Nevada
Environmental
Restoration
Project

DOE/NV--506-Rev. 1

Corrective Action Investigation Plan
for Corrective Action Unit 143:
Area 25 Contaminated Waste Dumps,
Nevada Test Site, Nevada

Controlled Copy No.: ____

Revision No.: 1

June 1999

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**CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 143:
AREA 25 CONTAMINATED WASTE DUMPS,
NEVADA TEST SITE, NEVADA**

DOE Nevada Operations Office
Las Vegas, Nevada

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**CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 143:
AREA 25 CONTAMINATED WASTE DUMPS,
NEVADA TEST SITE, NEVADA**

Approved by: _____ Date: _____

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List of Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site(s)
CAU	Corrective Action Unit(s)
CFR	<i>Code of Federal Regulations</i>
cm	Centimeter(s)
⁶⁰ Co	Cobalt-60
COPC	Contaminant(s) of potential concern
CPT	Cone Penetrometer
¹³⁷ Cs	Cesium-137
CWD	Contaminated Waste Dump(s)
D&D	Decontamination and decommissioning
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DOT	U.S. Department of Transportation
DQO	Data Quality Objective(s)
E-MAD	Engine Maintenance Assembly and Disassembly Facility
EPA	U.S. Environmental Protection Agency
¹⁵² Eu	Europium-152
FID	Flame ionization detector
FFACO	<i>Federal Facility Agreement and Consent Order</i>
ft	Foot (feet)
GC/MS	Gas chromatograph/mass spectrometer
GPR	Ground penetrating radar

List of Acronyms and Abbreviations (Continued)

HASP	Health and Safety Plan
IDW	Investigation-derived waste
in.	Inch(es)
INEEL	Idaho National Environmental Engineering Laboratory
ITLV	IT Corporation, Las Vegas Office
km ²	Square kilometer(s)
LANL	Los Alamos National Laboratory
LLW	Low-level radioactive waste
m	Meter(s)
m ³	Cubic meter(s)
mi ²	Square mile(s)
MS/MSD	Matrix spike and matrix spike duplicate
NAC	<i>Nevada Administrative Code</i>
NAS	National Academy of Sciences
NASA	National Aeronautic and Space Administration
⁹⁴ Nb	Niobium-94
NDEP	Nevada Division of Environmental Protection
NEPA	<i>National Environmental Policy Act</i>
NRDA	Nevada Research and Development Area
NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site
NTSWAC	<i>Nevada Test Site Waste Acceptance Criteria</i>
PAL	Preliminary action level(s)
PID	Photoionization detector
PPE	Personal protective equipment
ppm	Part(s) per million

List of Acronyms and Abbreviations (Continued)

^{239}Pu	Plutonium-239
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
^{226}Ra	Radium-226
R-MAD	Reactor Maintenance Assembly and Disassembly Facility
RCRA	<i>Resource Conservation and Recovery Act</i>
REEC _o	Reynolds Electrical & Engineering Co., Inc.
RPD	Relative percent difference
SAIC	Science Applications International Corporation
SSHASP	<i>Site-Specific Health and Safety Plan</i>
SNPO	Space Nuclear Propulsion Office
^{90}Sr	Strontium-90
SVOC	Semivolatile organic compound(s)
TID	Tamper-indicating device(s)
TNT	Transient Nuclear Test
TPH	Total petroleum hydrocarbon(s)
TRU	Transuranic waste
^{234}U	Uranium-234
^{235}U	Uranium-235
USGS	U.S. Geological Survey
VOC	Volatile organic compound(s)
yd ³	Cubic yard(s)

Executive Summary

The Corrective Action Investigation Plan for Corrective Action Unit 143, Area 25 Contaminated Waste Dumps, has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO, 1996) that was agreed to by the U.S. Department of Energy, Nevada Operations Office; the State of Nevada Division of Environmental Protection; and the U.S. Department of Defense. Corrective Action Unit 143 consists of two Corrective Action Sites: 25-23-09, Contaminated Waste Dump #1 at the Reactor Maintenance Assembly and Disassembly Facility (R-MAD) and 25-23-03, Contaminated Waste Dump #2 at the Engine Maintenance Assembly and Disassembly Facility (E-MAD).

Solid radioactive wastes were disposed of at both waste dumps. At Contaminated Waste Dump #1, solid radioactive wastes were disposed of in five separate areas: a waste dump below a railroad trestle southeast of R-MAD facility, two sites west of the railroad berm, a mound in the southwest corner of R-MAD east, six trenches in R-MAD west, and a pit south of R-MAD west. At Contaminated Waste Dump #2, solid radioactive wastes were disposed of in a single trench located outside the southwestern corner of the facility.

Based on the site history and other information collected to support the Data Quality Objectives process, a conceptual site model for the Corrective Action Unit was developed as follows:

- The landfill disposal areas contain solid wastes contaminated with radioactivity.
- Radionuclides are the primary constituents of concern and are located in disposal areas.
- Vertical and lateral migration of contaminants of potential concern is not likely.
- If contaminant migration has occurred, it will be limited to the soil beneath the Contaminated Waste Dump disposal areas.

A more detailed conceptual model is presented in [Section 3.0](#) of this investigation plan. The conceptual model serves as the basis for the sampling strategy.

Geophysics have been completed to determine the location and extent of the waste disposal areas.

The site investigation includes the following activities:

- Performing Cone Penetrometer (CPT) testing within and/or near radioactive solid waste disposal sites
- Conducting field analyses for radiological constituents and volatile organic compounds with the instruments in the CPT
- Collecting confirmatory surface and subsurface environmental soil samples using CPT and/or sonic drilling
- Collecting geotechnical subsurface soil samples
- Collecting background and subsurface soil samples
- Collecting required quality control samples
- Surveying sampling locations and the Contaminated Waste Dumps

Samples will be collected for laboratory analysis at selected sites. Additional sampling and analytical details are presented in [Section 4.0](#) of this investigation plan. Details of the waste management strategy for the Corrective Action Unit are included in [Section 5.0](#).

Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. The field work will be conducted following approval of the plan. The results of the field investigation will support a defensible evaluation of corrective action alternatives in the Corrective Action Decision Document.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the U.S. Department of Energy, Nevada Operations Office (DOE/NV); the State of Nevada Division of Environmental Protection (NDEP); and the U.S. Department of Defense (FFACO, 1996). The CAIP is a document that provides or references all of the specific information for investigation activities associated with Corrective Action Units (CAUs) or Corrective Action Sites (CASs). A CAU may consist of one or more CASs grouped together based on geography, technical similarity, or agency responsibility for the purpose of determining corrective actions. This CAIP provides specific information related to investigation activities associated with CAU 143 which consists of CASs 25-23-03 and 25-23-09 (FFACO, 1996; Liebendorfer, 1998).

This CAIP contains the sampling objectives and criteria for conducting corrective action investigation activities under CAU 143. The CAU consists of two Contaminated Waste Dumps (CWDs) that are located in Area 25 at the Nevada Test Site (NTS) ([Figure 1-1](#)). Area 25 is located in the southwestern corner of the NTS, which is approximately 130 kilometers (80 miles) northwest of Las Vegas, Nevada, the closest major population center. Contaminated Waste Dump #1 (CWD #1) is located at the Reactor Maintenance Assembly and Disassembly Facility (R-MAD) (CAS No. 25-23-09), and Contaminated Waste Dump #2 (CWD #2) is located at the Engine Maintenance Assembly and Disassembly Facility (E-MAD) (CAS No. 25-23-03) ([Figure 1-2](#)). Both facilities were originally constructed for the Nuclear Rocket Development Station (NRDS) which was administered by the Space Nuclear Propulsion Office (SNPO) (AEC, 1969). Nuclear reactors and engines were developed, assembled, tested, and then disassembled for further testing and evaluation. While specific records related to facility disposal practices are limited, weekly reports and NRDS procedures indicate that the disassembled rocket engine parts were disposed of in the individual CWDs of each facility.

1.1 Purpose

Solid radioactive wastes were disposed of at both waste dumps. At CWD #1, solid radioactive wastes were disposed of in five separate areas: below a railroad trestle southeast of the R-MAD facility, two

Figure 1-1
Nevada Test Site Location Map

Figure 1-2
R-MAD/E-MAD Locations at the Nevada Test Site

pits between and west of the railroad berm in R-MAD east, a mound in the southwest corner of R-MAD east, six trenches inside R-MAD west, and a pit south of R-MAD west. At the E-MAD facility, solid radioactive wastes were disposed of in a single trench located outside the southwestern corner of the facility (CWD #2). Due to the unregulated disposal activities commonly associated with landfill operations in the late 1950s through the late 1970s, it is necessary to conduct a corrective action investigation to:

- Identify the presence and nature of contaminants of potential concern (COPCs).
- Determine the vertical and lateral extent of fill materials and COPCs.
- Provide sufficient information and data to develop and evaluate appropriate corrective actions for the CAU.

This CAIP was developed using the U.S. Environmental Protection Agency (EPA) Data Quality Objectives (DQOs) (EPA, 1994) process to clearly define the goals for collecting and using environmental data, and to design a data collection program that will satisfy these goals and uses. A series of DQO scoping meetings were held prior to preparation of this plan; a brief summary of the DQOs is presented in [Section 3.4](#). A more detailed summary of the DQO process and results are included in [Appendix A](#).

1.2 Scope

Geophysical survey results (SAIC, 1998 and 1999) will be used to optimize and help direct the scope of work to be performed under this CAIP. The results of the preliminary geophysical assessment support the site assumptions for each CWD, as presented during the DQO process ([Appendix A](#)). The scope of this CAIP is to characterize the nature and extent of solid radioactive wastes and hazardous wastes, if any, that were disposed of at the CWDs and to obtain data sufficient to support selection of a corrective action for the CAU. The following tasks must be accomplished to address this problem statement:

- Use geophysical surveys and historical document review to select CWD areas and to determine vertical extent of buried wastes, as appropriate.
- Use Cone Penetrometer (CPT) to collect *in situ* field screening data and geotechnical, gamma radiation, and volatile organic compound field analyses to define the nature and extent of the

waste in the CWDs and, more importantly, any migration of contaminants that may have occurred.

- Collect soil samples from selected locations for off-site laboratory analysis of environmental and geotechnical parameters using the CPT and/or sonic drilling.

1.3 CAIP Contents

[Section 1.0](#) of this CAIP provides an introduction to this project, including the purpose and scope for this corrective action investigation. The remainder of the document details the investigation strategy and complies with FFACO (1996) requirements that CAIPs address. This CAIP contains the following elements:

- Management
- Technical aspects
- Quality assurance
- Health and safety
- Public involvement
- Field sampling
- Waste management

The managerial aspects of this project are discussed in the DOE/NV *Project Management Plan* (DOE/NV, 1994) and the site-specific Field Management Plan (to be developed prior to field activities). In addition, [Appendix B](#) to this document provides information regarding the project organization. The technical aspects of this CAIP are contained in [Sections 3.0](#) and [4.0](#) and in the DQO summary presented in [Appendix A](#). General field and laboratory quality assurance and quality control (QC) issues, including collection of QC samples, are presented in the *Industrial Sites Quality Assurance Project Plan* (QAPP) (DOE/NV, 1996b). The health and safety aspects of this project are documented in the *Environmental Restoration Project Health and Safety Plan* (HASP) (DOE/NV, 1998) and will also be supplemented with a site-specific HASP (SSHASP) written prior to the start of field work. No CAU-specific public involvement activities are planned at this time; however, an overview of public involvement is documented in the “Public Involvement Plan” in [Appendix V](#) of the FFACO (1996). Field sampling activities are discussed in [Section 4.0](#) and waste management issues are discussed in [Section 5.0](#). The project schedule and records availability information for this CAIP are discussed in [Section 6.0](#), and [Section 7.0](#) provides a list of project references.

2.0 Facility Description

There are two CASs currently under investigation for CAU 143. The first, CWD #1 is located at the R-MAD facility (CAS No. 25-23-09), while CWD #2 is located at the E-MAD facility (CAS No. 25-23-03). The R-MAD and E-MAD facilities originally constituted a portion of the NRDS in Area 25 at the NTS, and both CWDs primarily received solid radioactive wastes from discarded nuclear reactor or engine parts (IT, 1998). The R-MAD facility was decommissioned in January 1973 (DOE, 1980) and the E-MAD facility was decommissioned around 1972 (DOE/NV, 1997a).

2.1 Physical Setting

The CWDs are situated in Area 25 of the NTS which is located in Death Valley Basin Hydrogeographic Region of California and Nevada, as defined by Rush (1968) and the U.S. Geological Survey (USGS) (1978). More specifically, the CWDs are situated within the Fortymile Canyon, Jackass Flats hydrogeographic area of the Alkali Flat-Furnace Creek Ranch Subbasin. The hydrogeographic area is approximately 723 square kilometers (km²) (279 square miles [mi²]) and receives, on average, approximately 13 centimeters (cm) (5 inches [in.]) of rainfall annually (DOE/NV, 1988c). Geographically, the CWDs are located within the Jackass Flats and Skull Mountain Quadrangles (USGS, 1983a and b) ([Figure 2-1](#)). Of some importance to characterizing the CWDs are topographic influences on the drainage of surface water resulting from significant rainfall events. Hydrogeologic conditions beneath the CWDs are less important to site characterization since individual disposal units were originally 3 to 6 meters (m) (10 to 20 feet [ft]) below grade, Quaternary alluvium is likely to reach depths of greater than 30 m (100 ft) below ground surface (bgs) (DOE/NV, 1988c), and the depth to groundwater is approximately 290 m (950 ft) bgs (DOE/NV, 1988c).

Although the region has a generally arid to semiarid climate with a high average annual potential evaporation, low average annual precipitation, and infrequent storms, surface runoff from rainfall events does occur. Surface runoff results from regional storms that mostly occur in winter and occasionally in fall and spring. Localized thunderstorms occur mostly during the summer months.

Explanation

- Drainage
- Topography
- Nevada Test Site Area Boundary

Source: USGS digital topographic base maps provided by Bechtel Nevada, 1997

Figure 2-1
R-MAD/E-MAD Local Topography
and Surface Water Drainage Patterns

Quantitative data on rainfall, runoff, and evaporation for the area are not yet adequate to determine rainfall-runoff-recharge relations for individual storms, seasons, or years (DOE/NV, 1988c).

Dry washes provide channels that concentrate surface runoff. The dry washes, consequently, may be the principal sources of groundwater recharge to the area (DOE/NV, 1988c). There is no perennial streamflow in the region, but the closest major dry wash in the vicinity of the CWDs is the Topopah Wash which runs southwesterly through Jackass Flats to the middle of the south side of the NRDS approximately 1.5 kilometers (1 mile) south of E-MAD (Figure 2-1). As shown in Figure 2-1, the topographic relief in the vicinity of the R-MAD facility is relatively steep when compared to that of the E-MAD facility. Kiwi Mesa is immediately northeast and east of CWD #1, and Skull Mountain is east and southeast of CWD #1. Several minor dry washes in the vicinity of CWD #1 drain west and southwest towards larger dry washes such as the Topopah Wash south and east of E-MAD.

2.2 Operational History

From 1959 through 1973, the U.S. Atomic Energy Commission (AEC) participated jointly with the U.S. National Aeronautics and Space Administration (NASA) in the development of nuclear rocket engines at the NTS. The AEC and NASA formed SNPO to oversee the project. These nuclear rocket engines were tested at the NRDS, now known as the Nevada Research and Development Area (NRDA), located in Area 25 at the NTS. During the rocket engine test program, significant quantities of radioactive material were produced.

The following operational histories for R-MAD and E-MAD are based on historical document review. Sources reviewed included historic records, historic analytical data, systems descriptions, plans and drawings, mass balance documentation, literature search, former employee interviews, and documented procedures. Process knowledge indicates that solid radioactive wastes were disposed of in the CWDs and liquid wastes were disposed of in the R-MAD and E-MAD leachfields (Fauver, 1986; Geary, 1998).

2.2.1 Operational History for R-MAD CWD #1

Between 1959 and 1979, CWD #1 was used for the disposal of solid radioactive waste material from the R-MAD facility which was initially utilized for the assembly and disassembly of Kiwi Reactors (Fauver, 1986). The NRDS Master Plan states the following concerning CWD #1 (AEC, 1969):

“The hot dump [CWD #1] is used for the storage and cooling of used test cars, components and contaminated waste. The dump encompasses an area of 10 acres and is served by two spurs from the main railroad line. One spur ends in a trestle which permits remote dumping of contaminated waste from three dump cars into a pit under the trestle. The second spur ends in a depressed section of track where spent fuel is stored on hooded flatcars.”

Figure 2-2 identifies major CWD #1 activity areas identified from first-hand process knowledge of the facility (Geary, 1998). Solid radioactive wastes were transported via railroad from R-MAD to CWD #1, located at the terminus of a railroad spur southeast of R-MAD. The waste materials were unloaded from the dump cars to either side of a trestle at the railroad terminus for CWD #1. The waste materials were disposed of in a waste pit originally excavated to 6 m (20 ft) below grade (Appendix C, Figure C.1-1 and Figure C.1-2) (BN, 1997). The waste pit was consistently backfilled with original soil to reduce radiation exposure to site workers. Consequently, the waste pit is currently composed of alternating layers of solid radioactive waste and original site soil taken from a dirt mound south of the waste pit. Rocks and boulders that were too large to return to the waste pit were stored at a spoils pile east of CWD #1. Grossly contaminated materials were transported via dump cars to a decontamination facility prior to disposal at CWD #1. Wastewater from the decontamination facility was discharged to a leachfield (CAU 262) near R-MAD (Fauver, 1986).

The second railroad spur is located east of the CWD #1 disposal pit, surrounded on three sides by a soil berm used for shielding site workers from radioactive material. Radioactive material was stored on the eastern railroad spur until required for reuse by the R-MAD facility. After 1965, track from the eastern spur was removed, and the railroad spur was straightened from its previous S-shape (Figure 2-3).

Six trenches are located west of the trestle spur and the disposal pit. The trenches were identified in 1968 by Los Alamos Scientific Laboratory as the “Burial Pit R-MAD Hot Dump” (Appendix C, Figure C.1-3) (BN, 1997). For burial pits 1 through 4, the drawing indicates trench dimensions of

Source: EG&G Photograph Number 6411720 taken in 1964 (EG&G, 1964)

Legend:

A - Trestle Spur utilized for disposal of solid radioactive waste at either side of spur.

B - Soil berm utilized for shielding radioactive materials stored on eastern railroad spur.

C - Decontamination facility utilized to remove gross radioactivity from materials prior to their disposal in CWD #1; decontamination liquids were discharged to R-MAD leachfield.

D - Eastern spur utilized for storage of radioactive materials at railroad track terminus.

E - Spoils pile utilized for storage of boulders removed during excavations at CWD #1.

Legend source: Geary, 1998

Figure 2-2
R-MAD Operational History at CWD #1

Source: EG&G Photograph Number 8811-65 taken in 1988 (EG&G, 1988)

Figure 2-3
Aerial Photograph of R-MAD CWD #1

3 m x 3 m x 122 m (10 ft x 10 ft x 400 ft). The drawing indicates the dimensions of the burial pits 5 and 6 trenches as 3 m x 3 m x 137 m (10 ft x 10 ft x 450 ft). [Figure 2-3](#) depicts the locations of the trenches relative to the trestle spur and [Figure 2-4](#) depicts waste in at least one disposal trench

2.2.2 Operational History for E-MAD CWD #2

The E-MAD facility was designed and used for the assembly and preparation of nuclear engines for testing, the refurbishment of radioactive engines, and the disassembly and detailed post mortem inspection of test engines and components. Built in 1962, the facility was used for Project ROVER (the nuclear rocket program) until approximately 1973 when the program was canceled. Under Project ROVER, nuclear reactors and engines were developed, assembled, tested, and then disassembled for further testing and evaluation. While documentation related to facility disposal practices is limited, it is believed that only the disassembled rocket engine parts and other solid wastes were disposed of in the individual CWDs of each facility. The contaminated waste dumps received solid radioactive wastes including discarded nuclear reactor or engine parts. In 1978, the Fuel Demonstration Project set up operations at the E-MAD facility. All fuel cores were removed from the site, and the facility has been inactive since about 1989 (DRI, 1996). During the late 1960s, CWD #2 was used to dispose of solid radioactive waste material from E-MAD ([Appendix C, Figure C.1-4](#)) (BN, 1997). Located 91 m (100 yards) south of the southwest corner of the E-MAD facility fence, CWD #2 consists of a single trench which measures 3 m x 3 m x 60 m (10 ft x 10 ft x 200 ft) ([Figure 2-5](#)). Engineering drawings and ground-level photos indicate that the pit was not filled to capacity. A mound of soil south of the waste trench contains original soil from the waste trench.

2.3 Waste Inventory

The COPCs were released directly to CWD surface and subsurface soils as a result of solid radioactive waste burial related to nuclear reactor and engine development. Buried wastes include rocket engine parts, test assembly parts, and scrape and clean up materials activated or contaminated in the form of activation products, mixed fission products, and potential fuel particles as contaminants. The exact amount and type of solid waste disposed of in the CWDs is unknown.

Source: EG&G Photograph Number 664321 taken in 1966 (EG&G, 1966)

Figure 2-4
Photograph of Burial Trench R-MAD West Trench at CWD #1

2.4 Release Information

While liquid wastes were released to facility leachfields, migration of subsurface COPCs in the CWDs would result from the generation of leachate via natural processes (i.e., surface water infiltration). Migration of subsurface COPCs due to infiltration is assumed to be very minor due to the arid climate and the low permeabilities of the native soils. Release information related to the conceptual model for each CWD is further discussed in [Section 3.1](#).

Figure 2-5
Aerial Photograph of E-MAD

2.5 Investigative Background

In 1980, the R-MAD compound was decontaminated and decommissioned (D&D). Equipment, scrap metal, and salvage materials were segregated into radioactive and nonradioactive lots. Clean materials were either incorporated in the NTS usage system, or excessed for sale to the public (DOE, 1980). During D&D activities, 2,987 cubic meters (m^3) (3,904 cubic yards [yd^3]) of equipment and 1,150 m^3 (1,500 yd^3) of soil were removed from the R-MAD Radioactive Material Storage Area. The resulting void was filled with clean soil and contoured to original surface grade (Miller, 1984), and the waste was covered with at least 1.5 m (5 ft) of soil (DOE/NV, 1988b). The E-MAD facility was not included in the Area 25 cleanup of 1974-1983 (DOE/NV, 1988a).

Reynolds Electrical & Engineering Company, Inc. (REECo) (1986) reported radiological results from soil samples collected at the R-MAD and E-MAD CWDs. The radiological results were from previously unreported data that were included in Appendix A of the REECo (1986) report. Soil sampling locations within the CWDs are unknown. Soil samples were collected at three locations at the R-MAD CWD and at two locations at the E-MAD CWD. At each sampling location, three samples were collected: (1) surface interval (0 to 15 cm [0 to 6 in.]); (2) bottom interval (a minimum sampling depth of 168 cm [66 in.] and a maximum sampling depth of 274 cm [108 in.] was reported for the samples collected); and (3) tailings which consisted of a composite sample from ground surface to total depth at each location. Gamma spectroscopy was used to analyze the soil samples and only those radionuclides detected were reported by REECo (1986). [Table 2-1](#) summarizes the maximum and minimum activity levels of the isotopes that were detected in the soil samples. Radionuclides of concern include fission and activation products, Cesium-137 (^{137}Cs) and Cobalt-60 (^{60}Co). These radionuclides were detected at the surface and higher levels of ^{137}Cs were identified at the lower depths of both CWDs. No nonradioactive hazardous substances were detected at the R-MAD and E-MAD CWDs (REECo, 1986).

In accordance with the DOE/NV *National Environmental Policy Act* (NEPA) compliance program, a NEPA checklist shall be completed prior to commencement of site investigation activities at this CAU site. This checklist compels DOE/NV to evaluate this proposed project against a list of several potential environmental impacts which include, but are not limited to, air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the

appropriate level of NEPA documentation by the DOE/NV NEPA Compliance Officer for this project.

Table 2-1
List of Detected Radionuclides in Soil Samples Collected Prior to 1986

Isotope Sampled	R-MAD Facility CWD #1 Results ¹		E-MAD Facility CWD #2 Results ¹	
	Minimum Activity (pCi/g)	Maximum Activity (pCi/g)	Minimum Activity (pCi/g)	Maximum Activity (pCi/g)
⁴⁰ K	25.1	30.5	29.3	32.3
⁶⁰ Co	Not detected	11.2	Not Detected	Not Detected
¹³⁷ Cs	1.01	403	0.114	34.7
²²⁶ Ra	0.818	98.2	0.81	0.964
²²⁸ Th	1.34	2.1	1.47	1.68
²³² Th	1.05	2.33	1.36	1.65

¹Results reported in REECo (1986) as previously unreported data.
pCi/g = Picocurie(s) per gram

3.0 Objectives

The following section identifies the four primary objectives related to site investigation: conceptual site models, contaminants of potential concern, preliminary action levels, and the DQO process discussion for the CWDs. The sampling objectives were determined through the DQO process between the DOE/NV and the NDEP ([Appendix A](#)). This process included an evaluation of the preliminary geophysical assessment (SAIC, 1998 and 1999). The DQOs are qualitative and quantitative statements that specify the quality of the data required to support evaluation of potential corrective actions for the CWDs. The DQOs were developed to clearly define the purpose(s) for which environmental data will be used and to design an investigation plan that will satisfy the site investigation goals.

3.1 Conceptual Site Model

The site conceptual model ([Table 3-1](#)) provides the basis for planning adequate investigative activities and was developed to postulate potential contaminant exposure pathways from the CWDs. The conceptual model is based on the physical setting of the CWDs ([Section 2.1](#)), existing process knowledge, a geophysical investigation performed to identify disposal areas (SAIC, 1998 and 1999), and assumptions and premises that were discussed during the DQO process ([Appendix A](#)). If the environmental sampling results indicate that the conceptual model is significantly insufficient, NDEP will be notified, and the site investigation will be rescoped. The following summarizes the primary assumptions which were included in the DQOs and which were considered when formulating the conceptual models for each CWD:

- The landfill disposal areas contain solid wastes contaminated with radioactivity.
- Radionuclides are the primary constituents of concern and are located in disposal areas.
- Vertical and lateral migration of COPCs is not likely.
- If contaminant migration has occurred, it will be limited to the soil beneath the CWD disposal areas.

Through process knowledge and historical photographs, the potential contaminant sources at the CWDs have been identified as solid radioactive wastes buried beneath ground surface. Because the

Table 3-1
Conceptual Model

Conceptual Model Element	Assumptions	Source
SYSTEM DYNAMICS	Radionuclides are the primary concern: Buried wastes include activation products, mixed fission products, and potential fuel particles as contaminants.	Knowledge of past operations. Sample results (REECo, 1986) Radionuclide calculations (Tinney and Wheeler, 1999)
	Groundwater contamination is unlikely because of environmental conditions at the site, such as an arid climate, low permeabilities, and depth to groundwater at between 900 and 950 ft are not conducive to downward migration.	Knowledge of similar Area 25 Sites
	No driving forces other than limited precipitation and infiltration. Also, no known free liquids were released to the radioactive waste dumps. Analytical solutions were stabilized with adsorbent materials prior to burial.	Knowledge of past operations and similar sites (IT, 1998)
	Hazardous constituents are not known to have been disposed in the E-MAD and R-MAD dumps.	Knowledge of past operations
SOURCE LOCATION	Location and size of waste areas are estimated from aerial photographs and geophysics. Location of the majority of the buried metallic material is based on geophysical survey data. Location of all waste material is not known. Surface gamma readings are known.	Geophysical and surface radiological surveys
	The waste areas include: 1) R-MAD trestle pit 2) R-MAD East pits (2) 3) R-MAD south mound (TNT) 4) R-MAD West trenches (6) 5) R-MAD West pit (south) 6) E-MAD trench	DOE/NV, 1969c Wallace, 1965 Sanders, 1965a and b DOE/NV, 1970 IT, 1998 DOE/NV, 1969a
LATERAL MOVEMENT OF CONTAMINANTS	Subsurface effects limited by relatively low mobility of constituents.	Process Knowledge
	The potential lateral migration of contaminants is unknown. If migration has occurred, it is most likely confined to the boundaries of the waste dump disposal areas. Any lateral movement of surface contamination may be the result of erosion.	Hale and Westenburg, 1995 and knowledge of similar areas
VERTICAL MOVEMENT OF CONTAMINANTS	The vertical movement of contaminants is unknown. Vertical migration is expected to be limited by the lack of a driving force and relatively low mobility of contaminants. There is no indication that vertical movement will extend beyond trench bottoms.	Knowledge of similar Area 25 Sites
PHYSICAL AND PRACTICAL CONSTRAINTS	Nearby railroad tracks and fencing; adverse weather conditions; heavy equipment and resource availability; and approvals are possible constraints.	Site and practical knowledge
FUTURE USE	Area 25 is defined as a research and testing area. The area will be restricted and monitored.	Assumptions are defined in DOE/NV 1996c
POTENTIAL EXPOSURES	Very low exposure potential related to unlikely groundwater contamination. Groundwater is estimated to be at least 900 feet below the subject areas. These depths are greater than 20 times the expected maximum contamination depths.	Process Knowledge
	Oral ingestion, inhalation, or dermal contact (absorption) of COPC of the soil is extremely low as the CPT will provide soil punching. Respiratory protection will be used as required during drilling or excavation.	Process Knowledge

disposal areas are covered with soil and are not closed with an engineered cap, a release mechanism may exist via surface water infiltration through waste materials (Section 2.3). The presence of this release mechanism is not considered significant because the CWDs are located in the Mojave Desert where precipitation is minimal (Section 2.1); however, due to the surface water drainage patterns, periodic infiltration of surface water could occur at CWD #1. Dry washes in the vicinity of CWD #1 are presented in Figure 3-1. Significant surface water drainage patterns were not observed within the immediate vicinity of CWD #2 boundaries.

Based on the conceptual model, solid radioactive waste disposal is assumed to impact only shallow site soils. Because the depth to groundwater is approximately 290 m (950 ft) and because annual precipitation is approximately 13 cm (5 in.) (DOE/NV, 1988c), the site is not considered to have impacted groundwater. Site access into the CWDs is restricted by fences posted with appropriate signage, mitigating the potential for inadvertent exposure to subsurface site soils.

3.2 Potential Contaminants of Concern

The following COPCs were developed between the DOE/NV and the NDEP:

- Radionuclides
- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- RCRA metals

Previous sampling identified ^{137}Cs and ^{60}Co in pits and trenches in R-MAD and E-MAD. Activation products suspected as present in the CAU include ^{60}Co , europium-152 (^{152}Eu), and niobium-94 (^{94}Nb). Mixed fission products and potential fuel particles that may be found in the unit include ^{137}Cs , strontium-90 (^{90}Sr), plutonium-239 (^{239}Pu), uranium-234 (^{234}U) and uranium-235 (^{235}U).

While there is no information indicating disposal of hazardous or *Resource Conservation and Recovery Act* (RCRA)-regulated materials in the CWDs, analyses will be run for VOCs, SVOCs, and RCRA metals to verify the conceptual model.

Figure 3-1a: Dry wash draining out of CWD #1.
 (Location A in Figure 3-1f)

Figure 3-1b: Continuation of the dry wash identified in Figure 3-1a.
 (Location B in Figure 3-1f)

Figure 3-1c: Dry wash draining from the east into CWD #1.
 (Location C in Figure 3-1f)

Figure 3-1d: Dry washes draining into the burial pit below the CWD #1 trestle. (Location D in Figure 3-1f)

Figure 3-1e: Dry wash draining into CWD #1 parallel to the trestle spur. The unobservable end of the drainage pipe is buried and dead ends into site soils approximately 1 m (3 ft) inside the fenceline. Surface water drainage is believed to have eroded site soil to ground surface at the end of the buried portion of the drainage pipe. (Location E in Figure 3-1f)

Figure 3-1f: Aerial photograph of CWD #1. Arrows indicate the direction at which Figure 3-1 photographs were acquired.

Note: All photographs in Figures 3-1a through Figure 3-1e were acquired by IT Corporation taken 5/27/98 (IT, 1998) except Figure 3-1f, which was taken in 1988.

Figure 3-1
Dry Washes in the Vicinity
of R-MAD CWD #1

3.3 Preliminary Action Levels

Preliminary action levels (PALs) for on-site screening, on-site analysis, and off-site laboratory analysis are provided in [Table A.3-1](#) and will be used to determine the presence of contamination.

3.3.1 Field Screening Levels

The following field screening levels will be used to compare on-site field screening levels:

- The radiological (alpha and beta/gamma) screening levels are defined as the mean *in situ* background levels plus two times the standard deviation using *in situ* gamma spectrometry.
- The VOC soil gas screening levels are defined as 20 parts per million (ppm) or 2.5 times background, whichever is greater, using *in situ* photoionization detector (PID) and flame ionization detector (FID).

Radiation background and VOC background will be determined from *in situ* soil measurements made at depth with the CPT instruments outside the CWDs. The data from these pushes will be integrated over the length of the push and these data will be used as background. Daily background checks will be made with check sources to determine whether the instrument's response meets project requirements, prior to use in the field.

Concentrations exceeding field screening levels indicate potential contamination at the sample location. This information will be documented, and the investigation will be continued to obtain field analytical results for radionuclide identification and VOC speciation.

3.3.2 Field Analyses

Field analyses will be used to identify gamma-emitting radionuclides using *in situ* gamma spectroscopy analysis. Field analyses using a gas chromatograph/mass spectrometer (GC/MS) will provide data on VOC speciation and concentrations in soil gas. This field analytical data will provide information to assist in determining "step-out" sampling locations to define lateral extent of contamination. The field screening data and the results from field analyses will provide information for selecting locations for biased soil samples to be submitted for laboratory analysis.

3.3.3 Chemical Preliminary Action Levels

Field and off-site laboratory analytical chemistry results will be compared to the the following PALs to evaluate the need for possible corrective actions:

- The NDEP Corrective Action Regulations listed in the *Nevada Administrative Code* (NAC), NAC 445A.226 - NAC 445A.22755 (NAC, 1998a)
- Total petroleum hydrocarbons (TPH) above the TPH limit of 100 ppm per the NAC 445A.2272 (NAC, 1998b) and NAC 459.9973 (NAC, 1998c)

3.3.4 Radiological Preliminary Action Levels

The preliminary action levels for the radionuclides are isotope-specific and are defined as the maximum concentration for that isotope found in environmental samples taken from undisturbed background locations. Environmental background samples will be taken in the vicinity of CAU 143. These samples will be analyzed and compared with the results for environmental samples taken from other undisturbed background locations in Area 25. In addition, the radionuclide concentrations in the CAU 143 and Area 25 background samples will be compared with the radionuclide concentrations found in environmental samples taken from undisturbed background locations in the vicinity of the NTS presented in McArthur and Miller (1989) and Atlan-Tech (1992). The PAL for each isotope will be the maximum concentration of that isotope found in any samples taken from the undisturbed background locations described above.

Field analytical and laboratory results above action levels indicate the presence of COPCs at levels which may require corrective action. The evaluation of potential corrective actions and the justification for a preferred action will be evaluated in the Corrective Action Decision Document (CADD) which will be based on the results of this field investigation.

3.4 DQO Process Discussion

Details of the DQO process are presented in [Appendix A](#). The DQO results for this CAU indicated the need for a biased sampling approach. Due to potential subsurface migration of COPC, an investigation consisting primarily of subsurface sampling was identified. The COPCs, analytical methods, and reporting limits prescribed through the DQO process are provided in [Table 4-1](#). The

laboratory precision and accuracy requirements are those stated in the latest revision of the individual EPA SW-846 analytical methods (EPA, 1996). Representativeness of the investigation and resulting data will be evaluated by confirming or refuting the conceptual model.

4.0 Field Investigation

This section of the CAIP contains the sampling approach for investigating the CWDs. All sampling activities will be conducted in compliance with the Industrial Sites QAPP (DOE/NV, 1996b) and other applicable, approved procedures. Quality assurance/quality control requirements for field and laboratory environmental sampling are contained in the Industrial Sites QAPP (DOE/NV, 1996b) and in [Table 4-1](#).

Table 4-1
Laboratory Analytical Requirements
(Page 1 of 2)

Analyte	Medium ^a	Analytical Method	Minimum Reporting Limit ^b	Precision (RPD)	Accuracy (%R)
Total VOCs (in subsurface soils)	Water	8260B ^c	Analyte-specific estimated quantitation limits ^d	14	61 - 145
	Soil			24	59 - 172
Total SVOCs (in subsurface soils)	Water	8270C ^c	Analyte-specific estimated quantitation limits ^d	50	9 - 127
	Soil			50	11 - 142
Total RCRA Metals Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	Water	6010B/7470A ^c	10 µg/L 200 µg/L 5 µg/L 10 µg/L 3 µg/L 0.2 µg/L 5 µg/L 10µg/L	20	75 - 125
Total RCRA Metals Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	Soil	6010B/7471A ^c	1 mg/kg 20 mg/kg 0.5 mg/kg 1 mg/kg 0.3 mg/kg 0.1 mg/kg 0.5 mg/kg 1 mg/kg	20	75 - 125
Total Petroleum Hydrocarbons	Water (gasoline)	8015B modified ^c	0.1 mg/L	20	25 - 145
	Water (diesel)		0.5 mg/L	20	25 - 145
	Soil (gasoline)		0.5 mg/kg	30	30 - 130
	Soil (diesel)		25 mg/kg	30	30 - 130

Table 4-1
Laboratory Analytical Requirements
(Page 2 of 2)

Analyte	Medium ^a	Analytical Method	Minimum Reporting Limit ^b	Precision (RPD)	Accuracy (%R)
Gamma Spectroscopy (based on Cs ¹³⁷)	Water	EPA 901.1 ^e	20 pCi/L	20	80 - 120
	Soil	HASL 300, 4.5.2.3 ^f	0.2 pCi/g	35	80 - 120
Isotopic Plutonium	Water	NAS-NS-3058 ^g	2.0 pCi/L	20	80 - 120
	Soil	NAS-NS-3058	0.4 pCi/g	35	80 - 120
Isotopic Uranium	Water	NAS-NS-3050 ^h	2 pCi/L	20	80 - 120
	Soil	NAS-NS-3050	1.0 pCi/g	35	80 - 120
Gross Alpha	Water	EPA 900 ^e	1.0 pCi/L	<20	80 - 120
	Soil	SM-7110 ⁱ	10 pCi/g	<35	80 - 120
Gross Beta	Water	EPA 900 ^e	4 pCi/L	<20	80 - 120
	Soil	SM-7110 ⁱ	10 pCi/g	<35	80 - 120

^aQC (water) samples are included in table

^bIndustrial Sites Quality Assurance Project Plan (DOE/NV, 1996b)

^cEPA Test Methods for Evaluating Solid Waste, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996)

^dEstimated Quantitation Limit (EQL) as given in Method SW-846, U.S. EPA (EPA, 1996)

^ePrescribed Procedures for Measurement of Radioactivity in Drinking Water (Kreiger and Whittaker, 1980)

^fEnvironmental Measurements Laboratory Procedures Manual, HASL-300, U.S. Department of Energy (DOE, 1992)

^gNational Academy of Sciences (NAS), *Nuclear Science Series*, September 1963 (NAS, 1962)

^hThe Radiochemistry of Uranium, J.E. Grindler, in *Nuclear Science Series*, NAS-NS-3050. (NAS, 1962).

ⁱStandard Methods for the Examination of Water and Wastewater, American Public Health Association, 1998

RPD = Relative percent difference = 100 (Sample Result-Duplicate Result) / (Sample Result+Duplicate Result / 2)

%R = Percent recovery

mg/kg = Milligram(s) per kilogram

pCi/g = Picocurie(s) per gram

pCi/L = Picocurie(s) per liter

mg/L = Milligram(s) per liter

µg/L = Microgram(s) per liter

4.1 Technical Approach

The site investigation includes the following activities:

- Geophysics has been performed to determine the location and extent of the waste disposal areas
- Performing CPT within and/or near radioactive solid waste disposal sites
- Conducting field analyses for radiological constituents and VOCs with the instruments in the CPT
- Collecting confirmatory surface and subsurface environmental soil samples using CPT and/or sonic drilling

- Collecting geotechnical subsurface soil samples
- Collecting background and subsurface soil samples
- Collecting required quality control samples
- Surveying sampling locations and the CWDs

4.1.1 Geophysical Investigation

Biased locations will be selected for CPT pushes. The biased approach is appropriate because the locations of the waste disposal areas are relatively well known or can be reasonably assumed. Lithological data, soil gas information, and total gamma activity surveys will be conducted continuously.

Geophysical surveys conducted under a preliminary investigation of CAU 143 were used to guide and optimize surface and subsurface sampling locations (SAIC, 1998 and 1999). The geophysical investigation confirmed the assumed location of the waste disposal areas within each CWD and identified additional burial locations within and outside of R-MAD CWD#1. An electromagnetic conductivity meter (EM-31) was used to initially determine the most likely locations of the waste disposal sites containing buried metal. An EM-61 high-resolution metal detector was then utilized to confirm the presence of metallic waste and to gain a sense for depth at which identified buried waste is located. Potential disposal sites observed with the EM-31 and not with the EM-61 are considered to be near surface debris or wastes at depths of greater than 5 m (16 ft) bgs. Potential disposal sites identified with the EM-31 and EM-61 are considered to be near surface debris or wastes at depths up to 5 m (16 ft) bgs. In select areas where suspected disposal sites were observed through use of the EM-31 and/or EM-61, magnetometer and ground penetrating radar (GPR) surveys were additionally performed to further characterize suspected waste disposal areas.

Following the preliminary survey of CWDs, electromagnetic imaging was performed in the R-MAD dumps and at the location of a suggested pit south of R-MAD-West. These studies used a computer-driven dipole-dipole array to image the resistivity of a section through the identified dump sites. These images have proven useful in determining the depth of disturbed areas previously identified as burial areas. The information from these lines has been mapped in three dimensions, providing a basis for selecting target locations within the R-MAD CWD for CPT investigation.

4.1.1.1 R-MAD Geophysical Results Summary

In order to accommodate existing site fencing, the R-MAD geophysical survey was managed as two distinct areas: R-MAD-East and R-MAD-West (Figure 4-1). As anticipated, R-MAD-West was found to consist of six buried trenches of a configuration approximate to that of Figure 4-2. Furthermore, the upper 2 m (6 ft) of soil at R-MAD-West appears to have been excavated or reworked in the past.

At R-MAD-East, buried waste was identified in the vicinity of the burial pit beneath the railroad trestle spur (Figure 4-2, Anomaly A). The vertical extent of the waste could not be accurately determined with the geophysical methods utilized, but the waste was determined to be from 1 m (3 ft) to over 5 m (16 ft) bgs. No buried waste was identified at the eastern railroad spur, except in a localized area where waste may be present at a depth of at least 5 m (16 ft) bgs (Figure 4-2, Anomaly G). Buried waste was additionally identified in at least four other localized areas (Figure 4-2, Anomalies C, D, E, and H). Anomalies C and D appear to be greater than 5 m (16 ft) bgs, and Anomaly E appears to be between 4 m (13 ft) to over 5 m (16 ft) bgs. Anomaly H appears to be either surface debris or waste at least 5 m (16 ft) bgs. No waste has been identified in the berm south of the trestle spur (Figure 4-2, Anomaly B). Areas of potential concern on the soil berm surrounding the eastern railroad spur (Figure 4-2, Anomalies F and I) will be verified with geophysics in the field as buried debris or aberrant geophysical data due to surface topography. An additional survey conducted south of R-MAD-West trenches identified the location of a pit.

4.1.1.2 E-MAD Geophysical Results Summary

The geophysical survey data from E-MAD indicated that waste disposal only occurred within the waste trench and between the southern edge of the trench and the northern rim of the soil pile south of the trench (Figure 4-3, Anomaly A). Fill material within the trench is not highly conductive, as indicated by the electromagnetic surveys. Furthermore, the E-MAD waste trench does not appear to be symmetrical at the eastern sidewall of the southern end of the trench. The northern end of the trench appears to be about 3.5 m (11 ft) wide, and the southern end of the trench appears to be about 5 m (16 ft) wide. The depth of the trench is estimated to be about 2.5 m (8 ft) bgs.

Explanation

- Disturbed Ground
- Electrical Imaging Traverse and Identifier
- Railroad Tracks

Scale

Figure 4-1
R-MAD (CWD #1)
Geophysical Survey Areas

Explanation

- Disturbed Ground
- Electromagnetic Data
- Gamma Data
- Background Location
- Lateral CPT Push Location
- Primary CPT Push Location
- A-I Geophysical Anomalies

Scale

Figure 4-2
 R-MAD East and West Geophysical Anomalies
 and Approximate Borehole Locations

**Figure 4-3
 E-MAD Geophysical
 Anomaly and Approximate
 Borehole Locations**

4.1.2 Cone Penetrometer Testing

A CPT will be used to perform *in situ* measurements of gamma radiation, radionuclide identification, and VOCs at approximately 40 locations and to collect soil samples from biased locations based on at least 20 percent of the number of *in situ* sample locations in CAU 143. Preliminary locations are shown in [Figures 4-2 and 4-3](#). The CPT equipped with a sodium iodide scintillation counter will be used to measure radiation and identify radionuclides using gamma-ray spectrometry. The CPT will also be used to perform continuous logging of soil gas using: (1) an onboard Photoionization Detector (PID); (2) a Flame Ionization Detector (FID); and (3) a Gas Chromatograph/Mass Spectrometer (GC/MS) system for VOC analysis. These *in situ* field measurements and the results of laboratory analyses from soil samples will assist in determining the closure approach for CAU 143. The collective results of the geotechnical information, gamma survey data, and VOC soil gas analyses will be compared to screening levels. Soil sample analytical results will be compared to *in situ* field data and the PALs ([Table A.3-1](#)).

The CPT will be used to define subsurface conditions, gather field analytical data, and subsequently substantiate or refute the conceptual model established during the DQO process. The CPTs will be advanced within or adjacent to areas where wastes are believed to have been disposed. Proposed initial primary and lateral CPT push locations are identified in [Figures 4-2 and 4-3](#). The exact locations will be determined upon initiation of field activities. Generally, CPT pushes will be advanced 6 m (20 ft) bgs or until beyond the bottom of the feature under investigation. If field analytical results are negative for radiation and VOCs ([Section 3.3](#)) and the bottom of the feature under investigation is identified, the borehole will be terminated 10 feet into the virgin soil, regardless of the depth.

At R-MAD-East ([Figure 4-2](#)), geophysical anomalies are associated with areas of historical activity between the rail lines and are identified as deep wastes buried at depths in excess of 5 m (16 ft) (SAIC, 1998). The CPT sampling will bracket these areas of potential radioactive waste burial. In the trestle area, CPT pushes will be placed in the area where dumping from the rail cars occurred. This pit is considerably deeper than the other burial sites and shows geophysical evidence of abundant metallic debris. Historical information suggests that this pit was at least 12 m (40 ft) deep and the target depth is set at 15 m (50 ft). The intent is to reach the area below the bottom of the fill material. The mound in the southwest corner of R-MAD-East has been identified from historical

information as the burial site of debris from the Transient Nuclear Test (TNT). Geophysical data shows some high conductivity anomalies beneath this mound so a minimum of five pushes will be made from the top of the mound to delimit the waste buried beneath it.

At R-MAD-West (Figure 4-2), CPT pushes will be advanced up to 3 m (10 ft) below trench bottoms, as determined by geotechnical data from the CPT. Approximately 30 CPT pushes are planned to delineate the waste locations and the vertical extent of migration. The step-out strategy will be to investigate areas adjacent to elevated levels of radioactivity and any VOC contamination identified by field analytical methods using a 5-ft step-out pattern from the original CPT location.

At E-MAD CWD #2 (Figure 4-2), five CPT pushes will be advanced along the centerline of the waste trench. The step-out strategy for checking the horizontal extent of contamination is the same as that used for the R-MAD West trenches (Figure 4-3).

The characterization method should identify potential vertical contamination at the site, but additional step-out pushes may be used to further delineate the lateral extent of detected COPCs. Any step-out pushes will be made at the discretion of the Site Supervisor.

4.1.3 In Situ Sampling and Field Analyses

The CPT will be used to log gamma activity and to screen and measure VOC soil gas. Field analyses for radiation and VOCs will be conducted for all pushes and will provide information to establish the required maximum depth for each push and the need for any step-out pushes. The field analytical methods will consist of radiological analyses utilizing a scintillation detector in the cone of the CPT. Gamma radiation levels will be logged and the cone will be stopped at that level during retraction and the output of the scintillation counter will be directed to a multichannel analyzer for an extended count time to determine the isotopes present. Field analysis for VOCs will be performed utilizing a screened intake behind the cone head which transmits soil vapor samples to the surface. At the surface, VOCs will be detected by a combination of photoionization and flame ionization detectors and, if VOCs are detected, the vapor stream will be routed to a GC/MS for speciation and quantification of the gas phase(s) present. This analytical stream will be performed continuously during the penetration.

Field analytical data will serve three purposes. First, the data will provide quantitative to semiquantitative measurements of the subsurface conditions to help guide field decisions regarding the need for continued characterization. Second, the data will provide a mechanism for delineating any vertical and lateral migration of COPCs. Third, the data will be used to aid in the selection of samples to be submitted for laboratory analysis.

Surveying will be conducted to locate each push and sample location. This ensures the extent of migration has been adequately delineated.

4.1.4 Environmental Soil Samples

Environmental soil samples will be collected using the CPT and/or sonic drilling at intervals representing the increased levels of COPCs found and those representing evidence of migration of COPCs beyond the boundaries of the CWD. These samples represent confirmatory analyses for the *in situ* sampling field analytical methods. Soil samples will be collected using lined barrels on the CPT or core barrels. Soil samples will also be collected from the backhoe bucket following the limited excavation activity at the south “bottle” pit. All equipment which contacts soil to be sampled will be decontaminated in accordance with written and approved procedures. Core barrels will be decontaminated prior to each sampling event to minimize the potential for cross-contamination.

Soil samples will be collected with highest priority given to those that will be analyzed for VOCs. Soil samples for laboratory analysis will be collected from selected locations based on a minimum of 20 percent of the number of *in situ* sampling locations. Additional samples may be submitted to the laboratory at the discretion of the Site Supervisor.

The analytes, analytical methods, and associated QC ranges for precision and accuracy of the samples submitted to the laboratory are specified in [Table 4-1](#). Records will be maintained for the geotechnical data, field analytical measurements, and all other relevant data obtained during each push. Pertinent and required sampling information (e.g., date, time, sample interval) for the soil samples collected will be documented in accordance with the Industrial Sites QAPP (DOE/NV, 1996b). Approved chain of custody procedures will be followed to ensure sample integrity.

4.1.5 Geotechnical Samples

The geotechnical samples will be acquired from two pushes at CWD#1 and from one push at CWD#2. At CWD#1, geotechnical samples will be acquired from the disposal area in the vicinity of the trestle and from a trench in the vicinity of R-MAD-West. At CWD#2, geotechnical samples will be acquired from a borehole adjacent to or within the waste trench. An off-site laboratory will perform the analysis of geotechnical parameters listed in [Table 4-2](#). The methods shown are minimum standards; other equivalent or superior testing methods may be used.

Table 4-2
Geotechnical Analyses

Analysis	Method
Initial moisture content	ASTM ^a D 2216
Dry bulk density	EM ^b -1110-2-1906
Calculated porosity	EM-1110-2-1906
Saturated/unsaturated hydraulic conductivity	ASTM D 5084
Particle-size distribution	ASTM D 422
Water-release (moisture retention) curve	ASTM D 3152

^aAmerican Society for Testing and Materials (ASTM, 1996)

^bU.S. Army Corps of Engineering (USACE, 1970)

4.1.6 Background Samples

Background samples will be collected from a background location at each CWD in areas not known to have been disturbed by previous CWD operations. Data from the background locations will be collected in the same manner as the data collection scheme described in [Section 4.1.2](#) of this CAIP. Background information will be used in the CADD to evaluate the significance of the site data and to support the corrective action for this CAU.

4.1.7 Quality Control Samples

Samples will be collected as required by the Industrial Sites QAPP (DOE/NV, 1996b). These samples will include trip blanks, equipment blanks, field blanks, field duplicates, and matrix spike and matrix spike duplicate (MS/MSD) samples. Except for trip blanks, all QC samples will be

analyzed for applicable parameters in [Table 4-1](#). Trip blanks will only be analyzed for VOCs. One set of QC samples will be collected for each CWD. Additional QC samples may be submitted at the discretion of the Site Supervisor.

5.0 Waste Management

Management of investigation-derived waste (IDW) will be based on regulatory requirements, field observations, field screening, and the results of laboratory analysis of CAU 143 investigation samples. Decontamination activities will be performed according to approved contractor procedures as specified in the field sampling instructions and as appropriate for the COPCs likely to be identified within the CWDs.

Waste, other than soil, is potentially contaminated waste only by virtue of contact with potentially contaminated media. Therefore, sampling and analysis of IDW, separate from analyses of site characterization samples, will not be required. The data generated as a result of field screening and soil sampling during site characterization will be used to assign the appropriate waste type (i.e., sanitary, hazardous, low-level radioactive waste [LLW], or mixed waste) to the IDW with the exception noted in [Section 5.3](#).

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

In the following sections, operational requirements are provided for managing sanitary, hazardous, LLW, and mixed wastes. However, when the waste is initially generated, it will be managed according to mixed waste requirements until laboratory analyses are received and a final waste determination is made.

5.1 Waste Minimization

Corrective action investigation activities have been planned to minimize IDW generation. Decontamination activities are planned to minimize the use of rinsate; decontamination materials will consist of detergent, water, and wipes. Disposable sampling equipment, decon rinsate, and personal protective equipment (PPE) will be segregated to the greatest extent possible to minimize the generation of hazardous, radioactive, and/or mixed waste.

5.2 Potential Waste Streams

Historical records and process knowledge do not indicate that hazardous materials were disposed of at the CWDs. Wastes generated during the investigation activities will include the following:

- Potentially contaminated disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, scoops, bowls)
- PPE
- Decontamination rinsate
- Soil

The waste will be managed as two waste streams, and additional segregation will occur within each waste stream based on sample location. Waste will be traceable to its source, field screening measurements, and to individual samples.

5.3 Investigation-Derived Waste Management

To allow for the segregation of radioactive and nonradioactive waste and materials, radiological swipe surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting from within the controlled area. Removable contamination limits, as defined in Table 2-2 of the *Nevada Test Site/Yucca Mountain Radiological Control Manual* (DOE/NV, 1996c), shall be used to determine if such materials may be declared nonradioactive. Once a radioactive or nonradioactive waste determination has been made for a particular waste stream, a sanitary or hazardous waste determination will be made. The final disposition of such wastes will be determined by evaluating the analytical results of acquired soil samples. Management requirements for sanitary, low-level, hazardous, or mixed wastes are discussed further in the following sections.

5.3.1 Sanitary Wastes

Sanitary waste generated outside the controlled area will be contained in plastic bags and will be transported to a solid waste management unit. Sanitary waste generated within the controlled area will be swiped to determine if the removable contamination is under the limits defined in Table 2-2 of

the Radiological Control Manual (DOE/NV, 1996c). Analytical results from the swipe surveys will be used for determining if removable materials will be declared nonradioactive, and analytical results from field screening measurements will be used for determining if the materials will be declared sanitary.

5.3.2 Low-Level Radioactive Waste

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan and the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (DOE/NV, 1997b). Waste containers containing PPE, disposable sampling equipment, soil, and/or rinsate (when full) shall be staged at a designated Radioactive Materials Area pending certification and disposal under NTSWAC requirements (DOE/NV, 1997b). Waste containers shall be labeled “Caution Radioactive Material Pending Analysis.” All containers shall be locked or fitted with tamper-indicating devices (TIDs). Traceability shall be maintained by assigning unique waste tracking numbers to each container and by maintaining records that trace the IDW back to the original sampling locations.

The PPE and disposable sampling equipment shall be placed in clear plastic bags marked with the date and an associated borehole number. The bags will be tagged with a contractor-specific waste tracking tag and will be logged in the contractor-specific waste management logbook.

Rinsate shall be collected in containers that meet DOT specifications (49 *Code of Federal Regulations* [CFR] 172) (CFR, 1997) pending further treatment. Rinsate may be analyzed separately in order to determine final disposition.

5.3.3 Hazardous Waste

Suspected hazardous waste, if encountered, will be managed in accordance with RCRA and State of Nevada hazardous waste management regulations, interpreted as follows. Suspected hazardous waste will be placed in containers that meet DOT specifications (49 CFR 172) (CFR, 1997) and will be locked or fitted with TIDs. The IDW shall be containerized in compliance with Subpart CC of 40 CFR 265 (Elsevier, 1998), and the containers shall be compatible with the waste in accordance with the requirements of 40 CFR 265.172 (Elsevier, 1998). Incompatible waste is not expected to be

generated; however, if incompatible waste is encountered in the field, it will be managed in accordance with 40 CFR 265.177 (Elsevier, 1998) (i.e., shall not be placed in the same container), and separated such that in the event of a spill, leak, or release, incompatible wastes will not contact one another. Containers shall be handled and inspected in accordance with the requirements of 40 CFR 265.173 and 174, respectively (Elsevier, 1998).

Hazardous waste shall be characterized in accordance with the requirements of 40 CFR 261 (Elsevier, 1998). Characterization will be based on laboratory results from soil sampling. Containers containing IDW pending characterization will be marked with the words "Hazardous Waste Pending Analysis" until regulatory status can be determined through interpretation and evaluation of laboratory results. The IDW shall be traceable to its source and/or samples considered analogous to the IDW (such as PPE associated with a sample). Traceability shall be maintained by assigning unique waste tracking numbers to each container and by maintaining records that trace the IDW back to the samples. After receipt of analytical results, hazardous wastes, if identified, will be labeled and marked in accordance with the requirements of 40 CFR 262.32 (Elsevier, 1998) and State of Nevada requirements, including writing the EPA hazardous waste number on the hazardous waste label.

Alpha and gamma spectroscopy are included in the required site characterization analyses to determine if the waste will meet the *Nevada Test Site Performance Objectives for Certification of Nonradioactive Hazardous Waste*, Revision 0 (BN, 1995). These analyses are included in the event the waste generated during site characterization is determined to be hazardous.

Hazardous waste management methods, including the establishment of Satellite Accumulation Areas or a 90-day Hazardous Waste Accumulation Area, will be employed to temporarily accumulate IDW, pending characterization. These methods will be appropriate for the amount of waste being accumulated and will be in compliance with applicable State of Nevada and federal requirements.

Suspected hazardous waste will be accumulated at or near the site of generation for up to 90 days in accordance with 40 CFR 262.34 (Elsevier, 1998). Prior to or on the 90th day of accumulation, as specified in 40 CFR 262.34 (a) (Elsevier, 1998), hazardous waste will be shipped by a licensed/permitted hazardous waste transporter to a permitted treatment storage and disposal facility. If hazardous waste must remain on-site for longer than 90 days due to unforeseen, temporary, and uncontrollable circumstances, a letter requesting an extension for up to 30 days will be sent to the

NDEP in accordance with 40 CFR Part 262.11(b) (Elsevier, 1998). A copy of the uniform hazardous waste manifest shall be provided to the State of Nevada.

5.3.4 *Mixed Wastes*

Mixed waste, if generated, shall be managed in accordance with RCRA (40 CFR 262) (Elsevier, 1998) and State of Nevada NAC 444 (NAC, 1990). These regulations, as well as DOE requirements for radioactive waste, are interpreted as follows. Where there is a conflict in regulations or requirements, the most stringent shall apply. For example, the 90-day accumulation time limit and weekly inspections per RCRA regulations will be applied to mixed waste even though it is not required for radioactive waste. Conversely, while RCRA does not require documented traceability, the waste acceptance program for LLW does; therefore, traceability shall be documented as described in [Section 5.3.2](#).

In general, mixed waste shall be managed in the same manner as hazardous waste, with added mandatory radioactive waste management program requirements. Suspected mixed waste will be managed in accordance with applicable regulations and requirements and will be labeled “Hazardous Waste Pending Analysis” pending characterization and confirmation of its regulatory status. However, once the waste determination is made, or the RCRA 90-day time requirement draws to an end, mixed waste shall be transported via a permitted hazardous waste hauler to the NTS transuranic waste (TRU) storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituents that are below land-disposal restrictions may be disposed of at the Area 5 Radioactive Waste Management Site.

Mixed waste not meeting land disposal restrictions will require development of a treatment plan under the requirements of the Mutual Consent Order between DOE and the State of Nevada (NDEP, 1995).

6.0 *Duration and Records Availability*

Corrective Action Unit 143 schedule and records availability are provided in this section.

6.1 *Duration*

After the submittal of the Final CAIP for CAU 143 to NDEP (FFACO milestone date of, the following is a tentative schedule of activities [in calendar days]):

- Day 0: Preparation for field work will begin.
- Day 60: The field work, including field screening and sampling, will begin.
- Day 100: The field work will be completed.
- Day 155: The quality-assured laboratory analytical sample data will be available for review.
- The FFACO date for the CADD is July 7, 2000.

6.2 *Records Availability*

The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO. This document is available in the DOE Public reading rooms located in Las Vegas and Carson City, Nevada or by contacting the DOE Project Manager.

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Appendix A

Data Quality Objectives for Corrective Action Investigation Plan for Corrective Action Unit 143

A.1.0 Introduction

A.1.1 Problem Statement

The AEC jointly with NASA initiated the development of nuclear rocket engines in 1959. The program known as Project ROVER operated from 1959 through 1972. During Project ROVER twenty rocket engines were tested. Solid radioactive wastes generated during the program were buried at R-MAD CWD #1 and at the E-MAD CWD #2 in Area 25. The wastes are located in trenches, pits, and potentially beneath mounded areas. The focus of this investigation is to characterize and evaluate the nature and extent of contamination in R-MAD-West, R-MAD-East area, one pit south of R-MAD-West, and a trench at E-MAD.

A previous DQO was conducted for CAU 143 and a CAIP was prepared. Prior to starting field activities, additional historical information was obtained which raised concern about the investigative method described in the Revision 0 of the CAIP. Additional historical information suggested that high radiation levels might be present within the area of concern. The field investigation was terminated to reevaluate the original proposed strategy. This revision to the Data Quality Objectives is the product of the additional evaluation.

Purpose: Collect data adequate to close CAU 143 in accordance with the FFACO, NDEP, and DOE requirements potentially as a closure in place.

Conduct a sampling program including (1) *in situ* sampling and analysis and (2) soil sampling and analysis to evaluate the presence and potential extent of migration of COPCs laterally and vertically.

A.1.2 DQO Kickoff Meeting

The goal of the DQO process is to establish the quantity and quality of environmental data required to support the corrective action decisions for the CAU. This process will ensure that the information collected will provide sufficient and reliable information to identify, evaluate, and technically defend the chosen corrective action. Unless otherwise required by the results of this DQO and stated in the CAIP, the investigation will adhere to the *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996b). [Table A.1-1](#) lists the proposed participants at the kickoff meeting.

**Table A.1-1
DQO Meeting Participants**

Participant	Affiliation
Steve Adams	ITLV
Janet Appenzeller-Wing	DOE/NV
Brian Perkins	ITLV
Sabine Curtis	DOE/NV
Mark DiStefano	ITLV
Stephen Duce	ITLV
Cindy Dutro	ITLV
Bob Eastmond	ITLV
Dudley Emer	BN
David Wheeler	DOE/NV
Syl Hersh	ITLV
Brad Jackson	ITLV
Mike McKinnon	NDEP
Kevin Cabbie	DOE/NV
Jeff Smith	BN
Joe Tinney	SAIC

ITLV - IT Corporation, Las Vegas Office

BN - Bechtel Nevada

NDEP - Nevada Division of Environmental Protection

SAIC - Science Applications International Corporation

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

A.2.0 Conceptual Site Model

The conceptual site model ([Table 3-1](#)) describes the most probable scenario for the current conditions present at CAU 143. The resident waste materials are radioactive products disposed of from nuclear rocket testing in the 1960s and 1970s. Although the products of these disposal activities indicate some surface migration of radioactive contamination from the original material placed in the R-MAD confines, there is no available data to indicate subsurface migration of contamination. These waste materials are made up of discarded contaminated nuclear reactor components or irradiated/contaminated engine parts and other solid wastes from maintenance and cleanup activities buried in shallow and deep trenches and pits.

The contaminants were released directly to Area 25 surface and subsurface soils as the result of transport, storage, and disposal of used reactor parts. Vertical and lateral migration of radioactive and hazardous contaminants is considered to be limited to the soil surrounding the waste disposal areas. Exact types and quantities of waste are not known. The dimensions of the actual waste areas are not exactly known. The locations of many large metallic waste items are known. The CAU 143 dumps received solid radioactive wastes. Hazardous materials may also have been disposed of in E-MAD and R-MAD dump areas.

Drive over and walkover radiological surveys have been completed and clearly identify surface radiation. Geophysical surveys have been conducted to verify that waste disposal did occur in identified waste disposal areas. The geophysical and historical data surveys were successful in delineating the lateral limits of soil disturbance, landfill activities, and locating where metallic materials were buried. However, the surveys were not capable of consistently defining the depth of soil disturbance and landfill activities. Two additional surveys were performed at E-MAD (CWD #2) using electrical imaging to assist in defining the size and shape of the waste disposal areas.

There were 20 rocket engines tested in some 30 tests during Project ROVER. Following the nuclear rocket engines tests, the engines and recoverable debris were transported to the R-MAD facility where they were allowed to cool off in a bermed area prior to disassembly. Following

disassembly, parts scheduled for reuse were stored in various areas of R-MAD (CWD #1) and generated waste products and discards were placed within a rail car and dumped from a trestle into a discard pit. After 1963, a series of shallow R-MAD west trenches were used for disposal of radioactive materials.

The nuclear fuel rods were removed from the engines after each test and some were transported to LANL for post operational evaluation. Later this post operation was performed at the R-MAD Jr. Hot Cell facility. One-inch sections were reportedly cut from selected fuel rods for isotopic analysis in Jr. Hot Cell. Each analytical sample discarded solution (1-liter for each 1-inch fuel section) was poured into five 1-liter plastic bottles filled with vermiculite for disposal in the waste trenches. There are reports that some reactor engines without the reactor core were stored and may have been buried on site.

Since the Special Nuclear Material (^{235}U) in the Project ROVER reactor cores was valuable and protected for both safeguards and security concerns, the fuel was removed and transferred off site to Idaho National Environmental Engineering Laboratory (INEEL) for reprocessing. It is highly unlikely that any reactor fuel elements were disposed in CAU 143. There is a strong possibility that small fragments of the Kiwi-TNT reactor and irradiated and contaminated debris are disposed within CAU 143. It is unlikely that significant quantities of uranium are contained within CAU 143 for reasons stated above.

The nuclear engines did generate a large amount of fission products that initially included many radioactive isotopes. Most of these isotopes had short-lived half-lives and decayed quickly. The decay process has reduced the calculated exposure levels by several orders of magnitude in the 35 years since the reactors were first tested. The only fission product observed at CAU 143 is ^{137}Cs which can be detected with gamma instruments, and ^{90}Sr , a beta-emitting radionuclide which can be implied from the ^{137}Cs measurements.

The primary activation products generated during the rocket testing and likely to still be present include ^{60}Co , ^{152}Eu , and ^{94}Nb . Cobalt-60 was produced through neutron activation of stainless steel and has been detected in small quantities in the landfill trenches. Europium-152 is an activation product resulting from neutron activation of soil. Europium-152 has a 13.5-year half life and it is reasonable to assume that some of the activated soil may have been placed in the trenches during

cleanup operations. Another activation product is ^{94}Nb . To reduce erosion and corrosion of fuel from the high velocity hydrogen coolant gas, niobium was used as a cooling channel liner in the graphite rods.

ROVER reactor fuel processed at INEEL indicated the presence of ^{235}U , ^{137}Cs , and ^{94}Nb . The ^{90}Sr concentration can be approximated from the ^{137}Cs concentration. Small quantities of ^{239}Pu were also identified. Calculations of radionuclides associated with the ROVER program tests are reported in *Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site* (Tinney and Wheeler, 1999).

This CAU will be investigated based on the DQOs developed by representatives of the NDEP and DOE/NV. The investigation will determine if potential contaminants have migrated beyond previous boundaries. Information obtained will determine the extent and the impact (if any) to the adjacent surroundings and underlying soil to affect a resolution. Closure will be guided by the NDEP and DOE requirements as outlined in *Federal Facility Agreement and Consent Order* (FFACO, 1996).

A.3.0 Contaminants of Concern

The COPCs are the contaminants that were released directly to CAU 143 surface and subsurface soils as the result of transport, storage, and disposal used reactor parts. Vertical and lateral migration of radioactive and hazardous contaminants is considered to be limited to the soil surrounding the waste disposal areas. Exact types and quantities of waste are not known. The dimensions of the actual waste areas are not exactly known. The locations of many large metallic waste items are known. The CAU 143 dumps received solid radioactive wastes. Contaminants of potential concerns are identified in [Table 3-1](#).

Previous sampling identified ^{137}Cs and ^{60}Co in pits and trenches in R-MAD and E-MAD. Activation products suspected as present in the CAU include ^{60}Co , ^{152}Eu , and ^{94}Nb . Mixed fission products and potential fuel particles that may be found in the Unit include ^{137}Cs , ^{90}Sr , ^{239}Pu , ^{234}U and ^{235}U .

Hazardous materials may have been disposed of in E-MAD and R-MAD Dumps.

**Table A.3-1
Contaminants of Potential Concern**

Potential	Comments	Field Screening Methods	Field Screening Level	Preliminary Remediation Goals/Action Level
Total VOCs	Not expected; however, activities indicate possibility of some VOC's may be present	CPT VOC detectors	20 ppm or 2.5 times background (use greater value)	PRGs ^a NAC 445A ^b
Total SVOCs	Not expected	NA	NA	PRGs ^a NAC 445A ^b
Total RCRA Metals	Unknown	NA	NA	PRGs ^a NAC 445A ^b
Total pesticides, total herbicides and polychlorinated biphenyls	Not expected	NA	NA	PRGs ^a NAC 445A ^b
Total petroleum hydrocarbon (gasoline-and diesel-range organic)	Not expected	NA	NA	100 ppm NAC 445A ^b
Radionuclides	Gross alpha, gross beta; ⁶⁰ Co, ¹³⁷ Cs in previous samples; activation products ⁶⁰ Co, ⁹⁴ Nb; potential fission products ¹³⁷ Cs, ⁹⁰ Sr, ²³⁹ Pu, and fuel particles ²³⁴ U, ²³⁵ U, and ⁹⁴ Nb	Gamma Spectrometry, Electra™ Alpha/Beta Nal detector, and Alpha Spectrometry	Mean environmental background + 2 times standard deviation	The preliminary action levels for radionuclides are isotope-specific and are defined as the maximum concentration for that isotope found in environmental samples taken from undisturbed background locations.

^aEPA Region IX Preliminary Remediation Goals (PRGs) (EPA, 1998)

^bNDEP Nevada Administrative Code (NAC, 1998)

NA = Not Applicable

A.4.0 Decisions

A.4.1 Decisions

Decisions to be made by conducting both *in situ* and laboratory analytical sampling approach to the investigation include:

- Do contaminant concentrations exceed screening levels and PALs as specified in [Table A.3-1](#)?
- Are COPCs present at target locations?
- Have COPCs migrated beyond the initial disposal sites and, if so, to what extent?
- Are data sufficient to allow the development and evaluation of a corrective action?

[Table A.4-1](#) summarizes existing data and data gaps.

Table A.4-1
General Strategies
(Page 1 of 2)

Decision	Input	Existing Data	Data Gap	Strategy
The geophysical properties of the subsurface being investigated	Geotechnical Data	Size and location of trenches are estimated from geophysical survey; exact dimension of cover material and waste disposal area at each CPT location is estimated	Locate base of cover, and bottom of waste disposal area at each CPT location	Collect geotechnical and geophysical data for each CPT location.
Presence of Contamination	Potential contaminant migration	Potential radiological and hazardous contamination; VOC's will be analyzed by soil/gas sampling for verification of hazardous materials	Actual presence of radioactive and VOC contaminants	Use CPT to identify radioactive and VOC contamination; at bias locations, collect gamma spec and VOC analysis data.
Are contaminants present above screening levels beneath trench bottom and/or outside of trench boundaries at CAU 143	Potential contaminant concentrations	Gamma activity and VOC concentrations are not known	COPC concentrations exceeding screening levels	Survey using CPT to define gamma activity and soil/gas concentrations; at bias locations, collect gamma spec and VOC data.
Are contaminants above background levels	Field analytical results and laboratory data from background (uncontaminated) area(s)	Available data on radioactivity and VOCs from other Area 25 projects	Insufficient subsurface background data	Collect geotechnical, radiological, and VOC data from CPT push(es) at background locations for each CWD.
		No subsurface data in the vicinity of either CWD	Lack of subsurface background data	Collect geotechnical, radiological, and VOC data from CPT push(es) at background locations for each CWD.
Are potential contaminants migrating	Potential contaminant migration and distribution	Lateral contaminant migration may extend beyond the area boundaries into surrounding soil	Lateral extent of COPCs	To define the lateral extent of contamination, the CPT will step out 10 ft beyond the point where background readings are obtained.
		Vertical contaminant migration may extend beyond the trench bottoms into surrounding soil	Vertical extent of COPCs	To define the vertical extent of contamination, continue CPT until 10 ft beyond the point to which background readings are obtained, or 10 ft beyond waste disposal area; if contamination extends beyond CPT vertical limit, the local investigation will use roto sonic drilling.

Table A.4-1
General Strategies
(Page 2 of 2)

Decision	Input	Existing Data	Data Gap	Strategy
Data available to support closure	Closure in place	Potential for RCRA constituents; assume industrial PRGs per NAC 445A (NAC, 1998); assume use restrictions with signs and fencing as needed	Concentration of contaminants	Collect <i>in situ</i> and laboratory field data; compare results to screening levels and PALs; prepare CADD.
	Closure in place with engineering controls	Potential for RCRA constituents; assume industrial PRGs per NAC 445A (NAC, 1998); assume use restrictions with signs and fencing as needed	Concentration of contaminants	Collect <i>in situ</i> and laboratory field data; compare results to screening levels and PALs; prepare CADD.
	Closure in place with engineering controls and/or continued monitoring	Potential for RCRA constituents; assume industrial PRGs per NAC 445A (NAC, 1998); assume use restrictions with signs and fencing as needed	Concentration of contaminants	Collect <i>in situ</i> and laboratory field data; compare results to screening levels and PALs; prepare CADD.

A.5.0 Investigative Strategy

IT Corporation will use a CPT to perform *in situ* measurements of gamma radiation, radionuclides, and VOCs at approximately 40 locations and to collect soil samples from biased locations based on at least 20 percent of the number of *in situ* sample locations in CAU 143. Preliminary locations are shown in [Figures 4-2 and 4-3](#). The CPT equipped with a sodium iodide scintillation counter will be used to measure radiation and radionuclides using gamma-ray spectrometry. The CPT will also be used to perform continuous logging of soil gas using onboard PID and FID and VOC analysis using a GC/MS system. These *in situ* field measures and the results of laboratory analyses from soil samples will assist in determining the closure approach for CAU 143. The collective results of the geotechnical information, gamma survey data, and VOC soil gas analyses will be compared to screening levels and soil sample analytical results will be compared to *in situ* field data and the PALs ([Table A.3-1](#)).

The field sampling activities will occur at biased locations selected on the basis of process knowledge, geophysical data, and *in situ* gamma and VOC data to confirm or refute the conceptual model. Initial bias CPT sampling locations will be identified prior to field mobilization and will be adjacent to anomalies and associated disposal areas identified from the geophysical and existing radiological information.

The following activities are associated with the scope of work:

- Bias CPT sampling locations will be identified prior to field mobilization and will be adjacent to anomalies and along disposal areas identified from the geophysical and radiological surveys maps.
- The CPT will be calibrated prior to sampling at the site in accordance with manufacturer's procedures.
- The scintillation detector will be performance tested on-site.
- A minimum of two background push locations will be sampled for radiological measurements and VOC concentrations.
- Sampling will begin within CWD #1 in the South Pit “bottle area” and may include other areas of known elevated radioactivity such as near PVC-4.

- The South Pit (bottle area) will also be sampled via excavation to obtain confirmation of the nature of waste disposition at that location.
- Collection of CPT lithological data will be continuous and will be used to determine when the bottom of the cover material is reached, and delineate the bottom and outer perimeter of the waste disposal unit.
- Soil samples will be obtained for contaminant and soil physical analysis using the CPT and a roto sonic drill rig as directed by the IT lead scientist.
- Count rates will be displayed and collected continuously and will be used to determine gamma presence and potential migration. Gamma spectral measurements will be performed at locations determined by the IT lead scientist.

The QA/QC checks for the scintillation counter and multi-channel analyzer will be performed in accordance with ITLV-0425, "Measuring and Testing Equipment Calibration and Measurement," and ITLV-460, "Daily Source and Background Checks" (IT, 1993).

The CPT will be used to log gamma activity using the scintillation counter and to screen and measure VOC soil gas using a PID/FID and GC/MS. Logging of VOC information will be recorded through the vertical penetrometer push. During the CPT probe withdrawal, the probe may be halted to obtain a gamma spectral analysis. Specific locations for these analyses will be selected by the IT lead scientist. The gamma spectral analysis will be performed using the multichannel analyzer. Each penetration will be grouted to the topical elevation after the probe has been removed.

Data will be collected and compiled daily and copied onto electronic media. Field activity data will be controlled in accordance with ITLV-401, "Field Activities Documentation" (IT, 1993). The collected data will be subject to review and verification before they are used in the assessment of CAU 143. Concurrence from the IT lead scientist and project manager is required.

After logging the pertinent information and completion of *in situ* sampling, the CPT will be configured to collect soil samples. Soil samples for laboratory analysis will be collected from selected locations based on a minimum of 20 percent of the number of *in situ* sampling locations. The site supervisor and IT lead scientist shall choose the location and depth of these soil sample locations. Soil samples will also be used to obtain soil geotechnical data needed for corrective action design.

The CPT using a screened section above the probe will be used for collecting soil/gas VOC data. An inert gas is used to purge the rod and transfer samples to the surface where a GC/MS will analyze the gas. The sample stream will be continuously analyzed with a PID or FID to determine existence of VOCs. Interstitial air samples will be collected at:

- The base of the cover material
- The base of the waste disposal unit
- Bottom of the CPT push
- Locations identified by a PID/FID detection 2.5 times background

The PID and FID will be calibrated regularly in accordance with Standard Quality Practice ITLV-0425, "Measuring and Testing Equipment Calibration and Measurement" (IT, 1993). The GC/MS will be calibrated in accordance with the manufacturer's instructions.

A module located in the CPT tip transports gas samples up to the surface during selected tests. Gas samples may be collected using either of the two following techniques.

- Individual soil gas samples from a specific soil profile or a specific suspected contaminated depth. Multilevel samples in a single push can be recovered without returning the cone to the surface.
- On-line soil gas measurements allow continuous monitoring using multi-gas monitor as the CPT is advanced. A GC/MS can then be used for a more detailed breakdown and analysis of the sample.

To ascertain potential contamination at a specific location, concentrations exceeding the screening levels will indicate potential contamination at that specific location. Background levels of COPCs will be established from a minimum of two CPT pushes located near but outside of the CAU waste areas. Corrective action for this site will be based on *in situ* measurements and confirmatory samples. The following screening levels will be used as a guide for the collection laboratory samples:

- Radiation (gamma) screening level is the mean background activity plus two (2) times the standard deviation of the mean background activity (Adams, 1998)
- VOC levels of 2.5 times background

A.6.0 Decision Rules

The following decision rules will be used to guide the investigation and subsequent data evaluation.

- If during the course of the investigation, any of the following occur, then the investigation method will be reevaluated:
 - The investigative method is inadequate.
 - The conceptual site model fails.
 - Sufficient data are collected to support evaluation of corrective actions.
- If the CPT meets refusal, the advancement will be terminated and moved to an adjacent location.
- After achieving the depth of 10 ft below the bottom of the waste disposal areas, the advancement will be stopped and moved to the next CPT location.
- If, in determining the lateral extent of migration, a depth of 10 ft beyond the point that readings are below background levels is obtained, the advancement will be stopped and moved to the next CPT location.

[Table A.6-1](#) provides additional decision points.

Table A.6-1
CAU Subsurface Specific Decision Points and Rules

Decision Point	Decision Result	Decision Rule
CAN WASTES BE LOCATED AND SURVEYED WITH CPT	Yes	Proceed until 10 ft beyond the point to which background readings are obtained or 10 ft below the waste disposal area
	Yes, but in a different location	Adjust investigation location based on evidence of actual migration contaminant location; proceed until 10 ft beyond the point to which background readings are obtained or 10 ft below waste disposal area
	No	The investigation will use roto sonic drilling
CAN CPT REACH THE LATERAL EXTENT OF MIGRATION	Yes	Proceed until lateral extent of migration is determined; go laterally to 10 ft beyond last indication of COPC
	No	Move to another CPT location and redo, proceed until lateral extent of migration is determined
	No alternate CPT location(s) cannot define perimeter	The investigation will use roto sonic drilling
CAN CPT REACH THE VERTICAL EXTENT OF CONTAMINATION MIGRATION	Yes	Proceed until 10 ft beyond the point which background reading are not obtained or 10 ft below the waste disposal area
	No, due to refusal	Record data; move CPT location and sample again; proceed until 10 ft beyond the point to which background readings are not obtained or 10 ft below the waste disposal area
	No, alternate CPT locations cannot define extent	The investigation will use roto sonic drilling
	No, due to the depth of contamination migration	The investigation will use roto sonic drilling

A.7.0 Decision Error

Biased locations will be selected for CPT pushes. The biased approach is appropriate because the locations of the waste disposal areas are relatively well known or can be reasonably assumed. Lithological data, soil gas information, and total gamma activity surveys will be conducted continuously. Surveying during each push will be conducted for gamma and soil gas analysis. This ensures the extent of the migration has been adequately located, quantified, and identified.

A.8.0 References

Adams, Stephen R. (IT Corporation). 1998. Memo to Robert McCall regarding “Methodology for Determining Preliminary Action Levels for CAU 407, the Roller Coaster RADSAFE Area,” 16 June. Las Vegas, NV.

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

EPA, see U.S. Environmental Protection Agency.

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

Federal Facility Agreement and Consent Order. 1996, as amended. Agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.

Hale, G.S., and C.L. Westenburg. 1995. *Selected Ground-Water Data for Yucca Mountain Region, Southern Nevada and Eastern California, Calendar Year 1993*, Open-File Report 95-158. Carson City, NV.

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IT Corporation. 1993, as amended. *ITLV Program Procedures Manual, Standard Quality Practices*. Las Vegas, NV.

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Nevada Administrative Code. 1998. NAC445A.226 - NAC445A.22755, “Corrective Action Regulations.” Carson City, NV: Nevada Division of Environmental Protection.

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

U.S. Department of Energy, Nevada Operations Office. 1996a. *Industrial Sites Quality Assurance Project Plan*, Nevada Test Site, Nevada, Rev. 1, DOE/NV-372. Las Vegas, NV.

U.S. Environmental Protection Agency. 1998. Memorandum from S.J. Smucker to PRG table mailing list regarding *Region IX Preliminary Remediation Goals*, 1 August. San Francisco, CA.

Tinney, J.F. and Wheeler, D.L. 1999. *Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site*. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

Appendix B

Project Organization

B.1.0 Project Organization

The DOE/NV Project Manager is Janet Appenzeller-Wing, (702) 295-0461. The identification of the Health and Safety Officer and the Quality Assurance Officer for this project can be found in the appropriate DOE/NV plan. However, personnel are subject to change, and it is suggested that the Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Biweekly Activity Report prior to the start of field activities.

Appendix C

Historic Drawings

C.1.0 Historic Drawings For CWD #1 and CWD #2

Figure C.1-1. U.S. Atomic Energy Commission. “MAD Dump Area Expansion Trestle Plan & Profile,” Drawing Number 400-002-C8J.

Figure C.1-2. “Proposed Addition to MAD BLDG,” Dump Area. Drawing Number J6-SK-J125.

Figure C.1-3. Los Alamos Scientific Laboratory. “Burial Pit R-MAD Hot Dump,” Drawing Number J6-SK-JA-509.

Figure C.1-4. Space Nuclear Propulsion Office. “Radioactive Waste Disposal Area E-MAD,” Drawing NRDS-SF-P33/C1.

PROFILE
SCALE: HORIZ. 1"=30'
VERT. 1"=10'

SECTION
SCALE: HORIZ. 1"=30'
VERT. 1"=10'

PLAN
SCALE: 1"=30'

AS-BUILT
HOLMES & HARVEY, INC.
Engineers-Constructors
Cm 3-9-62
Approved: [Signature]

REVISIONS					1A952012		USER APPROVAL: LAGL TWX UG-61-35	
NO.	DATE	DESCRIPTION	CHG'D	APP.	U. S. ATOMIC ENERGY COMMISSION ALBUQUERQUE OPERATIONS OFFICE			
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- NOTES:
1. GRADE ACCESS ROAD; CLEAR & SHAPE SUB GRADE
 2. SPREAD 6" SELECT BORROW AGGREGATE BASE COURSE & COMPACT SOIL TO 95% OF MINIMUM DENSITY @ OPTIMUM MOISTURE CONTENT AS PER AASHTO STANDARD T-99, METHOD 'D'
 3. APPLY 2" LEVELING COURSE OF TYPE II ROAD AGGREGATE; WET & COMPACT
 4. GRADE 600'x800' AREA SHOWN FOR WASTE DISPOSAL FIELD; DIG 1'-10'x10'-200' TRENCH AS SHOWN FOR WASTE BURIAL
 5. INSTALL 200 TEE POSTS @ 10' SPACING & FASTEN (X) 2 STRAND BARB-WIRE TO THE TEE POSTS IN NEW RADIOACTIVE WASTE DISPOSAL FIELD AS SHOWN
 6. CUT WEST SIDE FENCE AS SHOWN & INSTALL NEW 20' CHAIN LINK GATE TO MATCH EXISTING GATE (EXISTING SECURITY FENCE IS 7'-0" HIGH MESH)
 7. INSTALL 28 EACH STANDARD RADIOACTIVE SIGNS @ 100' INTERVALS AROUND DISPOSAL FIELD (N.L.C.)
 8. FENCING WILL BE PUT ON AT A LATER DATE (N.L.C.)
 9. THE HEAVY LINES REPRESENT NEW CONSTRUCTION
 10. PILE EXCAVATED DIRT ALONGSIDE 10'x10'x200' TRENCH

REFERENCE DWS:
1. NTO: F100560 - EVACUATION ROUTE
2. PAA: 3313 & 3315 - E-MAD SITE & PLOT PLAN

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AEC - NASA SPACE NUCLEAR PROPULSION OFFICE - NEVADA NUCLEAR ROCKET DEVELOPMENT STATION JACKASS FLATS, NEVADA						
RADIOACTIVE WASTE DISPOSAL AREA E-MAD				DRAWN BY GENTIN DATE 11-1-97	CHECKED DATE 11-1-97	DATE 11-1-97
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				TELEC DATE 11-1-97	A/C DATE 11-1-97	
SHEET NO. 10-2-67		REQUESTER DATE		WG. NO. 97-000-05112		
PAN AMERICAN WORLD AIRWAYS, INC. SUPPORT SERVICES CONTRACTOR				DRAWING NO. NRDS-SF-P33/1		SHEET 1 OF 1

Appendix D

**Response to
NDEP Comments**

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

(Page 1 of 3)

1. Document Title/Number: CAIP CAU 143, Area 25 CWDs			2. Document Date: June 1998	
3. Revision Number: 0			4. Originator/Organization: IT Corporation	
5. Responsible DOE/NV ERP Subproject Mgr.: Janet Appenzeller-Wing			6. Date Comments Due: June 24, 1999	
7. Review Criteria: Full				
8. Reviewer/Organization/Phone No.: Nevada Department of Environmental Protection			9. Reviewer's Signature:	
10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1) CAIP, Section 3.3, Preliminary Action Levels, last bullet		Technical basis for assigning PALs for gross alpha concentrations greater than 12 pCi/g and gross beta concentrations greater than 18 pCi/g must be provided in the revised CAIP.	The PALs for radionuclides are isotope-specific and are defined as the mean concentration plus 2 standard deviations from the mean for each isotope found in environmental samples taken from undisturbed background locations. Environmental background samples will be taken in the vicinity of CWD #1 and CWD #2. The data from these samples will be compared to radionuclide concentrations found in environmental samples taken from other undisturbed background locations in Area 25 and as presented in McArthur and Miller (1989) and Atlan-Tech (1992).	
2) Appendix D, DOE reply to NDEP Comment 3		<i>"...It is still agreed that gross alpha and gross beta analysis of samples would be performed. If the gross alpha and gross beta concentrations exceed the preliminary action levels (PALs), the alpha spectroscopy and gamma spectroscopy would be performed on the archived samples..."</i> Gross alpha, gross beta and gamma measurements must be performed on each field-screened sample.	Field analysis with the gamma spectrometer in the CPT will provide the identity of the radioisotopes emitting gamma radiation. Our knowledge of the processes and materials deposited in the dump indicates that alpha and beta emitters are always associated with gamma emitters. Soil samples that are taken for laboratory confirmation will be analyzed for gross alpha and beta.	

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3) Appendix D, DOE reply to NDEP Comment 5		The Nevada Administrative Code (NAC) which is referenced (NAC 445A.345) is not "Corrective Action Regulations", but "Definitions" under "Notification of Release of Pollutants". The intended NACs are NAC 445A.226-NAC 445A.22755 (Action Levels for Contaminated Sites) and must be clearly stated in the revised CAIP.	The reference for the "Corrective Action Regulations" has been corrected to NAC 445A.226-NAC445.22755 in the CAIP.	
4) Appendix D, DOE reply to NDEP Comment 10		<i>"...Waste types will be determined from results of soil sampling from the CAIP..."</i> This statement is in conflict with paragraph 5.3.3, "This statement is in conflict with paragraph 5.3.3, <i>"...Characterization will be based on laboratory results from soil sampling..."</i> Waste Classification/characterization will be based on laboratory analysis and must be specified in the revised CAIP.	Waste, other than soil, is potentially contaminated waste only by virtue of contact with potentially contaminated media. Therefore, sampling and analysis of IDW, separate from analysis of site characterization samples, will not be required. The data generated as a result of field screening and soil sampling during site characterization will be used to assign the appropriate waste type to the IDW. The final disposition of such wastes will be determined by evaluating the analytical results of acquired soil samples.	
5) PA, Section 2.4.1, Comments/ Discussion		<i>"...In both meetings, Mr. Lencioni stated that solutions of perchloric, nitric and /or sulfuric acid and one-inch sections of fuel rods were made for analysis. A small part of the mixture was used in the analysis, and the remaining mixture was mixed with vermiculite, placed into 1 or 2 liter bottles, and taken out to the dump. As much as 1,000 liters of this solution may have been put in the dump..."</i> The dump referred to here is CWD 1, which is included in this CAIP. This process may involve "Radioactive high level wastes generated during the reprocessing of fuel rods" which is covered under 40 CFR 268.40, Subpart D, LDR Treatment Standards. The revised CAIP must address whether the required treatment standard was met, and if not, the proposed remedial action.	The analysis of sections of the fuel rods was performed immediately after the reactor run to assess the performance of the core from the distribution of radioisotopes and byproducts within the fuel elements. The one inch sections of the rods that were dissolved for analysis represent approximately 1/50th of the fuel rod volume for a limited number of fuel rods and for a period after these analyses were transferred from LANL to R-MAD Jr. Hot Cell. The remained of the fuel rods and fuel were sent to INEEL for eventual reprocessing (Tinney and Wheeler, 1999).	

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6) PA, Section 2.6.2, Comments/ Discussion, 1st bullet		<i>"...A spur off the main railroad line fed to a graveyard used to bury radioactive test hardware..."</i> Is this spur separate from the two spurs (trestle area and depressed area) already addressed? If different, this area must be located and characterized.	The main rail line ran into the R-MAD building and technically the line to the dump is a spur; the rail line into the dump consists of one line which splits into the trestle line (trestle area) and a second line that ends between the berms (depressed area) where materials on rail cars was temporarily stored to allow materials to cool after rocket engine testing.	
7) PA, Section 2.6.2, Comments/ Discussion, 3 rd and 4 th bullets		<i>"...The depressed section of track may have been built over a disposal pit..."</i> and <i>"...The depressed section of track was re-routed between 1965 and 1969..."</i> It is unclear whether this original depressed section of track is included in the CWD 1 investigation plan. This must be clarified in the revised CAIP.	The southernmost end of the depressed track between the berms was placed over a previously existing pit. There are no records of waste being placed in this pit but it has been targeted for investigation using the CPT.	
8) PA Attachment G-6, Record of Meeting		This meeting references the CALTP experiment wherein a rocket was launched from a tower into a pit. This pit was also used for disposal of the rocket propellant (perchlorate with aluminum flake). The location of this pit must be specified in the revised CAIP if the pit is part of the CWD 1. If not part of the CWD 1, it must be identified as part of another CAU investigation.	The CALTP rocket experiments were carried out from a stand on the north side of the R-MAD building. The testing conducted at this location concerned launch tests to ascertain that the rocket would clear the tower and the rockets were recovered from a pit approximately 50 feet down-range. All these activities occurred north of the R-MAD building and are clearly outside of CAU 143.	

^a Comment Types: M = Mandatory, S = Suggested.

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