RECORD OF TECHNICAL CHANGE

Technical Change No. CAIP-1 Page 1 of 6

Project/Job No. SL08-060 Date: July 30, 2008

Project/Job Name CAU 370 CAIP

The following technical changes (including justification) are requested by:

Patrick Matthews — SNJV Soils Project Manager (Title)

Description of Change

The method used to obtain field data to calculate the total effective dose equivalent (TEDE) is being modified. As currently written in the CAIP, the TEDE (both internal and external dose) is calculated based on analytical data obtained from homogenized field samples. The results from the homogenized sample were to be used to calculate the TEDE using the RESRAD computer code.

However, a homogenized sample could not be obtained as explained in the Justification section. The solution to this problem was to calculate the external dose using thermoluminescent dosimeters (TLDs) and to calculate the internal dose using RESRAD from the analytical results from only the fine particles in each soil sample. The TEDE would then be calculated as the sum of the internal and external doses. This Record of Technical Change modifies the CAIP to include these changes.

Specific changes to the document are provided in the attachment.

Justification: During recent field activities, it was discovered that the Trinity glass present at the site is very cohesive and durable. It was not possible to homogenize material containing the Trinity glass with the field grinding device. While the field grinder was effective in pulverizing the soil, the Trinity glass remained almost completely intact. The inability to homogenize the sample material precludes an accurate analytical measurement of the total sample. Trinity glass aggregates are not friable, are not to be amendable to inhalation or ingestion, and would not contribute to an internal dose to an industrial worker.

The change to the process as described above will resolve this problem and more accurately estimate total dose at the site. The TLD will measure the total radiation from all *in situ* materials (i.e., will not be affected by particle size or the non-friable nature of the Trinity glass), and the internal dose measurement will be calculated from the finer portion of the sample material that can potentially be inhaled or ingested. The use of only the finer particles to estimate internal dose is standard procedure used in the DOECAP analytical laboratory.

The project time will be **Unchanged**.

Applicable Project-Specific Document(s): **Corrective Action Investigation Plan for Corrective Action Unit 370: T-4 Atmospheric Test Site, Nevada Test Site, Nevada (DOE/NV--1269) April 2008.**

CC:

Approved By:

NNSA/NSO Federal Subproject Director Date 8/4/08

NNSA/NSO Federal Project Director Date 8/4/08

NDEP Concurrence Yes X No __ Date 8/6/08

NDEP Signature

Contract Change Order Required: Yes __ No X

Contract Change Order No.

Attachment
Request for Technical Change
Corrective Action Investigation Plan for Corrective Action Unit 370:
T-4 Atmospheric Test Site,
Nevada Test Site, Nevada (DOE/NV--1269)

Technical Change (list specific page/section/paragraph as appropriate):

1. **Section 1.1, pg 4, first complete paragraph (which begins "An investigation ..."), last sentence. Change from** "The selection of sample locations within sample plots, as well as the estimation of radiological doses within the plots, will be conducted probabilistically." **to** "The selection of soil sample locations within sample plots will be conducted randomly."

2. **Section 3.2, pg 18, following the first set of bullets. Insert as a new paragraph** "In addition, thermoluminescent dosimeters (TLDs) will be submitted for analysis of external dose."

3. **Section 3.4, pg 24, the paragraph at the middle of the page after the two bullets.** After the first sentence which begins "Decision I samples will be submitted ...." **add the following sentence** "In addition, TLDs will be submitted for analysis of external dose."

4. **Section 4.1.1, pg 27, first paragraph, last sentence. Add at the end of the paragraph** "These random locations will be sampled for the purpose of estimating the internal dose that a receptor might receive."

5. **Section 4.1.1, pg 27, end of section. Add new paragraph** "In addition to the estimation of internal dose by collection of composite samples, the external dose will be measured by staging a TLD at the approximate center of the plot, at approximately one meter above ground surface."

6. **Section 4.2.2, pg 29, after last paragraph. Add new paragraph** "At these locations of annular distributions that are sampled, the external dose portion of the TEDE will be measured using TLDs placed at the approximate center of each sample plot at a height of one meter (in accordance with established protocols used for environmental monitoring dosimeters at the NTS) (NNSA/NSO, 2006c). This technique would more accurately estimate external dose at the site as the TLD will measure the total radiation from all *in situ* materials (i.e., will not be affected by particle size or the non-friable nature of the Trinity glass)."

7. **Section 4.2.2, pg 30, last paragraph of section, first sentence. Insert** "for internal dose estimates" **into the sentence so it reads** "For the investigation of annular distributions, evaluation of the results will include the 95 percent upper confidence limit (UCL) of the average TEDE for internal dose estimates for Decision I sampling."

8. **Section 6.2, pg 40, after the first paragraph**. **Add new paragraph** "The use of TLDs for measurement of external dose follows the established protocols at the NTS, and abides by the NSTec Radiological Health Dosimetery Group QA/QC requirements (NNSA/NSO, 2006c)."

9. **Section 8.0, pg 51, after the 4th entry**. **Add new reference** "U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006c. *Nevada Test Site Environmental Report 2006*, DOE/NV/25946--259. Las Vegas, NV.

10. **Section A.4.1, pg A-19, first bullet**. **Change to read** "For probabilistic sampling, any dose measurement exceeding 25 mrem/yr will be defined as a COC."

11. **Section A.4.1, pg A-20, end of Note at top of page**. **Change reference data from** "2006" **to** "2006a."

12. **Section A.5.2, pg A-22, first (partial) paragraph, last sentence**. **To the sentence add** ", and external dose measurements," **to read** "Only validated data from analytical laboratories, and direct external dose measurements, will be used to make DQO decisions".

13. **Section A.5.2, pg A-22, last paragraph**. **Modify sentence, and insert** "and external dose measurements" **to read** "Information on decreasing TEDE rate trends will be generated by collecting surface soil samples and external dose measurements to calculate TEDE rates from plots."

14. **Section A.5.2.1.1, pp A-22 and A-23, third paragraph, first sentence**. **Modify to read** "The locations for Decision I soil samples within each sample plot at CAS 04-23-01 were selected ...".

15. **Section A.5.2.1.1, pg A-23, after the third paragraph**. **Add new paragraph** "At the sample plots of annular distributions that are sampled, the external dose portion of the TEDE will be measured using TLDs placed at the approximate center of each sample plot at a height of one meter (in accordance with established protocols used for environmental monitoring dosimeters at the NTS) (NNSA/NSO, 2006b). This technique would more accurately estimate external dose at the site as the TLD will measure the total radiation from all *in situ* materials (i.e., will not be affected by particle size or the non-friable nature of the Trinity glass)."

16. **Section A.5.2.2, pg A-26, after the paragraph**. **Add new paragraph** "The TLDs used to measure external dose are analyzed using automated TLD readers that are calibrated and maintained by the NSTec Radiological Control Department (NNSA/NSO, 2006b)."

17. **Section A.6.1, pg A-27, first paragraph, first sentence**. **Change** "the average TEDE" **to** "the TEDE."

18. **Section A.7.1, pg A-29, first paragraph, first sentence**. **Change** "the UCL of the average TEDE for each sample plot." **to** "the UCL of the TEDE will be calculated as the 95th UCL of the average internal dose plus the external dose."

19. **Section A.7.2, pg A-29, first paragraph, first sentence**. **Change reference data from** "2006" **to** "2006a."

20. **Section A.9.0, pg A-37, first paragraph, prior to last sentence**. **Insert** "Measurement of external dose at each sample plot will be accomplished by staging a TLD at the approximate center of each plot, one meter above ground surface, for a predetermined period of time."

21. **Section A.9.1, pg A-38, last paragraph**. **Insert** "and external dose measurement" **to read** "The four composite samples from each plot (and additional samples as required) and external dose measurement will be used to establish a 95 percent UCL estimate of the average TEDE at each plot." **Then add the following sentence** "The external dose measurement will be taken over a predetermined period of time from a TLD staged at the approximate center of each plot, one meter above ground surface."

22. **Section A.10.0, pg A-44, 9th entry**. **Change date** "2006" **to** "2006a."

23. **Section A.10.0, pg A-44, after the 9th entry**. **Add new reference** "U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006b. *Nevada Test Site Environmental Report 2006*, DOE/NV/25946--259. Las Vegas, NV.

24. **Section C.2.0, pg C-2**. **Replace the first paragraph to read** "Determination of the radiological dose (i.e., TEDE) at each sample plot requires evaluating, with a specified degree of confidence, whether the true TEDE for the sample plot exceeds the 25 mrem/yr FAL. The TEDE will be calculated by adding the calculated internal dose and the measured external dose. The internal dose will be calculated using RESRAD for each sample at each plot based on the results from each composited sample. The external dose will be measured from TLDs staged at the approximate center of each plot, one meter above ground surface.

    As the average internal dose calculated from sample results is only an estimate of the true (unknown) internal dose, it is uncertain how well the average internal dose actually represents the true internal dose. To reduce the probability of making a false negative decision error, a conservative estimate of the true internal dose will be used to estimate the TEDE. This conservative estimate (overestimation) of the true internal dose will be calculated by using the 95 percent UCL of the average internal dose calculated for each plot from the dose associated with composite sample. By definition, there will be a 95 percent probability that the true internal dose is less than the 95 percent UCL of the calculated average internal dose."

25. **Section C.2.1, pg C-3, first sentence, which begins "A UCL of the average ..". Revise to read** "A UCL of the average internal dose will be calculated for each plot. Computation of an appropriate UCL for the internal does requires that:".

26. **Section C.2.1.1, pg C-3, 4th and 5th bullets. Revise to read** "The average internal dose at each plot." **and** "The standard deviation of the internal dose at each plot."

27. **Section C.2.1.1, pg C-4, 2nd and 3rd bullets**. **Revise to read** "It may be conservatively assumed that the average internal dose for the plot exceeds the FAL." **and** "Justification for use of the resulting average internal dose without meeting the criteria will be made in the investigation report."

28. **Section C.2.1.1, pg C-4, Table C.1-1, Size of sample plot**. **Change from** "450 square meters" **to** "100 square meters," to match the approximate field of view for the TLDs.

29. **Section C.3.0, pg C-7, first paragraph**. **Change all** "average TEDE" **to** "estimated TEDE", **and all** "number of composite samples" to "number of samples."

Nevada
Environmental
Restoration
Project

DOE/NV--1269

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 370: T-4 Atmospheric Test Site Nevada Test Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

April 2008

Approved for public release; further dissemination unlimited.

Environmental Restoration
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CORRECTIVE ACTION INVESTIGATION PLAN FOR FOR CORRECTIVE ACTION UNIT 370: T-4 ATMOSPHERIC TEST SITE NEVADA TEST SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 0

April 2008

CORRECTIVE ACTION INVESTIGATION PLAN FOR
CORRECTIVE ACTION UNIT 370:
T-4 ATMOSPHERIC TEST SITE
NEVADA TEST SITE, NEVADA

Approved by: /s/ John Jones Date: 4/22/2008

John B. Jones
Federal Sub-Project Director
Soils Sub-Project

Approved by: /s/ John Jones Date: 4/22/2008

John B. Jones
Acting Federal Project Director
Environmental Restoration Project

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Appendix A - Data Quality Objectives

Table of Contents *(Continued)*

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List of Acronyms and Abbreviations

Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BEEF	Big Explosives Experimental Facility
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
cm	Centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRI	Desert Research Institute
EPA	U.S. Environmental Protection Agency
Eu	Europium

List of Acronyms and Abbreviations *(Continued)*

FAL	Final action level
FFACO	*Federal Facility Agreement and Consent Order*
ft	Foot
GZ	Ground zero
HASL	Health and Safety Laboratory
IDW	Investigation-derived waste
in.	Inch
km	Kilometer
kt	Kiloton
LCS	Laboratory control sample
m	Meter
MDC	Minimum detectable concentration
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NCRP	National Council on Radiation Protection and Measurement
ND	Normalized difference
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

List of Acronyms and Abbreviations *(Continued)*

NRS	*Nevada Revised Statutes*
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
NTSWAC	*Nevada Test Site Waste Acceptance Criteria*
NV/YMP	Nevada Yucca Mountain Project
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
POC	Performance Objective for the Certification of Nonradioactive Hazardous Waste
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary remediation goal
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RadCon	Radiological control
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RIDP	Radiological Inventory and Distribution Program
RL	Reporting limit
RMA	Radioactive material area
RPD	Relative percent difference
SDWS	Safe Drinking Water Standards

List of Acronyms and Abbreviations *(Continued)*

SNJV	Stoller-Navarro Joint Venture
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	Total effective dose equivalent
TPH	Total petroleum hydrocarbons
TSCA	*Toxic Substances Control Act*
U	Uranium
UCL	Upper confidence limit
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
VSP	Visual Sample Plan
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 370 is located in Area 4 of the Nevada Test Site, which is approximately 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 370 is comprised of Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4.

This site is being investigated because existing information on the nature and extent of potential contamination is insufficient to evaluate and/or implement a corrective action. Additional information will be obtained by conducting a corrective action investigation (CAI) before evaluating corrective action alternatives and selecting the appropriate corrective action for this CAS. The results of the field investigation will support a defensible evaluation of viable corrective action alternatives that will be presented in the Corrective Action Decision Document. The investigation results may also be used to evaluate improvements in the Soils Project strategy to be implemented.

The site will be investigated based on the data quality objectives (DQOs) developed on December 10, 2007, by representatives of the Nevada Division of Environmental Protection; U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office; Desert Research Institute; Stoller-Navarro Joint Venture; and National Security Technologies, LLC. 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 370.

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

The scope of the CAI for CAU 370 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Perform field screening.
- Collect and submit environmental samples for laboratory analysis to determine whether contaminants of concern are present.

- If contaminants of concern are present, collect samples to define the extent of the contamination.

- Collect samples of investigation-derived waste including debris deemed to be potential source material, as needed, for waste management purposes.

This Corrective Action Investigation Plan has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada; DOE, Environmental Management; U.S. Department of Defense; and DOE, Legacy Management (FFACO, 1996; as amended February 2008). Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Fieldwork will be conducted following approval of the plan.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 370: T-4 Atmospheric Test Site, Nevada Test Site (NTS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management (FFACO, 1996; as amended February 2008).

Corrective Action Unit 370 is located in Area 4 of the NTS, which is approximately 65 miles northwest of Las Vegas, Nevada (Figure 1-1). Corrective Action Unit 370 is comprised of Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4, shown on Figure 1-2.

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

1.1 Purpose

Corrective Action Site 04-23-01 is being investigated because CAS-related contamination may be present in concentrations that could potentially pose a threat to human health and the environment. Existing information on the nature and extent of potential contamination is insufficient to evaluate and/or implement corrective actions for the CAS. Additional information will be generated by conducting a CAI before evaluating and selecting corrective action alternatives.

The CAI for CAU 370 will investigate CAS-related contamination that was released at the site. This release resulted in two types of contaminant distributions:

- Contamination that was distributed in an annular (ring-like) geometric pattern (i.e., soil particle activation and initial fallout) following detonation of the nuclear devices, and is observed as circular isopleths around ground zero (GZ).

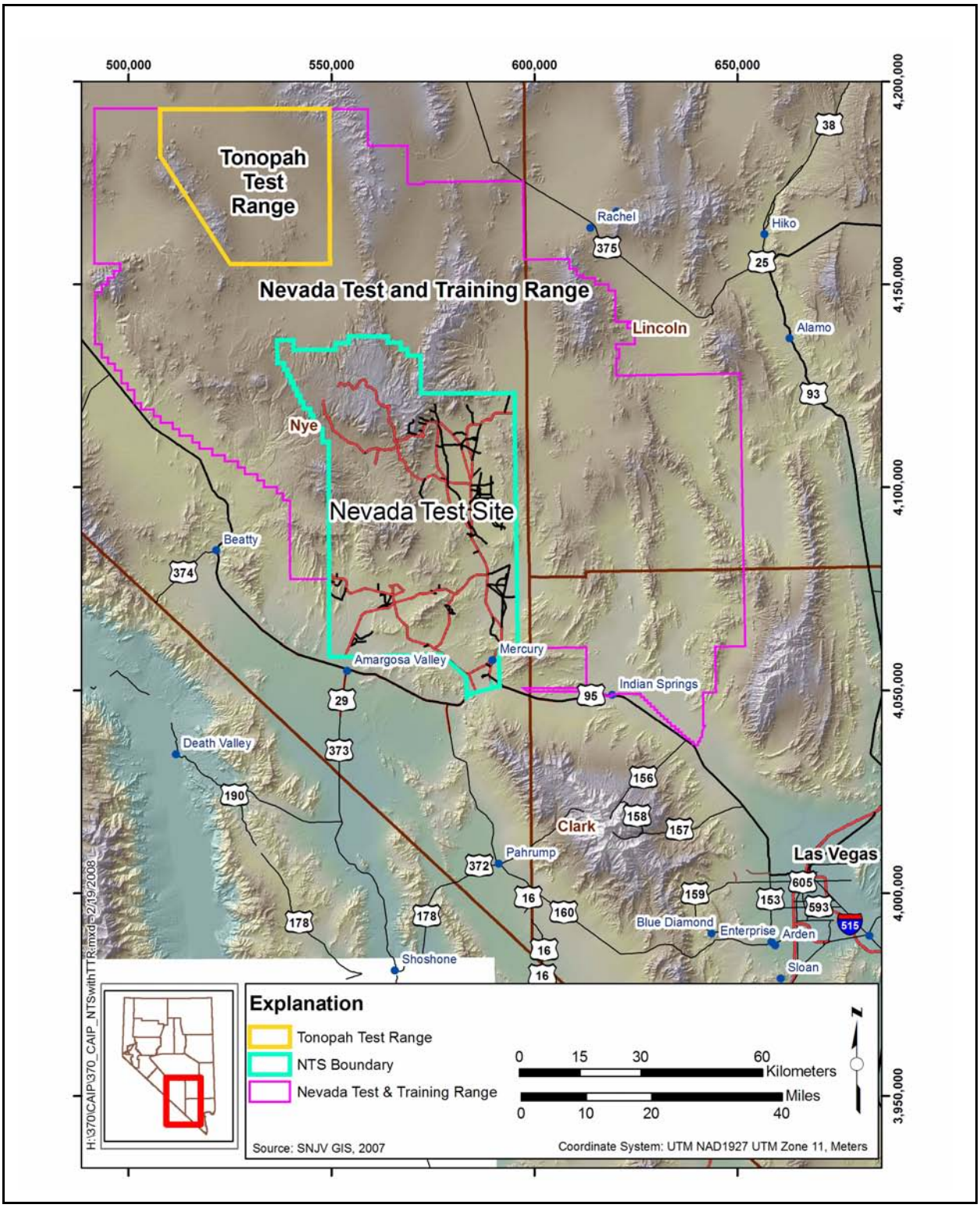

Figure 1-1
Nevada Test Site

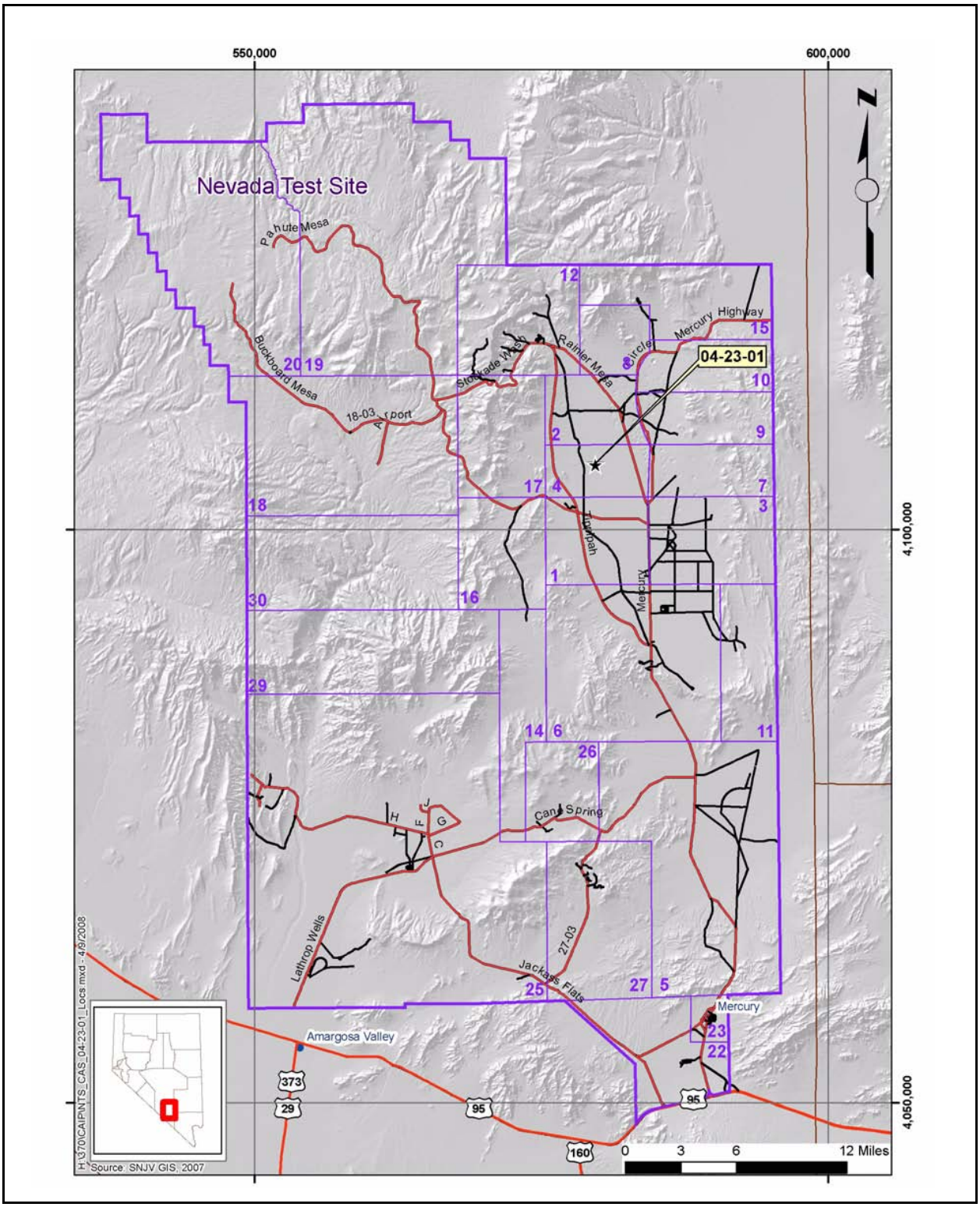

Figure 1-2
Corrective Action Unit 370, CAS Location Map

- Contamination that was released after the initial fallout and soil particle activation, and is present as other patterns of distribution at the site (e.g., fractionation from the main cloud, material carried down washes, chemical contamination).

An investigation of contamination present in an annular distribution will be implemented through a combination of judgmental and probabilistic sampling (Section 4.0 and Appendix C). Five sample plots, each along three sampling vectors, will be established judgmentally (Section A.5.2.1.1). The selection of sample locations within sample plots, as well as the estimation of radiological doses within the plots, will be conducted probabilistically.

An investigation of contamination that was released later (e.g., americium [Am]-241 plumes, chemical contamination, material carried down washes) will be implemented through judgmental sampling (Section A.9.0).

The CAI for CAU 370 will also contribute information to an evaluation of the potential use of data from the Radiological Inventory and Distribution Program (RIDP) in future Soils Project investigations.

1.1.1 History and Description

Corrective Action Site 04-23-01 consists of contamination of the soil in and around GZ that was impacted by releases from atmospheric tower testing of four nuclear devices at the T-4 site. The site includes remnants of the tower used for the testing, an associated bunker and soil berm, pieces of metallic and concrete debris, and the posted radioactive material area (RMA) from GZ to the fences, excluding the 4-04 Road. The site is divided by the 4-04 Road. Several washes enter the area from the west/northwest. Figure A.2-2 shows a site sketch of the CAS. The operational history for CAS 04-23-01 is detailed in Section 2.2.

1.1.2 Data Quality Objective Summary

The site will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP); DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO); Desert Research Institute (DRI); Stoller-Navarro Joint Venture (SNJV); and National Security Technologies, LLC (NSTec). The DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate

corrective actions for CAU 370. This CAIP describes the investigative approach developed to collect the data needs identified in the DQO process. While a detailed discussion of the DQO methodology and the DQOs specific to the CAS are presented in Appendix A, a summary of the DQO process is provided below.

The DQO problem statement for CAU 370 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and/or implement corrective actions." The information necessary to address this question will come from an investigation of contamination present in the CAS that was released and distributed during the initial detonation and by subsequent processes. Any contamination exceeding a final action level (FAL) will require a corrective action. The radiological FAL is the 25 millirem per year (mrem/yr) combined total effective dose equivalent (TEDE) from all contributing radionuclides. A contaminant of concern (COC) for chemical contamination 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, 2006a).

To address the problem of insufficient information at the CAS, the resolution of two decisions statements is required, as discussed in Section 3.4 and Section A.4.1.

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for CAU 370 and are presented in Appendix A. The information necessary to resolve the DQO decisions will be generated for the CAU 370 CAS by collecting and analyzing samples generated during a field investigation. The presence of contamination at CAS 04-23-01 will be determined by following these criteria:

- For Decision I judgmental sampling, samples must be collected in locations most likely to contain a COC.
- For Decision II judgmental sampling, samples must be collected in locations that bound COC contamination.
- For probabilistic sampling (Decision I and II), samples must be collected from random locations that represent the TEDE within the sample plot.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO processes, the scope of the CAI for CAU 370 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Perform field screening.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of any contamination released by the CAS.
- Collect samples of source material to determine the potential for a release.
- Collect samples of potential remediation wastes.
- Collect quality control (QC) samples.

Contamination of environmental media originating from activities not identified in the conceptual site model (CSM) of this 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 not considered COCs. If such contamination is present, the contamination will be identified as part of another CAS (new or existing).

The investigation of CAU 370 is designed to establish the extent of the area around the T-4 tower location where radiation levels may cause a site worker to receive a dose exceeding the FAL of 25 mrem/yr. For CAU 370, this determination will be made by comparing estimates of the TEDE at 15 locations along three vectors emanating from the T-4 tower. Seven of these locations were chosen to correspond to locations where information was gathered during the RIDP. The RIDP data provides *in situ* gamma spectroscopy data to estimate radioactive inventories at specific locations around many atmospheric locations at the NTS, including the T-4 tower location. Although the RIDP data is not being used to make closure decisions for CAU 370, results from the CAU 370 investigation will be used to evaluate the potential use of RIDP data to supplement investigation results in future investigations of Soils Project CASs. If this evaluation demonstrates that RIDP data correlate well to

analytical data or TEDEs, the use (including use limitations) of RIDP data in future Soils CASs will be proposed in the CAU 370 investigation report (i.e., Corrective Action Decision Document [CADD] or CADD/Closure Report).

The potential benefit of using RIDP data in supplementing future investigations includes: 1) reducing the number of new samples needed to make corrective actions decisions; and 2) potentially providing a more integrated estimate of TEDE. Estimating TEDE from soil samples is problematic due to the effect of discrete, anomalous radioactive particles within the sampled material. The distribution of plutonium (Pu) in soil has been found to vary by a factor of 10 between individual one gram aliquots from a single soil sample (LASL, 1971). For example (due to the small size of the aliquots used in radiological analyses) an aliquot containing a single particle of Pu may overestimate the TEDE while an aliquot not containing the single particle would underestimate the TEDE. However, the RIDP gamma measurements are not subject to these errors due to the larger sample size as the measurement "field of view" of approximately 450 square meters. This large "field of view" effectively integrates localized radiation variability and may give a more accurate estimate of the TEDE potentially received by a site worker.

1.3 Corrective Action Investigation Plan Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about CAU 370. Objectives of the investigation, including the CSM, are presented in Section 3.0. Field investigation and sampling activities are discussed in Section 4.0, and waste management issues for this project are discussed in Section 5.0. General field and laboratory quality assurance (QA) (including collection of QA samples) are presented in Section 6.0 and the *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002). The project schedule and records availability are discussed in Section 7.0. Section 8.0 provides a list of references.

Appendix A provides a detailed discussion of the DQO methodology, while Appendix B contains information on the project organization. Appendix C contains a description of the probabilistic sampling plan developed for CAU 370. Appendix D contains responses to NDEP comments on the draft version of this document.

2.0 Facility Description

Corrective Action Unit 370 is comprised of CAS 04-23-01, located in Area 4 of the NTS.

2.1 Physical Setting

This section describes the general physical settings of Area 4 of the NTS. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for these specific areas of the NTS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (USGS, 1990); *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996).

Corrective Action Site 04-23-01 is located within the Yucca Flat Hydrographic Area of the NTS. Yucca Flat is a closed basin, which is slowly being filled with alluvial deposits eroding from the surrounding mountains (USGS, 1996).

The direction of groundwater flow in Yucca Flat generally is from the northwest to southeast. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (USGS, 1996). The average annual precipitation at Station UCC on the Yucca Flat dry lake is 6.62 inches (in.) (NOAA, 2002). The annual recharge rate to the Yucca Flat area is relatively low (0.069 in.), and the thickness of the unsaturated zone extends to more than 600 feet (ft) below ground surface (bgs) (USGS, 1996).

Local topography within the vicinity of CAS 04-23-01 in the Yucca Flat area can influence the migration of potential contaminants released from the site. At CAS 04-23-01 the direction of precipitation runoff flow is into gullies and washes that generally drain to the southeast (Figure A.2-2). Ultimately, the system of washes around Yucca Flat terminate at the dry lake bed (Yucca Flat).

The nearest groundwater well to CAS 04-23-01 is USGS Test Well D, located approximately 3.4 kilometers (km) southeast of the site. Depth to groundwater averages approximately 525 meters (m) bgs (USGS and DOE, 2007; BN, 2006).

Vegetation at the site consists of grasses and short to moderately tall brush. Soils throughout the area appear to have a silty sand texture at the surface, trending to a finer texture (i.e., more clay) within approximately 15 centimeters (cm).

An active facility (Big Explosives Experimental Facility [BEEF]) is within 1 km to the east, and another abandoned aboveground testing site (T-4a) is approximately 1 km to the northeast. The 4-04 Road bisects the site along the south side of the T-4 bunker.

Several CASs are within a 1,000 m radius of the CAS 04-23-01 footprint. Corrective Action Sites 04-09-11, 04-09-17, and 04-99-03 are closed sites with no further action, and CAS 04-01-01 is a closed Housekeeping Site with no further action. Corrective Action Site 04-26-02 has been archived as an Historical Site, and consists of lead sheets on top of bunker 4-390. Corrective Action Site 04-26-03, Lead Bricks, is associated with a use restriction, and is 20 m west of GZ. Corrective Action Site 04-23-02 is associated with the T-4a site, approximately 1 km northeast of CAS 04-23-01.

2.2 Operational History

This section provides a description of the operational use and history of CAU 370 that may have resulted in potential releases to the environment. This summary is designed to describe the current definition of the CAS and illustrate all significant, known activities.

Corrective Action Site 04-23-01 is located on Yucca Flat in Area 4. The T-4 tower was the site of four weapons-related nuclear tests.

- Fox, part of Operation Tumbler-Snapper, was conducted on May 25, 1952, atop a 300-ft tower.
- Nancy, part of Operation Upshot Knothole, was conducted on March 24, 1953, atop a 300-ft tower.
- Apple-1, part of Operation Teapot, was conducted on March 29, 1955, atop a 500-ft tower.

- Kepler, part of Operation Plumbbob, was conducted on July 24, 1957, atop a 500-ft tower.

Following each test, debris and perhaps contaminated soil was removed from the site, apparently for site access and/or worker safety concerns. A limited site cleanup was also conducted in the late 1980s under the waste consolidation project at the NTS; lead and other material related to the tower debris was removed from the site (Johnston, 2008). The site does not appear to have been used for other purposes. More recently, however, the cleanup of lead bricks and sheeting, used in one or more tests at the T-4 site, was conducted immediately west and north of the T-4 bunker in 2004 for CAS 04-26-03 at CAU 357 (NNSA/NSO, 2005). The lead bricks and impacted soil were removed as a corrective action for CAU 357, and the CAS was closed with a use restriction (Figure A.2-2).

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. Historical information and site visits indicate that CAS 04-23-01 contains wastes such as impacted soil, metal, and concrete that upon generation may be classified as low-level radiological waste.

2.4 Release Information

Known or suspected releases from the CAS, including potential release mechanisms, and migration routes associated with CAS 04-23-01 are described in this section. There has been no known migration of contamination at this CAS beyond a shallow layer of surface soil. Potentially affected media for this CAS includes surface and shallow subsurface soil. Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils and/or debris. Site workers may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

2.5 Investigative Background

Previous investigations for CAS 04-23-01 include several flyover radiological surveys (e.g., aircraft using radiological detection systems to identify gamma radiation) and the RIDP investigation. The flyover surveys conducted at CAS 04-23-01 identified radiological contamination for gamma

emissions at the site, with the highest readings found in and around GZ (BN/RSL, 1999). Extended regions outward from GZ exhibited cesium (Cs)-137 and weak cobalt (Co)-60 photopeaks.

Also detected in the flyover surveys were several Am-241 regions that appear to have been distributed after the initial fallout (e.g., radiological plumes preferentially deposited in specific directions outward from GZ) at the T-4 site.

The RIDP investigation was conducted throughout the NTS from 1981 through 1986, and estimated the inventory of man-made radionuclides at the NTS through *in situ* soil measurements, and limited soil sampling (DRI, 1985; Gray et al., 2007). Both *in situ* gamma spectroscopy and limited confirmatory soil sampling were implemented at the study areas. Alpha-emitting radionuclides, primarily Pu isotopes, as well as gamma-emitting radionuclides, such as Am-241, Cs -137, Co-60, several europium (Eu) isotopes, and strontium (Sr)-90, were identified at the site.

Investigations for other CASs conducted in the area of CAS 04-23-01 include CAS 04-26-03 at CAU 357, which identified lead contamination in and around GZ at T-4 (Section 2.2); and CAS 04-26-02 at CAU 286, which identified lead sheets atop the bunker at T-4.

2.5.1 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 370.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed before beginning site investigation activities at CAU 370. This checklist requires NNSA/NSO project personnel to evaluate their proposed project activities against a list of potential impacts that include, but are not limited to: air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation by the NNSA/NSO NEPA Compliance Officer. This will be accomplished before mobilization for the field investigation.

3.0 Objectives

This section presents an overview of the DQOs for CAU 370 and formulation of the CSM. Also presented is a summary listing the contaminants of potential concern (COPCs), the preliminary action levels (PALs) for the investigation, 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 is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at any point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. It provides a good summary of how and where contaminants are expected to move and what impacts such movement may have. It is the basis for assessing how contaminants could reach receptors both in the present and future. The CSM describes the most probable scenario for current conditions at the site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. An accurate CSM is important because it serves as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for CAU 370 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 the conceptual pathways to receptors from CAU 370 sources. Figure 3-2 is a graphical depiction of the CSM. Several facets of the release of potential contamination at the CAS are addressed in the CSM as follows:

1. Activated soil (including Trinity glass) formed during the nuclear explosion is expected to contain activation products (i.e., Eu and Co isotopes) most concentrated closest to GZ. The activated soil is distributed in an annular pattern at the site.

2. The deposition of refractory materials (i.e., Pu isotopes that were volatilized during the detonation, and that solidified within a few seconds after detonation). The pattern of deposition for this material appears to be fractionated lobes away from the annular distribution (i.e., plumes of material preferentially deposited in a particular direction, such as the Am-241 plumes).

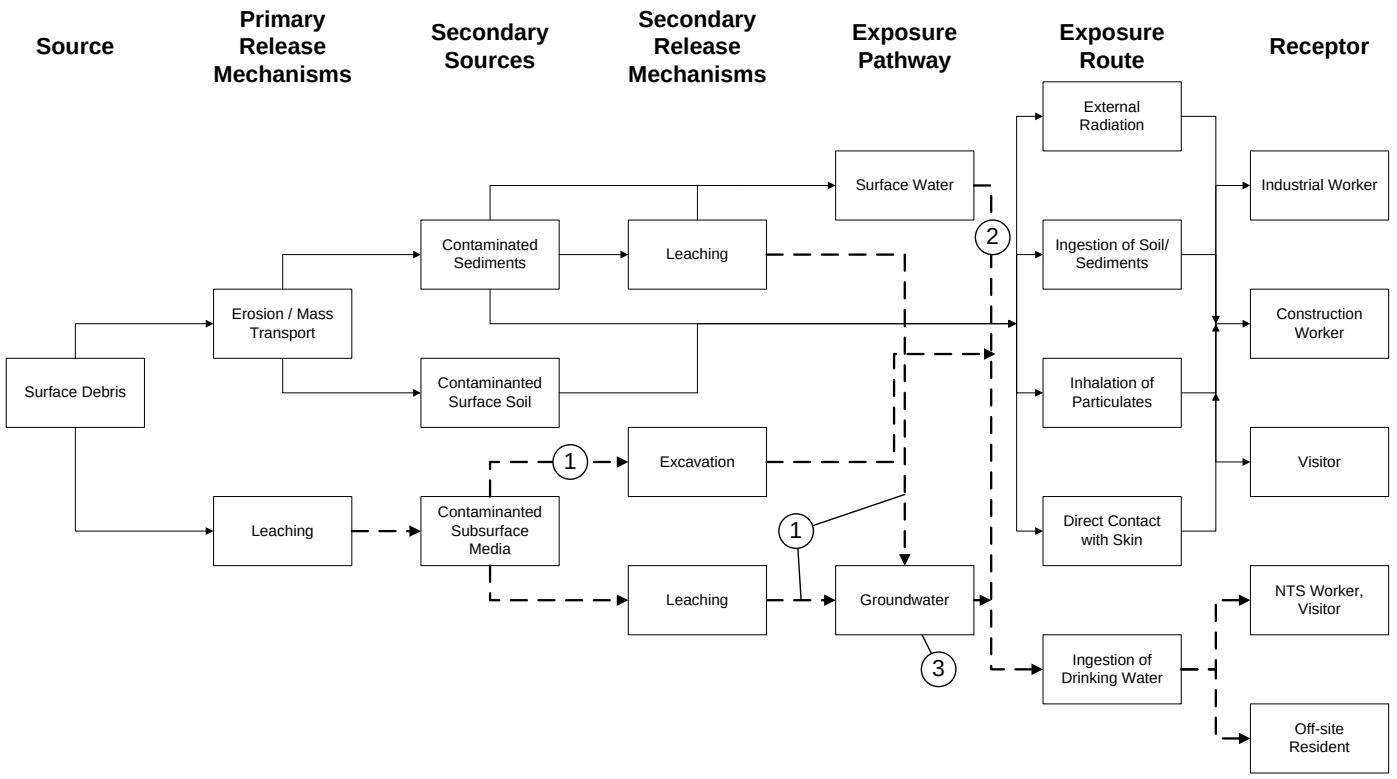

Figure 3-1
Conceptual Site Model Diagram

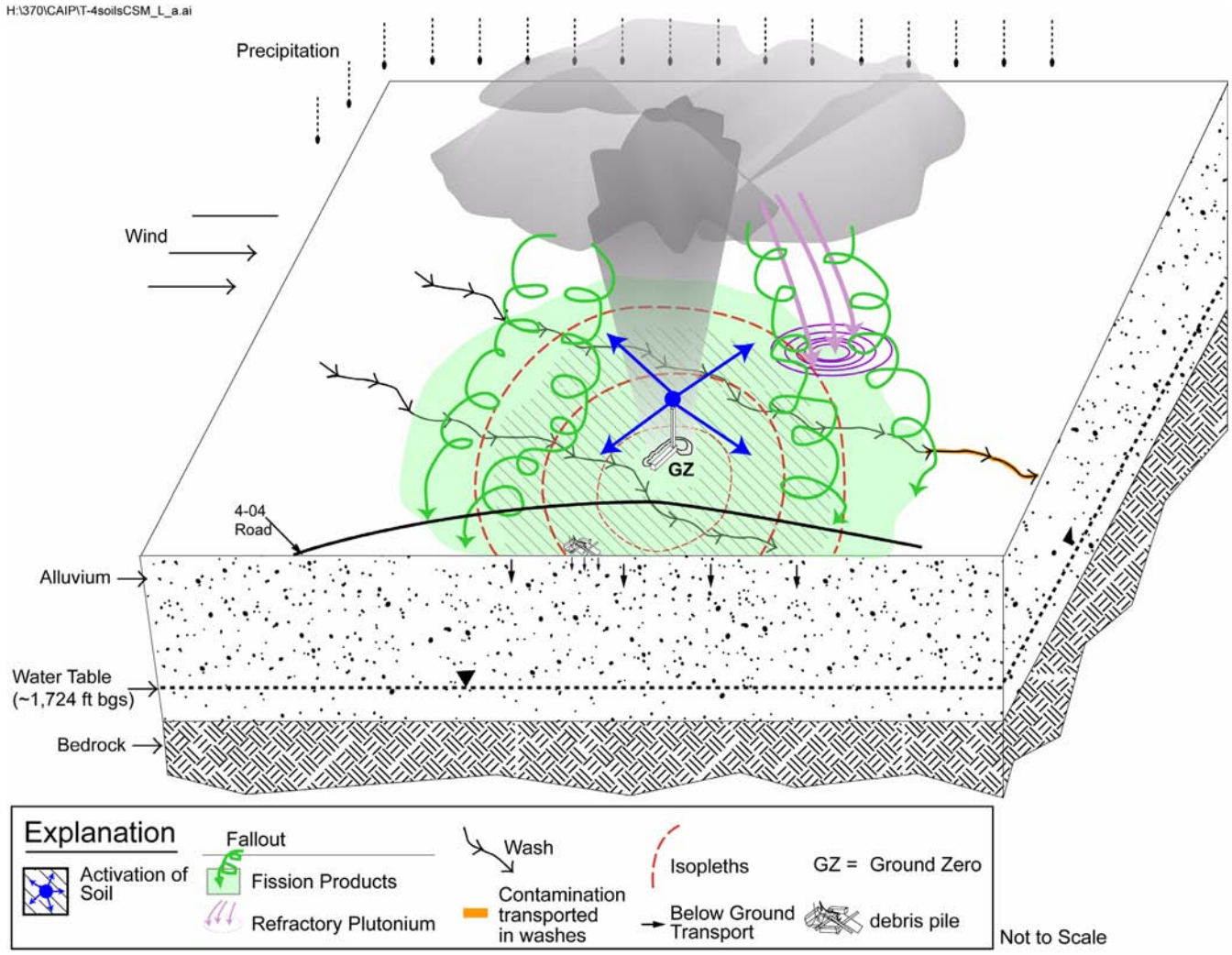

Figure 3-2
Corrective Action Unit 370 Conceptual Site Model

3. The deposition of semivolatile fission products (i.e., Sr-90 and Cs-137), likely distributed in an annular pattern, with some fractionation toward down-wind locations. This material is part of the fission products from the fallout depicted in Figure 3-2.

4. The deposition of volatile materials (i.e., iodine isotopes, that remained in a gaseous state for much longer periods of time), likely distributed partially in an annular pattern but more subjected to fractionation by wind directions. This material is also part of the fission products from the fallout, though most radioisotopes have since decayed away.

5. Debris, chemicals, and other materials (e.g., leaks of diesel, polychlorinated biphenyls [PCBs]) used either during the testing or left at the site during activities related to the testing program.

6. Contamination associated with CAS 04-23-01 that has been transported primarily in washes transecting the site since the original distribution. Other potential minor transport of contamination from the site includes wind-borne material and material pushed along dirt roads in the area (e.g., moved during road maintenance).

If evidence of contamination associated with this CAS that is not consistent with the presented CSM is identified during investigation activities, the situation will be reviewed, the CSM will be revised as necessary, the DQOs will be re-assessed, and a recommendation will be made as to how to proceed. In such cases, the decision-makers listed in Section A.3.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 370.

3.1.1 Land-Use and Exposure Scenarios

Corrective Action Site 04-23-01 is located in the land-use zone described as the "Nuclear and High Explosive Test Zone." This area is designated within the Nuclear Test Zone for additional underground nuclear tests and outdoor high-explosive tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998), and dictates future land use, and restricts current and future land use to nonresidential (i.e., industrial) activities.

The exposure scenario for CAS 04-23-01 has been categorized as an Occasional Use Area. This exposure scenario assumes exposure to industrial workers who are not assigned to the area as a

regular worksite but may use the site occasionally for intermittent or short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 8 hours per day, 10 days per year, for 5 years.

3.1.2 Contaminant Sources

The contamination source for the CSM is:

- Surface and near-surface soil and debris impacted by the atmospheric detonation of nuclear devices.
- Debris, chemicals, and other materials used either during the testing or left at the site during activities related to the testing program.

3.1.3 Release Mechanisms

The release mechanisms for the CSM are the atmospheric detonation of nuclear devices, leaching from contaminated debris, and spills at the site.

3.1.4 Migration Pathways

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils.

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 saturation, sorting, chemical composition, and organic content. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with high solubility, low affinity for media, and low density can be expected to be found further from release points. These factors affect the migration pathways and potential exposure points for the contaminants in the various media under consideration.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 Radiological Waste Management Site has been estimated at 62.6 in.)

(Shott et al., 1997) and limited precipitation for this region (6.4 in. annually at the Buster Jangle rain gauge), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (ARL/SORD, 2006).

Contaminants released into a wash leaving the site of release are subject to much higher transport mechanisms than contaminants released to other surface areas. The washes entering and leaving CAS 04-23-01 are generally dry but are subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas.

Contaminants may also be present along the dirt roads in the area (e.g., the 4-04 Road and secondary dirt roads) as a result of road maintenance activities (e.g., grading).

Subsurface migration pathways at CAS 04-23-01 are expected to be predominately vertical although any deposition at the ground surface may also have limited lateral migration before infiltration. The depth of infiltration (shape of the subsurface contaminant plume) will be dependent upon the type, volume, and duration of the discharge as well as the presence of relatively impermeable layers that could modify vertical or horizontal transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

3.1.5 Exposure Points

Exposure points for the CSM are expected to be areas of surface contamination where visitors and site workers will come in contact with soil surface and contaminated debris. Subsurface exposure points may also 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, inhalation, and/or dermal contact (absorption) from disturbance of, or direct contact with, contaminated media. Site workers may also be exposed to ionizing radiation by performing activities in proximity to radiologically contaminated materials.

3.1.7 Additional Information

Information concerning topography, geology, climatic conditions, hydrogeology, floodplains, and infrastructure at CAS 04-23-01 is available and 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 corrective action alternatives, as applicable. Climatic and site conditions (e.g., surface and subsurface soil descriptions) and specific structure descriptions will be recorded during the CAI. Areas of erosion and deposition within the washes will be evaluated qualitatively by a hydrologist to provide any additional information on potential offsite migration of contamination. Movement of active ephemeral stream channels in the last 50 years may be identified based on a comparison of historical photographs and visual observations where erosion and deposition has occurred within the washes.

3.2 Contaminants of Potential Concern

The COPCs from CAS 04-23-01 that are applicable to Decision I environmental samples are defined as the constituents reported from the following analyses:

- Gamma spectroscopy
- Isotopic U
- Isotopic Pu
- Strontium-90

If a biasing factor is encountered that indicates possible presence of chemical contamination, samples will be submitted for analysis based on the nature of the biasing factor (e.g., lead bricks, stains). These may include the constituent(s) reported from the following analyses:

- Total petroleum hydrocarbons-diesel-range organics
- Total petroleum hydrocarbons-gasoline-range organics
- Polychlorinated biphenyls
- Semivolatile organic compounds
- Volatile organic compounds
- *Resource Conservation and Recovery Act* metals

The constituents reported for each analytical method are listed in Table 3-1. The list of COPCs is intended to encompass all of the contaminants that could potentially be present at the CAS. These COPCs were identified during the planning process through the review of site history, process knowledge, past investigation efforts (where available), and inferred activities associated with the CAS.

Table 3-1
Constituents Reported by Analytical Methods

VOCs		SVOCs		TPH	PCBs	Metals	Isotopic Radionuclides
1,1,1-Trichloroethane	Dichlorodifluoromethane	2,3,4,6-Tetrachlorophenol	Di-n-octyl Phthalate		Aroclor 1016	Arsenic	Plutonium-238
1,1,1,2-Tetrachloroethane	Ethyl methacrylate	2,4-Dimethylphenol	Fluoranthene		Aroclor 1221	Barium	Plutonium-239/240
1,1,2,2-Tetrachloroethane	Ethylbenzene	2,4-Dinitrotoluene	Fluorene		Aroclor 1232	Beryllium	Strontium-90
1,1,2-Trichloroethane	Isobutyl alcohol	2,4,5-Trichlorophenol	Hexachlorobenzene		Aroclor 1242	Cadmium	Uranium-234
1,1-Dichloroethane	Isopropylbenzene	2,4,6-Trichlorophenol	Hexachlorobutadienea		Aroclor 1248	Chromium	Uranium-235
1,1-Dichloroethene	m-Dichlorobenzene (1,3)	2-Chlorophenol	Hexachloroethane		Aroclor 1254	Lead	Uranium-238
cis-1,2-Dichloroethene	Methacrylonitrile	2-Methylnaphthalene	Indeno(1,2,3-cd)pyrene		Aroclor 1260	Mercury	Tritium
1,2-Dichloroethane	Methyl methacrylate	2-Methylphenol	Naphthalene[b]		Aroclor 1268	Selenium	
1,2-Dichloropropane	Methylene chloride	2-Nitrophenol	Nitrobenzene			Silver	Gamma-emitting Radionuclides
1,2,4-Trichlorobenzene	N-Butylbenzene	3-Methylphenol[a]	N-Nitroso-di-n-propylamine				Actinium-228
1,2,4-Trimethylbenzene	N-Propylbenzene	4-Chloroaniline	Pentachlorophenol				Americium-241
1,2-Dibromo-3-chloropropane	o-Dichlorobenzene (1,2)	4-Methylphenol[a]	Phenanthrene				Cobalt-60
1,3,5-Trimethylbenzene	p-Dichlorobenzene (1,4)	4-Nitrophenol	Phenol				Cesium-137
1,4-Dioxane	p-isopropyltoluene	Acenaphthene	Pyrene				Europium-152
2-Butanone	sec-Butylbenzene	Acenaphthylene	Pyridine	TPH (Diesel-Range Organics and Gasoline-Range Organics)			Europium-154
2-Chlorotoluene	Styrene	Aniline					Europium-155
2-Hexanone	tert-Butylbenzene	Anthracene					Potassium-40
4-Methyl-2-pentanone	Tetrachloroethene	Benzo(a)anthracene					Niobium-94
Acetone	Toluene	Benzo(a)pyrene					Lead-212
Acetonitrile	Total Xylenes	Benzo(b)fluoranthene					Lead-214
Allyl chloride	Trichloroethene	Benzo(g,h,i)perylene					Thorium-234
Benzene	Trichlorofluoromethane	Benzo(k)fluoranthene					Thallium-208
Bromodichloromethane	Vinyl acetate	Benzoic Acid					Uranium-235
Bromoform	Vinyl chloride	Benzyl Alcohol					
Bromomethane		Bis(2-ethylhexyl) phthalate					
Carbon disulfide		Butyl benzyl phthalate					
Carbon tetrachloride		Carbazole					
Chlorobenzene		Chrysene					
Chloroethane		Dibenzo(a,h)anthracene					
Chloroform		Dibenzofuran					
Chloromethane		Diethyl Phthalate					

[a]May be reported as 3,4-methylpenol.
[b]May be reported with VOCs.

PCB = Polychlorinated biphenyl
SVOC = Semivolatile organic compound
TPH = Total petroleum hydrocarbons
VOC = Volatile organic compound

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 risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006a). This process conforms with *Nevada Administrative Code* (NAC) Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006c). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006d) requires the use of American Society for Testing and Materials (ASTM) Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

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

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

- Tier 2 evaluation - Conducted by calculating Tier 2 site-specific target levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total petroleum hydrocarbons (TPH) concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual 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 ASTM Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

  Note: The radiological FAL is established as the 25-mrem/yr TEDE.

The 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

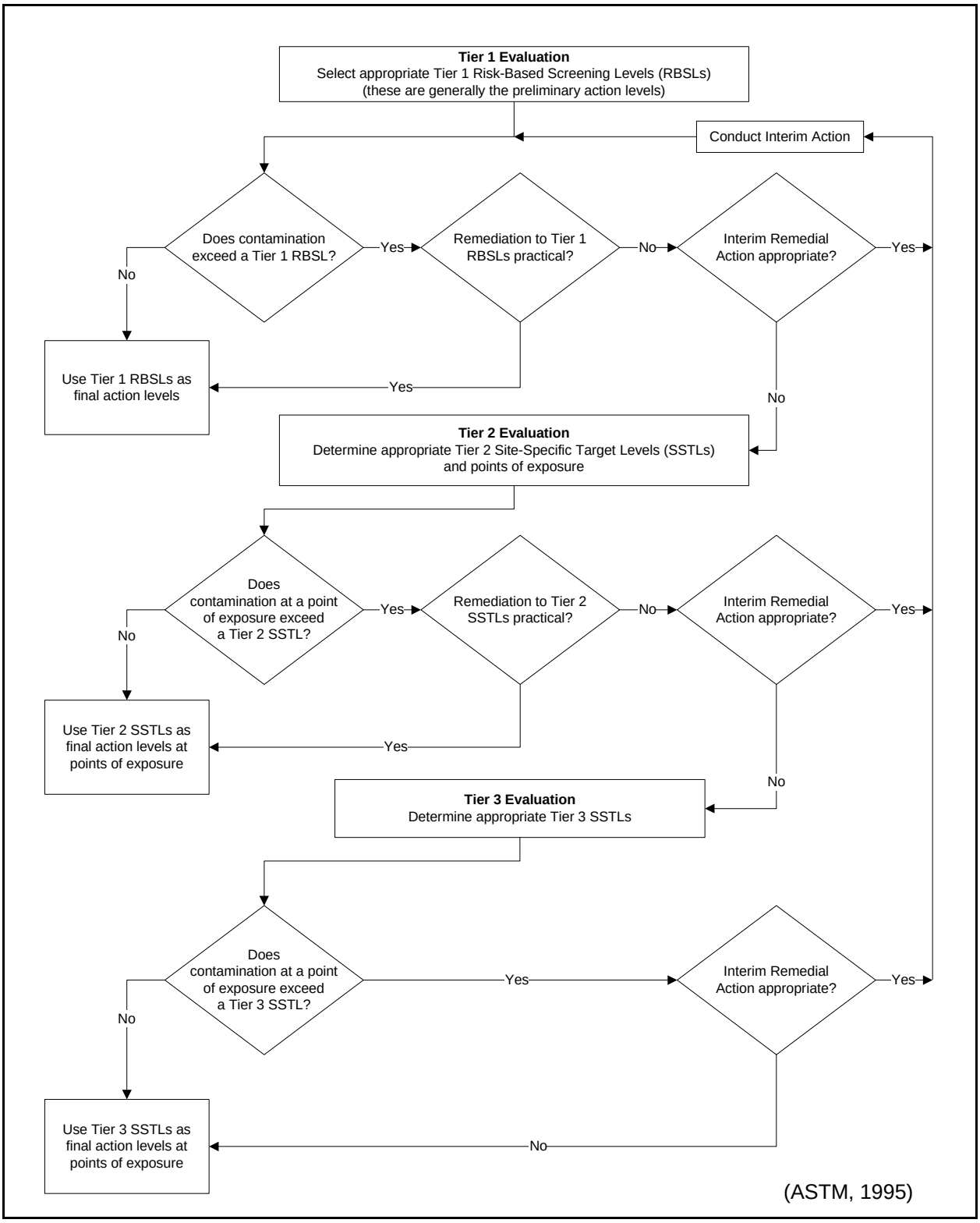

Figure 3-3
Risk-Based Corrective Action Decision Process

investigation and at any level (tier) of analysis. Concurrence of the decision makers listed in Section A.3.1 will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site following completion of any interim actions. Any interim actions conducted will be reported in the investigation report.

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

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Region 9 Risk-Based Preliminary Remediation Goals (PRGs)* for contaminant constituents in industrial soils (EPA, 2004a). Background concentrations for *Resource Conservation and Recovery Act* (RCRA) metals will be used instead of PRGs when natural background concentrations exceed the PRG, as is often the case with arsenic on the NTS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

3.3.2 Total Petroleum Hydrocarbon PALs

The PAL for TPH is 100 parts per million (ppm) as listed in NAC 445A.2272 (NAC, 2006e).

3.3.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the National Council on Radiation Protection and Measurement (NCRP) Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) using a 25-mrem/yr dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land-use scenarios as presented in Section 3.1.1.

3.4 Data Quality Objective Process Discussion

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

During development of the DQOs, the participants identified the presence of potential contamination at the site in two types of distributions (i.e., annular distribution following detonation, and other releases not equally distributed around GZ). In order that information is gathered from the annular distribution area separate from information gathered at other releases (i.e., to contribute to the overall Soils Project strategy for atmospheric tests), the DQO participants agreed to investigate the annular distribution through a combination of probabilistic and judgmental sample, and to investigate the other releases through judgmental sampling only. Therefore, discussions related to these separate investigations are presented separately.

The DQO strategy for CAU 370 was developed at a meeting on December 10, 2007. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and to design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 370 is: “Existing information on the nature and extent of contamination is insufficient to evaluate and/or implement corrective action alternatives for CAS 04-23-01.” The information necessary to address this question will come from an investigation of contamination present in the CAS that was released and distributed in an annular pattern and by other means of release. To address the problem of insufficient information at the CAS, the resolution of two decisions statements is required:

- Decision I: “Is any COPC associated with the CAS present in environmental media at a concentration exceeding its corresponding FAL?” Resolution of this decision statement is discussed in Section A.4.1.

- Decision II (annular pattern of distribution): "Is the extent of the area that provides a dose exceeding 25 mrem/yr defined?" Sufficient information to resolve this portion of Decision II discussed in Section A.4.1.

- Decision II (other releases): "Is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is to resolve this portion of Decision II discussed in Section A.4.1.

The presence of a COC, including a radiological dose above the 25-mrem/yr threshold, would require a corrective action. A corrective action may also be necessary if there is a potential for wastes that are present at a site to impose COCs into site environmental media if the wastes were to be released. To evaluate the potential for source material (i.e., surface and near surface soil and debris) to result in the introduction of a COC to the surrounding environmental media, the following conservative assumptions were made:

- That impacted-debris containment would fail at some point and the contents would be released to the surrounding media.

- That the resulting concentration of contaminants in the surrounding media would be equal to the concentration of contaminants in the impacted debris.

Decision I samples will be submitted to analytical laboratories for the analyses listed in Section 3.2. Decision II samples will be submitted for the analysis of all unbounded COCs. In addition, samples will be submitted for analyses as needed to support waste management or health and safety decisions.

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

To satisfy the DQI of sensitivity (presented in Section 6.2.8), the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. Analytical methods and target minimum detectable concentrations (MDCs) for each CAU 370 COPC are provided in Tables 3-2 and 3-3. The MDC is the lowest concentration of a chemical or radionuclide parameter that can be detected in a sample within an acceptable level of error. Due to changes in analytical methodology, and analytical laboratory contracts, information in Tables 3-2 and 3-3 that varies from corresponding information in the QAPP will supersede the QAPP (NNSA/NV, 2002).

Table 3-2
Analytical Requirements for Radionuclides for CAU 370

Analysis[a]	Matrix	Analytical Method	Minimum Detectable Concentration (MDC)[b]	Laboratory Precision	Laboratory Accuracy (%R)
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1[c]	< Preliminary Action Levels	RPD 35%[d] ND[e] -2<ND[e]<2	Laboratory Control Sample 80-120%R
	Nonaqueous	HASL-300[f]			
Other Radionuclides					
Tritium	Aqueous	EPA 906.0[c]	< Preliminary Action Levels	RPD 35%[d] ND[e] -2<ND[e]<2	Laboratory Control Sample 80-120%R Chemical Yield 30-105%R (not applicable for tritium and gross-alpha/beta) Matrix Spike Sample 61-140%R (tritium and gross alpha/beta only)
	Nonaqueous	Approved Laboratory Procedure[g]			
Plutonium-238	All	HASL-300[f]			
Plutonium-239/240	All	HASL-300[f]			
Strontium-90	All	HASL-300[f]			
Uranium-234	All	HASL-300[f]			
Uranium-235	All	HASL-300[f]			
Uranium-238	All	HASL-300[f]			

[a]Applicable constituents are listed in Table 3-1.
[b]The MDC is the lowest concentration of a radionuclide present in a sample and can be detected with a 95% confidence level.
[c]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water (*EPA, 1980)
[d]*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)
[e]ND is not RPD; rather, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (DOE, 1997a)
[f]*The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997b)
[g]Laboratory procedure must be approved by appropriate project personnel.

EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
ND = Normalized difference
RPD = Relative percent difference
%R = Percent recovery

Table 3-3
Analytical Requirements for Chemical COPCs for CAU 370

Analysis[a]	Matrix	Analytical Method (SW-846)[b]	Minimum Detectable Concentration (MDC)[c]	Laboratory Precision	Laboratory Accuracy (%R)
ORGANICS					
Total Volatile Organic Compounds	All	8260B	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
Total Semivolatile Organic Compounds	All	8270C	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
Polychlorinated Biphenyls	All	8082	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
Total Petroleum Hydrocarbons-Gasoline-Range Organics	All	8015B (modified)		Lab-specific[d]	Lab-specific[d]
Total Petroleum Hydrocarbons-Diesel-Range Organics	All	8015B (modified)		Lab-specific[d]	Lab-specific[d]
INORGANICS					
Metals	All	6010B	< Preliminary Action Levels	RPD 35% (nonaqueous)[e] 20% (aqueous)[e] Absolute Difference[f] ±2x RL (nonaqueous)[f] ±1x RL (aqueous)[f]	Matrix Spike Sample 75-125%R[b] Laboratory Control Sample 80-120%R[f]
Mercury	Aqueous	7470A			
	Nonaqueous	7471A			

[a]Applicable constituents are listed in Table 3-1.
[b]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) (EPA, 1996)
[c]The MDC is the lowest concentration that can be reliably achieved within specified limits of accuracy and precision.
[d]RPD and %R performance criteria are developed by the analytical laboratory according to approved procedures.
[e]*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)
[f]*USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004b)

RL = Reporting limit
RPD = Relative percent difference
TCLP = Toxicity Characteristic Leaching Procedure
%R = Percent recovery

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 370 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for the CAU 370 CAS by collecting and analyzing samples generated during a field investigation. The presence and nature of contamination at CAS 04-23-01 will be evaluated using a combination of judgmental and probabilistic approaches.

4.1.1 Investigation of the Annular Distribution of Radionuclides

For judgmental sampling of the area impacted by the initial distribution of radionuclides, sample plot locations at CAS 04-23-01 will be determined based upon the 1994 flyover radiological survey (Figure A.5-1), along three sampling vectors, outward from GZ, along lines that include at least two RIDP points. At least five sample plots will be established along each sampling vector (Section A.9.0). For each sampling vector, one innermost sample plot will be placed at the RIDP point closest to GZ, based upon the likelihood of the soil containing a COC, within the 25-mrem/yr-dose boundary. The outermost sample plot will be placed beyond the 25-mrem/yr-dose boundary, and the other sample plots will be placed between the innermost and outermost sample plots. Analytical suites will provide results for the radiological COPCs identified in Section 3.2.

Random (probabilistic) locations for Decision I samples within each sample plot at CAS 04-23-01 were selected using the Visual Sample Plan (VSP) software program (PNNL, 2005). At each plot, four separate composite samples will be collected. Each composite sample will consist of soil collected from nine sample locations within the plot. For each composite sample, the first location will be selected randomly by the VSP software program; the remaining eight sample locations will be established by VSP on a random-start, systematic, triangular grid (Section A.9.0).

Selection of probabilistic sample locations at this CAS, including the predetermined sample locations at one sample plot (Figure A.9-2) are presented in Appendix C. Appendix C briefly reviews the methodology and computational approach for the probabilistic sampling.

4.1.2 Investigation of Other Releases

Additional judgmental sampling of other releases (Section 1.1) will determine the nature and extent of those components of CAS 04-23-01.

Judgmental sampling will be used to investigate debris, and to investigate areas impacted by fractionated fallout, such as the Am-241 plume to the north. Biased locations will also be selected downstream in washes crossing the area, along dirt roads near the site, and at areas impacted by other releases identified during the investigation (e.g., lead bricks, soil staining, abandoned drums).

If there is a waste present that, if released, has the potential to release significant contamination into site environmental media, that waste will be characterized.

4.1.3 Overall Investigative Strategy

The sampling strategy is presented in Appendix A. The number, location, and spacing of step-outs may be modified by the Task Manager or Site Supervisor, as warranted by site conditions, to achieve DQO criteria stipulated in Appendix A. Where sampling locations are modified by the Task Manager or Site Supervisor, the justification for these modifications will be documented in the field logbook.

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

4.2 Field Activities

Field activities at CAU 370 include site preparation, sample location selection, and sample collection activities.

4.2.1 Site Preparation Activities

Site preparation activities conducted by the NTS management and operating contractor before the investigation may include, but not be limited to: relocation or removal of surface debris, construction of hazardous waste accumulation areas and site exclusion zones, and provision of sanitary facilities.

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

- Perform radiological surveys.
- Perform visual surveys to identify any staining, discoloration, disturbance of native soils, or any other indication of potential contamination.

4.2.2 Sample Collection

The CAU 370 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in this section.
- Collect required QC samples.
- Collect waste management samples.
- Collect soil samples from locations outside the influence of releases from the CAS, if necessary.
- Perform radiological characterization surveys of materials and debris as necessary for disposal purposes.
- Record global positioning system coordinates for each environmental sample location.

Decision I surface soil samples (0 to 5 cm bgs) will be collected at locations of annular distributions and other releases. If biasing factors are present in soils below locations where Decision I samples were collected, subsurface Decision I soil samples will also be collected by hand augering. Decision I subsurface soil samples will be collected at depth intervals selected by the Task Manager or Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present.

Decision II sampling will consist of further defining the extent of contamination where COCs have been confirmed. Step-out (Decision II) sampling locations at locations of other releases (i.e., not annular distributions) will be selected based on the CSM, biasing factors, field-screening results, existing data, and the outer boundary sample locations where COCs were detected. In general, for investigation of annular distributions, step-out sample locations will be arranged along sampling vectors containing a COC at distances based on site conditions. For investigation of other releases, step-out sample locations will be based on COC concentrations, process knowledge, and biasing factors. If COCs extend beyond step-out locations, additional Decision II samples will be collected from locations further from the source. If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor or Task Manager determines that extent sampling needs to be re-evaluated, then work will be suspended temporarily, NDEP notified, and the investigation strategy re-evaluated. A minimum of one analytical result from less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination. The lateral and vertical extent of COCs will be established based on validated laboratory analytical results (i.e., not field screening).

For the investigation of annular distributions, evaluation of the results will include the 95 percent upper confidence limit (UCL) of the average TEDE for Decision I sampling. Evaluation of the results for Decision II will include the identification of the area above the 25-mrem/yr dose, based on regression analyses of the TEDE, as a function of distance along each vector.

4.2.3 Sample Management

The laboratory requirements (i.e., detection limits, precision, and accuracy requirements) to be used when analyzing the COPCs are presented in Tables 3-2 and 3-3. The analytical program for the CAS is presented in Section 3.2. All sampling activities and QC requirements for field and laboratory environmental sampling will be conducted in compliance with the QAPP (NNSA/NV, 2002) and other applicable, approved procedures.

4.3 Site Restoration

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

- Removal of all equipment, wastes, debris, and materials associated with the CAI
- Removal of all signage and fencing (unless part of a corrective action)
- Grading of site to pre-investigation condition (unless changed condition is necessary under a corrective action)
- Inspection and certification of the site that restoration activities have been completed

5.0 Waste Management

Management of investigation-derived waste (IDW) will be based on regulatory requirements, field observations, process knowledge, and laboratory results from CAU 370 investigation samples.

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., metal and concrete). Therefore, sampling and analysis of IDW, separate from analyses of site investigation samples, may not be necessary for all IDW. However, if associated investigation samples are found to contain contaminants above regulatory levels, 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. Direct samples of IDW may also be taken to support waste characterization.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with applicable DOE orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP.

5.1 Waste Minimization

Investigation activities are planned to minimize IDW generation. This will be accomplished by incorporating the use of process knowledge, visual examination, and/or radiological survey and swipe results. When possible, disturbed media (such as soil removed during subsurface excavation) or debris will be returned to its original location. Contained media (e.g., soil managed as waste) as well as other IDW will be segregated to the greatest extent possible to minimize generation of hazardous, radioactive, or mixed waste. Hazardous material used at the sites will be controlled in order to limit unnecessary generation of hazardous or mixed waste. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during investigations.

5.2 Potential Waste Streams

Waste generated during the investigation activities will include the following potential waste streams:

- Personal protective equipment and disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, bowls)
- Decontamination rinsate
- Environmental media (e.g., soil)
- Surface debris in investigation area (e.g., metal and concrete)
- Field-screening waste (e.g., spent solvent, disposable sampling equipment, and/or PPE contaminated by field-screening activities)

5.3 Investigation-Derived Waste Management

The onsite management and ultimate disposition of IDW will be determined based on a determination of the waste type (e.g., sanitary, low-level, hazardous, hydrocarbon, mixed), or the combination of waste types. A determination of the waste type will be guided by several factors, including, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, waste generation process knowledge, field observations, field-monitoring/screening results, and/or radiological survey/swipe results.

Table 4-2 of the *NV/YMP Radiological Control* (RadCon) *Manual* (NNSA/NSO, 2004) shall be used to determine whether such materials may be declared nonradioactive. Onsite IDW management requirements by waste type are detailed in the following sections. Applicable waste management regulations and requirements are listed in Table 5-1.

Table 5-1
Waste Management Regulations and Requirements

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	N/A	NRS[a] 444.440 - 444.620 NAC[b] 444.570 - 444.7499 NTS Landfill Permit SW13.097.04[c] NTS Landfill Permit SW13.097.03[d]
Liquid/Rinsate (nonhazardous)	N/A	Water Pollution Control General Permit GNEV93001, Rev. 3iii[e]
Hazardous	RCRA[f], 40 CFR 260-282	NRS[a] 459.400 - 459.600 NAC[b] 444.850 - 444.8746 POC[g]
Low-Level Radioactive	N/A	DOE Orders and NTSWAC[h]
Mixed	RCRA[f], 40 CFR 260-282	NTSWAC[h] POC[g]
Hydrocarbon	N/A	NTS Landfill Permit SW13.097.02[i] NAC[b] 445A.2272
Polychlorinated Biphenyls	TSCA[j], 40 CFR 761	NRS[a] 459.400 - 459.600 NAC[b] 444.940 - 444.9555
Asbestos	TSCA[j], 40 CFR 763	NRS[a] 618.750 - 618.840 NAC[b] 444.965 - 444.976

[a]*Nevada Revised Statutes* (NRS, 2007a, b, c)
[b]*Nevada Administrative Code* (NAC, 2006a and e)
[c]Area 23 Class II Solid Waste Disposal Site (NDEP, 1997a)
[d]Area 9 Class III Solid Waste Disposal Site (NDEP, 1997c)
[e]Nevada Test Site Sewage Lagoons (NDEP, 1999)
[f]*Resource Conservation and Recovery Act* (CFR, 2007a)
[g]*Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)
[h]*Nevada Test Site Waste Acceptance Criteria,* Rev. 6-02 (NNSA/NSO, 2006b)
[i]Area 6 Class III Solid Waste Disposal Site for hydrocarbon waste (NDEP, 1997b)
[j]*Toxic Substances Control Act* (CFR, 2007b and c)

CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
N/A = Not applicable
NAC = *Nevada Administrative Code*
NRS = *Nevada Revised Statutes*
NTS = Nevada Test Site
NTSWAC = *Nevada Test Site Waste Acceptance Criteria*
POC = Performance Objective for the Certification of Nonradioactive Hazardous Waste
RCRA = *Resource Conservation and Recovery Act*
TSCA = *Toxic Substances Control Act*

5.3.1 Sanitary Waste

Sanitary IDW generated at each CAS will be collected, managed, and disposed of in accordance with the sanitary waste management regulations and the permits for operation of the NTS 10c Industrial Waste Landfill.

5.3.2 Low-Level Radioactive Waste

Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting a radiologically controlled area. This allows for the immediate segregation of radioactive waste from waste that may be unrestricted regarding radiological release. Removable contamination limits, as defined in Table 4-2 of the current version of the NV/YMP RadCon Manual (NNSA/NSO, 2004), will be used to determine whether such waste may be declared unrestricted regarding radiological release versus being declared radioactive waste. Direct sampling of the waste may be conducted to aid in determining whether a particular waste unit (e.g., drum of soil) contains low-level radioactive waste, as necessary.

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 Test Site Waste Acceptance Criteria* (NNSA/NSO, 2006b).

5.3.3 Hazardous Waste

Suspected hazardous wastes will be placed in DOT-compliant containers. All containerized hazardous waste will be handled, inspected, and managed in accordance with Title 40 *Code of Federal Regulations* (CFR) 265 Subpart I (CFR, 2007a).

5.3.4 Hydrocarbon Waste

Hydrocarbon soil waste containing more than 100 milligrams per kilogram of TPH will be managed on site in a drum or other appropriate container until fully characterized. Hydrocarbon waste may be disposed of at a designated hydrocarbon landfill (NDEP, 1997b), an appropriate hydrocarbon waste management facility (e.g., recycling facility), or other method in accordance with Nevada regulations.

5.3.5 Mixed Low-Level Waste

Mixed waste, if generated, shall be managed and dispositioned according to the requirements of RCRA (CFR, 2007a) or subject to agreements between NNSA/NSO and the State of Nevada, as well as DOE requirements for radioactive waste.

5.3.6 Polychlorinated Biphenyls

If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2007b) as well as State of Nevada requirements (NAC, 2006a), guidance, and agreements with NNSA/NSO.

5.4 Management of Specific Waste Streams

5.4.1 Personal Protective Equipment

Personal protective equipment and disposable sampling equipment will be visually inspected for stains, discoloration, and gross contamination as the waste is generated, and also evaluated for radiological contamination. Staining and/discoloration will be assumed to be the result of contact with potentially contaminated media such as soil, sludge, or liquid. Gross contamination is the visible contamination of an item (e.g., clumps of soil/sludge on a sampling spoon or free liquid smeared on a glove). While gross contamination can often be removed through decontamination methods, removal of gross contamination from small items, such as gloves or booties is not typically conducted. Any IDW that meets this description will be segregated and managed as potentially characteristic hazardous waste. This segregated population of waste will either: (1) be assigned the characterization of the soil/sludge that was sampled, (2) be sampled directly, or (3) undergo further evaluation using the soil/sludge sample results to determine how much soil/sludge would need to be present in the waste to exceed regulatory levels. Waste that is determined to be hazardous will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada. The PPE and equipment that is not visibly stained, discolored, or grossly contaminated and that is within the radiological free-release criteria will be managed as nonhazardous sanitary waste.

5.4.2 Management of Decontamination Rinsate

Rinsate at CAU 370 will not be considered hazardous waste unless there is evidence that the rinsate may display a RCRA characteristic. Evidence may include such things as the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. Decontamination rinsate that is potentially hazardous (using associated sample results and/or process knowledge) will be managed as characteristically hazardous waste (CFR, 2006a). The regulatory status of the potentially hazardous rinsate will be determined through the application of associated sample results or through direct sampling. If the associated samples do not indicate the presence of hazardous constituents, then the rinsate will be considered to be nonhazardous.

The disposal of nonhazardous rinsate will be consistent with guidance established in current NNSA/NSO Fluid Management Plans for the NTS as follows:

- Rinsate that is determined to be nonhazardous and contaminated to less than 5x Safe Drinking Water Standards (SDWS) for radiological constituents is not restricted as to disposal. Nonhazardous rinsate that contains levels of constituents at 5x to 10x SDWS will be disposed of in an established infiltration basin or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

- Nonhazardous rinsate that contains radiological constituents at greater than 10x SDWS will be disposed of in a lined basin or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

5.4.3 Management of Soil

This waste stream consists of soil removed for disposal during soil sampling, excavation, and/or drilling. This waste stream will be characterized based on laboratory analytical results from representative locations. If the soil is determined to potentially contain COCs, the material will be managed either onsite or containerized for transportation to an appropriate disposal site.

5.4.4 Management of Debris

This waste stream can vary depending on site conditions. Debris that requires removal for the investigation activities (soil sampling) must be characterized for proper management and disposition. Historical site knowledge, waste generation process knowledge, field observations,

field-monitoring/screening results, radiological survey/swipe results and/or the analytical results of samples either directly or indirectly associated with the waste may be used to characterize the debris.

5.4.5 Field-Screening Waste

The use of field test kits and/or instruments may result in the generation of small quantities of hazardous wastes. If hazardous waste is produced by field screening, it will be segregated from other IDW and managed in accordance with the hazardous waste regulations (CFR, 2007a). For sites where field-screening samples contain radioactivity above background levels, field-screening methods that have the potential to generate hazardous waste will not be used, thus avoiding the potential to generate mixed waste. In the event a mixed waste is generated, the waste will be managed in accordance with Section 5.3.5 of this document.

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 CAS 04-23-01 in CAU 370. Sections 6.1 and 6.2 discuss the collection of required QC samples in the field and QA requirements for laboratory/analytical data to achieve closure. Unless otherwise stated in this CAIP, or required by the results of the DQO process (see Appendix A), this investigation will adhere to the QAPP (NNSA/NV, 2002).

6.1 Quality Control Sampling Activities

Field QC samples will be collected in accordance with established procedures. Field QC samples are collected and analyzed to aid in determining the validity of environmental sample results. The number of required QC samples depends on the types and number of environmental samples collected. The minimum frequency of collecting and analyzing QC samples for this investigation, as determined in the DQO process, include:

- Trip blanks (1 per cooler containing samples for volatile organic compound [VOC] analysis).
- Equipment rinsate blanks (1 per sampling event for each type of decontamination procedure).
- Source blanks (1 per lot of uncharacterized source water that contacts sampled media).
- Field duplicates (1 per 20 environmental samples or 1 per matrix, if less than 20 collected).
- Field blanks (1 for the CAS depending on site conditions).
- Laboratory QC samples (1 per 20 environmental samples or 1 per matrix, if less than 20 collected).

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

6.2 Laboratory/Analytical Quality Assurance

Criteria for the investigation, as stated in the DQOs (Appendix A) and except where noted, require laboratory analytical quality data be used for making critical 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 QAPP (NNSA/NV, 2002), except where otherwise stipulated in this CAIP. All chemical and radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all required samples were appropriately collected, analyzed, and the results met data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether they meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

The DQIs are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. Data quality indicators are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance). The quality and usability of data used to make DQO decisions will be assessed based on the following DQIs:

- Precision
- Accuracy/bias
- Representativeness
- Comparability
- Completeness
- 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. Due to changes in analytical methodology and changes in analytical laboratory contracts, criteria for precision and accuracy in Tables 3-2 and 3-3 that vary from corresponding information in the QAPP will supersede the QAPP (NNSA/NV, 2002).

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 370 Data Quality Indicators

Data Quality Indicator	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 3.4.	If the performance metric is not met, the affected analytical results from the affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Accuracy	At least 80% of the sample results for each measured contaminant are not qualified for accuracy based on the method-specific and laboratory-specific criteria presented in Section 6.2.4.	If the performance metric is not met, the affected analytical results from the affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Sensitivity	Minimum detectable concentrations are less than or equal to respective FALs.	Cannot determine whether COCs are present or migrating at levels of concern.
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.
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.
Completeness	80% of the COPCs have valid results.	Cannot support/defend decision on whether COCs are present.

COC = Contaminant of concern
COPC = Contaminant of potential concern
DQO = Data quality objective
FAL = Final action level

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 to assess the need to "flag" (qualify) individual parameter results when corresponding QC sample results are not within established control limits.

The criteria used for the assessment of chemical precision when both results are greater than or equal to 5x reporting limit (RL) is 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x RL, a control limit of ±1x RL and ±2x RL for aqueous and soil samples, respectively, is applied to the absolute difference.

The criteria used for the assessment of radiological precision when both results are greater than or equal to 5x MDC is 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x MDC, the normalized difference (ND) should be between -2 and +2 for aqueous and soil samples. The parameters to be used for assessment of precision for duplicates are listed in Table 3-2.

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. The performance metric for assessing the DQI of precision on DQO decisions (see Table 6-1) is that at least 80 percent of sample results for each measured contaminant are not qualified due to duplicates exceeding the criteria. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants.

6.2.4 Accuracy

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

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

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

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

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

6.2.5 Representativeness

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

assured by carefully developing the 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 the Tolerable Limits on Decision Errors are:

- For Decision I judgmental sampling, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS.
- For Decision I probabilistic sampling, having a high degree of confidence that the sample locations selected will represent contamination of the CAS.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- For Decision II (annular distribution), having a high degree of confidence that the sample locations selected will identify the extent of the 25-mrem/yr-radiological TEDE.
- For Decision II (other releases), having a high degree of confidence that the sample locations selected will identify the extent of COCs.

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

6.2.6 Completeness

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

For the judgmental sampling approach, the completeness goal is 80 percent. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions.

The qualitative assessment of completeness is an evaluation of the sufficiency of information available to make DQO decisions. This assessment will be based on meeting the data needs identified in the DQOs and will be presented in the investigation report. Additional samples will be collected if it is determined that the number of samples do not meet completeness criteria.

6.2.7 Comparability

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

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2002). The evaluation criteria for this parameter will be that measurement sensitivity (i.e., MDCs) will be less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives. This assessment will be presented in the investigation report.

7.0 Duration and Records Availability

7.1 Duration

Table 7-1 is a tentative duration of activities (in calendar days) for CAI activities.

Table 7-1
Corrective Action Investigation Activity Durations

Duration (days)	Activity
10	Site Preparation
76	Fieldwork Preparation and Mobilization
55	Sampling
160	Data Assessment
180	Waste Management

7.2 Records Availability

Historical information and documents referenced in this plan are retained in the NNSA/NSO project files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Federal Sub-Project Director. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the DOE Federal Sub-Project Director. The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO.

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 370, T-4 Atmospheric Test Site field investigation. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the CAU 370 CAS is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 370 investigation will be based on the DQOs presented in this appendix as developed by representatives of the NDEP and the NNSA/NSO. The seven steps of the DQO process presented in Sections A.3.0 through A.9.0 were developed in accordance with *EPA Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

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

- A method to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.
- Criteria that will be used to establish the final data collection design such as:
  - The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
  - The decisions or estimates that need to be made and the order of priority to resolve them.
  - The type of data needed.
  - An analytical approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings.

- Acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data.

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

A.2.0 Background Information

Corrective Action Unit 370 is comprised of CAS 04-23-01, Atmospheric Test Site T-4, located in Area 4 of the NTS, as shown in Figure A.2-1.

This section provides a CAS description, physical setting and operational history, release information, and previous investigation results for CAS 04-23-01.

Corrective Action Site 04-23-01 consists of contamination of the soil in and around GZ that was impacted by releases from atmospheric tower testing of four nuclear devices at the T-4 site. The site includes remnants of the tower used for the testing, an associated bunker and soil berm, pieces of metallic and concrete debris, and the posted RMA from GZ to the fences, excluding the 4-04 Road. The site is divided by the 4-04 Road and several washes enter the area from the west/northwest. Figure A.2-2 shows a site sketch of the CAS.

Physical Setting and Operational History – Corrective Action Site 04-23-01 is located on Yucca Flat in Area 4. The T-4 tower was the site of four weapons-related nuclear tests:

- Fox, part of Operation Tumbler-Snapper, was conducted on May 25, 1952, atop a 300-ft tower.
- Nancy, part of Operation Upshot Knothole, was conducted on March 24, 1953, atop a 300-ft tower.
- Apple-1, part of Operation Teapot, was conducted on March 29, 1955, atop a 500-ft tower.
- Kepler, part of Operation Plumbbob, was conducted on July 24, 1957, atop a 500-ft tower.

Following each test, debris, and perhaps contaminated soil, was removed from the site, apparently for site access and/or worker safety concerns. A limited site cleanup was also conducted in the late 1980s under the waste consolidation project at the NTS; lead and other material related to the tower debris was removed from the site (Johnston, 2008). The site does not appear to have been used for other purposes. More recently, however, the cleanup of lead bricks and sheeting, that were used in one or more tests at the T-4 site, was conducted in 2004 immediately west and north of the bunker for

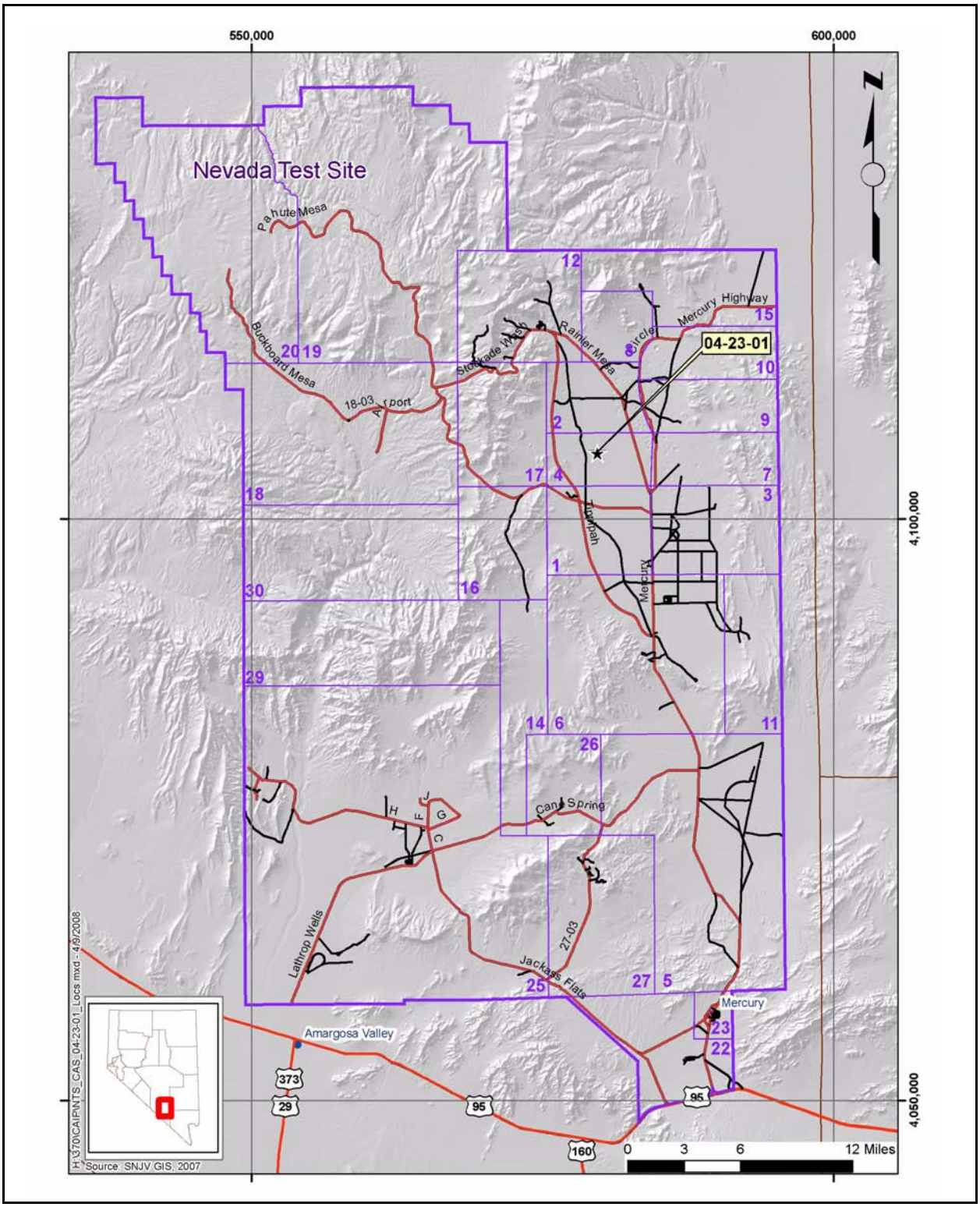

Figure A.2-1
Corrective Action Unit 370, CAS Location Map

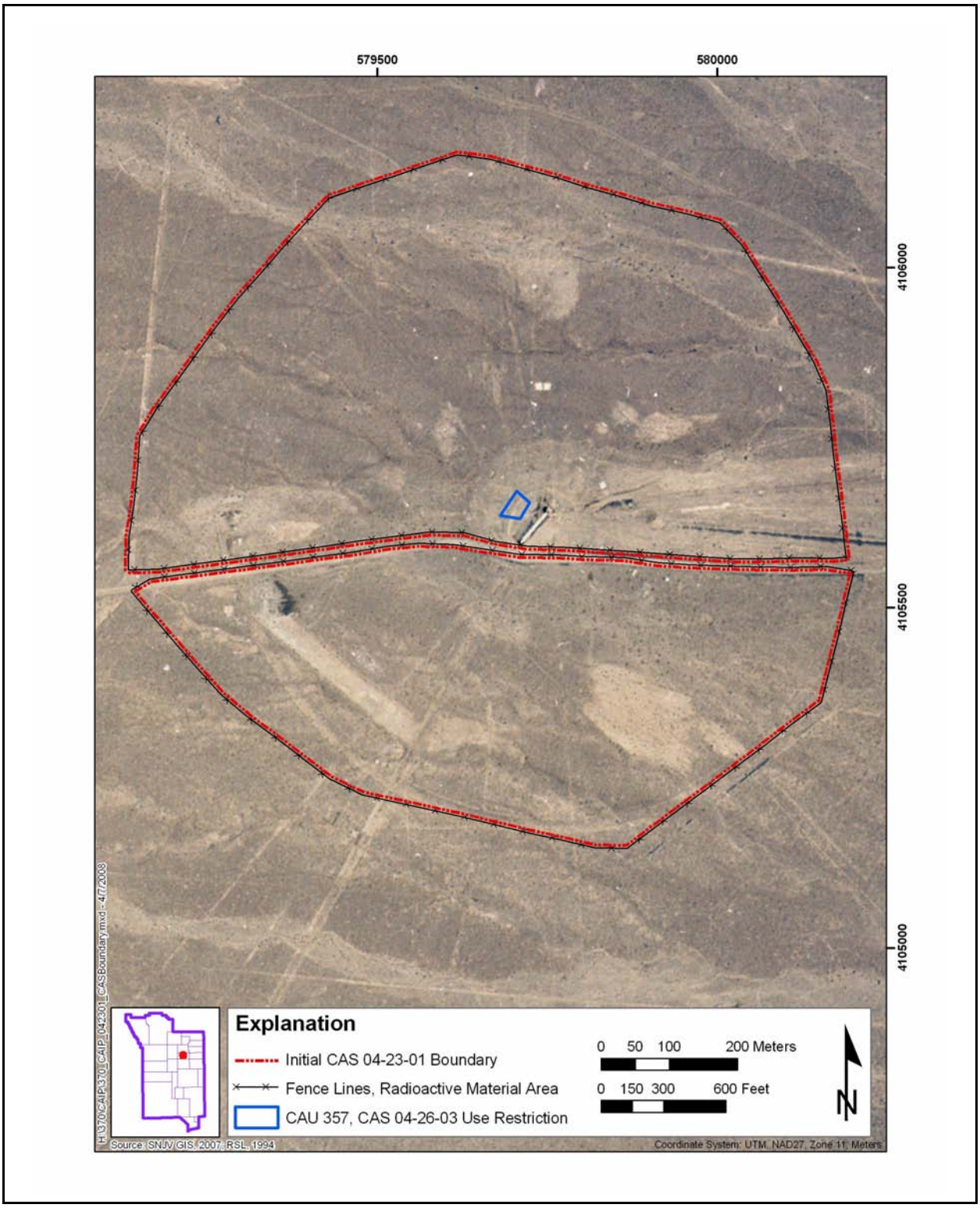

Figure A.2-2
Site Sketch of CAS 04-23-01

CAU 357, CAS 04-26-03 (NNSA/NSO, 2005). The lead bricks and impacted soil were removed as a corrective action for CAU 357, and the CAS was closed with a use restriction (Figure A.2-2).

Presently, the bunker, bottom portion of the tower, and the soil berm remain at the site (Figure A.2-3). Metal and concrete debris are scattered over the area to the north and west of the bunker, and Trinity glass is present throughout the area (Figure A.2-4). Several washes traverse the area (Figure A.2-5).

Release Information – Release of contamination at the site includes fallout due to nuclear weapons testing at this CAS as well as neutron activation resulting in Eu and Co isotopes in the soil.

Previous Investigation Results – Previous investigations for CAS 04-23-01 include several flyover radiological surveys (e.g., aircraft using radiological detection systems to identify gamma radiation), and the RIDP investigation. The flyover surveys conducted at CAS 04-23-01 identified radiological contamination for all gamma emissions at the site, with the highest readings found in and around GZ (BN/RSL, 1999). Extended regions outward from GZ exhibited Cs-137 and weak Co-60 photopeaks.

Also detected in the flyover surveys were several Am-241 regions that appear to have been distributed after the initial fallout (e.g., radiological plumes preferentially deposited in specific directions outward from GZ) at the T-4 site.

The RIDP investigation was conducted throughout the NTS from 1981 through 1986, and estimated the inventory of man-made radionuclides at the NTS through *in situ* soil measurements, and limited soil sampling (DRI, 1985; Gray et al., 2007). Both *in situ* gamma spectroscopy and limited confirmatory soil sampling were implemented at the study areas. Alpha-emitting radionuclides, primarily Pu isotopes, as well as gamma-emitting radionuclides, such as Am-241, Cs -137, Co-60, several Eu isotopes, and Sr-90, were identified at the site. One of the locations used for the RIDP near CAS 04-23-01 is shown in Figure A.2-6.

Investigations for other CASs conducted in the area of CAS 04-23-01 include CAS 04-26-03 at CAU 357, which identified lead contamination in and around GZ at T-4 (Section 2.2), and CAS 04-26-02 at CAU 286, which identified lead sheets atop the bunker at T-4.

Figure A.2-3
T-4 Bunker and Tower Remnants

Figure A.2-4
Metal Debris (left) and Trinity Glass (right) (approximately 3 in. long) near CAS 04-23-01

Figure A.2-5
Wash near CAS 04-23-01

Figure A.2-6
Area around One RIDP Point

A.3.0 Step 1 - State the Problem

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

The problem statement for CAU 370 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CAU 370."

A.3.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NSO, DRI, SNJV, and NSTec. The DQO planning team met on December 10, 2007, for the DQO meeting. The primary decision makers are the NDEP and NNSA/NSO representatives.

A.3.2 Conceptual Site Model

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

The CSM was developed for CAU 370 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of:

- Potential contaminant releases including media subsequently affected.

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

Several facets of the release of potential contamination at CAS 04-23-01 include:

1. Activated soil (including Trinity glass) formed during the nuclear explosion is expected to contain activation products (i.e., Eu and Co isotopes) most concentrated closest to GZ. The activated soil is distributed in an annular pattern at the site.

2. The deposition of refractory materials (i.e., Pu isotopes that were volatilized during the detonation, and that solidified within a few seconds after detonation). The pattern of deposition for this material appears to be fractionated lobes away from the annular distribution (i.e., plumes of material preferentially deposited in a particular direction, such as the Am-241 plumes).

3. The deposition of semivolatile fission products (i.e., Sr-90 and Cs-137), likely distributed in an annular pattern, with some fractionation toward down-wind locations. This material is part of the fission products from the fallout depicted in Figure A.3-1.

4. The deposition of volatile materials (i.e., iodine isotopes, that remained in a gaseous state for much longer periods of time), likely distributed partially in an annular pattern but more subjected to fractionation by wind direction. This material is also part of the fission products from the fallout, though most radioisotopes have decayed away.

5. Debris, chemicals, and other materials (e.g., leaks of diesel, PCBs) used either during the testing or left at the site during activities related to the testing program.

6. Contamination associated with CAS 04-23-01 that has been transported primarily in washes transecting the site since the original distribution. Other potential minor transport of contamination from the site includes wind-borne material and material pushed along dirt roads in the area (e.g., moved during road maintenance).

If additional elements are identified during the investigation 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 and NNSA/NSO will be notified and given the opportunity to comment on, or concur with, the recommendation.

The applicability of the CSM to the CAS is summarized in Table A.3-1 and discussed below. Table A.3-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure A.3-1 represents site conditions applicable to the CSM.

A.3.2.1 Contaminant Release

The most likely locations of the contamination and releases to the environment are the soil surface and activated debris. Any contaminants migrating from the CAS, regardless of physical or chemical characteristics, are expected to exist at interfaces, and in the soil adjacent to the area of soil-particle activation and fallout deposition in lateral and vertical directions. Contamination is expected to be contiguous to the release points. Concentrations are generally expected to decrease with horizontal and vertical distance from the source. Based on the depth to groundwater, contamination is not considered a likely scenario.

Table A.3-1
Conceptual Site Model
Description of Elements for CAU 370

CAS Identifier	04-23-01
CAS Description	**Atmospheric Test Site T-4**
Site Status	Site is inactive and abandoned
Exposure Scenario	Occasional Use Area
Sources of Potential Soil Contamination	Fallout and soil-particle activation from above ground nuclear testing
Location of Contamination/ Release Point	Interface between contaminated soil/debris and native soil
Amount Released	Unknown
Affected Media	Surface and shallow subsurface soil; debris such as concrete and metal
Potential Contaminants	Gamma and isotopic radionuclides
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside of the footprint of the CAS. Percolation of precipitation through subsurface media serves as a minor driving force for migration of contaminants.
Migration Pathways	Lateral transport expected to dominate over vertical transport due to low infiltration.
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or radiation by radioactive materials.

COC = Contaminant of concern
COPC = Contaminant of potential concern

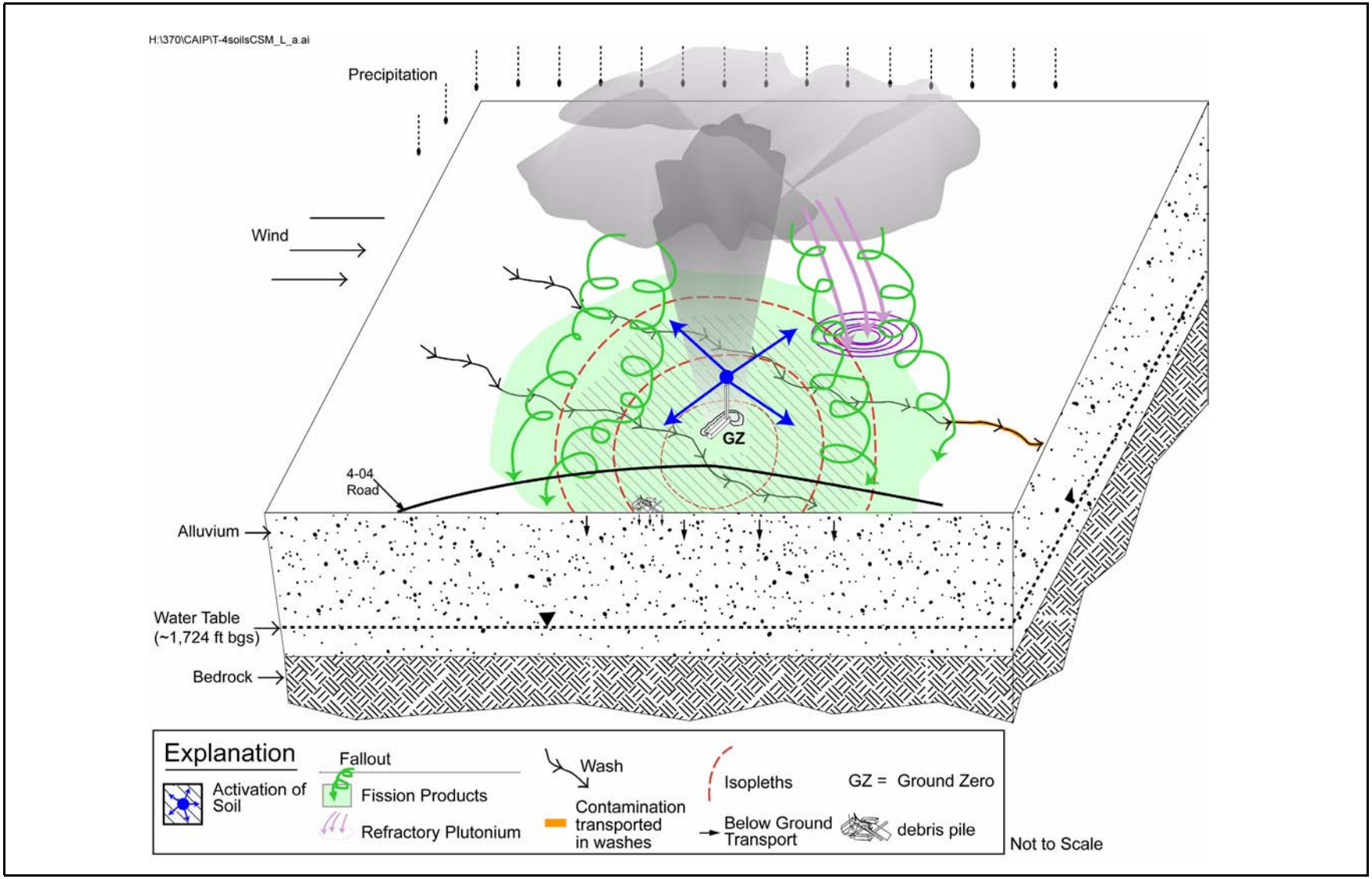

Figure A.3-1
CAU 370 Conceptual Site Model for CAS 04-23-01

A.3.2.2 Potential Contaminants

The COPCs were identified during the planning process through the review of site history, process knowledge, past investigation efforts (where available), and inferred activities associated with the CAS. The list of COPCs is intended to encompass all of the contaminants that could potentially be present at the CAS. The COPCs applicable to Decision I environmental samples from the CAS of CAU 370 are defined as the constituents reported from the following analyses:

- Gamma spectroscopy
- Isotopic U
- Isotopic Pu
- Strontium-90

If a biasing factor is encountered that indicates possible presence of chemical contamination, samples will be submitted for analysis based on the nature of the biasing factor (e.g., lead bricks, stains). These may include the constituent(s) reported from the following analyses:

- Total petroleum hydrocarbons-diesel-range organics
- Total petroleum hydrocarbons-gasoline-range organics
- Polychlorinated biphenyls
- Semivolatile organic compounds
- Volatile organic components
- *Resource Conservation and Recovery Act* metals

A.3.2.3 Contaminant Characteristics

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

A.3.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Physical properties include permeability, porosity, hydraulic conductivity, degree of saturation, sorting, chemical composition, and organic content. Topographical and

meteorological properties and attributes include slope stability, precipitation frequency and amounts, precipitation runoff pathways, drainage channels and ephemeral streams, and evapotranspiration potential.

A.3.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils. Contaminants released into ephemeral washes crossing the area are subject to much higher transport mechanisms than contaminants released to other surface areas. These ephemeral washes are generally dry but are subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identifiable by hydrologists as sedimentation areas.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 Radiological Waste Management Site has been estimated at 62.6 in. [Shott et al., 1997]) and limited precipitation for this region (6.37 in. annually [ARL/SORD, 2007]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

A.3.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or radiation by radioactive materials. The land-use and exposure scenarios for CAS 04-23-01 is listed in Table A.3-2. This is based on NTS current and future land use. Corrective Action Site 04-23-01 is at 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 this location on an occasional and temporary basis, such as a military exercise. Therefore, these sites are classified as occasional work areas.

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

CAS	Record of Decision Land-Use Zone	Exposure Scenario
04-23-01	Nuclear and High Explosives Test This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high-explosive tests. This zone includes compatible defense and nondefense research, development, and testing activities.	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.4.0 Step 2 - Identify the Goal of the Study

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

A.4.1 Decision Statements

The Decision I statement is: "Is any COPC associated with the CAS present in environmental media at a concentration exceeding its corresponding FAL?" To resolve this decision statement for the investigation of annular distribution of contamination:

- For probabilistic sampling, any COPC for which the 95 percent UCL of the mean exceeds its corresponding FAL will be defined as a COC.
- If a COC is detected, then Decision II must be resolved. If a COC is not detected, the investigation for CAU 370 is complete.

The Decision II statements for the investigation of annular distribution is:

- "Is the extent of the area that provides a dose exceeding 25 mrem/yr defined?" Sufficient information to resolve this portion of Decision II includes identifying the volume of media containing a radiological dose above the threshold.

To resolve the Decision I statement for the investigation of other releases:

- For judgmental sampling, any contaminant associated with the CAS that is present at concentrations exceeding its corresponding FAL will be defined as a COC.

The Decision II statement for the investigation of other releases:

- "Is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information to resolve this portion of Decision II include:
  - Identifying the lateral and vertical extent of COC contamination in media
  - The information needed to determine potential remediation waste types

> **Note**: For both judgmental and probabilistic sampling, the radiological FAL is the 25 mrem/yr-combined TEDE from all contributing radionuclides. A COC for chemical contamination may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006).

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 a site to cause the future contamination of site environmental media if the wastes were to be released.

If sufficient information is not available to evaluate potential corrective action alternatives then site conditions will be re-evaluated and additional samples will be collected (as long as the scope of the investigation is not exceeded and any CSM assumption has not been shown to be incorrect).

A.4.2 Alternative Actions to the Decisions

In this section, the actions that may be taken to solve the problem are identified depending on the possible outcomes of the investigation.

A.4.2.1 Alternative Actions to Decision I

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

A.4.2.2 Alternative Actions to Decision II

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

A.5.0 Step 3 - Identify Information Inputs

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

A.5.1 Information Needs

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

To resolve Decision II for the annular distributions of contamination, samples need to be collected and analyzed to meet the following criteria:

- A decreasing trend of TEDE rates from more than 25 mrem/yr to less than 25 mrem/yr in three directions (vectors) needs to be established sufficiently to determine a boundary around the area posing a more than 25-mrem/yr dose.

To resolve Decision II for other releases of contamination, samples need to be collected and analyzed to meet the following criteria:

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

A.5.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples using grab sampling or other appropriate sampling methods. These samples will be

submitted to analytical laboratories meeting the quality criteria stipulated in the QAPP (NNSA/NV, 2002). Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

Information on decreasing TEDE rate trends will be generated by collecting surface soil samples to calculate TEDE rates from plots, as described in Appendix C.

A.5.2.1 Sample Locations

Design of the sampling approaches for CAS 04-23-01 must ensure that the data collected are sufficient for selection of the corrective action alternatives (EPA, 2002). 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 sites that properly represent overall contamination at the CAS. Therefore, these sample locations can be selected by means of either (a) biasing factors used in judgmental sampling or (b) a probabilistic sampling design.

A.5.2.1.1 Investigation of Annular Distributions

An investigation of contamination thought to be initially distributed will be implemented through a combination of judgmental and probabilistic sampling. The establishment of sample plots on sampling vectors will be conducted judgmentally. The selection of sample locations within sample plots will be conducted probabilistically.

Sample plot locations at CAS 04-23-01 will be determined based upon the 1994 flyover radiological survey (Figure A.5-1), along three sampling vectors, outward from GZ, along lines that include at least two RIDP points. At least five sample plots will be established along each sampling vector (Section A.9.0). For each sampling vector, one innermost sample plot will be placed at the RIDP point closest to GZ, based upon the likelihood of the soil containing a COC, within the 25-mrem/yr-dose boundary. The outermost sample plot will be placed beyond the 25-mrem/yr-dose boundary, and the other sample plots will be placed between the innermost and outermost sample plots. Analytical suites will provide results for the radiological COPCs identified in Section A.3.2.2.

The locations for Decision I samples within each sample plot at CAS 04-23-01 were selected using the VSP software program (PNNL, 2005). At each plot, four separate composite samples will be

collected. Each composite sample will consist of soil collected from nine sample locations within the plot. For each composite sample, the first location will be selected randomly by the VSP software program; the remaining eight sample locations will be established by VSP on a random-start, systematic triangular grid (Section A.9.0).

Appendix C briefly reviews the methodology and computational approach for the probabilistic sampling and presents an example of the sample locations calculated by the VSP software program, including the values established as input for selecting random sample locations (PNNL, 2005).

A.5.2.1.2 Investigations of Other Releases

An investigation of contamination from other releases (e.g., Am-241 plumes, chemical contamination, material carried down washes) will be implemented through judgmental sampling.

Biasing factors will be used to select samples to be submitted for laboratory analyses based on existing site information and site conditions discovered during the investigation. The following factors will also be considered in selecting locations for analytical samples at CAU 370:

- Documented process knowledge on source and location of release (e.g., volume of release).
- Pre-selected areas based on process knowledge of the site: Locations for which evidence such as 1994 flyover radiological survey provide a basis upon which sample plots can be designated (e.g., Am-241 plumes) (Figure A.5-2).
- Debris, stains, lead bricks and other visual factors encountered during the CAI that indicate the possible presence of contaminants.
- Washes that transect the site and may carry contamination from the CAS.
- Other biasing factors: Factors not previously defined for the CAI but become evident once the site investigation is under way.

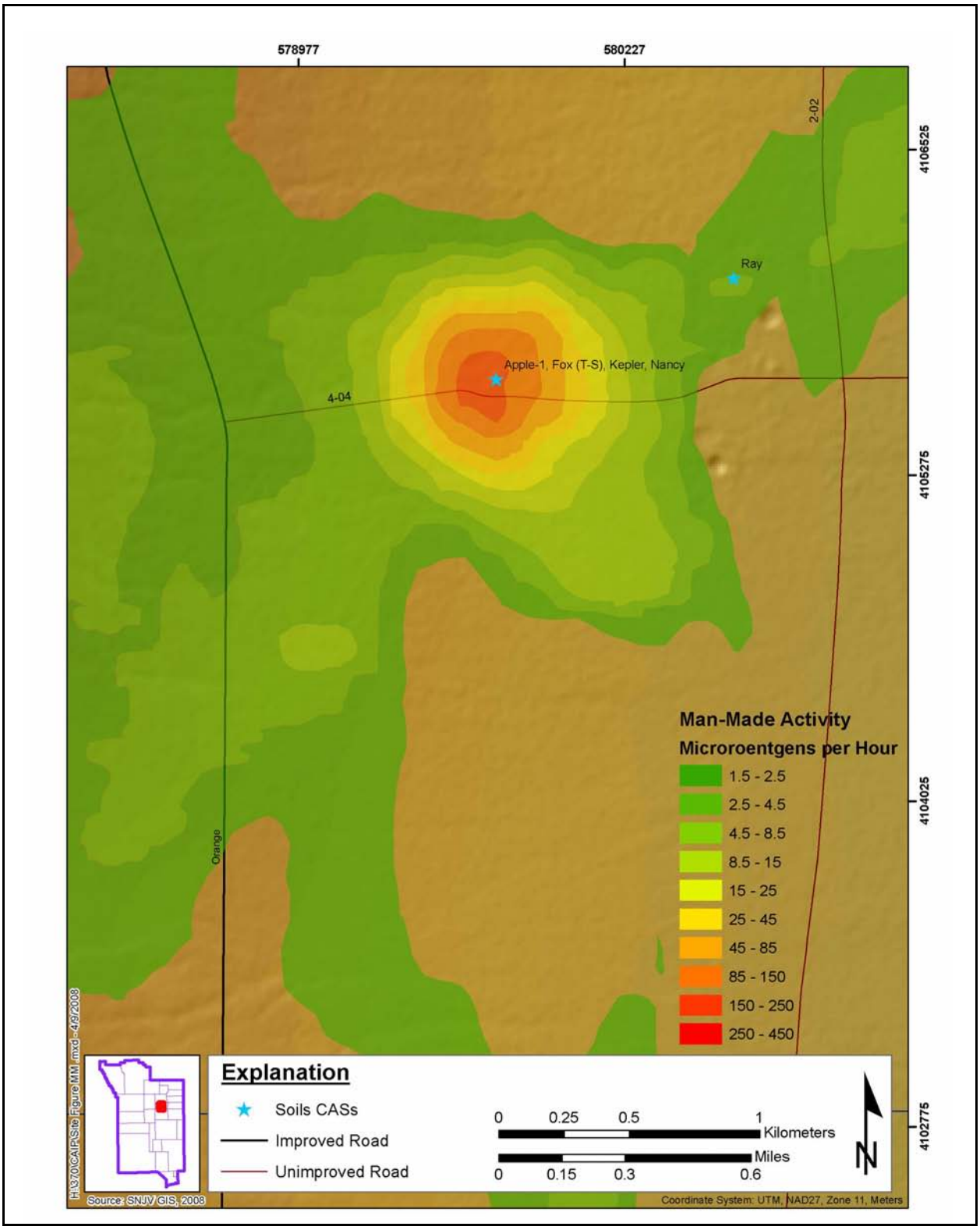

Figure A.5-1
Radiological Isopleths as Determined by the 1994 Flyover Survey

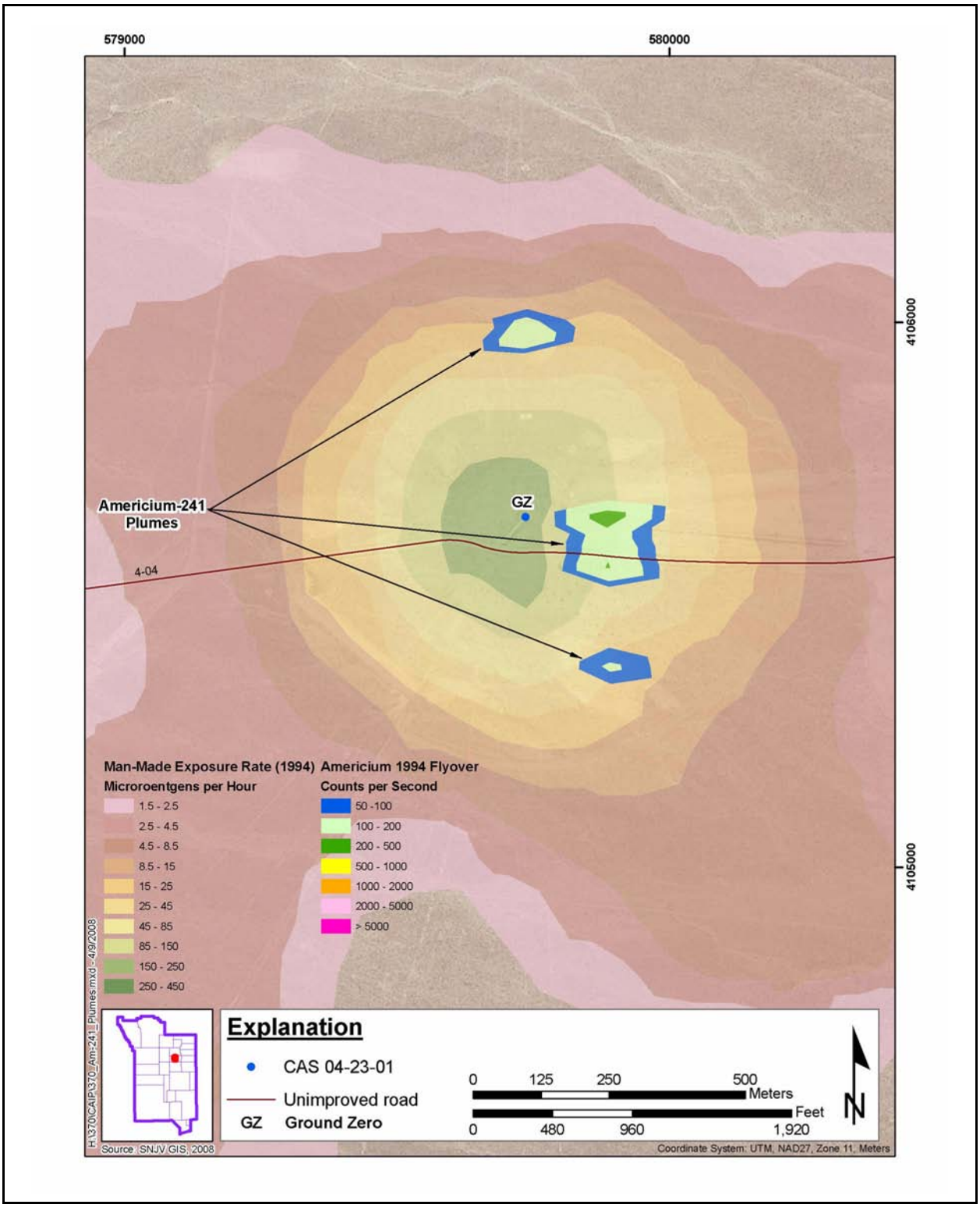

Figure A.5-2
Americium-241 Plumes as Determined by the 1994 Flyover Survey

A.5.2.2 Analytical Methods

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

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

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

A.6.1 Target Populations of Interest

The population of interest to resolve Decision I ("Is any COPC associated with the CAS present in environmental media at a concentration exceeding its corresponding FAL?") is the 95 percent UCL of the average TEDE of each sample plot (annular distribution investigation) or any individual sample (other releases). The populations of interest to resolve Decision II (annular distribution) ("Is the extent of the area that provides a dose exceeding 25 mrem/yr defined?") is the isopleth from the 1994 flyover radiological survey that bounds all locations exceeding a 25-mrem/yr-dose rate.

The populations of interest to resolve Decision II (other releases) ("If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?") are:

- Each one of a set of locations bounding contamination in lateral and vertical directions.
- Potential remediation waste characteristics.

A.6.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination at CAS 04-23-01, established as a 2-mile lateral buffer outward from the CAS boundary (fences) and a 2-ft vertical boundary. Contamination found beyond these boundaries may indicate a flaw in the CSM and may require re-evaluation of the CSM before the investigation could continue. This CAS is considered geographically independent and intrusive activities are not intended to extend into the boundaries of neighboring CASs.

A.6.3 Practical Constraints

The practical constraints associated with the investigation of CAS 04-23-01 are:

- Weather (i.e., high winds, rain, lightning, extreme heat).

- Possible complexity of underground utilities.
- Presence of the use restriction for CAU 357, requiring permission from NDEP before entry and work within this boundary.
- Periodic activation of the nearby BEEF for testing purposes.

A.6.4 Define the Sampling Units

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

A.7.0 Step 5 - Develop the Analytic Approach

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

A.7.1 Population Parameters

For investigation of the annular distributions, the population parameter of the sample results, for both Decision I and Decision II, is the UCL of the average TEDE for each sample plot. The population parameter will be compared to the corresponding FALs to determine the appropriate resolution to Decision I and Decision II.

For investigation of the other releases, the population parameter of the sample results for both Decision I and Decision II is the observed concentration of each contaminant from each individual analytical sample. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II.

A.7.2 Action Levels

The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006b) requires the use of ASTM Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

This RBCA process for chemical contamination defines the following 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. The TPH concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

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

  Note: The radiological FAL is established as the 25-mrem/yr TEDE.

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

A.7.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the EPA *Region 9 Risk-Based Preliminary Remediation Goals (PRGs)* for chemical contaminants in industrial soils (EPA, 2004). Background concentrations for RCRA metals and zinc will be used instead of PRGs when natural background concentrations exceed the PRG, as is often the case with arsenic on the NTS. 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 PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.7.2.2 Total Petroleum Hydrocarbon PALs

The PAL for TPH is 100 ppm as listed in NAC 445A.2272 (NAC, 2006c).

A.7.2.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25-mrem/yr-dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land use scenarios as presented in Section A.3.2.

A.7.3 Decision Rules

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

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

The decision rules for Decision I are:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that release in that population.

- If a waste is present that, if released, has the potential to cause a future release of COCs to environmental media, then a corrective action will be determined, else no further action will be necessary.

The decision rules for Decision II (annular contamination distribution) are:

- If a flyover isopleth exists that bounds all locations exceeding the 25-mrem/yr TEDE, then the isopleth will be established as the boundary for the 25-mrem/yr dose; otherwise, additional sample plots will be established until that boundary is determined.

The decision rules for Decision II (other releases) are:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL in any bounding direction, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

A.8.0 Step 6 - Specify Performance or Acceptance Criteria

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

A.8.1 Decision Hypotheses

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

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

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

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

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

- The development and concurrence of CSMs (based on process knowledge) by stakeholder participants during the DQO process.
- Validity testing of CSMs based on investigation results.
- Evaluation of the data quality based on DQI parameters.

A.8.2 False Negative Decision Error

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

A.8.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 2002). Judgmental sampling conclusions about the target population depend upon the validity and accuracy of professional judgment.

The false negative decision error (where consequences are more severe) for judgmental sampling designs is controlled by meeting these criteria:

- For Decision I, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS. For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- Having a high degree of confidence that the dataset is of sufficient quality and completeness.

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

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

These characteristics were considered during the development of the CSM and selection of sampling locations. The field-screening methods and biasing factors listed in Section A.5.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section A.6.1.

To satisfy the second criterion, Decision I samples will be analyzed for the radiological parameters listed in Section 3.2 of this document, as well as any potential chemical contaminants encountered during the CAI. Decision II samples will be analyzed for those chemical and radiological parameters that identified unbounded COCs. The DQI of sensitivity will be assessed for all analytical results to ensure that all sample analyses had measurement sensitivities (detection limits) that were less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed (for usability and potential impacts on meeting site characterization objectives) in the investigation report.

To satisfy the third criterion, the entire dataset, as well as individual sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the QAPP (NNSA/NV, 2002) and in Section 6.2.2 of this document. 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 constituent performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to standard EPA methods so that results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in Section 6.2.2 of this document.

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the QAPP (NNSA/NV, 2002):

- Field duplicates (minimum of 1 per matrix per 20 environmental samples)
- Laboratory QC samples (minimum of 1 per matrix per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

A.8.2.2 False Negative Decision Error for Probabilistic Sampling

The false negative error rate for CAS 04-23-01 was established by the DQO meeting participants at 0.05 (or 5 percent probability). Upon validation of the analytical results, statistical parameters will be calculated for each COC identified at each site. Maintenance of a false negative error rate of 0.05 is contingent upon:

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

Control of the false negative decision error for probabilistic sampling designs is, therefore, accomplished by ensuring that:

- 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 any COCs present in samples.

If these criteria cannot be met, the false negative decision error can also be controlled by assuming that COCs exist at the CAS.

A.8.3 False Positive Decision Error

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

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

- Trip blanks (1 per sample cooler containing VOC environmental samples)
- Equipment blanks (1 per sampling event for each type of decontamination procedure)
- Source blanks (1 per uncharacterized source lot)
- Field blanks (minimum of 1; additional blanks if field conditions change)

For probabilistic sampling, false positive decision error 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.8.2 for probabilistic sampling designs.

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

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. Judgmental and probabilistic sampling schemes will be implemented to select five sample plot locations along each of three vectors (judgmental), to investigate releases other than those in the annular distribution (judgmental) (Am-241 plumes, chemical contamination, transport in washes), and to select nine sample locations for each of four composite samples per sample plot (probabilistic). Sections A.9.1 through A.9.4 contain general information about collecting samples under judgmental and probabilistic sampling designs, and Decision II sampling.

A.9.1 Sampling of Annular Distributions

A combination of judgmental and probabilistic sampling approaches will be implemented for the investigation of the annular distribution of contamination at CAS 04-23-01.

The judgmental approach includes:

- Establishment of three sample vectors so that at least two RIDP points are covered by sample plots for each vector.
- Establishment of five sample plots along each vector.

A probabilistic sampling scheme will be implemented to select sample locations within each plot, and to evaluate analytical results from the plots. For each sample plot, randomly selected sample locations will be chosen with locations specified by the VSP software (PNNL, 2005) (Appendix C). If a pre-determined location cannot feasibly be sampled (e.g., rock, caliche or buried concrete) the Site Supervisor will establish an alternate sampling location at the nearest place that can be sampled. For the probabilistic sampling approach at each sample plot:

- Four composite samples will be collected from each plot.
- Nine randomly selected locations will be chosen for each composite sample.
- A sample representative of the composited material will be collected and submitted to the laboratory for analysis.

The proposed sampling vectors and sample plots are shown in Figure A.9-1. An example of the four composite samples, and nine locations per sample, at each sample plot is shown in Figure A.9-2.

The four composite samples from each plot (and additional samples as required) will be used to establish a 95 percent UCL estimate of the average TEDE at each plot.

A.9.2 Decision II Sampling of Annular Distribution

To meet the DQI of representativeness for Decision II samples collected, each sample plot must represent the TEDE from each plot. The methods described in Appendix C will assure that the TEDEs estimated from each sample are representative of the true dose at each plot.

A.9.3 Sampling of Other Releases

A judgmental sampling approach will be implemented for the investigation of other releases at CAS 04-23-01.

The investigation of other releases include:

- Areas of preferentially fractionated deposition of fallout, including Am-241 plumes (Figure A.5-2)
- Potential contaminant transport in the downstream direction of washes that transect the site, as well as along dirt roads near the site
- Locations of potential chemical contamination identified during the CAI (i.e., debris, brick, stains, roadway)

For the investigation of fractionated releases, some areas of the site may have received fallout that was preferentially fractionated during subsequent distributions (i.e., one or more radionuclides were not uniformly distributed around GZ in a circular pattern, but instead were preferentially deposited in one compass direction). These deposits will be identified by the flyover radiological surveys, and sampled independent of the investigation of the annular distributions. At these deposition areas, one sample location will be selected within the area identified by walkover surveys as having the highest radiological readings.

For the investigation of transport in washes, overland flow of runoff, especially through the washes transecting the site, may have transported contaminants from the area to settling locations down stream. Several sample locations will be established in each wash. Additionally, sample locations will be selected along nearby roads. These areas will be identified by walkover radiological surveys.

Finally, for the investigation of potential chemical contamination, biased samples will be collected based on biasing factors identified at the site such as lead bricks and stains that are identified during the CAI.

A.9.4 Decision II Sampling of Other Releases

To meet the DQI of representativeness for Decision II samples collected from other releases (that Decision II sample locations represent the population of interest as defined in Section A.6.1), judgmental sampling locations at each CAS will be selected based on the outer boundary sample locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in Section A.5.2. In general, sample locations will be arranged in a triangular pattern around the Decision I location or area at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The number, location, and spacing of step-outs may be modified by the Site Supervisor, as warranted by site conditions, but only if the modified locations meet the decision needs and criteria stipulated in this DQO.

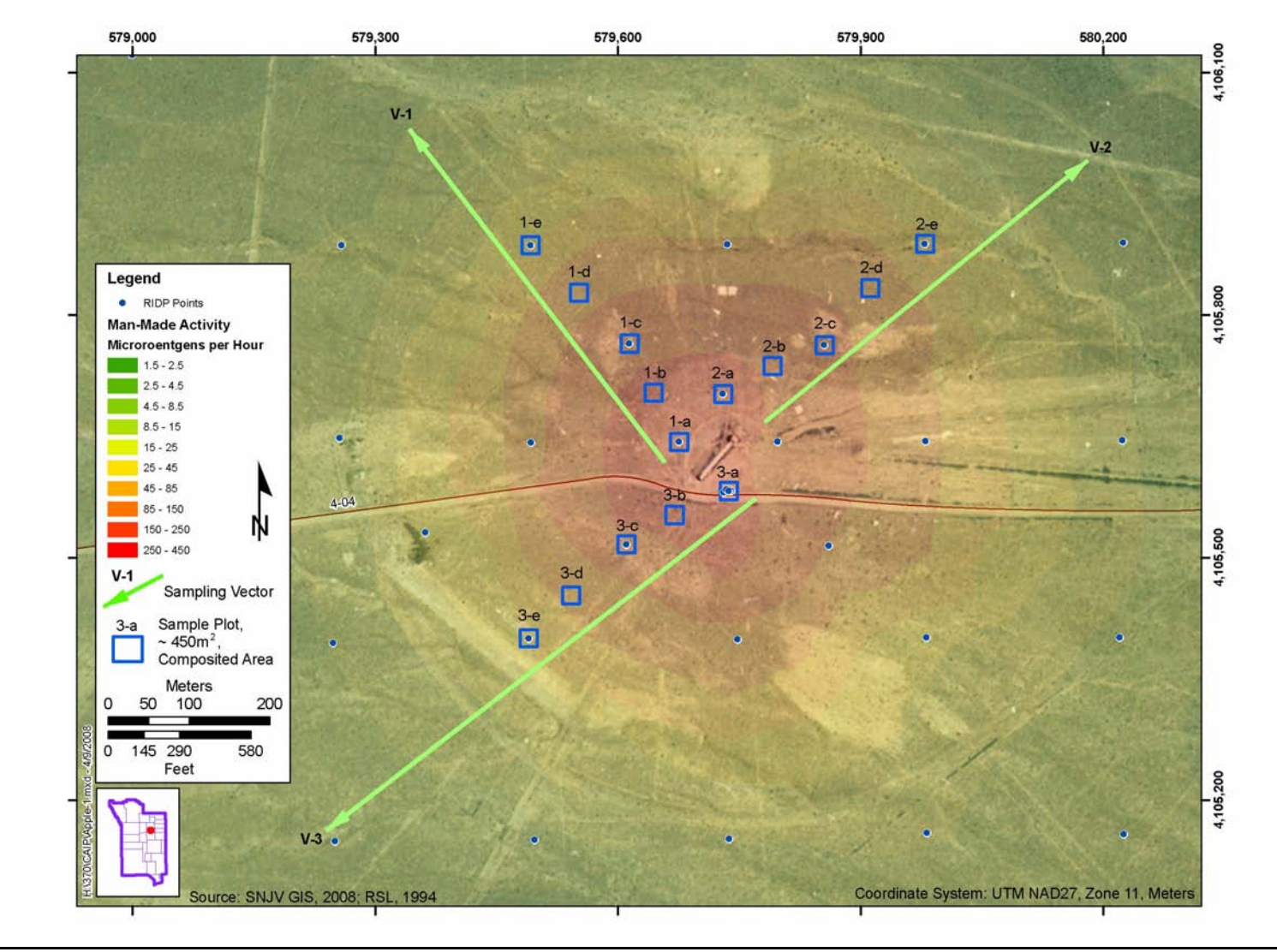

Figure A.9-1
Proposed Sample Locations at CAS 04-23-01

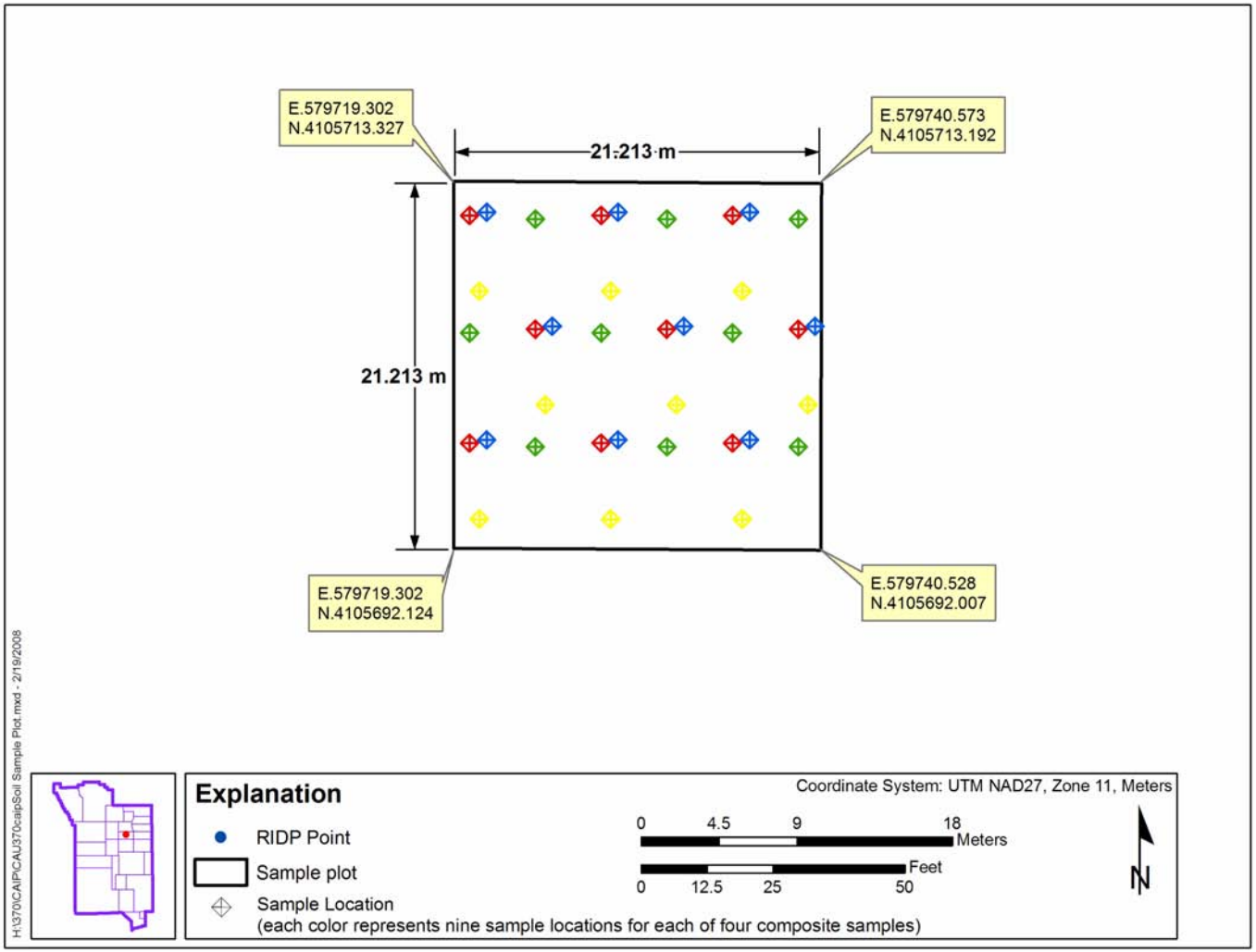

Figure A.9-2
Proposed Composite Sampling at Sample Plots, with Nine Locations per Composite, CAS 04-23-01

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Appendix B

Project Organization

B.1.0 Project Organization

The NNSA/NSO Federal Sub-Project Director is John Jones. He can be contacted at (702) 295-0532.

The identification of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change and it is suggested that the DOE Federal Sub-Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report before the start of field activities.

Appendix C

Probabilistic Sampling Plan

C.1.0 Purpose

This appendix describes the probabilistic sampling plan used to generate information needed to resolve the two DQO decisions for the investigation of annular distributions. For both Decision I and Decision II, information is needed on the TEDE at each plot (i.e., the sample TEDE from all contributing radionuclides present within the sample plot). For Decision II, information is also needed for identifying the location along each vector that corresponds to a 25-mrem/yr dose.

C.2.0 Computation of Total Effective Dose Equivalent

Determination of the radiological dose (i.e., TEDE) at each sample plot requires evaluating, with a specified degree of confidence, whether the true TEDE for the sample plot exceeds the 25 mrem/yr FAL. The TEDE calculated from the results of composited samples at each plot (i.e., the average TEDE, comprised of TEDEs calculated from individual, composited-samples) is an estimation of the true TEDE at the plot location. The average TEDE calculated from sample results is only an estimate of the true (unknown) TEDE. It is uncertain how well the average TEDE actually represents the true TEDE. If an average TEDE was directly compared to the FAL, any significant difference between the true TEDE and the sample TEDE could lead to decision errors. To reduce the probability of making a false negative decision error (thus increasing the probability of making a false positive decision error), a conservative estimate of the true TEDE is used to compare to the FAL. This conservative estimate (overestimation) of the true TEDE will be calculated as the 95 percent UCLs of the average TEDE calculated from the respective individual TEDEs associated with each composite sample. By definition, there will be a 95 percent probability that the true TEDE is less than the 95 percent UCL of the calculated average TEDE.

C.2.1 Computation of the Upper Confidence Limit

The computation of appropriate UCLs depends upon the data distribution, number of samples, variability of the dataset, and skewness associated with the dataset. The ProUCL statistical package will be used to:

- Determine the appropriate probability distribution (e.g., normal, log normal, gamma) and/or a suitable nonparametric distribution-free method.
- Test for outliers.
- Compute appropriate UCLs.

To ensure that the appropriate UCL computational method is used, the sample data will be tested for goodness-of-fit to all of the parametric and nonparametric UCL computation methods described in Office of Solid Waste and Emergency Response EPA guidance (OSWER, 2002).

A UCL of the average TEDE will be calculated for each plot. Computation of an appropriate UCL for the TEDE requires that:

- A minimum number of samples be collected from random locations at each site.
- The data originate from a population that fits a modeled distribution.
- The estimation of the variability is reasonable and representative of the population being sampled.
- The population values are not temporally or spatially correlated.

C.2.1.1 Sample Size

A minimum number of samples (i.e., composite samples) is required to compute a UCL. This number will be calculated from the individual TEDEs associated with each of the four composite samples from each plot. The VSP software will be used to calculate minimum sample sizes (PNNL, 2005). This software was developed by Pacific Northwest National Laboratory for the DOE and the EPA to determine the minimum number of samples needed to characterize a site based on the type of test to be performed, the distribution of the data, the variability of the data, and the acceptable false positive and false negative error rates.

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

- A confidence level that a false negative error will not occur will be set at 95 percent.
- A confidence level that a false positive error will not occur will be set at 80 percent.
- A gray region width of 50 percent of the FAL (25 mrem/yr).
- The average TEDE at each plot.
- The standard deviation of the TEDEs at each plot.

Because the minimum number of composite samples needed to perform the UCL comparison tests cannot be determined until after investigation results are obtained, the number of composite samples to be collected during the CAI must be estimated. The initial number of composite samples was estimated to be four from each plot.

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

- Additional samples may be collected.
- It may be conservatively assumed that the average TEDE for the plot exceeds the FAL.
- Justification for use of the resulting average TEDE without meeting the criteria will be made in the investigation report.

C.2.1.2 Sample Location Selection

The location of initial CAI samples which comprise each composite sample will be determined using the VSP software. The software was constrained to nine sample locations on a random-start, systematic, triangular grid pattern with a random starting location. If it is determined that additional composite samples need to be collected, based on the determination of minimum sample size using actual composite sample results, additional sample locations will be determined using the same methodology.

Values/settings used in VSP for the computation of the composite sample locations for each of the 15 sample plots (i.e., 5 plots on 3 vectors) are listed in Table C.1-1. An example of four sets (nine locations per set/composite) of sample location coordinates are listed in Table C.1-2.

Table C.1-1
VSP Placement of Random Composite Sample Locations

Primary objective of design	Nonstatistical
Type of sampling design	Ordinary - predetermined number of samples
Sample placement (location) in the field	Systematic with a random start location
Estimated initial number of samples	9
Size of sample plot	450 square meters
Grid pattern	Triangular

Table C.1-2
Example of Calculated Field Sampling Location Coordinates, CAS 04-23-01, Plot 2a
(Page 1 of 2)

Sample Location	Easting[a]	Northing[a]
Composite Sample 370-2a-C01		
370-2a-001	579,720	4,105,711
370-2a-002	579,728	4,105,711
370-2a-003	579,735	4,105,711
370-2a-004	579,724	4,105,705
370-2a-005	579,732	4,105,705
370-2a-006	579,739	4,105,705
370-2a-007	579,720	4,105,698
370-2a-008	579,728	4,105,698
370-2a-009	579,735	4,105,698
Composite Sample 370-2a-C02		
370-2a-010	579,721	4,105,712
370-2a-011	579,729	4,105,712
370-2a-012	579,736	4,105,712
370-2a-013	579,725	4,105,705
370-2a-014	579,733	4,105,705
370-2a-015	579,740	4,105,705
370-2a-016	579,721	4,105,698
370-2a-017	579,729	4,105,698
370-2a-018	579,736	4,105,698
Composite Sample 370-2a-C03		
370-2a-019	579,724	4,105,711
370-2a-020	579,732	4,105,711
370-2a-021	579,739	4,105,711
370-2a-022	579,720	4,105,705
370-2a-023	579,728	4,105,705
370-2a-024	579,735	4,105,705
370-2a-025	579,724	4,105,698
370-2a-026	579,732	4,105,698
370-2a-027	579,739	4,105,698
Composite Sample 370-2a-C04		
370-2a-028	579,721	4,105,707
370-2a-029	579,728	4,105,707
370-2a-030	579,736	4,105,707
370-2a-031	579,725	4,105,700

Table C.1-2
Example of Calculated Field Sampling Location Coordinates, CAS 04-23-01, Plot 2a
(Page 2 of 2)

Sample Location	Easting[a]	Northing[a]
370-2a-032	579,732	4,105,700
370-2a-033	579,740	4,105,700
370-2a-034	579,721	4,105,694
370-2a-035	579,728	4,105,694
370-2a-036	579,736	4,105,694

[a]Coordinates calculated by Visual Sample Plan software (PNNL, 2005).

C.3.0 Computation of the Area Exceeding the FAL

The area exceeding the FAL will be calculated using the average TEDEs from each plot along each vector. A trend of the average TEDEs along each vector will determine a point along each vector that is beyond all average TEDEs that exceed the FAL activity. This will be established based on a regression of the average TEDEs with distance along each vector (Figure C.2-1). The minimum number of composite samples needed to calculate the regression will be calculated as described in Section C.2.0 and compared to the total number of composite samples used to calculate the regression.

An isopleth from the 1994 flyover radiological survey (BN/RSL, 1999) will be chosen conservatively to bound the area of the CAS that exceeds a 25-mrem/yr-dose rate based on the following criteria:

- The area encompasses all plots that exceed a 25-mrem/yr-average TEDE.
- The area encompasses the estimated points along each vector that correspond to a 25-mrem/yr-average TEDE.

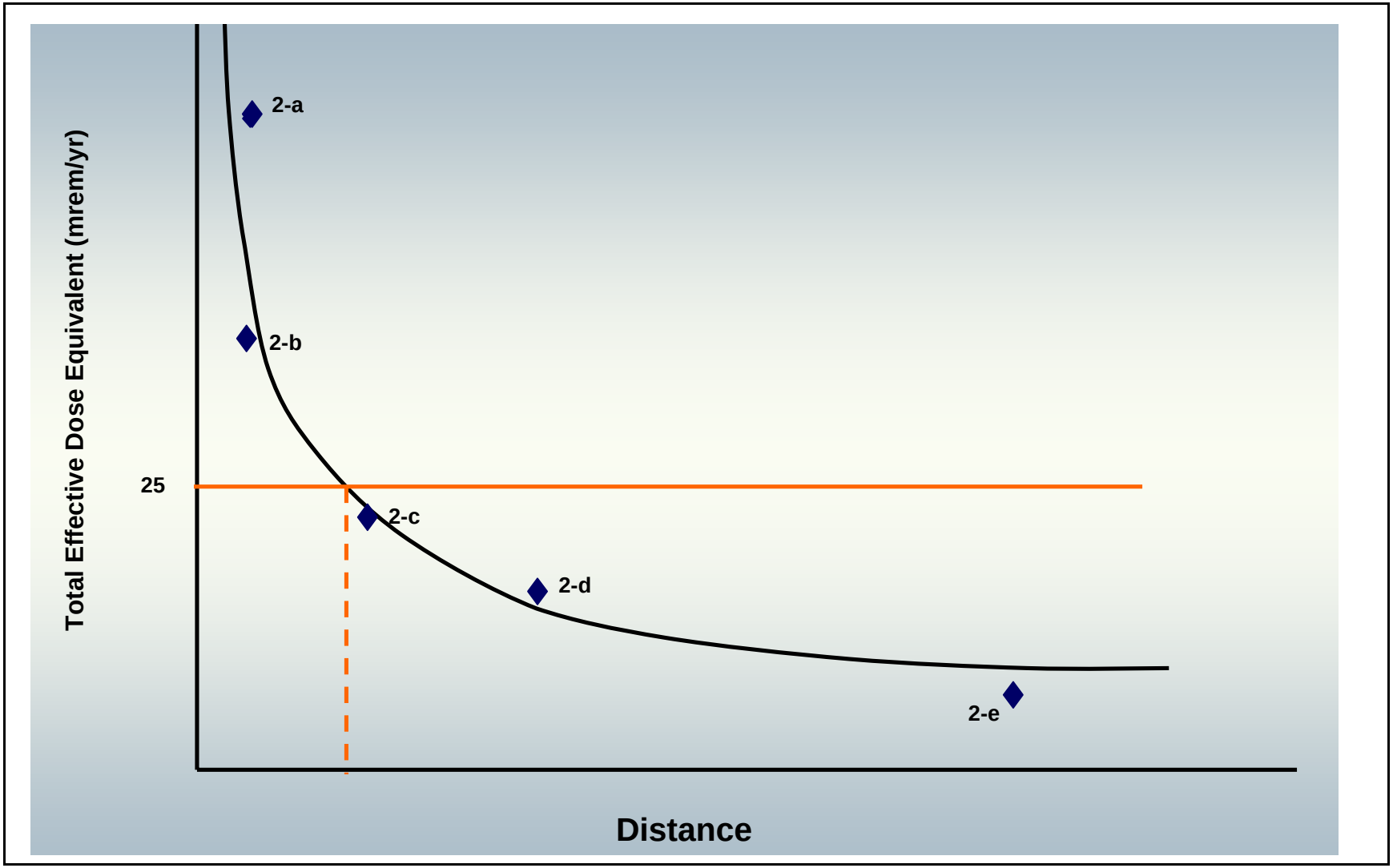

Figure C.2-1
Example of Sample TEDEs for Each Plot (e.g., 2-a)
and the Regression Line for Sample Vector 2

C.4.0 References

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Appendix D

Nevada Division of Environmental Protection Comment Responses

(1 Page)

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Investigation Plan for Corrective Action Unit 370: T-4 Atmospheric Test Site, Nevada Test Site, Nevada	**2. Document Date:** 02/20/2008
3. Revision Number: 0	**4. Originator/Organization:** Stoller-Navarro
5. Responsible NNSA/NV ERP Project Manager: John B. Jones	**6. Date Comments Due:** 03/21/2008
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No: Jeff MacDougall, NDEP, 486-2850	**9. Reviewer's Signature:**

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Page 1 of 53, 2nd Paragraph	Mandatory	The revision date for the FFACO is listed as 2007, which may not be the most recent date. Please verify and correct if necessary.	The date has been corrected to February 2008.	

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