

Nevada
Environmental
Restoration
Project

DOE/NV--1266



Corrective Action Decision Document/ Closure Report for Corrective Action Unit 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials Nevada Test Site, Nevada

Controlled Copy No.:
Revision No.: 0

April 2008

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U.S. Department of Energy
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**CORRECTIVE ACTION DECISION DOCUMENT/
CLOSURE REPORT
FOR CORRECTIVE ACTION UNIT 545:
DUMPS, WASTE DISPOSAL SITES, AND BURIED
RADIOACTIVE MATERIALS
NEVADA TEST SITE, NEVADA**

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

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FOR
CORRECTIVE ACTION UNIT 545:
DUMPS, WASTE DISPOSAL SITES, AND BURIED RADIOACTIVE MATERIALS
NEVADA TEST SITE, NEVADA**

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List of Acronyms and Abbreviations

Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAS	Chemical Abstracts Service
CAU	Corrective Action Unit
CLP	Contract Laboratory Program
cm	Centimeter
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
CR	Closure Report
Cs	Cesium
CSM	Conceptual site model
CZ	Contamination zone
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
Eu	Europium

List of Acronyms and Abbreviations (Continued)

FAL	Final action level
FD	Field duplicate
FFACO	<i>Federal Facility Agreement and Consent Order</i>
FID	Flame-ionization detector
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
g/m ³	Grams per cubic meter
g/yr	Grams per year
GPS	Global positioning system
GRO	Gasoline-range organics
HWAA	Hazardous waste accumulation area
ID	Identification
IDW	Investigation-derived waste
in.	Inch
LCS	Laboratory control sample
m	Meter
m/sec	Meters per second
m ²	Square meter
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mi	Mile
mrem	Millirem
mrem/yr	Millirem per year
MS	Matrix spike

List of Acronyms and Abbreviations (Continued)

MSD	Matrix spike duplicate
N/A	Not applicable
NAC	<i>Nevada Administrative Code</i>
NAD	North American Datum
ND	Nondetect
NDEP	Nevada Division of Environmental Protection
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
Pa	Protactinium
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
POC	Performance objective criteria
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary Remediation Goal
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
Ra	Radium
RadCon	Radiological Control
RBCA	Risk-based corrective action

List of Acronyms and Abbreviations (Continued)

RBSL	Risk-based screening level
RCRA	<i>Resource Conservation and Recovery Act</i>
RESRAD	Residual Radioactive
RMA	Radioactive material area
RPD	Relative percent difference
RWMS	Radioactive Waste Management Site
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
Th	Thorium
TPH	Total petroleum hydrocarbons
U	Uranium
UCL	Upper confidence level
UR	Use restriction
UTM	Universal Transverse Mercator
UXO	Unexploded ordnance
VOC	Volatile organic compound
VSP	Visual Sample Plan
yr	Year
%R	Percent recovery
µg/kg	Micrograms per kilogram

Executive Summary

This Corrective Action Decision Document (CADD)/Closure Report (CR) has been prepared for Corrective Action Unit (CAU) 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials, in Areas 2, 3, 9, and 20 of the Nevada Test Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* 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 (1996, as amended February 2008). Corrective Action Unit 545 is comprised of the following eight Corrective Action Sites (CASs):

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

While all eight CASs are addressed in this CADD/CR, sufficient information was available for the following three CASs; therefore, a field investigation was not conducted at these sites:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the data quality objective (DQO) meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a use restriction is recommended. Sampling in the craters was not considered necessary.
- For CAS 03-23-02, there were no potential releases of hazardous or radioactive contaminants identified. Therefore, the Corrective Action Investigation Plan for CAU 545 concluded that: "Sufficient information exists to conclude that this CAS does not exist as originally identified. Therefore, there is no environmental concern associated with CAS 03-23-02." This CAS is closed with no further action.
- For CAS 03-23-05, existing information about the two buried sources and lead pig was considered to be sufficient, and safety concerns existed about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site was not considered necessary.

The purpose of this CADD/CR is to provide justification and documentation to support the recommendation for closure of CAU 545 with no further corrective action. To achieve this, corrective action investigation (CAI) activities were performed from August 20 through November 02, 2007, as set forth in the CAU 545 Corrective Action Investigation Plan. The purpose of the CAI was to fulfill the following data needs as defined during the DQO process:

- Determine whether contaminants of concern (COCs) are present.
- If COCs are present, determine their nature and extent.
- Provide sufficient information and data to complete appropriate corrective actions.

The CAU 545 dataset from the investigation results was evaluated based on the data quality indicator parameters. This evaluation demonstrated the quality and acceptability of the dataset for use in fulfilling the DQO data needs.

Analytes detected during the CAI were evaluated against final action levels established in this CADD/CR. The results of the CAI identified no COCs at the five CASs investigated in CAU 545.

As a best management practice, repair of the fence enclosing CAS 03-08-03 has been completed.

Therefore, the DOE, National Nuclear Security Administration Nevada Site Office provides the following recommendations:

- Close in place COCs at CASs 03-08-03 and 03-23-05 with use restrictions.
- No further corrective action for CAU 545.
- No Corrective Action Plan.
- Corrective Action Unit 545 should be moved from Appendix III to Appendix IV of the *Federal Facility Agreement and Consent Order*.
- A Notice of Completion to the DOE, National Nuclear Security Administration Nevada Site Office is requested from the Nevada Division of Environmental Protection for closure of CAU 545.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Closure Report (CR) presents information to support closure of Corrective Action Unit (CAU) 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials, Nevada Test Site (NTS), Nevada. The corrective actions described in this document are 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). The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1).

Corrective Action Unit 545 is comprised of the eight Corrective Action Sites (CASs) that are shown on Figure 1-2 and listed below:

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan for Corrective Action Unit 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials* (NNSA/NSO, 2007). This document provides or references the specific information necessary to support closure of this CAU.

1.1 Purpose

This CADD/CR provides justification why no further corrective action is necessary, how and why use restrictions (URs) will be applied, and the technical rationale for implemented closure activities. This justification is based on the corrective actions implemented and the results of investigative activities that were conducted in accordance with the CAU 545 Corrective Action Investigation Plan (CAIP) (NNSA/NSO, 2007).

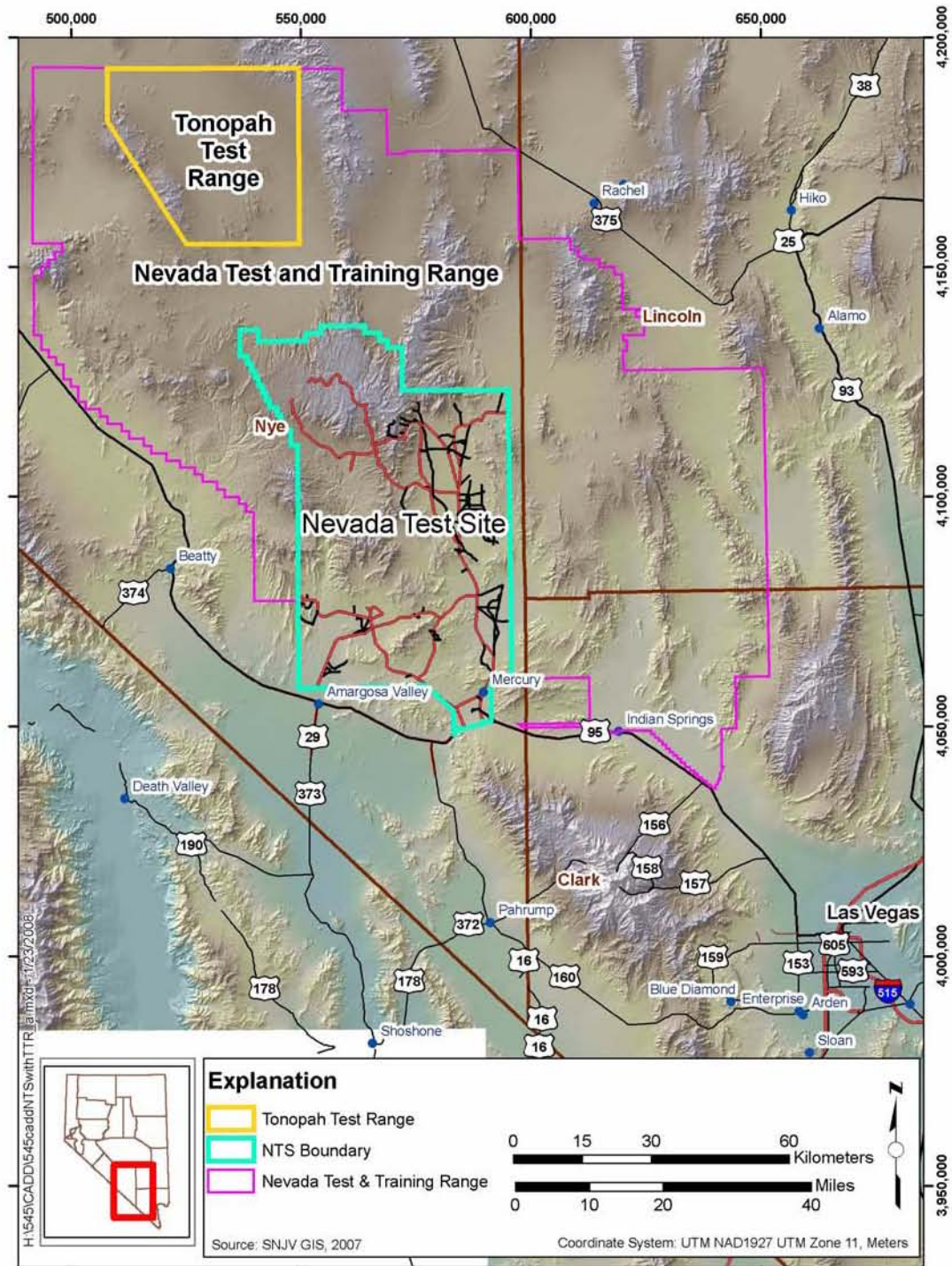


Figure 1-1
Nevada Test Site

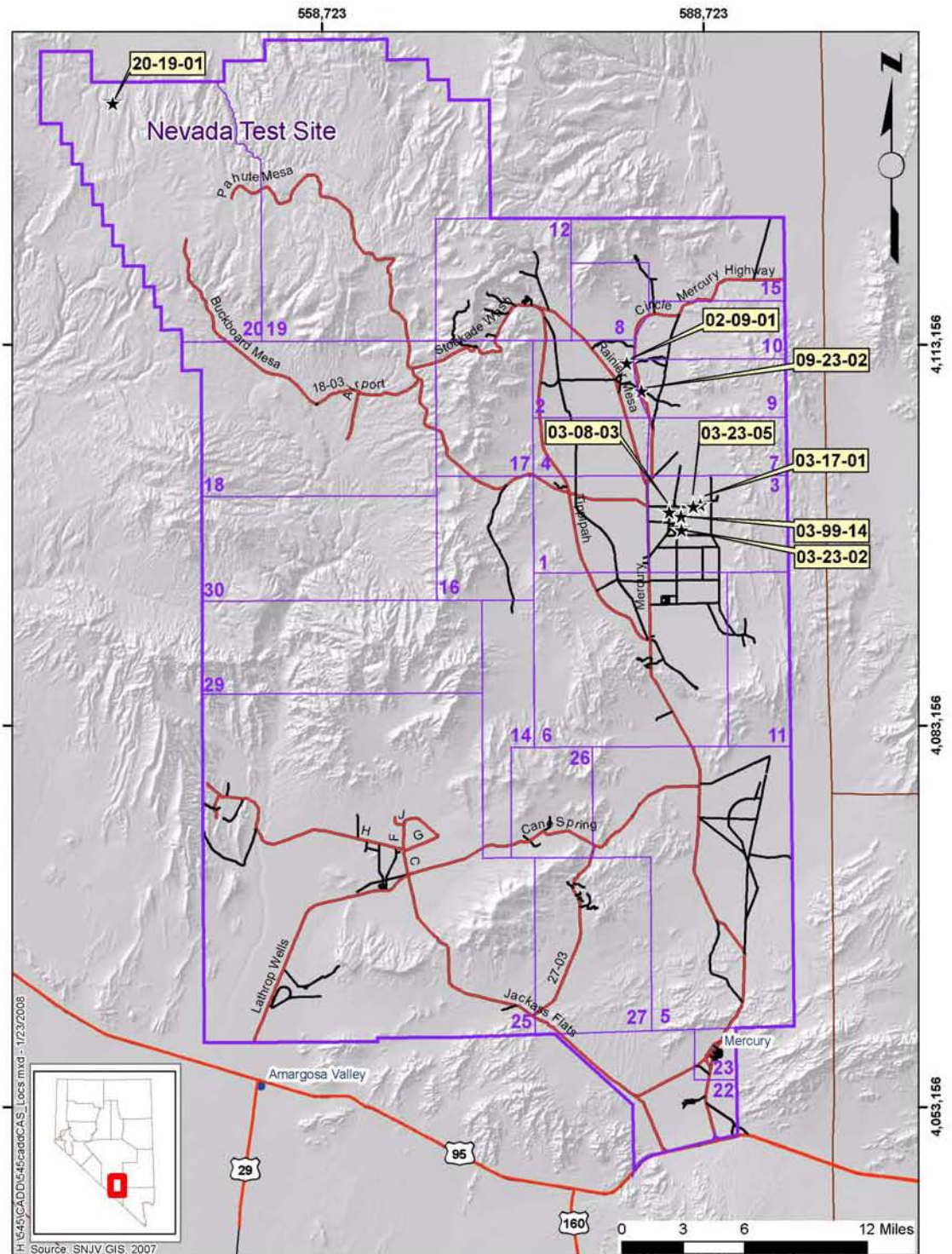


Figure 1-2
Corrective Action Unit 545, CAS Location Map

Corrective Action Unit 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials, consists of eight inactive sites located in the northeastern portion of Area 2, in the west-central portion of Area 3, on the western side of Area 9, and in the northwestern portion of Area 20. The eight CASs at CAU 545 consist of craters used for mud disposal, surface or buried waste disposed within craters or potential crater areas, and sites where surface or buried waste was disposed. The CAU 545 sites were used to support nuclear testing conducted from the 1950s through the early 1990s.

Corrective Action Sites 02-09-01, 03-08-03, and 09-23-02 consist of crater components that were used for the disposal of drilling mud. Records for disposal activities exist for CASs 03-08-03 and 09-23-02, but no records for disposal at CAS 02-09-01 were identified. Disposal of drilling mud at CAS 02-09-01 was along the west, south and east sides of the U-2ei crater, and extends outward approximately 250 ft. Disposal of radioactively contaminated drilling mud at CAS 03-08-03 occurred at a ramp into the craters located at the north end of the U-3ai and U-3be double crater. Records indicate radioactively contaminated drilling mud was disposed at CAS 03-08-03. Disposal of drilling mud at CAS 09-23-02 occurred at the U-9y crater bottom. Mud disposal records for CAS 09-23-02 do not indicate the contamination status of the drilling mud; however, the overflow from the crater into a wash located immediately east of the crater was documented.

Corrective Action Sites 03-17-01, 03-23-05, and 20-19-01 were used for the storage and/or disposal of materials used in the testing program at NTS. Corrective Action Site 03-17-01 was used to store debris and soil that originated from aboveground testing sites, as well as a consolidation location for debris originating from other testing and disposal sites. Corrective Action Site 03-23-05 was used in the burial of two radioactive sources; one encapsulated in a lead pig buried in the northwest component of the site, and the other source, along with the contaminated third floor of a tower used at the site during the underground testing, buried within the uncollapsed U-3ee crater. Corrective Action Site 20-19-01 consists of construction debris (e.g., wood, plastic, metal), as well as used oil filters from activities related to the underground testing at the U-20p test hole.

For CASs 03-23-02 and 03-99-14, documentation for the storage or disposal of materials was not identified for either site. Corrective Action Site 03-23-02 consists of the uncollapsed crater at the U-3gi test hole. Corrective Action Site 03-99-14 consists of an approximately 300-ft-long trench and

berm; the purpose is unknown. Corrective Action Site 03-99-14, along with the surrounding area, is posted as a “Radioactive Material Area,” due to nearby aboveground nuclear testing associated with several tests. The area encompassing the radioactive material area (RMA) will be investigated by the Soils Project for CAU 104.

1.2 Scope

The scope of this CADD/CR is to justify that no further corrective action is required at CAU 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials. The activities conducted to accomplish this scope included the following:

- Removal of surface debris and/or materials to facilitate sampling
- Radiological surveys
- Field screening
- Collection of environmental samples for laboratory analysis
- Collection of step-out samples to define the lateral and vertical extent of the contamination
- Collection of waste samples to determine the proper disposal of wastes
- Collection of quality control (QC) samples

Although the following CASs were not included in the scope of the field sampling activities for CAU 545, they are included in the scope of the CADD/CR:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the data quality objective (DQO) meeting participants agreed that sufficient information existed about the disposal and releases and that a corrective action of close in place with a UR is recommended. Sampling in the craters was not considered necessary.
- For CAS 03-23-02, there were no potential releases of hazardous or radioactive contaminants identified. Therefore, the CAIP for CAU 545 concluded: “Sufficient information exists to conclude that this CAS does not exist as originally identified. Therefore, there is no environmental concern associated with CAS 03-23-02.” This CAS is closed with no further action.
- For CAS 03-23-05, existing information about the two buried sources and lead pig was considered to be sufficient, and safety concerns existed about the stability of the crater component. Therefore, a corrective action of close in place with a UR is recommended, and sampling at the site was not considered necessary.

1.3 Corrective Action Decision Document/Closure Report Contents

This CADD/CR is divided into the following sections and appendices:

Section 1.0 – Introduction: Summarizes the purpose, scope, and contents of this CADD/CR.

Section 2.0 – Corrective Action Investigation (CAI) Summary: Summarizes the investigation field activities, the results of the investigation, the need for corrective action, and a summary of the results of the data quality objective (DQO) assessment.

Section 3.0 – Recommendation: States why no further corrective action is required.

Section 4.0 – References: Provides a list of the referenced documents used in the preparation of this CADD/CR.

Appendix A – *Corrective Action Investigation Results*: Provides a description of the project objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA). **Sections A.3.0** through **A.7.0** provide specific information regarding field activities, sampling methods, and laboratory analytical results from the investigation.

Appendix B – *Data Assessment*: Provides a data quality assessment (DQA) that reconciles DQO assumptions and requirements to the investigation results.

Appendix C – *Risk Assessment*: Presents an evaluation of risk associated with the establishment of final action levels (FALs).

Appendix D – *Closure Activity Summary*: Provides details on the completed closure activities and includes the required verification activities and supporting documentation.

Appendix E – *Sample Location Coordinates*: Provides the geophysical coordinates of the locations sampled.

Appendix F – *Nevada Division of Environmental Protection (NDEP) Comments*: Contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

All investigation activities were performed in accordance with the following documents:

- The CAIP for CAU 545 (NNSA/NSO, 2007)
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002)
- FFACO (1996, as amended February 2008)
- Approved procedures

1.3.2 Data Quality Assessment Summary

The DQA is presented in [Appendix B](#) and includes an evaluation of the DQIs to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA process as presented in [Appendix B](#) is comprised of the following steps:

- Step 1: Review DQOs and Sampling Design
- Step 2: Conduct a Preliminary Data Review
- Step 3: Select the Test
- Step 4: Verify the Assumptions
- Step 5: Draw Conclusions from the Data

Sample locations that support the presence and/or extent of contamination at each CAS are shown in [Appendix B](#). Based on the results of the DQA presented in [Appendix B](#), the nature and extent of COCs at CAU 545 have been defined adequately to support decisions on corrective actions. The DQA also determined that information generated during the investigation support the conceptual site model (CSM) assumptions and the data collected met the DQOs and support their intended use in the decision-making process.

2.0 Corrective Action Investigation Summary

The following sections summarize the investigation activities, investigation results, and justify why no further corrective action is needed at CAU 545. Detailed investigation activities and results for individual CAU 545 CASs are presented in [Appendix A](#).

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAIP for CAU 545 (NNSA/NSO, 2007) from August 20 through November 2, 2007, at the five CASs that were identified during the DQO process for sampling and further evaluation. The purpose of the CAU 545 CAI was to address the decision statements in the project-specific DQOs by:

- Determining whether contaminants of concern (COCs) are present in the soils associated with CASs 02-09-01, 03-17-01, 03-99-14, 09-23-02, and 20-19-01 in CAU 545.
- Determining the lateral and vertical extent of identified COCs.
- Ensuring adequate data have been collected to close the sites under NDEP, *Resource Conservation and Recovery Act (RCRA)* (CFR, 2006a), *Toxic Substance Control Act* (CFR, 2006b), and DOE requirements.

The scope of the CAI included the following activities:

- Performing radiological surveys (i.e., static, scanning, and swipe collection).
- Field screening soil samples for total alpha and beta/gamma radiation.
- Collecting environmental samples for laboratory analyses to determine the presence of COCs and to define the vertical and lateral extent of COCs, if present.
- Collecting QC samples for laboratory analyses to ensure that the data generated from the analysis of investigation samples meet the requirements of the DQIs.

A combination of judgmental and probabilistic sampling schemes were implemented to select sample locations and evaluate analytical results, as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007). Judgmental sampling allows the methodical selection of sample locations that target the populations of interest (defined in the DQOs) rather than nonselective random locations. Probabilistic sampling

uses random sample locations in the absence of adequate biasing factors to define site-wide contamination characteristics (e.g., average concentrations).

For the judgmental sampling scheme, individual sample results (rather than average concentrations) are used to compare to FALs. Therefore, statistical methods to generate site characteristics (averages) are not necessary (EPA, 2006). If good prior information is available on the target site of interest, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site does not contain unsafe levels of the contaminant without the samples being truly representative of the entire area.

The judgmental sampling design was used to confirm the existence of contamination at specific locations and provide information (such as extent of contamination) about specific areas of the site.

Confidence in judgmental sampling scheme decisions was established qualitatively by validation of the CSM and justification that sampling locations are the most likely locations to contain a COC, if a COC exists.

For the probabilistic sampling scheme, the average contaminant concentrations at the site in question were used to compare to FALs. The averages from sample analytical results for each constituent are an estimate of the true average contaminant concentrations. Because the average contaminant concentrations from samples is only an estimate of the true (unknown) average, it is uncertain how well the sample averages represent the actual averages. To reduce the probability of making a false negative decision error, the 95th percent upper confidence levels (UCLs) of the respective sample contaminant concentration averages were used to compare to FALs. Therefore, by definition, there is a 95 percent probability that the true average concentration is less than the 95th percent UCL of the sample average.

Confidence in probabilistic sampling scheme decisions was established by the validation of the CSM, justification that sampling locations are representative of site conditions, demonstration that a sufficient number of samples were collected, and contaminant distribution assumptions are valid and appropriate to the statistical test being performed.

Waste characterization activities were conducted to gather sufficient information and data to support waste disposal decisions. Information regarding waste characterization is presented in [Appendix A](#).

The following sections describe specific investigation activities conducted at each CAS. Additional information and details regarding the investigation is presented in [Appendix A](#).

2.1.1 Mud Disposal Area (CAS 02-09-01)

The following subsections summarize the activities conducted at CAS 02-09-01.

2.1.1.1 Radiological Survey

Radiological walkover surveys were conducted over the mud spill areas inside and outside the fence, up to 50 ft from the crater rim, at CAS 02-09-01. The survey did not identify elevated radioactivity on the mud-impacted area ([Figure A.3-2](#)); therefore, the radiological survey was not used in the selection of sample locations.

2.1.1.2 Visual Inspection

A visual inspection of the site did not identify any unusual staining or the presence of potentially containing hazardous or radiological materials (e.g., lead bricks, lead batteries, drums or other containers). The mounds of drilling mud ([Figure A.3-1](#)) and two sediment accumulation areas in the east disposal area were the only biasing factors. Because these were features identified for sample collection in the CAIP for CAU 545 (NNSA/NSO, 2007), no additional sample locations were identified.

2.1.1.3 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The field-screening results (FSRs) were compared to field-screening levels (FSLs) to guide subsequent sampling decisions where appropriate. Gross alpha radiation and beta/gamma radiation FSLs were not exceeded at CAS 02-09-01, and FSRs were not used in the selection of analytical samples.

2.1.1.4 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples within the drilling mud disposal areas ([Figure A.3-1](#)) at this CAS.

Environmental samples were collected from six mounds of drilling mud and two sediment accumulation areas. Sample 545A001 was collected from the surface interval (0.0 to 0.5 foot (ft) below ground surface [bgs]) at location A01, the westernmost mound in the west disposal area ([Figure A.3-1](#)). As no biasing factors were detected within the mound profile the subsurface sample (545A006) was collected at the drilling mud/native soil interface (0.75 to 1.25 ft bgs). At location A02, the second mound in the west disposal area, sample 545A002 was collected from the surface interval (0.0 to 0.5 ft bgs) and the subsurface sample (545A007) was collected at the drilling mud/native soil interface (1.0 to 1.5 ft bgs). For both mounds, gravel consistent with the surface rock in the area was mixed in with the drilling mud throughout the profiles. The presence of gravel in the mud suggests that either the mud has been used and the gravel represents drill cuttings; the mud was spilled onsite and mounded by dumping or pushing with mechanical equipment; or it was collected and transported to CAS 02-09-01.

Within the south disposal area, location A03 was established at the highest mound (approximately 7.0 ft) present outside of the 50-ft-worker-safety buffer. Samples collected at this location include the surface (545A003), a mid-mound subsurface sample (545A008) at 2.5 to 3.0 ft bgs, and a sample (545A009) collected at the drilling mud/native soil interface (7.0 to 7.5 ft bgs). The mud was fairly homogenous throughout the mound, though thin layers of the mud were present in the mid-section, and gravel was present through the entire profile.

Location A04 was at a mound, approximately 3.0 to 3.5 ft high, selected for sampling because two T-posts were identified protruding from the mound at different angles. The mound and T-posts had the appearance of originating from a mud spill at another location. At location A04, a sample (545A004) and duplicate (545A005) were collected at the surface (0.0 to 0.5 ft bgs); a sample (545A010) was collected from within the mound (2.0 to 2.5 ft bgs), and a sample (545A011) was collected at the drilling mud/native soil interface (3.0 to 3.5 ft bgs). The mound was homogenous throughout, with gravel present through the entire profile.

Location A05 was also at a shorter mound (approximately 3.5 ft high) that was identified for sampling because the mud was a darker gray than the other mud at the site. The dried mud formed a subangular blocky structure which was unique to the mud in the area. A sample (545A012) was collected at the surface (0.0 to 0.5 ft bgs), a sample (545A014) was collected within the mound (2.5 to 3.0 ft bgs), and a sample (545A015) was collected at the drilling mud/native soil interface (3.0 to 3.5 ft bgs).

Location A06 was at the highest mound (approximately 6 ft high) in the eastern portion of the south disposal area. At location A06, a sample (545A013) was collected at the surface (0.0 to 0.5 ft bgs), a sample (545A016) was collected within the mound (3.0 to 3.5 ft bgs), and a sample (545A017) was collected at the drilling mud/native soil interface (5.5 to 6.0 ft bgs).

Location A07 and A08 were selected at sediment accumulation points in the east disposal area. Before sampling, a rainstorm left several inches (in.) of runoff, from the surrounding mounds of drilling mud, at the two locations. Location A08 dried enough to be sampled a week later; however, location A07 had to be moved several feet to the west within the settling area, due to persistent standing water. Surface samples (545A018 and 545A019) were taken at locations A07 and A08 from 0.0 to 0.25 and 0.0 to 0.33 ft bgs, respectively. Subsurface samples (545A020 and duplicate 545A021, and 545A022) were collected at locations A07 and A08 from 0.25 to 1.0 ft bgs and 0.33 to 0.83 ft bgs, respectively.

2.1.1.5 Conceptual Site Model Validation

From the data gathered at the site, there were no findings that conflicted with the CSM as presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

2.1.2 Waste Consolidation Site 3B (CAS 03-17-01)

The following subsections summarize the activities conducted at CAS 03-17-01. Additional detail on the sampling activities is provided in [Appendix A](#).

2.1.2.1 Radiological Survey

A radiological walkover survey was conducted over the areas encompassing the circular and rectangular components of CAS 03-17-01 ([Figure A.4-2](#)). Several areas were found to have elevated radiological readings at approximately two times background and were used as biasing factors to select four locations for sampling.

2.1.2.2 Geophysical Survey

A geophysical survey was conducted over the areas encompassing the circular and rectangular components of CAS 03-17-01. The survey identified 101 discrete anomalies, interpreted to represent subsurface metal objects. Two of these locations were sampled. Details of the survey results, along with the survey map, are in the CAIP for CAU 545, Section A.2.3.1 (NNSA/NSO, 2007).

2.1.2.3 Visual Inspection

There were no visible biasing factors identified at this CAS. All locations were selected on the basis of the probabilistic sampling approach and from the geophysical and radiological survey data.

2.1.2.4 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were exceeded in eight samples and beta/gamma radiation FSLs were exceeded in nine samples at CAS 03-17-01. For the eight background samples collected outside the CAS, the gross alpha radiation FSL was exceeded in one sample and beta/gamma radiation FSL was exceeded in three samples. All samples exceeding FSLs were analyzed for radiological constituents.

2.1.2.5 Sample Collection

Decision I environmental sampling activities at both the circular and rectangular components were conducted within the guidelines of a probabilistic sampling approach, with additional biased soil samples collected from the rectangular component ([Figure A.4-1](#)), and outside the fenced boundaries. At CAS 03-17-01, 24 probabilistic, 24 judgmental, and 8 background samples were collected. Locations B01 through B16, and B19 through B26 were predetermined randomized locations.

Locations B17 and B18 were established at geophysical anomalies, and locations B27 through B30 were established at areas of elevated radiological readings. Step-out locations B31 through B38 were established at locations along the fence lines of both the circular and rectangular components. Background locations B39 through B46 were established in pairs, diagonally outward from the corners of the rectangular component. Locations B01 through B12 were established in the circular area, and B13 through B30, as well as B38, were established within the fence at the rectangular area.

Surface samples were collected at all locations from the interval of 0.0 to 0.5 ft bgs. Brush obstructing several locations was cleared back. Other obstructions such as large rocks or scrap metal were not encountered at any sample location.

The FSLs for alpha were exceeded at locations B10, B13, B14, B27, B28, B29, and B41; from just above the FSL to 15 times FSL, and the FSLs for beta were exceeded at locations B14, B16, B17, B27, B28, B29, B30, B40, B41 and B42; from just above the FSL to 1.8 times the FSL. The values for the FSRs are maintained in the project files.

Because FSLs were exceeded, nine shallow subsurface samples were collected at the two components at six locations with the highest screening readings.

2.1.2.6 Conceptual Site Model Validation

From the data gathered at the site, there were no findings that conflicted with the CSM as presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

2.1.3 Radioactive Material Disposal Area (CAS 03-99-14)

The following subsections summarize the activities conducted at CAS 03-99-14. Additional detail on the sampling activities is provided in [Appendix A](#).

2.1.3.1 Radiological Survey

A radiological walkover survey was conducted over the area encompassing the berm and trench at CAS 03-99-14. Several areas were found to have elevated radiological readings at two to five times

background. Trinity glass is present throughout the area and likely contributed to the elevated readings. Three of the four sample transects were placed across these areas ([Figure A.5-2](#)).

2.1.3.2 Geophysical Survey

A geophysical walkover survey was conducted at the CAS. Small surface and subsurface anomalies were detected, but no linear or significant subsurface features were found ([Figure A.5-3](#)). The geophysical survey was not used in the selection of sample locations.

2.1.3.3 Visual Inspection

No distinguishing features were visible in the trench or on the berm. The surface features for both components were uniform throughout the CAS.

2.1.3.4 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were exceeded in two samples, and beta/gamma radiation FSLs were exceeded in three samples; all collected for background activities at CAS 03-99-14. All samples exceeding FSLs were analyzed.

2.1.3.5 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples from both components ([Figure A.5-1](#)) at this CAS. Four transects were established across the trench and berm, and one location each was established on the trench and on berm, for a total of eight locations. Results from the radiological survey were employed to guide three transects across general areas of elevated radioactivity, while keeping the transects evenly spaced (approximately) apart across each quarter of the site. The fourth transect, encompassing locations C06 and C13, was an approximate equal distance between the third transect and the east end of the trench and berm.

Surface samples (0.0 to 0.5 ft bgs) were collected from locations C01 through C05 outside the eastern, southern, and western perimeter of the CAS to measure the contribution of radiological

contamination from sources other than the CAS. The two exceedences of the FSL for alpha, and the three for beta, were all from these background samples.

Surface samples were also collected at each of the eight locations (C06 through C13) in the four transects across the trench and berm. Neither the alpha nor the beta FSL were exceeded in any samples. Consequently, subsurface samples were not collected at the four locations in the trench, and just one shallow subsurface sample per location was collected from the berm/native soil interface at the four berm locations, as specified in the CAIP for CAU 545 (NNSA/NSO, 2007).

No staining or other biasing factors were found within the soil profile at any of the berm locations.

2.1.3.6 Conceptual Site Model Validation

From the data gathered at the site, there were no findings that conflicted with the CSM as presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

2.1.4 U-9y Drilling Mud Disposal Crater (CAS 09-23-02)

The following subsections summarize the activities conducted at CAS 09-23-02. Because of safety concerns, only the wash component of this CAS was sampled. Additional detail on the sampling activities is provided in [Appendix A](#).

2.1.4.1 Radiological Survey

A radiological walkover survey was conducted over the wash component of CAS 09-23-02. No areas of elevated radiological readings were found. Therefore, the radiological survey was not used in the selection of sample locations ([Figure A.6-2](#)).

2.1.4.2 Geophysical Survey

A geophysical walkover survey was conducted at the CAS. No linear or significant subsurface features were found ([Figure A.6-3](#)). Two anomalies, one along the south shoulder of the wash, and one along the east boundary of the CAS, were interpreted to possibly indicate areas of different soil type. One sample location was selected over each anomaly.

2.1.4.3 Visual Inspection

Visible features that were used to establish biased locations were limited to areas where suspended solids (i.e., silts and clays) settled out of water moving through the wash (i.e., settling areas). Two locations within the CAS, and two locations downstream from the CAS, were established at these areas. Other visible biasing factors at the CAS were not present.

2.1.4.4 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were not exceeded, but beta/gamma radiation FSLs were exceeded in four samples (and one duplicate) at CAS 09-23-02. All samples exceeding FSLs were analyzed.

2.1.4.5 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples within the wash and in two settling areas immediately downgradient ([Figure A.6-1](#)).

Within CAS 09-23-02, two locations were selected based upon the geophysical survey and two locations were selected in areas where fine sediment settled out from flowing runoff. Location D01 was selected at the settling area in the wash closest to the U-9y crater. Sample 545D001 was collected from the surface interval (0.0 to 0.5 ft bgs) but did not exceed FSLs. A shallow subsurface sample (545D009) was collected from 0.5 to 1.0 ft bgs, which exceeded the FSL for beta. Further down the soil profile at location D01, a layer of light-colored fine material, that may have been drilling mud, was encountered at 2.0 to 2.5 ft bgs. Sample 545D010 was collected from this layer but did not exceed FSLs. The interface of the wash material with the native soil was encountered at the interval of 4.0 to 4.5 ft bgs. Sample 545D011 was collected at this interface but also did not exceed FSLs.

Location D02 was selected in the lower third of the wash within the CAS ([Figure A.6-1](#)), at an obvious settling area. A sample (545D002) was collected from the surface interval (0.0 to 0.5 ft bgs), which did not exceed FSLs. Sample 545D013 was collected from the shallow subsurface interval between 2.0 and 2.5 ft bgs and exceeded the FSL for beta. Sample 545D014 at this location was

collected immediately below the wash/native soil interface between 3.0 and 3.5 ft bgs and was below FSLs.

Location D03 was selected at a settling area just down gradient from the CAS. A sample (545D003) was collected from the surface interval (0.0 to 0.5 ft bgs) and did not exceed FSLs. Sample (545D017) was collected from wash material between 1.5 and 2.0 ft bgs and did not exceed FSLs.

Location D04 was also selected at a settling area, approximately 60 ft downstream from the CAS boundary. A sample (545D004) and duplicate (545D005) was collected from the interval 0.0 to 0.5 ft bgs and exceeded the FSL for beta. Sample (545D006) was collected from wash material (immediately above native soil) from the interval 0.5 to 1.0 ft bgs and did not exceed FSLs. An additional shallow subsurface sample (545D018) was collected from the interval 1.0 to 1.17 ft bgs in native soil, which included an approximately 3/8-in.-thick layer of black, decomposed, natural organic matter. The sample screening results were below FSLs.

Location D05 was selected approximately midway through the CAS, and partially up the south bank of the wash at a geophysical anomaly that was identified as likely being local soil changes, fill material, or buried nonmetallic material. Sample 545D007 was collected from the surface interval (0.0 to 0.5 ft bgs) and was below FSLs. The location was excavated to native soil at 3.5 ft bgs, which consisted of a compact sandy silt. No evidence of drilling mud was observed. A shallow subsurface sample (545D012) was collected from wash material in the interval of 1.5 to 2.0 ft bgs, and exceeded FSL for beta.

Location D06 was selected at the east boundary of the CAS, along the wash bottom, also at a geophysical anomaly that indicated either local soil changes, buried nonmetallic debris, or fill material. Sample 545D008 was collected from the interval 0.0 to 0.5 ft bgs and did not exceed FSLs. A second sample (545D015) was collected from wash material from 1.5 to 2.0 ft bgs and did not exceed FSLs. A third sample (545D016) at this location was collected just below the wash material/native soil interface at 3.0 to 3.5 ft bgs and did not exceed FSLs.

No staining, debris, or biasing factors other than elevated radiological readings, were found in any of the sample location profiles.

2.1.4.6 Conceptual Site Model Validation

From the data gathered at the site, there were no findings that conflicted with the CSM as presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

2.1.5 Waste Disposal Site (CAS 20-19-01)

The following subsections summarize the activities conducted at CAS 20-19-01. Additional detail on the sampling activities is provided in [Appendix A](#).

2.1.5.1 Radiological Survey

A radiological walkover survey was conducted over CAS 20-19-01. No areas of elevated radiological readings were found. The radiological survey was not used in the selection of sample locations ([Figure A.7-2](#)).

2.1.5.2 Visual Inspection

Debris that was assumed to be related to the test conducted at U-20p was scattered throughout the site. Sample locations were established beneath the following visible materials: two locations at used oil filter(s), one location at a canister containing a greasy substance, two locations within the dried drilling mud spill that entered the site from the south, one location along the western edge where the soil was discolored yellowish tan and contained white flakes, one location at a small pile of what appeared to be corroded capacitors or batteries (slightly larger than D-cell size), one location within scattered photograph processing/fixing supplies, one location that was comprised of fine, whitish soil of a lower density than the native soil; and one location that appeared to be stained a darker shade of tan and that was adjacent to a yellow, solidified mass in the shape of a small (approximately 30-gallon [gal]) drum. An overall photograph of the debris at the site is shown in [Figure A.7-3](#).

2.1.5.3 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs was exceeded in one sample, and the beta/gamma radiation FSL was not exceeded at CAS 20-19-01. The sample exceeding the FSL was analyzed.

2.1.5.4 Sample Collection

Decision I environmental sampling activities included the collection of biased surface soil samples at potentially hazardous-containing materials ([Figure A.7-1](#)).

Environmental samples were collected from the soil containing the biasing factor (e.g., stained soil, drilling mud spill, oil stains). Sample 545E001 at location E01 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by release of used motor oil from several oil filters. The soil beneath this interval did not appear impacted by the oil. Sample 545E002 at location E02 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by release of used motor oil from a single oil filter. The soil beneath this interval also did not appear impacted by the oil. Sample 545E003 at location E03 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by a spill of drilling mud that entered the site along the southern side. The layer of drilling mud was approximately 1 in. thick and did not appear to impact the underlying soil. Sample 545E004 at location E04 was also collected from the surface interval (0.0 to 0.5 ft bgs) impacted by the release of drilling mud. The layer of drilling mud at this location was approximately 3 in. thick, and also did not appear to impact the underlying soil.

Sample 545E005 at location E05 was collected at the southwest extent of the debris, from the surface interval (0.0 to 0.5 ft bgs) beneath a canister, in which grease had seeped from a connection. The soil directly beneath this canister was impacted by the grease, but the impact was not visible beyond 0.5 ft bgs. Sample 545E006 at location E06 was collected from the surface interval (0.0 to 0.5 ft bgs) from soil which had a yellowish hue and contained white flecks of an unknown material. Neither the yellow hue nor the white flecks extended below this interval. Sample 545E007 at location E07 was collected from the surface interval (0.0 to 0.5 ft bgs) impacted by corroded capacitors or batteries. The impact from these materials did not appear to extend below this interval.

Sample 545E008 at location E08 was collected from 0.0 to 0.5 ft bgs in an area impacted by photographic materials. The impact from these materials did not appear to extend below this interval. Samples 545E009 and duplicate 545E010 at location E09 were collected from 0.0 to 0.5 ft bgs in an area of light-hued, loose, low-density material mixed in with soil. The impact of this material was limited to the surface. Sample 545E011 at location E10 was collected from 0.0 to 0.5 ft bgs in an area

of stained soil that was adjacent to a small, yellow, solidified mass in the shape of a small (approximately 30-gal) drum. The soil beneath this interval did not appear to be this darker hue.

2.1.5.5 Conceptual Site Model Validation

From the data gathered at the site, there were no findings that conflicted with the CSM as presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

2.2 Results

The data summary provided in [Section 2.2.1](#) defines the contaminants of potential concern (COPCs) that exceeded the FALs (i.e., COCs), within the CAU 545 CASs, and the extent of any identified COCs. [Section 2.2.2](#) summarizes the data assessment in [Appendix B](#), which demonstrates that the investigation results satisfy the DQO data requirements.

2.2.1 Summary of Analytical Data

Chemical and radiological results for environmental samples collected at each of the CASs are summarized in [Sections 2.2.1.1](#) through [2.2.1.5](#). Environmental sample results are evaluated against FALs to determine the presence of COCs and the extent of COC contamination, if present.

The preliminary action levels (PALs) for the CAU 545 investigation were determined during the DQO process and are discussed in Section 3.3 of the CAIP for CAU 545 (NNSA/NSO, 2007). The FALs used for determining the presence of COCs and for evaluating the need for additional corrective action are defined in [Section 2.3](#). Details about the methods used during this investigation and a comparison of environmental sample results to the FALs are presented in [Appendix A](#).

2.2.1.1 Mud Disposal Area (CAS 02-09-01)

Corrective Action Site 02-09-01 was sampled at eight judgmental locations, and two or three depths per location. The analytical results for this CAS were below the PALs for all COPCs. Maximum results for all analytes detected at CAS 02-09-01 are listed in [Table 2-1](#). Contamination in the mud disposal areas outside the crater is assumed to be representative of contamination within the crater. Therefore, no COCs are considered to be present in either CAS component.

**Table 2-1
Maximum Concentration of Detected
Contaminants for CAS 02-09-01, Mud Disposal Area**

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Actinium-228	2.67	545A018	0.0 - 0.25	A07	5	pCi/g
Cesium-137	2.04	545A022	0.33 - 0.83	A08	12.2	pCi/g
Lead-212	2.4	545A009	7.0 - 7.5	A03	5	pCi/g
Lead-214	1.44	545A019	0.0 - 0.33	A08	5	pCi/g
Plutonium-238	0.0578	545A022	0.33 - 0.83	A08	13	pCi/g
Plutonium-239/240	0.818	545A006	0.75 - 1.25	A01	12.7	pCi/g
Strontium-90	0.289	545A022	0.33 - 0.83	A08	838	pCi/g
Thallium-208	0.859	545A018	0.0 - 0.25	A07	5	pCi/g
Uranium-234	1.27	545A020	0.25 - 1.0	A07	143	pCi/g
Uranium-238	1.18	545A019	0.0 - 0.33	A08	105	pCi/g

bgs = Below ground surface
FAL = Final action level
ft = Foot
pCi/g = Picocuries per gram

2.2.1.2 Waste Consolidation Site 3B (CAS 03-17-01)

Corrective Action Site 03-17-01 was investigated, following a probabilistic sampling approach along with several judgmental locations, with 24 of the 31 locations within the fenced boundary being probabilistic sample locations. The analytical results for this CAS exceeded the PALs for americium (Am)-241 and/or plutonium (Pu)-239 at several locations in both the circular and rectangular components. A Tier 2 evaluation was conducted for these constituents using Residual Radioactive (RESRAD) computer code to determine the site-specific FALs. The probabilistic results for these two radionuclides (95 percent UCL of the mean) were compared to the FALs. The 95 percent UCLs (Table 2-2) and judgmental results were all below the FALs. Maximum results for all analytes detected at CAS 03-17-01 are listed in Table 2-3. This CAS is considered not to contain COCs.

Table 2-2
Statistical Values for Corrective Action Investigation Probabilistic Results for
Significant COPCs, CAS 03-17-01, Waste Consolidation Site 3B

Constituent	Average	Actual Standard Deviation	FAL ^a	Actual Required Minimum Number of Samples	UCL	UCL Value
Americium-241	5.70 pCi/g	5.46	1,501 pCi/g	8	95% Approximate Gamma	8.202 pCi/g
Plutonium-239/240	13.53 pCi/g	11.25	1,890 pCi/g	8	95% Approximate Gamma	20.09 pCi/g

^aEstablished in [Appendix C](#).

FAL = Final action level
pCi/g = Picocuries per gram
UCL = Upper confidence limit

Table 2-3
Maximum Concentration of Detected
Contaminants for CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL ^a	Units
Actinium-228	2.18	545B032	0 - 0.5	B29	5	pCi/g
Am-241	284	545B030	0 - 0.5	B27	1,501	pCi/g
Arsenic	7.6	545B019	0 - 0.5	B17	23	mg/kg
Barium	235 (J)	545B031	0 - 0.5	B28	67,000	mg/kg
Cadmium	0.37 (J)	545B013	0 - 0.5	B12	450	mg/kg
Cesium-137	5.14	545B032	0 - 0.5	B29	12.2	pCi/g
Chromium	9.6	545B028	0 - 0.5	B25	450	mg/kg
Europium-152	2.17	545B032	0 - 0.5	B29	5.67	pCi/g
Lead	13.3	545B031	0 - 0.5	B28	800	mg/kg
Lead-212	1.98	545B035	0.5 - 1.0	B28	5	pCi/g
Lead-214	1.35	545B030	0 - 0.5	B27	5	pCi/g
Mercury	0.04 (J-)	545B031	0 - 0.5	B28	310	mg/kg
Plutonium-238	5.14	545B033	0.5 - 1.0	B27	13	pCi/g
Plutonium-239/240	455	545B035	0.5 - 1.0	B28	1,890	pCi/g
Selenium	2.6 (J)	545B028	0 - 0.5	B25	5,100	mg/kg
Silver	0.24 (J)	545B021	0 - 0.5	B19	5,100	mg/kg
Strontium-90	1.1	545B032	0 - 0.5	B29	838	pCi/g
Thallium-208	0.781	545B031	0 - 0.5	B28	5	pCi/g
Uranium-234	2.42	545B035	0.5 - 1.0	B28	143	pCi/g

Table 2-3
Maximum Concentration of Detected
Contaminants for CAS 03-17-01, Waste Consolidation Site 3B
 (Page 2 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL ^a	Units
Uranium-235	0.116	545B032	0 - 0.5	B29	17.6	pCi/g
Uranium-238	1.1	545B045	1.0 - 1.75	B28	105	pCi/g

^aEstablished in [Appendix C](#).

bgs = Below ground surface

FAL = Final action level

ft = Foot

mg/kg = Milligrams per kilogram

pCi/g = Picocuries per gram

J = Estimated value

J- = The result is an estimated quantity, but the result may be biased low.

2.2.1.3 Radioactive Material Disposal Area (CAS 03-99-14)

Corrective Action Site 03-99-14 was sampled at eight judgmental locations, two per transect, and one to two depths per location. The analytical results for this CAS were below the PALs for all chemical and radiological constituents. Maximum results for all analytes detected at CAS 03-99-14 are listed in [Table 2-4](#). Five background locations outside of the CAS were also sampled; the background sample (545C003) taken at location C03 had the only result above PALs (i.e., for Pu-239), likely due to the nearby aboveground testing, and is not considered associated with this CAS. This CAS is therefore considered not to contain COCs.

2.2.1.4 U-9y Drilling Mud Disposal Crater (CAS 09-23-02)

Corrective Action Site 09-23-02 was sampled at four judgmental locations in the wash; within the CAS at two locations downstream from the lower CAS boundary, and two or three depths per location. The analytical results for this CAS were below the PALs for all COPCs. Maximum results for all analytes detected at CAS 09-23-02 are listed in [Table 2-5](#). Contamination in the wash outside the crater is assumed to be representative of contamination within the crater. Therefore, no COCs are considered to be present in either CAS component.

Table 2-4
Maximum Concentration of Detected
Contaminants for CAS 03-99-14, Radioactive Material Disposal Area

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Acetone	0.00369 (J)	545C015	0.0 - 0.5	C06	54,000	mg/kg
Actinium-228	1.96	545C013	3.5 - 4.0	C09	5	pCi/g
Americium-241	1.05 (J)	545C003	0.0 - 0.5	C03	12.7	pCi/g
Aroclor 1260	0.0024 (J)	545C009	0.0 - 0.5	C11	0.74	mg/kg
Arsenic	5.6	545C016	3.5 - 4.0	C08	23	mg/kg
Arsenic	5.6	545C015	0.0 - 0.5	C06	23	mg/kg
Barium	179	545C010	0.0 - 0.5	C10	67,000	mg/kg
Cesium-137	10.3	545C001	0.0 - 0.5	C01	12.2	pCi/g
Chromium	7.4	545C018	2.0 - 2.5	C06	450	mg/kg
Diesel-Range Organics	2.53 (J)	545C007	0.0 - 0.5	C12	100	mg/kg
Europium-152	4.62 (J)	545C005	0.0 - 0.5	C05	5.67	pCi/g
Lead	19.2 (J)	545C011	0.0 - 0.5	C09	800	mg/kg
Lead-212	1.94 (J)	545C018	2.0 - 2.5	C06	5	pCi/g
Lead-214	1.35 (J)	545C017	3.0 - 3.5	C07	5	pCi/g
Mercury	0.012 (J-)	545C008	0.0 - 0.5	C11	310	mg/kg
Mercury	0.012 (J-)	545C016	3.5 - 4.0	C08	310	mg/kg
Methylene chloride	0.00513	545C014	0.0 - 0.5	C07	21	mg/kg
Plutonium-238	2.18	545C003	0.0 - 0.5	C03	13	pCi/g
Plutonium-239/240 ^a	15.1	545C003	0.0 - 0.5	C03	12.7	pCi/g
Selenium	1.9	545C008	0.0 - 0.5	C11	5,100	mg/kg
Selenium	1.9	545C006	0.0 - 0.5	C13	5,100	mg/kg
Selenium	1.9	545C016	3.5 - 4.0	C08	5,100	mg/kg
Silver	0.33 (J)	545C012	0.0 - 0.5	C08	5,100	mg/kg
Strontium-90	5.67	545C006	0.0 - 0.5	C13	838	pCi/g
Styrene	0.00106	545C014	0.0 - 0.5	C07	1,700	mg/kg
Thallium-208	0.61	545C015	0.0 - 0.5	C06	5	pCi/g
Uranium-234	1.27	545C017	3.0 - 3.5	C07	143	pCi/g
Uranium-235	0.108	545C012	0.0 - 0.5	C08	17.6	pCi/g
Uranium-238	1.15	545C011	0.0 - 0.5	C09	105	pCi/g

^aThe only exceedence of the FAL for Pu-239/240 was identified in a sample taken from a background location for the purpose of measuring the impact from nearby atmospheric testing ([Section 2.2.1.3](#)). This result is not associated with CAS 03-99-14 and is only included in the table for completeness. The area containing the background locations will be addressed by the Soils Project, CAS 03-23-10.

bgs = Below ground surface
FAL = Final action level
ft = Foot

mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram
Pu = Plutonium

J = Estimated value
J- = The result is an estimated quantity, but the result may be biased low.

Table 2-5
Maximum Concentration of Detected
Contaminants for CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
1,2,4-Trimethylbenzene	0.00151	545D007	0.0 - 0.5	D05	170	mg/kg
1,4-Dichlorobenzene	0.000282 (J)	545D007	0.0 - 0.5	D05	7.9	mg/kg
Actinium-228	2.63	545D002	0.0 - 0.5	D02	5	pCi/g
Americium-241	0.376 (J)	545D003	0.0 - 0.5	D03	12.7	pCi/g
Americium-241	0.376	545D002	0.0 - 0.5	D02	12.7	pCi/g
Arsenic	7.7	545D012	1.5 - 2.0	D05	23	mg/kg
Barium	250 (J)	545D015	1.5 - 2.0	D06	67,000	mg/kg
Cadmium	0.2 (J-)	545D001	0.0 - 0.5	D01	450	mg/kg
Cesium-137	1.71	545D002	0.0 - 0.5	D02	12.2	pCi/g
Chromium	7.6	545D004	0.0 - 0.5	D04	450	mg/kg
Dichlorodifluoromethane	0.000951 (J)	545D002	0.0 - 0.5	D02	310	mg/kg
Diesel-Range Organics	11.4	545D003	0.0 - 0.5	D03	100	mg/kg
Lead	17.8 (J)	545D015	1.5 - 2.0	D06	800	mg/kg
Lead-212	2.42	545D002	0.0 - 0.5	D02	5	pCi/g
Lead-214	1.65	545D011	4.0 - 4.5	D01	5	pCi/g
Mercury	0.043 (J)	545D016	3.0 - 3.5	D06	310	mg/kg
Methylene Chloride	0.0023 (J)	545D007	0.0 - 0.5	D05	21	mg/kg
Plutonium-238	0.508	545D004	0.0 - 0.5	D04	13	pCi/g
Plutonium-239/240	7.3	545D005	0.0 - 0.5	D04	12.7	pCi/g
Selenium	2	545D018	1 - 1.17	D04	5,100	mg/kg
Selenium	2	545D016	3.0 - 3.5	D06	5,100	mg/kg
Selenium	2	545D015	1.5 - 2.0	D06	5,100	mg/kg
Styrene	0.00251	545D007	0.0 - 0.5	D05	1,700	mg/kg
Thallium-208	0.845	545D004	0.0 - 0.5	D04	5	pCi/g
Uranium-234	1.52	545D011	4.0 - 4.5	D01	143	pCi/g
Uranium-235	0.113	545D016	3.0 - 3.5	D06	17.6	pCi/g
Uranium-238	1.65	545D011	4.0 - 4.5	D01	105	pCi/g
Total Xylenes	0.0055	545D007	0.0 - 0.5	D05	420	mg/kg

bgs = Below ground surface

FAL = Final action level

ft = Foot

mg/kg = Milligrams per kilogram

pCi/g = Picocuries per gram

J = Estimated value

J- = The result is an estimated quantity, but the result may be biased low.

2.2.1.5 Waste Disposal Site (CAS 20-19-01)

Corrective Action Site 20-19-01 was sampled at 10 judgmental locations; each at the surface. The analytical results for this CAS were below the PALs for all chemical and radiological constituents except total petroleum hydrocarbons (TPH)-diesel-range organics (DRO) at two locations. The TPH-DRO was moved on to a Tier 2 evaluation and FALs were established for the hazardous constituents of TPH-DRO (see [Table C.1-3](#)). Concentrations of the hazardous constituents of TPH-DRO did not exceed FALs. Therefore, TPH-DRO is not considered a COC. Maximum results for all analytes detected at CAS 20-19-01 are listed in [Table 2-6](#). This CAS is therefore considered not to contain COCs.

Table 2-6
Maximum Concentration of Detected
Contaminants for CAS 20-19-01, Waste Disposal Site
(Page 1 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
2-Butanone	0.0142	545E005	0.0 - 0.5	E05	110,000	mg/kg
2-Hexanone	0.00935	545E005	0.0 - 0.5	E05	110,000	mg/kg
Acetone	0.408	545E008	0.0 - 0.5	E08	54,000	mg/kg
Actinium-228	2.33	545E005	0.0 - 0.5	E05	5	pCi/g
Americium-241	1.19	545E002	0.0 - 0.5	E02	12.7	pCi/g
Aroclor 1254	0.0066 (J)	545E002	0.0 - 0.5	E02	0.74	mg/kg
Aroclor 1268	0.0437	545E006	0.0 - 0.5	E06	0.74	mg/kg
Arsenic	9.1	545E009	0.0 - 0.5	E09	23	mg/kg
Barium	291 (J)	545E009	0.0 - 0.5	E09	67,000	mg/kg
Benzene	0.000429 (J)	545E006	0.0 - 0.5	E06	1.4	mg/kg
Benzoic Acid	41.3	545E007	0.0 - 0.5	E07	100,000	mg/kg
Bis(2-ethylhexyl)phthalate	3.99	545E008	0.0 - 0.5	E08	120	mg/kg
Cadmium	2.7	545E007	0.0 - 0.5	E07	450	mg/kg
Cesium-137	1	545E002	0.0 - 0.5	E02	12.2	pCi/g
Chromium	12.2	545E009	0.0 - 0.5	E09	450	mg/kg
Di-n-butyl phthalate	0.936	545E002	0.0 - 0.5	E02	62,000	mg/kg
Dichlorodifluoromethane	0.00215	545E009	0.0 - 0.5	E09	310	mg/kg
Diesel-Range Organics	157	545E007	0.0 - 0.5	E07	N/A ^a	mg/kg
Lead	106 (J)	545E009	0.0 - 0.5	E09	800	mg/kg
Lead-212	2.3	545E009	0.0 - 0.5	E09	5	pCi/g
Lead-214	2.09	545E010	0.0 - 0.5	E09	5	pCi/g
Mercury	0.46 (J)	545E007	0.0 - 0.5	E07	310	mg/kg
Methylene Chloride	0.0103	545E005	0.0 - 0.5	E05	21	mg/kg

Table 2-6
Maximum Concentration of Detected
Contaminants for CAS 20-19-01, Waste Disposal Site
(Page 2 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Phenanthrene	0.0157 (J)	545E006	0.0 - 0.5	E06	100,000	mg/kg
Phenol	0.358	545E006	0.0 - 0.5	E06	100,000	mg/kg
Plutonium-238	1.18 (J)	545E001	0.0 - 0.5	E01	13	pCi/g
Plutonium-239/240	2.73 (J)	545E007	0.0 - 0.5	E07	12.7	pCi/g
Selenium	2.1 (J-)	545E006	0.0 - 0.5	E06	5,100	mg/kg
Silver	22.1	545E008	0.0 - 0.5	E08	5,100	mg/kg
Styrene	0.00049 (J)	545E005	0.0 - 0.5	E05	1,700	mg/kg
Thallium-208	0.778	545E009	0.0 - 0.5	E09	5	pCi/g
Uranium-234	1.38	545E001	0.0 - 0.5	E01	143	pCi/g
Uranium-235	0.0908	545E010	0.0 - 0.5	E09	17.6	pCi/g
Uranium-238	1.43	545E010	0.0 - 0.5	E09	105	pCi/g

^aFALs are established for hazardous constituents of total petroleum hydrocarbons-diesel-range organics.

bgs = Below ground surface

FAL = Final action level

ft = Foot

mg/kg = Milligrams per kilogram

N/A = Not applicable

pCi/g = Picocuries per gram

J = Estimated value

J- = The result is an estimated quantity, but the result may be biased low.

2.2.2 Data Assessment Summary

The DQA is presented in [Appendix B](#) and includes an evaluation of the DQIs to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the correct type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA process is comprised of the following steps, as presented in [Appendix B](#):

- Step 1: Review DQOs and Sampling Design.
- Step 2: Conduct a Preliminary Data Review.
- Step 3: Select the Test.
- Step 4: Verify the Assumptions.
- Step 5: Draw Conclusions from the Data.

Sample locations that support the presence and/or extent of contamination at each CAS are shown in [Appendix A](#). Based on the results of the DQA ([Appendix B](#)), the DQO requirements have been met. The DQA also determined that information generated during the investigation support the CSM assumptions and the data collected support their intended use in the decision-making process.

2.3 Justification for No Further Action

No further corrective action is needed because:

- Corrective actions are implemented where needed.
- Use restrictions were implemented at CASs 03-08-03 and 03-23-05.
- Potential source material (PSM) (i.e., used oil filters) was removed at CAS 20-19-01.
- No COCs were identified at the remaining CASs.

Based on the results of the investigation, the remaining debris at CAS 20-19-01 was determined to not require corrective action. Soil samples were collected beneath the debris at locations identified as most likely to contain COCs. No COCs were identified; therefore, there is no indication that the debris is contributing contamination to the soil at concentrations that would require corrective action. Because removal of the debris from the potential crater area may pose a health and safety risk to workers (Pawloski, 2003), the debris was left in place.

2.3.1 Final Action Levels

The CAU 545 FALs are risk-based cleanup goals that, if met, will ensure that each release site will not pose an unacceptable risk to human health and the environment and that conditions at each site are in compliance with all applicable laws and regulations. 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, 2006). This process conforms with *Nevada Administration Code* (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) recommends 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 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 (nonsite-specific) conditions (i.e., the PALs established in the CAIP for CAU 545 [NNSA/NSO, 2007]). 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 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.

A Tier 1 evaluation was conducted for all COPCs to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. This was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP for CAU 545 [NNSA/NSO, 2007]).

The constituents detected at the CAU 545 CASs that exceeded Tier 1 action levels were:

- Total petroleum hydrocarbons at CAS 20-19-01
- Americium-241 at CAS 03-17-01
- Plutonium-239 at CAS 03-17-01

The concentrations of all constituents at CASs not listed above were below Tier 1 action levels (i.e., PALs) and the corresponding FALs were established as the Tier 1 action levels. Of the constituents at CASs that exceeded Tier 1 action levels, all were passed on to a Tier 2 evaluation.

The evaluation of TPH-DRO at CAS 20-19-01 was moved on to a Tier 2 evaluation. The Tier 2 evaluation of TPH-DRO consisted of evaluating the hazardous constituents of TPH to the Tier 2 SSTLs. The Tier 2 SSTLs for the hazardous constituents of TPH-DRO were established at the corresponding PAL concentrations. None of the individual hazardous constituents of TPH-DRO

exceeded the Tier 2 SSTLs. Therefore, corresponding FALs were established at the PAL concentrations, and neither TPH-DRO nor the individual hazardous constituents of TPH-DRO are considered COCs. Additional details of the Tier 2 evaluations for TPH-DRO are provided in [Appendix C](#).

The evaluation for Am-241 and Pu-239/240 at CAS 03-17-01 compared the analytical results for these radionuclides at these CASs to the Tier 2 action levels. The Tier 2 action levels were calculated for an industrial scenario using site-specific information on the detected radionuclides and other site-specific physical characteristics using the RESRAD code (version 6.3). This calculation determined the needed activities of all detected radionuclides that, together, would sum to an exposed dose of 25 millirem per year (mrem/yr) to a site receptor (based on their relative abundances at each CAS). These calculated activities were then established as the FALs for each radionuclide at each CAS that exceeded a Tier 1 action level. Because site contamination levels did not exceed an industrial scenario-based FAL, an administrative UR was not necessary. Additional details of the Tier 2 evaluations for Am-241 and Pu-239/240 at CAS 03-17-01 are provided in [Appendix C](#).

The bases for the derivation of FALs for all CAU 545 COPCs as presented in [Appendix C](#) are listed in [Table 2-7](#).

Table 2-7
Definition of Final Action Levels for CAU 545 Contaminants of Potential Concern

COPCs	Tier 1-Based FALs	Tier 2-Based FALs	Tier 3-Based FALs
VOCs	All CASs	None	None
SVOCs	All CAS	None	None
PCBs	All CAS	None	None
RCRA Metals	All CAS	None	None
TPH-DRO	All CAS except CAS 20-19-01	CAS 20-19-01	None
Radionuclides	All CAS except CAS 03-17-01	CAS 03-17-01	None

COPC = Contaminant of potential concern
 DRO = Diesel-range organics
 FAL = Final action level
 N/A = Not applicable
 PAL = Preliminary action level

PCB = Polychlorinated biphenyl
 RCRA = *Resource Conservation and Recovery Act*
 SVOC = Semivolatile organic compound
 TPH = Total petroleum hydrocarbons
 VOC = Volatile organic compound

3.0 Recommendation

No further corrective action is required at CAU 545. Selection of this corrective action is consistent with past practices for CASs that do not contain COCs. No further action was evaluated based on technical merits focusing on performance, reliability, feasibility, and safety.

The DOE National Nuclear Security Administration Nevada Site Office (NNSA/NSO) provides the following recommendations:

- Implement a UR for the radiologically impacted soil at CAS 03-08-03. The UR form and map are filed in the NNSA/NSO Facility Information Management System, the FFACO database, and the NNSA/NSO CAU/CAS files. Inspection of the sign postings will be conducted annually.
- Implement a UR for the lead and radiological source material present in the soil at CAS 03-23-05. The UR form and map are filed in the NNSA/NSO Facility Information Management System, the FFACO database, and the NNSA/NSO CAU/CAS files. Inspection of the sign postings will be conducted annually.

The NNSA/NSO requests that NDEP issues a Notice of Completion for this CAU and approval to move CAU 545 from Appendix III to Appendix IV of the FFACO.

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 545, which is located in Areas 2, 3, 9, and 20 of the NTS ([Figure 1-1](#)), and comprised of the eight CASs listed below:

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

Corrective Action Sites 03-08-03, 03-23-02, and 03-23-05 were not investigated because sufficient data existed in the CAU 545 CAIP to support the decisions necessary for site closure (NNSA/NSO, 2007).

Corrective Action Site 02-09-01, Mud Disposal Area, is located immediately to the west of the 2-05 Road and Circle Road intersection in Area 2 of the NTS. The CAS consists of potentially contaminated drilling mud released within and outside of the U-2ei crater, which formed as a result of the Coulommiers underground nuclear test conducted on September 27, 1977. The specific history of mud disposal activities at the U-2ei crater is unknown; however aerial photography indicates mud was disposed at the site between 1977 and 1984. The mud released at CAS 02-09-01 is assumed to be associated with NTS drilling operations, and therefore may either be pre-use material or else used pre-test and/or post-test drilling mud.

Corrective Action Site 03-17-01, Waste Consolidation Site 3B, is located 1.0 mi east of the Area 3 Radioactive Waste Management Site (RWMS) at the NTS. The CAS consists of an area used for storage of suspected radioactive materials associated with nearby atmospheric tests, which was cleaned up in the 1980s. Two components comprise the site: a rectangular area measuring 950 by 750 ft, posted as a contamination area; and an unposted, circular area measuring 145 ft in diameter. Some metallic debris, including the remnants of an ecology study, remain at the site.

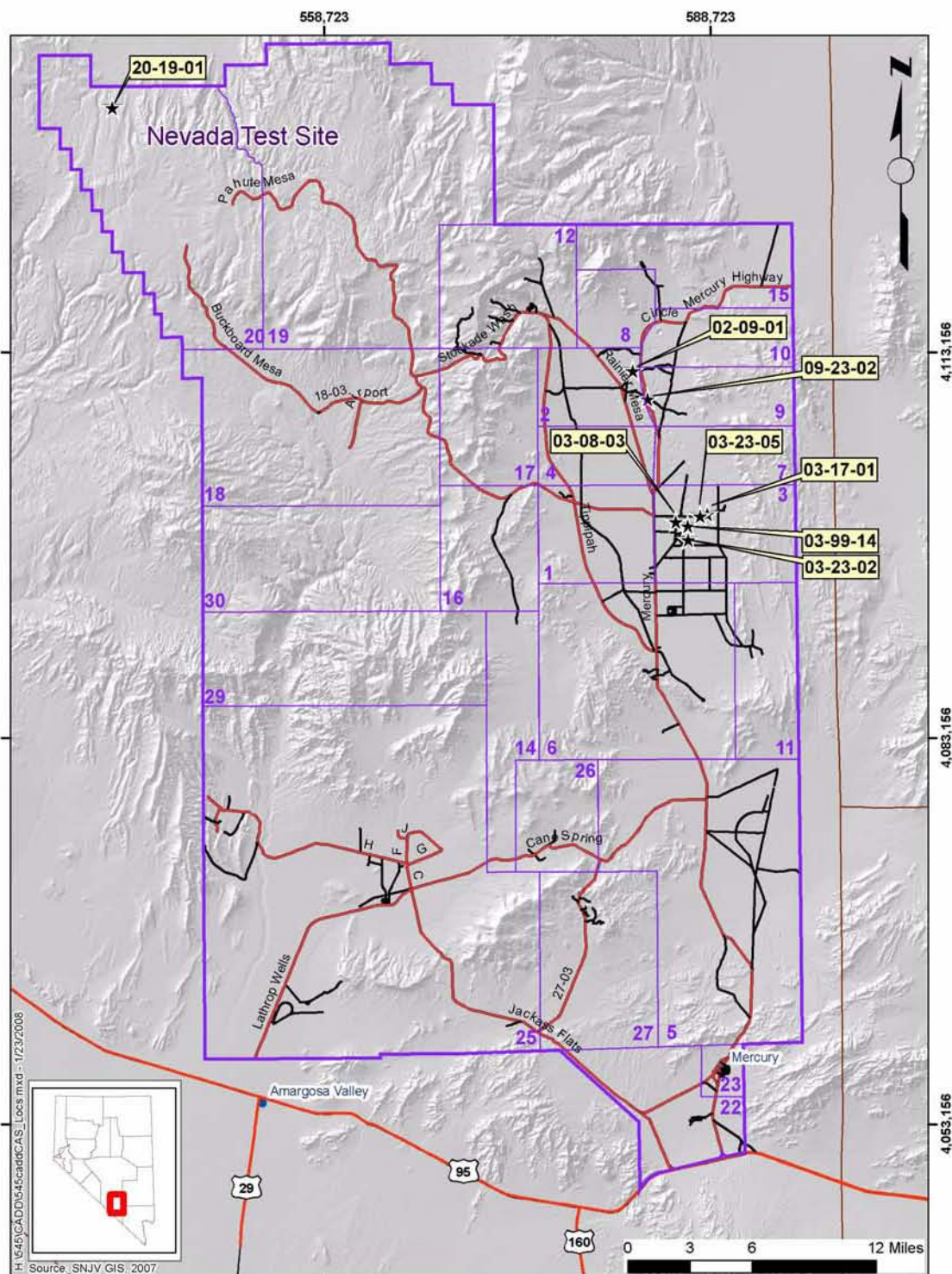


Figure A.1-1
Corrective Action Investigation Site Map for CAU 545 CASs

Corrective Action Site 03-99-14, Radioactive Materials Disposal Area, is located approximately 1.0 mi southeast of the Area 3 RWMS. The CAS consists of potential soil contamination associated with a soil berm and an associated trench approximately 350 ft long. The volume of soil on the berm appears to be equivalent to that missing from the trench. The original purpose for the berm and trench is unknown. The site, along with adjoining lands, is posted as an RMA. The posting is likely due to atmospheric testing that was conducted just to the west of the site. The area encompassing the RMA will be investigated by the Soils Project for CAU 104.

Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater, is located approximately 600 ft southeast of the 9-01 and Circle Roads intersection. The CAS consists of potentially radiological-contaminated drilling fluids and decontamination wastewater disposed of in the U-9y crater. This crater formed as a result of the Wichita underground nuclear test conducted on July 27, 1962. At some time between 1979 and 1980, the fluids inside the crater overflowed into the wash to the east, and use of the crater for disposal was discontinued. The wash is posted as a buried RMA, but it is not known if the posting is related to the overflow of the crater.

Corrective Action Site 20-19-01, Waste Disposal Site, is located to the east-northeast of the U-20p test hole, within the potential crater area, in the northwestern portion of Area 20. The CAS consists of the debris pile to the east-northeast of the test hole. The history of the debris is not known, but the contents are consistent with general construction debris. Several used oil filters were identified at the site. A drilling mud spill entering the site from the south was also identified at the site.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.1.1 Project Objectives

The primary objective of the investigation was to provide sufficient information and data to develop appropriate corrective action alternatives for each CAS in CAU 545. This objective was achieved by identifying the absence or presence of COCs and the vertical and lateral extent of the COCs, if present. Corrective Action Sites 03-08-03, 03-23-02, and 03-23-05 were not investigated because sufficient information existed about the sites.

The selection of soil and/or waste characterization sample locations was based on site conditions and the strategy developed during the DQO process as presented in the CAIP for CAU 545 (NNSA/NSO, 2007). The sampling strategy implemented a judgmental sampling approach at CASs 02-09-01, 03-99-14, 09-23-02 and 20-19-01, and a combination of probabilistic and judgmental sampling approaches at CAS 03-17-01.

A.1.2 Contents

This appendix describes the investigation and presents the results. The contents of this appendix are as follows:

- [Section A.1.0](#) describes the investigation background, objectives, and content.
- [Section A.2.0](#) provides an investigation overview.
- [Sections A.3.0](#) through [A.7.0](#) provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- [Section A.8.0](#) summarizes waste management activities.
- [Section A.9.0](#) discusses the QA and QC processes followed and the results of the QA/QC activities.
- [Section A.10.0](#) provides a summary of the investigation results.
- [Section A.11.0](#) provides a list of the referenced documents used in the preparation of this document.

The complete field documentation and laboratory data, including Field Activity Daily Logs (FADLs), sample collection logs (SCLs), analysis request/chain-of-custody forms, soil sample descriptions, laboratory certificates of analyses, analytical results, and surveillance results are retained in project files as hard copy files and electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 545 CAI were conducted from August 20 through November 2, 2007. [Table A.2-1](#) lists the CAI activities conducted at each of the five CAU 545 CASs identified for sampling during the DQOs.

Table A.2-1
Corrective Action Investigation Activities Conducted at Each Corrective Action Site To Meet Corrective Action Investigation Plan Requirements for CAU 545

Corrective Action Investigation Activities	Corrective Action Site				
	02-09-01	03-17-01	03-99-14	09-23-02	20-19-01
Inspected and verified the CAS components identified in the Corrective Action Investigation Plan.	X	X	X	X	X
Performed site walkovers to identify biased sampling locations.	X	X	X	X	X
Conducted scanning radiological walkover surveys (i.e., soil, concrete surfaces, debris) using a handheld detector and a global positioning system (GPS) receiver with a TSCITM data logger.	X	X	X	X	X
Performed swipe sampling for removable radioactivity using a handheld survey instrument and/or a gamma scintillator (Building 23-153, Mercury, NV).	X	X	X	X	X
Conducted geophysical surveys.	--	X	X	X	--
Collected biased soil samples.	X	X	X	X	X
Collected randomly located soil samples.	--	X	--	--	--
Collected soil samples from step-out sample locations (Decision II) based on the outer boundary sample locations where contaminants of concern were detected in Decision I soil samples.	--	--	--	--	--
Field screened samples for alpha and beta/gamma radiation using a handheld survey instrument.	X	X	X	X	X
Submitted select samples for offsite laboratory analysis.	X	X	X	X	X
Collected GPS coordinates for sample locations and points of interest.	X	X	X	X	X

-- = Not applicable

The investigation and sampling program was managed in accordance with the requirements set forth in the CAIP for CAU 545 (NNSA/NSO, 2007). Field activities were performed in compliance with safety documents that are consistent with the DOE Integrated Safety Management System. Samples were collected and documented following approved protocols and procedures. Quality control

samples (e.g., field blanks, equipment rinsate blanks, trip blanks, and duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002) and the CAIP for CAU 545 (NNSA/NSO, 2007).

Weather conditions at the site varied to include sun (high temperatures), below average rainfall, haze, and light to strong winds. Strong wind gusts delayed site operations due to the potential for airborne debris. Lightning strikes within 10 mi of several work sites also led to suspension of work on several occasions.

The CASs were investigated by conducting radiological surface screening and surveys, and sampling surface and subsurface soils. Surface soil samples were collected by hand excavation. Subsurface soil samples were collected using hand augering or a backhoe. The soil samples were field screened at specific locations for alpha and beta/gamma radiation. The results were compared against screening levels to guide in the CAS-specific investigations. Soil samples were field screened to guide in the selection of the samples shipped to offsite laboratories for analysis. Field screening was also for health and safety controls and to meet transportation requirements.

Except as noted in the following CAS-specific sections, CAU 545 Decision I sampling locations were accessible and sampling activities at planned locations were not restricted. Decision II step-out sample locations were accessible and remained within anticipated spatial boundaries.

[Sections A.2.1](#) through [A.2.4](#) provide the investigation methodology and laboratory analytical information.

A.2.1 Sample Locations

Investigation locations selected for sampling were based on interpretation of aerial and land photographs, interviews with former and current site employees, information obtained during site visits, and site conditions as provided in the CAIP for CAU 545 (NNSA/NSO, 2007). Sampling points for each site were selected based on the approach provided in the CAIP. The planned biased and random sample locations are discussed in text and represented on figures in the CAIP. Actual environmental sample locations are shown on the figures included in [Sections A.3.0](#) through [A.7.0](#). In some cases, the review of FSRs and/or laboratory analytical results identified the need for step-out sampling. All sample locations were staked, labeled, and surveyed with a global positioning system

(GPS) instrument. A Trimble GeoXT GPS instrument was used to determine sample location coordinates as well as CAS points of interest. [Appendix E](#) presents the coordinates in a tabular format.

A.2.2 Investigation Activities

The investigation activities performed at CAU 545 were based on field investigation activities discussed in the CAIP for CAU 545 (NNSA/NSO, 2007). The technical approach consisted of the activities listed in [Table A.2-1](#). The investigation strategy allowed the nature and extent of contamination associated with each CAS to be established. The following sections describe the specific investigation activities that took place at CAU 545.

A.2.2.1 Radiological Surveys

Radiological surveys (i.e., walkover) were performed at each CAS during the CAI. Radiological surveys were performed to identify the presence, the nature, and the extent of radiological contaminants at activities statistically greater than background.

A.2.2.2 Geophysical Surveys

Geophysical surveys were conducted at CAS 03-17-01 before the CAI, and at CASs 03-99-14 and 09-23-02 during the CAI, to identify subsurface anomalies. The geophysical results were only useful for identifying smaller anomalies at CAS 03-17-01, where two anomaly locations were sampled. Additionally, two locations of less distinct anomalies at CAS 09-23-02 were also sampled. Additional information is retained in the project files.

A.2.2.3 Field Screening

Field-screening activities for alpha and beta/gamma radiation were performed as specified in the CAIP for CAU 545 (NNSA/NSO, 2007). Site-specific FSLs for alpha and beta/gamma radiation were defined as the mean background activity level plus two times the standard deviation of readings from 10 background locations selected near each CAS. The radiation FSLs are instrument-specific and were established for each instrument and CAS before use.

All field screening for alpha and beta/gamma radiation screening was performed at each CAS using a NE Technology Electra or E-600 fitted with a DP6 dual-alpha and beta/gamma radiation scintillation probe.

The CAS-specific sections of this document identify the CASs where field screening was conducted and how the FSLs were used to aid in the selection of samples to submit for analyses. The FSRs are recorded on SCLs that are retained in project files.

A.2.2.4 *Surface and Subsurface Soil Sampling*

Soil samples were collected using “scoop and trowel” (surface hand-grab sampling), hand auger and backhoe. All sample locations were initially field screened for alpha and beta/gamma radiation before the start of sampling. Additional screening was conducted during sample collection to both guide the investigation and serve as a health and safety control to protect the sampling team. Labeled sample containers were filled according to a prescribed sequence. Volatile organic compounds (VOCs) sample containers were filled with soil directly from the sample location. Additional soil was transferred into a contaminant-free pan, homogenized, and field screened for alpha and beta/gamma radiation. Samples for the analysis of gamma radiation and TPH-DRO were then collected from the homogenized soil. All remaining sample containers were then filled. Excess soil was returned to its original location, and the sample containers appropriately disposed of, based on FSR and/or analytical results.

Surface soil samples were collected from 0.0 to 0.5 ft bgs at biased locations focusing on stained soil, aboveground features (e.g., presence of oil filters, photograph development supplies), settling areas, mounds of drilling mud, subsurface geophysical anomalies, or areas with elevated radiological measurements. Subsurface soil samples were also collected at surface sample locations where field-screening and analytical results indicated contamination. In addition to the collection of samples from biased locations, probabilistic surface sample locations were established for both the circular and rectangular components of CAS 03-17-01 due to the limited number of biasing factors. The probabilistic sample locations were generated using the Visual Sample Plan (VSP) program (PNNL, 2002).

A.2.2.5 Waste Characterization Sampling

Characterization of decontamination rinsate waste was performed to support recommendations for disposal.

Samples were analyzed in accordance with the CAIP for CAU 545 (NNSA/NSO, 2007). The specific analyses for each CAS are listed in CAS-specific sections, and the analytical results were compared to the federal limits for hazardous waste, NDEP hydrocarbon action limit, landfill acceptance criteria, and the limits in the NTS performance objective criteria (POC) (BN, 1995). The POC limits have been established for NTS hazardous waste generators to ensure that all hazardous waste being shipped offsite contains no “added radioactivity.”

A.2.3 Laboratory Analytical Information

Chemical and radiological analyses were performed by General Engineering Laboratories, LLC, of Charleston, South Carolina. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in [Table A.2-2](#). Analytical results are reported in this appendix if they were detected above the minimum detectable concentrations (MDCs). The complete laboratory data packages are maintained in the project files.

Table A.2-2
Laboratory Analytical Parameters and Methods, CAU 545 Investigation Samples^a
(Page 1 of 2)

Analytical Parameter	Analytical Method^b
Volatile Organic Compounds	EPA SW-846 8260B ^c
Semivolatile Organic Compounds	EPA SW-846 8270C ^c
RCRA Metals ^d Plus Beryllium	EPA SW-846 6010B/7470A/7471A ^c
TPH-DRO	EPA SW-846 8015 ^c Modified
TPH-GRO	EPA SW-846 8015 ^c Modified
Polychlorinated Biphenyls	EPA SW-846 8082 ^c
Gamma Spectroscopy	DOE EML HASL 300 ^e Approved Laboratory SOPs ^f
Isotopic Uranium	DOE EML HASL-300 ^e U-02-RC Modified, Approved Laboratory SOPs ^f
Isotopic Plutonium	DOE EML HASL-300 ^e PU-02-RC/PU-10-RC Modified, Approved Laboratory SOPs ^f

Table A.2-2
Laboratory Analytical Parameters and Methods, CAU 545 Investigation Samples^a
(Page 2 of 2)

Analytical Parameter	Analytical Method ^b
Strontium-90	EPA 905.0 ^g Modified, Approved Laboratory SOPs ^f
Gross Alpha/Beta	EPA 900.0 ^g Modified, Approved Laboratory SOPs ^f
Tritium	EPA 906.0 ^g Modified, Approved Laboratory SOPs ^f

^aInvestigation samples include both environmental and waste characterization samples and associated quality control samples.

^bThe most current EPA, DOE, ASTM, or NIOSH or equivalent accepted analytical method may be used.

^c*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, 3rd edition, Parts 1-4, SW-846 CD-ROM (EPA, 1996).

^dArsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.

^e*The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997).

^fLaboratory Standard Operating Procedures approved by SNJV in accordance with industry standards and the SNJV Model Statement of Work requirements (SNJV, 2006).

^g*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EMSL/ORD, 1980).

Note: The term "modified" indicates modifications of approved methods. All modifications have been approved by the SNJV Analytical Services Department.

ASTM = American Society of Testing and Materials

DOE = U.S. Department of Energy

DRO = Diesel-range organics

EML = Environmental Measurements Laboratory

EPA = U.S. Environmental Protection Agency

GRO = Gasoline-range organics

HASL = Health and Safety Laboratory

NIOSH = National Institute for Occupational Safety and Health

RCRA = *Resource Conservation and Recovery Act*

SOP = Standard Operating Procedure

SNJV = Stoller-Navarro Joint Venture

TPH = Total petroleum hydrocarbons

Validated analytical data for CAU 545 investigation samples have been compiled and evaluated to confirm the presence of contamination and define the extent of contamination, if present. The analytical results for each CAS are presented in [Sections A.3.0](#) through [A.7.0](#).

The analytical parameters are CAS-specific and were selected through application of the DQOs process as documented in the CAIP for CAU 545 (NNSA/NSO, 2007). Samples collected during step-out sampling were only analyzed for the COPCs that exceeded FALs in the original samples.

A.2.4 Comparison to Action Levels

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006).

Multiple constituent analyses are presented in [Appendix C](#).

If COCs are present, corrective action must be considered for the CAS. The FALs for the CAU 545 investigation are defined in [Section 2.3.1](#) for each CAS. Results that are equal to or greater than FALs are identified by bold text in the CAS-specific results tables ([Sections A.3.0](#) through [A.7.0](#)).

The evaluation of the need for corrective action included the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released. To evaluate the potential for waste material to result in the introduction of a COC to the surrounding environmental media, the following conservative assumptions were made:

- That any 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 nonliquid waste.
- That any contaminant in the liquid wastes exceeding the RCRA toxicity characteristic concentration can result in introduction of a COC to the surrounding media.

Oil filters with contaminant concentrations exceeding an equivalent FAL would be considered a PSM.

A.3.0 Corrective Action Site 02-09-01, Mud Disposal Area

Corrective Action Site 02-09-01 is located immediately to the west of the 2-05 Road and Circle Road intersection in Area 2 of the NTS ([Figure A.1-1](#)). The site encompasses the U-2ei crater and three adjacent mud disposal areas. Due to safety concerns, a worker safety buffer was established 50 ft from the rim of the crater and was precluded from sampling activities. During the DQOs, it was agreed that the material within the crater and buffer zone is the same as the material outside at the three disposal areas. Therefore, the sampling results from the material collected outside these two areas would be applied to all components of the CAS including the crater and the buffer zone. Additional detail is provided in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.3.1 Corrective Action Investigation

A total of 22 characterization samples (including two field duplicates [FDs]) were collected during investigation activities at CAS 02-09-01. The sample locations are shown on [Figure A.3-1](#). The sample locations, identifications (IDs), types, and analyses are listed in [Table A.3-1](#). The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2007) are described in the following sections.

A.3.1.1 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation and beta/gamma radiation FSLs were not exceeded at CAS 02-09-01, and FSRs were not used in the selection of analytical samples.

A.3.1.2 Radiological Surveys

Radiological walkover surveys were conducted over the mud spill areas inside and outside the fence, up to 50 ft from the crater rim, at CAS 02-09-01. The survey did not identify elevated radioactivity on the mud-impacted area ([Figure A.3-2](#)); therefore, the radiological survey was not used in the selection of sample locations.

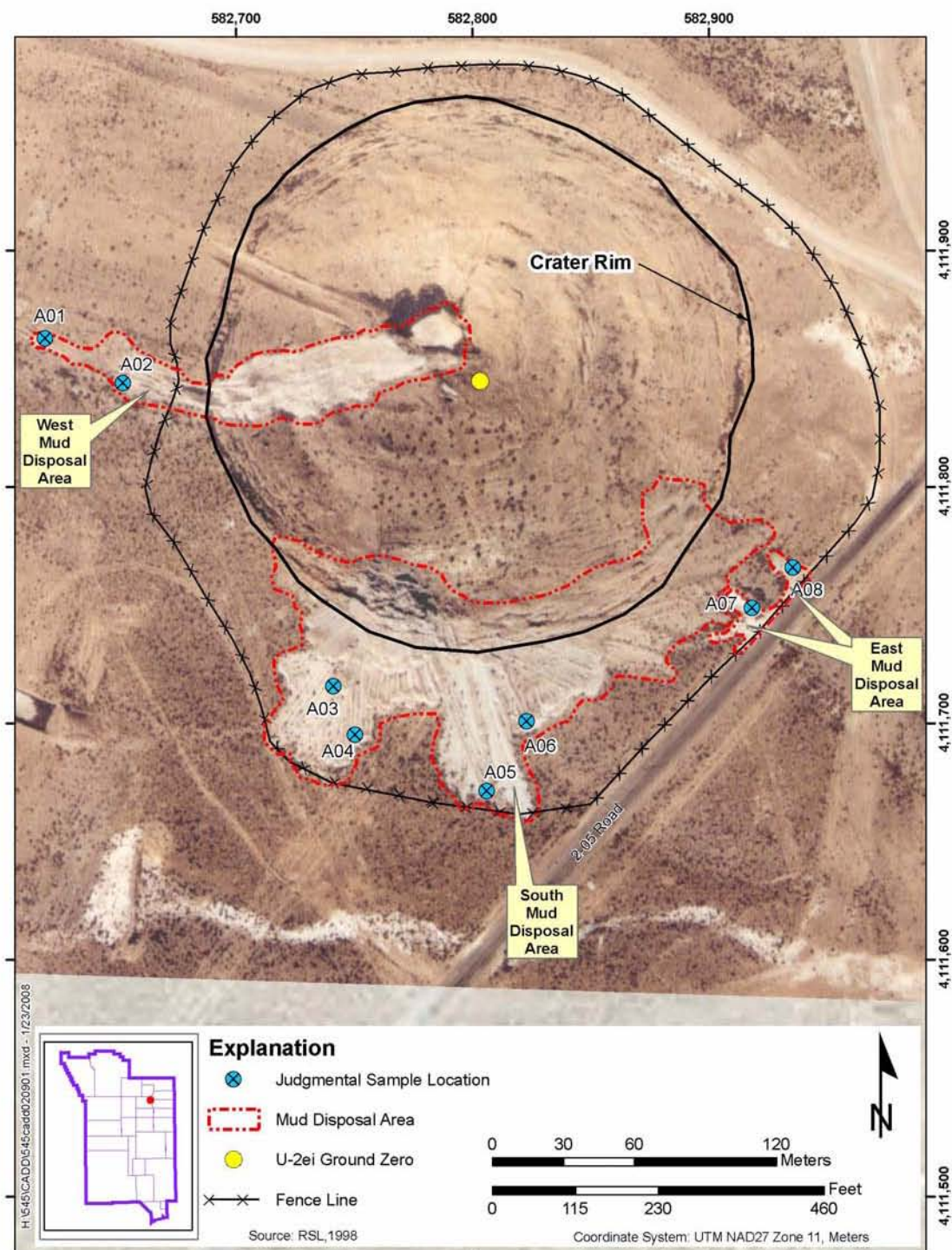


Figure A.3-1
Sample Locations at CAS 02-09-01, Mud Disposal Area

Table A.3-1
Samples Collected at CAS 02-09-01, Mud Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
A01	545A001	0.0 - 0.5	Soil	Environmental	Set 1
	545A006	0.75 - 1.25	Soil	Environmental	Set 1
A02	545A002	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 1
	545A007	1.0 - 1.5	Soil	Environmental	Set 1
A03	545A003	0.0 - 0.5	Soil	Environmental	Set 1
	545A008	2.5 - 3.0	Soil	Environmental	Set 1
	545A009	7.0 - 7.5	Soil	Environmental	Set 1
A04	545A004	0.0 - 0.5	Soil	Environmental	Set 1
	545A005	0.0 - 0.5	Soil	Field Duplicate of #545A004	Set 1
	545A010	2.0 - 2.5	Soil	Environmental	Set 1
	545A011	3.0 - 3.5	Soil	Environmental	Set 1
A05	545A012	0.0 - 0.5	Soil	Environmental	Set 1
	545A014	2.5 - 3.0	Soil	Environmental	Set 1
	545A015	3.5 - 4.0	Soil	Environmental	Set 1
A06	545A013	0.0 - 0.5	Soil	Environmental	Set 1
	545A016	3.0 - 3.5	Soil	Environmental	Set 1
	545A017	5.5 - 6.0	Soil	Environmental	Set 1
A07	545A018	0.0 - 0.25	Soil	Environmental	Set 1
	545A020	0.25 - 1.0	Soil	Environmental	Set 1
	545A021	0.25 - 1.0	Soil	Field Duplicate of #545A020	Set 1
A08	545A019	0.0 - 0.33	Soil	Environmental, Full Lab QC	Set 1
	545A022	0.33 - 0.83	Soil	Environmental	Set 1
N/A	545A301	N/A	Water	Field Blank	Set 1
N/A	545A302	N/A	Water	Equipment Rinsate	Set 1
N/A	545A501	NA	Liquid	Waste Management	Set 1, Gross Alpha/Beta, Tritium
N/A	545A502	N/A	Liquid	Waste Management	Set 1, Gross Alpha/Beta, Tritium

Set 1 = Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

bgs = Below ground surface

ft = Foot

N/A = Not applicable

QC = Quality control

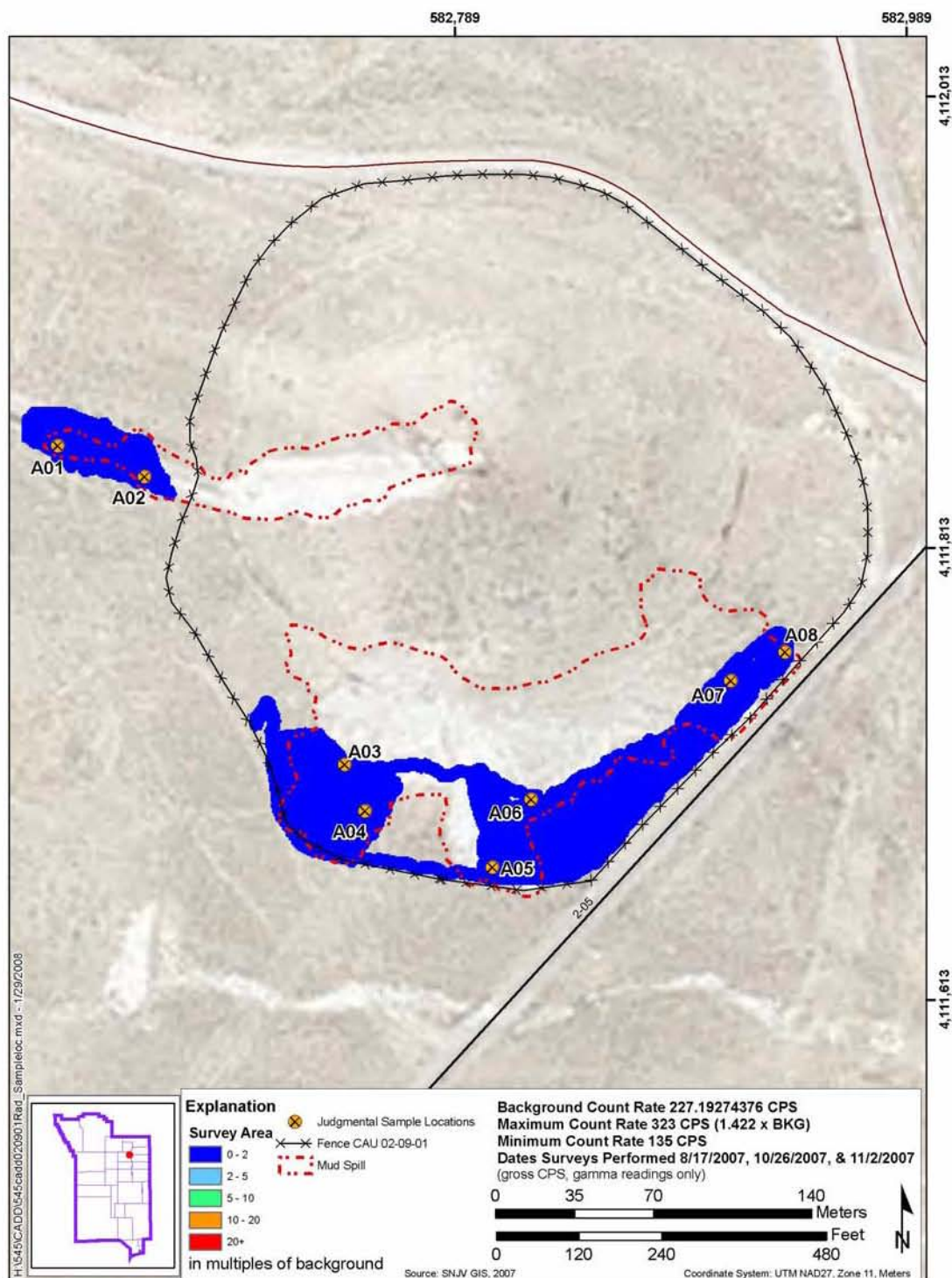


Figure A.3-2
Radiological Survey for CAS 02-09-01, Mud Disposal Area

A.3.1.3 Visual Inspections

A visual inspection of the site did not identify any unusual staining or the presence of potentially containing hazardous or radiological materials and debris (e.g., lead bricks, lead batteries, drums or other containers). The drilling mud (Figure A.3-3), and two sediment accumulation areas in the east disposal area, were the only biasing factors. As these were features identified for sample collection in the CAIP (NNSA/NSO, 2007), no additional sample locations were identified.

A.3.1.4 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples within the drilling mud disposal areas (Figure A.3-1) at this CAS.

Environmental samples were collected from six mounds of drilling mud and two sediment accumulation areas. Sample 545A001 was collected from the surface interval (0.0 to 0.5 ft bgs) at location A01, the westernmost mound in the west disposal area (Figure A.3-1). As no biasing factors were detected within the mound profile the subsurface sample (545A006) was collected at the drilling mud/native soil interface (0.75 to 1.25 ft bgs). At location A02 at the second mound in the west disposal area, Sample 545A002 was collected from the surface interval (0.0 to 0.5 ft bgs) and the subsurface sample (545A007) was collected at the drilling mud/native soil interface (1.0 to 1.5 ft bgs). For both mounds, gravel consistent with the surface rock in the area was mixed in with the drilling mud throughout the profiles. The presence of gravel in the mud suggests that either the mud has been used, and the gravel represents drill cuttings; the mud was spilled onsite and mounded by dumping or pushing with mechanical equipment; or it was collected and transported to CAS 02-09-01.

Within the south disposal area, location A03 was established at the highest mound (approximately 7.0 ft) present outside of the 50-ft worker safety buffer. Samples collected at this location include the surface (545A003), a mid-mound subsurface sample (545A008) at 2.5 to 3.0 ft bgs, and a sample (545A009) collected at the drilling mud/native soil interface (7.0 to 7.5 ft bgs). The mud was fairly homogenous throughout the mound; though thin layers of the mud were present in the mid-section, and gravel was present through the entire profile.

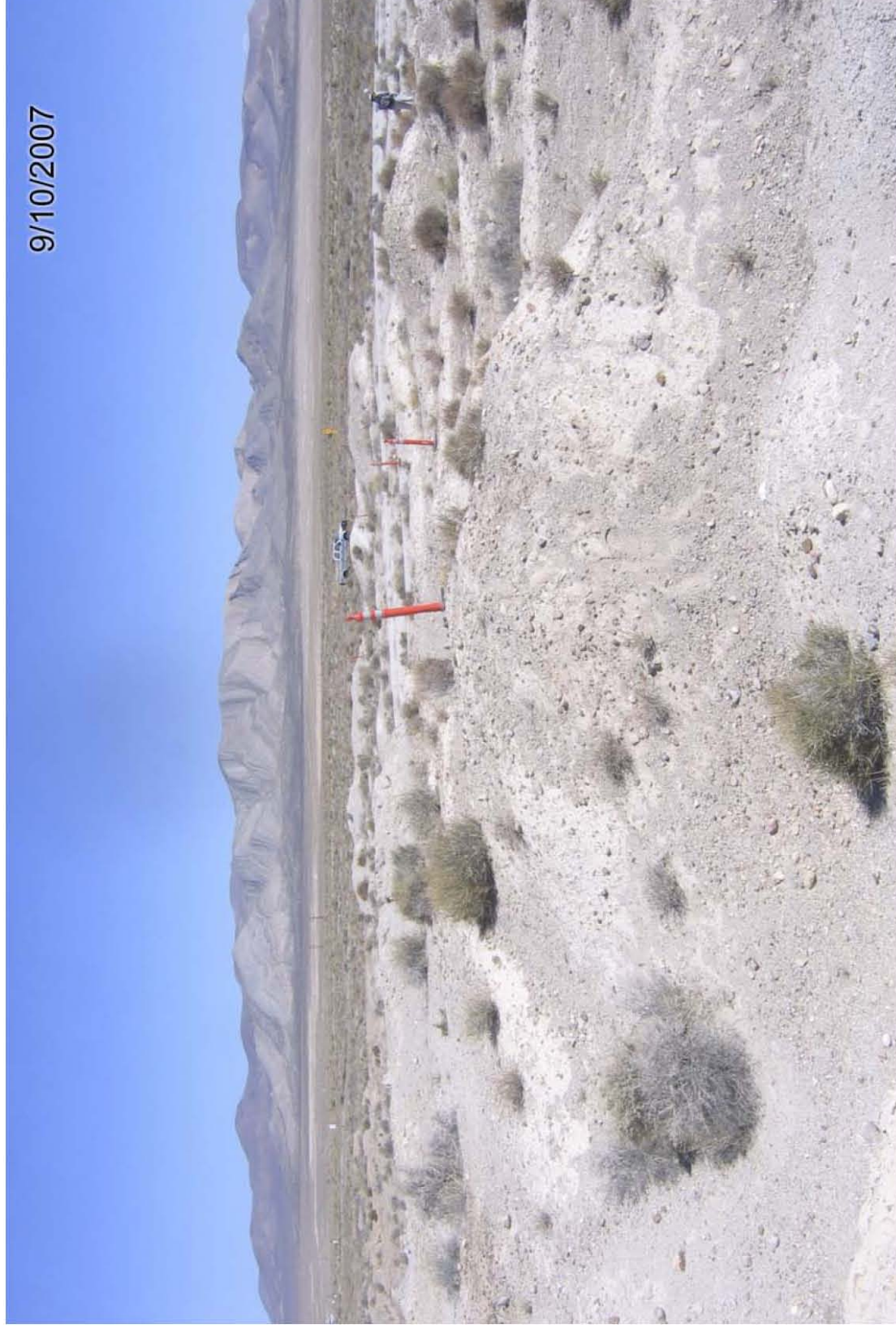


Figure A.3-3
Mounds of Drilling Mud at CAS 02-09-01

Location A04 was at a mound approximately 3.0 to 3.5 ft high selected for sampling because two T-posts protruding from the mound at different angles were identified. The mound and T-posts had the appearance of originating from a mud spill at another location. At location A04, a sample (545A004) and duplicate (545A005) were collected at the surface (0.0 to 0.5 ft bgs), a sample (545A010) was collected from within the mound (2.0 to 2.5 ft bgs), and a sample (545A011) was collected at the drilling mud/native soil interface (3.0 to 3.5 ft bgs). The mound was homogenous throughout with gravel present through the entire profile.

Location A05 was also at a shorter mound (approximately 3.5 ft high) identified for sampling because the mud was a darker gray than other mud at the site. The dried mud formed a subangular blocky structure which was unique to the mud in the area. A sample (545A012) was collected at the surface (0.0 to 0.5 ft bgs), a sample (545A014) was collected within the mound (2.5 to 3.0 ft bgs), and a sample (545A013) was collected at the drilling mud/native soil interface (3.0 to 3.5 ft bgs).

Location A06 was at the highest mound (approximately 6.0 ft high) in the eastern portion of the south disposal area. A sample (545A013) was collected at the surface (0.0 to 0.5 ft bgs), a sample (545A016) was collected within the mound (3.0 to 3.5 ft bgs), and a sample (545A017) was collected at the drilling mud/native soil interface (5.5 to 6.0 ft bgs).

Locations A07 and A08 were selected at sediment accumulation points in the east disposal area. Before sampling, a rainstorm left several inches of runoff from the surrounding mounds of drilling mud at the two locations. Location A08 was dry enough to be sampled a week later; however, location A07 had to be moved a several feet to the west within the settling area, due to persistent standing water. Surface samples (545A018 and 545A019) were taken at locations A07 and A08 from 0.0 to 0.25 and 0.0 to 0.33 ft bgs, respectively. Subsurface samples (545A020 and duplicate 545A021, and 545A022) were collected at locations A07 and A08 from 0.25 to 1.0 ft bgs and 0.33 to 0.83 ft bgs, respectively.

A.3.1.5 Deviations

Investigation samples were collected as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007) and submitted for laboratory analysis. There were no deviations to the planned sampling.

A.3.2 Investigation Results

The following sections provide analytical results from the samples collected at CAS 02-09-01 to complete investigation activities as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007).

[Table A.3-1](#) lists the sample-specific analytical suite for CAS 02-09-01, which included gamma-emitting radionuclides, isotopic Pu, strontium (Sr)-90, and isotopic uranium (U). The analytical parameters and laboratory methods used to analyze the investigation samples are listed in [Table A.2-2](#). The waste characterization analytical results are discussed in [Section A.8.0](#).

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in the following sections. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. Establishment of the FALs is presented in [Appendix C](#). The FALs were established as the corresponding PAL concentrations or activities if the contaminant concentrations were below their respective PALs.

A.3.2.1 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.3-2](#). No gamma-emitting radionuclide exceeded the FALs. The FALs were established at the PAL concentrations.

A.3.2.2 Plutonium, Strontium-90, and Uranium Isotopes

Isotopic Pu and isotopic U analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.3-3](#). No isotopic Pu, isotopic U, or Sr-90 exceeded the FALs. The FALs were established at the PAL concentrations.

A.3.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected during the CAI, no COCs were identified at CAS 02-09-01.

A.3.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2007) were met at this CAS, and no revisions were necessary to the CSM.

Table A.3-2
Soil Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at CAS 02-09-01, Mud Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Actinium-228	Cesium-137	Lead-212	Lead-214	Thallium-208
Final Action Levels			5 ^a	12.2 ^b	5 ^a	5 ^a	5 ^a
A01	545A001	0.0 - 0.5	2.14	--	2.21	1.31	0.751
	545A006	0.75 - 1.25	1.78	1.23	1.96	1.26	0.725
A02	545A002	0.0 - 0.5	1.82	--	1.88	1.25	0.686
	545A007	1.0 - 1.5	2.06	--	1.83	1.05	0.572
A03	545A003	0.0 - 0.5	1.94	--	2.05	1.08	0.503
	545A008	2.5 - 3.0	1.42	--	2.02	1.21	0.624
	545A009	7.0 - 7.5	1.9	--	2.4	1.37	0.65
A04	545A004	0.0 - 0.5	1.75	--	1.71	1.08	0.539
	545A005	0.0 - 0.5	1.64	--	1.95	1.23	0.506
	545A010	2.0 - 2.5	2.03	--	2.03	1.31	0.655
	545A011	3.0 - 3.5	1.92	--	1.73	1.03	0.572
A05	545A012	0.0 - 0.5	2.3	--	1.81 (J)	1.4 (J)	0.496
	545A014	2.5 - 3.0	1.61	--	1.8 (J)	1.34 (J)	0.469
	545A015	3.5 - 4.0	2.31	0.727	1.96 (J)	1.25 (J)	0.652
A06	545A013	0.0 - 0.5	2.01	--	2.12	1.25	0.685
	545A016	3.0 - 3.5	2.05	--	2.16	1.24	0.662
	545A017	5.5 - 6.0	1.95	0.201	1.87 (J)	1.32 (J)	0.627
A07	545A018	0.0 - 0.25	2.67	0.504	2.38	1.43	0.859
	545A020	0.25 - 1.0	2.06	0.625	1.94	1.41	0.7
	545A021	0.25 - 1.0	2.18	0.74	1.96	1.27	0.65
A08	545A019	0.0 - 0.33	2.12	0.542	2.39	1.44	0.737
	545A022	0.33 - 0.83	1.6	2.04	2.2	1.32	0.741

^aTaken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993). The PALs for these isotopes are specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

^bTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

cm = Centimeter

DOE = U.S. Department of Energy

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Table A.3-3
Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 02-09-01, Mud Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
Final Action Levels ^a			13	12.7	838	143	105
A01	545A001	0.0 - 0.5	--	--	0.255	1.11	0.912
	545A006	0.75 - 1.25	--	0.818	--	0.892	0.685
A02	545A002	0.0 - 0.5	--	--	--	0.992	1.08
	545A007	1.0 - 1.5	--	--	--	0.841	0.765
A03	545A003	0.0 - 0.5	--	--	--	1.08	0.986
	545A008	2.5 - 3.0	--	--	--	0.944	0.866
	545A009	7.0 - 7.5	--	--	--	1.21	0.928
A04	545A004	0.0 - 0.5	--	0.0551	--	0.934	0.956
	545A005	0.0 - 0.5	--	--	--	0.861	0.784
	545A010	2.0 - 2.5	--	--	--	1.25	1.04
	545A011	3.0 - 3.5	--	--	--	0.91	0.885
A05	545A012	0.0 - 0.5	--	0.18	--	0.808	0.798
	545A014	2.5 - 3.0	--	0.288	--	0.9	0.942
	545A015	3.5 - 4.0	--	0.294	--	0.7	0.724
A06	545A013	0.0 - 0.5	--	--	--	1.14	0.954
	545A016	3.0 - 3.5	--	--	--	0.978	0.964
	545A017	5.5 - 6.0	--	--	--	0.917	0.898
A07	545A018	0.0 - 0.25	--	0.407 (J)	--	1.15	1.09
	545A020	0.25 - 1.0	0.0249	0.152 (J)	--	1.27	0.792
	545A021	0.25 - 1.0	--	0.188 (J)	--	0.714	0.915
A08	545A019	0.0 - 0.33	--	0.461 (J)	--	1.26	1.18
	545A022	0.33 - 0.83	0.0578	0.725 (J)	0.289	1.14	1.15

^aTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year-dose.

bgs = Below ground surface
ft = Foot

NCRP = National Council on Radiation Protection and Measurements
pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

A.4.0 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

Corrective Action Site 03-17-01 is located 1.0 mi east of the Area 3 RWMS at the NTS ([Figure A.1-1](#)). The site served as the consolidation area for debris from atmospheric testing during the 1950s and 1960s, which was then removed during the 1980s. The site consists of two components: a rectangular area measuring 950 by 750 ft, posted as a contamination area; and a unposted circular area measuring 145 ft in diameter. The site was sampled by a combined probabilistic and judgmental approach. Additional detail is provided in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.4.1 Corrective Action Investigation

A total of 58 characterization samples (including three FDs) were collected at 46 locations during investigation activities at CAS 03-17-01. Surface samples taken for the probabilistic approach were collected at locations B01 through B16, and B19 through B26, for a total of 24 samples. All other surface samples, and all subsurface samples, were collected as judgmental samples. The sample locations are shown on [Figure A.4-1](#). The sample locations, IDs, types, and analyses are listed in [Table A.4-1](#). The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2007) are described in the following sections.

A.4.1.1 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were exceeded in eight samples and beta/gamma radiation FSLs were exceeded in nine samples at CAS 03-17-01. For the eight background samples collected outside the CAS, the gross alpha radiation FSL was exceeded in one sample and beta/gamma radiation FSL was exceeded in three samples. All samples exceeding FSLs were analyzed for radiological constituents.

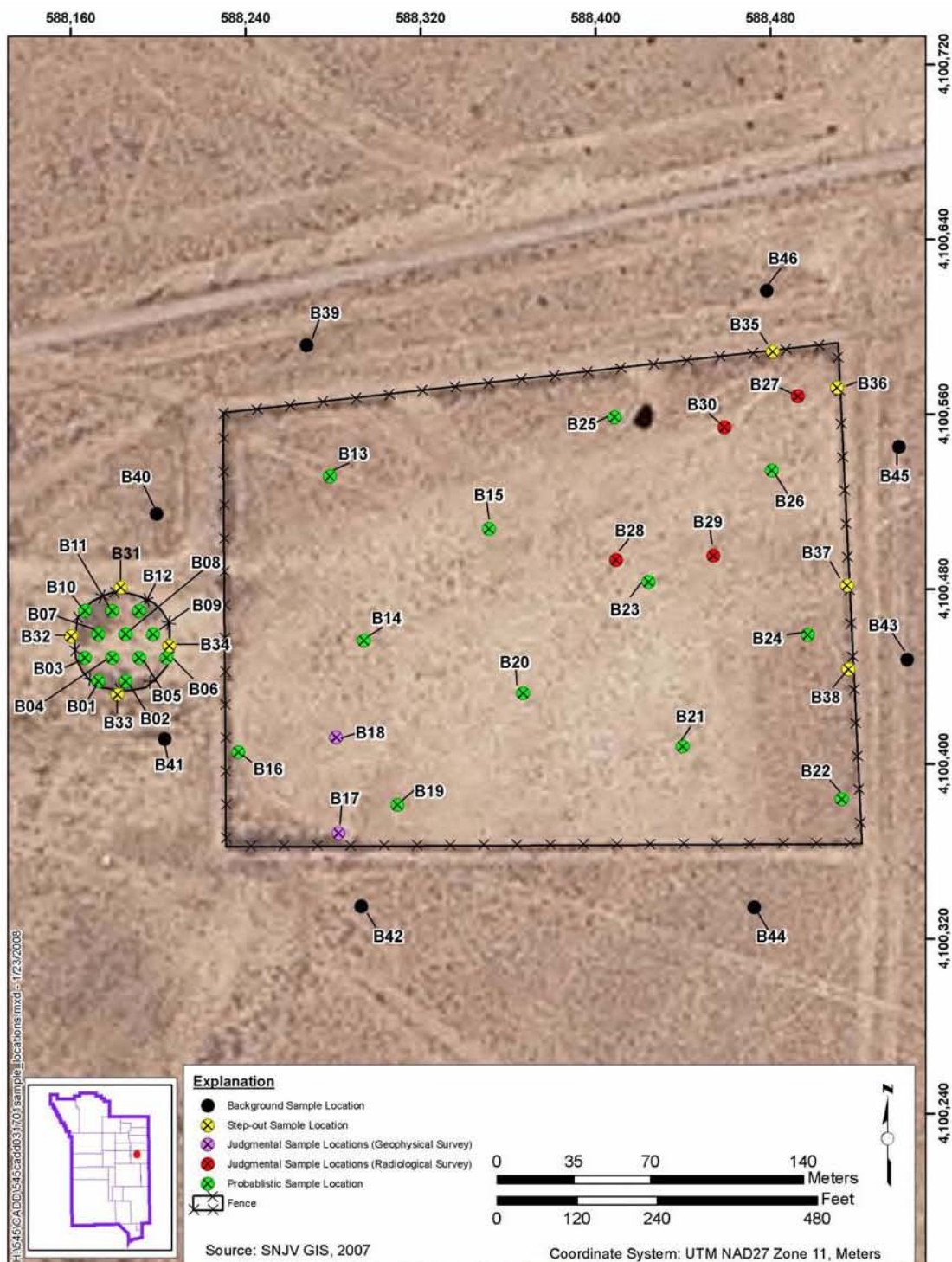


Figure A.4-1
Sample Locations at CAS 03-17-01, Waste Consolidation Site 3B

Table A.4-1
Samples Collected at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
B01	545B001	0.0 - 0.5	Soil	Environmental	Set 2
B02	545B002	0.0 - 0.5	Soil	Environmental	Set 2
B03	545B003	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 2
B04	545B004	0.0 - 0.5	Soil	Environmental	Set 2
B05	545B005	0.0 - 0.5	Soil	Environmental	Set 2
B06	545B006	0.0 - 0.5	Soil	Environmental	Set 2
B07	545B007	0.0 - 0.5	Soil	Environmental	Set 2
	545B008	0.0 - 0.5	Soil	Field Duplicate of #545B007	Set 2
B08	545B009	0.0 - 0.5	Soil	Environmental	Set 2
B09	545B010	0.0 - 0.5	Soil	Environmental	Set 2
B10	545B011	0.0 - 0.5	Soil	Environmental	Set 2
	545B014	0.5 - 1.0	Soil	Environmental	Set 2
B11	545B012	0.0 - 0.5	Soil	Environmental	Set 2
	545B050	1.0 - 1.5	Soil	Environmental	Set 1
B12	545B013	0.0 - 0.5	Soil	Environmental	Set 2
B13	545B015	0.0 - 0.5	Soil	Environmental	Set 2
B14	545B016	0.0 - 0.5	Soil	Environmental	Set 2
B15	545B017	0.0 - 0.5	Soil	Environmental	Set 2
B16	545B018	0.0 - 0.5	Soil	Environmental	Set 2
B17	545B019	0.0 - 0.5	Soil	Environmental	Set 2
B18	545B020	0.0 - 0.5	Soil	Environmental	Set 2
B19	545B021	0.0 - 0.5	Soil	Environmental	Set 2
B20	545B022	0.0 - 0.5	Soil	Environmental	Set 2
B21	545B023	0.0 - 0.5	Soil	Environmental	Set 2
B22	545B024	0.0 - 0.5	Soil	Environmental	Set 2
B23	545B025	0.0 - 0.5	Soil	Environmental	Set 2
B24	545B026	0.0 - 0.5	Soil	Environmental	Set 2
B25	545B027	0.0 - 0.5	Soil	Environmental	Set 2
	545B028	0.0 - 0.5	Soil	Field Duplicate of #545B027	Set 2
B26	545B029	0.0 - 0.5	Soil	Environmental	Set 2
B27	545B030	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 2
	545B033	0.5 - 1.0	Soil	Environmental	Set 2
	545B041	1.0 - 1.5	Soil	Environmental	Set 1
B28	545B031	0.0 - 0.5	Soil	Environmental	Set 2
	545B035	0.5 - 1.0	Soil	Environmental	Set 2
	545B045	1.0 - 1.75	Soil	Environmental	Set 1

Table A.4-1
Samples Collected at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
B29	545B032	0.0 - 0.5	Soil	Environmental	Set 2
	545B036	0.5 - 1.0	Soil	Environmental	Set 2
	545B043	1.0 - 2.0	Soil	Environmental	Set 1
	545B044	1.0 - 2.0	Soil	Field Duplicate of #545B043	Set 1
B30	545B034	0.0 - 0.5	Soil	Environmental	Set 2
	545B042	1.0 - 1.5	Soil	Environmental	Set 1
B31	545B053	0.0 - 0.25	Soil	Environmental	Set 1
B32	545B054	0.0 - 0.5	Soil	Environmental	Set 1
B33	545B052	0.0 - 0.5	Soil	Environmental	Set 1
B34	545B051	0.0 - 0.5	Soil	Environmental	Set 1
B35	545B037	0.0 - 0.5	Soil	Environmental	Set 1
B36	545B038	0.0 - 0.5	Soil	Environmental	Set 1
B37	545B039	0.0 - 0.5	Soil	Environmental	Set 1
B38	545B040	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 1
B39	545B055	0.0 - 0.5	Soil	Environmental, Background	Set 1
B40	545B056	0.0 - 0.5	Soil	Environmental, Background	Set 1
B41	545B057	0.0 - 0.5	Soil	Environmental, Background	Set 1
B42	545B058	0.0 - 0.5	Soil	Environmental, Background	Set 1
B43	545B049	0.0 - 0.5	Soil	Environmental, Background	Set 1
B44	545B048	0.0 - 0.5	Soil	Environmental, Background	Set 1
B45	545B047	0.0 - 0.5	Soil	Environmental, Background	Set 1
B46	545B046	0.0 - 0.5	Soil	Environmental, Background	Set 1
N/A	545B301	N/A	Water	Field Blank	Set 2
N/A	545B302	N/A	Water	Equipment Rinsate	Set 1
N/A	545B501	N/A	Liquid	Waste Management	Set 2, Gross Alpha/Beta, Tritium
N/A	545B502	N/A	Liquid	Waste Management	Set 1, Gross Alpha/Beta, Tritium

Set 1 = Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

Set 2 = RCRA Metals, Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

bgs = Below ground surface

ft = Foot

N/A = Not applicable

QC = Quality control

RCRA = Resource Conservation and Recovery Act

A.4.1.2 Radiological Surveys

A radiological walkover survey was conducted over the areas encompassing the circular and rectangular components of CAS 03-17-01 ([Figure A.4-2](#)). Several areas were found to have elevated radiological readings at approximately two times background and were used as biasing factors to select four locations for sampling.

A.4.1.3 Geophysical Survey

A geophysical survey was conducted over the areas encompassing the circular and rectangular components of CAS 03-17-01. The survey identified 101 discrete anomalies, interpreted to represent subsurface metal objects. Two of these locations were sampled. Details of the survey results, along with the survey map, are in the CAIP for CAU 545, Section A.2.3.1 (NNSA/NSO, 2007).

A.4.1.4 Visual Inspections

There were no visible biasing factors identified at this CAS. All locations were selected on the basis of the probabilistic sampling approach and from the geophysical and radiological survey data.

A.4.1.5 Sample Collection

Decision I environmental sampling activities at both the circular and rectangular components were conducted within the guidelines of a probabilistic sampling approach, with additional biased soil samples collected from the rectangular component ([Figure A.4-1](#)), and outside the fenced boundaries. Locations B01 through B16 and B19 through B26 were predetermined randomized locations. Locations B17 and B18 were established at geophysical anomalies, and locations B27 through B30 were established at areas of elevated radiological readings. Step-out locations B31 through B38 were established at locations along the fence lines of both the circular and rectangular components. Background locations B39 through B46 were established in pairs diagonally outward from the corners of the rectangular component. Locations B01 through B12 were established in the circular area, and B13 through B30, as well as B38, were established within the fence at the rectangular area.

Surface samples were collected at all locations from the interval of 0.0 to 0.5 ft bgs. Brush obstructing several locations was cleared back. Other obstructions such as large rocks or scrap metal were not encountered at any sample location.

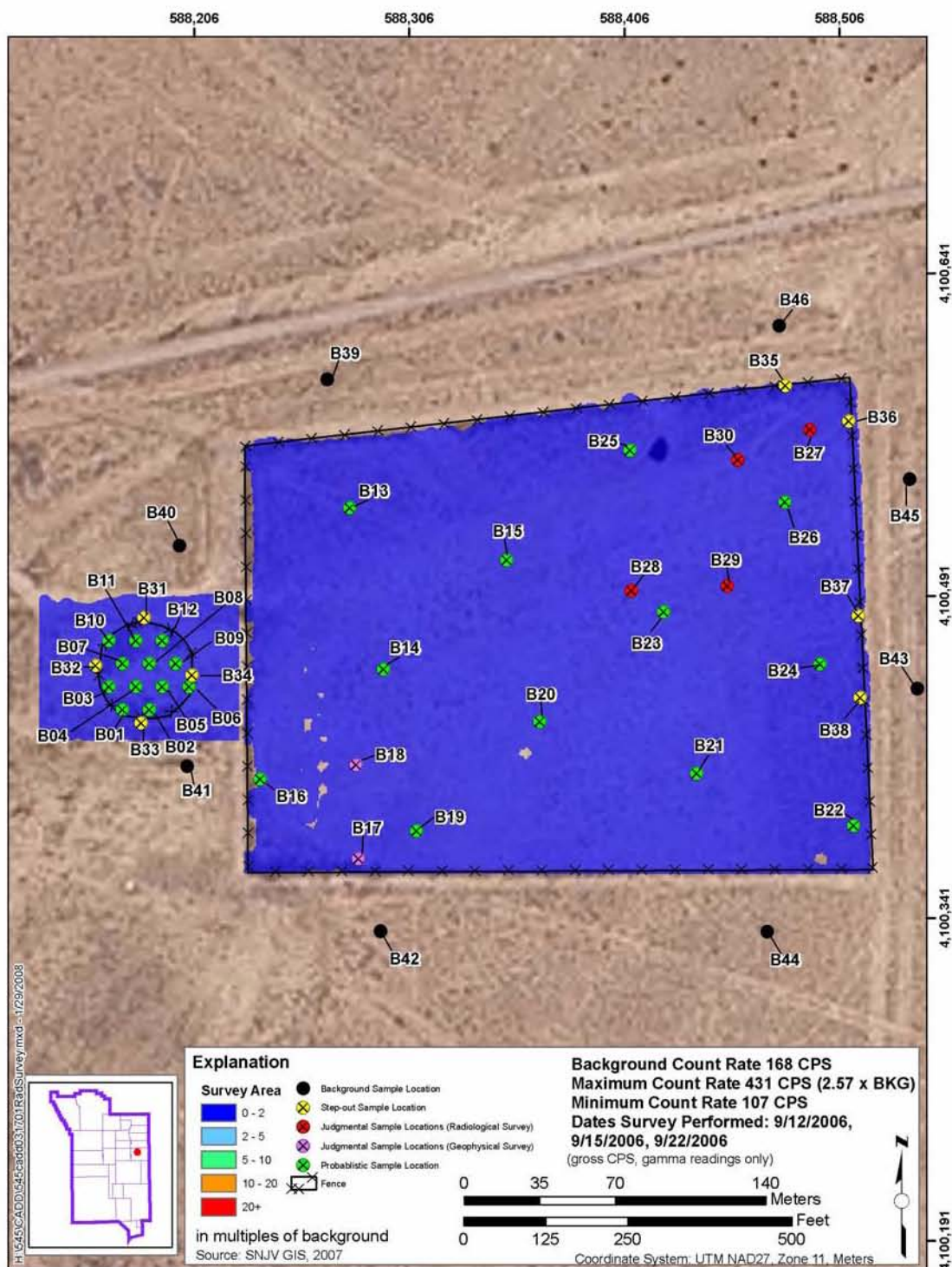


Figure A.4-2
Radiological Survey of CAS 03-17-01

The FSLs for alpha were exceeded at locations B10, B13, B14, B27, B28, B29, and B41, from just above the FSL to 15 times FSL; and the FSLs for beta were exceeded at locations B14, B16, B17, B27, B28, B29, B30, B40, B41, and B42, from just above the FSL to 1.8 times the FSL. The values for the FSRs are maintained in the project files.

Because FSLs were exceeded, nine shallow subsurface samples were collected at the two components at six locations with the highest screening readings.

A.4.1.6 Deviations

Investigation samples were collected as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007) and submitted for laboratory analysis. All sample locations were accessible and each probabilistic sample was collected at its predetermined location.

A.4.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007). Investigation samples were analyzed for the CAIP-specified COPCs, which included RCRA metals, gamma-emitting radionuclides, isotopic Pu, Sr-90, and isotopic U. The analytical parameters and laboratory methods used during this investigation are listed in [Table A.2-2](#). [Table A.4-1](#) lists the sample-specific analytical suite for CAS 03-17-01. The waste characterization analytical results are discussed in [Section A.8.0](#).

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in the following sections. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. The FALs were established as the corresponding PAL concentrations or activities if the contaminant concentrations were below their respective PALs. For constituents that were reported at concentrations exceeding their respective PAL, the FAL determinations are presented in [Appendix C](#).

A.4.2.1 RCRA Metals

The RCRA metals analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.4-2](#). No RCRA metals were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

Table A.4-2
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Final Action Levels			23 ^a	67,000 ^b	450 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b	5,100 ^b
B01	545B001	0.0 - 0.5	3.2	137 (J)	0.22 (J)	6.8	7.7	0.0081 (J-)	0.55 (J+)	--
B02	545B002	0.0 - 0.5	4.1	134 (J)	0.16 (J)	7.5	8.6	0.006 (J-)	0.78 (J+)	--
B03	545B003	0.0 - 0.5	3.8	127 (J)	0.19 (J)	8.6	8.5	0.0087 (J-)	0.66 (J+)	--
B04	545B004	0.0 - 0.5	3.7	137 (J)	0.32 (J)	7.6	7.7	0.0049 (J-)	--	--
B05	545B005	0.0 - 0.5	4.2	223 (J)	0.23 (J)	6.8	8.7	0.0086 (J-)	0.88 (J+)	--
B06	545B006	0.0 - 0.5	3.3	158 (J)	0.23 (J)	7	8.7	0.0088 (J-)	--	--
B07	545B007	0.0 - 0.5	3.3	129 (J)	0.3 (J)	8.1	8.5	0.0076 (J-)	0.64 (J+)	0.1 (J)
	545B008	0.0 - 0.5	3.6	131 (J)	0.32 (J)	7.8	8.3	0.0083 (J-)	--	--
B08	545B009	0.0 - 0.5	3.6	147 (J)	0.32 (J)	7.8	9.9	0.0064 (J-)	0.75 (J+)	--
B09	545B010	0.0 - 0.5	3.4	174 (J)	0.33 (J)	7.8	7.7	0.0053 (J-)	0.53 (J+)	--
B10	545B011	0.0 - 0.5	3.2	146 (J)	0.29 (J)	6.9	9.7	0.01 (J-)	--	0.23 (J)
	545B014	0.5 - 1.0	3.8	121 (J)	0.24 (J)	7	6.8	0.0047 (J-)	0.82 (J+)	0.1 (J)
B11	545B012	0.0 - 0.5	3.3	166 (J)	0.3 (J)	7.2	9.5	0.0087 (J-)	--	0.1 (J)
B12	545B013	0.0 - 0.5	3.6	133 (J)	0.37 (J)	7.6	7.8	0.01 (J-)	0.99 (J+)	--
B13	545B015	0.0 - 0.5	4.1	129 (J)	--	8.4	8.9	0.015 (J-)	1.7 (J-)	--
B14	545B016	0.0 - 0.5	3.2	159 (J)	--	8	8.8	0.006 (J-)	1.4 (J-)	--
B15	545B017	0.0 - 0.5	3.9	164 (J)	--	8.2	8.5	0.0078 (J-)	1.8 (J-)	--
B16	545B018	0.0 - 0.5	4.5	153 (J)	--	8.2	9.9	0.013 (J-)	1.6 (J-)	--
B17	545B019	0.0 - 0.5	7.6	137 (J)	--	7.7	7.9	0.0088 (J-)	1.4 (J-)	--
B18	545B020	0.0 - 0.5	7.3	118 (J)	--	7.9	8.5 (J)	--	--	--
B19	545B021	0.0 - 0.5	4.6	127 (J)	--	8.1	9.4 (J)	--	--	0.24 (J)
B20	545B022	0.0 - 0.5	4.1	116 (J)	--	6.6	8.1 (J)	0.031 (J)	--	--
B21	545B023	0.0 - 0.5	4	133 (J)	--	7	6.7 (J)	--	--	--
B22	545B024	0.0 - 0.5	4.8	144 (J)	--	8.3	10 (J)	--	--	--

Table A.4-2
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Final Action Levels			23 ^a	67,000 ^b	450 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b	5,100 ^b
B23	545B025	0.0 - 0.5	4.7	140 (J)	--	7.5	9.7 (J)	--	--	--
B24	545B026	0.0 - 0.5	5.4	155 (J)	--	9	11.9 (J)	--	--	--
B25	545B027	0.0 - 0.75	3.9	132 (J)	--	9	8	0.012 (J-)	1.9	--
	545B028	0.0 - 0.5	4.8	121 (J)	--	9.6	7.7	0.012 (J-)	2.6 (J)	--
B26	545B029	0.0 - 0.5	4	137 (J)	--	8.3	8.5	0.0089 (J-)	2.2	--
B27	545B030	0.0 - 0.5	4.9	181 (J)	--	6.7	11.6	0.013 (J-)	1.4 (J)	--
	545B033	0.5 - 1.0	3.7	151 (J)	--	7.9	7.6	0.0078 (J-)	1.4 (J)	--
B28	545B031	0.0 - 0.5	4.9	235 (J)	--	8.2	13.3	0.04 (J-)	1.5 (J)	--
	545B035	0.5 - 1.0	4	212 (J)	--	6.6	9.7	0.011 (J-)	1.6	--
B29	545B032	0.0 - 0.5	4.3	172 (J)	--	7	10.8	0.011 (J-)	1.6	--
	545B036	0.5 - 1.0	3.2	100 (J)	--	6	6.5	0.0087 (J-)	1.3 (J)	--
B30	545B034	0.0 - 0.5	3.8	133 (J)	--	8.8	9.4	0.011 (J-)	2	--

^aBased on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

^bBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

J+ = The result is an estimated quantity, but the result may be biased high.

J- = The result is an estimated quantity, but the result may be biased low.

-- = Not detected above minimum detectable concentrations.

A.4.2.2 Gamma-Emitting Radionuclides

Analytical results for gamma-emitting radionuclides are discussed separately for samples collected through a probabilistic approach (i.e., most surface samples at this CAS) and samples collected through a judgmental approach (i.e., some surface samples within the CAS and all surface samples outside the CAS, as well as all subsurface samples at the CAS).

Probabilistic Sampling Results: Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.4-3](#). The probabilistic sampling design as described in the CAIP for CAU 545 (NNSA/NSO, 2007) stipulates comparing the 95th percent UCL of the mean of each significant COPC (i.e., contaminants present at concentrations greater than PALs) to the FAL to determine whether a COC is present. Therefore, only significant COPCs are evaluated for the presence of COCs. To demonstrate the selection of significant COPCs, [Table A.4-3](#) lists the PALs for gamma-emitting radionuclides.

Table A.4-3
Probabilistic Soil Sample Results for Gamma-Emitting Radionuclides Detected above
Minimum Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
Preliminary Action Levels ^a			5	12.7	12.2	5.7	5	5	5
Final Action Levels ^b			5	1,501	12.2	5.7	5	5	5
Average			NC	5.70	NC	NC	NC	NC	NC
Standard Deviation			NC	5.46	NC	NC	NC	NC	NC
VSP Required Minimum Number of Samples			NC	8	NC	NC	NC	NC	NC
Maximum Result			1.93	29.1	2.2	1.19	1.92	1.283	0.623
95% UCL ^c			NC	8.202	NC	NC	NC	NC	NC
B01	545B001	0.0 - 0.5	1.65	6.35 (J)	0.462 (J)	--	1.53 (J)	1.06 (J)	0.439
B02	545B002	0.0 - 0.5	1.54	4.8 (J)	0.291 (J)	--	1.57 (J)	1.13 (J)	0.466
B03	545B003	0.0 - 0.5	1.42	3.05 (J)	0.63 (J)	--	1.92 (J)	1.09 (J)	0.498
B04	545B004	0.0 - 0.5	1.73	0.828 (J)	--	--	1.52 (J)	1.06 (J)	0.432
B05	545B005	0.0 - 0.5	1.7	6.48 (J)	0.553 (J)	--	1.64 (J)	1.06 (J)	0.479
B06	545B006	0.0 - 0.5	1.53	5.21 (J)	0.424 (J)	--	1.46 (J)	0.959 (J)	0.523
B07	545B007	0.0 - 0.5	1.9	1.3 (J)	--	--	1.49 (J)	1.06 (J)	0.506
	545B008	0.0 - 0.5	1.69	1.14 (J)	0.131 (J)	--	1.6 (J)	1.2 (J)	0.391
B08	545B009	0.0 - 0.5	1.93	15.8 (J)	0.627 (J)	--	1.55 (J)	1.1 (J)	0.454
B09	545B010	0.0 - 0.5	1.56	4.17 (J)	0.335 (J)	--	1.54 (J)	0.972 (J)	0.465
B10 ^d	545B011	0.0 - 0.5	1.71	29.1 (J)	1.37 (J)	--	1.49 (J)	0.941 (J)	0.537
B11	545B012	0.0 - 0.5	1.64	21 (J)	1.05 (J)	--	1.73 (J)	1.25 (J)	0.48

Table A.4-3
Probabilistic Soil Sample Results for Gamma-Emitting Radionuclides Detected above
Minimum Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
B12	545B013	0.0 - 0.5	1.36	10.6 (J)	0.646 (J)	--	1.64 (J)	1.04 (J)	0.528
B13	545B015	0.0 - 0.5	1.66	1.79 (J)	0.959	--	1.65 (J)	1.15 (J)	0.472
B14	545B016	0.0 - 0.5	1.39	16.2 (J)	0.47	0.57 (J)	1.55 (J)	0.961 (J)	0.437
B15	545B017	0.0 - 0.5	1.64	4.33 (J)	0.267	--	1.67 (J)	1.12 (J)	0.565
B16	545B018	0.0 - 0.5	1.56	2.93 (J)	1.29	1.19 (J)	1.62 (J)	1.16 (J)	0.509
B19	545B021	0.0 - 0.5	1.58	0.81	0.257	--	1.87	1.23	0.582
B20	545B022	0.0 - 0.5	1.52	--	--	--	1.67 (J)	1.09 (J)	0.476
B21	545B023	0.0 - 0.5	1.55	3.2 (J)	--	--	1.39 (J)	0.832 (J)	0.617
B22	545B024	0.0 - 0.5	1.33	2.57 (J)	2.2	--	1.76 (J)	1.25 (J)	0.577
B23	545B025	0.0 - 0.5	1.54	1.42 (J)	--	--	1.89 (J)	1.28 (J)	0.422
B24	545B026	0.0 - 0.5	1.73	4.74 (J)	0.353	--	1.67 (J)	1.09 (J)	0.534
B25	545B027	0.0 - 0.75	1.81	2.4 (J)	0.485	--	1.68 (J)	1.01 (J)	0.535
	545B028	0.0 - 0.75	1.48	3.99 (J)	0.69	--	1.56 (J)	0.923 (J)	0.443
B26	545B029	0.0 - 0.5	1.71	9.37	0.403	--	1.63	1.16	0.623

^aDefined in the CAIP for CAU 545 (NNSA/NSO, 2007).

^bEstablished in [Appendix C](#).

^cValue for Am-241 derived as the 95% Approximate Gamma UCL, a nonparametric distribution, and used as a proxy for the 95% UCL.

^dThe result for Am-241 from sample 545B011 was identified as a statistical outlier and was not included in the calculation of the 95% UCL of the mean. The result is included with the probabilistic data for completeness. If this result was included with the other 23 sample results in calculations, the value for the 95% UCL would be 9.757 (95% Approximate Gamma).

Am = Americium

bgs = Below ground surface

CAIP = Corrective Action Investigation Plan

ft = Foot

pCi/g = Picocuries per gram

UCL = Upper confidence limit

VSP = Visual Sample Plan

J = Estimated value

NC = Not calculated, as the contaminant did not qualify as a significant contaminant of potential concern.

-- = Not detected above minimum detectable concentrations.

One gamma-emitting radionuclide (Americium [Am]-241) met the criteria established in the CAIP for CAU 545 (NNSA/NSO, 2007) to be a significant COPC at CAS 03-17-01 for the probabilistic sampling (i.e., any result exceeds a PAL). The statistics for this radionuclide are presented in [Table A.4-3](#).

Based on the initial data review it was determined by the ProUCL test for outliers that the result of 29.1 pCi/g for sample 545B011 is an outlier and should not be included in the dataset. The outlier value of 29.1 pCi/g was compared directly to the FAL for Am-241 along with the judgmental sample results.

The statistics were run by ProUCL for the Am-241 results from CAS 03-17-01 for remaining dataset. The resulting estimation of the variability was found to be reasonable and representative of the population being sampled. Based on the process established in the CAIP for establishing minimum sample size (NNSA/NSO, 2007), the required minimum number of samples needed for valid statistical analysis is eight. Because more than eight samples were collected (23), a UCL of the mean was calculated for comparison to the FAL.

To derive the UCL of the mean for the Am-241 results, computations by the ProUCL software (e.g., for determination of data distributions and the 95 percent UCL) determined that the dataset met the criteria for a gamma distribution. The recommended 95 percent Approximate Gamma UCL of 8.202 picocuries per gram (pCi/g) based on the gamma distribution was selected.

The site-specific FAL for Am-241 was calculated with RESRAD using the industrial scenario in a Tier 2 evaluation. The FAL for Am-241 was determined to be 1,501 pCi/g. The calculation of the FAL for Am-241 is presented in [Appendix C](#). The outlier and the 95 percent Approximate Gamma UCL for the remaining probabilistic dataset are below the FAL for Am-241, and Am-241 is not considered a COC.

Judgmental Sampling Results: Analytical results for gamma-emitting radionuclides in judgmental samples taken from outside the CAS and the subsurface soil at the CAS that were detected above MDCs are presented in [Table A.4-4](#). The radionuclide Am-241 was detected at activities that exceeded the PAL of 12.7 pCi/g in surface samples taken at nine locations (B27, B28, B29, B30, B31, B33, B34, B36, and B41), and in subsurface samples taken at locations B27 and B28 as shown on [Figure A.4-1](#). Americium-241 was advanced onto a Tier 2 evaluation in which RESRAD was used to determine a site-specific FAL for Am-241 under an industrial scenario. Americium-241 results did not exceed the industrial FAL of 1,501 pCi/g at any location, and therefore is not considered a COC at this CAS. The calculation of the FAL for Am-241 is presented in [Appendix C](#). No other

Table A.4-4
Judgmental Soil Sample Results for Gamma-Emitting Radionuclides Detected above
Minimum Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
Final Action Levels			5 ^a	1,501 ^b	12.2 ^c	5.7 ^c	5 ^a	5 ^a	5 ^a
B10	545B014	0.5 - 1.0	1.28	1.29 (J)	0.205 (J)	--	1.45 (J)	1.02 (J)	0.44
B11	545B050	1.0 - 1.5	1.51	--	--	--	1.56 (J)	0.852 (J)	0.483
B17	545B019	0.0 - 0.5	1.61	1.81 (J)	1.14	--	1.51 (J)	1.04 (J)	0.534
B18	545B020	0.0 - 0.5	1.75	2.67 (J)	0.463	--	1.69 (J)	0.998 (J)	0.552
B27	545B030	0.0 - 0.5	1.98	284	3.36	1.49	1.97	1.35	0.481
	545B033	0.5 - 1.0	1.93	73.8 (J)	1.79	--	1.76 (J)	1.12 (J)	0.536
	545B041	1.0 - 1.5	1.76	134	1.71	--	1.59	1.17	0.508
B28	545B031	0.0 - 0.5	1.85	57.2	3.41	1.77	1.69	1.26	0.781
	545B035	0.5 - 1.0	1.69	71.9	3.97	1.88	1.98	1.14	0.642
	545B045	1.0 - 1.75	1.34	3.55 (J)	0.329	--	1.69 (J)	0.865 (J)	0.504
B29	545B032	0.0 - 0.5	2.18	132	5.14	2.17	1.74	1.18	0.583
	545B036	0.5 - 1.0	1.48	1.72 (J)	0.494	--	1.4 (J)	1.05 (J)	0.491
	545B043	1.0 - 2.0	1.57	5.02 (J)	0.319	--	1.48 (J)	0.994 (J)	0.47
	545B044	1.0 - 2.0	1.47	4.03 (J)	0.295	--	1.56 (J)	0.876 (J)	0.574
B30	545B034	0.0 - 0.5	1.58	28.4	1.03	--	1.47	1.05	0.424
	545B042	1.0 - 1.5	1.64	0.952 (J)	--	--	1.72 (J)	0.761 (J)	0.58
B31	545B053	0.0 - 0.25	1.46	25.9 (J)	2.18	0.602 (J)	1.71 (J)	1.02 (J)	0.536
B32	545B054	0.0 - 0.5	1.56	7.94 (J)	0.664	--	1.4 (J)	1 (J)	0.442
B33	545B052	0.0 - 0.5	1.39	30.8 (J)	2.08	--	1.51 (J)	1.04 (J)	0.403
B34	545B051	0.0 - 0.5	1.34	14.5 (J)	0.627	--	1.5 (J)	1.14 (J)	0.441
B35	545B037	0.0 - 0.5	1.26	8.91 (J)	0.404	--	1.6 (J)	0.893 (J)	0.538
B36	545B038	0.0 - 0.5	1.46	32.2 (J)	0.75	--	1.39 (J)	0.897 (J)	0.467
B37	545B039	0.0 - 0.5	1.7	5.75 (J)	0.866	--	1.26 (J)	1.02 (J)	0.508
B38	545B040	0.0 - 0.5	1.65	2.32 (J)	1.07	--	1.6 (J)	1.04 (J)	0.485
B39	545B055	0.0 - 0.5	0.846	0.765 (J)	0.517	--	1.41 (J)	0.867 (J)	0.426
B40	545B056	0.0 - 0.5	1.74	5.16 (J)	1.47	--	1.62 (J)	0.977 (J)	0.494
B41	545B057	0.0 - 0.5	1.81	12.9	0.375	--	1.8	1.2	0.522
B42	545B058	0.0 - 0.5	1.32	0.811 (J)	0.947	0.388 (J)	1.36 (J)	0.885 (J)	0.499
B43	545B049	0.0 - 0.5	1.97	3.07 (J)	1.23	--	1.65 (J)	1.03 (J)	0.505
B44	545B048	0.0 - 0.5	1.76	3.66 (J)	1.24	--	1.51 (J)	0.883 (J)	0.603

Table A.4-4
Judgmental Soil Sample Results for Gamma-Emitting Radionuclides Detected above
Minimum Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
Final Action Levels			5 ^a	1,501 ^b	12.2 ^c	5.7 ^c	5 ^a	5 ^a	5 ^a
B45	545B047	0.0 - 0.5	1.55	2.25 (J)	0.898	--	1.44 (J)	0.918 (J)	0.426
B46	545B046	0.0 - 0.5	1.48	0.899 (J)	0.153	--	1.52 (J)	0.975 (J)	0.618

^aTaken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993). The PALs for these isotopes are specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

^bFALs are established in [Appendix C](#).

^cTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year-dose.

bgs = Below ground surface

cm = Centimeter

DOE = U.S. Department of Energy

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

PAL = Preliminary action level

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

gamma-emitting radionuclides were detected at activities exceeding their PALs, therefore the FALs were established as the corresponding PAL activities for all gamma-emitting radionuclides other than Am-241.

Summary of Gamma-Emitting Radionuclide Results: Americium-241 concentrations detected at CAS 03-17-01 were moved on to a Tier 2 evaluation in which RESRAD was used to determine the site-specific FALs for radionuclides under an industrial scenario. Americium-241 did not exceed the FAL of 1,501 pCi/g at any location. No other gamma-emitting radionuclides were detected at activities exceeding their PALs, therefore the FALs were established as the corresponding PAL activities for all gamma-emitting radionuclides other than Am-241. No gamma-emitting radionuclide COCs were identified at CAS 03-17-01.

A.4.2.3 Plutonium, Strontium-90, and Uranium Isotopes

Analytical results for Pu, Sr-90, and U isotopic radionuclides are discussed separately for those samples collected through a probabilistic approach (i.e., most surface samples at this CAS) and those samples collected through a judgmental approach (i.e., some surface samples within the CAS and all surface samples outside the CAS, as well as all subsurface samples at the CAS).

Probabilistic Sampling Results: Isotopic Pu and isotopic U analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.4-5](#). The probabilistic sampling design as described in the CAIP for CAU 545 (NNSA/NSO, 2007) stipulates comparing the 95th percent UCL of the mean of each significant COPC (i.e., contaminants present at concentrations greater than PALs) to the FAL to determine whether a COC is present. Therefore, only significant COPCs are evaluated for the presence of COCs. To demonstrate the selection of significant COPCs, [Table A.4-5](#) lists the PALs for isotopic radionuclides.

Of these radioisotopes, only Pu-239/240 met the criteria established in the CAIP for CAU 545 (NNSA/NSO, 2007) to be a significant COPC at CAS 03-17-01 for the probabilistic sampling (i.e., any result exceeds a PAL). The statistics for this radionuclide are presented in [Table A.4-5](#).

Based on the initial data review, it was determined by the ProUCL test for outliers that the results of 93.9 pCi/g for sample 545B012 is an outlier, and 71.1 pCi/g for sample 545B013 is an outlier, and both should not be included in the dataset. The outlier values of 93.9 and 71.1 pCi/g were compared directly to the FAL for Pu-239/230 along with the judgmental sample results.

The statistics were run by ProUCL for the Pu-239/230 results from CAS 03-17-01 for remaining dataset. The resulting estimation of the variability was found to be reasonable and representative of the population being sampled. Based on the process for establishing minimum sample size, established in the CAIP for CAU 545 (NNSA/NSO, 2007), the required minimum number of samples needed for valid statistical analysis is eight. Because more than eight samples were collected (22), a UCL of the mean was calculated for comparison to the FAL.

To derive the UCL of the mean for the Pu-239/230 results, computations by the ProUCL software (e.g., for determination of data distributions and the 95 percent UCL) determined that the dataset met

Table A.4-5
Probabilistic Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
Preliminary Action Levels ^a			13	12.7	143	17.5	105
Final Action Levels ^b			13	1,890	143	17.5	105
Average			NC	13.53	NC	NC	NC
Standard Deviation			NC	11.25	NC	NC	NC
VSP Required Minimum Number of Samples			NC	8	NC	NC	NC
Maximum Result			3.73	93.9	1.11	0.0927	1.08
95% UCL ^c			NC	20.09	NC	NC	NC
B01	545B001	0.0 - 0.5	--	7.99	0.771	--	0.78
B02	545B002	0.0 - 0.5	0.251	14.3	0.888	--	1.08
B03	545B003	0.0 - 0.5	--	8.59 (J)	0.777	--	0.943
B04	545B004	0.0 - 0.5	--	1.23	0.862	--	0.748
B05	545B005	0.0 - 0.5	0.337	25	0.935	--	0.879
B06	545B006	0.0 - 0.5	0.337	22.1	1.11	--	0.996
B07	545B007	0.0 - 0.5	--	2.65	0.586	--	0.74
	545B008	0.0 - 0.5	--	2.72	0.793	--	0.891
B08	545B009	0.0 - 0.5	--	25.7	0.823	--	0.901
B09	545B010	0.0 - 0.5	3.73	33.9	0.66	--	0.9
B10	545B011	0.0 - 0.5	--	31.7 (J)	0.746	--	0.752
B11 ^d	545B012	0.0 - 0.5	1.3	93.9	0.88	--	0.75
B12 ^d	545B013	0.0 - 0.5	--	71.1	0.953	--	0.65
B13	545B015	0.0 - 0.5	--	2.08	0.796	--	0.732
B14	545B016	0.0 - 0.5	--	28.7	1.09	0.0927	0.855
B15	545B017	0.0 - 0.5	0.119	7.54 (J)	0.727	--	0.851
B16	545B018	0.0 - 0.5	0.154	10.6	0.867	--	0.824
B19	545B021	0.0 - 0.5	--	1.2 (J)	0.739	--	0.851
B20	545B022	0.0 - 0.5	--	0.263 (J)	0.787	--	0.687
B21	545B023	0.0 - 0.5	0.144	9.46	0.708	0.0716	0.726
B22	545B024	0.0 - 0.5	--	6.09	0.811	--	0.68
B23	545B025	0.0 - 0.5	--	6.12	0.725	--	0.726

Table A.4-5
Probabilistic Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
B24	545B026	0.0 - 0.5	0.221	13.1 (J)	0.814	--	0.749
B25	545B027	0 - 0.75	--	4.03	0.678	--	0.847
	545B028	0.0 - 0.5	0.298	7.45	0.592	--	0.631
B26	545B029	0.0 - 0.5	0.602	31.9	0.773	--	0.671

^aDefined in the CAIP for CAU 545 (NNSA/NSO, 2007).

^bEstablished in [Appendix C](#).

^cValue for Pu-239 derived as the 95% Approximate Gamma UCL, a nonparametric distribution, and used as a proxy for the 95% UCL.

^dThe results for Pu-239/240 from samples 545B012 and 545B013 were identified as statistical outliers and were not included in the calculation of the 95% UCL of the mean. The results are included with the probabilistic data for completeness. If these results were included with the other 22 sample results in calculations, the value for the 95% UCL would be 29.52 (95% Approximate Gamma).

bgs = Below ground surface

CAIP = Corrective Action Investigation Plan

ft = Foot

pCi/g = Picocuries per gram

Pu = Plutonium

UCL = Upper confidence limit

VSP = Visual Sample Plan

J = Estimated value

NC = Not calculated, as the contaminant did not qualify as a significant contaminant of potential concern.

-- = Not detected above minimum detectable concentrations.

the criteria for a gamma distribution. The recommended 95 percent Approximate Gamma UCL of 20.09 pCi/g based on the gamma distribution was selected.

The site-specific FAL for Pu-239/230 was calculated with RESRAD using the industrial scenario in a Tier 2 evaluation. The FAL for Pu-239/230 was determined to be 1,890 pCi/g. The calculation of the FAL for Pu-239/230 is presented in Appendix C. The outliers and the 95 percent Approximate Gamma UCL for the remaining probabilistic dataset are below the FAL for Pu-239/230, and Pu-239/230 is not considered a COC.

Judgmental Sampling Results: Analytical results for isotopic radionuclides in judgmental samples taken from outside the CAS and from subsurface soil at the CAS that were detected above MDCs are

presented in [Table A.4-6](#). The radionuclide Pu-239/240 was detected at activities that exceeded the PAL of 12.7 pCi/g in surface samples taken at locations: B27, B28, B29, B30, B31, B32, B33, B34, B36, B38 and B40; and in subsurface samples taken at locations B27, B28, and B29 ([Figure A.4-1](#)). Plutonium-239/240 was moved to a Tier 2 evaluation in which RESRAD was used to determine the site-specific FALs for radionuclides under an industrial scenario. Plutonium-239/240 did not exceed the FAL of 1,890 pCi/g at any location, and therefore is not considered a COC at this CAS. The calculation of the FAL for Pu-239/240 is presented in [Appendix C](#). No other isotopic radionuclides were detected at activities exceeding their PALs, therefore the FALs were established as the corresponding PAL activities for all gamma-emitting radionuclides other than Pu-239/240.

Table A.4-6
Judgmental Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels			13 ^a	1,890 ^b	838 ^a	143 ^a	17.6 ^a	105 ^a
B10	545B014	0.5 - 1.0	--	3.3	--	0.813	--	0.717
B11	545B050	1.0 - 1.5	--	--	--	0.899	--	0.649
B17	545B019	0.0 - 0.5	0.115	7.39	--	0.88	--	0.746
B18	545B020	0.0 - 0.5	0.105	10.1	--	0.654	--	0.665
B27	545B030	0.0 - 0.5	--	231	0.556	1.55	--	0.827
	545B033	0.5 - 1.0	5.14	413	0.35	0.935	--	0.742
	545B041	1.0 - 1.5	1.67	91.4	--	1.37	--	0.942
B28	545B031	0.0 - 0.5	--	245	0.785	1.68	--	0.856
	545B035	0.5 - 1.0	--	455	0.989	2.42	--	0.81
	545B045	1.0 - 1.75	--	18.7	--	1.14	--	1.1
B29	545B032	0.0 - 0.5	3.12	270	1.1	1.83	0.116	0.888
	545B036	0.5 - 1.0	--	10.6	--	0.827	--	0.721
	545B043	1.0 - 2.0	--	34.8	0.249	0.856	--	0.716
	545B044	1.0 - 2.0	--	51.2	--	1.05	--	0.719
B30	545B034	0.0 - 0.5	0.952	72.7	--	0.656	--	0.615
	545B042	1.0 - 1.5	--	1.21	--	0.783	--	0.647

Table A.4-6
Judgmental Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 03-17-01, Waste Consolidation Site 3B
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels			13 ^a	1,890 ^b	838 ^a	143 ^a	17.6 ^a	105 ^a
B31	545B053	0 - 0.25	--	54.3 (J)	0.451	--	--	0.796
B32	545B054	0.0 - 0.5	0.224	19.8 (J)	--	0.821	--	0.857
B33	545B052	0.0 - 0.5	--	89.1 (J)	0.483	1.08	--	0.788
B34	545B051	0.0 - 0.5	--	25.4	0.244	0.89	--	0.882
B35	545B037	0.0 - 0.5	--	8.01	--	0.681	--	0.755
B36	545B038	0.0 - 0.5	0.452	26.8	--	0.818	--	0.812
B37	545B039	0.0 - 0.5	--	6.76	--	0.612	--	0.827
B38	545B040	0.0 - 0.5	--	13.8	--	0.849	--	0.776
B39	545B055	0.0 - 0.5	--	3.95 (J)	--	0.813	--	0.913
B40	545B056	0.0 - 0.5	0.161	13.9 (J)	0.245	0.902	--	0.631
B41	545B057	0.0 - 0.5	0.103	8.51 (J)	--	1.4	--	1.01
B42	545B058	0.0 - 0.5		2.87 (J)	--	0.96	--	0.715
B43	545B049	0.0 - 0.5	0.167	4.87	--	0.693	--	0.668
B44	545B048	0.0 - 0.5	--	5.99	--	0.71	--	0.77
B45	545B047	0.0 - 0.5	--	4.59	--	0.672	--	0.719
B46	545B046	0.0 - 0.5	--	5.16	--	0.906	--	0.851

^aTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year-dose.

^bFALs are established in [Appendix C](#).

bgs = Below ground surface

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Summary of Isotopic Radionuclide Results: Plutonium-239/240 concentrations detected at CAS 03-17-01 were moved onto a Tier 2 evaluation in which RESRAD was used to determine the site-specific FALs for radionuclides under the industrial scenario. Plutonium-239/240 did not exceed

the FAL of 1,890 pCi/g at any location. No other isotopic radionuclides were detected at activities exceeding their PALs, therefore the FALs were established as the corresponding PAL activities for all gamma-emitting radionuclides other than Pu-239/240. No isotopic radionuclide COCs were identified at CAS 03-17-01.

A.4.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected within CAS 03-17-01, no COCs were identified at this CAS.

A.4.4 Revised Conceptual Site Model

The CAIP requirements were met at this CAS (NNSA/NSO, 2007), and no revisions were necessary to the CSM.

A.5.0 Corrective Action Site 03-99-14, Radioactive Material Disposal Area

Corrective Action Site 03-99-14 is located at the immediate southeast corner of the Area 3 RWMS, on the south side of the 3-14 Road ([Figure A.1-1](#)). The site consists of a berm and adjacent trench, approximately 350 ft in length. The purpose for these features at this site has not been determined. The entire area was impacted by atmospheric testing to the west, and the areas adjacent to the 3-14 Road are posted as RMAs. In addition to sampling the CAS on the berm and trench, five locations along the west, south and east perimeter were sampled at the surface to establish background radiological activities for comparison to the site data. Additional detail is provided in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.5.1 Corrective Action Investigation

A total of 18 characterization samples (including one FD, and five background) were collected during investigation activities at CAS 03-99-14. The sample locations are shown on [Figure A.5-1](#). The sample locations, IDs, types, and analyses are listed in [Table A.5-1](#). The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2007) are described in the following sections.

A.5.1.1 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were exceeded in two samples, and beta/gamma radiation FSLs were exceeded in three samples; all collected for background activities at CAS 03-99-14. All samples exceeding FSLs were analyzed.

A.5.1.2 Radiological Survey

A radiological walkover survey was conducted over the area encompassing the berm and trench at CAS 03-99-14. Several areas were found to have elevated radiological readings at two to five times background. Trinity glass is present throughout the area and likely contributed to the elevated readings. Three of the four sample transects were placed across these areas ([Figure A.5-2](#)).

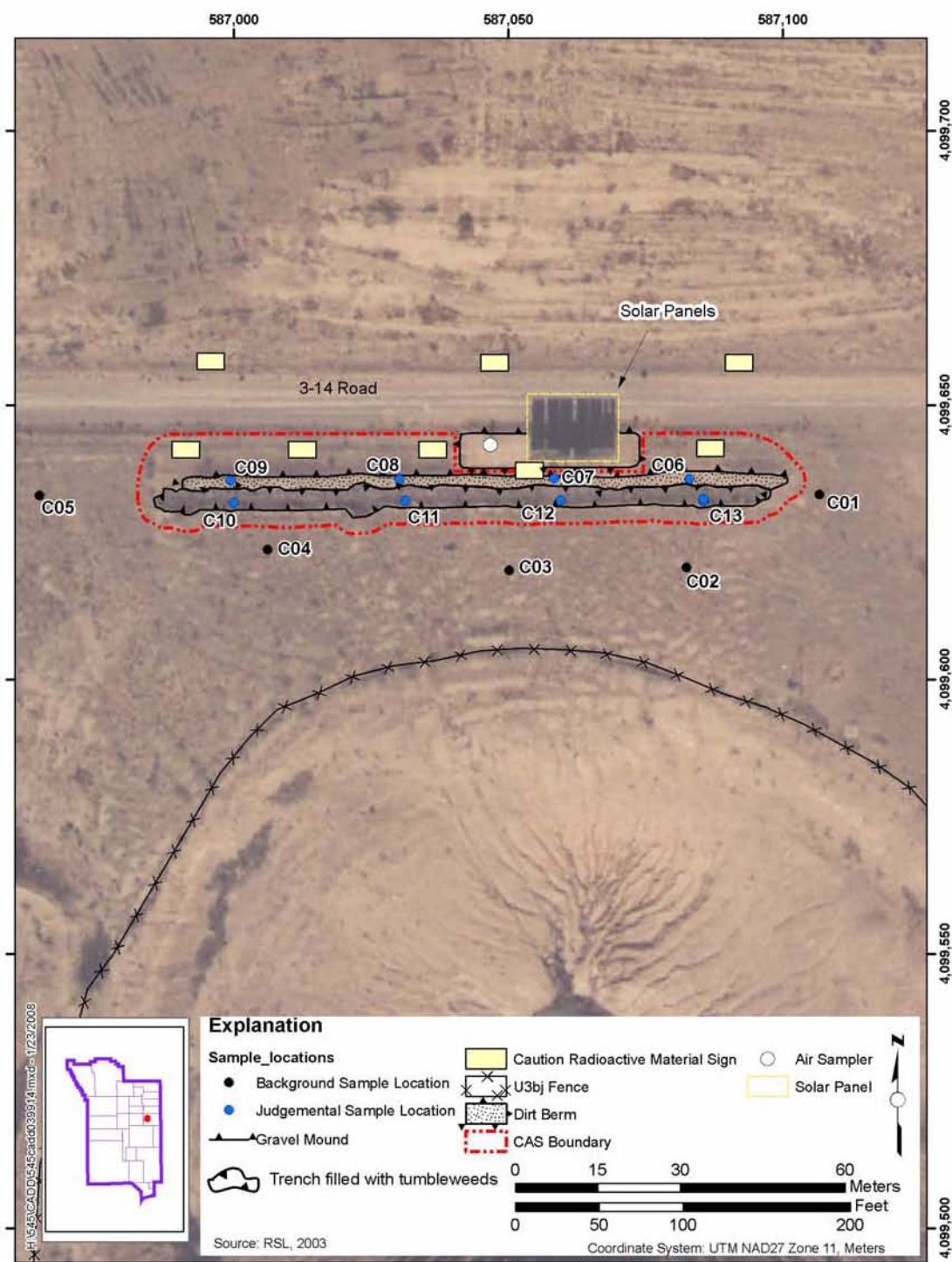


Figure A.5-1
Sample Locations at CAS 03-99-14, Radioactive Material Disposal Area

Table A.5-1
Samples Collected at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
C01	545C001	0.0 - 0.5	Soil	Environmental, Background	Set 1
C02	545C002	0.0 - 0.5	Soil	Environmental, Background	Set 1
C03	545C003	0.0 - 0.5	Soil	Environmental, Background	Set 1
C04	545C004	0.0 - 0.5	Soil	Environmental, Background	Set 1
C05	545C005	0.0 - 0.5	Soil	Environmental, Background	Set 1
C06	545C015	0.0 - 0.5	Soil	Environmental	Set 3
	545C018	2.0 - 2.5	Soil	Environmental	Set 3
C07	545C014	0.0 - 0.5	Soil	Environmental	Set 3
	545C017	3.0 - 3.5	Soil	Environmental	Set 3
C08	545C012	0.0 - 0.5	Soil	Environmental	Set 3
	545C016	3.5 - 4.0	Soil	Environmental	Set 3
C09	545C011	0.0 - 0.5	Soil	Environmental	Set 3
	545C013	3.5 - 4.0	Soil	Environmental	Set 3
C10	545C010	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 3
C11	545C008	0.0 - 0.5	Soil	Environmental	Set 3
	545C009	0.0 - 0.5	Soil	Field Duplicate of #545C008	Set 3
C12	545C007	0.0 - 0.5	Soil	Environmental	Set 3
C13	545C006	0.0 - 0.5	Soil	Environmental	Set 3
N/A	545C301	N/A	Water	Trip Blank	VOCs
N/A	545C302	N/A	Water	Trip Blank	VOCs
N/A	545C303	N/A	Water	Equipment Rinsate	Set 3
N/A	545C304	N/A	Water	Field Blank	Set 3
N/A	545C305	N/A	Water	Trip Blank	VOCs
N/A	545C306	N/A	Water	Trip Blank	VOCs
N/A	545C307	N/A	Liquid	Source Blank	Set 3
N/A	545C501	N/A	Liquid	Waste Management	Set 3, Gross Alpha/Beta, Tritium

Set 1 = Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

Set 3 = VOCs, SVOCs, TPH-DRO, PCBs, RCRA Metals, Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

bgs = Below ground surface

DRO = Diesel-range organic

ft = Foot

N/A = Not applicable

PCB = Polychlorinated biphenyl

QC = Quality control

RCRA = *Resource Conservation and Recovery Act*

SVOC = Semivolatile organic compound

TPH = Total petroleum hydrocarbon

VOC = Volatile organic compound

**Figure A.5-2
Radiological Survey for CAS 03-99-14**

A.5.1.3 Geophysical Survey

A geophysical walkover survey was conducted at the CAS. Small surface and subsurface anomalies were detected, but no linear or significant subsurface features were found (Figure A.5-3). The geophysical survey was not used in the selection of sample locations.

A.5.1.4 Visual Inspections

No distinguishing features were visible in the trench or on the berm. The surface features for both components were uniform throughout the CAS.

A.5.1.5 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples from both components (Figure A.5-1) at this CAS. Four transects were established across the trench and berm, and one location each was established on trench and on the berm. Results from the radiological survey were employed to guide three transects across general areas of elevated radioactivity while keeping the transects evenly spaced (approximately) apart across each quarter of the site. The fourth transect, encompassing locations C06 and C13, was an approximate equal distance between the third transect and the east end of the trench and berm.

Surface samples (0.0 to 0.5 ft bgs) were collected from locations C01 through C05 outside the eastern, southern, and western perimeters of the CAS to measure the contribution of radiological contamination from sources other than the CAS. The two exceedences of the FSL for alpha, and the three for beta, were all from these background samples.

Surface samples were also collected at each of the eight locations (C06 through C13) in the four transects across the trench and berm. Neither the alpha nor the beta FSL were exceeded in any samples. Consequently, subsurface samples were not collected at the four locations in the trench, and just one shallow subsurface sample per location was collected from the berm/native soil interface at the four berm locations.

No staining or other biasing factors were found within the soil profile at any of the berm locations.

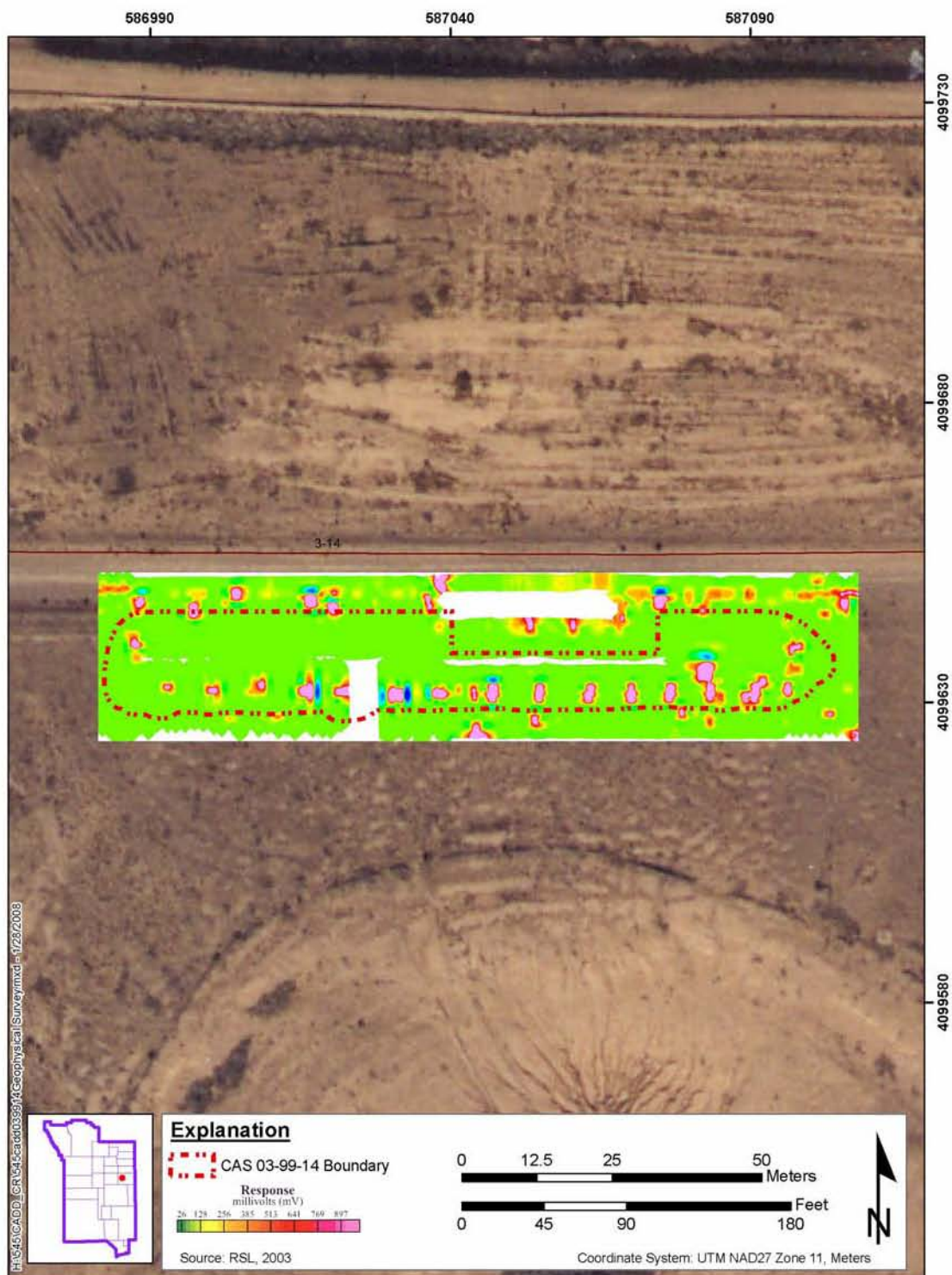


Figure A.5-3
Geophysical Survey for CAS 03-99-14

A.5.1.6 Deviations

Investigation samples were collected as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007) and submitted for laboratory analysis. There were no deviations from the planned sampling. All sample locations were accessible.

A.5.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007). Investigation samples were analyzed for the CAIP-specified COPCs, which included VOCs, semivolatile organic compounds (SVOCs), TPH-DRO, RCRA metals, polychlorinated biphenyls (PCBs), gamma-emitting radionuclides, isotopic Pu, Sr-90, and isotopic U. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in [Table A.2-2](#). [Table A.5-1](#) lists the sample-specific analytical suite for CAS 03-99-14. The waste characterization analytical results are discussed in [Section A.8.0](#).

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in the following sections. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. Establishment of the FALs is presented in [Appendix C](#). The FALs were established as the corresponding PAL concentrations or activities if the contaminant concentrations were below their respective PALs.

A.5.2.1 Volatile Organic Compounds

Analytical results for VOC environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.5-2](#). No VOCs were detected at concentrations exceeding their respective PALs. The FALs were established at the PAL concentrations.

A.5.2.2 Semivolatile Organic Compounds

Analytical results for SVOC environmental samples collected at this CAS did not exceed the MDCs.

Table A.5-2
Soil Sample Results for Total VOCs Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)		
			Acetone	Methylene Chloride	Styrene
Final Action Levels ^a			54,000	21	1,700
C06	545C015	0.0 - 0.5	0.00369 (J)	0.00284 (J)	0.000549 (J)
C07	545C014	0.0 - 0.5	--	0.00513	0.00106
C08	545C012	0.0 - 0.5	--	--	0.000602 (J)
	545C016	3.5 - 4.0	0.00368 (J)	0.00415 (J)	0.000855 (J)
C09	545C011	0.0 - 0.5	--	--	0.000384 (J)
	545C013	3.5 - 4.0	--	--	0.000212 (J)
C12	545C007	0.0 - 0.5	--	--	0.000248 (J)

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

A.5.2.3 Total Petroleum Hydrocarbons

The TPH-DRO analytical results for soil samples collected at this CAS that were detected above MDCs are presented in [Table A.5-3](#). Total petroleum hydrocarbons-DRO was not detected at concentrations exceeding the PAL. The FAL was established at the PAL concentration.

A.5.2.4 RCRA Metals

The RCRA metals analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.5-4](#). No result exceeded the respective PAL. The FALs were established at the PAL concentrations.

A.5.2.5 Polychlorinated Biphenyls

The PCBs detected above MDCs are presented in [Table A.5-5](#). No PCBs were detected at concentrations exceeding the PAL. The FAL was established at the PAL concentration.

Table A.5-3
Soil Sample Results for TPH-DRO Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel-Range Organics
Preliminary Action Levels ^a			100
C09	545C011	0.0 - 0.5	1.85 (J)
C10	545C010	0.0 - 0.5	2.21 (J)
C11	545C008	0.0 - 0.5	1.9 (J)
C12	545C007	0.0 - 0.5	2.53 (J)

^aEstablished in the CAIP for CAU 545 (NNSA/NSO, 2007).

bgs = Below ground surface
CAIP = Corrective Action Investigation Plan
ft = Foot
mg/kg = Milligrams per kilogram

J = Estimated value

Table A.5-4
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Mercury	Selenium	Silver
Final Action Levels			23 ^a	67,000 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b	5,100 ^b
C06	545C015	0.0 - 0.5	5.6	126	7.1	10.5 (J)	0.011 (J-)	1.6	--
	545C018	2.0 - 2.5	4.1	169 (J-)	7.4	10.2	0.0069 (J-)	--	--
C07	545C014	0.0 - 0.5	4.4	113	6.3	9.5 (J)	0.01 (J-)	1.7	--
	545C017	3.0 - 3.5	3.9	135 (J-)	5.6	8.8	0.008 (J-)	--	--
C08	545C012	0.0 - 0.5	5.2	124	6.3	10.6 (J)	0.009 (J-)	1.8	0.33 (J)
	545C016	3.5 - 4.0	5.6	137	6.7	12.1 (J)	0.012 (J-)	1.9	--
C09	545C011	0.0 - 0.5	4.9	173	5.8	19.2 (J)	0.0083 (J-)	1.8	--
	545C013	3.5 - 4.0	3.5	147	5.1	9 (J)	0.0042 (J-)	1.6	--

Table A.5-4
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Mercury	Selenium	Silver
Final Action Levels			23 ^a	67,000 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b	5,100 ^b
C10	545C010	0.0 - 0.5	3.6	179	3.9	9.9 (J)	0.0078 (J-)	1.4 (J)	--
C11	545C008	0.0 - 0.5	4.7	168	4.8	11.8 (J)	0.012 (J-)	1.9	--
	545C009	0.0 - 0.5	3.8	169	4.9	11.9 (J)	0.011 (J-)	1.3 (J)	--
C12	545C007	0.0 - 0.5	3.8	155	4.3	17.3 (J)	0.01 (J-)	1.5 (J)	--
C13	545C006	0.0 - 0.5	4.7	153	5	11.5 (J)	0.0099 (J-)	1.9	--

^aBased on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

^bBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

J- = The result is an estimated quantity, but the result may be biased low.

-- = Not detected above minimum detectable concentrations.

Table A.5-5
Soil Sample Results for PCBs Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Aroclor 1260
Final Action Levels ^a			0.74
C11	545C009	0 - 0.5	0.0024 (J)

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

A.5.2.6 *Gamma-Emitting Radionuclides*

Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.5-6](#). No gamma-emitting radionuclides were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

A.5.2.7 *Plutonium, Strontium-90, and Uranium Isotopes*

Isotopic Pu and isotopic U analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.5-7](#). The only exceedence of a PAL was for Pu-239 for the background sample from location C03 outside of the CAS. This result is likely due to the aboveground testing conducted west of the site. No isotopic Pu, isotopic U, or Sr-90 were detected at concentrations exceeding the respective PALs within the CAS. The FALs were established at the PAL concentrations.

A.5.2.8 *Nature and Extent of Contamination*

Based on the analytical results for soil samples collected within CAS 03-99-14, no COCs were identified at this CAS.

A.5.3 *Revised Conceptual Site Model*

The CAIP requirements were met at this CAS (NNSA/NSO, 2007), and no revisions were necessary to the CSM.

Table A.5-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
Final Actions Levels			5 ^a	12.7 ^b	12.2 ^b	5.67 ^b	5 ^a	5 ^a	5 ^a
C01	545C001	0.0 - 0.5	1.78	--	10.3	0.826 (J)	1.58 (J)	1.07 (J)	0.555
C02	545C002	0.0 - 0.5	1.78	--	3.82	1.2 (J)	1.69 (J)	0.925 (J)	0.495
C03	545C003	0.0 - 0.5	1.39	1.05 (J)	5.1	3.05 (J)	1.59 (J)	1.12 (J)	0.489
C04	545C004	0.0 - 0.5	1.73	--	5.23	3.57 (J)	1.81 (J)	0.956 (J)	0.483
C05	545C005	0.0 - 0.5	1.51	--	6.74	4.62 (J)	1.55 (J)	0.951 (J)	0.442
C06	545C015	0.0 - 0.5	1.73	--	--	--	1.78 (J)	1.2 (J)	0.61
	545C018	2.0 - 2.5	1.63	--	5	0.806	1.94 (J)	1.18 (J)	0.491
C07	545C014	0.0 - 0.5	1.49	--	0.55	--	1.61 (J)	0.991 (J)	0.539
	545C017	3.0 - 3.5	1.83	--	2.62	--	1.66 (J)	1.35 (J)	0.546
C08	545C012	0.0 - 0.5	1.82	--	--	--	1.62 (J)	1.13 (J)	0.578
	545C016	3.5 - 4.0	1.93	--	--	--	1.89 (J)	1.14 (J)	0.585
C09	545C011	0.0 - 0.5	1.91	--	--	--	1.91 (J)	1.06 (J)	0.53
	545C013	3.5 - 4.0	1.96	--	--	--	1.74 (J)	1.06 (J)	0.485
C10	545C010	0.0 - 0.5	1.42	--	4.82	2.91 (J)	1.64 (J)	1.17 (J)	0.464
C11	545C008	0.0 - 0.5	1.52	--	6.25	2.11 (J)	1.69 (J)	1.06 (J)	0.539
	545C009	0.0 - 0.5	1.62	--	5.41	2.23 (J)	1.42 (J)	0.866 (J)	0.56
C12	545C007	0.0 - 0.5	1.69	0.472 (J)	6.34	1.57 (J)	1.5 (J)	1.08 (J)	0.59
C13	545C006	0.0 - 0.5	1.75	--	7.73	1.17 (J)	1.72 (J)	1.2 (J)	0.53

^aTaken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993). The PALs for these isotopes are specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

^bTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface
cm = Centimeter
DOE = U.S. Department of Energy

ft = Foot
NCRP = National Council on Radiation Protection and Measurements
pCi/g = Picocuries per gram

J = Estimated value
-- = Not detected above minimum detectable concentrations.

Table A.5-7
Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 03-99-14, Radioactive Material Disposal Area

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Actions Levels ^a			13	12.7	838	143	17.6	105
C01	545C001	0.0 - 0.5	--	0.49	5.17	0.75	--	0.728
C02	545C002	0.0 - 0.5	--	0.468	1.97	0.746	--	0.846
C03	545C003	0.0 - 0.5	2.18	15.1	1.4	0.785	0.0891	0.796
C04	545C004	0.0 - 0.5	0.199	2.35	2.64	0.691	--	0.65
C05	545C005	0.0 - 0.5	--	1.27	4.32	1.02	--	0.841
C06	545C015	0.0 - 0.5	--	--	--	0.942	0.097	0.971
	545C018	2.0 - 2.5	--	--	2.65	0.829	--	0.814
C07	545C014	0.0 - 0.5	--	--	--	0.85	--	0.899
	545C017	3.0 - 3.5	--	1.39	0.589	1.27	--	1.09
C08	545C012	0.0 - 0.5	--	--	--	0.91	0.108	0.848
	545C016	3.5 - 4.0	0.0551	--	--	0.81	--	0.822
C09	545C011	0.0 - 0.5	--	--	--	1.02	--	1.15
	545C013	3.5 - 4.0	--	--	--	0.717	--	0.786
C10	545C010	0.0 - 0.5	0.117	1.08	4.88	0.684	--	0.682
C11	545C008	0.0 - 0.5	0.188	1.2	4.02	0.61	--	0.754
	545C009	0.0 - 0.5	--	1.01	3.3	0.869	--	0.673
C12	545C007	0.0 - 0.5	0.57	2.88	4.65	0.757	--	0.866
C13	545C006	0.0 - 0.5	0.367	2.18	5.67	0.683	--	0.807

^aTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

-- = Not detected above minimum detectable concentrations.

A.6.0 Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

Corrective Action Site 09-23-02 is located at the U-9y drilling mud disposal crater in Area 9 approximately 600 ft southeast of the 9-01 and Circle Roads intersection ([Figure A.1-1](#)). The U-9y crater was used for the disposal of radiologically contaminated drilling fluids and decontamination wastewater. At some point in 1979 or 1980, the crater overflowed into the wash to the east. Because the crater presently cannot be entered due to safety concerns, the wash component was the focus of this investigation. Additional detail is provided in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.6.1 Corrective Action Investigation

A total of 18 characterization samples (including one FD) were collected during investigation activities at CAS 09-23-02. The sample locations are shown on [Figure A.6-1](#). The sample locations, IDs, types, and analyses are listed in [Table A.6-1](#). The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2007) are described in the following sections.

A.6.1.1 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were not exceeded, but beta/gamma radiation FSLs were exceeded in four samples (and one duplicate) at CAS 09-23-02. All samples exceeding FSLs were analyzed.

A.6.1.2 Radiological Survey

A radiological walkover survey was conducted over the wash component of CAS 09-23-02. No areas of elevated radiological readings were found. Therefore, the radiological survey was not used in the selection of sample locations ([Figure A.6-2](#)).

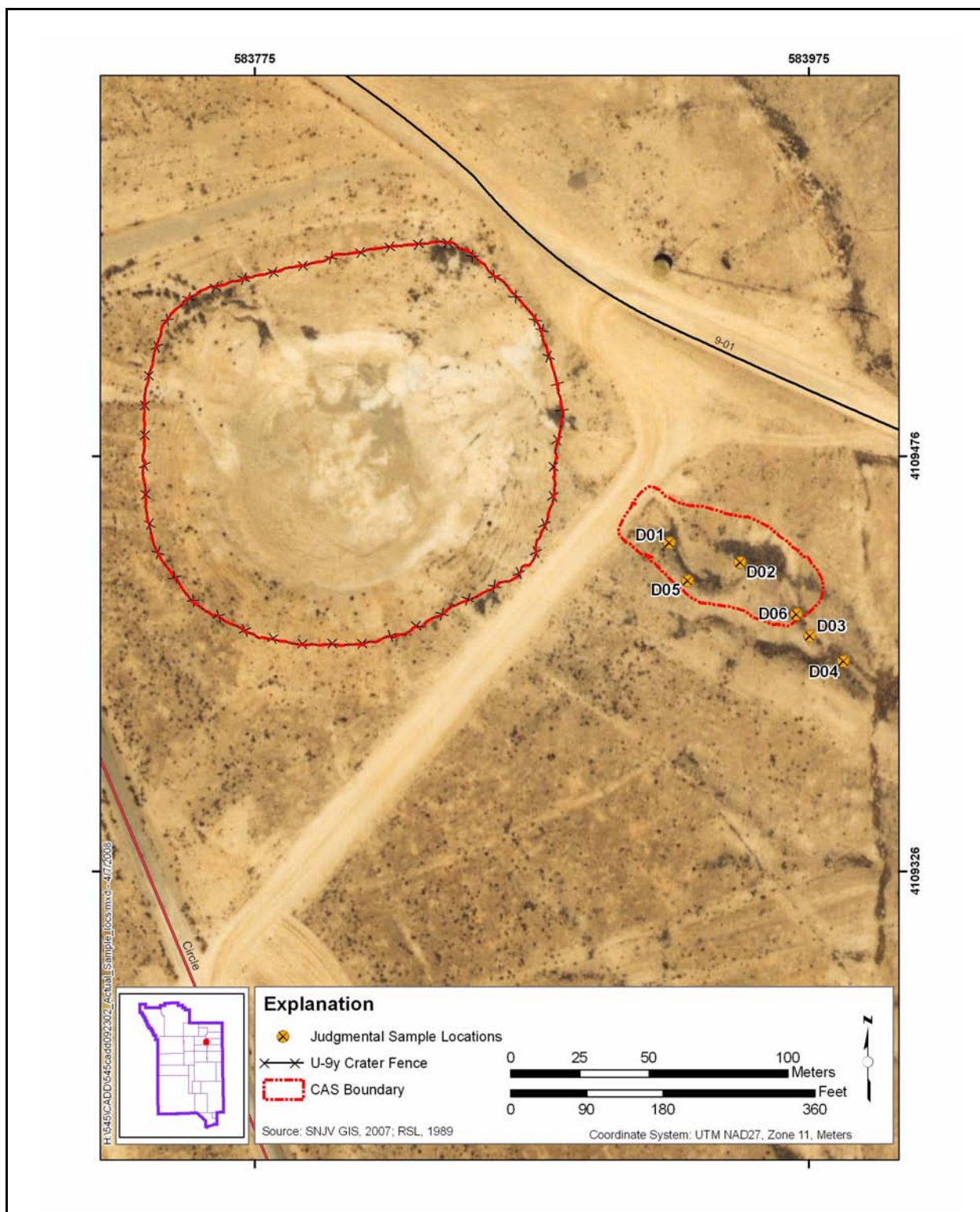


Figure A.6-1
Sample Locations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Table A.6-1
Samples Collected at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
D01	545D001	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 4
	545D009	0.5 - 1.0	Soil	Environmental	Set 4
	545D010	2.0 - 2.5	Soil	Environmental	Set 4
	545D011	4.0 - 4.5	Soil	Environmental	Set 4
D02	545D002	0.0 - 0.5	Soil	Environmental	Set 4
	545D013	2.0 - 2.5	Soil	Environmental	Set 4
	545D014	3.0 - 3.5	Soil	Environmental	Set 4
D03	545D003	0.0 - 0.5	Soil	Environmental	Set 4
	545D017	1.5 - 2.0	Soil	Environmental	Set 4
D04	545D004	0.0 - 0.5	Soil	Environmental	Set 4
	545D005	0.0 - 0.5	Soil	Field Duplicate of #545D004	Set 4
	545D006	0.5 - 1.0	Soil	Environmental	Set 4
	545D018	1.0 - 1.17	Soil	Environmental	Set 4
D05	545D007	0.0 - 0.5	Soil	Environmental	Set 4
	545D012	1.5 - 2.0	Soil	Environmental	Set 4
D06	545D008	0.0 - 0.5	Soil	Environmental	Set 4
	545D015	1.5 - 2.0	Soil	Environmental	Set 4
	545D016	3.0 - 3.5	Soil	Environmental	Set 4
N/A	545D301	N/A	Water	Trip Blank	VOCs
N/A	545D302	N/A	Water	Field Blank	Set 4
N/A	545D303	N/A	Water	Source Blank	Set 5
N/A	545D304	N/A	Water	Trip Blank	VOCs
N/A	545D305	N/A	Water	Trip Blanks	VOCs
N/A	545D306	N/A	Water	Trip Blank	VOCs
N/A	545D307	N/A	Water	Trip Blanks	VOCs
N/A	545D308	N/A	Water	Trip Blank	VOCs
N/A	545D309	N/A	Water	Equipment Rinsate	Set 4
N/A	545D310	N/A	Water	Source Blank	Gross Alpha/Beta
N/A	545D501	N/A	Liquid	Waste Management	Set 4, Gross Alpha/Beta, Tritium

Set 4 = VOCs, SVOCs, TPH-DRO, RCRA Metals, Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90
Set 5 = VOCs, SVOCs, TPH-DRO and GRO, RCRA Metals, Beryllium, PCBs, Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90, Gross Alpha/Beta, Tritium

DRO = Diesel-range organics

bgs = Below ground surface

GRO = Gasoline-range organics

N/A = Not applicable

QC = Quality control

PCB = Polychlorinated biphenyl

RCRA = *Resource Conservation and Recovery Act*

SVOC = Semivolatile organic compound

TPH = Total petroleum hydrocarbons

VOC = Volatile organic compound

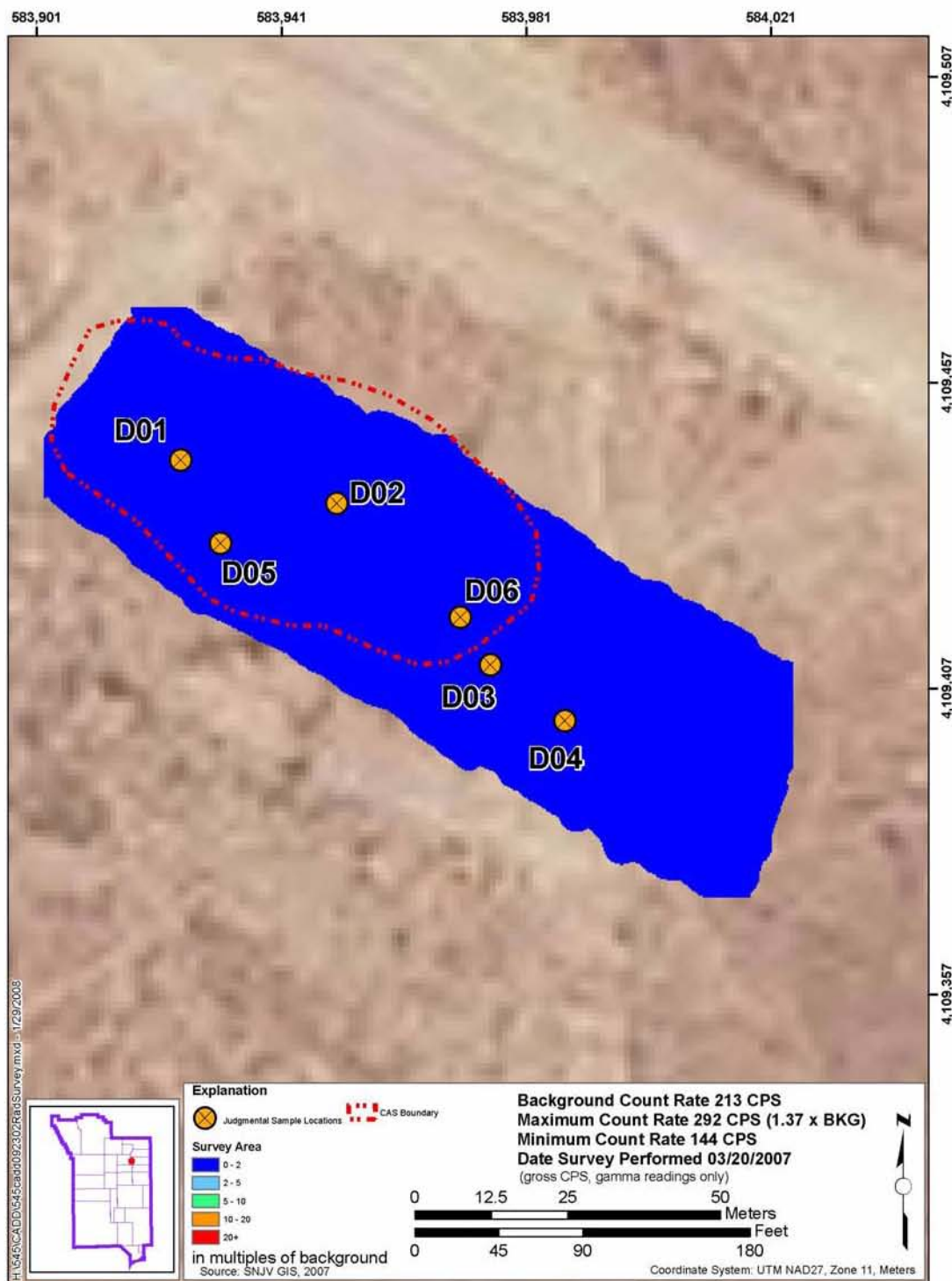


Figure A.6-2
Radiological Survey at CAS 09-23-02

A.6.1.3 Geophysical Survey

A geophysical walkover survey was conducted at the CAS. No linear or significant subsurface features were found ([Figure A.6-3](#)). Two anomalies, one along the south shoulder of the wash, and one along the east boundary of the CAS, were interpreted to possibly indicate areas of different soil type. One sample location was placed over each anomaly.

A.6.1.4 Visual Inspections

Visible features that were used to establish biased locations were limited to areas where suspended solids (i.e., silts and clays) settled out of water moving through the wash (i.e., settling areas).

Two locations within the CAS, and two locations down stream from the CAS, were established at these areas. Other visible biasing factors were not present at the CAS.

A.6.1.5 Sample Collection

Decision I environmental sampling activities included the collection of biased surface and subsurface soil samples within the wash and in two settling areas immediately down gradient ([Figure A.6-1](#)) at this CAS.

Within the CAS, two locations were selected based upon the geophysical survey, and two locations were selected in areas where fine sediment settled out from flowing runoff. Location D01 was selected at the settling area in the wash closest to the U-9y crater. Sample 545D001 was collected from the surface interval (0.0 to 0.5 ft bgs), but did not exceed FSLs. A shallow subsurface sample (545D009) was collected from 0.5 to 1.0 ft bgs, which exceeded the FSL for beta. Further down the soil profile at location D01; a layer of light-colored, fine material that may have been drilling mud, was encountered at 2.0 to 2.5 ft bgs. Sample 545D010 was collected from this layer, but did not exceed FSLs. The interface of the wash material with the native soil was encountered at the interval of 4.0 to 4.5 ft bgs. Sample 545D011 was collected at this interface, but also did not exceed FSLs.

Location D02 was selected in the lower third of the wash within the CAS ([Figure A.6-1](#)), at an obvious settling area. A sample (545D002) was collected from the surface interval (0.0 to 0.5 ft bgs), which did not exceed FSLs. Sample 545D013, collected from the shallow subsurface interval

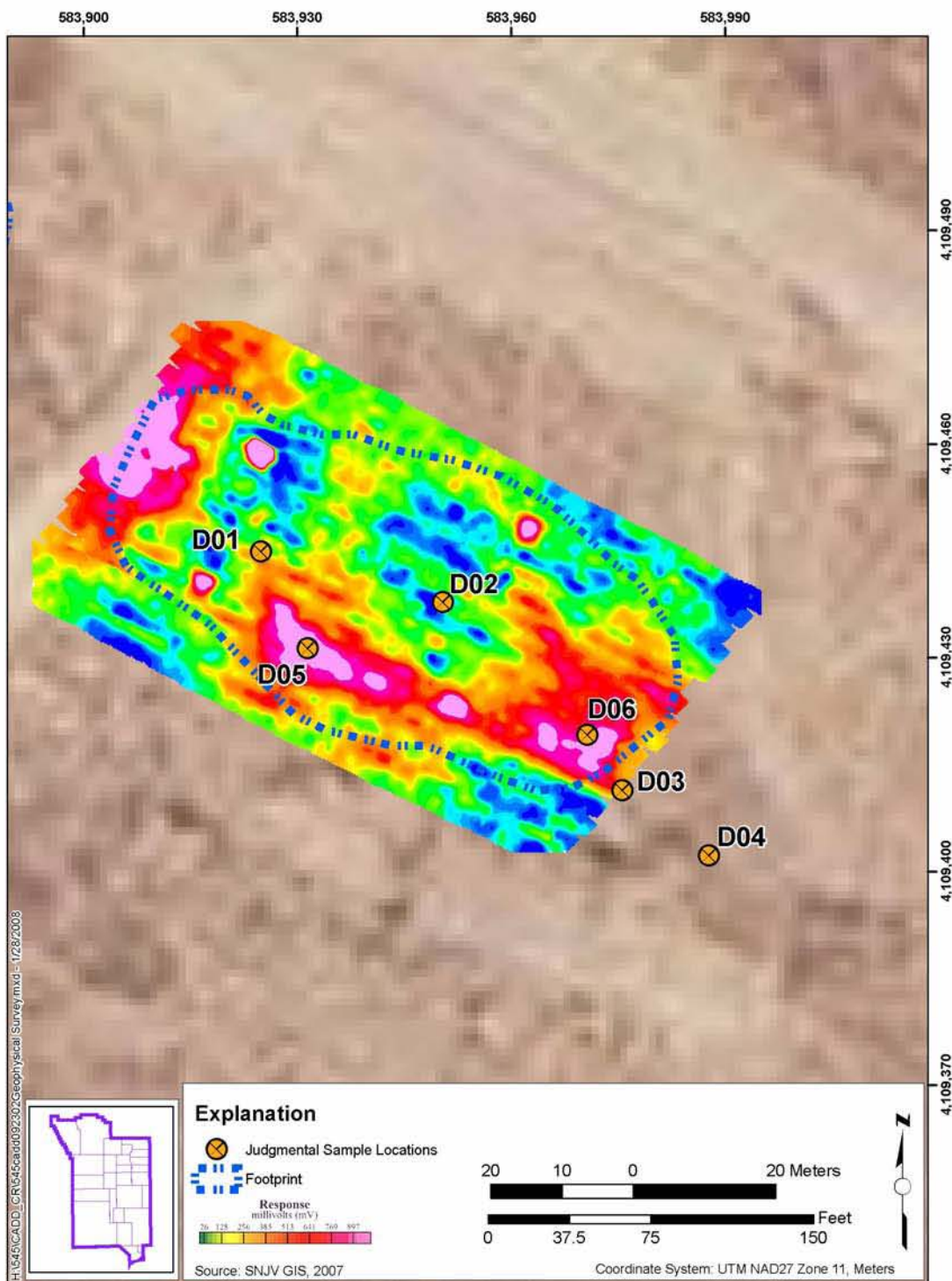


Figure A.6-3
Geophysical Survey at CAS 09-23-02

between 2.0 and 2.5 ft bgs exceeded the FSL for beta. Sample 545D014 at this location was collected immediately below the wash/native soil interface between 3.0 and 3.5 ft bgs, and was below FSLs.

Location D03 was selected at a settling area just down gradient from the CAS. A sample (545D003) was collected from the surface interval (0.0 to 0.5 ft bgs), and did not exceed FSLs. A sample (545D017) was collected from wash material between 1.5 and 2.0 ft bgs, and did not exceed FSLs.

Location D04 was also selected at a settling area, approximately 60 ft down stream from the CAS boundary. A sample (545D004) and duplicate (545D005) was collected from the interval 0.0 to 0.5 ft bgs, and exceeded the FSL for beta. Sample (545D006) was collected from wash material (immediately above native soil) from the interval 0.5 to 1.0 ft bgs, and did not exceed FSLs. An additional shallow subsurface sample (545D018) was collected from the interval 1.0 to 1.17 ft bgs in native soil, which included an approximately 3/8-in. thick layer of black, decomposed natural organic matter. The sample screening results were below FSLs.

Location D05 was selected approximately midway through the CAS and partially up the south bank of the wash, at a geophysical anomaly that was identified as likely being local soil changes, fill material, or buried nonmetallic material. Sample 545D007 was collected from the surface interval (0.0 to 0.5 ft bgs) and was below FSLs. The location was excavated to native soil at 3.5 ft bgs, which consisted of a compact sandy silt. No evidence of drilling mud was observed. A shallow subsurface sample (545D012) was collected from wash material in the interval of 1.5 to 2.0 ft bgs and exceeded FSL for beta.

Location D06 was selected at the east boundary of the CAS, along the wash bottom, also at a geophysical anomaly that indicated either local soil changes, buried nonmetallic debris, or fill material. Sample 545D008 was collected from the interval 0.0 to 0.5 ft bgs and did not exceed FSLs. A second sample (545D015) was collected from wash material from 1.5 to 2.0 ft bgs and did not exceed FSLs. A third sample (545D016) at this location was collected just below the wash material/native soil interface at 3.0 to 3.5 ft bgs, and did not exceed FSLs.

No staining, debris, or biasing factors other than elevated radiological readings, were found in any of the sample location profiles.

A.6.1.6 Deviations

Investigation samples were collected as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007) and submitted for laboratory analysis. There were no deviations from the planned sampling. All sample locations were accessible.

A.6.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007). Investigation samples were analyzed for the CAIP-specified COPCs, which included VOCs, SVOCs, TPH-DRO, RCRA metals, gamma-emitting radionuclides, isotopic Pu, Sr-90, and isotopic U. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in [Table A.2-2](#). [Table A.6-1](#) lists the sample-specific analytical suite for CAS 09-23-02. The waste characterization analytical results are discussed in [Section A.8.0](#).

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in the following sections. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. Establishment of the FALs is presented in [Appendix C](#). The FALs were established as the corresponding PAL concentrations or activities if the contaminant concentrations were below their respective PALs.

A.6.2.1 Volatile Organic Compounds

Analytical results for VOC environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.6-2](#). No VOCs were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

A.6.2.2 Semivolatile Organic Compounds

Analytical results for SVOC environmental samples collected at this CAS did not exceed the MDCs.

Table A.6-2
Soil Sample Results for Total VOCs Detected above Minimum
Detectable Concentrations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)					
			1,2,4-Trimethylbenzene	1,4-Dichlorobenzene	Dichlorodifluoromethane	Methylene Chloride	Styrene	Total Xylenes
Final Action Levels ^a			170	7.9	310	21	1,700	420
D02	545D002	0.0 - 0.5	--	--	0.000951 (J)	--	--	--
D03	545D017	1.5 - 2.0	--	--	--	--	0.000552 (J)	--
D05	545D007	0.0 - 0.5	0.00151	0.000282 (J)	--	0.0023 (J)	0.00251	0.0055
D06	545D008	0.0 - 0.5	0.000449 (J)	0.000281 (J)	--	--	--	--

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface
ft = Foot
mg/kg = Milligrams per kilogram

J = Estimated value
-- = Not detected above minimum detectable concentrations.

A.6.2.3 Total Petroleum Hydrocarbons

The TPH-DRO analytical results for soil samples collected at this CAS that were detected above MDCs are presented in [Table A.6-3](#). Total petroleum hydrocarbons-DRO was not detected at concentrations exceeding the PAL of 100 milligrams per kilogram (mg/kg). The FAL was established at the PAL concentration.

A.6.2.4 RCRA Metals

The RCRA metals analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.6-4](#). No results exceeded the PALs. The FALs were established at the PAL concentrations.

Table A.6-3
Soil Sample Results for TPH-DRO Detected above Minimum
Detectable Concentrations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel-Range Organics
Preliminary Action Levels ^a			100
D01	545D001	0.0 - 0.5	6.17
D02	545D002	0.0 - 0.5	9.07
D03	545D003	0.0 - 0.5	11.4
	545D017	1.5 - 2.0	2.44 (J)
D04	545D004	0.0 - 0.5	4.91
	545D005	0.0 - 0.5	5.65
	545D006	0.5 - 1.0	4.51
	545D018	1.0 - 1.2	1.65 (J)
D06	545D008	0.0 - 0.5	1.6 (J)
	545D015	1.5 - 2.0	5.76
	545D016	3.0 - 3.5	3.63 (J)

^aEstablished in the CAIP for CAU 545 (NNSA/NSO, 2007).

bgs = Below ground surface

CAIP = Corrective Action Investigation Plan

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

A.6.2.5 Gamma-Emitting Radionuclides

Gamma-emitting radionuclide concentrations in environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.6-5](#). No gamma-emitting radionuclides were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

A.6.2.6 Plutonium, Strontium-90, and Uranium Isotopes

Isotopic Pu and isotopic U concentrations in environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.6-6](#). No isotopic Pu, isotopic U, or Sr-90 were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

Table A.6-4
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium
Final Action Levels			23 ^a	67,000 ^b	450 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b
D01	545D001	0.0 - 0.5	3.8	160 (J)	0.2 (J-)	6.9	13.2 (J)	0.029 (J)	0.83 (J-)
	545D009	0.5 - 1.0	3.3	131 (J)	--	5.9	13.3	0.005 (J-)	0.89 (J-)
	545D010	2.0 - 2.5	3.8	130 (J)	--	5.7	13.6	0.013 (J-)	0.97 (J-)
	545D011	4.0 - 4.5	3.4	100 (J)	--	6.3	10	0.016 (J-)	0.68 (J-)
D02	545D002	0.0 - 0.5	--	142 (J)	0.12 (J-)	7.3	14.7 (J)	0.025 (J)	1.1 (J-)
	545D013	2.0 - 2.5	3.8	97.6 (J)	--	6.1	14.3	0.0066 (J-)	0.55 (J-)
	545D014	3.0 - 3.5	4.3	117 (J)	--	5.3	10.7	0.027 (J-)	--
D03	545D003	0.0 - 0.5	--	160 (J)	0.14 (J-)	5.6	15.8 (J)	0.014 (J-)	0.72 (J-)
	545D017	1.5 - 2.0	3.8	89 (J)	--	5.5	9.2 (J)	--	1.5 (J)
D04	545D004	0.0 - 0.5	--	120 (J)	0.19 (J-)	7.6	12.7 (J)	0.013 (J-)	1.1 (J-)
	545D005	0.0 - 0.5	--	123 (J)	0.17 (J-)	7	13.3 (J)	0.014 (J-)	0.65 (J-)
	545D006	0.5 - 1.0	--	189 (J)	0.17 (J-)	7.4	16.5 (J)	0.013 (J-)	0.67 (J-)
	545D018	1.0 - 1.17	4.2	150 (J)	--	6.5	12 (J)	--	2
D05	545D007	0.0 - 0.5	3.3	138 (J)	0.17 (J)	5.9	9.7	0.013 (J-)	0.73 (J+)
	545D012	1.5 - 2.0	7.7	90.9 (J)	--	7.5	10.9	0.022 (J-)	1.4 (J-)
D06	545D008	0.0 - 0.5	3.2	157 (J)	0.18 (J)	5.2	11.8	0.024 (J-)	0.63 (J+)
	545D015	1.5 - 2.0	3.3	250 (J)	--	4.9	17.8 (J)	--	2
	545D016	3.0 - 3.5	4.8	110 (J)	--	7.4	13.9 (J)	0.043 (J)	2

^aBased on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

^bBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

J+ = The result is an estimated quantity, but the result may be biased high.

J- = The result is an estimated quantity, but the result may be biased low.

-- = Not detected above minimum detectable concentrations.

Table A.6-5
Soil Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Americium-241	Cesium-137	Lead-212	Lead-214	Thallium-208
Final Action Levels			5 ^a	12.7 ^b	12.2 ^b	5 ^a	5 ^a	5 ^a
D01	545D001	0.0 - 0.5	2.14	--	0.832	1.94 (J)	1.22 (J)	0.597
	545D009	0.5 - 1.0	1.98	--	0.552	1.58 (J)	1.08 (J)	0.594
	545D010	2.0 - 2.5	2.36	--	--	2.04	1.11	0.573
	545D011	4.0 - 4.5	1.76	--	--	2.07	1.65	0.723
D02	545D002	0.0 - 0.5	2.63	0.376	1.71	2.42	1.53	0.665
	545D013	2.0 - 2.5	1.99	--	--	1.87 (J)	1.08 (J)	0.654
	545D014	3.0 - 3.5	1.99	--	--	2.07	1.52	0.565
D03	545D003	0.0 - 0.5	1.17	0.376 (J)	1.51	1.9 (J)	1.33 (J)	0.581
	545D017	1.5 - 2.0	1.95	--	0.222	1.82	0.99	0.692
D04	545D004	0.0 - 0.5	2.09	0.308 (J)	1.01	2.04 (J)	1.09 (J)	0.845
	545D005	0.0 - 0.5	2.21	--	0.992	1.91 (J)	1.22 (J)	0.576
	545D006	0.5 - 1.0	2.58	--	0.459	2.39	1.21	0.718
	545D018	1.0 - 1.17	1.87	--	0.518	2.11	1.4	0.759
D05	545D007	0.0 - 0.5	1.65	--	0.324 (J)	1.69 (J)	0.992 (J)	0.64
	545D012	1.5 - 2.0	1.82	--	0.162	2.06 (J)	1.05 (J)	0.672
D06	545D008	0.0 - 0.5	1.85	--	1.09 (J)	1.92 (J)	1.13 (J)	0.706
	545D015	1.5 - 2.0	2.06	--	--	2.13	1.22	0.775
	545D016	3.0 - 3.5	2.16	--	--	2.37	1.6	0.818

^aTaken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993). The PALs for these isotopes are specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

^bTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

DOE = U.S. Department of Energy

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

PAL = Preliminary action level

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Table A.6-6
Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
Final Action Levels ^a			13	12.7	143	17.6	105
D01	545D001	0.0 - 0.5	--	0.122	1.1	--	1.04
	545D009	0.5 - 1.0	--	--	0.913	--	0.734
	545D010	2.0 - 2.5	--	--	1.11	--	1.39
	545D011	4.0 - 4.5	--	0.78 (J)	1.52	0.111	1.65
D02	545D002	0.0 - 0.5	--	0.708	1.08	--	0.935
	545D013	2.0 - 2.5	--	--	0.92	--	0.838
	545D014	3.0 - 3.5	--	--	1.05	--	1.17
D03	545D003	0.0 - 0.5	--	1.38	1.08	--	1.1
	545D017	1.5 - 2.0	--	--	0.943	--	0.792
D04	545D004	0.0 - 0.5	0.508	6.7	0.9	--	0.786
	545D005	0.0 - 0.5	--	7.3	0.75	--	0.808
	545D006	0.5 - 1.0	--	0.182	0.845	--	0.824
	545D018	1.0 - 1.17	--	0.653 (J)	1.05	0.0928	0.928
D05	545D007	0.0 - 0.5	--	0.0874	1.05	--	1.13
	545D012	1.5 - 2.0	0.0618	1.45	0.798	0.0632	0.909
D06	545D008	0.0 - 0.5	0.0622	1.22	0.861	--	1.1
	545D015	1.5 - 2.0	--	1.13 (J)	0.945	--	0.882
	545D016	3.0 - 3.5	--	--	1.48	0.113	1.18

^aTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

A.6.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected within CAS 09-23-02, no COCs were identified at this CAS.

A.6.4 Revised Conceptual Site Model

The CAIP requirements were met at this CAS (NNSA/NSO, 2007), and no revisions were necessary to the CSM.

A.7.0 Corrective Action Site 20-19-01, Waste Disposal Site

Corrective Action Site 20-19-01 is located northeast of the test hole for U-20p, and encompasses a debris pile that contains mostly construction rubble (i.e., plywood, two-by-fours). Several 55-gal drums that had been at the site were removed in 1991 under the scope of CAS 20-22-03. The remaining debris was placed under the scope of CAS 20-19-01. Additional detail is provided in the CAIP for CAU 545 (NNSA/NSO, 2007).

A.7.1 Corrective Action Investigation

A total of 11 characterization samples (including one FD) were collected during investigation activities at CAS 20-19-01. The sample locations are shown on [Figure A.7-1](#). The sample locations, IDs, types, and analyses are listed in [Table A.7-1](#). The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2007) are described in the following sections.

A.7.1.1 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs was exceeded in one sample, and the beta/gamma radiation FSL was not exceeded at CAS 20-19-01. The sample exceeding the FSL was analyzed.

A.7.1.2 Radiological Survey

A radiological walkover survey was conducted over CAS 20-19-01. No areas of elevated radiological readings were found. The radiological survey was not used in the selection of sample locations. ([Figure A.7-2](#)).

A.7.1.3 Visual Inspections

Debris assumed to be related to the test conducted at U-20p was scattered throughout the site. Sample locations were established beneath the following visible materials: two locations at used oil filter(s), one location at a canister containing a greasy substance, two locations within the dried drilling mud spill that entered the site from the south, one location along the western edge where the soil was discolored yellowish tan and contained white flakes, one location at a small pile of what appeared to

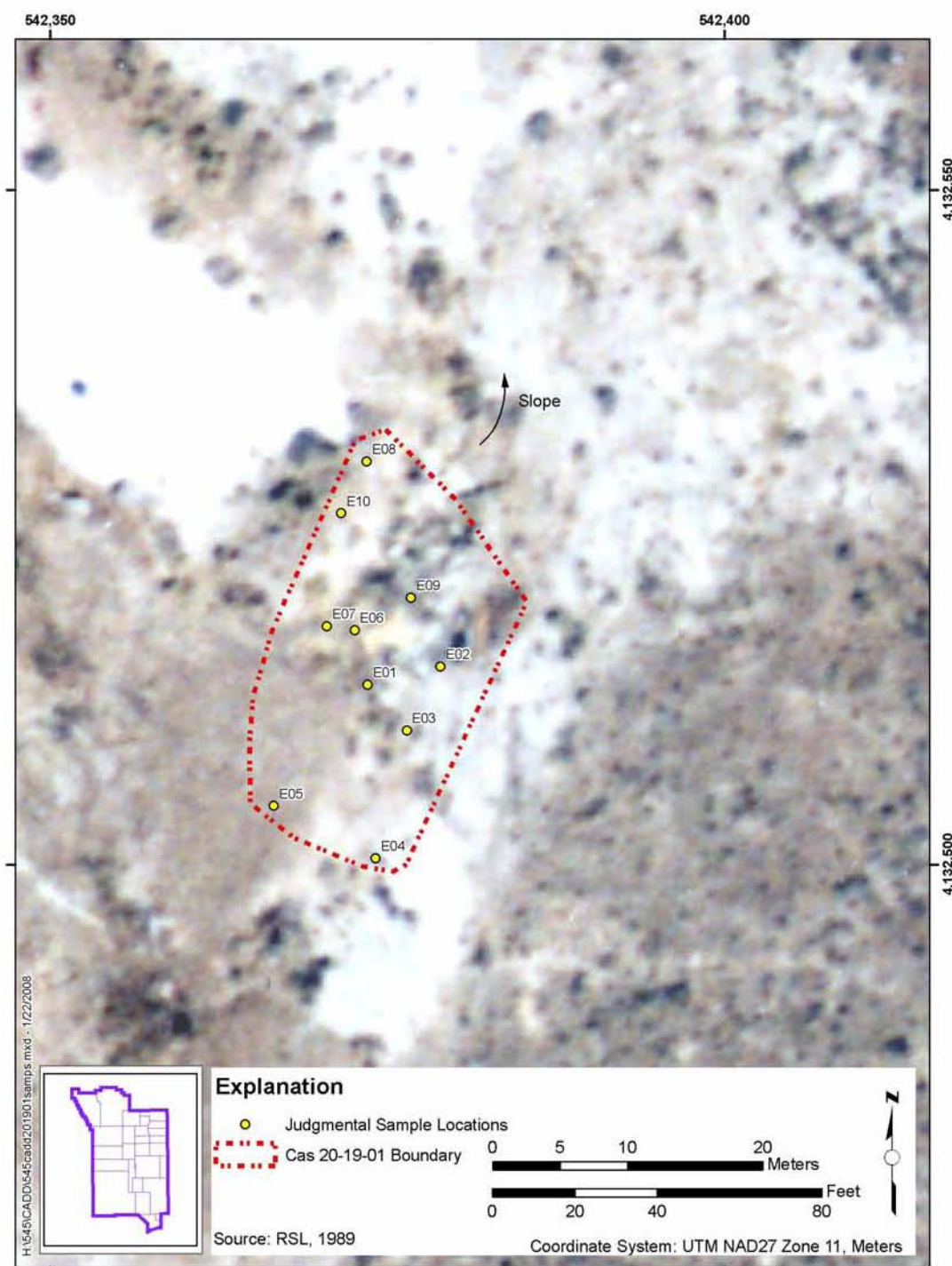


Figure A.7-1
Sample Locations at CAS 20-19-01, Waste Disposal Site

Table A.7-1
Samples Collected at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
E01	545E001	0.0 - 0.5	Soil	Environmental	Set 3
E02	545E002	0.0 - 0.5	Soil	Environmental	Set 3
E03	545E003	0.0 - 0.5	Soil	Environmental, Full Lab QC	Set 3
E04	545E004	0.0 - 0.5	Soil	Environmental	Set 3
E05	545E005	0.0 - 0.5	Soil	Environmental	Set 3
E06	545E006	0.0 - 0.5	Soil	Environmental	Set 3
E07	545E007	0.0 - 0.5	Soil	Environmental	Set 3
E08	545E008	0.0 - 0.5	Soil	Environmental	Set 3
E09	545E009	0.0 - 0.5	Soil	Environmental	Set 3
	545E010	0.0 - 0.5	Soil	Field Duplicate of #545E009	Set 3
E10	545E011	0.0 - 0.5	Soil	Environmental	Set 3
N/A	545E301	N/A	Water	Trip Blank	VOCs
N/A	545E302	N/A	Water	Trip Blank	VOCs
N/A	545E303	NA	Water	Field Blank	Set 3

Set 3 = VOCs, SVOCs, TPH-DRO, PCBs, RCRA Metals, Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Strontium-90

DRO = Diesel-range organics
ft = Feet below ground surface
N/A = Not applicable
PCB = Polychlorinated biphenyl

QC = Quality control
RCRA = *Resource Conservation and Recovery Act*
SVOC = Semivolatile organic compound
TPH = Total petroleum hydrocarbons

be corroded capacitors or batteries (slightly larger than D-cell size), one location within scattered photograph processing/fixing supplies, one location that was comprised of fine, whitish soil of a lower density than the native soil; and one location that appeared to be stained a darker shade of tan, and that was adjacent to a yellow, solidified mass in the shape of a small (approximately 30-gal) drum. An overall photograph of the debris at the site is shown in [Figure A.7-3](#).

A.7.1.4 Sample Collection

Decision I environmental sampling activities included the collection of biased surface soil samples at potentially hazardous-containing materials ([Figure A.7-1](#)).

Environmental samples were collected from the soil containing the biasing factor (e.g., stained soil, drilling mud spill, oil stains). Sample 545E001 at location E01 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by release of used motor oil from several oil filters. The soil beneath this interval did not appear impacted by the oil. Sample 545E002 at location E02 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by release of used motor oil

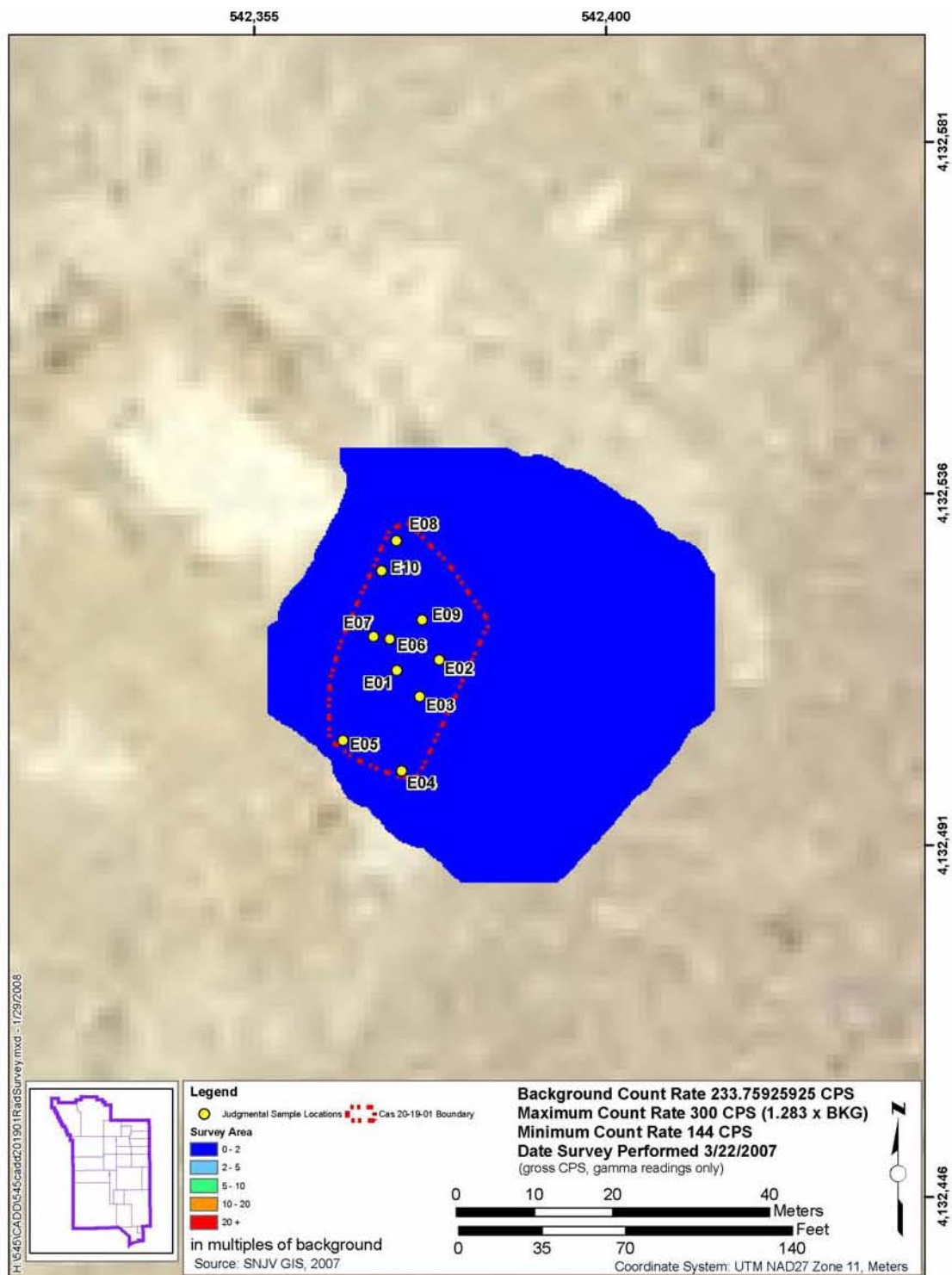


Figure A.7-2
Radiological Survey for CAS 20-19-01



Figure A.7-3
Overall View of Debris at CAS 20-19-01

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from a single oil filter. The soil beneath this interval also did not appear impacted by the oil.

Sample 545E003 at location E03 was collected from the surface interval (0.0 to 0.5 ft bgs) that was impacted by a spill of drilling mud that entered the site along the southern side. The layer of drilling mud was approximately 1 in. thick and did not appear to impact the underlying soil. Sample 545E004 at location E04 was also collected from the surface interval (0.0 to 0.5 ft bgs) impacted by the release of drilling mud. The layer of drilling mud at this location was approximately 3 in. thick, and also did not appear to impact the underlying soil.

Sample 545E005 at location E05 was collected at the southwest extent of the debris, from the surface interval (0.0 to 0.5 ft bgs), beneath a canister in which grease had seeped from a connection. The soil directly beneath this canister was impacted by the grease, but the impact was not visible below 0.5 ft bgs. Sample 545E006 at location E06 was collected from the surface interval (0.0 to 0.5 ft bgs) from soil which had a yellowish hue and contained white flecks of an unknown material. Neither the yellow hue nor the white flecks extended below this interval. Sample 545E007 at location E07 was collected from the surface interval (0.0 to 0.5 ft bgs) and impacted by corroded capacitors or batteries. The impact from these materials did not appear to extend below this interval.

Sample 545E008 at location E08 was collected from 0.0 to 0.5 ft bgs in an area impacted by photographic materials. The impact from these materials did not appear to extend below this interval. Samples 545E009 and duplicate 545E010 at location E09 were collected from 0.0 to 0.5 ft bgs in an area of light-hued, loose, low-density material mixed in with soil. The impact of this material was limited to the surface. Sample 545E011 at location E10 was collected from 0.0 to 0.5 ft bgs in an area of stained soil that was adjacent to a yellow, solidified mass in the shape of a small (approximately 30-gal) drum. The soil beneath this interval did not appear to be this darker hue.

A.7.1.5 Deviations

Investigation samples were collected as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007) and submitted for laboratory analysis. There were no deviations from the planned sampling.

A.7.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP for CAU 545 (NNSA/NSO, 2007). Investigation

samples were analyzed for the CAIP-specified COPCs, which included VOCs, SVOCs, TPH-DRO, RCRA metals, PCBs, gamma-emitting radionuclides, isotopic Pu, Sr-90, and isotopic U. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in [Table A.2-2](#). [Table A.7-1](#) lists the sample-specific analytical suite for CAS 20-19-01.

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in the following sections. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. Establishment of the FALs is presented in [Appendix C](#). The FALs were established as the corresponding PAL concentrations or activities if the contaminant concentrations were below their respective PALs.

A.7.2.1 Volatile Organic Compounds

Analytical results for VOC environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.7-2](#). No VOCs were detected at concentrations exceeding their respective PALs. The FALs were established at the PAL concentrations.

A.7.2.2 Semivolatile Organic Compounds

Analytical results for SVOC environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.7-3](#). No SVOCs were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

A.7.2.3 Total Petroleum Hydrocarbons

The TPH-DRO analytical results for soil samples collected at this CAS that were detected above MDCs are presented in [Table A.7-4](#). Two surface samples exceeded the PAL of 100 mg/kg for TPH-DRO. The TPH-DRO was moved on to a Tier 2 evaluation and FALs were established for the hazardous constituents of TPH-DRO. Concentrations of the hazardous constituents of TPH-DRO did not exceed FALs. Therefore, TPH-DRO is not considered a COC. The calculation of FALs for the hazardous constituents of TPH-DRO are presented in [Appendix C](#).

Table A.7-2
Soil Sample Results for Total VOCs Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			2-Butanone	2-Hexanone	Acetone	Benzene	Dichlorodifluoromethane	Methylene Chloride	Styrene
Final Action Levels ^a			110,000	110,000	54,000	1.4	310	21	1,700
E01	545E001	0.0 - 0.5	0.00322 (J)	--	0.0555	--	--	0.00338 (J)	0.000229 (J)
E03	545E003	0.0 - 0.5	--	--	--	--	--	0.00557	0.000406 (J)
E04	545E004	0.0 - 0.5	--	--	--	--	0.00139	0.00572	0.000209 (J)
E05	545E005	0.0 - 0.5	0.0142	0.00935	0.0313	--	--	0.0103	0.00049 (J)
E06	545E006	0.0 - 0.5	0.00214 (J)	--	0.00309 (J)	0.000429 (J)	--	0.00674	0.000315 (J)
E07	545E007	0.0 - 0.5	--	--	--	--	--	0.00817	0.00028 (J)
E08	545E008	0.0 - 0.5	0.00604	--	0.408	0.00041 (J)	--	--	--
E09	545E009	0.0 - 0.5	0.00416 (J)	--	0.0173	--	0.00215	0.005 (J)	--
	545E010	0.0 - 0.5	--	--	0.00358 (J)	--	0.00205	0.00509 (J)	--
E10	545E011	0.0 - 0.5	0.00231 (J)	--	--	0.000375 (J)	0.000803 (J)	--	0.000276 (J)

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Table A.7-3
Soil Sample Results for Total SVOCs Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)				
			Benzoic Acid	Bis(2-ethylhexyl)phthalate	Di-n-butyl phthalate	Phenanthrene	Phenol
Final Action Levels ^a			100,000	120	62,000	100,000	100,000
E01	545E001	0.0 - 0.5	1.1	0.13 (J)	0.0906 (J)	--	0.0741 (J)
E02	545E002	0.0 - 0.5	--	--	0.936	--	--
E05	545E005	0.0 - 0.5	--	0.0767 (J)	--	--	--
E06	545E006	0.0 - 0.5	8.53	--	0.107 (J)	0.0157 (J)	0.358
E07	545E007	0.0 - 0.5	41.3	--	--	--	--
E08	545E008	0.0 - 0.5	15.2	3.99	--	--	--
E09	545E009	0.0 - 0.5	0.81	--	0.0405 (J)	--	--
	545E010	0.0 - 0.5	0.821	0.0949 (J)	--	--	--
E10	545E011	0.0 - 0.5	7.2	--	0.0838 (J)	0.0134 (J)	0.286 (J)

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface
ft = Foot
mg/kg = Milligrams per kilogram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Table A.7-4
Soil Sample Results for TPH-DRO Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel-Range Organics
Preliminary Action Levels ^a			100
E01	545E001	0.0 - 0.5	51.3
E02	545E002	0.0 - 0.5	35.2
E03	545E003	0.0 - 0.5	16.9
E04	545E004	0.0 - 0.5	4.1
E05	545E005	0.0 - 0.5	88.2
E06	545E006	0.0 - 0.5	93.7
E07	545E007	0.0 - 0.5	157
E08	545E008	0.0 - 0.5	123
E09	545E009	0.0 - 0.5	49.1
	545E010	0.0 - 0.5	24.3
E10	545E011	0.0 - 0.5	63.4

^aEstablished in the CAIP for CAU 545 (NNSA/NSO, 2007).

bgs = Below ground surface
CAIP = Corrective Action Investigation Plan
ft = Foot
mg/kg = Milligrams per kilogram

A.7.2.4 RCRA Metals

The RCRA metals analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.7-5](#). No results exceeded the FALs. The FALs were established at the PAL concentrations.

A.7.2.5 Polychlorinated Biphenyls

The PCBs detected above MDCs are presented in [Table A.7-6](#). No PCBs were detected at concentrations exceeding the PAL. The FAL was established at the PAL concentration.

Table A.7-5
Soil Sample Results for RCRA Metals Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Final Action Levels			23 ^a	67,000 ^b	450 ^b	450 ^b	800 ^b	310 ^b	5,100 ^b	5,100 ^b
E01	545E001	0.0 - 0.5	6	143 (J)	0.87	10.3	39.5 (J)	0.025 (J)	0.65 (J-)	0.26 (J)
E02	545E002	0.0 - 0.5	7.1	160 (J)	0.19 (J)	10.1	35.4 (J)	0.03 (J)	1.2 (J-)	3.6
E03	545E003	0.0 - 0.5	6.4	139 (J)	--	7.8	15.5 (J)	0.015 (J-)	1.2 (J-)	--
E04	545E004	0.0 - 0.5	7.6	189 (J)	0.24 (J)	12.1	17.9 (J)	0.022 (J)	1.2 (J-)	--
E05	545E005	0.0 - 0.5	5.9	112 (J)	0.19 (J)	8.4	43.2 (J)	0.014 (J-)	0.91 (J-)	--
E06	545E006	0.0 - 0.5	6.4	257 (J)	0.44 (J)	9.5	22.5 (J)	0.023 (J)	2.1 (J-)	0.13 (J)
E07	545E007	0.0 - 0.5	5.6	170 (J)	2.7	8	40.9 (J)	0.46 (J)	0.53 (J-)	--
E08	545E008	0.0 - 0.5	6.5	233 (J)	0.72	10.7	83.1 (J)	0.05 (J)	0.96 (J-)	22.1
E09	545E009	0.0 - 0.5	9.1	291 (J)	0.63	12.2	106 (J)	0.022 (J)	1.4 (J-)	0.65
	545E010	0.0 - 0.5	7.2	254 (J)	0.55	11.8	93.9 (J)	0.023 (J)	1.3 (J-)	0.39 (J)
E10	545E011	0.0 - 0.5	5.1	131 (J)	0.29 (J-)	10.3	25.6 (J)	0.03 (J)	1 (J-)	2.5

^aBased on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

^bBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

J- = The result is an estimated quantity, but the result may be biased low.

-- = Not detected above minimum detectable concentrations.

Table A.7-6
Soil Sample Results for PCBs Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)	
			Aroclor 1254	Aroclor 1268
Final Action Levels ^a			0.74	0.74
E02	545E002	0.0 - 0.5	0.0066 (J)	--
E06	545E006	0.0 - 0.5	--	0.0437

^aBased on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004).

bgs = Below ground surface

ft = Foot

mg/kg = Milligrams per kilogram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

A.7.2.6 Gamma-Emitting Radionuclides

Gamma-emitting radionuclide concentrations in environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.7-7](#). No gamma-emitting radionuclides were detected at concentrations exceeding the respective PALs. The FALs were established at the PAL concentrations.

A.7.2.7 Plutonium and Uranium Isotopes

Isotopic Pu and isotopic U concentrations in environmental samples collected at this CAS that were detected above MDCs are presented in [Table A.7-8](#). No isotopic Pu or isotopic U exceeded the PALs. The FALs were established at the PAL concentrations.

A.7.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected within CAS 20-19-01, no COCs were identified at this CAS.

A.7.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2007) were met at this CAS, and no revisions were necessary to the CSM.

Table A.7-7
Soil Sample Results for Gamma-Emitting Radionuclides Detected above
Minimum Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Americium-241	Cesium-137	Lead-212	Lead-214	Thallium-208
Final Action Levels			5 ^a	12.7 ^b	12.2 ^b	5 ^a	5 ^a	5 ^a
E01	545E001	0.0 - 0.5	1.83	0.676 (J)	0.662	1.86 (J)	1.8 (J)	0.561
E02	545E002	0.0 - 0.5	2.01	1.19	1	1.95	1.55	0.639
E03	545E003	0.0 - 0.5	1.9	0.885 (J)	0.655	1.79 (J)	1.54 (J)	0.55
E04	545E004	0.0 - 0.5	1.85	--	--	1.89 (J)	1.69 (J)	0.627
E05	545E005	0.0 - 0.5	2.33	--	--	2.18	1.65	0.634
E06	545E006	0.0 - 0.5	1.68	--	--	1.7	1.01	0.489
E07	545E007	0.0 - 0.5	1.85	--	0.542	1.73	1.48	0.504
E08	545E008	0.0 - 0.5	1.79	0.466	0.415	1.69	1.45	0.574
E09	545E009	0.0 - 0.5	1.76	0.568	0.567	2.3	2.07	0.778
	545E010	0.0 - 0.5	1.57	--	0.507	1.87	2.09	0.552
E10	545E011	0.0 - 0.5	1.99	--	0.386	2.02	1.45	0.76

^aTaken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993). The PALs for these isotopes are specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

^bTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

cm = Centimeter

DOE = U.S. Department of Energy

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

Table A.7-8
Soil Sample Results for Isotopes Detected above Minimum
Detectable Concentrations at CAS 20-19-01, Waste Disposal Site

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
Final Action Levels ^a			13	12.7	143	17.6	105
E01	545E001	0.0 - 0.5	1.18 (J)	2.29 (J)	1.38	--	1.2
E02	545E002	0.0 - 0.5	1.09 (J)	2.59 (J)	0.829	--	0.647
E03	545E003	0.0 - 0.5	0.317 (J)	1.68 (J)	0.771	--	0.779
E04	545E004	0.0 - 0.5	--	0.107 (J)	1.04	--	1.2
E05	545E005	0.0 - 0.5	--	--	0.772	--	0.733
E06	545E006	0.0 - 0.5	--	--	1	--	1.06
E07	545E007	0.0 - 0.5	0.801 (J)	2.73 (J)	1.23	--	1
E08	545E008	0.0 - 0.5	0.224 (J)	1.52 (J)	0.992	--	1.03
E09	545E009	0.0 - 0.5	0.267 (J)	1.86 (J)	1.25	--	1.37
	545E010	0.0 - 0.5	1.09 (J)	1.67 (J)	1.33	0.0908	1.43
E10	545E011	0.0 - 0.5	1.04 (J)	0.85 (J)	0.73	--	0.901

^aTaken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-millirem-per-year dose.

bgs = Below ground surface

ft = Foot

NCRP = National Council on Radiation Protection and Measurements

pCi/g = Picocuries per gram

J = Estimated value

-- = Not detected above minimum detectable concentrations.

A.8.0 Waste Management

Waste management areas were established and managed as specified in the CAIP for CAU 545 (NNSA/NSO, 2007). For regulated waste, the amount, type, and source of the waste placed into each waste container was recorded in a log at the time of generation. Characterization and disposal were completed within regulatory requirements and acceptance criteria.

A.8.1 Sanitary Waste

Personal protective equipment (PPE) and disposable sampling equipment generated during the site activities were determined to be sanitary based on observation and process knowledge. The waste not containerized ([Section A.2.1](#)) was bagged, marked, and placed in a roll-off box for disposition at the industrial landfill. Office and lunch waste was placed in a dumpster as sanitary trash.

A.8.2 Waste Minimization

Investigation-derived waste (IDW) was generated during the field activities. In an effort to reduce the amount of waste generated, waste minimization techniques were integrated into the field activities and waste was segregated to the greatest extent possible. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste.

Decontamination activities were planned and executed to minimize the volume of rinsate generated.

A.8.2.1 Waste Streams/Disposal

All waste dispositions were based on process knowledge, radiological surveys, site samples, and direct samples of the waste, when necessary ([Table A.8-1](#)). The characterization and disposition was based on federal and state regulations, permit limitations, and acceptance criteria. The load verification and shipping documentation for CAU 545 are in [Appendix D](#). The wastes at CAU 545 are being managed and disposed of as follows:

- Solids
- Debris
- Rinsate

**Table A.8-1
Waste Summary**

CAS	Waste Item	Volume/ Capacity	Process Knowledge	Analytical Data	Landfill Limits	NTS POC	Lagoon Criteria	Disposal Pathway	Volume	Disposal Date	Disposal Document
02-09-01	Solids (Solidified Rinsate)	(2) 55-gal drums	-	Sanitary Waste	Meets	Meets	Exceeds	Area 9 – U10c LF	(2) 55-gal drums	March 2008	Pending LVF
03-08-03	No waste was generated at CAS 03-08-03										
03-17-01	Debris (Sampling Debris and PPE)	(1) 55-gal drum	-	Sanitary Waste	Meets	Meets	-	Area 9 – U10c LF	(1) 55-gal drum	March 2008	Pending LVF
	Rinsate	(2) 10-gal drums	-	Sanitary Waste	Meets	Meets	Meets	Area 23 – Lagoon	5.5 gal	March 2008	Pending BOL
03-23-02	No waste was generated at CAS 03-23-02										
03-23-05	No waste was generated at CAS 03-23-05										
03-99-14	Rinsate	(1) 10-gal drum	-	Sanitary Waste	Meets	Meets	Meets	Area 23 – Lagoon	3 gal	March 2008	Pending BOL
09-23-02	Rinsate	(1) 10-gal drum	-	Sanitary Waste	Meets	Meets	Meets	Area 23 – Lagoon	5 gal	March 2008	Pending BOL
20-19-01	Debris (Oil Filters and Grease Canister)	(1) 10-gal drum	Hydrocarbon Waste	-	Meets	Meets	-	Area 6 – hydrocarbon LF	(1) 10-gal drum	March 2008	Pending LVF

BOL = Bill of Lading

gal = Gallon

LF = Landfill

LVF = Load Verification Form

- = Unitless

NTS = Nevada Test Site

POC = Performance objective criteria

PPE = Personal protective equipment

Corrective Action Site 02-09-01

Due to the investigation activities at CAS 02-09-01, two drums of IDW were generated. These two (rinsate) drums of IDW were solidified and are recommended for disposal at the NTS U10c Industrial Landfill.

Corrective Action Site 03-17-01

Due to the investigation activities at CAS 03-17-01, three drums of IDW were generated. One drum of IDW, debris, is recommended for disposal at the NTS U10c Industrial Waste Landfill; and two (rinsate) drums of IDW are recommended for disposal in the NTS A23 Lagoon.

Corrective Action Site 03-99-14

Due to the investigation activities at CAS 03-99-04, one drum of IDW was generated. This (rinsate) drum of IDW is recommended for disposal in the NTS A23 Lagoon.

Corrective Action Site 09-23-02

Due to the investigation activities at CAS 09-23-02, one drum of IDW was generated. This (rinsate) drum of IDW is recommended for disposal in the NTS A23 Lagoon.

Corrective Action Site 20-19-01

Due to the investigation activities at CAS 20-19-01, one drum of IDW was generated. This debris (oil filter and grease container) drum of IDW is recommended for disposal at the NTS Area 6 Hydrocarbon Waste Landfill.

A.8.2.2 Waste Streams

Investigation-derived waste managed at CAU 545 includes:

- One drum of hydrocarbon impacted soil/debris for disposal as hydrocarbon waste.
- Three drums of solid waste for disposal as industrial waste.
- Four drums of rinsate for disposal at the A23 Lagoon.

Waste disposal documents are located in [Appendix D](#).

A.9.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 545 CAI. The following sections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in [Appendix B](#).

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory samples including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the QAPP (NNSA/NV, 2002).

A.9.1 Data Validation

Data validation was performed in accordance with the QAPP and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 545 were evaluated for data quality in a tiered process and are presented in [Sections A.9.1.1 through A.9.1.3](#). Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

One hundred percent of the data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on approximately 5 percent of the data analyzed.

A.9.1.1 Tier I Evaluation

Tier I evaluation for chemical and radiochemical analysis examines, but is not limited to:

- Sample count/type consistent with chain of custody.
- Analysis count/type consistent with chain of custody.
- Correct sample matrix.
- Significant problems and/or nonconformances stated in cover letter or case narrative.
- Completeness of certificates of analysis.

- Completeness of Contract Laboratory Program (CLP) or CLP-like packages.
- Completeness of signatures, dates, and times on chain of custody.
- Condition-upon-receipt variance form included.
- Requested analyses performed on all samples.
- Date received/analyzed given for each sample.
- Correct concentration units indicated.
- Electronic data transfer supplied.
- Results reported for field and laboratory QC samples.
- Whether or not the deliverable met the overall objectives of the project.

A.9.1.2 Tier II Evaluation

Tier II evaluation for chemical analysis examines, but is not limited to:

- Correct detection limits achieved.
- Sample date, preparation date, and analysis date for each sample.
- Holding time criteria met.
- Quality control batch association for each sample.
- Cooler temperature upon receipt.
- Sample pH for aqueous samples, as required.
- Detection limits properly adjusted for dilution, as required.
- Blank contamination evaluated and applied to sample results/qualifiers.
- Matrix spike (MS)/matrix spike duplicate (MSD) percent recoveries (%R) and relative percent differences (RPDs) evaluated and qualifiers applied to laboratory results, as necessary.
- Field duplicate RPDs evaluated using professional judgment and qualifiers applied to laboratory results, as necessary.
- Laboratory duplicate RPDs evaluated and qualifiers applied to laboratory results, as necessary.
- Surrogate %R evaluated and qualifiers applied to laboratory results, as necessary.
- Laboratory control sample (LCS) %R evaluated and qualifiers applied to laboratory results, as necessary.
- Initial and continuing calibration evaluated and qualifiers applied to laboratory results, as necessary.
- Internal standard evaluation.
- Mass spectrometer tuning criteria.
- Organic compound quantitation.

- Inductively coupled plasma interference check sample evaluation.
- Graphite furnace atomic absorption QC.
- Inductively coupled plasma serial dilution effects.
- Recalculation of 10 percent of laboratory results from raw data.

Tier II evaluation for radiochemical analysis examines, but is not limited to:

- Correct detection limits achieved.
- Blank contamination evaluated and, if significant, qualifiers are applied to sample results.
- Certificate of Analysis consistent with data package documentation.
- Quality control sample results (duplicates, LCSs, laboratory blanks) evaluated and used to determine laboratory result qualifiers.
- Sample results, uncertainty, and MDC evaluated.
- Detector system calibrated with National Institute for Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.9.1.3 Tier III Evaluation

A Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 5 percent of the sample analytical data was performed by TLI Solutions of Lakewood, Colorado. Tier II and Tier III results were compared and where differences are noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

- Case narrative, chain of custody, and sample receipt forms
- Lab qualifiers (applied appropriately)

- Method of analyses performed as dictated by the chain of custody
- Raw data, including chromatograms, instrument printouts, preparation logs, and analytical logs
- Manual integrations to determine whether the response is appropriate
- Data package for completeness

Determine sample results qualifiers through the evaluation of (but not limited to):

- Tracers and QC sample results (e.g., duplicates, LCSs, blanks, MSs) evaluated and used to determine sample results qualifiers.
- Sample preservation, sample preparation/extraction and run logs, sample storage, and holding time.
- Instrument and detector tuning.
- Initial and continuing calibrations.
- Calibration verification (initial, continuing, second source).
- Retention times.
- Second column and/or second detector confirmation.
- Mass spectra interpretation.
- Interference check samples and serial dilutions.
- Post digestion spikes and method of standard additions.
- Breakdown evaluations.

Calculation checks of:

- At least one analyte per QC sample and its recovery.
- At least one analyte per initial calibration curve, continuing calibration verification, and second source recovery.
- At least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error).

Verify that target compound detects identified in the raw data are reported on the results form.

Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.9.2 Field Quality Control Samples

Field QC samples consisted of 12 trip blanks, 4 equipment rinsate blanks, 5 field blanks, 2 source blanks, 8 full laboratory QCs, and 8 FDs collected and submitted for analysis by the laboratory analytical methods and applicable parameters shown in [Table A.2-2](#). Trip blanks were analyzed for VOCs only. The QC samples were assigned individual sample numbers and sent to the laboratory “blind.” Additional samples were selected by the laboratory to be analyzed as laboratory duplicates.

Review of the source blank analytical data resulted in possible gross alpha/beta contamination of one sample. A second source blank sample was submitted for gross alpha/beta analysis, and no contamination was detected. Results for a source blank of the Well 3 water showed contamination by arsenic, barium, acetone, di-n-butylphthalate, TPH-DRO, and isotopic U. Results for the source blank taken from water used for field blanks showed contamination by acetone and chloroform. However, none of the field blank analyses showed a detection of acetone or chloroform.

During the CAI, eight FDs were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in [Table A.2-2](#). For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding FD sample results) were evaluated. The results of this evaluation are provided in [Section B.1.1.1.1](#), Criterion 3, Precision, of [Appendix B](#).

A.9.2.1 Laboratory Quality Control Samples

Analysis of preparation QC blanks were performed on each sample delivery group (SDG) for inorganics. Analysis for surrogate spikes and method blanks were performed on each SDG for organics only. Initial and continuing calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

The laboratory included a preparation blank, LCS, and a laboratory duplicate sample with each batch of field samples analyzed for radionuclides.

A.9.2.2 *Field Nonconformances*

There were no field nonconformances identified for the CAI.

A.9.3 *Laboratory Nonconformances*

Laboratory nonconformances are generally due to inconsistencies in the analytical instrumentation operation, sample preparations, extractions, missed holding times, and fluctuations in internal standard and calibration results. The laboratories issued 42 nonconformances that may or may not have resulted in qualifying data. These laboratory nonconformances have been accounted for and resolved during the data qualification process.

A.10.0 Summary

Organic, inorganics, and radionuclide contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 545. Assessment of the data generated from investigation activities indicates the FALs were not exceeded at any of the five CASs investigated. The following summarizes the results for each CAS.

CAS 02-09-01, Mud Disposal Area

Suspected releases at this site were potentially radiological contamination of the drilling mud disposed on the soil surface. The radiological survey did not identify any area of elevated radioactivity on the drilling mud. The analytical results for surface and shallow subsurface samples collected at eight locations were below the PALs for the site. The FALs for all analytes were established at the PAL concentrations. No COCs were identified at CAS 02-09-01. Therefore, no further action is required at this CAS.

CAS 03-17-01, Waste Consolidation Site 3B

Suspected releases at this site were potentially RCRA metal and/or radiological contamination of the soil from debris and contaminated soil previously stored and the site. Several biased locations were determined using the highest values from the radiological survey. The site was sampled following a probabilistic sampling approach, with some judgmental sampling conducted at biasing locations identified during the radiological and geophysical surveys. The analytical results for surface and shallow subsurface samples collected at 31 locations in the CAS and 15 locations outside the CAS fence line identified several areas of Am-241 and/or Pu-239/240 above the PALs. The radiological results for the site were moved on to a Tier 2 evaluation. All individual results were below the FALs. For the probabilistic results that were statistically analyzed, the 95 percent UCLs for Am-241 and Pu-239/240 were also below the industrial scenario FALs. No COCs were identified at CAS 03-17-01. Therefore, no further action is required at this CAS.

CAS 03-99-14, Radioactive Material Disposal Area

Suspected releases at this site were potentially chemical and/or radiological contamination of material disposed at the site. Radiological contamination in the form of trinity glass was present, and

attributed to nearby aboveground nuclear testing. The radiological survey did identify areas of elevated radioactivity, from two to five times background, most likely due to the presence of the Trinity glass. The analytical results for surface and shallow subsurface samples collected at eight locations were below the PALs for the site. The FALs for all analytes were established at the PAL concentrations. One background sample taken from outside the south border of the site exceeded the PAL for Pu-239/240, most likely due to the nearby aboveground testing, but no COCs were identified at CAS 03-19-14. Therefore, no further action is required at this CAS.

CAS 09-23-02, U-9y Drilling Mud Disposal Crater

Suspected releases at this site were potentially chemical and/or radiological contamination of drilling mud disposed in the crater component of the site, and the overflow of the mud into the wash. The radiological survey did not identify any area of elevated radioactivity. The analytical results for surface and shallow subsurface samples (collected at four locations in the wash at the CAS and two in the wash downstream from the site) were below the PALs. The FALs for all analytes were established at the PAL concentrations. No COCs were identified at CAS 09-23-02. Therefore, no further action is required at this CAS.

CAS 20-19-01, Waste Disposal Site

Suspected releases at this site were potentially chemical and/or radiological contamination of debris disposed on the soil surface. The radiological survey did not identify any area of elevated radioactivity on the drilling mud. The analytical results for surface and shallow subsurface samples collected at 10 locations were below the PALs for the site with the exception of TPH-DRO in two samples. No hazardous constituents of TPH-DRO exceeded FALS in the Tier 2 evaluation, thus TPH-DRO is not a COC for this site. The FALs for all analytes were established at the PAL concentrations. No COCs were identified at CAS 20-19-01. Potential source material, in the form of used oil filters, were staged in containers and removed from the site. Therefore, no further action is required at this CAS.

A.11.0 References

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 545 CAIP (NNSA/NSO, 2007) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. The five steps are briefly summarized as follows:

Step 1: Review DQOs and Sampling Design – Review the DQO Process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false negative (Type I) or false positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.

Step 2: Conduct a Preliminary Data Review – Perform a preliminary data review by reviewing QA reports and inspecting the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.

Step 3: Select the Test – Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

Step 4: Verify the Assumptions – Perform tests of assumptions. If data are missing or censored, determine the impact on DQO decision error.

Step 5: Draw Conclusions from the Data – Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAIP for CAU 545 (NNSA/NSO, 2007). The DQO decisions are presented with the DQO provisions to limit false negative or false positive decision errors. Special features, potential problems, and deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAIP: “Is any COC present in the environmental media within the CAS?” (NNSA/NSO, 2007).

Decision I Rules:

- If the population parameter of any COPC in the Decision I population of interest (defined in step 4 of the DQOs) exceeds the corresponding FAL, then that contaminant is identified as a COC.
- If a COC is detected, then Decision II samples will be collected.
- If COCs are not identified, then the investigation is complete.
- If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.6.2 of the CAIP (NNSA/NSO, 2007), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.
- If a waste is present that, if released, has the potential to cause the further contamination of site environmental media, then a corrective action will be determined, else no further action will be necessary.

B.1.1.1.1 DQO Provisions To Limit False Negative Decision Error

The investigation conducted at CAU 545 used the judgmental and probabilistic sampling approaches to collect the data required to assess the site. A false negative decision error (where consequences are more severe) was controlled by meeting the following criteria:

- 1a. Having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the CAS (judgment sampling).

- 1.b Having a high degree of confidence that the average sample contaminant concentrations represent the true average contaminant concentrations (probabilistic).
2. Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples at an acceptable level of sensitivity.
3. Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criterion 1:

Improper selection of sampling locations and number of locations could result in not identifying one or more COCs that may be present at a CAS. Along with proper management and transportation of samples, the judicious collection of samples (i.e., sufficient number of sample locations and proper selection of those locations) at a CAS, as specified in approved DQOs, can avoid sampling error and result in a high degree of confidence that any COCs present in the CAS were identified.

For judgmental sampling designs (i.e., CASs 02-09-01, 03-99-14, 09-23-02, 20-19-01, and part of 03-17-01), the number of locations to sample were specified in the DQOs (NNSA/NSO, 2007).

Selecting locations for judgmental sampling designs, that are representative of the populations of interest, involve the use of biasing factors. To identify COCs at a CAS using a judgmental sampling design, the following methods (stipulated in the DQOs) were used in selecting sample locations.

1. Selection of sampling locations associated with the results of the radiological walkover and geophysical surveys.
2. Selection of sampling locations associated with staining, mounds, trenches, presence of debris, and other items was accomplished by visual field observations.
3. Selection of sampling locations associated with surface drainage (e.g., washes).
4. Selection of sampling locations associated with professional judgment based on acceptable knowledge was accomplished by:
 - Source and location of release.
 - Chemical nature and fate properties.
 - Physical transport pathways and properties.
 - Transport drivers.

Selection of sample locations at CAS 02-09-01 varied slightly from planned activities. Sample locations at CAS 02-09-01 were selected based on site features (i.e., mounds and low-lying areas).

For probabilistic sampling designs (i.e., most of CAS 03-17-01) the minimum number of sample locations required was calculated from the field investigation sample results for each significant COPC at each CAS (CAU 545 CAIP). For the purposes of determining sample size requirements, significant COPCs are considered to be the analytes detected above the PALs, as defined in Section A.5.2.1.2 of the CAIP (NNSA/NSO, 2007). The VSP software was used to calculate final minimum sample sizes using the following inputs (PNNL, 2002):

- A two-sided 95 percent confidence interval (e.g., the false rejection rate equals 5 percent).
- A false acceptance rate of 15 percent.
- The maximum acceptable half-width of confidence interval for each population-specific significant COPC set to half the FAL value (gray region).
- The calculated standard deviation for each population-specific significant COPC.

The input values and VSP determined minimum number of samples to be taken for each significant COPC at CAS 03-17-01 are listed in [Table B.1-1](#).

Table B.1-1
Input Values and VSP Determined Minimum Number
of Samples for CAU 545, CAS 03-17-01

CAS	Constituent	Actual Standard Deviation	FAL ^a	Gray Region	Initial Estimate of Minimum Number of Samples	Actual Required Minimum Number of Samples
03-17-01	Americium-241	5.46	1,501 pCi/g	750.5	24	8
	Plutonium-239	11.25	1,890 pCi/g	945		8

^aSite-specific FALs determined with RESRAD for radionuclides under an industrial scenario ([Appendix C](#)).

FAL = Final action level

pCi/g = Picocuries per gram

RESRAD = Residual Radioactive

For the Am-241 and Pu-239 results at CAS 03-17-01, the variability of the results was less than initial estimates ([Table B.1-1](#)), thus the 95 percent UCL for these significant COPCs was used to make DQO decisions.

Criterion 2:

All samples were analyzed for the chemical and radiological constituents listed in Table A.3-2 of Section A.3.2.2 of the CAIP (NNSA/NSO, 2007). [Table B.1-2](#) provides a reconciliation of samples analyzed to the planned analytical program.

Table B.1-2
CAU 545 Analyses Performed

CAS	Total VOCs	Total SVOCs	PCBs	RCRA Metals	TPH-DRO	Gamma Spectroscopy	Isotopic Uranium	Isotopic Plutonium	Strontium-90
02-09-01	N/A	N/A	N/A	N/A	N/A	RS	RS	RS	RS
03-17-01	N/A	N/A	N/A	RS	N/A	RS	RS	RS	RS
03-99-14	RS	RS	RS	RS	RS	RS	RS	RS	RS
09-23-02	RS	RS	NA	RS	RS	RS	RS	RS	RS
20-19-01	RS	RS	RS	RS	RS	RS	RS	RS	RS

DRO = Diesel-range organics

N/A = Not applicable

PCB = Polychlorinated biphenyl

RCRA = *Resource Conservation and Recovery Act*

SVOC = Semivolatile organic compound

TPH = Total petroleum hydrocarbons

VOC = Volatile organic compound

RS = Required and submitted

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The sensitivity acceptance criterion defined in the CAIP is that analytical detection limits will be less than the corresponding action level (NNSA/NSO, 2007). This criterion was not achieved for the analytical results listed in [Table B.1-3](#). Results not meeting the sensitivity acceptance criterion will not be used in making DQO decisions and, therefore, be considered rejected data. The impact on DQO decisions is addressed in the assessment of completeness.

Table B.1-3
Analytes Failing Sensitivity Criteria

Sample Number	Constituent	Minimum Detection Concentration (mg/kg)	Final Action Level (mg/kg)
545E007	Hexachlorobenzene	1.35	1.1
	N-Nitroso-Di-N-Propylamine	1.35	0.25
545E008	N-Nitroso-Di-N-Propylamine	0.68	0.25

mg/kg = Milligrams per kilogram

Criterion 3:

To satisfy the third criterion, the entire dataset, as well as individual sample results, were assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NSO, 2007). As presented in [Tables B.1-3 through B.1-6](#), the acceptance criteria for the DQIs are discussed under the following sections.

Precision

Precision was evaluated as described in Section 6.2 of the CAIP (NNSA/NSO, 2007). [Table B.1-4](#) provides the chemical and radiological precision analysis results for all constituents that were qualified for precision. The chemical constituents qualified for precision were barium and lead. The radionuclides qualified for precision were Pu-238 and -239/240 and cesium (Cs)-137.

Table B.1-4
Precision Measurements

Constituent	User Test Panel	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Barium	Metals	11	78	85.9
Lead	Metals	22	78	71.8
Cesium-137	Gamma	16	127	87.4
Plutonium-238	Plutonium	11	127	91.3
Plutonium-239/240	Plutonium	34	127	73.2

As shown in [Table B.1-4](#), the precision rates for all chemical and radionuclides were above the CAIP acceptance criterion of 80 percent except for Pu-239/240 and lead. The precision rates for all other constituents is 100 percent. The samples qualified for Pu-239/240 precision were based on differences in laboratory duplicate sample results. High variability in the sampled matrix may indicate the potential that discrete particles of contamination are present within the sample. Therefore, mixing will not produce homogeneity. This does not mean the precision of the measurement is poor but that activities are variable within the sample. This is commonly observed in isotopic Pu results, as a single particle of plutonium within a sample can result in detectable activities attributed to the entire sample. There are no obvious reasons (e.g., matrix interference) for the discrepancies; however, the potential for a false negative DQO decision error is negligible because the highest reported concentration (455 mg/kg) is significantly less than the FAL (1,890 pCi/g). Therefore, when a duplicate sample is analyzed for isotopic Pu, the results can be significantly different depending on how many discrete particles are contained in each sample.

The samples qualified for lead precision were estimated based on the duplicate precision failures on laboratory quality control samples. There are no obvious reasons (e.g., matrix interference) for the discrepancies; however, the potential for a false negative DQO decision error is negligible because the highest reported concentration (19.2 mg/kg) is significantly less than the FAL (800 mg/kg).

Therefore, Pu-239/240 and lead results that were qualified for reasons of precision can be confidently used confidently to support DQO decisions. As the precision rates for all other constituents met the acceptance criteria for precision, the dataset is determined to be acceptable for the DQI of precision.

Accuracy

Accuracy was evaluated as described in Section 6.2 of the CAIP (NNSA/NSO, 2007) [Table B.1-5](#) provides the chemical accuracy analysis results for all constituents qualified for accuracy. Accuracy rates are above the CAIP criterion of 80 percent, except for barium, which has a rate of 28.2 percent. There were no radiological data qualified for accuracy.

The 56 barium results qualified for accuracy were associated with an MS recovery outside control limits, which could be biased high or low. Because the FAL for barium (67,000 mg/kg) is orders of

**Table B.1-5
Accuracy Measurements**

Constituent	User Test Panel	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Barium	Metals	56	78	28.2
Benzene	VOCs	1	42	97.6
Chlorobenzene	VOCs	1	42	97.6
Toluene	VOCs	1	42	97.6
Aroclor 1221	PCBs	2	24	91.7
Aroclor 1232	PCBs	2	24	91.7
Aroclor 1242	PCBs	2	24	91.7
Aroclor 1248	PCBs	2	24	91.7
Aroclor 1254	PCBs	2	24	91.7
Aroclor 1260	PCBs	2	24	91.7
Aroclor 1268	PCBs	2	24	91.7
Aroclors (low risk)	PCBs	2	24	91.7

PCB = Polychlorinated biphenyl
VOC = Volatile organic compound

magnitude higher than the reporting limit, these results did not affect the decision-making process. Therefore, the dataset is acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NSO, 2007) was used to address sampling and analytical requirements for this CAU. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination or represent contamination of the CAS [probabilistic approach] and locations that bound COCs). The sampling locations identified in the Criterion 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 545 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAIP (NNSA/NSO, 2007), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NTS. Therefore, project datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

Also, standard, approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP (NNSA/NSO, 2007).

Completeness

The CAIP defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions (NNSA/NSO, 2007). This is initially evaluated as 80 percent of CAS-specific noncritical constituents identified in the CAIP having valid results and 100 percent of critical constituents (including Decision II samples) having valid results. Critical constituents for CAU 545 are CAS-specific and limited to the following radiological contaminants:

- CAS 03-17-01: Am-241, Cs-137, europium (Eu)-152, Pu-238, and Pu-239/240
- CAS 09-23-02: Am-241, Cs-137, Pu-238, and Pu-239/240
- CAS 20-19-01: The hazardous constituent of diesel because TPH detected greater than 100 ppm

Rejected data (either qualified as rejected or data that failed the criterion of sensitivity) were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion. [Table B.1-6](#) provides the rejected data for the site, and [Table B.1-3](#) provides the data that failed sensitivity criteria.

Hexachlorobenzene and N-Nitroso-Di-N-Propylamine failed the criterion for sensitivity (see [Table B.1-3](#)) in specific samples while Am-241 and mercury were qualified as rejected due to analytical quality issues. All critical analytes met the 100 percent criteria for completeness, because no Am-241 data were rejected for CASs 03-17-01 and 09-23-02. All other data met the 80 percent completeness criteria. Therefore, all data for critical constituents were within the acceptable criteria.

**Table B.1-6
Rejected Measurements**

Constituent	User Test Panel	Number of Measurements Rejected	Number of Measurements Performed	Percent within Criteria
Americium-241	Gamma	1	127	99.2
Mercury	Metals	9	78	88.5

B.1.1.1.2 DQO Provisions To Limit False Positive Decision Error

The false positive decision error was controlled by assessing the potential for false positive analytical results. Quality assurance/QC samples such as field blanks, trip blanks, LCSs, and method blanks were used to determine whether a false positive analytical result may have occurred. Of all QA/QC samples submitted, no samples detected potential cross-contamination that could cause a false positive determination.

Proper decontamination of sampling equipment and the use of certified clean sampling equipment and containers also minimized the potential for cross contamination that could lead to a false positive analytical result.

B.1.1.2 Decision II

Decision II was assessed for CASs 03-08-03 and 03-23-05 because COCs were identified for only those sites. The COCs as CAS 03-08-03 are contained within the drilling mud disposed in the craters. Based on previous investigations of mud pits, contaminants have not migrated laterally beyond the mud pit boundaries. The UR boundary was conservatively set at the fence line, which is approximately 30 ft from the craters.

The COCs at CAS 03-23-05 are entombed in grout and are not expected to have migrated. The UR boundary was conservatively set at the fence line, which varies from 10 to 20 ft from the buried material.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2007) made the following commitments for sampling:

1. A probabilistic sampling design was developed for CAS 03-17-01 with six additional judgmental locations selected at the most prominent anomalies detected in the geophysical and radiological surveys. Some randomly chosen locations were specified at CASs 09-23-02 and 20-19-01 because biasing factors appeared to be absent.

Result: All random sample locations were designated by the VSP and collected at CAS 03-17-01. Random sample locations were not required for CASs 09-23-02 and 20-19-01 due to the presence of biasing factors (e.g., used oil filters, photographic supplies, drilling mud spill, soil staining, geophysical surveys, sediment setting areas).

2. A judgmental sampling design was employed for CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01 due to the presence and significance of biasing factors.

Result: Sample locations were determined at CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01 based on the presence of biasing factors (e.g., soil staining, radiological/geophysical survey results).

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated. Data were validated and verified to ensure that the measurement systems performed were in accordance with the criteria specified. The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO Decision I was the comparison of the maximum analyte result from each CAS to the corresponding FAL. The test for making DQO Decision II was the comparison of all COC analyte results from each bounding sample to the corresponding FALs.

The key assumptions that could impact a DQO decision are listed in [Table B.1-7](#).

**Table B.1-7
Key Assumptions**

Exposure Scenario	Industrial and construction workers, and military personnel conducting training in an Occasional Use Area, may be exposed to contaminants of potential concern through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials, or through irradiation by radioactive materials.
Affected Media	Surface soil and shallow subsurface soil. Deep groundwater contamination is not a concern, and contaminants migrating to regional aquifers are not considered.
Location of Contamination/ Release Points	Drilling mud (CAS 02-09-01). Debris at location(s) of disposed/stored waste or materials (CASs 03-17-01, 03-99-14, and 20-19-01). Drilling mud or possible buried materials (CAS 09-23-02). The conceptual site model accounts for potential releases resulting from migration of contaminants from the source outward to the contiguous environment. The extent of contaminant of concern concentration decreases with increased distance from the area of contamination.
Transport Mechanisms	Surfacewater runoff of dissolved or suspended contaminants is the most likely potential transport mechanism for waste materials placed on and in soils at the Nevada Test Site (NTS). The potential for overland migration of contaminants increases with slope gradient and precipitation. Infiltration and percolation of precipitation through subsurface media could serve as a major driving force for migration of contaminants. However, due to the arid environment of the NTS, percolation of precipitation is limited and migration of contaminants is limited. Evapotranspiration potentials significantly exceed available soil moisture from precipitation (i.e., 6 to 10 inches) (Winograd and Thordarson, 1975).
Preferential Pathways	Lateral transport expected to dominate over vertical transport, except for subsurface releases and within craters.
Lateral and Vertical Extent of Contamination	Contamination, where present, is contiguous to the release points, and decreases with distance from the source. Lateral and vertical extent of COC contamination is within the spatial boundaries.
Groundwater Impacts	None
Future Land Use	Occasional Use Area
Other Data Quality Objective Assumptions	The grout surrounding the buried lead pig and protactinium-233 would fail at some point, and lead and radionuclides would be released to the surrounding media. Waste or debris containing materials that are comprised of contaminants (e.g., lead batteries, fluorescent light bulbs and ballasts, floor tiles, preserved wood) would decompose at some point and release the contaminant(s) to the surrounding media. The resulting concentration of contaminants in the surrounding media would be greater than applicable action levels.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 545 DQOs (NNSA/NSO, 2007) and [Table B.1-7](#) and no revisions to the CSMs were required.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2007) made the following commitments for sampling:

The presence of a COC 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 a future release from source material, introducing a COC to the surrounding environmental media, the following conservative assumptions were made:

- The contaminant surrounding both the Eu-152 source and the buried lead pig and protactinium-233 source at CAS 03-23-05 would fail at some point, and lead and radionuclides would be released to the surrounding media.
- Waste or debris containing materials that are comprised of contaminants (e.g., lead batteries, fluorescent light bulbs and ballasts, floor tiles, preserved wood) would decompose at some point and release the contaminant(s) to the surrounding media.
- The resulting concentration of contaminants in the surrounding media would exceed applicable action levels.

Result: It was determined that the buried radioactive sources (i.e., Pa-233 and Eu-152) at CAS 03-23-05 were PSM and require a corrective action.

Result: Several used oil filters discarded at CAS 20-19-01 are potential source material and require corrective action.

- The CAIP (NNSA/NSO, 2007) assumed that COCs are present at CAS 03-08-03.

Result: This contamination is a PSM and requires a corrective action.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 545 CASs.

B.1.5.1 Decision Rules for Decision I

Decision Rule: 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 sampling will be resolved, else no further investigation is needed for that COPC in that population.

Result: No COCs were identified in samples collected from CASs 02-09-01, 03-17-01, 03-99-14, 09-23-02, and 20-19-01, therefore, no further action was identified as the corrective action for these CASs.

Potential source material was identified at CASs 03-23-05 and 20-19-01; therefore, corrective actions were required at these CASs.

Radiological COCs are assumed to exist at CAS 03-08-03, therefore, requiring corrective action.

B.2.0 References

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

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

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Appendix C

Risk Assessment

C.1.0 Evaluation of Risk

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 (NAC, 2006a), which lists the requirements for sites with soil contamination. For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006b) recommends 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.”

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.

This section contains documentation of the RBCA process used to establish FALs described in the *Industrial Sites Project Establishment of FALs* (NNSA/NSO, 2006). This process defines three tiers (or levels) to establish FALs used to evaluate DQO decisions:

- Tier 1 – Sample results from source areas (highest concentrations) compared to RBSLs (i.e., PALs) based on generic (nonsite-specific) conditions.
- Tier 2 – Sample results from exposure points compared to SSTLs calculated using site-specific inputs and Tier 1 formulas.
- Tier 3 – Sample results from exposure points compared to SSTLs and points of compliance calculated using chemical fate/transport and probabilistic modeling.

The RBCA decision process stipulated in the *Industrial Sites Project Establishment of FALs* (NNSA/NSO, 2006) is summarized in [Figure C.1-1](#).

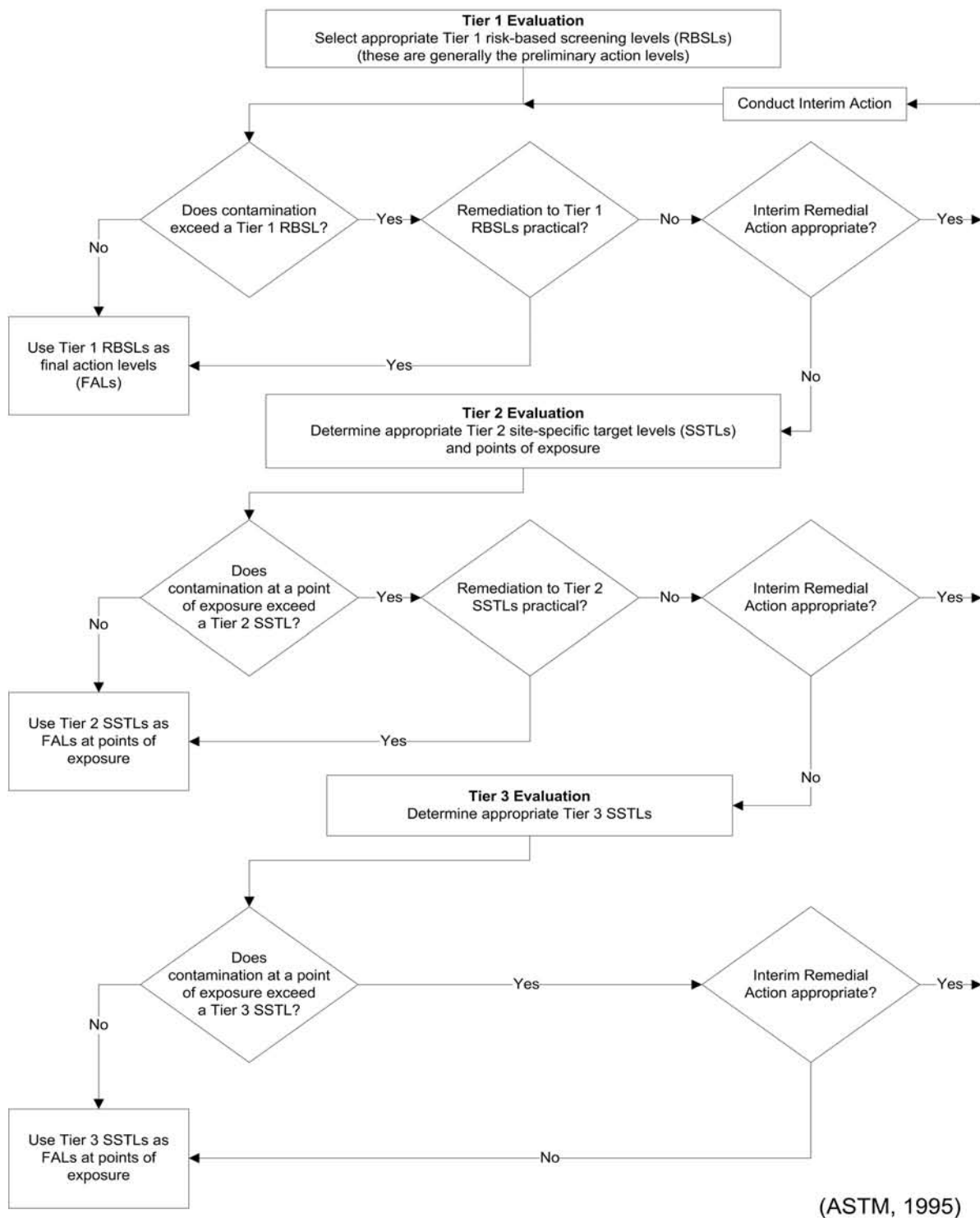


Figure C.1-1
Risk-Based Corrective Action Decision Process

C.1.1 A. Scenario

Corrective Action Unit 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials consists of the following eight inactive CASs within Areas 2, 3, 9, and 20 of the NTS:

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

Corrective Action Site 02-09-01, Mud Disposal Area, is located immediately to the west of the 2-05 Road and Circle Road intersection in Area 2 of the NTS. The CAS consists of potentially contaminated drilling mud released within and outside of the U-2ei crater, which formed as a result of the Coulommiers underground nuclear test conducted on September 27, 1977. The specific history of mud disposal activities at the U-2ei crater is unknown; however aerial photography indicates mud was disposed at the site between 1977 and 1984. The mud released at CAS 02-09-01 is assumed to be associated with NTS drilling operations, and therefore may either be pre-use material or else used pre-test and/or post-test drilling mud.

Corrective Action Site 03-08-03 consists of two adjacent craters (U-3ai and U-3be test holes) that were used for the disposal of drilling mud. The site is located southeast of the intersection of the 3-03 and 3-12 Roads. The CAS consists of the releases associated with the two craters. Disposal of drilling mud at CAS 03-08-03 occurred at a ramp located at the north end of the site. Records indicate radioactively contaminated drilling mud was disposed at CAS 03-08-03. The craters are posted as an RMA. A contamination area is adjacent to the craters to the east. For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the DQO meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a UR for isotopic U, isotopic Pu, fission products and decay products is recommended. Sampling in the craters was not considered necessary.

For CASs 03-23-02 no documentation was identified for the storage or disposal of materials at the site. Corrective Action Site 03-23-02 consists of the uncollapsed crater at the U-3gi test hole. The

site was originally posted as an underground RMA, but is now posted as a contamination area. For CAS 03-23-02, there were no potential releases of hazardous or radioactive contaminants identified. Therefore, no additional information was needed to recommend a no further action corrective action decision, and DQOs were not developed for this CAS. This CAS is closed with no further action.

Corrective Action Site 03-23-05 consists of the crater area formed from the Pommard underground nuclear test. The CAS consists of the releases associated with two radioactive sources, one contained in a lead “pig” at the northwest portion of the site, and the contaminated third floor of a tower used at the site during the underground testing; along with the other source within the uncollapsed U-3ee crater. For CAS 03-23-05, existing information about the two buried sources and lead pig was considered to be sufficient, and safety concerns existed about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site was not considered necessary.

Corrective Action Site 03-17-01, Waste Consolidation Site 3B, is located 1.0 mi east of the Area 3 RWMS at the NTS. The CAS consists of an area used for storage of suspected radioactive materials associated with nearby atmospheric tests, which was cleaned up in the 1980s. Two components comprise the site: a rectangular area measuring 950 by 750 ft, posted as a contamination area; and an unposted, circular area measuring 145 ft in diameter. Some metallic debris, including the remnants of an ecology study, remain at the site.

Corrective Action Site 03-99-14, Radioactive Materials Disposal Area, is located approximately 1.0 mi southeast of the Area 3 RWMS. The CAS consists of potential soil contamination associated with a soil berm and an associated trench approximately 350 ft long. The volume of soil on the berm appears to be equivalent to that missing from the trench. The original purpose for the berm and trench is unknown. The site, along with adjoining lands, is posted as an RMA. The posting is likely due to atmospheric testing that was conducted just to the west of the site. The area encompassing the RMA will be investigated by the Soils Project for CAU 104.

Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater, is located approximately 600 ft southeast of the 9-01 and Circle Roads intersection. The CAS consists of potentially radiologically contaminated drilling fluids and decontamination wastewater disposed of in the U-9y crater. This crater formed as a result of the Wichita underground nuclear test conducted on July 27, 1962. At

some time between 1979 and 1980, the fluids inside the crater overflowed into the wash to the east, and use of the crater for disposal was discontinued. The wash is posted as a buried RMA, but it is not known if the posting is related to the overflow of the crater.

Corrective Action Site 20-19-01, Waste Disposal Site, is located to the east-northeast of the U-20p test hole, within the potential crater area, in the northwestern portion of Area 20. The CAS consists of the debris pile to the east-northeast of the test hole. The history of the debris is not known, but the contents are consistent with general construction debris. Several used oil filters were identified at the site. A drilling mud spill entering the site from the south was also identified at the site.

C.1.2 B. Site Assessment

The CAI at CAS 02-09-01, Mud Disposal Area, involved conducting visual inspection, radiological survey, and soil sampling activities at the CAS. Surface and subsurface soil samples were collected from biased locations identified as potential sources or release points (i.e., mounds or low lying areas). Based on investigation results, no COPCs were identified at concentrations exceeding the PALs.

The CAI at CAS 03-17-01, Waste Consolidation Site 3B, involved conducting visual inspection, radiological survey, geophysical survey, and soil sampling activities at the CAS. Surface and subsurface soil samples were collected from randomly selected locations (probabilistic sampling approach) and biased locations identified as potential sources or release points (i.e., subsurface anomalies, areas of elevated radioactivity). Americium-241 and Pu-239/240 were detected at concentrations that exceeded their PALs of 12.7 pCi/g at multiple locations.

The CAI at CAS 03-99-14, Radioactive Material Disposal Area, involved conducting visual inspection, radiological survey, geophysical survey, and soil sampling activities at the CAS. Surface and subsurface soil samples were collected from biased locations identified as potential sources or release points (i.e., the trench and berm). Based on the results of the investigation, no COPCs were identified at concentrations exceeding the PALs.

The CAI at CAS 09-23-02, U-9y Drilling Mud Disposal Crater, involved conducting visual inspection, radiological survey, geophysical survey, and soil sampling activities at the CAS. Surface

and subsurface soil samples were collected from biased locations identified as potential sources or release points (i.e., the wash and low-lying areas). Based on the results of the investigation, no COPCs were identified at concentrations exceeding the PALs.

The CAI at CAS 20-19-01, Waste Disposal Site, involved conducting visual inspection, radiological survey, and soil sampling activities at the CAS. Surface and subsurface soil samples were collected from biased locations identified as potential sources or release points (i.e., debris piles, discolored soil). The only COPC identified at concentrations exceeding the PALs was TPH-DRO. No hazardous constituents of TPH-DRO exceeded PALs. The source, release point, and nature and extent of the COCs are consistent with the CSM presented in the CAIP for CAU 545 (NNSA/NSO, 2007).

Corrective Action Sites 03-08-03, 03-23-02, and 03-23-05 were not investigated because sufficient data existed to support the decisions necessary for site closure (NNSA/NSO, 2007).

The maximum concentration of contaminant identified at each CAS, and their corresponding PALs, are presented in [Table C.1-1](#).

C.1.3 C. Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are: (1) immediate threat to human health, safety, and the environment; (2) short-term (0 to 2 years) threat to human health, safety, and the environment; (3) long-term (more than 2 years) threat to human health, safety, or the environment; and (4) no demonstrated long-term threats.

Based on the CAI, none of the CASs present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. Based on this information, five of the eight CASs are determined to be Classification 4 sites as defined by ASTM Method E 1739-95 (ASTM-1995) and pose no demonstrated near- or long-term threats. At CASs 03-08-03, 03-23-05, and 20-19-01, PSM existed that may pose long-term threats to human health, safety, or the environment and have been determined to be Classification 3 sites as defined by ASTM Method E 1739-95.

C.1.4 D. Development of Tier 1 Lookup Table of Risk-Based Screening Levels

Tier 1 action levels have been defined as the PALs established during the DQO process. The PALs are a tabulation of chemical-specific (but not site-specific) screening levels based on the type of media (soil) and potential exposure scenarios (industrial). These are very conservative estimates of risk, are preliminary in nature, and are used as action levels for site screening purposes. Although the PALs are not intended to be used as FALs, a FAL may be defined as the Tier 1 action level (i.e., PAL) value if individual contaminant analytical results are below the corresponding Tier 1 action level value. The FAL may also be established as the Tier 1 action level value if individual contaminant analytical results exceed the corresponding Tier 1 action level value and implementing a corrective action based on the FAL is practical. The PALs are defined as:

- The EPA Region 9 Risk-Based PRGs for Industrial Soils (2004).
- Background concentrations for RCRA metals will be evaluated when natural background exceeds the PAL, as is often the case with arsenic. Background is considered the mean plus two times the standard deviation based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- The TPH concentrations above the action level of 100 mg/kg per NAC 445A.2272 (NAC, 2006a).
- For COPCs without established PRGs, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established PRG from another EPA region may be chosen.
- The PALs for material, equipment, and structures with residual surface contamination are the allowable total residual surface contamination values for unrestricted release of material and equipment listed in the DOE Order 5400.5 (DOE, 1993), which is also Table 4-2 of the *NV/YMP Radiological Control Manual* (NNSA/NSO, 2004).
- The PALs for radioactive contaminants 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 (Appenzeller-Wing, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

The PALs were developed based on an industrial scenario. Because the CAU 545 CASs are not assigned work stations, and considered to be in remote or occasional use areas, industrial scenario based PALs are used conservatively. The Tier 1 lookup table is defined as the PAL concentrations or activities defined in the CAIP (NNSA/NSO, 2007).

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
(Page 1 of 3)

CAS No.	Constituent	Preliminary Action Level	Units	Maximum Reported Value				
				02-09-01	03-17-01	03-99-14	09-23-02	20-19-01
95-63-6	1,2,4-Trimethylbenzene	170	mg/kg	N/A	N/A	--	0.002	--
106-46-7	1,4-Dichlorobenzene	7.9	mg/kg	N/A	N/A	--	0.0003 (J)	--
78-93-3	2-Butanone	110,000	mg/kg	N/A	N/A	--	--	0.01
591-78-6	2-Hexanone	110,000	mg/kg	N/A	N/A	--	--	0.009
67-64-1	Acetone	54,000	mg/kg	N/A	N/A	0.004 (J)	--	0.41
71-43-2	Benzene	1.4	mg/kg	N/A	N/A	--	--	0.0004 (J)
75-71-8	Dichlorodifluoromethane	310	mg/kg	N/A	N/A	--	0.001 (J)	0.002
75-09-2	Methylene Chloride	21	mg/kg	N/A	N/A	0.005	0.002 (J)	0.01
100-42-5	Styrene	1,700	mg/kg	N/A	N/A	0.001	0.003	0.0005 (J)
1330-20-7	Total Xylenes	420	mg/kg	N/A	N/A	--	0.006	--
65-85-0	Benzoic Acid	100,000	mg/kg	N/A	N/A	--	--	41.3
117-81-7	Bis(2-ethylhexyl)phthalate	120	mg/kg	N/A	N/A	--	--	3.99
84-74-2	Di-n-butyl phthalate	62,000	mg/kg	N/A	N/A	--	--	0.94
85-01-8	Phenanthrene	100,000	mg/kg	N/A	N/A	--	--	0.02 (J)
108-95-2	Phenol	100,000	mg/kg	N/A	N/A	--	--	0.36
68334-30-5	Diesel-Range Organics	100	mg/kg	N/A	N/A	2.53 (J)	11.4	157
11097-69-1	Aroclor 1254	0.74	mg/kg	N/A	N/A	--	--	0.007 (J)
11096-82-5	Aroclor 1260	0.74	mg/kg	N/A	N/A	0.002 (J)	--	--
11100-14-4	Aroclor 1268	0.74	mg/kg	N/A	N/A	--	--	0.04

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
(Page 2 of 3)

CAS No.	Constituent	Preliminary Action Level	Units	Maximum Reported Value				
				02-09-01	03-17-01	03-99-14	09-23-02	20-19-01
7440-38-2	Arsenic	23	mg/kg	N/A	7.6	5.6	7.7	9.1
7440-39-3	Barium	67,000	mg/kg	N/A	235 (J)	179	250 (J)	291 (J)
7440-43-9	Cadmium	450	mg/kg	N/A	0.37 (J)	--	0.2 (J-)	2.7
7440-47-3	Chromium	450	mg/kg	N/A	9.6	7.4	7.6	12.2
7439-92-1	Lead	800	mg/kg	N/A	13.3	19.2 (J)	17.8 (J)	106 (J)
7439-97-6	Mercury	310	mg/kg	N/A	0.04 (J-)	0.01 (J-)	0.04 (J)	0.46 (J)
7782-49-2	Selenium	5,100	mg/kg	N/A	2.6 (J)	1.9	2	2.1 (J-)
7440-22-4	Silver	5,100	mg/kg	N/A	0.24 (J)	0.33 (J)	--	22.1
14331-83-0	Actinium-228	5	pCi/g	2.67	2.18	1.96	2.63	2.33
14596-10-2	Americium-241	12.7	pCi/g	--	284	1.05 (J)	0.38	1.19
10045-97-3	Cesium-137	12.2	pCi/g	2.04	5.14	10.3	1.71	1
14683-23-9	Europium-152	5.7	pCi/g	--	2.17	4.62 (J)	--	--
15092-94-1	Lead-212	5	pCi/g	2.4	1.98	1.94 (J)	2.42	2.3
15067-28-4	Lead-214	5	pCi/g	1.44	1.35	1.35 (J)	1.65	2.09
14913-50-9	Thallium-208	5	pCi/g	0.86	0.78	0.61	0.85	0.78
13981-16-3	Plutonium-238	13	pCi/g	0.06	5.14	2.18	0.51	1.18 (J)
15117-48-3	Plutonium-239/240	12.7	pCi/g	0.82	455	15.1 ^a	7.3	2.73 (J)
10098-97-2	Strontium-90	838	pCi/g	0.29	1.1	5.67	--	--
13966-29-5	Uranium-234	143	pCi/g	1.27	2.42	1.27	1.52	1.38

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
(Page 3 of 3)

CAS No.	Constituent	Preliminary Action Level	Units	Maximum Reported Value			
				02-09-01	03-17-01	03-99-14	09-23-02
15117-96-1	Uranium-235	17.6	pCi/g	--	0.12	0.11	0.11
7440-61-1	Uranium-238	105	pCi/g	1.18	1.1	1.15	1.65
							1.43

^aValue of 15.1 pCi/g for Pu-239/240 is for background sample collected outside Corrective Action Site 03-99-14.

CAS = Chemical Abstracts Service
mg/kg = Milligrams per kilogram
N/A = Not applicable
pCi/g = Picouries per gram
Pu = Plutonium

J = Estimated value
J- = The result is an estimated quantity, but the result may be biased low.
-- = Not detected above minimum detectable concentrations.
Bold indicates the value exceeds the preliminary action level.

C.1.5 E. Exposure Pathway Evaluation

The DQOs stated that site workers would be exposed to COCs only through oral ingestion, inhalation, or dermal contact (absorption) due to exposure to potentially contaminated media (i.e., soil) at the CASs. The results of the CAI showed that no COCs were identified within CAU 545, except at CASs 03-08-03 and 03-23-05. The radiological contamination, in the form of drilling mud, at CAS 03-08-03 does not have a pathway to a receptor, as it is within the craters where access is restricted. The contamination at CAS 03-23-05, in the form of PSM (lead pig and radiological sources) does not have a pathway to a receptor, as both sources within are buried and are in blocks of grout, with one encapsulated source buried within the potential crater area. Access is restricted to these two components of CAS 03-23-05. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater, supports the selection and evaluation only surface and shallow subsurface contact as the complete exposure pathways. Groundwater is not considered to be a significant exposure pathway.

The oil filters, as surface PSM, at CAS 20-19-01, were subject to a direct contact pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 Risk-Based Screening Levels

All analytical results from CAU 545 samples were less than corresponding Tier 1 action levels (i.e., PALs) except for those listed in [Table C.1-2](#).

Additionally, PSM, in the form of the lead pig and radioactive sources, exists at CAS 03-23-05; PSM in the form of the used oil filters existed at CAS 20-19-01; and radiologically contaminated drilling mud exists at CAS 03-08-03.

C.1.7 G. Evaluation of Tier 1 Results

For all contaminants at all CASs not listed in [Table C.1-2](#), the FALs were established as the Tier 1 RBSLs. It was determined that no further action is required for these contaminants at these CASs.

C.1.8 H. Tier 1 Remedial Action Evaluation

It was determined by NNSA/NSO that corrective actions for the contaminants listed in [Table C.1-2](#) were not practical. Therefore, a Tier 2 SSTL will be calculated for these contaminants.

Table C.1-2
Contaminants of Potential Concern Detected
above Preliminary Action Levels (µg/kg)

CAS	TPH-DRO	Americium-241	Plutonium-239/240
02-09-01	--	--	--
03-17-01	--	X	X
03-99-14	--	--	--
09-23-02	--	--	--
20-19-01	X	--	--

DRO = Diesel-range organics
TPH = Total petroleum hydrocarbons
µg/kg = Micrograms per kilogram

-- = Not applicable

TPH-DRO Evaluation

Corrective actions for TPH-DRO at CAS 20-19-01 to Tier 1 action levels are not practical; therefore, TPH-DRO was moved to a Tier 2 evaluation.

Radionuclide Evaluation

Corrective actions to remediate Am-241 and Pu-239/240 at CAS 03-17-01 to Tier 1 action levels are not practical; therefore, these radionuclides at this CAS were moved to a Tier 2 evaluation.

Also, PSM, in the form of the lead pig and radioactive sources, exists at CAS 03-23-05; and radiologically contaminated drilling mud exists at CAS 03-08-03.

C.1.9 I. Tier 2 Evaluation

No additional data were needed to complete a Tier 2 evaluation.

C.1.10J. Development of Tier 2 Table of Site-Specific Target Levels

Evaluation of TPH-DRO SSTLs

Method E 1739-95 stipulates that risk evaluations for TPH contamination be calculated and evaluated based on the risk posed by the potentially hazardous constituents of TPH. Section 6.4.3 (“Use of Total Petroleum Hydrocarbon Measurements”) of ASTM Method E 1739-95 states: “TPHs should not be used for risk assessment because the general measure of TPH provides insufficient information about the amounts of individual chemical(s) of concern present” (see also Sections X1.5.4 and X1.42 of Method E 1739-95 in ASTM [1995]). Therefore, the individual potentially hazardous constituents will be evaluated for risk in place of TPH-DRO. The PAL for TPH-DRO was exceeded at CAS 20-19-01. The SSTLs were established for the individual potentially hazardous constituents in TPH-DRO at the corresponding PAL concentrations. (Note: The PALs were based on an industrial use scenario in the CAIP [NNSA/NSO, 2007]). These SSTLs and the maximum reported level for each diesel constituent are presented in [Table C.1-3](#).

Evaluation of Radiological Contaminant SSTLs

The Tier 2 evaluation consisted of evaluating the mixture of all radionuclides detected at each CAS to develop Tier 2 action levels for the two radionuclides that exceeded Tier 1 levels. The CAS-specific Tier 2 action levels for CAS 03-17-01 were calculated using the RESRAD computer code (version 6.3) and site-specific parameters. The RESRAD calculations were based on continued industrial use of the site assuming that a worker will be on the site for 250 days per year, 8 hours per day, for 25 years. A more detailed discussion of the RESRAD code, site-specific parameters used, and the printed RESRAD outputs is provided in [Attachment A](#) of this appendix.

Table C.1-3
Tier 2 SSTLs and CAU 545 Results for
Hazardous Constituents of Diesel

Common Name	SSTL (mg/kg)	Maximum Reported Value (mg/kg)
		CAS 20-19-01
Benzo(a)pyrene	0.21	ND
Benzene	1.4	0.0004 (J)
Benzo(a)anthracene	2.1	ND
Benzo(b)fluoranthene	2.1	ND
Benzo(k)fluoranthene	21	ND
1,3,5-Trimethylbenzene	70	ND
Naphthalene	190	ND
2-Methylnaphthalene	190	ND
Chrysene	210	ND
n-Propylbenzene	240	ND
n-Butylbenzene	240	ND
Ethylbenzene	400	ND
Total Xylenes ^a	420	ND
Toluene	520	ND
Fluoranthene	22,000	ND
Fluorene	26,000	ND
Benzo(g,h,i)perylene	29,000	ND
Pyrene	29,000	ND
Anthracene	100,000	ND
Phenanthrene	100,000	0.02 (J)

^aCombination of o-, m-, and p-xylenes

mg/kg = Milligrams per kilogram

ND = Nondetect

SSTL = Site-specific target level

J = Estimated value

All detected radionuclides at a CAS are used in the sum-of-fractions calculation, and a unique Tier 2 SSTL was developed for the two radionuclides that initially exceeded Tier 1 RBSLs. [Table C.1-4](#) provides the CAS-specific FALs established for the two radionuclides specific to CAS 03-17-01.

Table C.1-4
Final Action Levels for Radionuclides

CAS	Americium-241 (pCi/g)		Plutonium-239/240 (pCi/g)	
	Maximum Reported Value	FAL	Maximum Reported Value	FAL
	284	1,501 ^a	455	1,890 ^a

^aTier 2 action level (site-specific target level)

FAL = Final action level

pCi/g = Picocuries per gram

C.1.11 K. Comparison of Site Conditions with Tier 2 Table Site-Specific Target Levels

The Tier 2 action levels are typically 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. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a contaminant of concern originating from a CAS. For CAU 545, the Tier 2 action levels were compared to maximum contaminant concentrations from each sample location.

A comparison was conducted between the maximum concentration of the two radionuclides identified above Tier 1 action levels (i.e., Am-241 and Pu-239/240), as shown in [Table C.1-1](#), against the CAS-specific Tier 2-based FALs listed in [Table C.1-4](#). No radionuclides are identified above the Tier 2 action levels. The Tier 2 action levels were established as the FALs for Am-241 and Pu-239/240 at CAS 03-17-01.

C.1.12 L. Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation of the TPH-DRO hazardous constituents, the TPH-DRO contamination at CAS 20-19-01 does not pose an unacceptable risk to human health and the environment. Therefore, no further action is required concerning TPH-DRO at CAS 20-19-01.

Based on the Tier 2 evaluation of the radiological contaminants (Am-241 and Pu-239/240), the radiological contamination at CAS 03-17-01 does not pose an unacceptable risk to human health and the environment. Therefore, no further action is required at CAS 03-17-01.

As all contaminant FALs were established as Tier 1 or Tier 2 action levels, a Tier 3 evaluation was not considered necessary.

C.2.0 Recommendations

All of the site contaminant concentrations in soils from the analysis of CAU 545 samples were less than the corresponding FALs at all locations. It was determined that contamination at these locations does not pose a significant risk to human health or the environment and, therefore, do not warrant corrective actions.

The radiologically contaminated drilling mud (i.e., assumed to be contaminated with isotopic U, isotopic Pu, fission products, and decay products) at CAS 03-08-03 remains in place. The site was closed with a UR.

The PSM (i.e., lead pig and radiological sources) at CAS 03-23-05 were left in place; buried in blocks of grout. The site was closed with a UR.

The PSM (i.e., used oil filters) at CAS 20-19-01 were removed from the site and managed as hydrocarbon waste.

C.3.0 References

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Attachment A
RESRAD Report

Attachment 1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 545, CAS 03-17-01, Waste Consolidation Site 3B, Nevada Test Site, Nevada

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at
Corrective Action Unit (CAU) 545, Corrective Action Site (CAS) 03-17-01, Waste
Consolidation Site 3B, Nevada Test Site, Nevada

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**Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at
Corrective Action Unit (CAU) 545, Corrective Action Site (CAS) 03-17-01,
Waste Consolidation Site 3B, Nevada Test Site, Nevada**

1.0 Introduction

The U.S. Department of Energy (DOE), the U.S. and the National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Restoration Division have numerous sites impacted from the development, testing, and production of nuclear weapons. These impacts can take the form of chemical and/or radiological contaminants. Similar to its approach for chemical contamination, the NNSA/NSO is committed to properly evaluating, radiologically characterizing, and where appropriate, managing these sites to ensure the doses to radiation workers and members of the public are maintained as-low-as-reasonably achievable; at a minimum, below the primary dose limits as stated in DOE Order 5400.5 (DOE, 1993).

To accomplish this, the potential for residual radioactive contamination in soils must be evaluated to determine the status of compliance with the requirements of DOE Order 5400.5 (DOE, 1993). The DOE Order 5400.5 requires that: “The Authorized Limits shall be established to (1) provide that, at a minimum, the basic dose limits ... will not be exceeded, or (2) be consistent with applicable generic guidelines.” Because generic guidelines have not been established for volumetric residual radioactivity for the radionuclides of concern at CAU 545 CAS 03-17-01, Authorized Limits or final action levels (FALs), were derived using the Residual Radioactive (RESRAD) model and computer code (Yu et al., 2001). The goal of this effort was to produce Authorized Limits, in units of picocuries per gram (pCi/g) in soil above background, for CAU 545 CAS 03-17-01 that would result in radiation doses less than 25 mrem per year (mrem/yr) to an industrial worker at the site.

To develop the FALs, a “realistic” yet conservative radiation dose analysis was conducted using approved exposure scenarios and site-specific data to determine the translation between surface soil concentrations and individual radiation doses. For this analysis, site-specific data included soil sampling results obtained during site investigation activities at CAU 545 CAS 03-17-01, and meteorological data obtained from the Air Resources Laboratory/Special Operations and Research Division. This report provides the radiation dose modeling analysis supporting the technical derivation of the Authorized Limits for CAU 545 CAS 03-17-01, Waste Consolidation Site 3B. This report also defines the radionuclides considered and approved exposure scenarios for the NTS, identifies the applicable exposure pathways and key input data or assumptions, presents the radiation doses for unit concentrations of radionuclides in soil, and establishes the FALs for CAU 545 CAS 03-17-01 (ARL/SORD, 2007).

2.0 Site Closure Activities and Sample Results

Radionuclides were found in the soil samples. The RESRAD calculations are based on validated analytical sample results obtained during site investigation activities and other applicable information specified in the CAU 545 Corrective Action Investigation Plan (NNSA/NSO, 2007). Because the sampling plan was a mixture of randomized and biased sampling, RESRAD calculation is based on the maximum value of the radionuclide found in the samples. Appendix A of the CAU 545 Corrective Action Decision Document/Closure Report contains a detailed description of the sample results, analytical parameters, and laboratory methods used to analyze the soil samples. The maximum concentrations (including background) found at CAS 03-17-01 are listed in Table 2-1.

Table 2-1
Maximum Radionuclide Results Found in
CAU 545, CAS 03-17-01, Soil Samples

Radionuclide	Sample Number	Concentration (pCi/g)
Americium-241	545B030	284
Cesium-137	545B032	5.14
Europium-152	545B032	2.17
Plutonium-238	545B033	5.14
Plutonium-239/240	545B035	455
Strontium-90	545B032	1.1
Uranium-233	545B035	2.42
Uranium-235	545B032	1.16
Uranium-238	545B045	1.10

pCi/g = Picocuries per gram

3.0 Initial Concentrations for Principal Radionuclides

Principal radionuclides are defined as radionuclides with a half-life greater than six months. The decay products of any principal radionuclide down to, but not including, the next principal radionuclide in its decay chain are defined as associated radionuclides. The RESRAD assumes that a principal radionuclide is in secular equilibrium with its associated radionuclides at the point of exposure. Therefore, associated radionuclides and radionuclides with half-lives less than six months are not input into the RESRAD calculations.

3.1 Authorized Values for Initial Concentrations of Principal Radionuclides

The authorized exposure scenarios specify that value of the arithmetic mean plus the 95 percent upper confidence level (UCL) obtained from site-specific sampling results are entered as the principal radionuclide concentrations for RESRAD calculates. The sample results for all samples with radionuclide concentrations above the minimum detectable concentration within the land parcels are entered into the EPA software application ProUCL version 4.0. The ProUCL software is used to calculate the 95 percent UCL for principal radionuclide concentrations based on the distribution of the unknown mean.

For instances where the ProUCL software determined that there was not enough data to calculate the 95 percent UCL for a specific radionuclide, the maximum concentration from the sample dataset was used as the initial concentration for that radionuclide.

3.2 Authorized Values Initial Concentrations of Principal Radionuclides for Area Averaging/Location Specific Scenarios

The DOE Order 5400.5 (DOE, 1993) states: “Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m²” (5400.5, IV, 4.a.). DOE Order 5400.5 also states: “If the average concentration of any surface or below-surface area less than or equal to 25 m², exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, [where A is the area (in square meters) of the region in which concentrations are elevated], limits for “hot-spots” shall also be developed and applied” (5400.5, IV, 4.a.(1)). DOE Order 5400.5, IV, 4.a.(1) indicates that criterion for these location-specific analysis is discussed in DOE G 441.1-XX (DOE, 2002) Section 5.2.2.

The purpose of the location-specific analysis criterion is to ensure that applying the homogeneous criteria, in which the concentrations of residual radioactive material are averaged over a 100-square meter (m²) area, does not result in the release of small areas that, because of averaging, contain unacceptably high concentrations of residual radioactive material. The location-specific criterion is used to supplement Authorized Limits for larger areas and is intended to prevent excessive exposures from a small, contaminated area that is within a larger area that meets the basic Authorized Limits. Thus, it is intended for use in areas where the residual radioactive material concentrations are not uniform. Also, the above criterion was derived conservatively, assuming the Authorized Limits were based on a dose constraint of 25 mrem/yr, and selected to ensure unlikely exposure conditions would not cause the primary dose limit (100 mrem/yr) to be exceeded. The authorized exposure scenarios specify that the value of the maximum concentration of principal radionuclides obtained from site-specific

sampling results be entered as the principal radionuclide concentrations for RESRAD location-specific calculations. The authorized area parameters for RESRAD location-specific calculations are 1 m², 10 m², and 100 m² contamination areas.

3.3 Inhomogeneous Contamination and Initial Radionuclide Concentrations

A contaminated zone is inhomogeneous if it contains a contaminated region within which the concentration of a radionuclide exceeds three times the average for the contaminated zone. The RESRAD uses a mathematical construct that assumes uniform distribution of radionuclides within a volume. However, RESRAD recognizes that radiological contamination is inhomogeneous in nature and provides detailed guidance for applying inhomogeneous criteria (e.g., location-specific criteria, sum of fractions rule). The RESRAD User's Manual states that the inhomogeneous release criteria are generally more realistic and hence less restrictive than the homogeneous release criteria (Yu, et.al, 2001). This shows that the approved initial radionuclide concentration values (i.e., arithmetic mean plus 95 percent UCL or the maximum radionuclide concentration from the sample dataset) will result in more restrictive release criteria. The arithmetic mean plus the 95 percent UCL are used for the initial concentrations of principal radionuclides when the sample results are obtained using a random sampling method. The maximum radionuclide concentration values are used for the initial concentrations of principal radionuclides when the sample results are obtained using a nonrandom (e.g., bias or judgmental sampling) sampling method.

The RESRAD states that a statistical approach should always be considered as a first priority regarding the estimation of soil concentrations, as cited in the *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil* (Yu et al., 1993). The 95 percent UCL represents a value that has a 5 percent chance that the actual mean of the dataset would exceed it. The 95 percent UCL is computed using the EPA code ProUCL. The code calculates the 95 percent UCL based on the distribution of the dataset (e.g., normal, log-normal, gamma, nonparametric).

The ProUCL software has been developed to compute an appropriate 95 percent UCL of the unknown population mean to support exposure assessment and cleanup decisions for EPA projects. A 95 percent UCL of the unknown population arithmetic mean is often used to:

- Estimate the exposure point concentration (EPC) term.
- Determine the attainment of cleanup standards.
- Estimate background level mean contaminant concentrations, or
- Compare the soil concentrations with site-specific soil screening levels.

It is important to compute a reliable, conservative, and stable 95 percent UCL of the population mean using the available data. The 95 percent UCL should approximately provide the 95 percent coverage for the unknown population mean.

The EPA has recommended that the maximum value of the dataset be used for the initial EPC term when the 95 percent UCL exceeds the maximum (EPA, 1992). However, if the maximum value of the dataset is used, then most of the statistical data associated with the distribution of the dataset are ignored (except for the maximum). Therefore, by using the mean plus the 95 percent

UCL, the statistical data associated with the dataset are retained, and the value approaches or exceeds the maximum value of the dataset as recommended by EPA.

3.4 *Initial Concentrations of Principal Radionuclide for CAU 545, CAS 03-17-01*

The initial radionuclide concentrations used for the RESRAD calculations are those listed in Table 2-1. Because the sampling plan was a mixture of randomized and biased sampling, the maximum value of the radionuclide found in the samples is used for RESRAD analysis.

4.0 Authorized RESRAD Exposure Pathways and Scenarios

This section describes the input parameters, exposures scenarios, and guidance for calculating site-specific radiological remediation levels for projects using the RESRAD computer code, as agreed to by NNSA/NSO and Nevada Division of Environmental Protection (NDEP).

4.1 Guidance for RESRAD Calculations

The guidance in this section was developed by NNSA/NSO and NDEP and is only applicable to soils containing residual radioactive material. This guidance does not apply to structures, facilities, equipment, and building materials containing contaminated surfaces or volume contamination. The primary dose limit for any member of the public is 100-millirem (mrem) total effective dose equivalent in a year. This limit applies to the sum of internal and external doses resulting from all modes of exposure to all radiation sources other than background radiation and doses received as a patient from medical sources as required by DOE 5400.5, II.1.a.(3)(a) (DOE, 1993). The dose constraint is defined as one quarter of the dose limit (i.e., 25-mrem) and will be applied to ensure that, in a 1,000-year period, the maximally exposed individual does not exceed the dose constraint in any single year. The requirements of Chapter IV of DOE 5400.5 Chapter IV will not specifically apply if NNSA/NSO chooses to continue to own and actively control access or use of the site. However, the radiation protection requirements in the other sections of DOE 5400.5 will apply to NNSA/NSO owned and maintained sites.

Due to the large spatial variability in background amongst sites, the “above background criterion” will be defined as the concentration of a specific radionuclide in soil that equals or exceeds its corresponding preliminary action level (PAL). The source data for these radionuclide specific PALs are taken directly from National Council on Radiation Protection and Measurements Report No. 129 Table 2.1, Construction, Commercial, Industrial land-use scenario column for a 25-mrem dose constraint (NCRP, 1999). The generic guidelines for residual concentrations of radium (Ra)-226, Ra-228, thorium (Th)-230, and Th-232 are found in Chapter IV of DOE Order 5400.5, Change 2, *Radiation Protection of the Public and Environment* (DOE, 1993).

Background radiation refers to the local area and includes:

- Concentration of naturally occurring radionuclides.
- Cosmic radiation.
- Radionuclides of anthropogenic origin that have been globally dispersed and are present at low concentrations such as fallout from nuclear weapons. (Note: This is not the case at the NTS because the historical aspects of the NTS [e.g., above and underground testing, and other operations resulted in dispersion of radionuclides locally].)

Due to the impracticality of determining “true” background, a dose constraint with no background subtraction will be used (i.e., a dose constraint not in excess of background). The

use of the dose constraint with no background subtraction is a far more conservative and sensitive approach because it does not deal with the uncertainty of natural background.

4.2 Description of Approved Scenarios

Detailed description for each scenario can be found in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NV, 2006).

4.3 Residual Radioactive Material Guideline

The residual radioactive material guideline represents the concentration of residual radioactive material that can remain in place and still allow use of that area without radiological restrictions. Using site-specific parameters and sample analysis results, the radioactive material guideline, G , can be calculated for a given dose limit of H_{EL} for an individual as follows;

$$G = H_{EL} / DSR,$$

where DSR is the total dose/source concentration ratio. The dose limit H_{EL} , used to derive the residual radioactive material guideline is 25 mrem/yr.

Single radionuclide guidelines are calculated for individual radionuclides such that the annual dose to industrial/construction workers at the site should not exceed an annual dose limitation of 25 mrem/yr. Sites contaminated with two or more radionuclides (i.e., a mixture of radionuclides) require further evaluation to ensure that collective exposures from individual radionuclides do not exceed the 25 mrem/yr annual dose constraint. This evaluation is performed using a sum of the fractions method. The initial soil concentration of each radionuclide is divided by the single radionuclide guideline for that radionuclide to produce a ratio. These ratios are then summed. If the sum is less than or equal to unity, then the collective annual dose from all radionuclides at the site should not exceed the 25 mrem/yr annual dose constraint. If the sum does exceed unity, the annual dose to industrial/construction workers could exceed the 25 mrem/yr dose constraint, even if the concentrations of residual radionuclides at the site are below the single radionuclide guideline values. For sites where the sum of the ratios exceeds unity, residual radioactive material guidelines for mixtures of radionuclides are calculated such that the following equation is satisfied;

$$\overline{M} = \sum_i \overline{S}_i(t_o) / G_i(t_m) \leq 1$$

Where:

\overline{M}	=	average mixture sum (dimensionless)
$\overline{S}_i(t_o)$	=	initial concentration of the i th principal radionuclide averaged over an area determined by scenario activities

$G_i(t_m)$ = single radionuclide soil concentration guideline for the i th principal radionuclide at time t maximum.

For a site where the sum of the ratios does not exceed unity, the residual radioactive guidelines for single radionuclides are the radionuclide concentrations to be used as the FAL. For sites where the sum of the ratios exceeds unity, the residual radioactive guidelines for mixtures of radionuclides are mathematically adjusted so that the above equation is satisfied. Those adjusted values are then used as the FAL.

5.0 RESRAD Calculations for CAU 545 CAS 03-17-01, Waste Consolidation Site 3B

This section discusses the RESRAD calculations and results for CAU 545 CAS 03-17-01. Industrial Worker scenario is selected as the exposure scenario because the operational history of the CAS and to demonstrate conservatism for the final action levels.

5.1 User Input Parameters

The RESRAD default parameters that were modified for the calculations performed for CAU 545 CAS 03-17-01 in this report and the site-specific values entered are presented in Table 5-1, RESRAD Parameter Input Values for CAU 545 CAS 03-17-01. The initial radionuclide concentrations used for analyses are those listed in Table 2-1.

5.2 Radionuclide Concentrations and Dose Estimates

The maximum dose results from RESRAD calculations for the CAU 545 CAS 03-17-01 is 12.76 mrem/yr (Table 5-2) occurring at year zero (current year) and the dose will decrease to zero year 300. The detailed RESRAD results for this CAS are provided in Exhibit 1, RESRAD Summary Report: CAU 545 CAS 03-17-01.

Uncertainty in the derivation of dose estimates and dose/source contribution ratios comes from the distribution of possible input parameter values, as well as uncertainty in the conceptual model used to represent the site. The pathway contributing to the total annual dose at the time of maximum dose occurs are inhalation (58.72 percent), external exposure (22.13 percent), and soil ingestion (19.16 percent). Therefore, uncertainties in the following parameters: soil disturbance (e.g., erosion rates), thickness of contaminated zone, and occupancy factors have the greatest significance on the model predictions.

Because the radionuclide concentrations found at this site pose a dose level below the 25 mrem/yr constraint under the current site conditions, remediation alternative is not necessary for the site.

5.3 Residual Radioactive Material Guidelines for CAU 545 CAS 03-17-01

The sum of the ratios for CAU 545 CAS 03-17-01 does not exceed unity. Table 5-3, presents the calculations results for deriving guidelines for radionuclides for this CAS. The FAL for the CAU 545 CAS 03-17-01 scenario is the residual radioactive material guideline values for single radionuclide.

Table 5-1
RESRAD Parameters Input Values for CAU 545 CAS 03-17-01

Parameter	Units	CAU 545 CAS 03-17-01	Defaults	Reference/Rationale
Area of CZ	m ²	1.000E+02	1.000E+04	Estimated using the sampling boundary
Thickness of CZ	m	1.500E-01	2.000E+00	Top layer of the contamination soil
Principal radionuclides	pCi/g	See Table 2-1	0.0	Initial concentrations are the maximum concentrations from sample results.
Average Annual Wind Speed	m/sec	4.07	2.000E+00	NNSA/NSO, 2007
Precipitation	m/yr	1.626E-01	1.000E+00	Data from Air Resources Laboratory
Runoff Coefficient	-	4.000E-01	2.000E-01	Open Sandy Loam 30% impervious Table 10.1 (Yu, et al., 1993)
Mass Loading for Inhalation	g/m ³	6.00E-04	1E-04	The estimated mass loading for construction activities. (Yu, et al., 1993)
Exposure Duration	yr	25	30	Standard for Industrial/Commercial Scenario
Shielding Factor Inhalation	-	1.0	0.4	Assumes no indoor time fraction
Shielding Factor External Gamma	-	1.0	0.7	Assumes no indoor time fraction
Fraction of Time Spent Indoors	-	0.0	0.5	Assumes no indoor time fraction
Fraction of Time Spent Outdoors	-	8.55E-02	0.25	NNSA/NSO, 2007
Soil Ingestion Rate	g/yr	108	36.5	NNSA/NSO, 2007
CZ = Contaminated Zone g/m ³ = Grams per cubic meter g/yr = Grams per year m = Meter m ² = Square meter				m/sec = Meters per second m/yr = Meters per year pCi/g = Picocuries per gram RESRAD = Residual Radioactive yr = Year - = Unitless

Table 5-2
Maximum Dose Contributions for CAU 545 CAS 03-17-01
Using Industrial Worker Scenario (dose as mrem/yr)

Radionuclide	Ground		Inhalation		Soil Ingestion		Total	
	Annual Dose	Fraction	Annual Dose	Fraction	Annual Dose	Fraction	Annual Dose	Fraction
Americium-241	8.778E-01	0.0688	2.906E+00	0.2278	9.455E-01	0.0741	4.730E+00	0.3707
Cesium-137	1.050E+00	0.0823	3.759E-06	0.0000	2.338E-04	0.0000	1.051E+00	0.0823
Europium-152	8.671E-01	0.0680	1.084E-05	0.0000	1.261E-05	0.0000	8.671E-01	0.0680
Plutonium-238	5.991E-05	0.0000	4.654E-02	0.0036	1.508E-02	0.0012	6.168E-02	0.0048
Plutonium-239/240	9.196E-03	0.0007	4.527E+00	0.3548	1.482E+00	0.1162	6.018E+00	0.4717
Strontium-90	1.703E-03	0.0001	3.287E-05	0.0000	1.523E-04	0.0000	1.888E-03	0.0001
Uranium-233	2.412E-04	0.0000	7.566E-03	0.0006	6.427E-04	0.0001	8.450E-03	0.0007
Uranium-235	5.932E-03	0.0005	3.302E-04	0.0000	2.849E-05	0.0000	6.291E-03	0.0005
Uranium-238	1.026E-02	0.0008	3.005E-03	0.0002	2.714E-04	0.0000	1.354E-02	0.0011
Total	2.823E+00	0.2213	7.490E+00	0.5872	2.444E+00	0.1916	1.276E+01	1.0000

mrem/yr = Millirem per year

Table 5-3
CAU 545, CAS 03-17-01, Final Action Level

Radionuclide	Initial Radionuclide Concentration (pCi/g)	Final Action Level (pCi/g)
Americium-241	2.840E+02	1.501E+03
Cesium-137	5.140E+00	1.223E+02
Europium-152	2.170E+00	6.256E+01
Plutonium-238	5.140E+00	2.083E+03
Plutonium-239/240	4.550E+02	1.890E+03
Strontium-90	1.100E+00	1.457E+04
Uranium-233	2.420E+00	7.160E+03
Uranium-235	1.160E+01	4.610E+02
Uranium-238	1.100E+00	2.031E+03

pCi/g = Picocuries per gram

6.0 References

ARL, see Air Resources Laboratory.

Air Resources Laboratory. 2007. "Climatological Information and Data." As accessed at <http://www.sord.nv.doe.gov> on 28 November.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

NCRP, see National Council on Radiation Protection and Measurements.

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

Exhibit 1

RESRAD Summary Report: CAU 545 CAS 03-17-01 (27 pages)

Table of Contents

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 MORBIDITY

[illegible]

Site-Specific Parameter Summary (continued)

	Menu	Parameter	User Input	Default	(If different from user input)	Used by RESRAD	Parameter Name
	R017	Exposure duration	2.500E+01	3.000E+01	---	---	ED
	R017	Shielding factor, inhalation	1.000E+00	4.000E-01	---	---	SHF3
	R017	Shielding factor, external gamma	1.000E+00	7.000E-01	---	---	SHF1
	R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	---	FIND
	R017	Fraction of time spent outdoors (on site)	8.550E-02	2.500E-01	---	---	FOTD
	R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	---	FS
	R017	Radii of shape factor array (used if FS = -1):					
	R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	---	RAD_SHAPE(1)
	R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	---	RAD_SHAPE(2)
	R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	---	RAD_SHAPE(3)
	R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	---	RAD_SHAPE(4)
	R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	---	RAD_SHAPE(5)
	R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	---	RAD_SHAPE(6)
	R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	---	RAD_SHAPE(7)
	R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	---	RAD_SHAPE(8)
	R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	---	RAD_SHAPE(9)
	R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	---	RAD_SHAPE(10)
	R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	---	RAD_SHAPE(11)
	R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	---	RAD_SHAPE(12)
	R017	Fractions of annular areas within AREA:					
	R017	Ring 1	not used	1.000E+00	---	---	FRACA(1)
	R017	Ring 2	not used	2.732E-01	---	---	FRACA(2)
	R017	Ring 3	not used	0.000E+00	---	---	FRACA(3)
	R017	Ring 4	not used	0.000E+00	---	---	FRACA(4)
	R017	Ring 5	not used	0.000E+00	---	---	FRACA(5)
	R017	Ring 6	not used	0.000E+00	---	---	FRACA(6)
	R017	Ring 7	not used	0.000E+00	---	---	FRACA(7)
	R017	Ring 8	not used	0.000E+00	---	---	FRACA(8)
	R017	Ring 9	not used	0.000E+00	---	---	FRACA(9)
	R017	Ring 10	not used	0.000E+00	---	---	FRACA(10)
	R017	Ring 11	not used	0.000E+00	---	---	FRACA(11)
	R017	Ring 12	not used	0.000E+00	---	---	FRACA(12)
	R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	---	DIET(1)
	R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	---	DIET(2)
	R018	Milk consumption (L/yr)	not used	9.200E+01	---	---	DIET(3)
	R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	---	DIET(4)
	R018	Fish consumption (kg/yr)	not used	5.400E+00	---	---	DIET(5)
	R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	---	DIET(6)
	R018	Soil ingestion rate (g/yr)	1.080E+02	3.650E+01	---	---	SOIL
	R018	Drinking water intake (L/yr)	not used	5.100E+02	---	---	DWI
	R018	Contamination fraction of drinking water	not used	1.000E+00	---	---	FDW
	R018	Contamination fraction of household water	not used	1.000E+00	---	---	FHHW
	R018	Contamination fraction of livestock water	not used	1.000E+00	---	---	FLW
	R018	Contamination fraction of irrigation water	not used	1.000E+00	---	---	FIRW
	R018	Contamination fraction of aquatic food	not used	5.000E-01	---	---	FR9
	R018	Contamination fraction of plant food	not used	3--1	---	---	FPLANT
	R018	Contamination fraction of meat	not used	3--1	---	---	FMEAT
	R018	Contamination fraction of milk	not used	3--1	---	---	FMILK

Contaminated Zone Dimensions

Initial Soil Concentrations, pCi/g

Area: 100.00 square meters

Thickness: 0.15 meters

Cover Depth: 0.00 meters

Am-241 2.840E+02

Cs-137 5.140E+00

Eu-152 2.170E+00

Pu-238 5.140E+00

Pu-239 4.550E+02

Sr-90 1.100E+00

U-233 2.420E+00

U-235 1.160E-01

U-238 1.100E+00

0

Total Dose TDose(t), mrem/yr

Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years): 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03

TDose(t): 1.276E+01 1.256E+01 1.217E+01 1.094E+01 8.216E+00 2.651E+00 0.000E+00 0.000E+00

M(t): 5.103E-01 5.023E-01 4.868E-01 4.378E-01 3.286E-01 1.061E-01 0.000E+00 0.000E+00

0Maximum TDose(t): 1.276E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

0 0	Inhalation			Radon			Plant			Meat			Milk			Soil		
	Radio- Nuclide	Ground mrem/yr fract.	fract.	Radio- Nuclide	fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.
	Am-241	8.778E-01	0.0688	Am-241	8.778E-01	0.0688	Am-241	8.778E-01	0.0688	Am-241	8.778E-01	0.0688	Am-241	8.778E-01	0.0688	Am-241	8.778E-01	0.0688
	Cs-137	1.050E+00	0.0823	Cs-137	1.050E+00	0.0823	Cs-137	1.050E+00	0.0823	Cs-137	1.050E+00	0.0823	Cs-137	1.050E+00	0.0823	Cs-137	1.050E+00	0.0823
	Eu-152	8.671E-01	0.0680	Eu-152	8.671E-01	0.0680	Eu-152	8.671E-01	0.0680	Eu-152	8.671E-01	0.0680	Eu-152	8.671E-01	0.0680	Eu-152	8.671E-01	0.0680
	Pu-238	5.991E-05	0.0000	Pu-238	5.991E-05	0.0000	Pu-238	5.991E-05	0.0000	Pu-238	5.991E-05	0.0000	Pu-238	5.991E-05	0.0000	Pu-238	5.991E-05	0.0000
	Pu-239	9.196E-03	0.0007	Pu-239	9.196E-03	0.0007	Pu-239	9.196E-03	0.0007	Pu-239	9.196E-03	0.0007	Pu-239	9.196E-03	0.0007	Pu-239	9.196E-03	0.0007
	U-233	1.703E-03	0.0001	U-233	1.703E-03	0.0001	U-233	1.703E-03	0.0001	U-233	1.703E-03	0.0001	U-233	1.703E-03	0.0001	U-233	1.703E-03	0.0001
	U-235	5.932E-03	0.0005	U-235	5.932E-03	0.0005	U-235	5.932E-03	0.0005	U-235	5.932E-03	0.0005	U-235	5.932E-03	0.0005	U-235	5.932E-03	0.0005
	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008
	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008	U-238	1.026E-02	0.0008
	Total	2.823E+00	0.2213	Total	2.823E+00	0.2213	Total	2.823E+00	0.2213	Total	2.823E+00	0.2213	Total	2.823E+00	0.2213	Total	2.823E+00	0.2213

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

0 0	Water			Fish			Radon			Plant			Meat			Milk			All Pathways*		
	Radio- Nuclide	Water mrem/yr fract.	fract.	Radio- Nuclide	Water mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.	Radio- Nuclide	mrem/yr fract.	fract.
	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000	Am-241	0.000E+00	0.0000
	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000	CS-137	0.000E+00	0.0000
	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000	Eu-152	0.000E+00	0.0000
	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000	Pu-238	0.000E+00	0.0000
	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000	Pu-239	0.000E+00	0.0000
	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000	Sr-90	0.000E+00	0.0000
	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000	U-233	0.000E+00	0.0000
	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000	U-235	0.000E+00	0.0000
	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000
	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000	U-238	0.000E+00	0.0000
	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000	Total	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i, p, t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At $t = 3.000E+00$ years
Water Independent Pathways (Inhalation excludes radon)

Water Independent Pathways (Inhalation excludes radon)														
Ground			Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	8.458E-01	0.0695	2.744E+00	0.2255	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.929E-01	0.0734
Cs-137	9.707E-01	0.0798	3.436E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.137E-04	0.0000
Eu-152	7.337E-01	0.0603	9.078E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.056E-05	0.0000
Pu-238	5.847E-05	0.0000	4.452E-02	0.0037	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.442E-02	0.0012
Pu-239	9.143E-03	0.0008	4.434E+00	0.3643	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.452E+00	0.1193
Sr-90	1.540E-03	0.0001	2.935E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.360E-04	0.0000
U-233	3.053E-04	0.0005	7.352E-03	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.241E-04	0.0001
U-235	5.822E-03	0.0005	3.197E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.764E-05	0.0000
U-238	1.004E-02	0.0008	2.906E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.626E-04	0.0000
Total	2.577E+00	0.2117	7.233E+00	0.5943	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.361E+00	0.1939

Total Dose Contributions TDOSE(i, p, t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

[illegible]

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground			Inhalation			Radon			Plant			Meat			Milk			Soil		
	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.
Radio- Nuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	7.757E-01	0.0709	0.0737	2.397E+00	0.2190	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	8.067E-01	0.0737	0.0737	2.783E-06	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	4.962E-01	0.0453	0.0453	5.996E-06	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	5.524E-05	0.0000	0.0000	4.009E-02	0.0037	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	9.015E-03	0.0008	0.0008	4.218E+00	0.3854	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	1.216E-03	0.0001	0.0001	2.250E-05	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	4.473E-04	0.0000	0.0000	6.866E-03	0.0006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	5.568E-03	0.0005	0.0005	2.963E-04	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	9.547E-03	0.0009	0.0009	2.685E-03	0.0002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	9.547E-03	0.0009	0.0009	2.685E-03	0.0002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	2.105E+00	0.1923	0.1923	6.665E+00	0.6090	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Dependent Pathways

Radio- Nuclide	Water			Fish			Radon			Plant			Meat			Milk			All Pathways*		
	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.
Radio- Nuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.0000	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground			Inhalation			Radon			Plant			Meat			Milk			Soil		
	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.
Radio- Nuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	2.352E-01	0.0887	2.800E-01	0.1056	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	5.475E-02	0.0206	1.229E-07	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	2.389E-03	0.0009	1.928E-08	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.530E-05	0.0000	6.919E-03	0.0026	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	6.094E-03	0.0023	1.478E+00	0.5576	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	4.421E-05	0.0000	4.909E-07	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	1.191E-03	0.0004	1.933E-03	0.0007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	2.419E-03	0.0009	7.765E-05	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	3.783E-03	0.0014	6.460E-04	0.0002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	3.783E-03	0.0014	6.460E-04	0.0002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	3.059E-01	0.1154	1.768E+00	0.6668	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

Radio- Nuclide	Water			Fish			Radon			Plant			Meat			Milk			All Pathways*		
	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.	mrem/yr	fract.	fract.
Radio- Nuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i, p, t) for Individual Radionuclides (i) and Pathways (p)

As mrem/vr and Fraction of Total Dose At $t = 3.000E+02$ years

Water Independent Pathways (Inhalation excludes radon)

[illegible]

Total Dose Contributions TDOSE(i, p, t) for Individual Radionuclides (i) and Pathways (p)

As mrem/vr and Fraction of Total Dose At $t = 3.000E+02$ years

Water Dependent Pathways

[illegible]

0*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways									
Parent and Progeny Principal Radionuclide Contributions Indicated				DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)					
0	Parent (i)	Product (j)	Thrad Fraction	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+02	1.000E+03
	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ
	Am-241	Am-241	1.000E+00	1.665E-02	1.636E-02	1.579E-02	1.599E-02	9.616E-03	0.000E+00
	Am-241	Np-237+D	1.000E+00	1.432E-08	4.258E-08	9.746E-08	2.730E-07	6.479E-07	8.563E-07
	Am-241	U-233	1.000E+00	8.194E-16	5.675E-15	2.928E-14	2.398E-13	4.853E-12	0.000E+00
	Am-241	Th-229+D	1.000E+00	8.623E-19	1.284E-17	1.474E-16	3.685E-15	7.539E-14	1.145E-12
	Am-241	ÄDSR(j)	1.665E-02	1.636E-02	1.579E-02	1.392E-02	9.617E-03	2.135E-03	0.000E+00
	0Cs-137+D	Cs-137+D	2.044E-01	1.991E-01	1.889E-01	1.570E-01	9.157E-02	1.065E-02	0.000E+00
	0Eu-152	Eu-152	7.208E-01	2.724E-01	2.437E-01	1.648E-01	5.335E-02	7.935E-04	0.000E+00
	0Eu-152	Eu-152	2.792E-01	1.116E-01	1.055E-01	9.440E-02	6.385E-02	2.066E-02	3.074E-04
	Eu-152	Gd-152	2.792E-01	5.087E-18	1.482E-17	3.245E-17	7.801E-17	1.257E-16	6.393E-17
	Eu-152	ÄDSR(j)	1.116E-01	1.055E-01	9.440E-02	6.385E-02	2.066E-02	3.074E-04	0.000E+00
	0Pu-238	Pu-238	2.208E-11	2.176E-11	2.112E-11	1.902E-11	1.388E-11	3.288E-12	0.000E+00
	0Pu-238	Pu-238	1.200E-02	1.182E-02	1.148E-02	1.034E-02	7.545E-03	1.787E-03	0.000E+00
	Pu-238	U-234	4.725E-09	1.401E-08	3.188E-08	8.727E-08	1.923E-07	1.731E-07	0.000E+00
	Pu-238	Th-230	3.450E-14	2.393E-13	1.238E-12	1.026E-11	6.844E-11	2.362E-10	0.000E+00
	Pu-238	Ra-226+D	2.922E-16	4.354E-15	5.006E-14	1.258E-12	2.607E-11	4.035E-10	0.000E+00
	Pu-238	Pb-210+D	2.169E-20	6.632E-19	1.620E-17	1.131E-15	5.742E-14	1.642E-12	0.000E+00
	Pu-238	ÄDSR(j)	1.200E-02	1.182E-02	1.148E-02	1.034E-02	7.545E-03	1.787E-03	0.000E+00
	0Pu-239	Pu-239	1.323E-02	1.314E-02	1.296E-02	1.233E-02	1.053E-02	4.326E-03	0.000E+00
	Pu-239	U-235+D	2.671E-11	7.983E-11	1.846E-10	5.366E-10	1.413E-09	2.638E-09	0.000E+00
	Pu-239	Pa-231	1.000E+00	1.794E-16	1.247E-15	6.480E-15	5.449E-14	3.801E-13	1.586E-12
	Pu-239	Ac-227+D	8.211E-18	1.213E-16	1.369E-15	3.214E-14	5.565E-13	5.204E-12	0.000E+00
	Pu-239	ÄDSR(j)	1.323E-02	1.314E-02	1.296E-02	1.233E-02	1.053E-02	4.326E-03	0.000E+00
	0Sr-90+D	Sr-90+D	1.716E-03	1.659E-03	1.550E-03	1.221E-03	6.113E-04	4.270E-05	0.000E+00
	0U-233	U-233	3.484E-03	3.447E-03	3.372E-03	3.118E-03	2.458E-03	7.677E-04	0.000E+00
	U-233	Th-229+D	7.324E-06	2.185E-05	5.037E-05	1.445E-04	3.664E-04	5.894E-04	0.000E+00
	U-233	ÄDSR(j)	3.492E-03	3.468E-03	3.422E-03	3.263E-03	2.824E-03	1.357E-03	0.000E+00
	0U-235+D	U-235+D	5.423E-02	5.388E-02	5.318E-02	5.076E-02	4.410E-02	2.144E-02	0.000E+00
	U-235+D	Pa-231	5.464E-07	1.625E-06	3.716E-06	1.038E-05	2.424E-05	2.771E-05	0.000E+00
	U-235+D	Ac-227+D	3.327E-08	2.286E-07	1.158E-06	8.916E-06	4.932E-05	1.131E-04	0.000E+00
	U-235+D	ÄDSR(j)	5.423E-02	5.388E-02	5.318E-02	5.076E-02	4.417E-02	2.158E-02	0.000E+00
	0U-238	U-238	5.400E-05	1.605E-07	1.588E-07	1.553E-07	1.435E-07	1.128E-07	3.469E-08
	0U-238+D	U-238+D	1.231E-02	1.221E-02	1.201E-02	1.134E-02	9.529E-03	4.079E-03	0.000E+00
	U-238+D	U-234	4.730E-09	1.405E-08	3.208E-08	8.897E-08	2.033E-07	2.072E-07	0.000E+00
	U-238+D	Th-230	3.453E-14	2.397E-13	1.244E-12	1.039E-11	7.099E-11	2.650E-10	0.000E+00
	U-238+D	Ra-226+D	2.923E-16	4.360E-15	5.022E-14	1.270E-12	2.680E-11	4.406E-10	0.000E+00
	U-238+D	Pb-210+D	2.171E-20	6.640E-19	1.624E-17	1.139E-15	5.874E-14	1.772E-12	0.000E+00
	U-238+D	ÄDSR(j)	1.231E-02	1.221E-02	1.201E-02	1.134E-02	9.529E-03	4.079E-03	0.000E+00
	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

ONuclide	t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
(i)									
Aa-241	1.501E+03	1.528E+03	1.584E+03	1.796E+03	2.600E+03	1.171E+04	1.171E+04	*3.431E+12	*3.431E+12
Cs-137	1.223E+02	1.256E+02	1.324E+02	1.593E+02	2.730E+02	2.347E+03	2.347E+03	*8.704E+13	*8.704E+13
Eu-152	6.256E+01	6.614E+01	7.394E+01	1.093E+02	3.378E+02	2.271E+04	2.271E+04	*1.765E+14	*1.765E+14
Pu-238	2.083E+03	2.114E+03	2.178E+03	2.419E+03	3.313E+03	1.399E+04	1.399E+04	*1.712E+13	*1.712E+13
Pu-239	1.890E+03	1.903E+03	1.930E+03	2.028E+03	2.374E+03	5.778E+03	5.778E+03	*6.214E+10	*6.214E+10
Sr-90	1.457E+04	1.507E+04	1.613E+04	2.048E+04	4.090E+04	5.854E+05	5.854E+05	*1.365E+14	*1.365E+14
U-233	7.160E+03	7.208E+03	7.305E+03	7.663E+03	8.853E+03	1.842E+04	1.842E+04	*9.678E+09	*9.678E+09
U-235	4.610E+02	4.840E+02	4.701E+02	4.923E+02	5.659E+02	1.158E+03	1.158E+03	*2.161E+06	*2.161E+06
U-238	2.031E+03	2.048E+03	2.081E+03	2.205E+03	2.623E+03	6.128E+03	6.128E+03	*3.361E+05	*3.361E+05
fffff	fffff	fffff	fffff	fffff	fffff	fffff	fffff	fffff	fffff
*At specific activity limit									

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)

and Single Radionuclide Soil Guidelines G(i,t) in pCi/g

at tmin = time of minimum single radionuclide soil guideline

and at tmax = time of maximum total dose = 0.000E+00 years

ONuclide	Initial	tmin	DSR(i,tmin)	G(i,tmin)	DSR(i,tmax)	G(i,tmax)
(i)						
Aa-241	2.840E+02	0.000E+00	1.665E-02	1.501E+03	1.665E-02	1.501E+03
Cs-137	5.140E+00	0.000E+00	2.044E-01	1.223E+02	2.044E-01	1.223E+02
Eu-152	2.170E+00	0.000E+00	3.996E-01	6.256E+01	3.996E-01	6.256E+01
Pu-238	5.140E+00	0.000E+00	1.200E-02	2.083E+03	1.200E-02	2.083E+03
Pu-239	4.550E+02	0.000E+00	1.323E-02	1.890E+03	1.323E-02	1.890E+03
Sr-90	1.100E+00	0.000E+00	1.716E-03	1.457E+04	1.716E-03	1.457E+04
U-233	2.420E+00	0.000E+00	3.492E-03	7.160E+03	3.492E-03	7.160E+03
U-235	1.160E-01	0.000E+00	5.423E-02	4.610E+02	5.423E-02	4.610E+02
U-238	1.100E+00	0.000E+00	1.231E-02	2.031E+03	1.231E-02	2.031E+03
fffff	fffff	fffff	fffff	fffff	fffff	fffff

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

ONuclide	Parent	THF(i)	t=	DOSE(j,t), mrem/yr									
(j)	(i)			0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+03	1.000E+03
AA-244	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA	AA-244AA
Am-241	Am-241	Am-241	Am-241	4.730E+00	4.646E+00	4.483E+00	3.952E+00	2.731E+00	6.060E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ONp-237	Am-241	Am-241	Am-241	4.066E-06	1.209E-05	2.768E-05	7.753E-05	1.840E-04	2.432E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OU-233	Am-241	Am-241	Am-241	2.327E-13	1.612E-12	8.316E-12	6.811E-11	4.403E-10	1.378E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	U-233	U-233	U-233	8.432E-03	8.341E-03	8.160E-03	7.546E-03	5.947E-03	1.858E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	ADOSE(j)			8.432E-03	8.341E-03	8.160E-03	7.546E-03	5.947E-03	1.858E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OTH-229	Am-241	Am-241	Am-241	2.449E-16	3.647E-15	4.187E-14	1.046E-12	2.141E-11	3.251E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	U-233	U-233	U-233	1.772E-05	5.288E-05	1.219E-04	3.498E-04	8.866E-04	1.426E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	ADOSE(j)			1.772E-05	5.288E-05	1.219E-04	3.498E-04	8.866E-04	1.426E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OCs-137	Cs-137	Cs-137	Cs-137	1.051E+00	1.023E+00	9.709E-01	8.069E-01	4.707E-01	5.476E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OEu-152	Eu-152	Eu-152	Eu-152	6.250E-01	5.912E-01	5.288E-01	3.577E-01	1.158E-01	1.722E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	Eu-152	Eu-152	2.421E-01	2.290E-01	2.048E-01	1.385E-01	4.484E-02	6.670E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	ADOSE(j)			8.671E-01	8.202E-01	7.337E-01	4.962E-01	1.606E-01	2.389E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OGd-152	Eu-152	Eu-152	Eu-152	1.104E-17	3.217E-17	7.041E-17	1.693E-16	2.727E-16	1.387E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OPu-238	Pu-238	Pu-238	Pu-238	1.135E-10	1.118E-10	1.086E-10	9.775E-11	7.136E-11	1.690E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pu-238	Pu-238	Pu-238	6.168E-02	6.078E-02	5.901E-02	5.313E-02	3.878E-02	9.185E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	ADOSE(j)			6.168E-02	6.078E-02	5.901E-02	5.313E-02	3.878E-02	9.185E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OU-234	Pu-238	Pu-238	Pu-238	2.428E-08	7.203E-08	1.639E-07	4.486E-07	9.885E-07	8.898E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	U-238	U-238	U-238	5.203E-09	1.546E-08	3.529E-08	9.787E-08	2.237E-07	2.279E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	ADOSE(j)			2.949E-08	8.748E-08	1.991E-07	5.464E-07	1.212E-06	1.118E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OTH-230	Pu-238	Pu-238	Pu-238	1.773E-13	1.230E-12	6.365E-12	5.273E-11	3.518E-10	1.214E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	U-238	U-238	U-238	3.798E-14	2.637E-13	1.368E-12	1.143E-11	7.809E-11	2.915E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	ADOSE(j)			2.153E-13	1.494E-12	7.734E-12	6.416E-11	4.299E-10	1.506E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ORa-226	Pu-238	Pu-238	Pu-238	1.502E-15	2.238E-14	2.573E-13	6.465E-12	1.340E-10	2.074E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	U-238	U-238	U-238	3.216E-16	4.796E-15	5.524E-14	1.397E-12	2.948E-11	4.846E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	ADOSE(j)			1.823E-15	2.718E-14	3.126E-13	7.862E-12	1.635E-10	2.559E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OPb-210	Pu-238	Pu-238	Pu-238	1.115E-19	3.409E-18	8.326E-17	5.811E-15	2.951E-13	8.441E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-238	U-238	U-238	2.388E-20	7.304E-19	1.787E-17	1.253E-15	6.461E-14	1.949E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	ADOSE(j)			1.354E-19	4.139E-18	1.011E-16	7.065E-15	3.597E-13	1.039E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OPu-239	Pu-239	Pu-239	Pu-239	6.018E+00	5.977E+00	5.895E+00	5.608E+00	4.792E+00	1.969E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OU-235	Pu-239	Pu-239	Pu-239	1.216E-08	3.632E-08	8.401E-08	2.441E-07	6.429E-07	1.200E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	U-235	U-235	U-235	6.291E-03	6.250E-03	6.169E-03	5.888E-03	5.116E-03	2.487E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	ADOSE(j)			6.291E-03	6.250E-03	6.169E-03	5.888E-03	5.116E-03	2.489E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OPa-231	Pu-239	Pu-239	Pu-239	8.164E-14	5.673E-13	2.948E-12	2.479E-11	1.730E-10	7.217E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	U-235	U-235	U-235	6.339E-08	1.885E-07	4.311E-07	1.204E-06	2.812E-06	3.215E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	ADOSE(j)			6.339E-08	1.885E-07	4.311E-07	1.204E-06	2.812E-06	3.215E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

ONuclide (j)	Parent (i)	THF(i)	t=	DOSE(j,t), mrem/yr									
AA-227	AA-227	AA-227	AA-227	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	AA-227	AA-227
Ac-227	Pu-239	1.000E+00	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	U-235	1.000E+00	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	ADOSE(j)		AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	Sr-90	1.000E+00	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	U-238	5.400E-05	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	U-238	9.999E-01	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	ADOSE(j)		AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	ADOSE(j)		AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227
Ac-227	ADOSE(j)		AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227	AA-227

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

ONuclide	Parent (j)	THF (i)	t=	S (j, t), pCi/g							
Am-241	Am-241	Am-241	2.840E+02	2.805E+02	2.737E+02	2.510E+02	1.961E+02	8.262E+01	6.993E+00	1.233E-03	
Am-241	Am-241	Am-241	0.000E+00	9.138E-05	2.706E-04	8.615E-04	2.276E-03	5.024E-03	6.014E-03	3.445E-03	
Am-241	Am-241	Am-241	0.000E+00	2.000E-10	1.779E-09	1.893E-08	1.523E-07	1.154E-06	3.972E-06	4.135E-06	
U-233	U-233	U-233	2.420E+00	2.410E+00	2.389E+00	2.318E+00	2.125E+00	1.570E+00	6.612E-01	3.204E-02	
U-233	U-233	U-233	0.000E+00	6.304E-15	1.687E-13	6.060E-12	1.501E-10	4.169E-09	5.487E-08	3.494E-07	
Th-229	Th-229	Th-229	0.000E+00	2.280E-04	6.811E-04	2.235E-03	6.420E-03	1.846E-02	3.773E-02	4.830E-02	
Th-229	Th-229	Th-229	0.000E+00	2.280E-04	6.811E-04	2.235E-03	6.420E-03	1.846E-02	3.773E-02	4.830E-02	
Cs-137	Cs-137	Cs-137	5.140E+00	5.022E+00	4.795E+00	4.078E+00	2.565E+00	5.075E-01	4.949E-03	4.531E-10	
Eu-152	Eu-152	Eu-152	1.564E+00	1.484E+00	1.337E+00	9.275E-01	3.261E-01	8.406E-03	2.428E-07	3.142E-23	
Eu-152	Eu-152	Eu-152	6.059E-01	5.750E-01	5.179E-01	3.593E-01	1.263E-01	3.256E-03	9.403E-08	1.217E-23	
Eu-152	Eu-152	Eu-152	2.170E+00	2.060E+00	1.855E+00	1.287E+00	4.524E-01	1.166E-02	3.368E-07	4.360E-23	
Eu-152	Eu-152	Eu-152	0.000E+00	3.788E-15	1.079E-14	3.024E-14	5.860E-14	7.244E-14	6.911E-14	5.750E-14	
Pu-238	Pu-238	Pu-238	5.140E+00	5.099E+00	5.018E+00	4.744E+00	4.042E+00	2.308E+00	4.651E-01	1.710E-03	
Pu-238	Pu-238	Pu-238	5.140E+00	5.099E+00	5.018E+00	4.744E+00	4.042E+00	2.308E+00	4.651E-01	1.710E-03	
U-234	U-234	U-234	0.000E+00	1.448E-05	4.291E-05	1.370E-04	3.635E-04	7.910E-04	7.231E-04	5.110E-05	
U-234	U-234	U-234	0.000E+00	3.105E-06	9.234E-06	2.986E-05	8.217E-05	2.024E-04	2.558E-04	4.140E-05	
U-234	U-234	U-234	0.000E+00	1.759E-05	5.215E-05	1.669E-04	4.457E-04	9.934E-04	9.789E-04	9.250E-05	
U-234	U-234	U-234	0.000E+00	6.532E-11	5.830E-10	6.295E-09	5.224E-08	4.405E-07	1.937E-06	3.650E-06	
Th-230	Th-230	Th-230	0.000E+00	1.399E-11	1.252E-10	1.364E-09	1.159E-08	1.057E-07	5.581E-07	1.386E-06	
Th-230	Th-230	Th-230	0.000E+00	7.931E-11	7.083E-10	7.659E-09	6.383E-08	5.467E-07	2.495E-06	5.036E-06	
Pa-226	Pa-226	Pa-226	0.000E+00	9.434E-15	2.527E-13	9.103E-12	2.272E-10	6.421E-09	8.362E-08	3.899E-07	
Pa-226	Pa-226	Pa-226	0.000E+00	2.021E-15	5.423E-14	1.966E-12	4.996E-11	1.500E-09	2.263E-08	1.405E-07	
Pa-226	Pa-226	Pa-226	0.000E+00	1.145E-14	3.069E-13	1.107E-11	2.772E-10	7.921E-09	1.062E-07	5.304E-07	
Pa-226	Pa-226	Pa-226	0.000E+00	7.289E-17	5.789E-15	6.679E-13	4.486E-11	3.055E-09	6.388E-08	3.581E-07	
Pb-210	Pb-210	Pb-210	0.000E+00	1.561E-17	1.242E-15	1.440E-13	9.817E-12	7.052E-10	1.701E-08	1.282E-07	
Pb-210	Pb-210	Pb-210	0.000E+00	8.849E-17	7.030E-15	8.119E-13	5.467E-11	3.760E-09	8.090E-08	4.863E-07	
Opu-239	Pu-239	Pu-239	4.550E+02	4.549E+02	4.548E+02	4.544E+02	4.531E+02	4.488E+02	4.367E+02	3.967E+02	
Opu-239	Pu-239	Pu-239	0.000E+00	4.471E-07	1.335E-06	4.383E-06	1.258E-05	3.612E-05	7.349E-05	9.196E-05	
U-235	U-235	U-235	1.160E-01	1.155E-01	1.145E-01	1.111E-01	1.019E-01	7.531E-02	3.174E-02	1.542E-03	
U-235	U-235	U-235	1.160E-01	1.155E-01	1.145E-01	1.111E-01	1.019E-01	7.534E-02	3.181E-02	1.634E-03	
OpPa-231	Pu-239	Pu-239	0.000E+00	4.727E-12	4.229E-11	4.604E-10	3.909E-09	3.553E-08	1.854E-07	4.331E-07	
Pa-231	U-235	U-235	0.000E+00	2.444E-06	7.268E-06	2.350E-05	6.466E-05	1.592E-04	2.008E-04	3.229E-05	
Pa-231	U-235	U-235	0.000E+00	2.444E-06	7.268E-06	2.350E-05	6.466E-05	1.592E-04	2.008E-04	3.229E-05	

Individual Nuclide Soil Concentration

Parent Nuclide		and Branch Fraction Indicated		S(j,t), pCi/g	
ONuclide	Parent	THF(i)	t=	0.000E+00	1.000E+00
(j)	(i)				
AA-227	Pu-239	1.000E+00	AA-227	1.000E+01	3.000E+01
Ac-227	U-235	1.000E+00	Ac-227	1.000E+02	3.000E+02
Ac-227	As(j):		Ac-227	1.000E+03	1.000E+03
OSr-90	Sr-90	1.000E+00	OSr-90	1.000E+04	1.000E+04
OU-238	U-238	5.400E-05	OU-238	1.000E+05	1.000E+05
U-238	U-238	9.999E-01	U-238	1.000E+06	1.000E+06
U-238	As(j):		U-238	1.000E+07	1.000E+07
íííííí	íííííí	íííííí	íííííí	íííííí	íííííí
THF(i) is the thread fraction of the parent nuclide.					
ORSCALC.EXE execution time = 2.42 seconds					

Appendix D

Closure Activity Summary
(Use Restriction)

D.1.0 Closure Activity Summary

The following sections document closure activities completed at CASs 03-08-03, 03-23-05, and 20-19-01, including verification activities and supporting documents. Closure activities were not necessary at the five other CASs of CAU 545 and are not discussed in this appendix.

D.1.1 CAS 03-08-03 Closure Activities

For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the DQO meeting participants agreed that sufficient information was available about disposal and releases at the site and recommended that a corrective action of close in place with a UR. Sampling in the craters was not considered necessary. The radiological contamination is estimated to be comprised of isotopic U, isotopic Pu, fission products, and decay products.

The corrective action of closure in place with a UR was accomplished by securing the site against unauthorized entry through the repair of fencing at the site and by securing 14 UR signs (Figures D.1-1 and D.1-3) to the fencing at intervals of approximately 200 ft. The post-closure activities for this CAS include annual inspections of the postings.

D.1.2 CAS 03-23-05 Closure Activities

For CAS 03-23-05, existing information about the two buried sources and lead pig was considered to be sufficient, and safety concerns existed about the stability of the crater component. Therefore, a corrective action of close in place with a UR was recommended, and sampling at the site was not considered necessary.

The corrective action of close in place with a UR was accomplished by securing the site against unauthorized entry by attaching seven UR signs (Figures D.1-2 and D.1-4); four at each of the four sides of the fencing surrounding the burial site for the Pa-233 source and lead pig, and three at locations, at intervals of approximately 200 ft, on the fencing surrounding the burial site for the Eu-152 source. The post-closure activities for this CAS include annual inspections of the postings.



Figure D.1-1
CAS 03-08-03 Use Restriction Posting



Figure D.1-2
CAS 03-23-05 Use Restriction Postings

D.1.3 CAS 20-19-01 Closure Activities

For CAS 20-19-01, a corrective action of removal of the used oil filters was conducted to remove this PSM from the site. Also removed from the site was a grease canister and soil impacted by the oil filters.

D.1.4. Disposition of Drummed IDW for CAU 545

Eight drums of IDW from all CASs were generated as a result of this investigation. Four drums were emptied into the A23 Lagoons (see [Attachment D-1](#) for Load Verification Form and Waste Manifest). Three drums containing solids were disposed of at the U10c Industrial Landfill (see [Attachment D-1](#) for Load Verification Form). One drum containing hydrocarbon waste from CAS 20-19-01 was disposed of at the Area 6 Hydrocarbon Landfill (see [Attachment D-1](#) for Load Verification Form).

CAU Use Restriction Information

CAU Number/Description: CAU 545. Dumps, Waste Disposal Sites, and Buried Radioactive Materials

Applicable CAS Number(s)/Description(s): CAS 03-08-03. Mud Disposal Site

Contact (organization/project): NNSA/NSO Industrial Sites Federal Sub-Project Director

Surveyed Area (UTM, Zone 11, NAD 27, meters):

Southeast Side:	N = 4099841.21;	E = 586324.48
SSE Side:	N = 4099798.78;	E = 586286.57
South Side:	N = 4099784.64;	E = 586249.80
SSW Side:	N = 4099794.82;	E = 586193.80
Southwest Side:	N = 4099825.37;	E = 586149.68
WSW Side:	N = 4099946.43;	E = 586077.83
West Side:	N = 4099984.90;	E = 586068.78
WNW Side:	N = 4100019.40;	E = 586070.48
Northwest Side:	N = 4100060.70;	E = 586102.16
NNW Side:	N = 4100081.63;	E = 586141.19
North Side:	N = 4100072.01;	E = 586195.50
NNE Side:	N = 4100061.83;	E = 586226.04
Northeast Side:	N = 4100042.60;	E = 586243.58
ENE Side:	N = 4099991.12	E = 586270.73
East Side:	N = 4099929.46;	E = 586330.70
ESE Side:	N = 4099896.65;	E = 586336.92

Survey Date: December 2007

Survey Method (GPS, etc): Heads-up digitizing

Site Monitoring Requirements: Inspection of postings

Required Frequency (quarterly, annually?): Annual

If Monitoring Has Started, Indicate last Completion Date: Not Applicable

Use Restrictions

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU Closure Report or other CAU 545 documentation, unless appropriate concurrence is obtained in advance.

Comments: This UR is for the surface and subsurface disturbances. The use restricted area is fenced and identified with signs at approximately 200-ft intervals for the CAS. Coordinates for the

area will be entered into the NTS database. Annual post-closure inspections will be conducted to ensure postings are in place, intact, and readable. See the CADD/CR for additional information on the condition of the site. The radiological contamination is estimated to be comprised of isotopic uranium, isotopic plutonium, fission products, and decay products.

Submitted By: Kevin Cabbala Date: 3-27-08

cc with copy of survey map (paper and digital (.dgn) formats):
CAU Files (2 copies)

The use restriction signs state the following information:

WARNING
Radiologically Contaminated Area
FFACO Site CAU 545/CAS 03-08-03
CAS 03-08-03 Mud Disposal Site
No activities that alter or modify the containment control are permitted without U.S. Government
permission.
Before working in this area,
Contact Real Estate Services at 295-2528

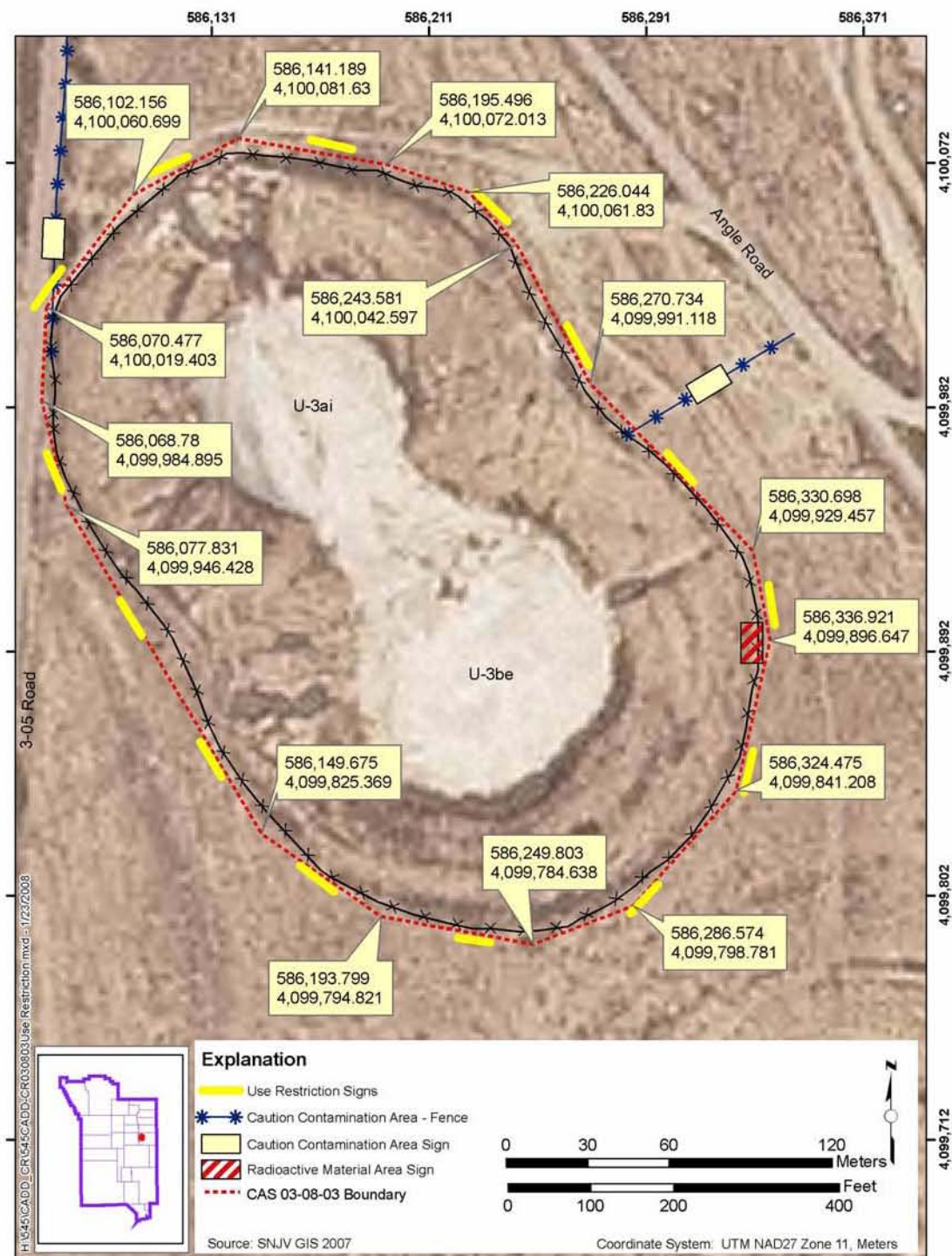


Figure D.1-3
CAS 03-08-03 Land Use Restriction Boundary

CAU Use Restriction Information

CAU Number/Description: CAU 545. Dumps, Waste Disposal Sites, and Buried Radioactive Materials

Applicable CAS Number(s)/Description(s): CAS 03-23-05. Europium Disposal Site

Contact (organization/project): NNSA/NSO Industrial Sites Federal Sub-Project Director

Surveyed Area (UTM, Zone 11, NAD 27, meters):

Pa-233 and Lead Pig Burial Site:

Southeast Corner: N = 4100485.18; E = 587905.89
Southwest Corner: N = 4100484.50; E = 587892.69
Northwest Corner: N = 4100498.60; E = 587892.24
Northeast Corner: N = 4100499.28; E = 587905.67

Eu-235 Burial Site:

Southeast Side: N = 4100403.26; E = 587980.42
South Side: N = 4100397.22; E = 587966.55
SSW Side: N = 4100398.11; E = 587952.67
Southwest Side: N = 4100407.96; E = 587938.79
West Side: N = 4100430.12; E = 587938.12
Northwest Side: N = 4100443.99; E = 587949.31
North Side: N = 4100446.46; E = 587968.78
Northeast Side: N = 4100439.52; E = 587980.65
East Side: N = 4100419.15; E = 587988.26

Survey Date: December 2007

Survey Method (GPS, etc): Heads-up digitizing

Site Monitoring Requirements: Inspection of postings

Required Frequency (quarterly, annually?): Annual

If Monitoring Has Started, Indicate last Completion Date: Not Applicable

Use Restrictions

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU Closure Report or other CAU 545 documentation, unless appropriate concurrence is obtained in advance.

Comments: This UR is for the surface and subsurface disturbances. The use restricted area is fenced. Signs, at approximately 200-ft intervals for the CAS, have been placed to notify personnel

visiting the site, as required by this UR. Coordinates for the area will be entered into the NTS database. Annual post-closure inspections will be conducted to ensure postings are in place, intact, and readable. See the CADD/CR for additional information on the condition of the site. Contaminants present at the site, as potential source materials, include lead (i.e., in the form of a lead "pig"), a europium-152 source (i.e., and decay product gadolinium-152), and a protactinium-233 source (i.e., and decay product uranium-233).

Submitted By: Kevin Cabbie Date: 3-27-08

cc with copy of survey map (paper and digital (.dgn) formats):
CAU Files (2 copies)

The use restriction signs state the following information:

WARNING
Underground Radiological and Lead Contaminated Area
FFACO Site CAU 545/CAS 03-23-05
CAS 03-23-05 Europium Disposal Site
No activities that alter or modify the containment control are permitted without U.S. Government
permission.
Before working in this area,
Contact Real Estate Services at 295-2528

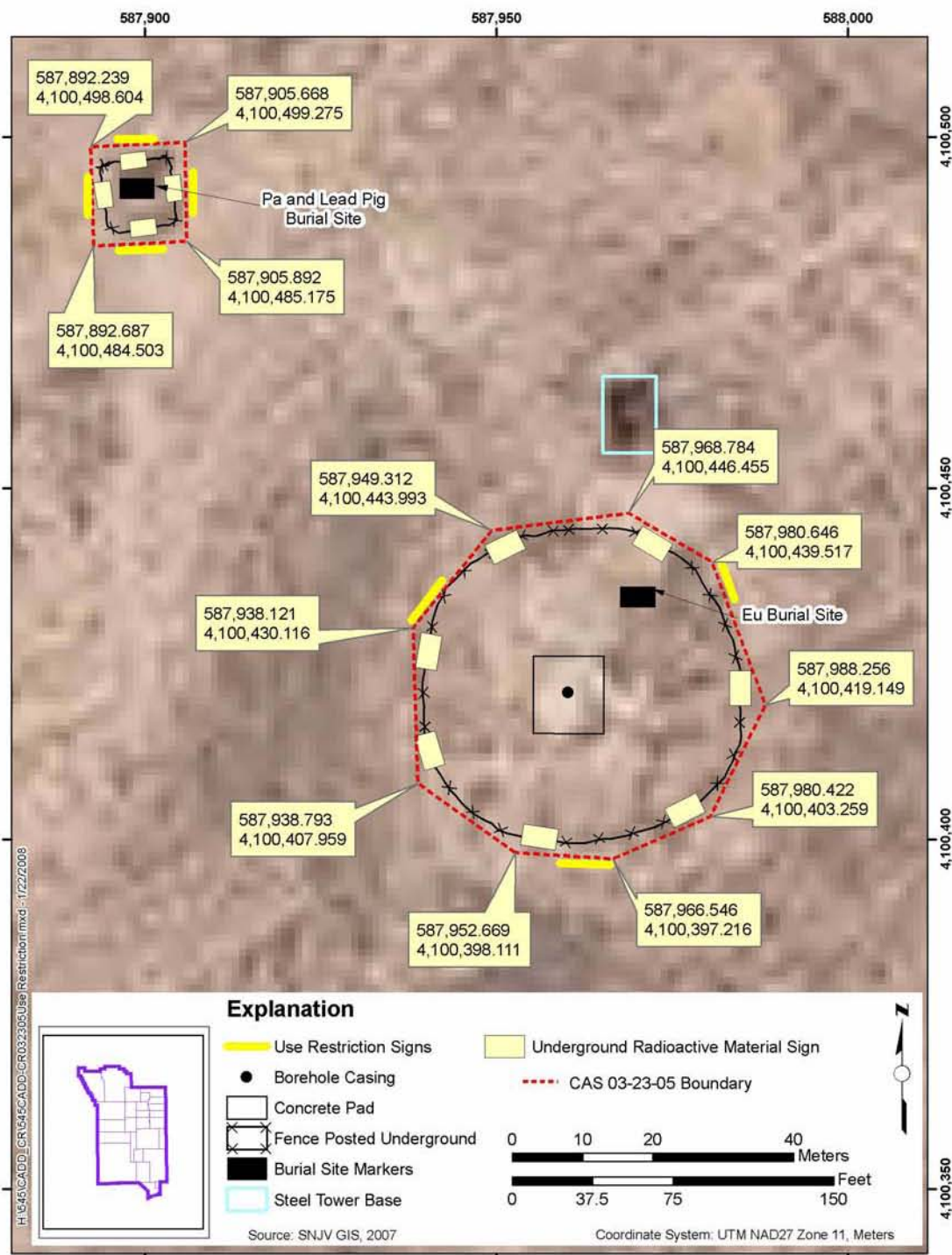


Figure D.1-4
CAS 03-23-05 Land Use Restriction Boundary

D.2.0 References

SNJV GIS, see Stoller-Navarro Joint Venture Geographic Information Systems.

Stoller-Navarro Joint Venture Geographic Information Systems. 2007. ESRI ArcGIS Software.

Attachment D-1

Disposition of IDW

(3 Pages)

NSTec

Form

FRM-0918

NTS LANDFILL LOAD VERIFICATION

08/23/06

Rev. 0

Page 1 of 2

SWO USE (Select One) AREA ☐ 23 ☒ 6 ☒ LANDFILL

For waste characterization, approval, and/or assistance, contact Solid Waste Operation (SWO) at 5-7898.

REQUIRED: WASTE GENERATOR INFORMATION

(This form is for rollofs, dump trucks, and other onsite disposal of materials.)

Waste Generator: Rene Robles (SNJV, WO) Phone Number: 5-2100

Location / Origin: CAU 545, CAS 20-19-01, Area 20; 1 Drum (Oil stained material and soil) SNN0719

Waste Category: (check one) ☐ Commercial ☒ Industrial

Waste Type: ☐ NTS ☐ Putrescible ☒ FFACO-onsite ☐ WAC Exception
(check one) ☐ Non-Putrescible ☐ Asbestos Containing Material ☐ FFACO-offsite ☐ Historic DOE/NV

Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP

Pollution Prevention Category: (check one) ☒ Clean-Up ☐ Routine

Method of Characterization: (check one) ☒ Sampling & Analysis ☒ Process Knowledge ☐ Contents

Prohibited Waste at all three NTS landfills: Radioactive waste; RCRA waste; Hazardous waste; Free liquids, PCBs above TSCA regulatory levels, and Medical wastes (needles, sharps, bloody clothing).

Additional Prohibited Waste at the Area 9 U10C Landfill: Sewage Sludge, Animal carcasses, Wet garbage (food waste); and Friable asbestos

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES

Check all allowable wastes that are contained within this load:

NOTE: Waste disposal at the Area 6 Hydrocarbon Landfill must have come into contact with petroleum hydrocarbons or coolants, such as: gasoline (no benzene, lead); jet fuel; diesel fuel; lubricants and hydraulics; kerosene; asphaltic petroleum hydrocarbon; and ethylene glycol.

Acceptable waste at any NTS landfill: ☐ Paper ☐ Rocks / unaltered geologic materials ☐ Empty containers
☐ Asphalt ☐ Metal ☐ Wood ☐ Soil ☐ Rubber (excluding tires) ☐ Demolition debris
☐ Plastic ☐ Wire ☐ Cable ☐ Cloth ☐ Insulation (non-Asbestosform) ☐ Cement & concrete
☐ Manufactured items: (swamp coolers, furniture, rugs, carpet, electronic components, PPE, etc.)

Additional waste accepted at the Area 23 Mercury Landfill: ☐ Office Waste ☐ Food Waste ☐ Animal Carcasses
☐ Asbestos ☐ Friable ☐ Non-Friable (contact SWO if regulated load) Quantity: _____

Additional waste accepted at the Area 9 U10c Landfill:

☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water
☐ Light ballasts (contact SWO) ☐ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above
☐ Hydrocarbons (contact SWO) ☐ Other _____ Ground Tanks

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐

☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☒ Crushed non-teme plated oil filters
☐ Plants ☒ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: _____ (If initialed, no radiological clearance is necessary.)

The above mentioned waste was generated outside of a Controlled Waste Manag knowledge, does not contain radiological materials.

To the best of my knowledge, the waste described above contains only those ma site. I have verified this through the waste characterization method identified ab prohibited and allowable waste items. I have contacted Property Management an is approved for disposal in the landfill.

Radiological Survey Release for Waste Disposal
RCT Initials

This container/load meets the criteria for no added man-made radioactive material

This container/load meets the criteria for Radcon Manual Table 4.2 release limits.

This container/load is exempt from survey due to process knowledge and origin.

SIGNATURE: Chao-Hsiung Tung DATE: 1/24/08

BN-5548 (10/03)

Print Name: Joe Molter

Signature: /s/ Joe Molter

Date: 1/24/08

"Radiological Release Sticker"
here. Onsite use only.

Note: "Food waste, office trash and animal carcasses do not require a radiological clearance. Freon-containing appliances must have signed removal certification statement with Load Verification."

SWO USE ONLY

Load Weight (net from scale or estimate): 20 lbs Signature of Certifier: Jim Wadley

NTS LANDFILL LOAD VERIFICATION

SWO USE (Select One) AREA ☐ 23 ☐ 6 ☒ 9 ☒ LANDFILL

For waste characterization, approval, and/or assistance, contact Solid Waste Operation (SWO) at 5-7898.

REQUIRED: WASTE GENERATOR INFORMATION

(This form is for rollofs, dump trucks, and other onsite disposal of materials.)

Waste Generator: Rene Robles (SNJV, WO) Phone Number: 5-2100

Location / Origin: CAU 545, CAS 02-09-01, Area 2; 2 Drums (Solidified Liquid) 545A01 and 545A02

Waste Category: (check one) ☐ Commercial ☒ Industrial
Waste Type: ☐ NTS ☐ Putrescible ☒ FFACO-onsite ☐ WAC Exception
(check one) ☐ Non-Putrescible ☐ Asbestos Containing Material ☐ FFACO-offsite ☐ Historic DOE/NV
Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP
Pollution Prevention Category: (check one) ☒ Clean-Up ☐ Routine
Method of Characterization: (check one) ☒ Sampling & Analysis ☒ Process Knowledge ☐ Contents

Prohibited Waste at all three NTS landfills: Radioactive waste; RCRA waste; Hazardous waste; Free liquids, PCBs above TSCA regulatory levels, and Medical wastes (needles, sharps, bloody clothing).

Additional Prohibited Waste at the Area 9 U10C Landfill: Sewage Sludge, Animal carcasses, Wet garbage (food waste); and Friable asbestos

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES

Check all allowable wastes that are contained within this load:

NOTE: Waste disposal at the Area 6 Hydrocarbon Landfill must have come into contact with petroleum hydrocarbons or coolants, such as: gasoline (no benzene, lead); jet fuel; diesel fuel; lubricants and hydraulics; kerosene; asphaltic petroleum hydrocarbon; and ethylene glycol.

Acceptable waste at any NTS landfill: ☐ Paper ☐ Rocks / unaltered geologic materials ☐ Empty containers
☐ Asphalt ☐ Metal ☐ Wood ☐ Soil ☐ Rubber (excluding tires) ☐ Demolition debris
☐ Plastic ☐ Wire ☐ Cable ☐ Cloth ☐ Insulation (non-Asbestosform) ☐ Cement & concrete
☐ Manufactured items: (swamp coolers, furniture, rugs, carpet, electronic components, PPE, etc.)

Additional waste accepted at the Area 23 Mercury Landfill: ☐ Office Waste ☐ Food Waste ☐ Animal Carcasses
☐ Asbestos ☐ Friable ☐ Non-Friable (contact SWO if regulated load) Quantity: _____

Additional waste accepted at the Area 9 U10c Landfill:

☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water
☐ Light ballasts (contact SWO) ☐ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above
☐ Hydrocarbons (contact SWO) ☒ Other Solidified Rinsate Ground Tanks

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐

☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☐ Crushed non-teme plated oil filters
☐ Plants ☐ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: _____ (If initialed, no radiological clearance is necessary.)

The above mentioned waste was generated outside of a Controlled Waste Man knowledge, does not contain radiological materials.

To the best of my knowledge, the waste described above contains only those prohibited and allowable waste items. I have contacted Property Management is approved for disposal in the landfill.

Print Name: Joe Molter

Signature: /s/ Joe Molter

Date: 1/31/08

Radiological Survey Release for Waste Disposal
RCR Initials

☒ This container/load meets the criteria for no added man-made radioactive material
☒ This container/load meets the criteria for Radcon Manual Table 4.2 release limits.
☐ This container/load is exempt from survey due to process knowledge and origin.

SIGNATURE: Chao-Hsiung Tung DATE: 1/31/08

BN-0048 (10/95)

"Radiological Release Sticker"
here. Onsite use only.

Note: "Food waste, office trash and animal carcasses do not require a radiological clearance. Freon-containing appliances must have signed removal certification statement with Load Verification."

SWO USE ONLY

Load Weight (net from scale or estimate):

400

Signature of Certifier: /s/ Jim Wadley

Shipper: NSTec FOR USDOE

Shipper No.: _____

Nevada Test Site, Receiving Warehouse 160, Mercury, NV 89021

Date: _____

Purchase/Customer Order No. _____

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown) marked, consigned, and destined shown below, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any said property over all or any portion of said route to destination, and as to each party as any time hereinafter in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Freight Bill of Lading set forth (1) in Uniform Freight Classification in effect on the date hereof, if this is a rail or air-water shipment, or (2) to the applicable motor carrier classification or tariff if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back hereof, set forth in the classification or tariff which governs the transportation of this shipment and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consignee:		Carrier
Stoller-Navarro Joint Venture		NSTech Sanitary Waste Operations
CAU 545 IDW Rinsate removal		PRD NO.:
		CAR OR VEHICLE INITIALS & NO.:
		SEAL NO.:

Route:		CARRIER NO.		SECTION 13712 TENDER NO.1			
No. PKGS.	HM	Description of Articles (Subject to Correction), Kind of Package, Special Marks and Exemptions (See NMFC item, Rule 2001)	Weight (Subject to Correction)	Chgs	Rate	Charges	Subject to Section 7 of conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges. NSTec Signature of Consignor If freight charges are to be prepaid write or stamp here "TO BE PREPAID" TO BE PREPAID Note: When the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per lb. * Job order, reference, account, or work order number
1		Sanitary Rinsate, 1, 10 gallon DM Drum Number: SNN0723					

IN THE EVENT OF AN EMERGENCY, PHONE _____

* 24 HOUR

ITEM NO.	NMFC 100-	NPM NO.		

Remarks: (If you receive this shipment damaged, please note immediately receipt. Contact NSTec Traffic at (702) 295-3266, Reference Shippers Number).

For SNJV tracking purposes.

TECHNICAL CONTACT: Rene Robles

Jim Wadley

This is to certify that the above named property is properly classified, described, packaged, marked, and labeled, and is in proper condition for transportation according to the applicable regulations of the Department of Transportation. (Applicable for Hazardous Materials Only.)

This shipment is for U.S. Department of Energy and the actual total transportation charges paid to the carrier(s) by the consignor or consignee are refundable to, and shall be reimbursed by, the U.S. Government and is subject to the terms and conditions set forth in the standard form of the U.S. Government Bill of Lading and to any available special rates or charges (41 CFR 101-40.60 and 41 CFR 40.3)

☐ YES ☐ NO
Shipper: NSTec FOR USDOE

* The addition on the back hereof and to the terms and conditions are hereby noted

Acting under contract DCA00088NV1718 with U.S. Dept of Energy

Carrier: _____ Date: _____

Per: _____ Date: _____
 P. O. Box 98521, Las Vegas, NV 89193
 TRANSPORTATION DEPT. - Permanent Post Office Address of Shipper

Per: _____ Date: _____

Page 1 of 1

FRM-0040 (08/08)

Appendix E

Sample Location Coordinates

E.1.0 Sample Location Coordinates

Probabilistic sample location coordinates for CAS 03-17-01 were determined by VSP software, version 4.0. Judgmental sample location coordinates for the CAI sampling were measured using a Trimble Pro XRS unit (a portion of CAS 03-17-01 and all of CAS 20-19-01), and a Trimble Geo XT GPS unit (a portion of CAS 03-17-01, and all of CASs 02-09-01, 03-99-14, and 09-23-02). These coordinates identify the Decision I and II sampling locations (easting and northing positions) at CAU 545 listed in [Table E.1-1](#).

Table E.1-1
Sample Location Coordinates
(Page 1 of 4)

Easting	Northing	Samples Location
CAS 02-09-01		
582613.85	4111858.43	A01
582652.31	4111844.61	A02
582740.92	4111717.35	A03
582749.90	4111696.77	A04
582806.20	4111671.82	A05
582823.36	4111701.85	A06
582911.73	4111754.34	A07
582935.82	4111767.09	A08
CAS 03-17-01		
588173.07	4100437.82	B01
588185.48	4100437.82	B02
588166.87	4100448.56	B03
588179.28	4100448.56	B04
588191.69	4100448.56	B05
588204.10	4100448.56	B06
588173.07	4100459.31	B07
588185.48	4100459.31	B08
588197.89	4100459.31	B09
588166.87	4100470.06	B10
588179.28	4100470.06	B11
588191.69	4100470.06	B12

Table E.1-1
Sample Location Coordinates
(Page 2 of 4)

Easting	Northing	Samples Location
588278.85	4100531.69	B13
588294.33	4100456.52	B14
588351.69	4100507.51	B15
588236.98	4100405.53	B16
588282.77	4100368.47	B17
588281.65	4100412.18	B18
588309.82	4100381.36	B19
588367.17	4100432.35	B20
588440.00	4100408.17	B21
588512.83	4100384.00	B22
588424.52	4100483.34	B23
588497.35	4100459.16	B24
588409.04	4100558.50	B25
588481.87	4100534.32	B26
588492.64	4100568.19	B27
588409.55	4100493.24	B28
588454.18	4100495.31	B29
588459.23	4100554.06	B30
588183.20	4100480.76	B31
588160.63	4100458.43	B32
588181.76	4100431.69	B33
588205.51	4100454.02	B34
588481.32	4100588.67	B35
588510.65	4100572.20	B36
588515.14	4100481.64	B37
588515.98	4100443.34	B38
588268.19	4100591.54	B39
588199.56	4100514.24	B40
588203.22	4100411.48	B41
588293.02	4100334.80	B42
588542.61	4100447.76	B43

Table E.1-1
Sample Location Coordinates
(Page 3 of 4)

Easting	Northing	Samples Location
588472.75	4100334.54	B44
588538.96	4100545.05	B45
588478.37	4100616.47	B46
CAS 03-99-14		
587106.70	4099638.64	C01
587082.51	4099625.29	C02
587050.24	4099624.82	C03
587006.19	4099628.63	C04
586964.67	4099638.44	C05
587083.03	4099641.41	C06
587058.36	4099641.57	C07
587030.20	4099641.47	C08
586999.43	4099641.22	C09
587000.02	4099637.15	C10
587031.24	4099637.44	C11
587059.53	4099637.57	C12
587085.60	4099637.82	C13
CAS 09-23-02		
583924.89	4109444.81	D01
583950.40	4109437.73	D02
583975.54	4109411.30	D03
583987.74	4109402.17	D04
583931.42	4109431.23	D05
583970.65	4109419.08	D06
CAS 20-19-01		
542373.51	4132513.34	E01
542378.90	4132514.68	E02
542376.42	4132509.95	E03
542374.11	4132500.47	E04
542366.57	4132504.36	E05
542372.56	4132517.37	E06
542370.50	4132517.67	E07

Table E.1-1
Sample Location Coordinates
(Page 4 of 4)

Easting	Northing	Samples Location
542372.73	4132526.29	E08
542376.73	4132519.78	E09
542374.48	4132525.12	E10

Coordinate system: UTM, NAD 27, Zone 11, meters

Appendix F

Nevada Division of Environmental Protection Comments

(2 Pages)

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials, Nevada Test Site, Nevada	2. Document Date:	02/01/2008
3. Revision Number:	0	4. Originator/Organization:	Stoller-Navarro
5. Responsible NNSA/NV ERP Project Manager:	Kevin J. Cabbie	6. Date Comments Due:	03/03/2008
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No: Dennis Nicodemus, NDEP, 486-2850			
9. Reviewer's Signature:			

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Section 2.2.1.5 Waste Disposal Site	Mandatory	Include reference to Table C.1-3 in this section.	The reference has been added to the end of the third sentence.	
2.) Section 2.3 Justification for No Further Action	Mandatory	Include a statement explaining why a BMP was not performed at 20-19-01. Include appropriate referenced documents.	The following information has been added to Section 2.3: "Based on the results of the investigation the remaining debris at CAS 20-19-01 was determined to not require corrective action. Soil samples were collected beneath debris at locations identified as most likely to contain COCs. No COCs were identified; therefore, there is no indication that the debris is contributing contaminants to the soil at concentrations that would require corrective action. Because removal of the debris from the potential crater area may pose a health and safety risk to workers (Pawloski, 2003) the debris was left in place."	
3.) Table 2-4	Mandatory	Bold or otherwise denote Pu 239/240 result and provide reference back to Section 2.2.1.3.	The result has been converted to bold font, and the following footnote has been added to Table 2-4: "The only exceedence of the PAL for Pu-239/240 was identified in a sample taken from a background location for the purpose of measuring the impact from nearby atmospheric testing (Section 2.2.1.3). This result is not associated with CAS 03-99-14, and is only included in the table for completeness. The area containing the background locations will be addressed by the Soils Project, CAS 03-23-10."	

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
4.) Table 2-2	Mandatory	Include units for mean values.	The units have been added to the table, and the word "mean" has been changed to "average" for a broader understanding.	
5.) Section 2.3.1 Final Action Levels; pg 30 4th and 6th paragraphs	Mandatory	Wrong CAU is used. Remove reference to TPH-GRO because a Tier II evaluation was only done for TPH-DRO.	The CAU number has been corrected to list "545". The reference to TPH-GRO has been removed.	
6.) Table C.1-1	Mandatory	Bold maximum values over the PALs (DRO at 20-19-001 & Pu 239/240 at 3-17-01).	The maximum values for DRO at CAS 20-19-01, and Am-241 and Pu-239/240 at CAS 03-17-01 have been put into bold font.	
7.) Section C.1.10 J	Mandatory	Rewrite first paragraph. Suggest just using TPH instead of TPH-DRO for first 2 sentences. Then state the PAL was exceeded for TPH-DRO and thus the individual potentially hazardous constituents of TPH-DRO were examined. If a statement is taken from a standard and in quotes it must have the same language.	All references to TPH-DRO in the first two sentences have been changed to TPH. Also, following the third sentence in that paragraph (ending with "will be evaluated for risk in place of TPH-DRO."), the following sentence has been added: "The PAL for TPH-DRO was exceeded at CAS 20-19-01."	

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