Tests	2 Excavations	3 Debris/Spills	4 Migration	5 Landfills
Site Status	Sites are inactive and/or abandoned				
Exposure Scenario	Occasional Use/Nuclear and High Explosives Test Zone				
Sources of Potential Soil Contamination	Fallout and soil activation from nuclear detonations	Fallout and soil activation from nuclear detonations	Leaking containers and surface disposal of discarded materials	Migration of soil initially from atmospheric testing	Surface disposal of discarded materials
Location of Contamination/ Release Point	Surface soil at or near location(s) of atmospheric tests	Soil mounds at or near location(s) of atmospheric tests	Surface and subsurface soil at or near location of debris	Surface and subsurface soil at or near location within drainages	Surface and subsurface soil at or near location of debris
Amount Released	Unknown				
Affected Media	Surface and shallow subsurface soil; debris, such as concrete, steel, and wood				
Potential Contaminants	Fission products		Unknown		
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Surface water runoff may provide for the transportation of some contaminants within or outside the footprints of the sites. Include any surface liquids (e.g., ponds, streams) or liquid released over time (e.g., leaks from tanks) that may also have provided a hydraulic driver for percolation and migration of contaminants.				
Migration Pathways	Vertical transport expected to dominate over lateral transport due to small surface gradients.				
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.				
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion or inhalation of, or dermal contact (absorption) with soil and/or debris due to inadvertent disturbance of these materials, or irradiation by radioactive materials.				

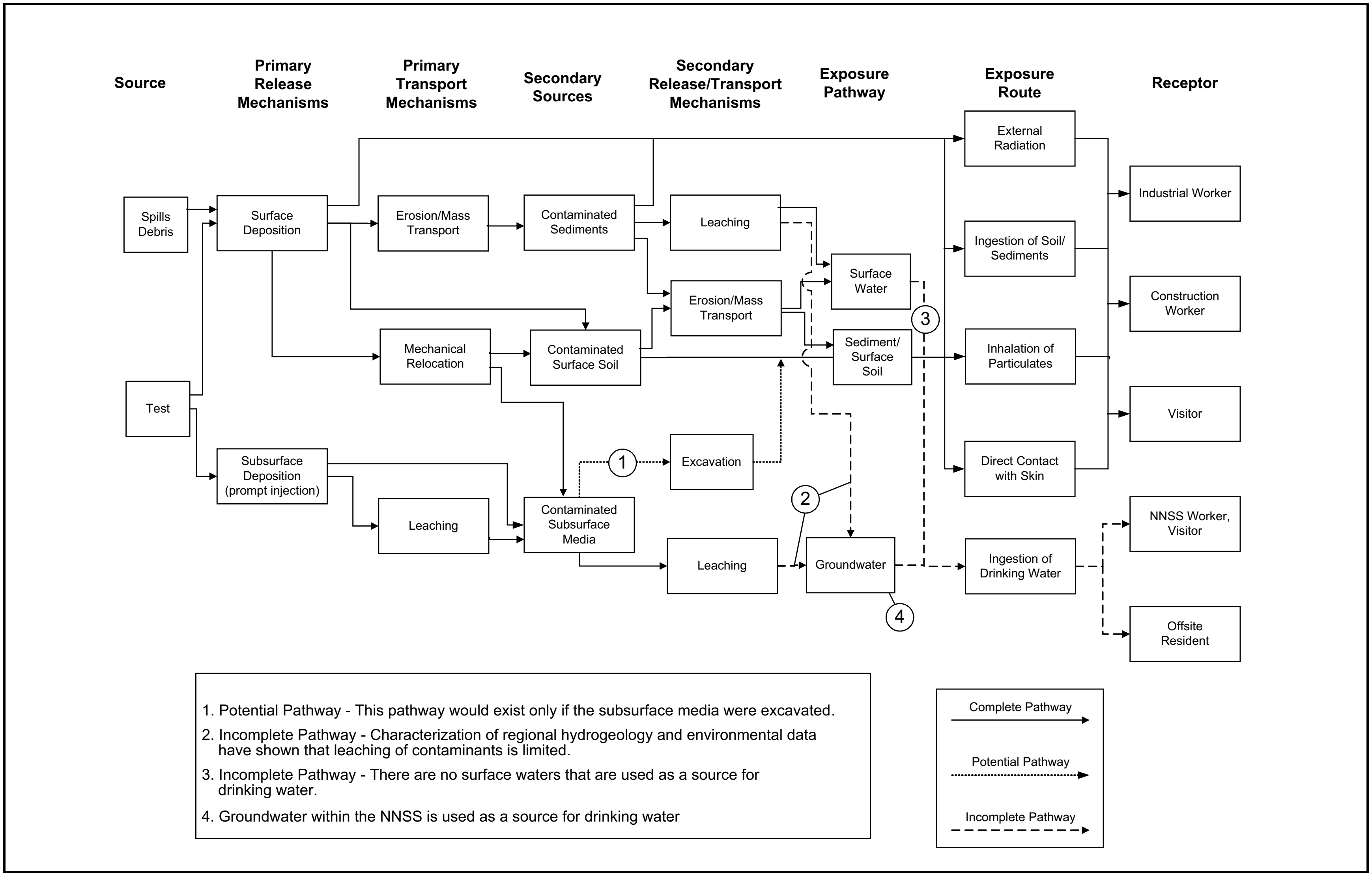

Figure A.2-1
CSM Diagram

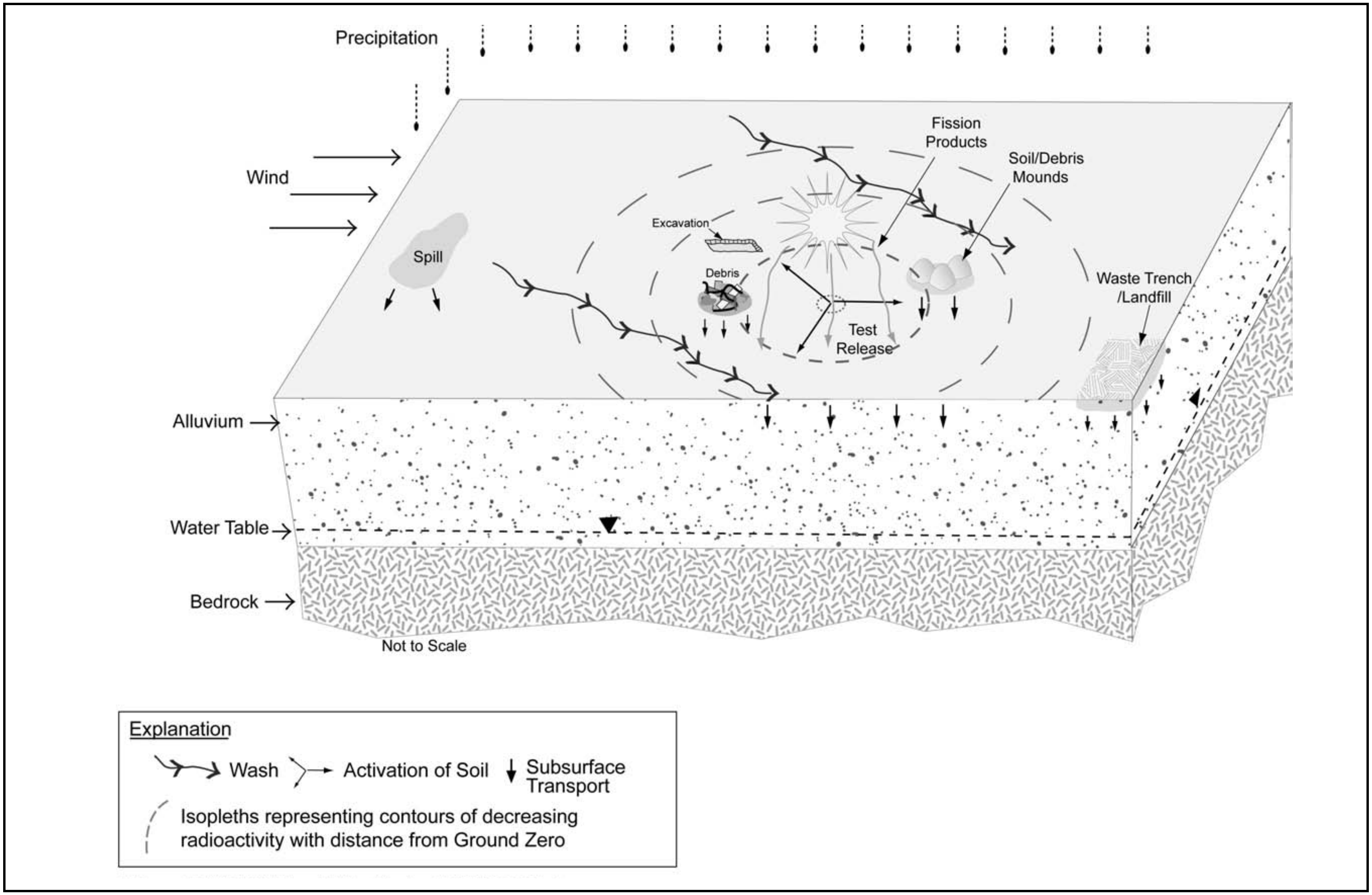

Figure A.2-2
CAU 105 CSM

- **SG 3 (Debris/Spills)**. This group investigates any chemical or radiological contamination associated with debris and/or spills. The debris will be evaluated for PSM, and spills will be evaluated based on the presence of biasing factors such as discoloration or elevated instrument readings.

- **SG 4 (Migration)**. This group investigates the translocation of contaminated surface soil (from an SG 1 type of release) by stormwater runoff into drainages.

- **SG 5 (Landfills**). This group investigates potential subsurface soil contamination resulting from the burial of waste.

The following identifies the release sources specific to SG 1 (Atmospheric Tests) (DOE/NV, 2000):

- **Site T-2 (CAS** 02-23-04**,** Atmospheric Test Site - Whitney**)**. The Whitney source was a weapons-related test with a yield of 19 kt detonated from a tower at 500 ft agl on September 23, 1957.

- **Site T-2 (CAS** 02-23-08**,** Atmospheric Test Site T-2**)**. The Badger and How sources were weapons-related tests detonated from 300-ft towers. With a yield of 23 kt, Badger was detonated on April 18, 1953. With a yield of 14 kt, How was detonated on June 5, 1952.

- **Site T-2 (CAS** 02-23-09**,** Atmospheric Test Site - Turk**)**. The Turk source was a weapons-related test with a yield of 43 kt detonated from a tower at 500 ft agl on March 7, 1955.

- **Site T-2A, Shasta (CAS** 02-23-05**,** Atmospheric Test Site T-2A**)**. The Shasta source was a weapons-related test with a yield of 17 kt detonated from a tower at 500 ft agl on August 18, 1957.

- **Site T-2B, Diablo (CAS** 02-23-06**,** Atmospheric Test Site T-2B**)**. The Diablo source was a weapons-related test with a yield of 17 kt detonated from a tower at 500 ft agl on July 15, 1957.

The following identifies release sources specific to SG 2 (Excavations):

- As part of the consolidation efforts performed in 1989, surface soil was excavated and disposed of at the Area 3 RWMS. Some soil was placed into mounds before disposal. These mounds remain as consolidation efforts were discontinued and are a potential source of contamination.

The following identifies release sources specific to SG 3 (Debris/Spills):

- Wastes and debris could be a source for a release.

The following identifies release sources specific to SG 4 (Migration):

- Drainages flowing through all sites could comprise potential releases associated with CAU 105.

The following identifies release sources specific to SG 5 (Landfills):

- A previously unidentified waste trench located 0.7 mi east of Site T-2 contains wastes and debris that are a potential release source.

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

A.2.2.2 Potential Contaminants

The release-specific COPCs are defined as the contaminants reasonably expected at the site that could contribute to a dose or risk exceeding FALs. Based on the nature of the releases identified in Section 2.4 and previous investigation results presented in Section 2.5, the following COPCs are reasonably suspected to be present at CAU 105:

- Uranium isotopes (U-234, U-235, and U-238)
- Plutonium isotopes (Pu-238 and Pu-239/240)
- Am-241
- Cs-137
- Europium isotopes (Eu-152, Eu-154, Eu-155)

These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs and other releases (including those that may be discovered during the investigation). Of these COPCs, Cs-137 and the europium isotopes are expected to be the major radiological contaminants present at the release sites due to the nature of their production and their longer half-lives. Cesium is a fission product, and europium isotopes are activation products.

Additional COPCs for SGs 3 and 5 may be discovered during the investigation. Specific COPCs (and subsequently the analyses requested) will be determined for other potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

Although other COPCs are not suspected to be present, analysis will be performed to eliminate the possibility of their presence due to an incomplete history of site testing operations as discussed in Section A.2.2.2. The site-specific possible, but not suspected, radiological COPCs include the following:

- Cobalt-60
- Strontium-90
- Technetium (Tc)-99
- Neptunium (Np)-237
- Plutonium-241
- Curium (Cm)-243
- Curium-244
- Americium-243
- Silver (Ag)-108m
- Aluminum (Al)-26
- Niobium (Nb)-94
- Thorium (Th)-232
- Uranium-233

The COPCs applicable to Decision I environmental samples from each of the SGs are listed in Table A.2-2. Table A.2-3 lists the analytical methods required for these COPCs, while Table A.2-4 lists all the analytes that are reported by the analytical laboratory for each of the analytical methods.

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 farther from release points or in low areas where evaporation of ponding will concentrate dissolved contaminants. Fission fragments were released in an annular pattern around GZ. Radionuclides with a low melting point (e.g., iodine) traveled significant distances before condensing and falling out of the plume, while those with higher melting points (e.g., cesium) condensed earlier and were deposited closer to GZ. Any nuclear fuel that did not fission (e.g., uranium and plutonium isotopes) has a very high melting point and is generally found very near to GZ.

Table A.2-2
Contaminants of Potential Concern

COPCs	SGs				
	1 Atmospheric Tests	2 Excavations	3 Debris/Spills	4 Migration	5 Landfills
Organic COPCs					
PAHs	--	--	X[a]	--	X[a]
Inorganic COPCs					
Lead	--	--	X[a]	--	X[a]
Expected Radionuclide COPCs					
Cs-137	X	X	--	X	--
Eu-152/154/155	X	X	--	X	--
Isotopic U Analytes	X	X	--	X	--
Isotopic Pu Analytes	X	X	--	X	--
Isotopic Am (Am-241)	X	X	--	X	--
Possible, but Not Suspected Radionuclide COPCs[b]					
Gamma Spectroscopy analytes[c]	X	X	--	X	--
Pu-241	X	X	--	X	--
Sr-90	X	X	--	X	--
Tc-99	X	X	--	X	--

[a]Analyses to be selected based on nature of release.
[b]Analysis will be performed on a limited selection of samples.
[c]See Table A.2-4 for reported analytes.

PAH = Polyaromatic hydrocarbon

X = COPC associated with this release
-- = COPC not associated with this release

The radionuclide contaminants in all sites are moderately to highly adsorbed on the alluvial materials present in CAU 105. A summary of the inherent vertical migration potential of these contaminants through the vadose zone due to their adsorption properties is presented in Table A.2-5. This table also presents the contaminant sorption coefficients (K_d) along with the equivalent retardation factor (based on an average bulk density of 1.5 grams per milliliter and porosity of 0.3) (SNJV, 2007). Based on these properties and the maximum estimated recharge rate of 50 m in 1,000 years (Section 3.1.4), the major radionuclide contaminants at CAU 105 are estimated to migrate no more than 1/10 of a meter in 1,000 years except for uranium, which could migrate up to 8 m in 1,000 years.

Table A.2-3
Analysis Required by Study Group[a]

	SGs				
Analytical Method	**1 Atmospheric Tests**	**2 Excavations**	**3 Debris/Spills**	**4 Migration**	**5 Landfills**
Organic COPCs					
VOCs	--	--	X[b]	--	X[b]
SVOCs	--	--	X[b]	--	X[b]
Inorganic COPCs					
RCRA Metals	--	--	X[b]	--	X[b]
Radionuclide COPCs					
Gamma Spectroscopy[c]	X	X	--	X	--
Isotopic U[d]	X	X	--	X	--
Isotopic Pu[d]	X	X	--	X	--
Pu-241[d]	X	X	--	X	--
Isotopic Am[d]	X	X	--	X	--
Sr-90[d]	X	X	--	X	--
Tc-99[d]	X	X	--	X	--

[a]Analytical methods are provided in Table A.2-4.
[b]Analytical method may be included depending upon type of release investigation.
[c]A limited number of Decision I samples will be submitted for this analysis.
[d]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.

X = Required analytical method as described in Soils QAP
-- = Not required

The migration potential of radionuclides released from a nuclear detonation was demonstrated in a long-term radionuclide migration study of an underground nuclear test. A well installed into the groundwater 91 m away from the Cambric test GZ (and much closer to the nearest extent of the test cavity) was continuously pumped from 1975 to 1991 in order to draw radionuclides from the detonation cavity. The May 1965 Cambric test released a yield of 750 tons at a depth of 294 m below the land surface and 73 m below the water table (DOE/NV, 2000; Hoffman and Daniels, 1984). No radionuclides associated with nuclear fission tests (including the major contributing radionuclides plutonium, uranium, cesium, europium, strontium, or cobalt) other than tritium and krypton (which are considered to be conservative tracers in groundwater, as they do not interact with the geologic media through which the water moves) were detected in the pumped groundwater

Table A.2-4
Analytes Reported Per Method

VOCs		SVOCs		Metals	Radionuclides	
Method 8260[a]		**Method 8270[a]**		**Method 6010[a]**	**Method Ga-01[b]**	**Method U-02[b]**
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	1,4-Dioxane	Bis(2-ethylhexyl)phthalate	Arsenic	Ac-228	U-234
1,1,1-Trichloroethane	Chlorobenzene	2,3,4,6-Tetrachlorophenol	Butyl benzyl phthalate	Barium	Ag-108m	U-235
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,5-Trichlorophenol	Carbazole	Beryllium	Al-26	U-238
1,1,2-Trichloroethane	Chloroform	2,4,6-Trichlorophenol	Chrysene	Cadmium	Am-241	
1,1-Dichloroethane	Chloromethane	2,4-Dimethylphenol	Di-n-butyl phthalate	Chromium	Cm-243	**Method Sr-02**
1,1-Dichloroethene	Chloroprene	2,4-Dinitrotoluene	Di-n-octyl phthalate	Lead	Co-60	Sr-90
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Chlorophenol	Dibenzo(a,h)anthracene	Selenium	Cs-137	
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylnaphthalene	Dibenzofuran	Silver	Eu-152	**Lab-Specific Methods[d]**
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Methylphenol	Dimethyl phthalate		Eu-154	Pu-241
1,2-Dichlorobenzene	Ethyl methacrylate	2-Nitrophenol	Fluoranthene	**Method 7471[a]**	Eu-155	Tc-99
1,2-Dichloroethane	Ethylbenzene	3-Methylphenol[c] (m-cresol)	Fluorene	Mercury	K-40	
1,2-Dichloropropane	Isobutyl alcohol	4-Methylphenol[c] (p-cresol)	Hexachlorobenzene		Nb-94	
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Chloroaniline	Hexachlorobutadiene	**Method 7196[a]**	Pa-233	
1,3-Dichlorobenzene	Methacrylonitrile	4-Nitrophenol	Hexachloroethane	Chromium VI	Pb-212	
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthene	Indeno(1,2,3-cd)pyrene		Pb-214	
2-Butanone	Methylene chloride	Acenaphthylene	n-Nitroso-di-n-propylamine		Th-229	
2-Chlorotoluene	n-Butylbenzene	Aniline	Naphthalene		Th-234	
2-Hexanone	n-Propylbenzene	Anthracene	Nitrobenzene		Tl-208	
4-Isopropyltoluene	sec-Butylbenzene	Benzo(a)anthracene	Pentachlorophenol		U-235	
4-Methyl-2-pentanone	Styrene	Benzo(a)pyrene	Phenanthrene			
Acetone	tert-Butylbenzene	Benzo(b)fluoranthene	Phenol		**Method Am-01[b]**	
Acetonitrile	Tetrachloroethene	Benzo(g,h,i)perylene	Pyrene		Am-241	
Allyl chloride	Toluene	Benzo(k)fluoranthene	Pyridine		Am-243	
Benzene	Total xylenes	Benzoic acid	Diethyl phthalate			
Bromodichloromethane	Trichloroethene	Benzyl alcohol			**Method Pu-02[b]**	
Bromoform	Trichlorofluoromethane				Pu-238	
Bromomethane	Vinyl acetate				Pu-239/240	
Carbon disulfide	Vinyl chloride					

[a] *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2012b)
[b] *The Procedures Manual of the Environmental Measurements Laboratory*, which includes HASL-300 Methods (DOE, 1997)
[c] May be reported as 3,4-Methylphenol or m,p-cresol.
[d] The most current EPA, DOE, or equivalent accepted analytical method may be used including; Laboratory Standard Operating Procedures approved by the contractor in accordance with industry standards and the contractor's Statement of Work requirements.

Ac = Actinium
HASL = Health and Safety Laboratory
K = Potassium
Pa = Proactinium
Pb = Lead
Tl = Thallium

Table A.2-5
Vertical Migration Potential through the Vadose of the Major Radionuclide Contaminants

COC	Approximate Range of K_d Values (mL/g)	Equivalent Retardation Factor	Migration Distance in 1,000 years (m)
Uranium	1 - 10	6 - 50	1 - 8
Plutonium	100 - 10,000	500 - 50,000	0.001 - 0.1
Europium	1,000 - 100,000	5,000 - 500,000	0.0001 - 0.01
Thorium	100 - 10,000	500 - 50,000	0.001 - 0.1
Cesium	1,000 - 10,000	5,000 - 50,000	0.001 - 0.01
Americium	10,000 - 100,000	50,000 - 500,000	0.0001 - 0.001

mL/g = Milliliters per gram

during the 29 years of pumping (Bryant, 1992; Hoffman and Daniels, 1984). This test demonstrated the relative immobility of the fission radionuclides under conditions of very high mass flow (more than 1.5 billion gallons of water pumped) in a saturated matrix. Under unsaturated conditions (such as surface soil with atmospheric deposition from nuclear test releases), infiltrating water percolating through the vadose zone provides a small fraction of the migration potential (mass flow is less than 3 cm of recharge per year). Therefore, it can be assumed that while the major fission radionuclides are relatively immobile in saturated conditions with an artificial gradient (i.e., under pumping conditions), they will be even less mobile under unsaturated conditions with limited net infiltration of precipitation. Based on this evidence, 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, ephemeral drainage channels, and evapotranspiration potential. Meteorological data are presented in Section 2.1.

The five CASs in CAU 105 are located in Area 2 of the NNSS in Yucca Flats. The area is nearly flat but slopes gently toward the southeast. The area is sparsely vegetated with native plants. The soil in and around CAU 105 consists of sand to cobble-sized alluvium of various lithologies. No perennial streamflow exists in the region. Drainages in the area flow through ephemeral drainage channels that travel to the south and southeast into the 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 lateral transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identifiable as sedimentation areas. Other migration pathways for contamination from the sites include windborne material and materials displaced from maintenance activities (e.g., moved during road maintenance). Contaminants may also be moved through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include activities such as decontamination and demolition of facilities, investigation and resolution of sites, and disassembly and removal of equipment and support structures.

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 major contaminants that are reasonably expected to be present at CAU 105 (presented in Section A.2.2.2) have low solubilities and high affinity for media. The physical characteristics of the vadose material generally include medium and high adsorbive capacities, low moisture contents (i.e., available water-holding capacity), and relatively long distances to groundwater (e.g., 1,452 ft bgs). Based on these physical and chemical factors, contamination is expected to be found relatively close to release points.

Infiltration and percolation of precipitation serve as a driving force for downward migration of contaminants. However, due to high PET (annual PET at the Area 3 RWMS has been estimated at 61.8 in. [Shott et al., 1997]) and limited precipitation for this region (6.3 in./yr [Winograd and Thordarson, 1975]), 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 105 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 lateral 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 or inhalation of, or dermal contact (absorption) with soil or debris due to inadvertent disturbance of these materials, or external irradiation by radioactive materials. The land-use and exposure scenario for the CAU 105 sites is listed in Table A.2-6. This scenario is based on current and future land use at the NNSS (DOE/NV, 1996). Although CAU 105 is located in an area where past activities have taken place, no facilities or structures are present that would support an assigned work station for NNSS site personnel. However, as site personnel may periodically perform work at these sites, it is considered to be an occasional use work areas. Therefore, the current site usage at CAU 105 is conservatively represented by the Occasional Use Area exposure scenario.

Table A.2-6
Land-Use and Exposure Scenarios

CASs	Record of Decision Land-Use Zone	Exposure Scenario
All	**Nuclear and High Explosives Test** This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high explosives tests. This zone includes compatible defense and nondefense research, development, and testing activities.	**Industrial Area** Worker will be exposed to the site full time (250 days per year, 8 hours per day for 25 years). Active powered buildings with toilets are present at the site.
		Remote Work Area Worker will be exposed to the site part time (up to 336 hours per year for 25 years). Site structures are present for shelter and comfort of the worker.
		Occasional Use Area Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.

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

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

A.3.1 Decision Statements

The Decision I statement is as follows: "Is any COC present in environmental media within the CAS?" For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For the 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, 2012b). 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 corrective action alternatives

A corrective action will be determined for any site containing a COC. Decision I samples will be collected to determine the presence of COC at each site. If a COC is detected than further sampling will be performed to determine a corrective action boundary. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

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

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.

- Based on process knowledge and/or professional judgment, some waste may be assumed 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 (after degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.

  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (after degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.

  - For liquid wastes, the resulting concentration of contaminants in the surrounding soil would 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 he liquid waste would be considered to be PSM.

A corrective action will also be required if a combination of contaminants is determined to jointly pose an unacceptable risk (NNSA/NSO, 2012b).

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

A.3.2 Alternative Actions to the Decisions

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

A.3.2.1 Alternative Actions to Decision I

If no COC associated with a release is detected, further assessment of the site is not required. If a COC associated with a release is detected, 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 have 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 migration of COC contamination beyond the corrective action boundary, 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 site) 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 site (probabilistic sampling)
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To resolve Decision II for SG 1, TED rates need to be established at locations that bound the FAL dose rate and provide sufficient information to establish a high (greater than 0.8) correlation to radiation survey isopleths. A boundary will then be determined around the radiation survey isopleth the correlates to the 25-mrem/yr FAL.

To resolve Decision II for SGs 2 through 5 (determine whether sufficient information is available to evaluate potential CAAs), samples must be collected in areas contiguous to the contamination but where contaminant concentrations are below FALs. To resolve Decision II for any SG, samples need to be collected and analyzed to meet the following criteria:

- 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.

Decision II sampling will not be conducted for the drainage sedimentation areas (SG 4). If a COC is present in the sediment, the entire volume of the sediment will be assumed to require corrective action.

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 Soils QAP (NNSA/NSO, 2012a). TLDs will be submitted to the Environmental Technical Services group at the NNSS, which is certified by the DOE Laboratory Accreditation Program for dosimetry. Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

A.4.2.1 Sample Locations

Design of the sampling approaches for the CAU 105 sites 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 site (probabilistic). These sample locations, therefore, can be selected by means of either (a) biasing factors used in judgmental sampling (e.g., a stain, likely containing a spilled substance) or (b) randomly using a probabilistic sampling design. The implementation of a judgmental approach for sample location selection, and of a probabilistic sampling approach, for CAU 105 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., precision, and accuracy) for soil samples are provided in the Soils QAP (NNSA/NSO, 2012a).

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

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

A.5.1 Target Populations of Interest

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

- For SGs 1 and 2, TED and corresponding radiation survey values from locations where TED varies from above the FAL to below the FAL.
- For SGs 3, 4, and 5, COC concentrations for each one of a set of locations bounding contamination in lateral and vertical directions
- Investigation waste and potential remediation waste characteristics

A.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. Spatial boundaries were determined by an agreement reached in the DQO meeting with decision makers. Decision II spatial boundaries are as follows:

- **Vertical.** SGs 1 and 2: 1 ft below original ground surface
- **Vertical.** SGs 3, 4, and 5: 15 ft bgs
- **Lateral.** All SGs: 1 mi from GZ

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

A.5.3 Practical Constraints

Practical constraints (e.g., 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.

A.5.4 Define the Sampling Units

The scale of decision making refers to the smallest, most appropriate area or volume for which decisions will be made. The scale of decision making in Decision I is the CAS component (defined by a specific release). The presence of a COC associated with a CAS component will cause the determination that the CAS component is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area containing a COC originating from the CAS component. 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.

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 chemical contaminants, the population parameter is the observed concentration of each contaminant from each individual analytical sample. For radiological contaminants, it is the calculated TED for each location. 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 corrective action is required (for Decision I), or that the extent of COC contamination is not bounded (for Decision II).

A.6.1.2 Probabilistic Sampling Design

For probabilistic sampling results, the population parameter is the true TED over the area of the sample plot. Resolution of DQO decisions associated with the probabilistic sampling design requires determining, with a specified degree of confidence, whether the true TED at the site in question exceeds the FAL. Because a calculated TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the calculated TED were significantly different from the true TED, a decision based on the calculated TED could result in a decision error. To reduce the probability of making a false negative decision error, a conservative estimate of the true TED is used to compare to the FAL instead of the calculated TED. This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED values (Section 4.1). By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED.

The computation of appropriate UCLs depends upon the data distribution, the number of samples, the variability of the dataset, and the skewness associated with the dataset. A statistical package will be used to determine the appropriate probability distribution (e.g., normal, lognormal, gamma) and/or a suitable nonparametric 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 parametric and nonparametric 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 in accordance with Section A.8.1.2.
- 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 *Soils Risk-Based Corrective Action Evaluation Process* (NNSA/NSO, 2012b). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012b) requires the adoption 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 or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

This RBCA process 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 concentrations of TPH 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 CADD. The FALs will be defined (along with the basis for their definition) in the CADD.

A.6.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the Region 9 Regional Screening Levels for chemical contaminants in industrial soils (EPA, 2012a). Background concentrations for RCRA metals will be used instead of screening levels when natural background concentrations exceed the screening level (e.g., arsenic on the NNSS). Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the CADD.

A.6.2.2 Radionuclide PALs

The PAL for radioactive contaminants is a TED of 25 mrem/yr, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in the *Soils Risk-Based Corrective Action Evaluation Process* (NNSA/NSO, 2012b). The TED is calculated as the sum of external dose and internal dose. External dose is determined directly from TLD measurements. Internal dose is determined by comparing analytical results from soil samples to RRMGs that were established using the RESRAD computer code (Yu et al., 2001). The RRMGs are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram of surface soil, for a particular radionuclide that would result in an internal dose of 25 mrem/yr to a receptor (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). The RRMGs are presented in the Soils RBCA document (NNSA/NSO, 2012b). In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used. The default and site-specific input parameters used in the RESRAD calculation of RRMGs for each exposure scenario are listed in the Soils RBCA document.

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 will be resolved, else no further investigation is needed for that COPC in that population.
- If a COC exists at any release site, then a corrective action will be determined, else no further action will be necessary.
- If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, else no further action will be necessary.

The decision rules for Decision II are as follows:

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

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

A.7.0 Step 6 - Specify Performance or Acceptance Criteria

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

A.7.1 Decision Hypotheses

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

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

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

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

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

- Developing a CSM (based on process knowledge) that is agreed to by decision makers listed in Section A.2.1.
- 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 site. For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- Having a high degree of confidence that the dataset is of sufficient quality and completeness.

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

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

These characteristics were considered during the development of the CSM and selection of sampling locations. The field-screening methods and biasing factors listed in Section A.4.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. The CADD 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 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 CADD.

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 Soils QAP (NNSA/NSO, 2012a) and in Section 6.2.2. The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the analyte performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to industry standard methods so that results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in Section 6.2.2.

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the Soils QAP (NNSA/NSO, 2012a):

- Field duplicates (minimum of 1 per matrix per 20 environmental grab samples)
- Laboratory QC samples (minimum of 1 per matrix per 20 environmental samples, or 1 per site 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 Soils QAP (NNSA/NSO, 2012a):

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

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

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

Step 7 of the DQO process selects and documents a design that will produce data that exceed performance or acceptance criteria. Judgmental sampling schemes will be implemented to select sample plot locations for the atmospheric test releases. Probabilistic sampling schemes will be implemented to select the sample locations within each of the sample plots. Judgmental sampling will also be used to investigate any other releases as described in Section A.2.2.1. Investigation results will be compared to FALs to determine the need for corrective action. PSM 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 Investigation for Study Group 1, Atmospheric Tests

Because Site T-2A, Shasta and Site T-2B, Diablo are physically separate from Site T-2, CASs 02-23-05 (Shasta) and 02-23-06 (Diablo) will be investigated individually. Because the four tests performed at Site T-2 (Whitney, Badger, How, and Turk) were similar type tests performed at the same physical location, CASs 02-23-04, 02-23-08, and 02-23-09 will be investigated as a group.

A.8.1.1 Internal Dose Sampling for Study Group 1, Atmospheric Tests

A judgmental sampling design will be implemented for locating Decision I sample plots for SG 1. These sample locations have been determined judgmentally based on the highest results of the radiological surveys. This will be done in an effort to find the location where the internal dose contributes the greatest amount to the TED.

One Decision I sample plot has been selected for each of the SG 1 sites. The proposed sample plot locations were selected based on the radiological surveys conducted during the preliminary investigation. Further ground-based radiological surveys may result in the relocation of the proposed sample plots. For Site T-2A, Shasta, one Decision I sample plot will be located near GZ. For Site T-2B, Diablo, one sample plot will be located southwest of GZ. The Decision I sample plot for Site T-2 will be located slightly south of GZ. The proposed Decision I sampling plot locations are depicted on Figures A.8-1 through A.8-3.

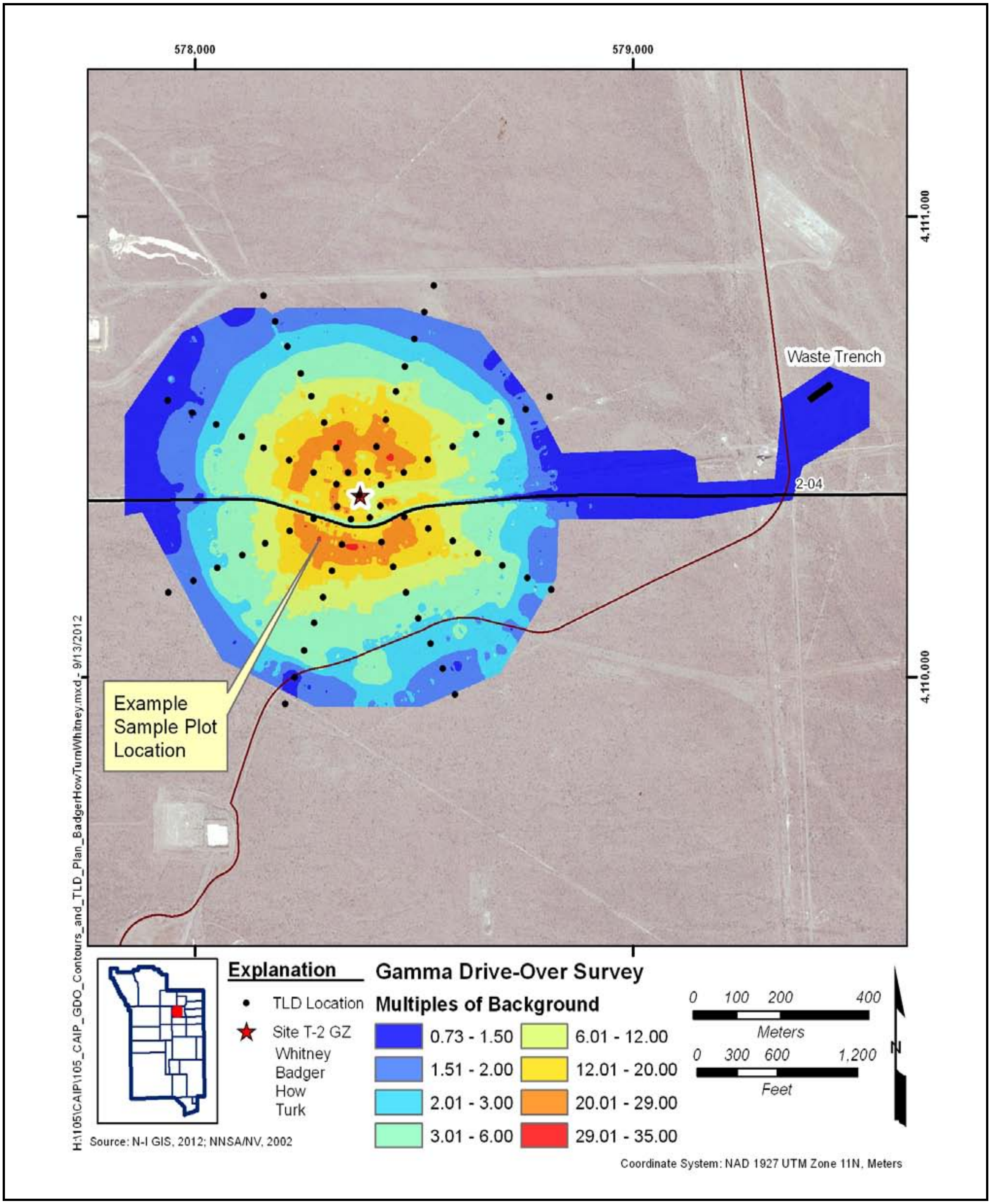

Figure A.8-1
Sample Plot and TLD Locations for Site T-2

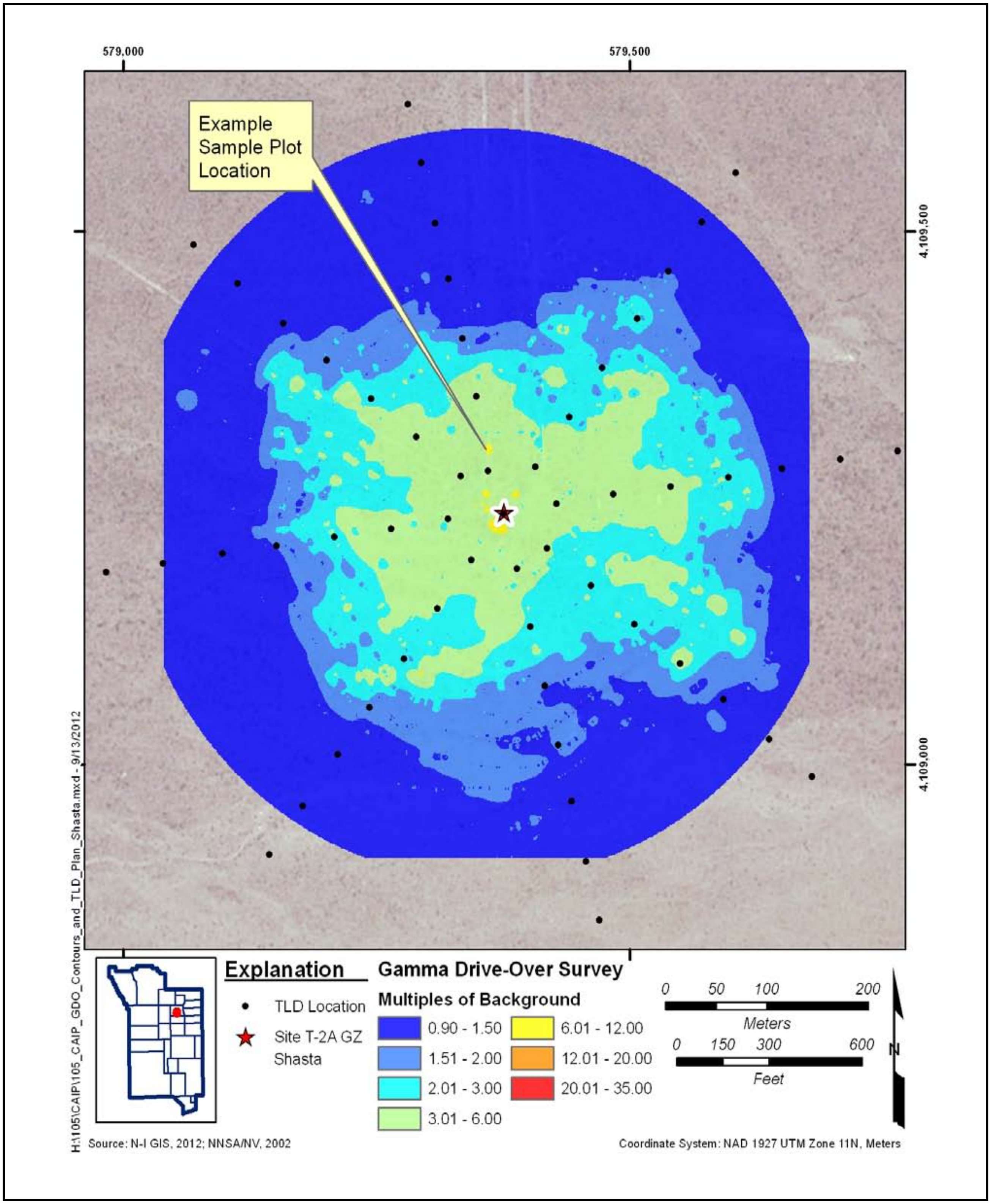

Figure A.8-2
Sample Plot and TLD Locations for Site T-2A, Shasta

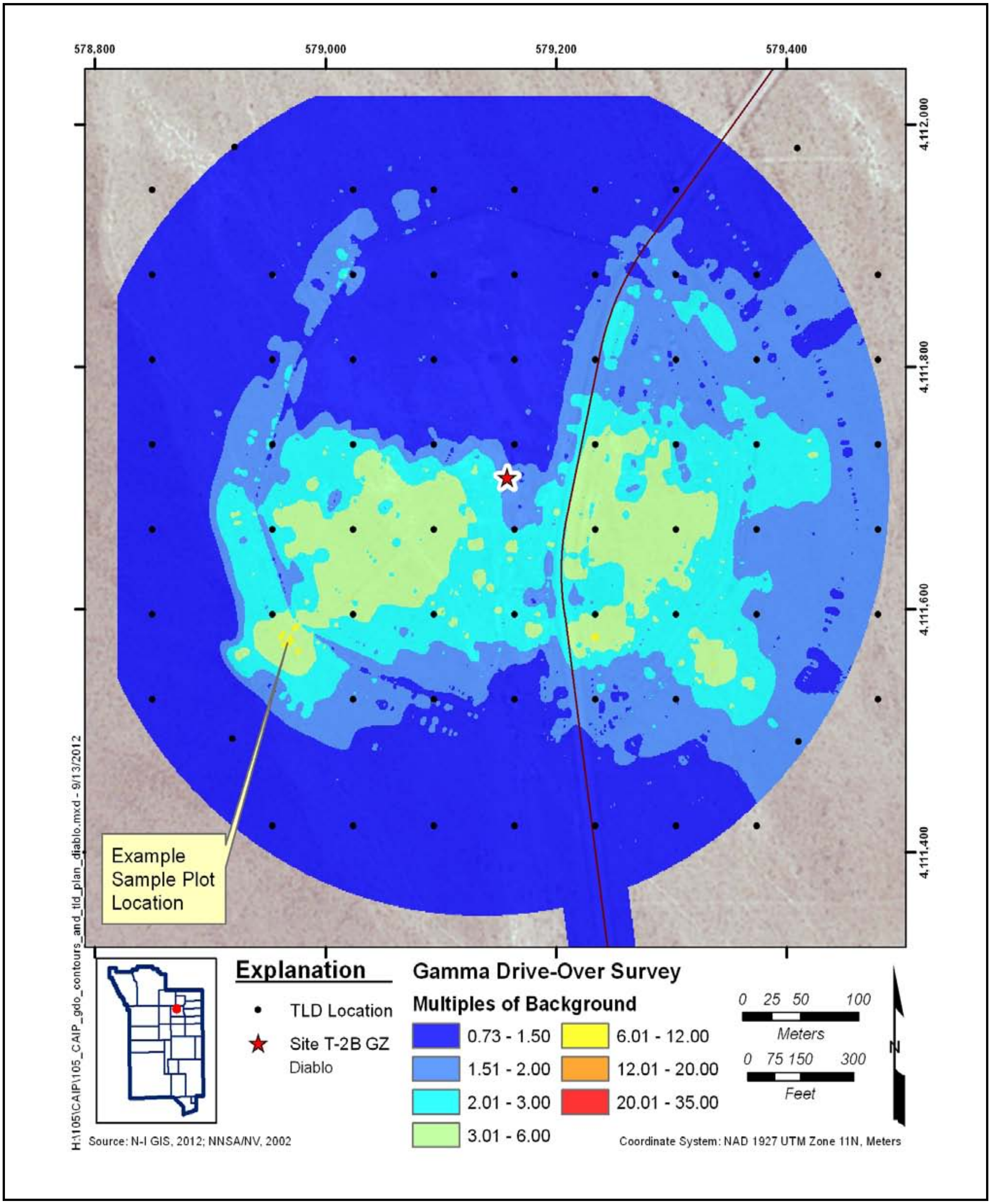

Figure A.8-3
Sample Plot and TLD Locations for Site T-2B, Diablo

All samples will be analyzed for the expected COPCs as discussed in Section A.2.2.2. Subsequent analysis for possible radionuclides will be based upon an initial sample collected at the location with the highest alpha field-screening level (FSL) results. Each sample will be screened with an alpha/beta contamination meter to determine samples to be submitted for possible radionuclide analysis. The analysis of additional samples will be based on the presence of possible radionuclides at levels that would provide significant contribution to dose.

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 based on a random start, triangular pattern. If sufficient sample material cannot be collected at a specified location (e.g., rock, caliche, or buried concrete), the Site Supervisor will establish the location at the nearest place that a surface sample can be obtained. Statistical methods that generate site characteristics will be used to establish internal dose estimates that represent the sample plot as a whole. Composite samples will be collected at each sample plot in the following manner:

- Four composite samples will be collected from each established sample plot.
- Each composite sample will be composed of nine aliquots taken from randomly selected locations within each plot. These locations will be predetermined using a random start with a triangular grid pattern.
- 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.

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

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

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 results in a value less than three, three is adopted as the minimum number of samples required.

All calculations for the determination of sample size sufficiency will be provided in the CADD. If the criteria established in this section result in a determination that the minimum sample size was not met for a plot, one of the following actions may be taken:

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

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

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.

For TLD locations where soil samples are not collected, the internal dose will be estimated. This will be accomplished using the external dose for the location to be estimated (calculated from the TLD at that location) and the internal dose to external dose ratio from the location of the highest internal dose using the following formula:

$$Internal\ dose_{est} = External\ dose_{est} \times [Internal\ dose / External\ dose]_{max}$$

where

est = location for the estimate of internal dose
max = location of maximum internal dose

Use of this method to estimate internal dose will overestimate the internal dose (and therefore TED) as the internal to external dose ratio generally decreases with decreasing TED values.

A.8.1.3 External Dose Sampling for Study Group 1, Atmospheric Tests

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

TLD placement and processing will follow the protocols established in *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). TLDs will be in place for a targeted total exposure time of 2,000 hours, or the resulting data will be adjusted to be equivalent to an exposure time of 2,000 hours.

Estimates of external dose, in mrem/IA-yr, will be presented as net values (e.g., a background has been subtracted from the raw result). Naturally occurring terrestrial and cosmic radiation (i.e., background) will be registered on a TLD. These background radiation values can be comparable to the value of the FAL. Therefore, the FAL is only applicable to radiation dose from man-made sources at the NNSS and is a value in excess of what would be present if there were no nuclear activities at the site.

Approximate background TLD locations chosen for CAU 105 are shown in Figure A.8-4.

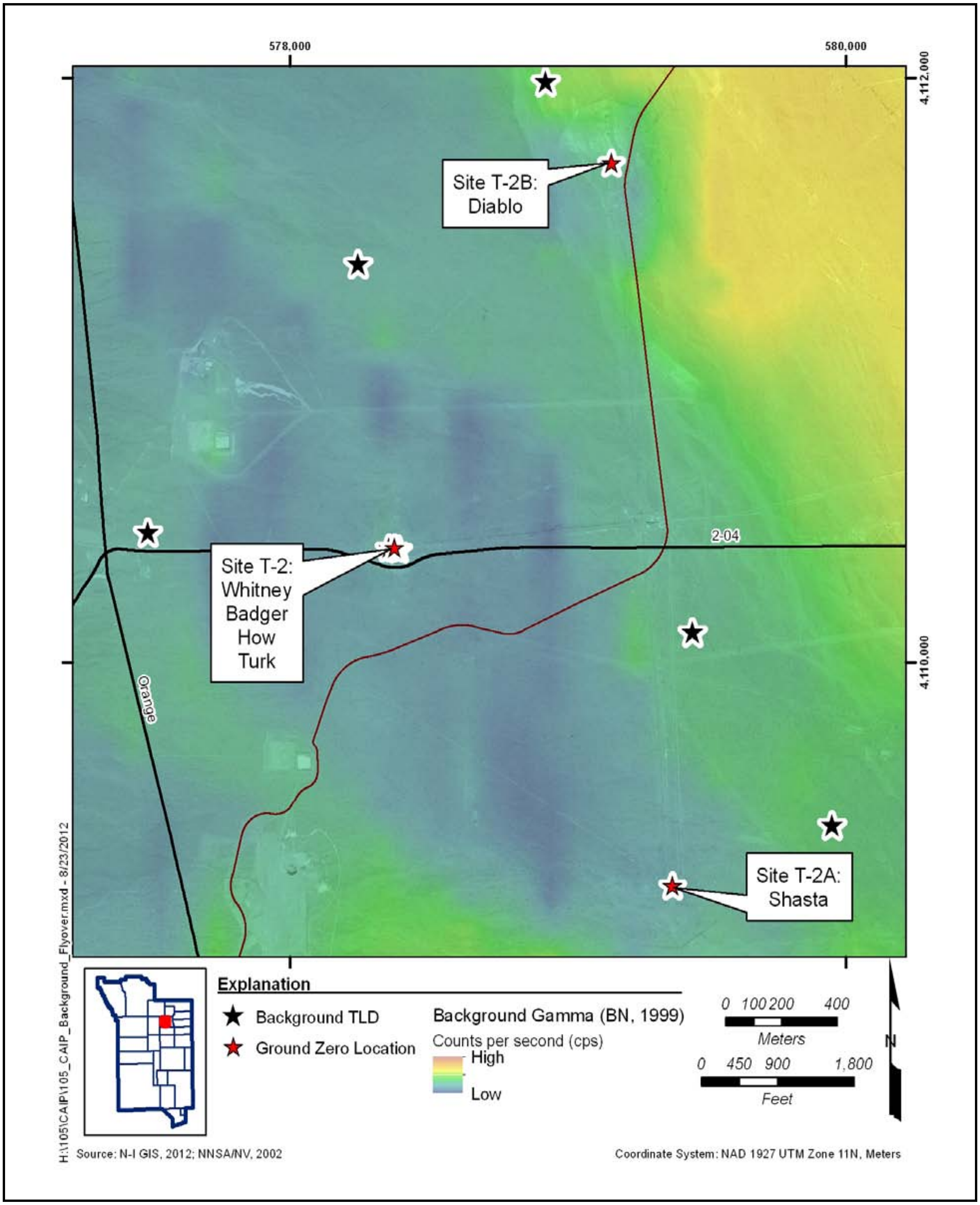

Figure A.8-4
Background Sample Locations

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

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 the following formula:

$$Equivalent\ Subsurface_{TLD} = Subsurface_{RR}\ x\ (Surface_{TLD} / Surface_{RR})$$

where

TLD = external dose based on TLD readings
RR = external dose based on RESRAD calculation from analytical soil concentrations

A.8.1.4 Evaluation of Total Effective Dose for Study Group 1, Atmospheric Tests

As discussed in Section A.6.1.2, the 95 percent UCL of the TED from each sample location will be used to establish the corrective action boundary. The 95 percent UCL of the TED for each sample location will be established as the sum of the 95 percent UCL of the internal dose and the 95 percent UCL of the external dose. These 95 percent UCL dose estimates will be calculated using the three external dose measurements from the TLD and the RRMG-calculated internal dose estimates from the soil samples.

The initial corrective action boundary area will be calculated using the 95 percent UCL of the TED from each sample location and a corresponding measurement from an appropriate radiation survey.

These paired values will be used to establish a correlation for each radiation survey and identify the radiation survey that has the best correlation to TED values. This correlation will be used to establish a radiation survey value corresponding to the 25-mrem/yr FAL (using the appropriate exposure scenario). An isopleth of this value from the radiological survey will be used as the initial corrective action boundary.

A.8.2 General Sampling for Study Groups 2 through 5

Sample locations for releases identified for SGs 2 through 5 will be determined based upon the likelihood of a contaminant release at the site. These locations will be selected based on the identification of biasing factors during the investigation. Additional sampling may be identified during site characterization activities and will be investigated as appropriate. The following factors will also be considered in selecting locations for analytical samples at CAU 105:

- *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 laterally.

- *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 input from interviewee exists that a release of hazardous or radioactive substances may have occurred.

- *Preselected areas based on process knowledge of the contaminant(s).* Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.

- Experience and data from investigations of similar sites.

- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.
- Presence of debris, waste, or equipment.
- *Other biasing factors.* Factors not previously defined for the CAI that become evident during the CAI.

A.8.3 Decision I for Study Groups 2 through 5

A judgmental sampling design will be implemented for the releases from these SGs to establish sample locations and evaluate sample results. 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).

A biased sampling strategy will be used to target areas with the highest potential to contain a COC, if it is present anywhere in the site. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in Section A.4.2.1. If biasing factors are present in soils below locations where Decision I samples were removed, additional 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 the DQOs.

A.8.4 Investigation for Study Group 2, Excavations

The soil and debris piles observed at Site T-2B, Diablo will be investigated to document content and estimate the TED. The soil pile closest to GZ will be investigated as representative of the other soil piles located at the site. At least two perpendicular trenches will be constructed to partially excavate up to one quarter of this soil pile closest to GZ. This partial excavation will be performed to document content and determine the TED. The excavated soil and debris will be arrayed on the ground adjacent to the soil pile in at least a 4-by-4-m area. This will be performed to obtain a grab sample for internal dose determination and to place a TLD for external dose. The approximate location of the trenches and soil lay out areas are shown on Figure A.8-5. Decision II will be resolved by the assumption that the entire volume of the soil pile where a COC was identified, to include other soil piles at the site, contains the COC.

A.8.5 Investigation for Study Group 3, Debris/Spills

For releases related to spills or debris, biasing factors such as stains, radiological survey results, and wastes suspected of containing hazardous or radiological components will be used to select the most appropriate samples from a particular location for submittal to an analytical laboratory. Samples will be collected from the material that presents the greatest degree of the biasing factor identified. The specific analyses requested for SG 3 samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

Decision II will be resolved by collecting judgmental sampling based on the location of COCs, the CSM, and other field screening and biased factors. In general, sample locations will be arranged in a triangular pattern around the area containing COCs based upon field conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, samples will be collected from locations farther from the source. A clean sample (i.e., COCs less than the FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination.

A.8.6 Investigation for Study Group 4, Migration

The migration of contamination is most likely to occur due to surface runoff in drainages from the sites. For the investigation of drainages, sample locations will be selected from the center of sediment collection areas or at locations of elevated radiological readings.

Drainage will be visually surveyed for the presence of sediment accumulation areas within the wash. Ground-based radiological surveys will be conducted to identify elevated readings to select a minimum of two sediment accumulation areas for each of the drainages identified for investigation in the DQO process. A sampling location will be established at the center of the selected sediment

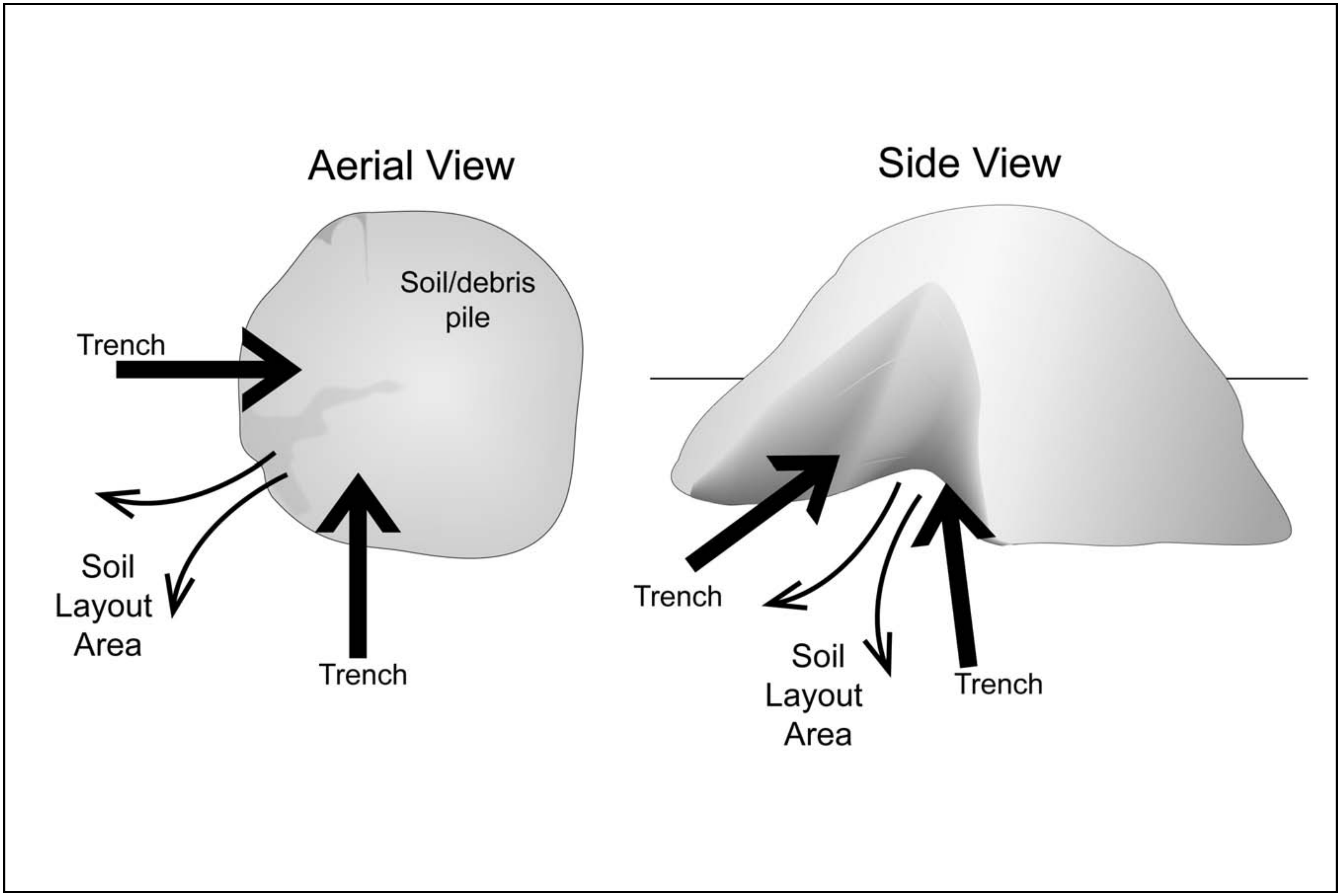

Figure A.8-5
Soil Pile Characterization Strategy

accumulation areas likely to be outside and adjacent to the initial corrective action boundary. Judgmental samples will be collected as follows:

- At each sample location within the sediment accumulation area, a sample will be collected from each 10-cm depth interval until native material is encountered.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent) than surface sample FSR and greater than the FSL, then submit only the surface sample for analysis.
- If the FSR of the sample at depth is at least 20 percent greater than the surface sample and exceeds the FSL, then submit both samples for analysis.

Drainages have been identified for study at each location and Decision I will be evaluated by measuring TED at individual sample locations. Individual soil samples will be collected at locations to determine internal dose with TLDs co-located to measure external dose. It will be conservatively assumed that the highest TED from either surface or subsurface samples will be used to resolve DQO decisions. If a subsurface sample results in a higher internal dose than a surface sample, a TLD-equivalent external dose will be calculated for the subsurface sample. This will be accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the RESRAD-calculated external dose from the subsurface samples. This surface TLD reading will be increased by this proportion to estimate a TLD-equivalent external dose for the subsurface soil.

If a COC is found in any drainage at a sediment accumulation area sampling location, additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain COCs. Decision II will be resolved by the assumption that the entire volume of sediment in each sediment accumulation area where a COC was identified contains the COC.

All drainage samples will be submitted for the analyses listed in Table A.2-3. Information (such as sample results and the results of the radiological survey) needed to assess the 25-mrem/yr boundary will be obtained during the field investigation and addressed in the CADD.

A.8.7 Investigation for Study Group 5, Landfills

The previously unidentified waste trench and associated area is included in SG 5 (landfills) and will be investigated using a judgmental sampling approach and geophysical surveys. A judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. Biasing factors such as stains, presence of lead bricks and lead-acid batteries, and wastes suspected of containing hazardous or radiological components will be used to select the most appropriate sample locations at the waste trench. Specific analysis requested for these samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks). Decision II will be resolved by collecting judgmental sampling based on the location of COCs, the CSM, and other field screening and biased factors. In general, sample locations will be arranged in a triangular pattern around the area containing COCs based upon field conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, samples will be collected from locations farther from the source. A clean sample (i.e., COCs less than the FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination.

In addition, geophysical surveys will be performed at the ends of the open trench and at disturbed areas south of the trench as identified from aerial photography. These linear areas will be surveyed to identify buried materials and to determine extent. Corrective actions will be performed for the open waste trench and any identified buried contamination.

A.8.8 Establishment of Final Corrective Action Boundary

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

A.9.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2002). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* ASTM E1739 - 95(2002). West Conshohocken, PA.

BN, see Bechtel Nevada.

Bechtel Nevada. 2003. *Nevada Test Site Routine Radiological Environmental Monitoring Plan*, DOE/NV/11718--804. Prepared for the U.S. Department of Energy, National Nuclear Security Administration, Nevada Site Office. Las Vegas, NV.

Bryant, E.A. 1992. *The Cambric Migration Experiment, A Summary Report*, LA-12335-MS. Los Alamos, NM: Los Alamos National Laboratory.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

Gilbert, R.O., E.H. Essington, D.N. Brady, P.G. Doctor, and L.L Eberhardt. 1977. "Statistical Activities during 1976 and the Design and Initial Analysis of Nuclear Site Studies." In *Transuranics in Desert Ecosystems*, NVO-181. pp. 331–366. November. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

Hoffman, D.C., and W.R. Daniels. 1984. "Assessment of the Potential for Radionuclide Migration from a nuclear Explosion Cavity." In *Groundwater Contamination*, pp. 139-146. Washington, DC: National Academy Press.

McArthur, R.D., and J.F. Kordas. 1983. *Radionuclide Inventory and Distribution Program: The Galileo Area*, DOE/NV/10162-14; Publication No. 45035. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2. Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M Todd (SAIC) titled "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV: IT Corporation.

Murphy, T., Bureau of Federal Facilities. 2004. Letter to R. Bangerter (NNSA/NSO) titled "Review of Industrial Sites Project Document *Guidance for Calculating Industrial Sites Project Remediation Goals for Radionuclides in Soil Using the Residual Radiation (RESRAD) Computer Code*," 19 November. Las Vegas, NV.

NAC, see *Nevada Administrative Code*.

NBMG, see Nevada Bureau of Mines and Geology.

N-I GIS, see Navarro-Intera Geographic Information Systems.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro-Intera Geographic Information Systems. 2012. ESRI ArcGIS Software.

Nevada Administrative Code. 2012a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 May.

Nevada Administrative Code. 2012b. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 May.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Reno, NV.

SNJV, see Stoller-Navarro Joint Venture

Shott, G.J., V. Yucel, M.J. Sully, L.E. Barker, S.E. Rawlinson, and B.A. Moore. 1997. *Performance Assessment/Composite Analysis for the Area 3 Radioactive Waste Management Site at the Nevada Test Site, Nye County, Nevada*, Rev. 2.0. Las Vegas, NV.

Stoller-Navarro Joint Venture, 2007. *Phase I Contaminant Transport Parameters for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 97: Yucca Flat/Climax Mine, Nevada Test Site, Nye County, Nevada*, Rev. 0. S-N/99205--096. Las Vegas, NV.

Tamura, T. 1977. "Plutonium Distribution in a Desert Pavement–Desert Mound Soil System in Area 11." In *Environmental Plutonium on the Nevada Test Site and Environs*, NVO-171. June. Las Vegas, NV: Energy Research and Development Administration, Nevada Applied Ecology Group.

U.S. Department of Energy. 1997. *The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300. 28th Edition, Vol. I. February. New York, NY.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Nevada Test Site Orthophoto Site Atlas*, DOE/NV/11718--604. Aerial photos acquired Summer 1998. Prepared by Bechtel Nevada. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1992. *Remedial Investigation and Feasibility Study for the Plutonium Contaminated Soils at Nevada Test Site, Nellis Air Force Range and Tonopah Test Range*. April. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV--209-REV 15. Las Vegas, NV.

U.S. Environmental Protection Agency. 2002a. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, OSWER 9285.6-10. December. Washington, DC: Office of Emergency and Remedial Response.

U.S. Environmental Protection Agency. 2002b. *Guidance for Quality Assurance Project Plans*, EPA QA/G5, EPA/240/R-02/009. Washington, DC: Office of Environmental Information.

U.S. Environmental Protection Agency. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001. Washington, DC: Office of Environmental Information.

U.S. Environmental Protection Agency. 2012a. *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants*. As accessed at http://www.epa.gov/region9/superfund/prg on 3 May. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

U.S. Environmental Protection Agency. 2012b. *SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. As accessed at http://www.epa.gov/epawaste/hazard/testmethods/sw846 on 3 May.

Winograd, I.J., and W. Thordarson. 1975. *Hydrology and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site*, USGS Professional Paper 712-C.

Yu, C., A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.5 released in October 2009.)

Appendix B

Project Organization

B.1.0 Activity Organization

The NNSA/NSO Soils Activity Lead is Tiffany Lantow. She can be contacted at (702) 295-7645.

The identification of the activity 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 Soils Activity Lead be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report prior to the start of field activities.

Appendix C

Nevada Division of Environmental Protection Comments

(15 Pages)

Nevada Environmental Management Operations Activity

DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Executive Summary, Page ES-1, 3rd Paragraph	Mandatory	Add: "The site investigation process will also be conducted in accordance with the Soils Activity Quality Assurance Plan (Soils QAP), which establishes requirements, technical planning, and general quality practices to be applied to this activity."	Suggested sentence was added as edited: "The site investigation process will also be conducted in accordance with the Soils Activity Quality Assurance Plan, which establishes requirements, technical planning, and general quality practices to be applied to this activity."	
2.) Section 1.0, Page 1	Mandatory	This looks like a table, suggest titling it as Table 1-1.	The cited information was established as Table 1-1.	
3.) Figure 1-1, Page 2	Mandatory	Add CAS numbers to caption boxes IAW listed on Page 1.	CAS numbers was added to the caption boxes on Figure 1-1.	
4.) Figure 1-1, Page 2	Mandatory	Identify "Demarcation Line" legend item (CA/HCA?)	A new figure (Figure 2-1)was added to identify site features. The demarcation lines were identified as radioactive material area (RMA) boundaries on this figure. Also included with this figure are features such as the waste trench and soil mounds identified in Section 2.2, *Operational History,*and 2.4, *Release Information*. The following text was added to the end of the second paragraph in Section 2.2: “However, radioactive material areas (RMAs) are present around ground zero (GZ) at each of the three sites as depicted in Figure 2-1.” A reference to Figure 2-1 was also added in the last paragraph of Section 2.2.1 where the waste trench is discussed and to Section 2.4.2 where the soil mounds are discussed.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
5.) Section 2.1, Page 7, 4th Paragraph	Mandatory	Revise first sentence: "CAU 570 is located within the Yucca Flat Tributary Flow System, part of regional carbonate aquifer flow system, and moves generally from northeast to southwest." The reference is: *Groundwater Flow Systems at the Nevada Test Site, Nevada: A Synthesis of Potentiometric Contours, Hydrostratigrapy, and Geologic Structures, Professional Paper 1771. Fenelon, et al (USGS 2010).*	The first sentence of the paragraph was replaced with the suggested sentence and reference, as edited: "CAU 105 is located within the Yucca Flat Tributary Flow System, a part of the regional carbonate aquifer flow system that moves generally from northeast to southwest (Fenelon et al., 2010)."	
6.) Section 2.2, Table 2-2, Page 9	Mandatory	If there are known or suspected releases from these adjacent localities that may have impacted this CAU, then place this table in Section 2.4; if no such impacts to CAU 105 are known or suspected, consider omitting this table.	One CAS with a suspected?release was moved to Section 2.4.6, *Concrete Box with Lead Lining,* to include further information about the CAS and potential release information. Other CASs in the vicinity of the site were retained in the table and figure and moved to Section 2.5.5, *Other Surrounding CASs,* to retain information on historical activities performed.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
7.) Section 2.2, Page 8		Is the "Consolidation Project" so unique as to warrant initial caps?	The referenced Consolidation Project was a unique project initiated and completed in the late 1980s. The official title of the project is the “Radioactive Waste Consolidation Project” as stated in the Fiscal Year 1989 Plan (REECO, 1988). A reference to the fiscal year plan was included with the other cited documentation, and references to the project were revised globally in the document. Section 2.2 of the document was revised to replace the first sentence of Section 2.2, paragraph 3 with the following: “In 1989, the Radioactive Waste Consolidation Project was initiated at each of the CAU 105 sites to determine the feasibility of remediating contaminated surface soils and debris (REECO, 1988; Johnston, 2012)."	
8.) Figure 2-1, Page 10	Mandatory	See comments 3 and 4.	CAS numbers were included on Figure 1-1. The site locations (i.e., Site T-2, Site T-2a, and Site T-2b) are used in the document for identification of these areas and were maintained on other figures. A new Figure 2-1 was included within the document to identify the radioactive material area (RMA) boundaries.	
9.) Section 2.2.3, Page 12, 3rd Paragraph	Mandatory	If a reference for the first sentence is available, please cite it.	The applicable document references were provided in the first sentence to include REECO, 1998, and Johnston, 2012.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
10.) Section 2.5, Page 16, 1st Paragraph	Mandatory	Please replace sentence 1 with: "In accordance with the graded approach described in the Soils QAP, the quality required for a dataset will be determined by its intended use in decision making. Ground based and aerial radiological survey data are classified as decision supporting, and are not used, by themselves, used to make corrective action decisions".	Section 2.5 was revised to include the replacement of the first sentence as requested, with "Ground-based" hyphenated.	
11.) Section 2.5, Page 16, 3rd Paragraph, Last Sentence	Mandatory	Please explain the meaning of this sentence.	The comment is in regards to the differential fallout patterns of fission products and unfissioned nuclear material. The last sentence was change to read as follows, "Physical and chemical properties of the radionuclides associated with fission products and unfissioned material affect the spatial distribution of the radionuclides as discussed in Section A.2.2.3." In addition to this change, the second paragraph of Section 3.1.3 discussing differential fallout was moved to the more appropriate Section A.2.2.3, *Contaminant Characteristics,* at the end of the first paragraph.	

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
12.) Section 2.5.1, Page 16, 1st Paragraph, Last Sentence	Mandatory	Please explain the meaning of this sentence.	The last sentence was replaced with the following: "There are no detectable Am-241 signatures significantly above the minimum detectable activity for the sensor configuration and signal processing method used to produce this aerial survey. Therefore, this method is not able to reliably determine the presence or absence of Am-241."	
13.) Figure 2-2, Page 17	Mandatory	See comments 3 and 4; please enlarge the microreontgen legend and add saturation to color blocks to more closely match the map.	The legend was enlarged and the opacity of the microroentgen contours increased so that the color saturation of the legend more closely matches the color of the figure contours. CAS numbers were included on Figure 1-1. The site locations (i.e., Site T-2, Site T-2a, and Site T-2b) are used in the document for identification of these areas and were maintained on other figures. Figure 2-1 was added to the document to identify radioactive material area (RMA) boundaries.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
14.) Figure 2-3, Page 17	Mandatory	See comments 3 and 4; please enlarge the microreontgen legend and add saturation to color blocks to more closely resemble the map.	The legend was enlarged and the opacity of the microroentgen contours increased so that the color saturation of the legend more closely matches the color of the figure contours. CAS numbers were included on Figure 1-1. The site locations (i.e., Site T-2, Site T-2a, and Site T-2b) are used in the document for identification of these areas and were maintained on other figures. Figure 2-1 was added to the document to identify radioactive material area (RMA) boundaries.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
15.) Section 2.5.2, Page 19	Mandatory	Spell out section headings please; also, was it decided on CAIP for CAU 570 that RIDP content would be omitted because it would not bias sampling? If so, consider same here.	The document was revised to spell out section headings where an acronym had been used. It was decided to maintain the RIDP data in the CAIP as it was presented as background information during the DQO process. To clarify the usability of the information, Section 2.5.2 was modified in the following manner: Replace the last sentence of the first paragraph with, “RIDP data are provided as they present a general distribution of data used as background information during the DQO process as discussed in Appendix A.” The following was added as the second sentence in the last paragraph, “In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), RIDP data are classified as decision supporting and will not be used for sample location planning and preliminary corrective action boundary identification.” The following was added as the last sentence of the last paragraph, “The data show elevated readings centered around the GZ for SG 1 at each of the three sites.” NAEG was removed from the title as only RIDP data was presented in this section. In the first paragraph, “Section 2.5.2” was replaced with “this section” to correct the error of providing a reference to itself.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
	Mandatory			
16.) Section 2.5.3 and Figure 2-5, Pages 21 and 22	Mandatory	Paragraph 1: please add location of "waste trench" to Figure 2-5, because it received much emphasis in the discussion.	The location of the “waste trench” was included on Figure 2-1 and Figure 2-5 and a reference to Figure 2-1 included in Section 2.5.3.	
17.) Section 2.5.4, Page 21	Mandatory	Update NEPA reference to current (draft) NNSS Site Wide EIS.	We are not able to reference a draft document. The reference was made to the 1996 SWEIS.	
18.) Figure 2-5, Page 22	Mandatory	See comment 4 and comment 16.	Figure 2-1 was added to the document to identify radioactive material area (RMA) boundaries. The location of the “waste trench” was included on Figure 2-1 and Figure 2-5.	
19.) Section 3.1.1, Page 26	Mandatory	Update NEPA reference to current (draft) NNSS Site Wide EIS.	The DOE/NV, 1998 reference is to the NTS Resource Management Plan and not the SWEIS. The resource management plan will be retained as the reference.	

Nevada Environmental Management Operations Activity

DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
20.) Figure 3-2, Page 25	Mandatory	Verify that document contains a working definition or discussion of "isopleth".	The word “isopleth” was replaced with “isopleths representing contours of decreasing radioactivity with distance from GZ" for clarity.	
21.) Section 3.1.3, Page 27, 3rd Paragraph, 1st Sentence	Suggested	"...distinguishable to any test." Suggest replace "distinguishable" with "traceable".	The word “distinguishable” was replaced with “traceable” in Section 3.1.3. In addition, the entire first sentence of this paragraph was replaced with the following for clarity: “As discussed in Section 2.4, the multiple detonations from the same Site T-2 release location have overlapping depositions resulting in a layer of contamination that is not traceable to any test.”	
22.) Section 3.1.4, Page 29, 3rd Paragraph	Mandatory	Add "zone" after "vadose".	The word “zone” was included with the term “vadose zone alluvium”	
23.) Figure 3-3, Page 32	Mandatory	Highlight the Tier 1, 2, and 3 Evaluation boxes; change "ASTM, 1995" at right corner to "Adopted from ASTM, 1995".	The boxes have been highlighted and the reference revised as requested.	
24.) Section 6.0, Page 47, 1st Paragraph	Mandatory	State before the TLD QA discussion that all characterization activities, including those related to TLD measurements will be conducted in accordance with the Soils Activity QAP.	The following sentence was inserted after the first sentence of the first paragraph in Section 6.0: "Characterization activities, including those related to TLD measurements, will be conducted in accordance with the Soil QAP (NNSA/NSO, 2012b)."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
25.) Section 6.2.2, Page 50, 1st Paragraph, 3rd Sentence	Mandatory	Add sentence after: "Significant DQI criteria variations from the Soils QAP will be reported with the affected analytical results".	The following sentence was inserted after the second sentence of the first paragraph in Section 6.2.2: "Significant DQI criteria variations from the Soils QAP (NNSA/NSO, 2012b) will be reported in the CADD."	
26.) Section A.5.2, Page A-22, 1st Paragraph	Mandatory	Add a brief discussion about how the vertical and lateral boundary distances were determined.	The following statement was added to the first paragraph of Section A.5.2 as the second sentence, "Spatial boundaries were determined by an agreement reached in the DQO meeting with decision makers."	
27.) Section A.5.4, Page A-23	Mandatory	Unclear. "Scale of decision making" means areal extent of contamination of Decision I? "Site" means CAS? "bounded laterally and vertically? means the determining through sampling the maximum areal extent of contamination in soils surrounding the CAS?	The paragraph was changed to read, "The scale of decision making refers to the smallest, most appropriate area or volume for which decisions will be made. The scale of decision making in Decision I is the CAS component (defined by a specific release). The presence of a COC associated with a CAS component will cause the determination that the CAS component is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area containing a COC originating from the CAS component. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
28.) Section A.6.1.2, Page A-25, 2nd Paragraph, 1st Bullet	Mandatory	Clarify sufficient sample size required to establish a UCL.	Sample size requirements to establish a UCL are provided in Section A.8.1.2. The following was added to the first bullet in Paragraph 3 of Section A.6.1.2: “in accordance with Section A.8.1.2.”	
29.) Figure A.8-1, Page A-34	Mandatory	Add GZ location.	The GZ location was added to the figure.	
30.) Figure A.8-2, Page A-35	Mandatory	Add GZ location.	The GZ location was added to the figure.	
31.) Figure A.8-3, Page A-36	Mandatory	Add GZ location.	The GZ location was added to the figure.	
32.) Section A.8.1.2, Page A-38	Mandatory	1st Paragraph: Expression should be: n = 2nd Paragraph: add definition for 'n'	(n) was placed in the last sentence of the paragraph after “minimum sample size” and the equation modified to reflect an equality (=), not an inequality(=).	
33.) Section A.8.1.3, Page A-39	Mandatory	Are the proposed locations for background TLDs shown in Figure A.8-4 part of the ten locations identified in the NTS ER 2006? Unclear.	The paragraph identifying the 10 NNSS background TLDs was deleted as none of the 10 TLD locations are in the vicinity of CAU 105.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
34.) Other Applicable Comments		The following revisions to the CAU 105 CAIP were made to incorporate applicable comments from the recently reviewed CAU 570 CAIP.		
35.) Other Applicable Comments		Clarify that there are not expected to be any off-NNSS human receptors; and that site worker exposure will be minimized by use of PPE.	The following sentence was added to the end of the second paragraph in Section 2.4, “Therefore, the CSM will include the potential for receptors to receive an internal dose from contaminated soil and an external dose from contaminated soil and debris.”	
36.) Other Applicable Comments		Provide a brief discussion and analysis for each figure, comparing the results, describing apparent differences and similarities of spatial distribution and concentration of radionuclides.	Replace the 4th and 5th sentence in paragraph 1 of Section 2.5.1 with the following, “Figure 2-2 displays the results of the aerial survey depicting the man-made radiological activity for CAU 105. Elevated concentrations are observed concentrically around each of the three sites with the highest levels of up to 450 roentgens per hour (R/hr) at the Site T-2 GZ (BN, 1999). Results from the 1994 aerial survey show the highest gross count radiological activity at Site T-2 of up to 900 microroentgens per hour (μR/hr). Elevated concentrations are also observed at GZ for each of the three sites as shown in Figure 2-3.”	

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
37.) Other Applicable Comments		Suggest a follow-on sentence describing the use (if any) of radiological survey for this dataset to guide sampling.	The following revisions were made to describe the use of radiological survey datasets to guide sampling: The last sentence in the last paragraph of Section 2.5.2 was changed to: "The data show elevated readings centered around the GZ for SG 1 at each of the three sites." The following sentence was added to paragraph 1 in Section 2.5.3: "Results from the visual survey will be used in determining sample locations for SG 3."The following was added as the next to last sentence of paragraph 2 in Section 2.5.3: "The 2011 gamma drive-over survey is used to identify bias used in the selection of sample locations for SGs 1 and 2, and will be evaluated for use in defining corrective action boundaries in the Corrective Action Decision Document (CADD)."	
38.) Other Applicable Comments		Suggest replacing "streams" with ephemeral drainage "channels" or "drainages".	Replaced "ephemeral stream channels" with "ephemeral drainage channels" in the first paragraph of Section 3.1.7 and A.2.2.4.	
39.) Other Applicable Comments		Suggest retitle table such as, "Analytical Method by COPC and Release Group"; ensure that all acronyms in this table have been defined in the table footer notes. Should this table contain the method number and/or name where the Xs are?	The title of Table A.2-3 was changed to "Analysis Required by Study Group". Method numbers were provided through a reference to Table A.2-4 that was modified to include analytical method numbers.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
40.) Other Applicable Comments		Add reference (i.e., SWEIS)	A reference to the SWEIS was provided in the third sentence of the first paragraph in Section A.2.2.6.	
41.) Other Applicable Comments		At the end of this sentence add, "The details of how this estimate will be made are discussed in Section 4.1."	To provide details of how sample size estimates will be made, the following was added as the 6th sentence of paragraph 1 in Section A.6.1.2, "This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED values (Section 4.1)."	
42.) Other Applicable Comments		Replace "stakeholders" with "decision makers listed in Section A.2.1."	In the first bullet of the third paragraph in Section A.7.1, the word "stakeholder" was replaced with "decision makers listed in Section A.2.1."	
43.) Other Applicable Comments		Instrument calibration statement does not appear to be appropriate for this section.	The following statement was removed from Section A.7.2.1: "Radiological survey instruments and field screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	7/19/2012
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
44.) Other Applicable Comments		Issue identified during review of the draft document.	Table 3-1 and the table reference in Section 3.3.2 were removed because RRMG values are available in the referenced Soils Risk-Based Corrective Action Evaluation Process (RBCA) document.	

Library Distribution List

	Copies
U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Technical Library P.O. Box 98518, M/S NSF 151 Las Vegas, NV 89193-8518	1 (Uncontrolled, electronic copy)
U.S. Department of Energy Office of Scientific and Technical Information P.O. Box 62 Oak Ridge, TN 37831-0062	1 (Uncontrolled, electronic copy)
Southern Nevada Public Reading Facility c/o Nuclear Testing Archive P.O. Box 98521, M/S 400 Las Vegas, NV 89193-8521	2 (Uncontrolled, electronic copies)
Manager, Northern Nevada FFACO Public Reading Facility c/o Nevada State Library & Archives 100 N. Stewart Street Carson City, NV 89701-4285	1 (Uncontrolled, electronic copy)