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Clean Slate Corrective Action Investigation Plan

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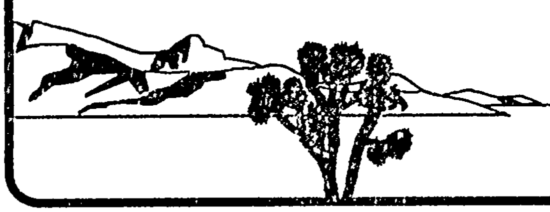

U.S. Department of Energy
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CLEAN SLATE
CORRECTIVE ACTION INVESTIGATION PLAN

DOE Nevada Operations Office
Las Vegas, Nevada

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CLEAN SLATE
CORRECTIVE ACTION INVESTIGATION PLAN

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Nevada Environmental Restoration Project

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List of Acronyms and Abbreviations

AEC	Atomic Energy Commission
amsl	Average mean sea level
AR/COC	Analysis Request and Chain of Custody
ATV	All Terrain Vehicle
°C	Degree(s) centigrade
°F	Degree(s) Fahrenheit
CADD	Corrective Action Decision Document
CAI	Corrective action investigation
CAIP	Corrective Action Investigation Plan
CAU	Corrective Action Unit
CAUWP	Corrective Action Unit Work Plan
CFR	Code of Federal Regulations
cm	Centimeter(s)
CPM	Count(s) per minute
CMS	Corrective Measures Study
COC	Contaminant of Concern
CS-1, CS-2, and CS-3	Clean Slate Locations 1, 2, and 3
DOE	U.S. Department of Energy
DOE/NV	DOE Nevada Operations Office
DOT	U.S. Department of Transportation
DQO	Data Quality Objective(s)
DU	Depleted Uranium
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Project
F+	False positive
F-	False negative
FADL	Field Activity Daily Log
FFACO	Federal Facility Agreement and Consent Order
FIDLER	Field Instrument for the Detection of Low Energy Radiation
ft	Foot (feet)
fps	Foot (feet) per second

List of Acronyms and Abbreviations *(Continued)*

GPR	Ground Penetrating Radar
GPS	Global Positioning System
GZ	Ground Zero
H_a	Alternative hypothesis
HCL	Hydrochloric acid
HNO_3	Nitric acid
H_o	Null hypothesis
H&S	Health and Safety
HASP	Health and Safety Plan
HPGe	High Purity Germanium
IDW	Investigation-derived waste
in.	Inch(es)
IT	International Technology Corporation
km	Kilometer(s)
km^2	Square kilometer(s)
L	Liter(s)
LDR	Land Disposal Restriction
LLW	Low-level waste
m	Meter(s)
m^3	Cubic meter(s)
mg/L	Milligram(s) per liter
MHz	Megahertz
mi	Mile(s)
mi^2	Square mile(s)
mL	Milliliter(s)
mm	Millimeter(s)
M&O	Management and Operating
mph	Mile(s) per hour
M&TE	Measurement and Test Equipment
NAFR	Nellis Air Force Range
NaI	Sodium Iodide
NDEP	Nevada Department of Environmental Protection

List of Acronyms and Abbreviations (Continued)

NV ERP	Nevada Environmental Restoration Project
NTS	Nevada Test Site
NTS PO	Nevada Test Site Performance Objective
NTSO	Nevada Test Site Office
OD	Outside diameter
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
pCi/g	Picocurie(s) per gram
PCB	Polychlorinated biphenyl(s)
PPE	Personal protective equipment
ppm	Part(s) per million
Pu	Plutonium
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
REDAR	Radiation and environmental data recorder
REECo	Reynolds Electrical & Engineering Co., Inc.
RSL	Remote Sensing laboratory
SAP	Sampling and Analysis Plan
SNL	Sandia National Laboratories
SQP	Standard Quality Practice
SSHASP	Site-Specific Health and Safety Plan
SVOC	Semivolatile organic compound(s)
TC	Toxicity characteristic
TCLP	Toxicity characteristic leaching procedure
TRU	Transuranic
TSCA	Toxic Substances Control Act
TTR	Tonopah Test Range
U	Uranium
USAF	U.S. Air Force

List of Acronyms and Abbreviations (Continued)

UXO	Unexploded Ordnance
VOC	Volatile organic compound(s)
yd^3	Cubic yard(s)

1.0 Introduction

The Clean Slate sites discussed in this report are situated in the central portion of the Tonopah Test Range (TTR), north of the Nevada Test Site (NTS) on the northwest portion of the Nellis Air Force Range (NAFR) which is approximately 390 kilometers (km) (240 miles [mi]) northwest of Las Vegas, Nevada.

These sites were the locations for three of the four Operation Roller Coaster experiments. These experiments evaluated the dispersal of plutonium in the environment from the chemical explosion of a plutonium-bearing device. Although it was not a nuclear explosion, Operation Roller Coaster created some surface contamination which is now the subject of a corrective action strategy being implemented by the Nevada Environmental Restoration Project (NV ERP) for the U.S. Department of Energy (DOE).

Corrective Action Investigation (CAI) activities will be conducted at three of the Operation Roller Coaster sites. These are Clean Slate 1 (CS-1), Clean Slate 2 (CS-2), and Clean Slate 3 (CS-3) sites, which are located on the TTR (Figure 1-1). The document that provides or references all of the specific information relative to the various investigative processes is called the Corrective Action Investigation Plan (CAIP). This CAIP has been prepared for the DOE Nevada Operations Office (DOE/NV) by IT Corporation (IT).

1.1 Project Purpose

The primary objective of this project is to collect sufficient data to characterize the extent of contamination from previous on-site activities in the identified areas. The collected data will be used to determine the overall extent of the contamination and to identify and remove "hot spots." Data will also be used to estimate the volume of contaminated soil and debris, to develop closure strategies, and to adequately characterize the soil to meet disposal criteria.

1.2 Investigation Scope

The scope of the CAI includes:

- Collection of *in situ* radiological data to define the horizontal extent of contamination using a variety of instruments
- Determination of vertical extent of contamination by conducting soil depth profiles and *in situ* radiologic measurements at discrete locations

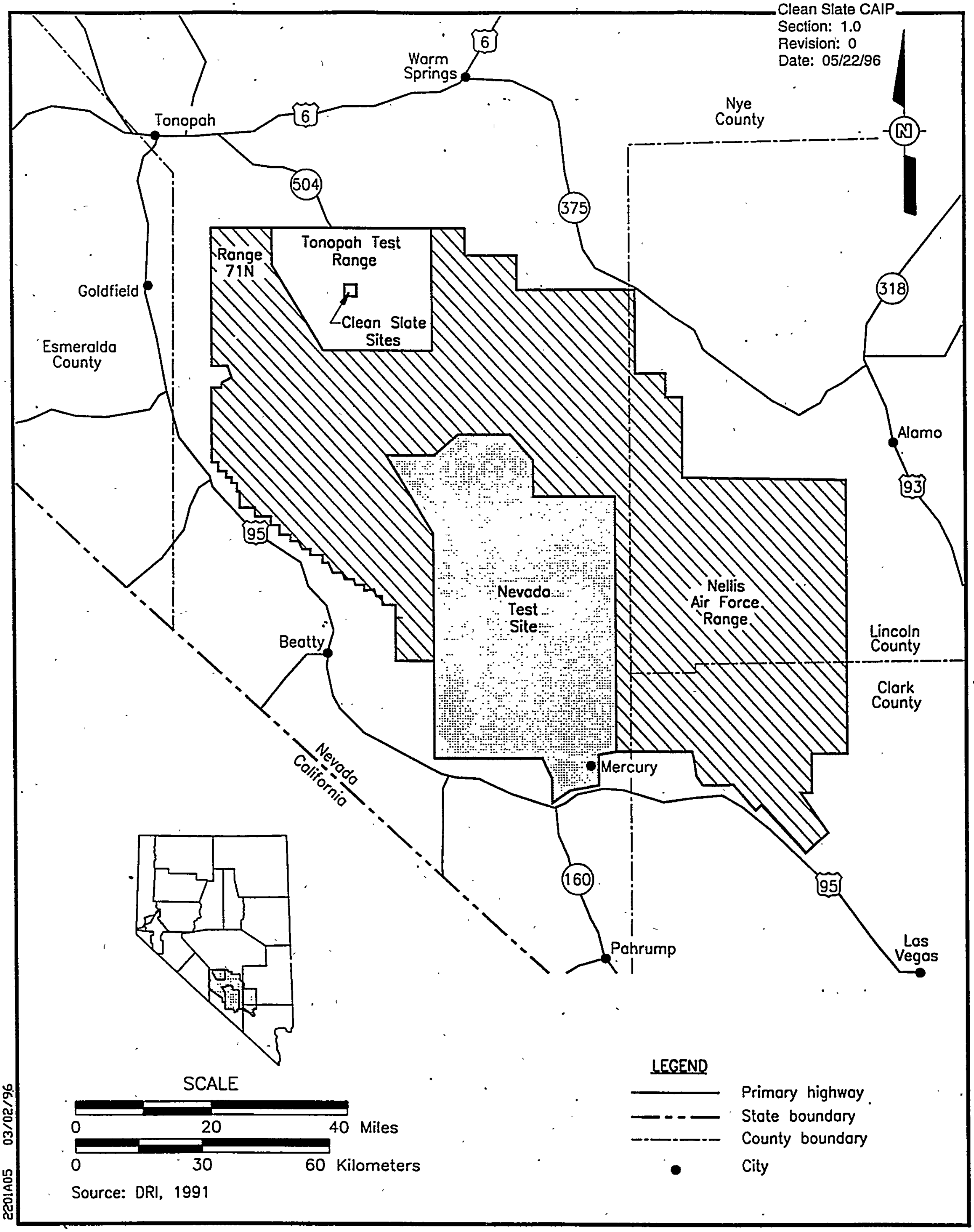


Figure 1-1
General Site Location Map

- Removal of "hot spot" materials and transportation and storage of these materials in the GZ areas

- Locate ground zero (GZ) structures and/or debris using geophysical methods

- Verify the depth of contaminated soils at GZ with hand auger borings and making *in situ* radiological measurements

- Conduct geotechnical, wet chemistry, and radiological analysis of selected soil samples for collection of data required to develop closure strategies and characterize waste

1.3 Document Outline

The remainder of this document provides a detailed description of past and present site conditions, the investigation data quality objectives (DQO), and the methods and procedures to be used for CAI activities. This work plan has been organized as follows:

- Section 1.0 - Introduction
- Section 2.0 - Facility Description
- Section 3.0 - Study Objective
- Section 4.0 - Corrective Action Investigation Sampling and Analysis Tasks
- Section 5.0 - Waste Management Plan
- Section 6.0 - Reporting/Project Schedule
- Section 7.0 - References

The content of this work plan includes the required elements identified in the Federal Facility Agreement and Consent Order (FFACO). Table 1-1 shows the location of information for each FFACO requirement within this document or other reference documents supporting this CAIP. Attached as appendices is a detailed discussion of environmental setting (Appendix A), previous investigation results (Appendix B), a detailed discussion of DQO development for the CAI (Appendix C), and the Site-Specific Health and Safety Plan (Appendix D).

Table 1-1
Federal Facility Agreement and Consent Order Requirements/Corrective Action Investigation Plan Crosswalk

FFACO Requirement	Where the Requirement is Met
Management	DOE/NV ERP Project Management Plan
	CAIP - Timeline
Technical	TTR CAU Work Plan
	CAIP
Quality Assurance	SMOU QAPP
Health and Safety	DOE/NV ERP Health and Safety Plan
	CAIP - Site-Specific Health and Safety Plans[a]
Public Involvement	FFACO Appendix V, Public Involvement Plan
Field Sampling	CAIP
Waste Management	TTR CAU Work Plan

[a]A Site-Specific HASP has been prepared and is attached as Appendix D. This plan will be changed accordingly as CAIP field activities are conducted.

ERP - Environmental Restoration Project
SMOU - Soils Media Operable Unit
QAPP - Quality Assurance Project Plan
CAU - Corrective Action Unit

2.0 Facility Description

The TTR is located in Nye County in southern Nevada, on the northwestern portion of the NAFR. CS-1, CS-2, and CS-3 are located in the central portion of the TTR approximately 224 km (140 mi) northwest of Las Vegas by air and approximately 64 km (40 mi) southeast of Tonopah, Nevada. The approximate locations of these facilities are shown in Figure 2-1. A detailed discussion of regional and local topography, surface soils, geology, hydrogeology, and climate which may effect the migration of contaminants is provided in Appendix A.

2.1 Site History

Prior to 1940, TTR was used mainly for grazing, hunting, and numerous small mining operations for gold, silver, and other metals. In 1940, over 1.2 million hectares (3 million acres) were transferred from the U.S. Department of the Interior to the War Department. This area became the Las Vegas Bombing and Gunnery Range, the predecessor to the NAFR (Sandia, 1964).

In 1956, a Memorandum of Understanding between the U.S. Air Force (USAF) and the Atomic Energy Commission (AEC), a predecessor agency to the DOE, provided 149,448 hectares (369,280 acres) to the AEC for the creation of the TTR. This facility became operational in 1957 with Sandia National Laboratories (SNL) in charge of operating the TTR facility.

Since 1957, the TTR has been used by the United States government as a test site for weapons ballistics, rocket and gun firings, chemical explosives, and nuclear ordnance. In May and June of 1963, experiments were conducted at three locations (CS-1, CS-2, and CS-3) as part of Operation Roller Coaster. The primary function of this project was to study the dispersion of plutonium from nonnuclear explosions of plutonium weapons. The experiments required the detonation of various simulated weapons from a variety of near-surface structures. Surface air sampling, deposition sampling, and some animal exposure studies were completed to study the distribution of plutonium from these detonations.

Radiological measurements taken during and immediately after the experiment indicated that surface contamination was of sufficient activity that perimeter fences were constructed to isolate the most highly contaminated areas. Since the completion of Operation Roller Coaster, the CS sites have been monitored to evaluate the potential migration of radiological contamination from surface winds and/or surface water infiltration.

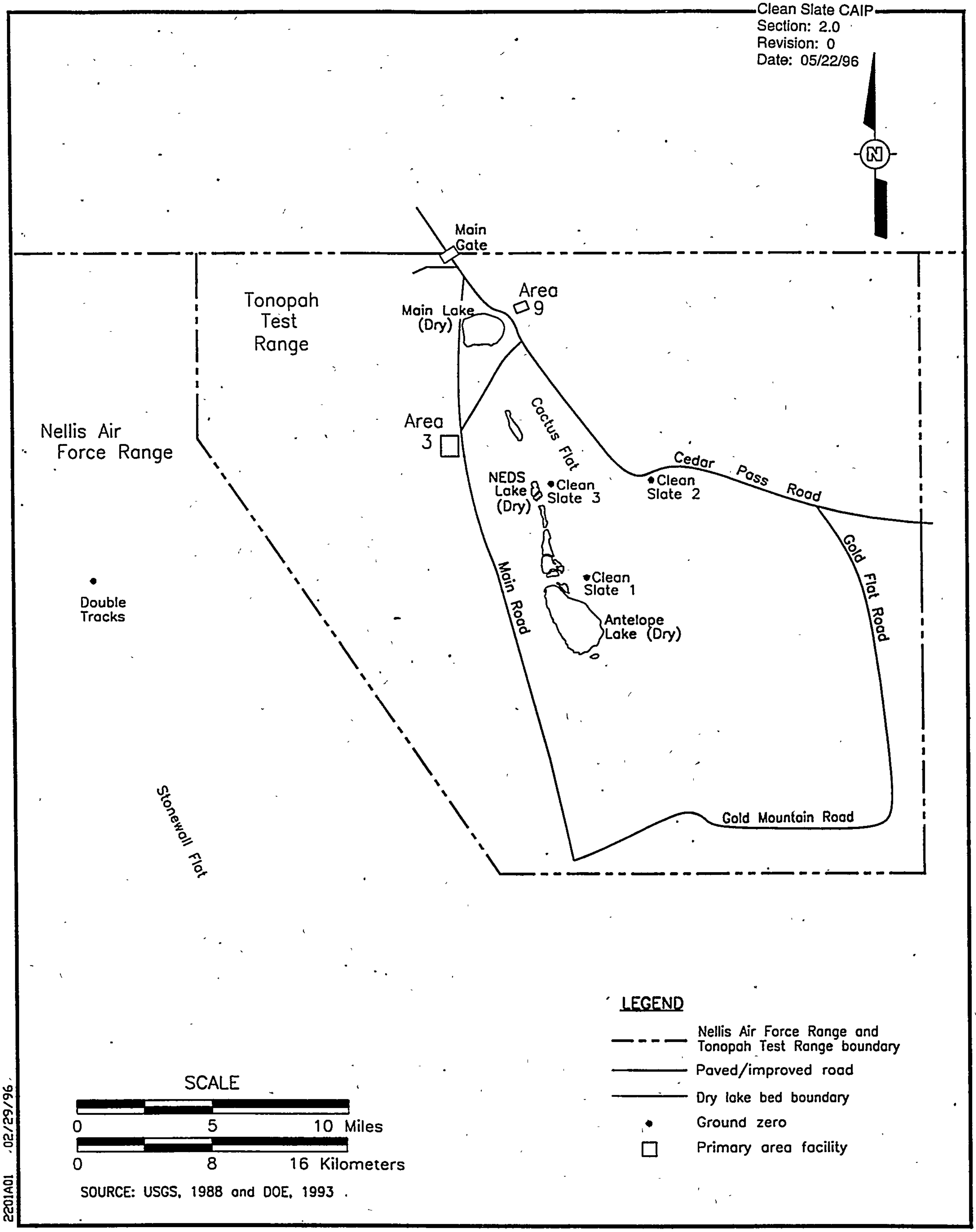


Figure 2-1
Clean Slate Site Location Map

The TTR is presently in use by the government for conventional nonnuclear weapons testing-related activities; however, the CS sites have remained inactive within the perimeter fenced areas.

2.2 Investigation Background

Extensive investigations were completed by Sandia Corporation at the CS sites in 1963 as part of the Operation Roller Coaster experiments. Since the completion of the experiments, numerous studies have been conducted to monitor the migration of contamination associated with Operation Roller Coaster activities (Shreve, 1965). A detailed discussion of the various CS site investigations and monitoring programs is provided in Appendix B.

2.3 Waste Inventory

Based on Sandia Corporation historical site information, the only waste materials documented at the CS sites are the radioactive debris and soil buried near the GZ at each CS location. These materials have been contaminated with plutonium (Pu) 239/240, depleted uranium (U) 238, and trace amounts of other isotopes as a result of the Operation Roller Coaster experiment. An unquantified volume of soil outside the GZ has also been contaminated.

2.4 Release Information

The only documented release of contamination at the CS sties was the Pu-239/240 and depleted uranium (DU) dispersed during the Operation Roller Coaster experiment. Quantities of the materials used during the experiment varied at each site, and the actual quantities of radioactive materials are classified. The approximate mass ratios of uranium to plutonium used for each test are provided below.

- CS-1 47.2:1 depleted uranium to total plutonium
- CS-2 100.4:1 depleted uranium to total plutonium
- CS-3 99.7:1 depleted uranium to total plutonium

The americium to plutonium ratio of the material used in the Clean Slate experiments is not known, but is suspected to be the same as that used at the Double Tracks Test Site experiment.

3.0 Study Objectives

The objective of the CAI is to develop sufficient data of acceptable quality to determine the extent of contamination at the CS test sites for the purpose of developing a cost-effective and environmentally acceptable closure strategy for each individual test site. To meet these objectives, a conceptual model has been developed for each test site. DQOs have been established, and a technical approach identified for completion of the work.

3.1 Conceptual Model

The conceptual model for the CS sites takes into account the source of the problem, the potential migration pathways, the potential receptors, the contaminants of concern, the regulatory requirements dictating characterization, and the closure strategy. The conceptual model for the CS sites was developed from available historical information related to the Operation Roller Coaster experiment (Shreve, 1964) and previous investigation results (Gilbert et al., 1975).

Due to the similarity of the data for the three CS sites, a single conceptual model has been prepared, and any differences in the data provided for a specific site are identified in the conceptual model. This model will be used as the basis for the CAI and is described as follows.

3.1.1 Contaminant Source

- Plutonium and DU in the devices used for the CS experiments were spread over an extended area of CS-1, CS-2, and CS-3 when the experimental devices were detonated using conventional high explosives.

3.1.2 Migration Pathways

- Radioactive materials were dispersed from GZ by the force of the detonations and carried downwind from the sites in the debris cloud.
- Minimal quantities of radioactive materials have migrated further downwind of the sites from surface erosion of soils by wind.
- Vertical contamination within the near-surface soils is limited to approximately the top 5 centimeters (cm) of soil in areas outside the GZ exclusion fences.

- Vertical contamination in the GZ areas is located in mounded and/or burial areas. Depth of contamination is estimated to be within the top 1.5 meters (m) (5 feet [ft]) of soil at CS-1 and CS-2, and 3.0 m (10 ft) at CS-3 (TTR Project Manager Report - Unpublished Reference).

- Lateral contamination is confined within the perimeter exclusion fences with some minor areas outside the fences at CS-1 and CS-2 (e.g., east of CS-1, southwest of CS-2).

- Surface water has had minimal impact in vertical migration of radioactive materials due to infiltration or horizontal transport due to surface erosion.

- Groundwater is not present within 30.5 m (100 ft) of the ground surface at each location and has not been impacted by the contaminants of concern (COC) originating from the CS experiments.

- Estimated volumes of soil to be excavated are 2,500 cubic meters (m^3) (3,330 cubic yards [yd^3]) for CS-1; 10,200 m^3 (13,330 yd^3) for CS-2; and 21,200 m^3 (27,780 yd^3) for CS-3.

- See Figures 3-1, 3-2, and 3-3 for maps of each Clean Slate Site.

3.1.3 Potential Receptors

- On-site personnel are considered to have minimal exposure and associated risk due to existing fences which limit site access.

- Plants and roaming animals (i.e., large mammals) outside the fenced enclosures are considered to have minimal exposure and associated risk.

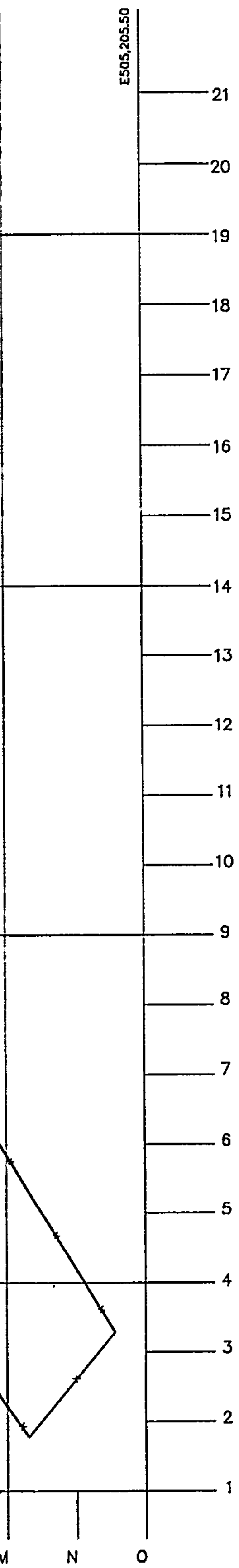
- Future land use in close proximity to the site could be negatively impacted by the presence of contamination remaining at the site.

3.1.4 Contaminants of Concern

- The COCs for the CS individual test sites consist of radioactive materials (including Pu-239/240, Am-241 and U-238) dispersed from the detonation of the Operation Roller Coaster experimental devices, and those analytes required for disposal under NVO-325.

3.1.5 Site Characterization Controls

The conceptual model site characterization controls are the assumption made concerning anticipated characterization results.



LEGEND

Perimeter fence

o GZ Ground zero (GZ) location

200 200-pCi/g contour based on 1993 aerial survey by EG&G

NOTES

Site location and fences based on REECo drawing No. 52-TTS-C34.1, titled "Clean Slates #1 Grid" (As-Built).

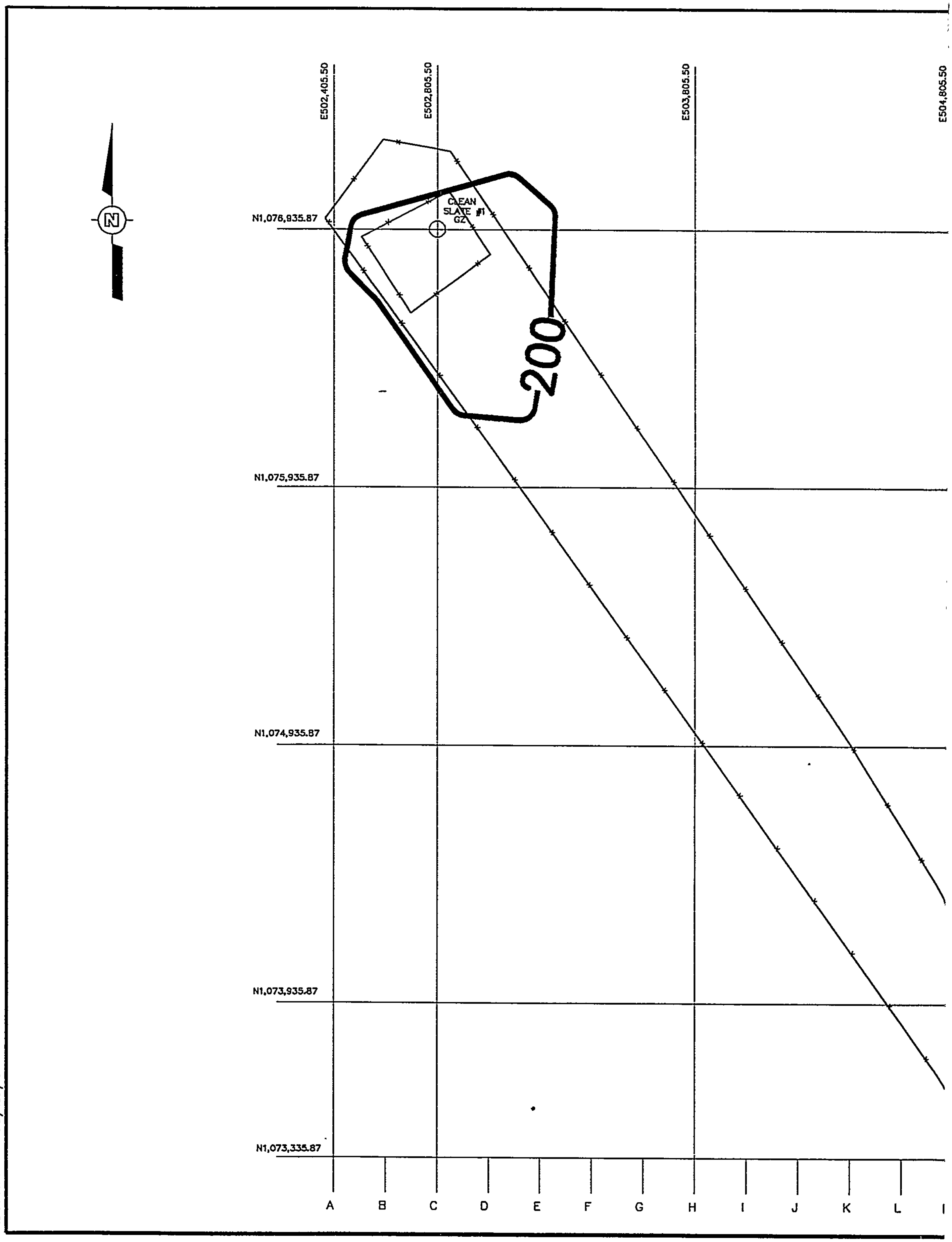
200-pCi/g contour based on Proctor and Hendrix, 1994.

SCALE

0 500 1,000 Feet

0 200 400 Meters

Figure 3-1
Clean Slate #1 Site Plan



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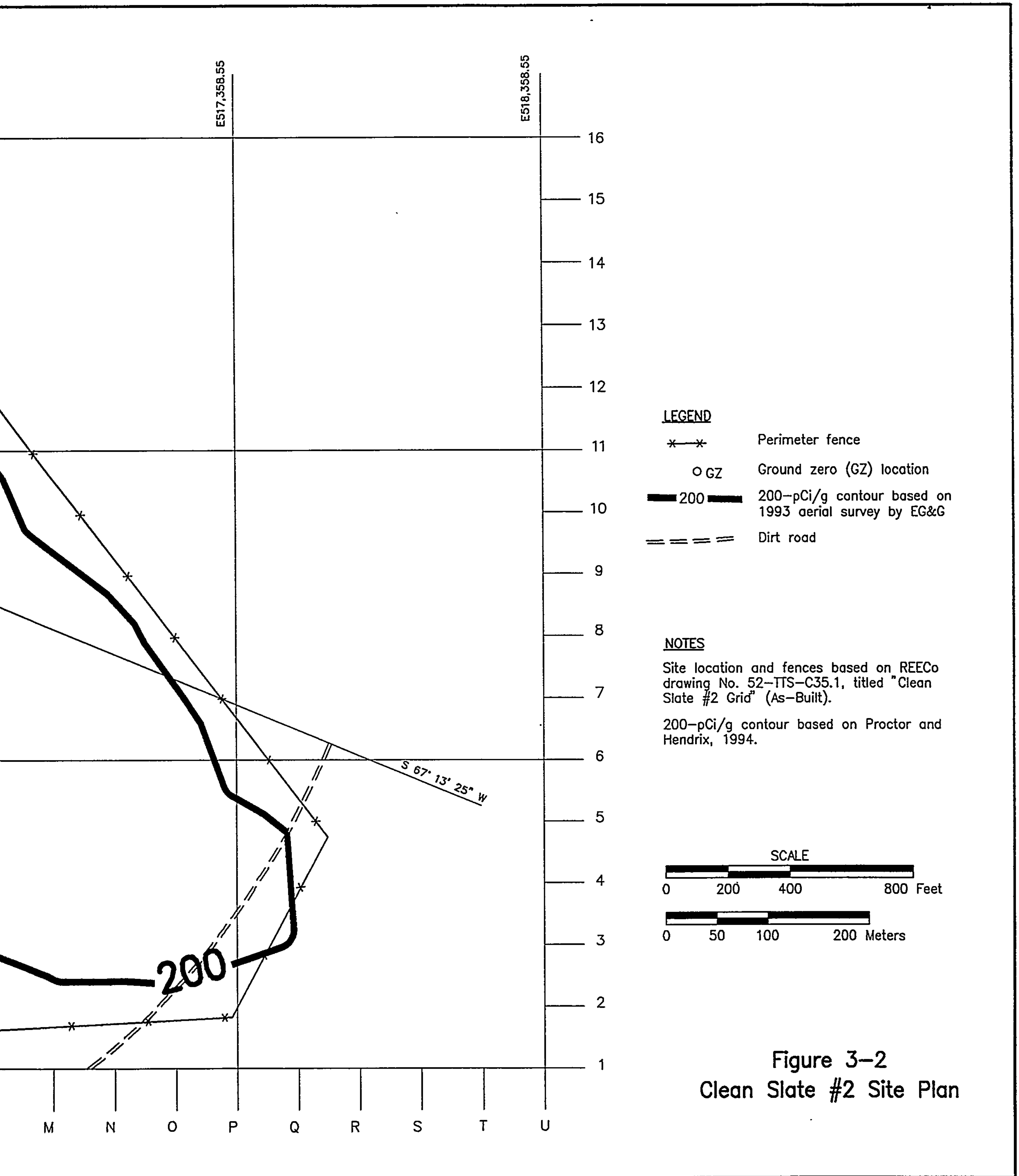
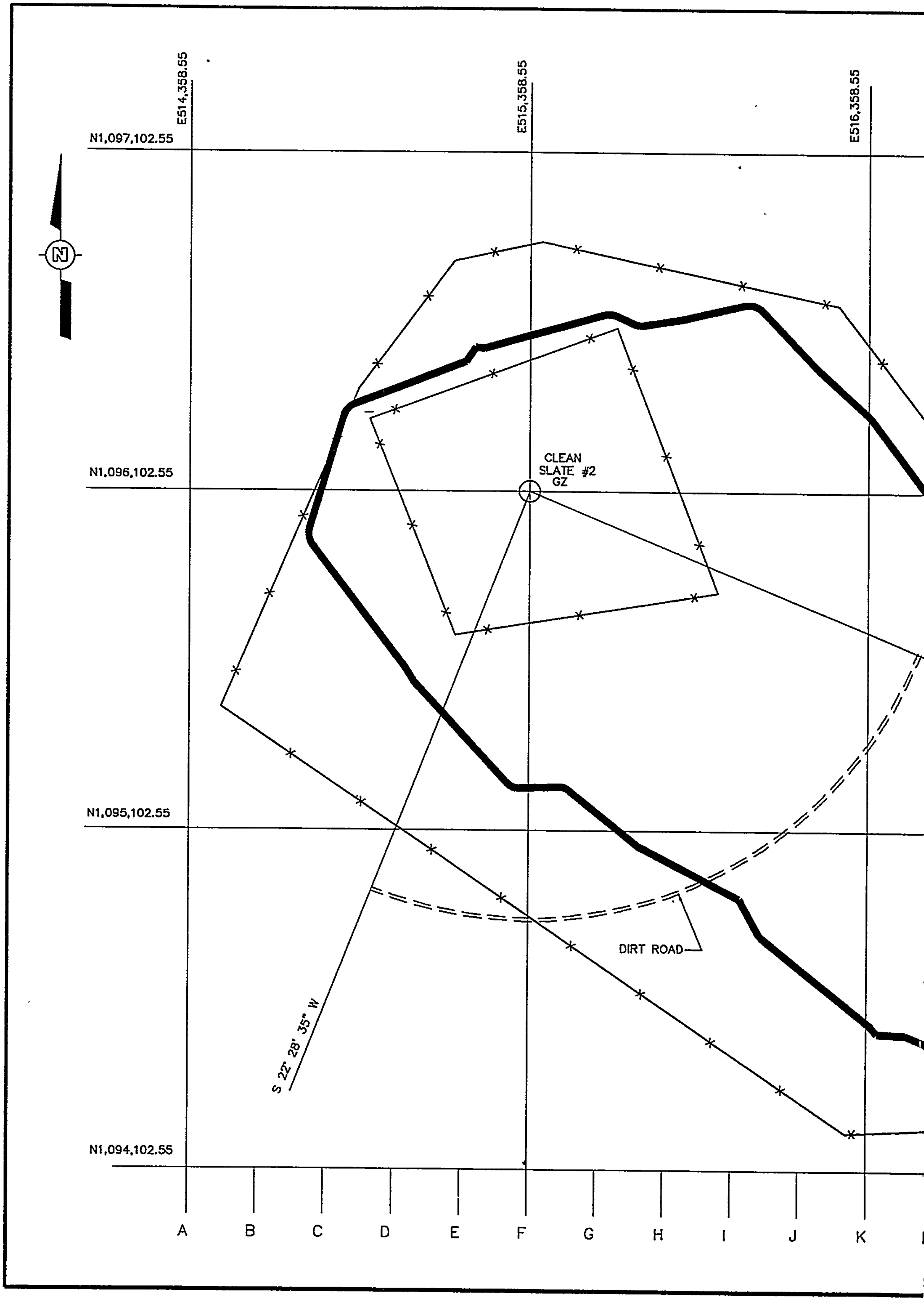


NOTES

Site location and fences based on REECo drawing No. 52-TTS-C35.1, titled "Clean Slate #2 Grid" (As-Built).

200-pCi/g contour based on Proctor and Hendrix, 1994.

Figure 3-2
Clean Slate #2 Site Plan



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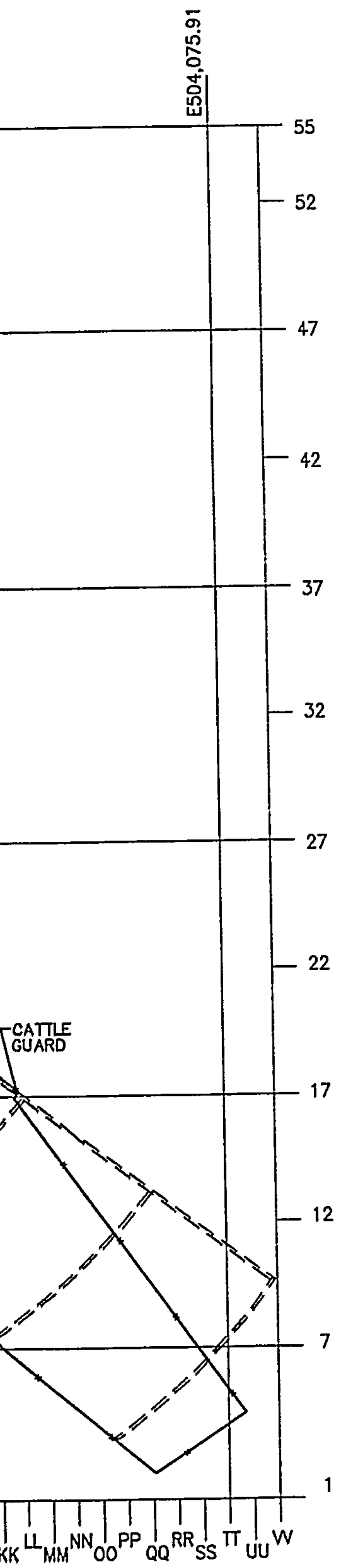


LEGEND

Perimeter fence

o GZ Ground zero (GZ) location

—200— 200–pCi/g contour based on 1993 aerial survey by EG&G

Dirt road

NOTES

Site location and fences based on REECo drawing No. 52–TTS–C36.1, titled "Clean Slate #3 Grid" (As–Built).

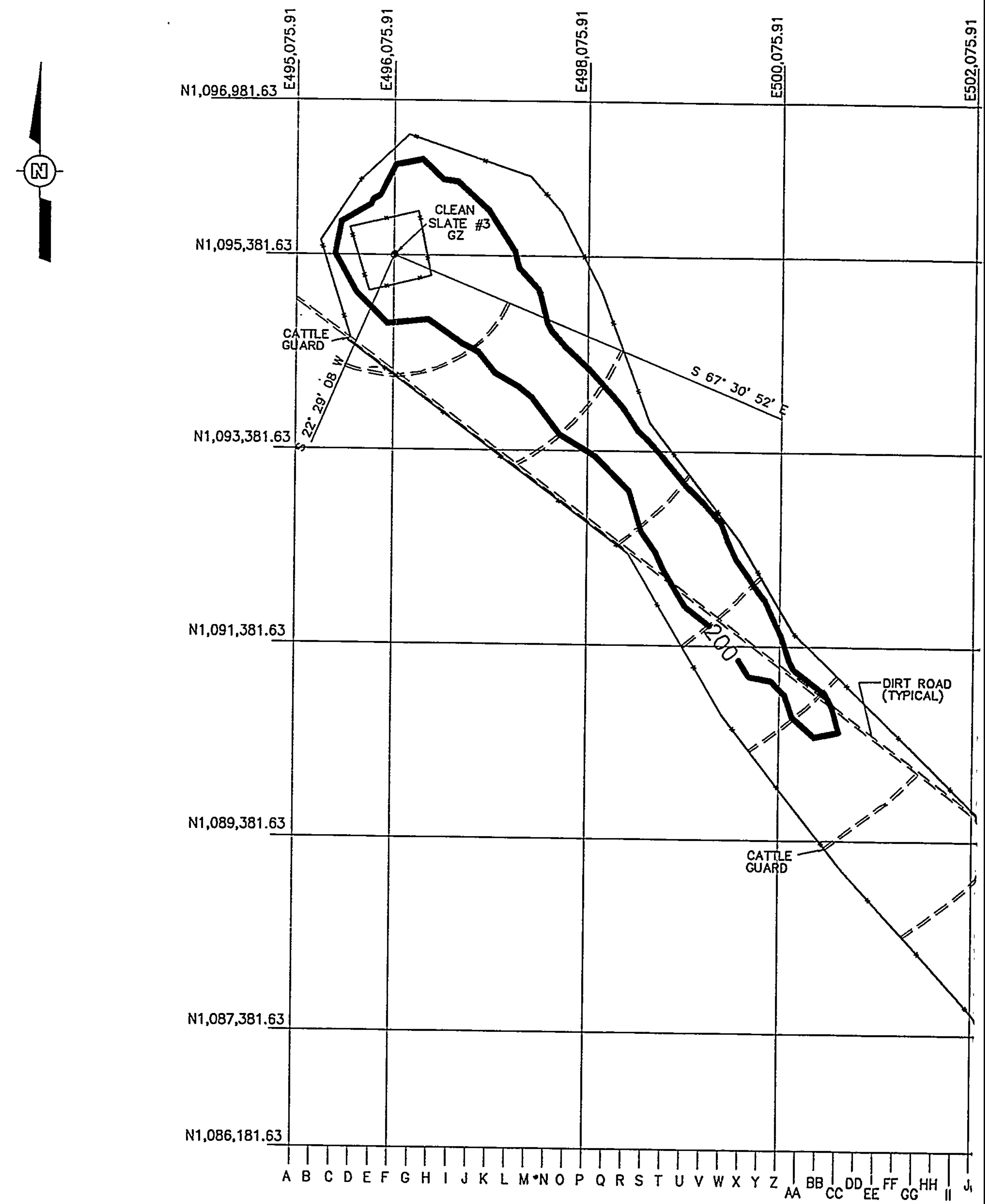
200–pCi/g contour based on Proctor and Hendrix, 1994.

SCALE

0 1,500 3,000 Feet

0 400 800 Meters

Figure 3–3
Clean Slate #3 Site Plan



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- Contaminant materials to be removed with respect to the following CAI activities:
  - Soil materials collected for analysis as part of the characterization activities
  - The generation of other investigation-derived waste (IDW) (i.e., personal protection equipment and decontamination water) as a result of characterization activities
- Contaminants/waste types:
  - Soils and other IDW generated are expected to be considered as low-level radioactive waste (LLW).
  - Small quantities of Transuranic (TRU) waste may be generated from collection of metal debris from the original experiment devices. Transuranic, as used in this CAIP, is "waste that is contaminated with alpha emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay." (DOE Order 5820.2A, Attachment 2.)
- Regulatory requirements:
  - Soils and IDW will be managed by temporary on-site storage until completion of CAI activities with final disposal of the soils and IDW at the NTS facility.

3.1.6 Closure Strategy

The sampling objectives will be incorporated into a sampling methodology providing data that will confirm, modify, evaluate, or refute the presented conceptual model. The proposed data-collection activities will provide data that are meaningful, valid, and defensible and will be used to develop an acceptable, cost-effective closure strategy. The proposed closure strategy for the three CS test sites includes excavation of contaminated soils with activities identified as the result of a risk assessment of the sites and disposal of these materials at an NTS disposal facility. For the purpose of site characterization activities an activity level of 200 picocuries per gram (pCi/g) has been chosen to identify potential areas requiring remediation. After completion of remediation activities, the sites will be resurveyed to ensure all excess radioactive contamination has been removed and then the site will be revegetated. The fences will be removed after vegetation has been reestablished to prevent grazing animals from disturbing the freshly replaced plants.

3.2 Data Quality Objectives

The approach to site characterization at the CS sites is an iterative process. As part of the quality assurance (QA) and quality control (QC) program for the project, an approach described in *Data*

Quality Objectives Process for Superfund (U.S. Environmental Protection Agency [EPA], 1993) is employed to ensure that the environmental data gathered for site characterization are adequate to support further characterization, remediation, and/or the development of a closure strategy for the CS sites. The DQO process allows conceptual models and resulting project decisions to be refined as additional information or data needs are discovered or generated during the implementation of site characterization activities.

The DQO process outlined in the EPA document consists of seven steps that are applied to design the initial sampling plan and are reevaluated as more information becomes available during the site investigation. These steps are:

1. Problem Statement - stating the problem to be resolved

2. Identification of Decisions - the principle study question(s) that must be answered by the characterization and the decision process

3. Decision Inputs - identifying inputs to the decision (i.e., data needs)

4. Study Boundaries - defining the characteristic, spatial, and temporal study boundaries

5. Decision Rules - developing decision rules (i.e., logic statements)

6. Decision Error Limits - developing limits on decision errors (i.e., uncertainty constraints)

7. Design Optimization - developing a Sampling and Analysis Plan (SAP) for obtaining data that satisfies the needs identified in steps 1 through 6

Details regarding the DQOs for the characterization of the three CS sites are provided in Appendix C.

3.3 Technical Approach

To date, the characterization activities at the CS sites have included:

- Extensive site investigation and sampling activities were part of the Operation Roller Coaster experiment. The investigations provided data regarding the extent and activity of radioactive contamination (Shreve, 1965).

- Numerous studies following the completion of Operation Roller Coaster were used to further monitor the extent of contamination as well as the potential migration of contaminants from winds and/or surface water (Gilbert, 1975).

- Data from the characterization of the Double Tracks Test Site, which was also part of the Operation Roller Coaster experiment, has provided analogous contaminant soil characterization and transport data regarding the potential migration of contamination especially from surface water infiltration (DOE, 1996).

- This CAIP has been developed to guide the collection of field data. The DQOs process (EPA, 1993) has been employed to formulate a sound, logical sampling plan for the collection of data. The primary objective of this plan is to produce data that are adequate for determining further characterization and/or closure strategies for the site.

The CAI will be conducted to allow for either the modification or termination of characterization activities (when it is determined that sufficient data exist to support or refute the conceptual model). The CAI will consist of a multiphase investigation with the results of initial surveys to be used as the baseline for additional survey tasks. However, if during planned CAI activities, the conceptual model is proven to be incorrect (i.e., the extent of contamination is greater than predicted), a contingency has been developed to adjust the scope of the CAI. For example, this contingency may include the modification of the radiological surveys to include areas outside the original study limits to fully identify the extent of contamination.

The approach for the completion of the CAI at the CS sites will involve the following activities:

- Conduct an *in situ* field survey to detect low energy radiation with three FIDLERs mounted of the front of an all-terrain vehicle (ATV). The primary function of this survey will be to verify the site boundaries established based on existing aerial survey results and identify and remove "hot spots" which could affect other survey activities.

- Complete a detailed radiological survey using a system composed of three pods of Sodium Iodide (NaI) detectors mounted on the rear bumper of a specially modified Suburban vehicle (named the KIWI). The objective of this survey will be to accurately establish the lateral extent of contamination requiring corrective action.

- Complete depth profile measurements at selected locations using a tripod-mounted collimated High Purity Germanium (HPGe) detector and also a NaI detector. The two objectives of this activity are to obtain data regarding the vertical extent of soil contamination and to determine the depth at which contaminants are being measured when surface radiation measurements are taken.

- Complete the bias soil sampling program at selected locations to verify Pu-239/240 and Am-241 ratios as well as U-238/Pu-239 ratios. Samples will be selected from areas indicating contamination as identified by other site characterization activities and for samples selected to satisfy disposal requirements.

- Complete the *in situ* field survey with a mast mounted HPGe detector at selected locations. This HPGe detector can measure with more accuracy the radioactive contaminants than the other detectors employed. The detector system's disadvantage is that it is more time consuming than the other systems. This detector system will be used to cross check the other detector systems, and take measurements in areas where the other detectors are not getting reliable results. This mast HPGe detector system will also be used to collect background and isotopic ratio measurements.

- Complete nonintrusive geophysical surveys (i.e., electromagnetic [EM], magnetic and Ground Penetrating Radar [GPR]) in an attempt to locate the concrete pad at CS-1 and any burial areas at CS-2 and CS-3.

- Complete hand auger borings within the GZ areas to determine depths of contamination and assist in locating buried structures.

- Site survey data and analytical data will be used to determine whether the conceptual model for the site is valid or if additional investigations are required to support an alternative model.

- The data will be used to propose a plan for achieving closure of the site and for evaluating the regulatory requirements of the waste generated during closure activities.

The field sampling and analytical programs have been designed to meet the DQOs for the CAI and are presented in the SAP found in Section 4.0 of this plan. A more complete discussion of the types of detectors and their capabilities is presented in Section 4.3.

4.0 Corrective Action Investigation Sampling and Analysis Tasks

Data will be collected during the CIA to confirm or refute the conceptual model for the CS sites, thus assessing the concentration of COCs and determining the extent of COCs which exceed the characterization contaminant level of 200 pCi/g. Samples will also be collected to determine disposal options for contaminated soils and for treatability studies used for evaluating closure strategies. The site boundaries for CAI activities are shown in Figures 3-1, 3-2, and 3-3. The following sections define the technical approach and detail activities to be completed for the CAI. Unexpected site conditions may require modifications of the CAI as well as the conceptual model for the site and/or the DQOs for the CAI.

4.1 Project Organization and Responsibility

To ensure that data obtained from this characterization are of adequate quality to meet project goals, the project roles and responsibilities must be defined and the lines of communication established. These lines of communication need to be established prior to the data collection effort in anticipation of difficulties and changes that typically occur with all field efforts. By establishing these lines of communication early, changes to strategy and scopes of work presented in this CAIP can be made in a well informed, timely, and cost-effective manner.

4.1.1 Project Responsibilities

The Soils Media Quality Assurance Project Plan (QAPP) (DOE, 1996) describes the project-wide responsibility. The intent of this section is to describe the subproject responsibilities, in particular, as they apply to the characterization activities that will be conducted at the CS Sites. The responsibilities of the primary project personnel are described in the following paragraphs. The Clean Slates CAIP Project Organizational Chart is presented in Figure 4-1.

4.1.1.1 DOE/NV Project Manager

The DOE/NV Project Manager reports directly to and is the prime point of contact with the DOE/NV Program Manager. The DOE/NV Project Manager has day-to-day management responsibilities for the technical, financial, and scheduling aspects of the subproject and shall

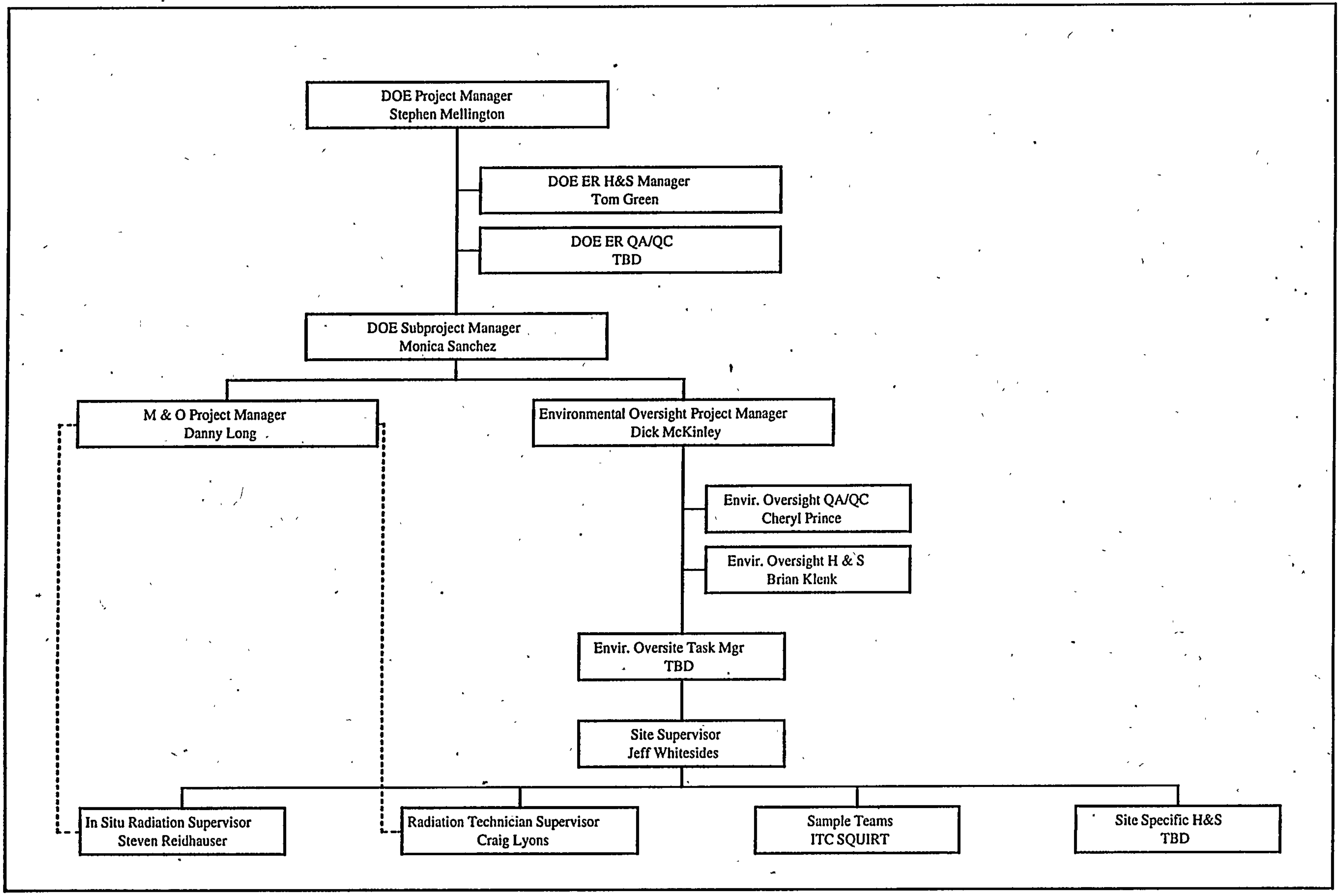


Figure 4-1
Clean Slate Corrective Action Investigation Plan Organization Chart

monitor contractor performance of project activities. At a minimum, the DOE/NV Project Manager shall:

- Review, approve, and direct the implementation of the CAIP.
- Participate in the organization and planning of activities to consistently meet project quality objectives.
- Disseminate pertinent information from DOE/NV to project participants.
- Review and approve variances to DOE/NV project documents.
- Notify the DOE/NV Program Manager, the DOE/NV Quality Assurance Coordinator (QAC), and other involved personnel of significant conditions adverse to quality or any identified trends.
- Monitor the quality-achieving activities of participating organizations and provide direction and guidance for improvement.

4.1.1.2 DOE/NV Quality Assurance Coordinator

The DOE/NV Quality Assurance Coordinator (QAC) reports to the DOE/NV Program Manager and has a direct line of communication with the DOE/NV Project Manager. The DOE/NV QAC is responsible for assisting project management in the verification and implementation of the CAIP and will provide the overall direction of the quality assurance function. At a minimum, the DOE/NV QAC shall:

- Identify and respond to QA and quality control needs, resolve problems, and provide guidance or assistance.
- Review and evaluate quality-related changes to the CAIP and other documents that contain QA criteria.
- Verify that appropriate corrective actions are taken for nonconformances.
- Notify the DOE/NV Program Manager, the DOE/NV Project Manager, and other involved personnel of significant conditions adverse to quality or any adverse trends.

4.1.1.3 Nevada Test Site Office

The Nevada Test Site Office (NTSO) provides field direction and coordinates activities among contractors at the NTS and TTR. The assigned NTSO Project Manager ensures that the performance of any site activity are in compliance with approved plans, procedures, specifications, and QA requirements.

The NTSO Project Manager shall be consulted regarding Corrective Action Unit activities at the TTR because it is currently an operational responsibility of the NTSO. The direction of the TTR Site Manager shall be sought in the scheduling and coordination of CS site CAI field efforts with TTR range operations personnel.

4.1.1.4 Corrective Action Investigation Plan Participants

Participants in the CAIP are responsible for ensuring that all work is performed in accordance with applicable federal, state, local, and DOE regulations; applicable QA program requirements; and approved subproject plans and procedures. To fulfill responsibilities specific to QA, the contractor subproject management shall, at a minimum:

- Report to the DOE/NV Project Manager about scope, schedules, costs, technical execution, and quality achievement of task order activities.
- Ensure that proper resources and budget are provided for QA personnel and that QA activities are integrated into subproject activities.
- Evaluate task order activities to ensure that planning document requirements are implemented.
- Implement procedures and instructions that govern CAIP project activities.
- Ensure that work is technically sound, of acceptable quality, and consistent with subproject objectives.
- Evaluate the qualifications of personnel and identify and provide additional training, as needed.
- Ensure that personnel are trained and qualified to consistently achieve initial proficiency, maintain proficiency, and adapt to changes in technology, methods, or job responsibilities.
- Provide orientation and any necessary activity-specific training to field personnel on the requirements of the QAPP and other subproject plans prior to the start of work.
- Perform audits and surveillances to verify compliance with applicable requirements.
- Identify deficient areas and implement effective corrective actions for quality problems.

- Notify the DOE/NV Project Manager and other involved personnel of any significant conditions adverse to quality or any adverse trends.
- Verify that appropriate corrective actions are taken for nonconformances.
- Track and trend nonconformances for conditions adverse to quality.
- Ensure that all measurement and test equipment (M&TE) is calibrated and that calibration is documented prior to using the equipment.
- Establish and maintain a records management system.

4.1.2 Project Organization

Figure 4-1 summarizes key administrative, technical, quality assurance, and health and safety personnel involved with the CS Site CAIP. Field activities conducted in accordance with the CAIP, the H&S procedures in Site-Specific H&S plan, and Radiation Work Permits (RWPs) will be supervised by the environmental oversight contractor who will ensure completion of all site characterization activities. The environmental oversight contractor will solicit assistance from the NTS/TTR Management and Operating (M&O) contractor for such tasks as radiation technician, *in situ* field instrumentation, general health and safety, and site logistical support. Most key members of the project team assembled for the CS Site CAIP had previously worked on the Double Tracks Test Site characterization field efforts.

4.2 Site Preparation Activities

Prior to the initiation of sampling activities at the CS sites, several preliminary tasks must be completed. Site preparation tasks will be initiated after completion of a threatened or endangered species preactivity survey at each CS site. These tasks include:

- As required, create access gates through the perimeter and GZ fences for personnel and equipment. Barbed wire will be repaired upon completion of characterization activities
- Set up contaminant reduction zones and decontamination facilities for personnel and equipment.
- Based on existing survey markings, establish reference points and sampling grids required for the completion of the proposed CAI sampling activities.
- Survey and mark (as required) any unexploded ordnance (UXO) encountered.

All preliminary preparation as well as all sampling activities will be completed in a manner that is protective of human health and the environment. Detailed information regarding Health and Safety (H&S) procedures and Radiation Worker Permit information are provided in the site-specific H&S Plan. This plan is attached as Appendix D and will be approved by the appropriate organizations prior to initiation of any field activities related to the CAI.

4.3 Corrective Action Investigation Sampling Activities

The sampling activities to be completed at the three CS sites are presented in the general order they will be performed. The data from initial sampling activities will be reviewed and used to perform subsequent sampling activities. Although this represents a phased approach in the completion of the site characterization process, the intention is that all characterization activities will be completed with a minimal number of mobilizations of personnel and equipment. It should also be noted that several site characterization activities may be performed concurrently at individual or multiple CS sites.

Prior to and during the completion of the *in situ* radiation surveys, background radiation measurements will be collected. To accurately determine background radiation at the Clean Slate sites, four independent detector systems will be used, including the tripod-mounted HPGe detectors, the Kiwi NaI detector system, and the boom-mounted HPGe detector system, as well as hand-held and ATV-mounted FIDLERs. As part of the routine daily calibration of these instrument systems, radiation measurements will be taken in an area not suspected to be contaminated. This value is then subtracted from that day's measured values to calculate the activity of contamination above background levels. Because all the instruments measure the activity at the same location every day, there is a lot of data available for statistical analysis. To prove that the background location is not contaminated, the detector system characterization activities will measure activities in areas that are contaminated as well as areas that are lightly contaminated or contamination is not detected. These characterization measurement results will cross-correlate to establish that the background location is not contaminated.

4.3.1 All Terrain Vehicle Survey

An area with a radius of approximately 300 m from the GZ at each CS site will be surveyed with the ATV unit. If during the completion of the survey no radioactivity is measured for a radius of 50 meters from the last indication of radioactive material, the survey will be terminated even though the 300-meter radius may not have been reached. The objective of this survey is to identify any areas of highly contaminated materials (e.g., hot spots). The ATV survey areas are shown in Figures 4-2 through 4-4.

This ATV unit is equipped with three FIDLER detectors mounted on the front of the vehicle. The collimated detectors are mounted so their individual field-of-view is approximately 0.6-m (2-ft) diameter. There is sufficient overlap between the field-of-views to ensure complete coverage over an area of approximately 1.5 m (5 ft). The area to be surveyed at each CS site will be between the GZ fence and the 300-m (1,000-ft) radius line. Based on the data for the location of each GZ, the GZs tend to be near a corner or edge of the perimeter exclusion fence. As a result, some ATV work may be completed outside the perimeter fence. The area to be surveyed will be located by on-site personnel using a backpack Global Positioning System (GPS) unit, marking the survey line with pin flags. The ATV will travel back and forth within the survey area to provide continuous coverage of the area. When an area of increased radioactivity is identified, a flag will be placed in the ground identifying that location.

Identified "hot spot" areas will be resurveyed by a pair of "miners" using a hand-held FIDLER unit. The purpose of this activity is to locate and remove isolated high radioactive concentrations of debris, and/or contaminated soils which would bias the results of the KIWI survey. A detailed search of the immediate "hot spot" areas will be completed, and the hot fragment and/or small volume of contaminated soil will be removed by the miners. Any excavated materials will be stored in the GZ area and later disposed of at an appropriate disposal site.

4.3.2 KIWI Survey

The initial radiological survey to be performed will be the identification of the 200 pCi/g concentration limit at each CS site. This task will be performed with a specially modified Suburban vehicle, named the KIWI, equipped with three pods of NaI detectors mounted on the rear bumper. The array of six 5-cm (2-inch [in.]) by 10-cm (4-in.) by 41-cm (16-in.) NaI detectors mounted 0.75 m (2.5 ft) above the ground surface produces a footprint of approximately 3 m (10 ft). This NaI detector system is identical to the detector system previously employed in the 1993 helicopter survey of the Operation Roller Coaster sites. The John Chance differential GPS will be used to determine the position of the instrument readings with a positioned uncertainty of approximately 1 meter.

For the purpose of the KIWI survey, it is assumed that the entire area within the inner GZ fence at each CS site has radionuclide concentrations greater than 200 pCi/g and will not require further surveying. The KIWI will survey the areas outside the inner GZ fence and inside the perimeter fences with a line spacing of approximately 3 m (10 ft), traveling at a speed of about 9.66 kilometers per hour (6 miles per hour [mph]) 2.74 meters per second (9 ft per second). The orientation and lengths of the survey lines are shown in Figures 4-2 through 4-4.

Due to the area to be covered at CS-3, the survey lines could be spaced at 18 m (50-ft) intervals if time and/or resources require. Due to suspected contamination levels greater than 200 pCi/g outside the perimeter fence at CS-1 and CS-2, some limited survey work will be performed outside the fenced area.

4.3.3 High Purity Germanium Detector Survey

To cross-correlate the KIWI detector results, including background measurements, a HPGe detector suspended on a mast attached to a Suburban will be employed. When the detector is fully extended approximately 7.6 m (25 ft) above the ground surface, it has approximately a 13-m (43-ft) diameter field-of-view. It is anticipated that 300 to 600 second counts will be conducted. The HPGe detector is more sensitive to Am-241 than the KIWI (NaI) detector system; therefore, more accurate results will be obtained. The difficulty with the HPGe system is that it is much slower, requires longer counting times, and is not as cost-effective to operate as the KIWI. Therefore, the HPGe system will be employed only to cross-correlate the KIWI detector system and take measurements where the KIWI detector system results are suspect. Approximately 30 measurements, each, will be taken at CS-1 and CS-2, and 60 at CS-3. The exact number of measurements and their locations will be based on the KIWI detector system results obtained during site characterization. This detector system was used during characterization activities at the Double Tracks Test Site and provided very reliable results (DOE, 1996).

4.3.4 Vertical Soil Profiles

In an effort to determine the vertical extent of contamination, vertical soil profile data will be collected at each CS site. The purpose of this activity is to obtain data that will be utilized to make estimates of contaminated soil volumes which may be excavated during remediation activities. Soil profiles will only be conducted within the >200 pCi/g area identified utilizing the KIWI survey data. CS sites 1 and 2 will be divided into 18-m by 18-m (50-ft by 50-ft) grids and CS-3 will be divided into 36-m x 36-m (100-ft by 100-ft) grids. Each grid will be numbered, and a random number generator program will be run to select grids to be sampled. Vertical soil profile data will be collected from 10 locations in CS-1 and CS-2 and from 20 locations at CS-3 outside the hot areas of the GZ.

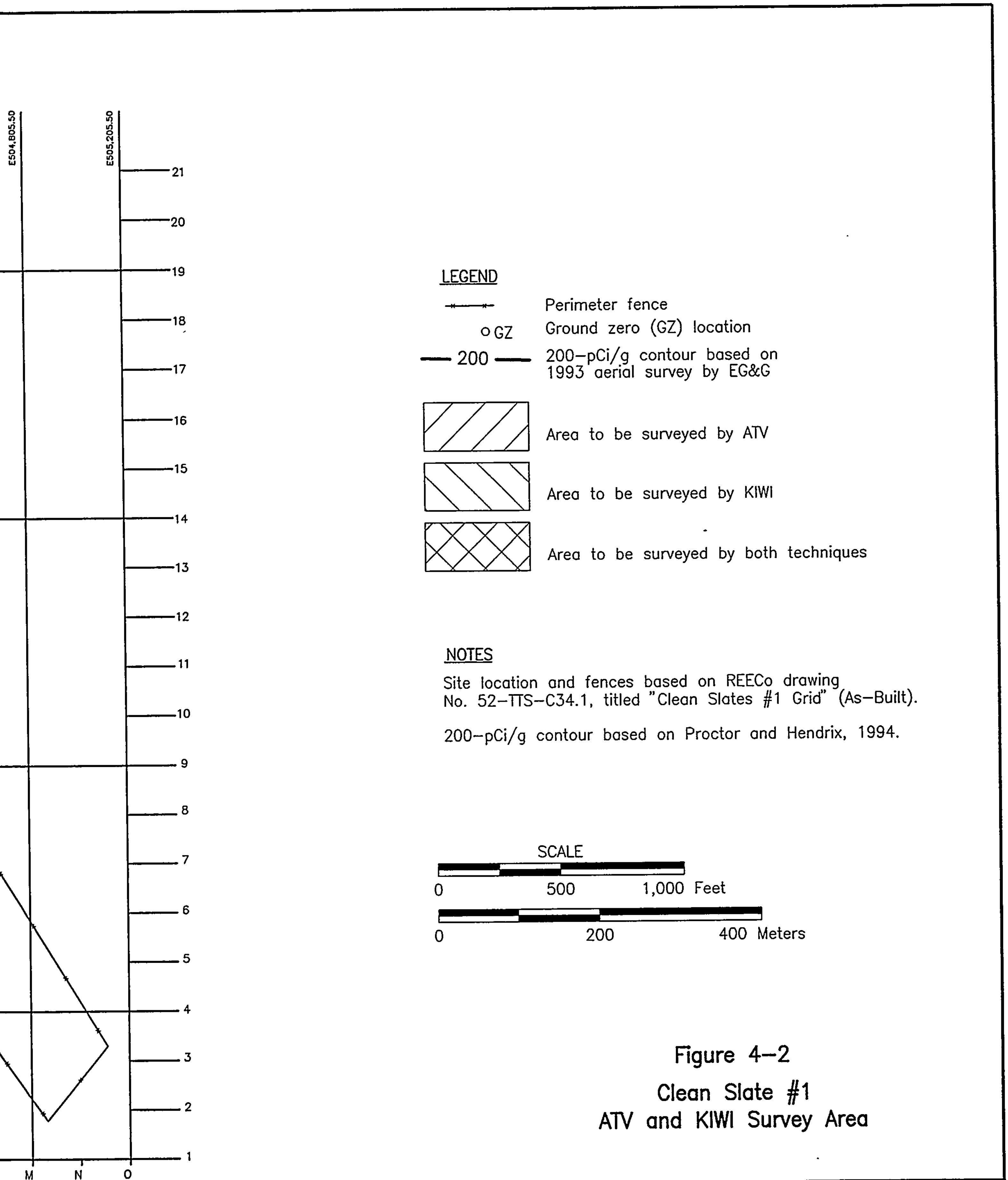
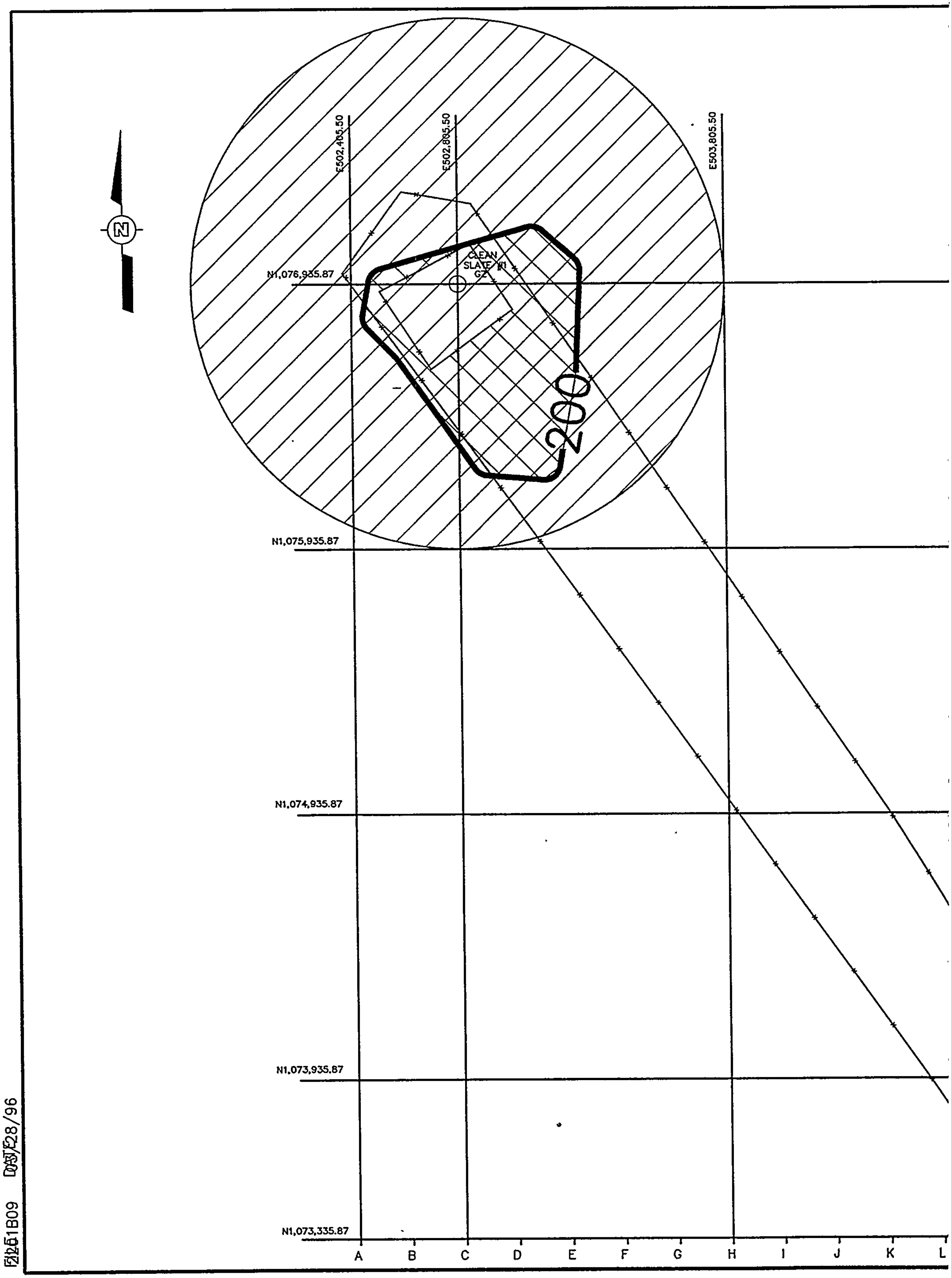


Figure 4-2
Clean Slate #1
ATV and KIWI Survey Area



N
E502,405.50
E502,805.50
E503,805.50
CLEAN
SLATE #1
GZ
N1,076,935.87
N1,075,935.87
N1,074,935.87
N1,073,935.87
N1,073,335.87
200
A
B
C
D
E
F
G
H
I
J
K
L

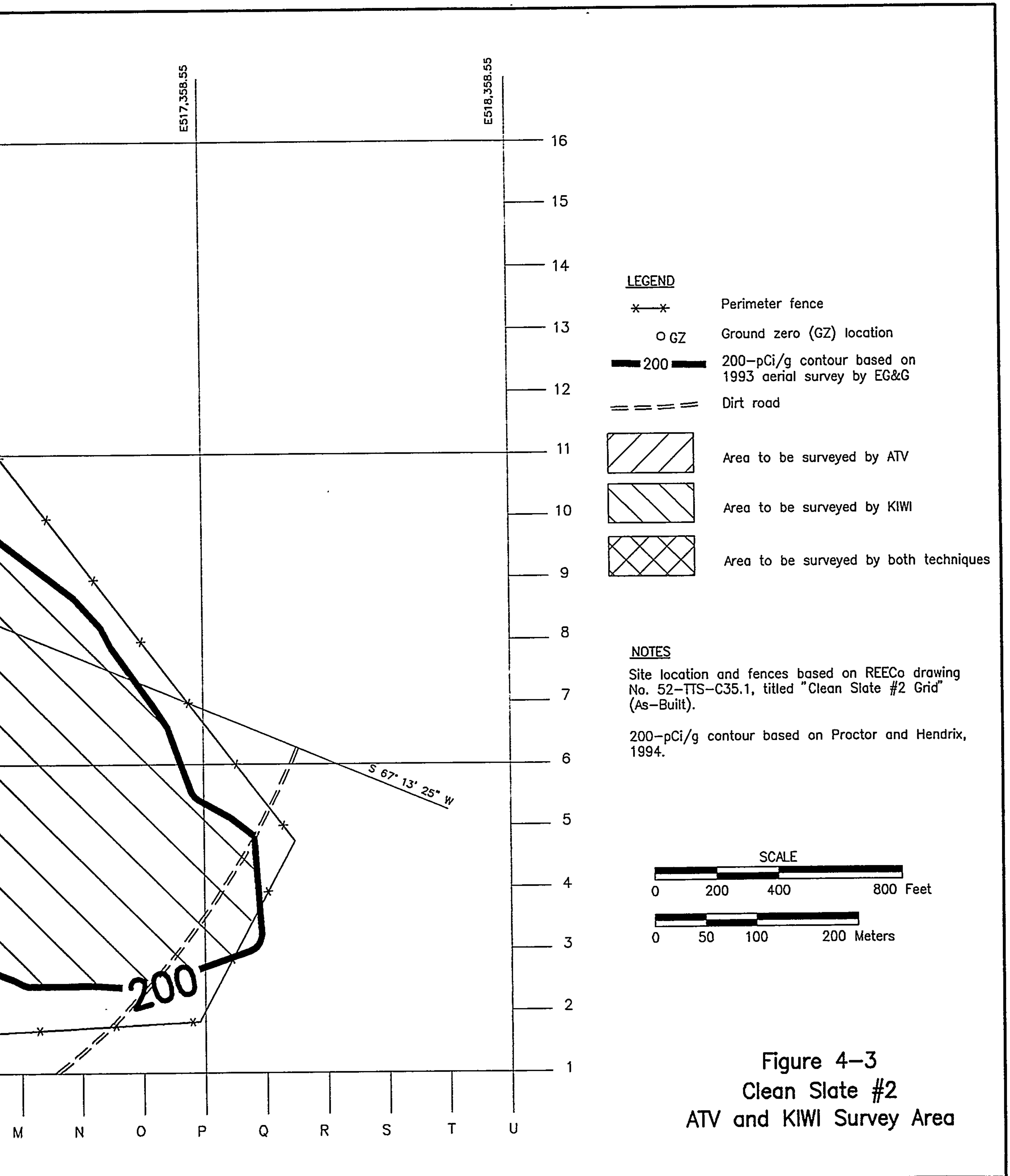
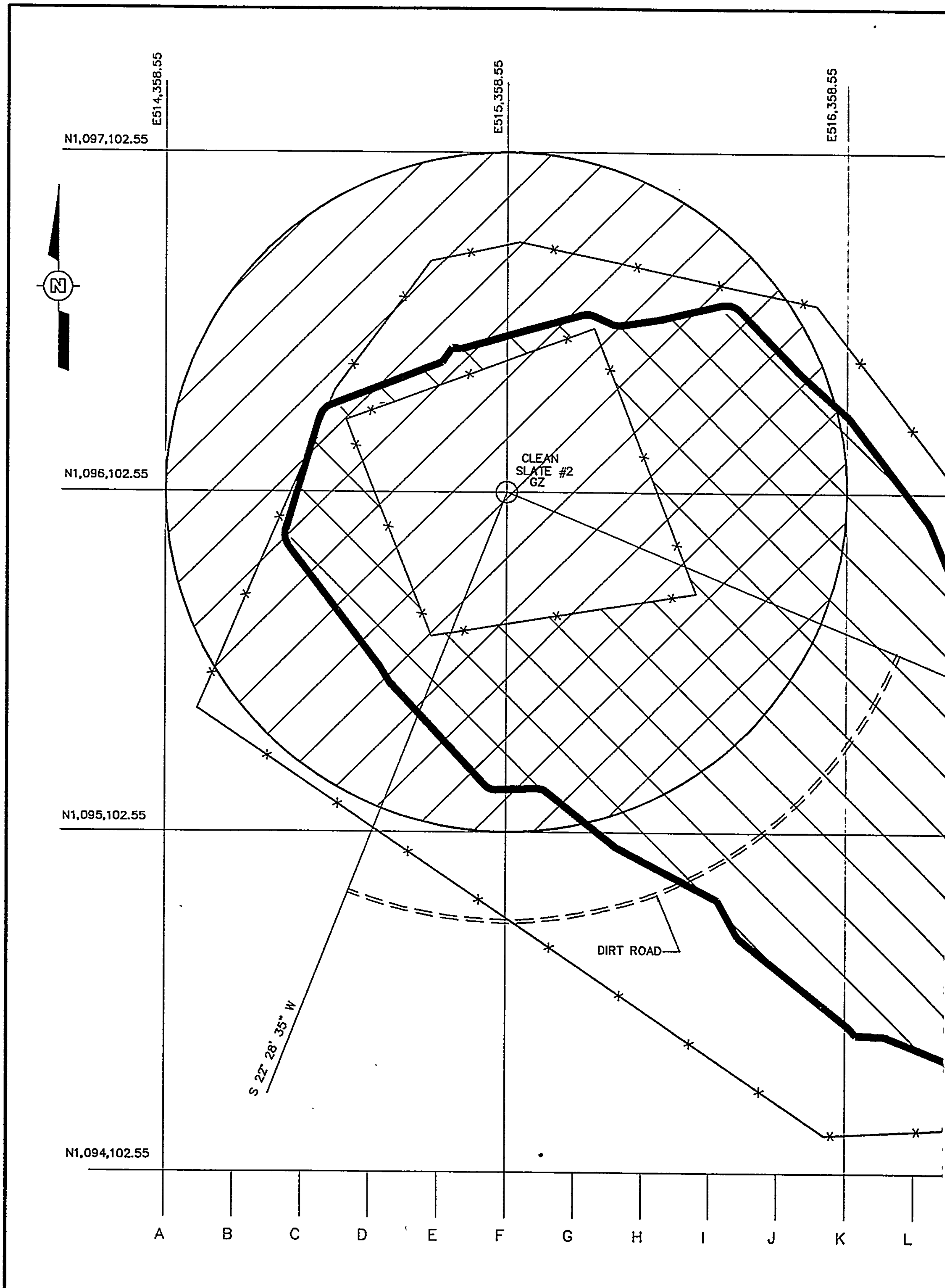


Figure 4-3
Clean Slate #2
ATV and KIWI Survey Area



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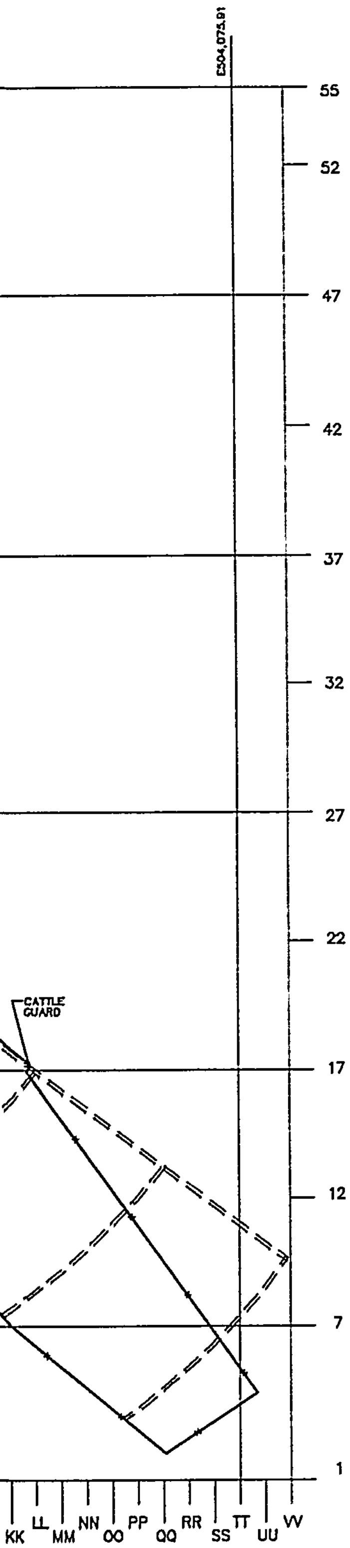


LEGEND

- Perimeter fence
- GZ — Ground zero (GZ) location
- 200 — 200–pCi/g contour based on 1993 aerial survey by EG&G
- Dirt road
- Area to be surveyed by ATV
- Area to be surveyed by KIWI
- Area to be surveyed by both techniques

NOTES

Site location and fences based on REECo drawing No. 52–TTS–C36.1, titled "Clean Slate #3 Grid" (As–Built).

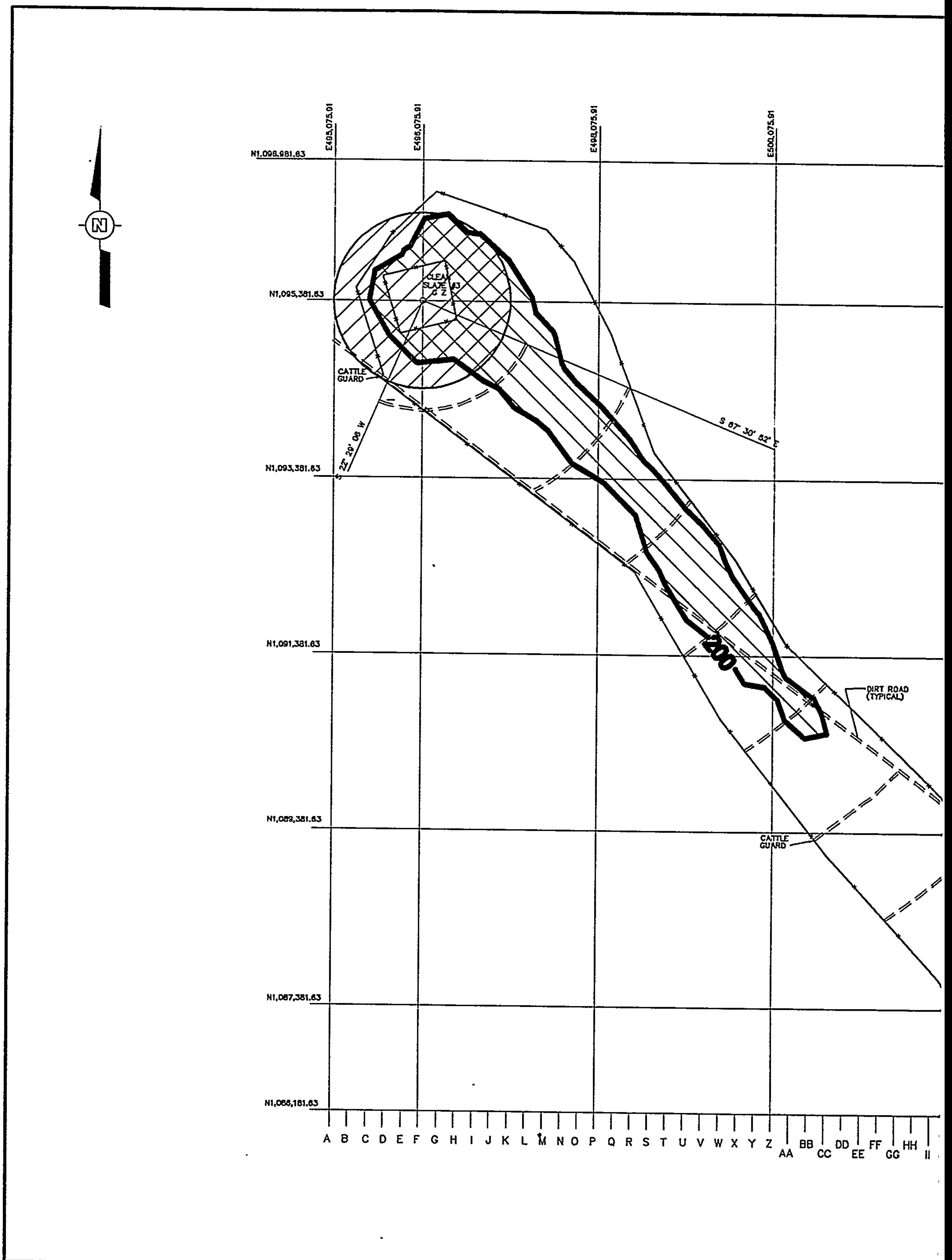
200–pCi/g contour based on Proctor and Hendrix, 1994.

SCALE

0 — 1,500 — 3,000 Feet

0 — 400 — 800 Meters

Figure 4–4
Clean Slate #3
ATV and KIWI Survey Area



2201B07 03/28/96

Vertical soil profile data will be collected using an HPGe detector mounted on a low tripod. The detector will be collimated to limit the field of view to an area of approximately 30 cm (12 in.). After the initial reading has been made at the ground surface, a 1-cm to 2-cm layer of soil will be removed. Soil layers will be removed by first spraying the soil with water, then scooping away the wet soil using a flat metal dust pan. This process requires some practice to determine how much water must be sprayed to moisten the desired thickness of soil. The area of soil to be removed will be somewhat larger than the field of view of the collimated detector to ensure that only the newly exposed soil surface is measured. After the soil layer has been removed, the exposed area will be resurveyed. Additional soil layers will be removed and the exposed area resurveyed until 90 percent of the first layers radioactivity, less background, has been removed. Soil samples will be collected from the upper most layer of soil at selected depth profile locations and submitted to the laboratory for isotopic analysis.

In addition, at selected locations during vertical soil profile collection activities, data will be gathered to determine the total transuranics to Am-241 ratio. This data will be gathered from ten locations, each, at CS-1 and CS-2 and at twenty locations in CS-3. Data will be collected using a HPGe detector mounted on a tripod. The collimator for the detector will extend from the detector to the ground surface to ensure that only radiation directly below the detector is counted. Count data will be collected for time periods ranging from 300 to 600 seconds. Radiation depth distribution data from the vertical soil profiles collected will be used in the equation to determine the plutonium to americium ratio for each site.

4.3.5 Ground Zero Investigation

A detailed investigation will be completed at each CS GZ in an attempt to identify the limits of the soil/debris mounds and/or concentrated areas of debris. Based on the operation Roller Coaster data, the experiment at CS-1 was conducted on a concrete pad 6.1 m by 6.1 m by 0.3 m (20 ft by 20 ft by 1 ft). The experiment at CS-2 was placed in a metal arch bunker measuring 8.2 m by 3.3 m (27 ft by 11 ft) and covered with 0.61 m (2 ft) of soil. The CS-3 experiment was also placed in a steel arch bunker measuring 11.6 m by 3.3 m (38 ft by 11 ft) with a 24-m (8-ft) soil cover. Both bunkers had concrete footers to anchor the building and possibly concrete floors. It is believed that the concrete pad is still intact and is buried at the CS-1 GZ location (unpublished Operation Roller Coaster report). At CS-2 and CS-3, soil and/or debris may have been buried in trenches within the GZ areas. Four different investigative tools will be used to characterize the GZ areas: ground penetrating radar, a magnetometer survey, electromagnetic survey and shallow hand-auger borings. The locations of the electromagnetic and magnetometer survey grids are shown in Figures 4-5 through 4-7. The following sections provide additional information regarding each of these methods.

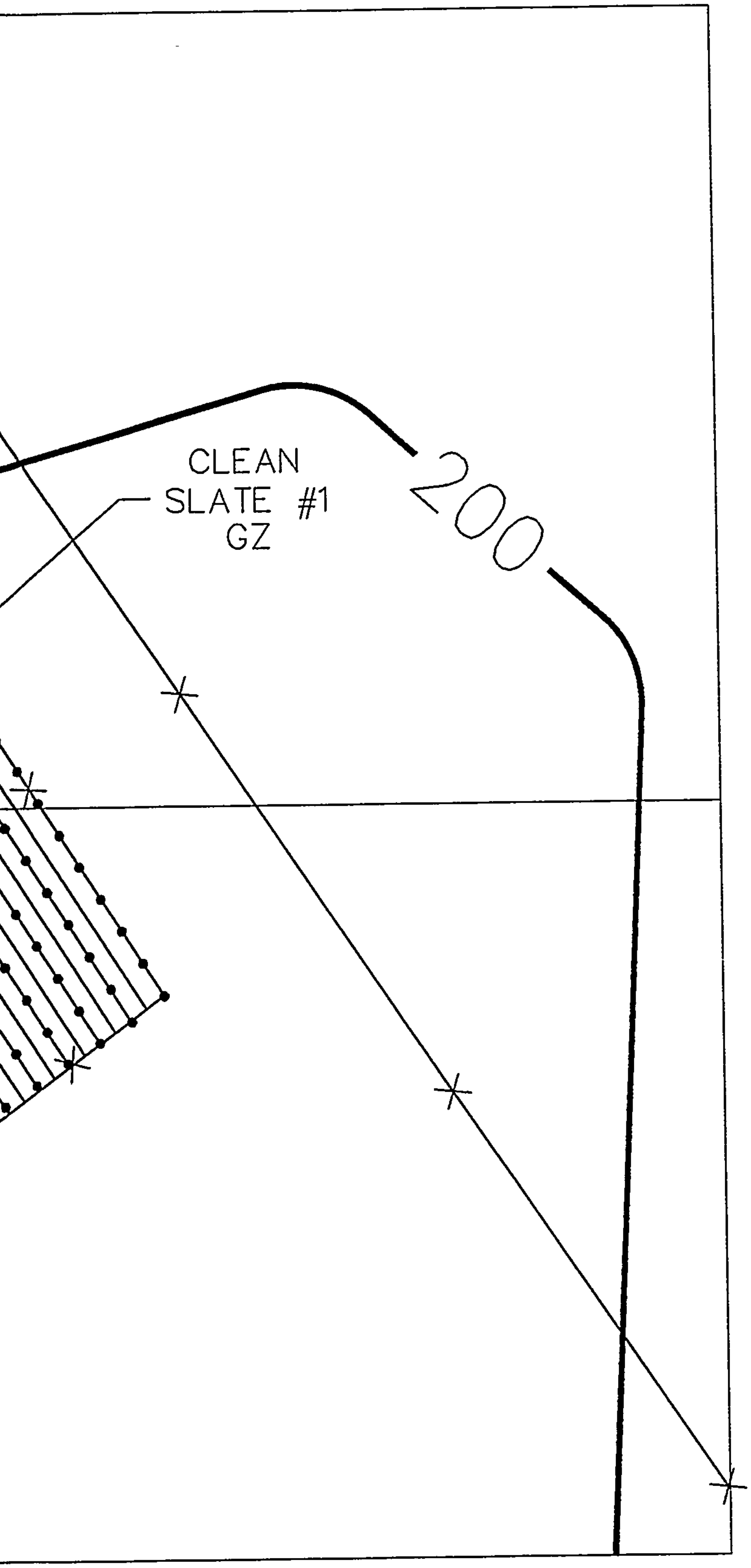
4.3.5.1 Magnetometer Survey

Each GZ area at the CS sites will be surveyed utilizing a proton precession magnetometer such as an Electromagnetic Data Analyzer OMNI IV tie-line magnetometer (OMNI IV) or approved equivalent. This instrument will be used as a magnetic gradiometer for these surveys. In this mode, the instrument can read and store magnetic field measurements from two vertically displaced sensors activated simultaneously for calculating true magnetic gradient measurements, and the instrument sensitivity will emphasize near-surface sources.

The instrument has a solid state memory with the capacity of storing 1,200 gradient readings. The sensor is external and is separated from the instrument so that it is relatively unaffected by the magnetic field generated by the observer and can be positioned easily away from the recording instrument. Nevertheless, magnetic objects will not be worn or carried by the observer during the survey. The sensor head is mounted on a collapsible aluminum staff and the instrument operated on a large rechargeable battery.

The same grid system will be used for both the magnetometer survey and the electromagnetic survey. The magnetometer survey will be completed on traverse lines creating a grid with grid nodes spaced 6.1 m (20 ft) apart (see Figures 4-5, 4-6, and 4-7). After the grid has been established, data will be recorded at each grid coordinate. As data collection proceeds, grid-point locations near potential surficial interferences (e.g., fences, metal debris, etc.) will be noted in the field log so that anomalous data recorded near these features will not be incorrectly attributed to subsurface ferrometallic objects.

The magnetometer data will be stored in the solid-state memory, and items that will be recorded include the line and position (grid coordinates), the total magnetic field as recorded at each sensor, and the internally calculated magnetic gradient. The data will subsequently be entered or dumped into a computer graphics program (e.g., SURFER, Version 4.0 or GEOSOFT), and isoconductivity maps will be generated. The isoconductivity maps will then be interpreted by the project geophysicist, and locations of anomalous magnetic data will be delineated.



LEGEND

Perimeter fence

○ GZ Ground zero (GZ) location

200 200-pCi/g contour based on 1993 aerial survey by EG&G

GPR traverses

Magnetics data grid location

NOTES

Site location and fences based on REECo drawing No. 52-TTS-C34.1, titled "Clean Slate #1 Grid" (As-Built).

200-pCi/g contour based on Proctor and Hendrix, 1994.

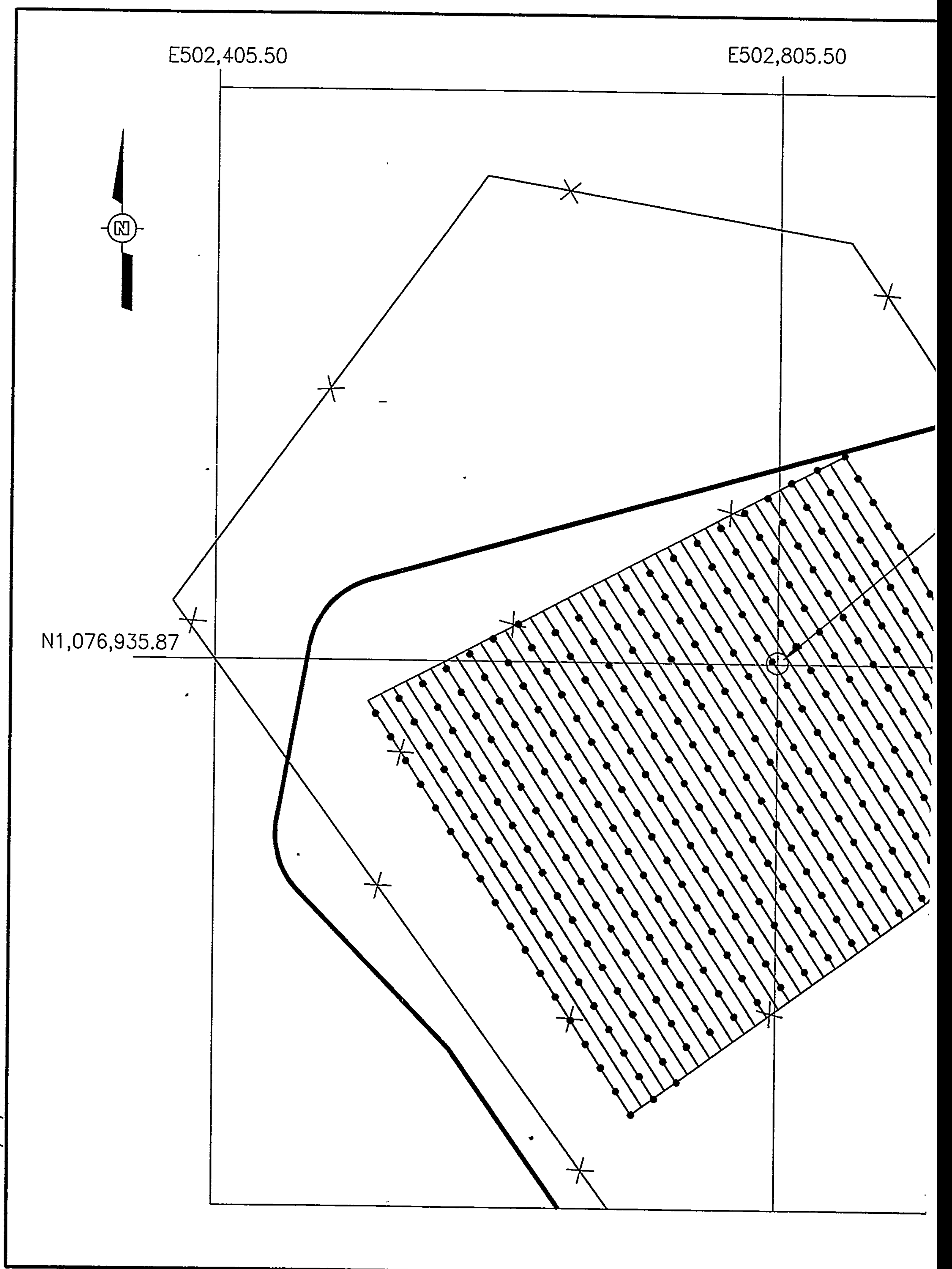
SCALE

0 100 200 Feet

0 30 60 Meters

Figure 4-5

Clean Slate #1
GZ Geophysical Survey Grid



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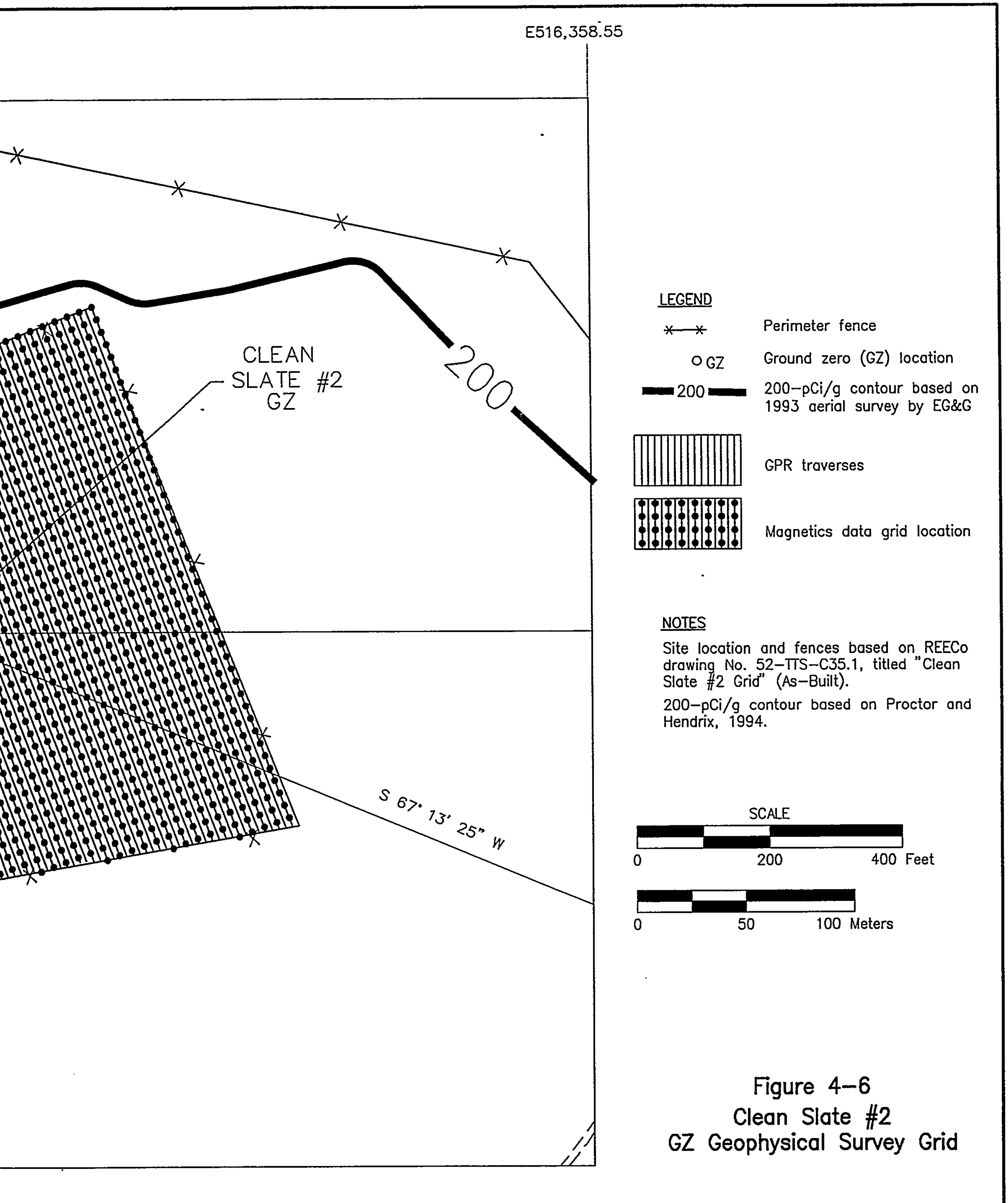
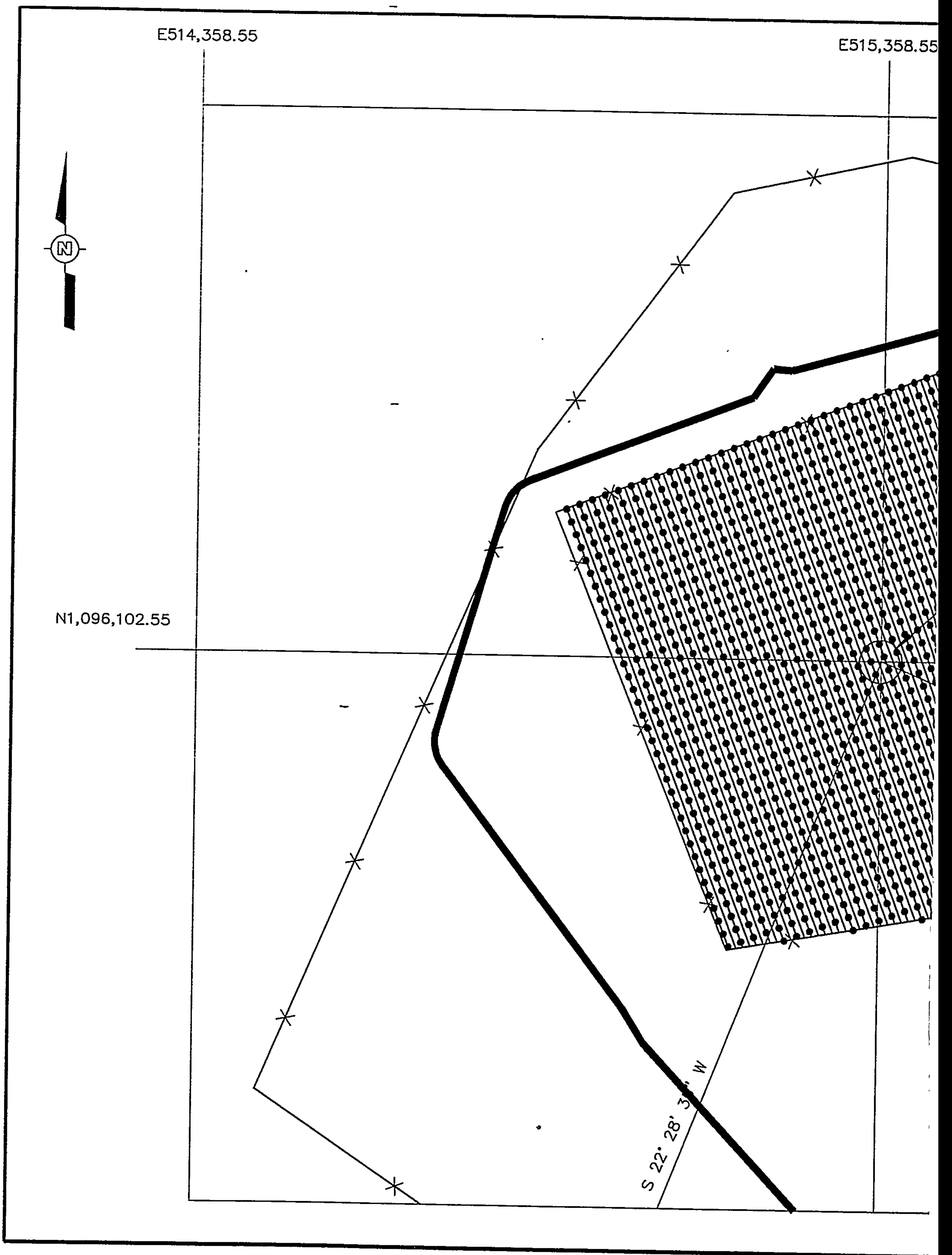


Figure 4–6
Clean Slate #2
GZ Geophysical Survey Grid



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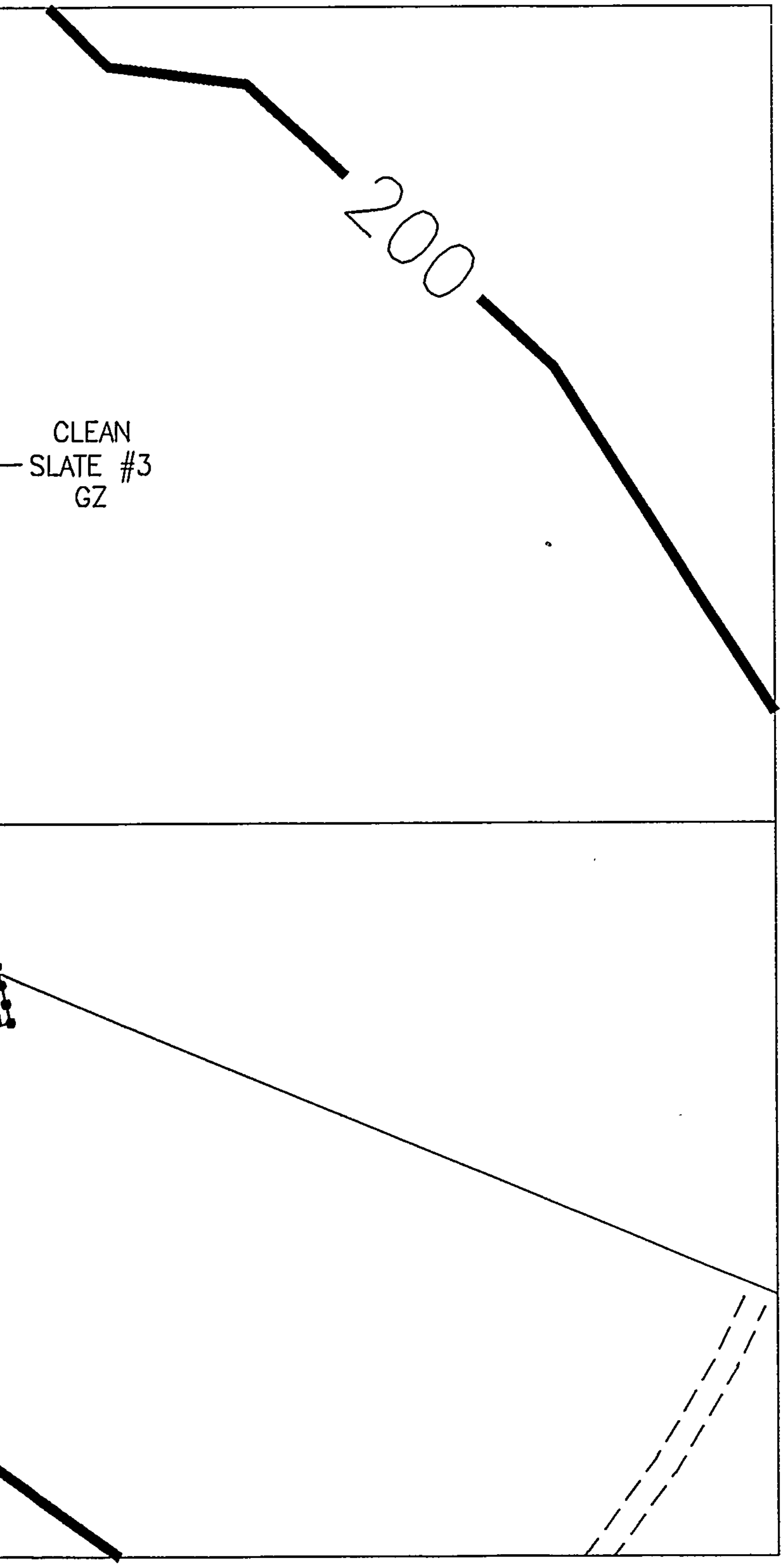


LEGEND

Perimeter fence

GZ Ground zero (GZ) location

200 200-pCi/g contour based on 1993 aerial survey by EG&G

Dirt road

GPR traverses

Magnetic data grid location

NOTES

Site location and fences based on REECo drawing No. 52-TTS-C36.1, titled "Clean Slate #3 Grid" (As-Built).

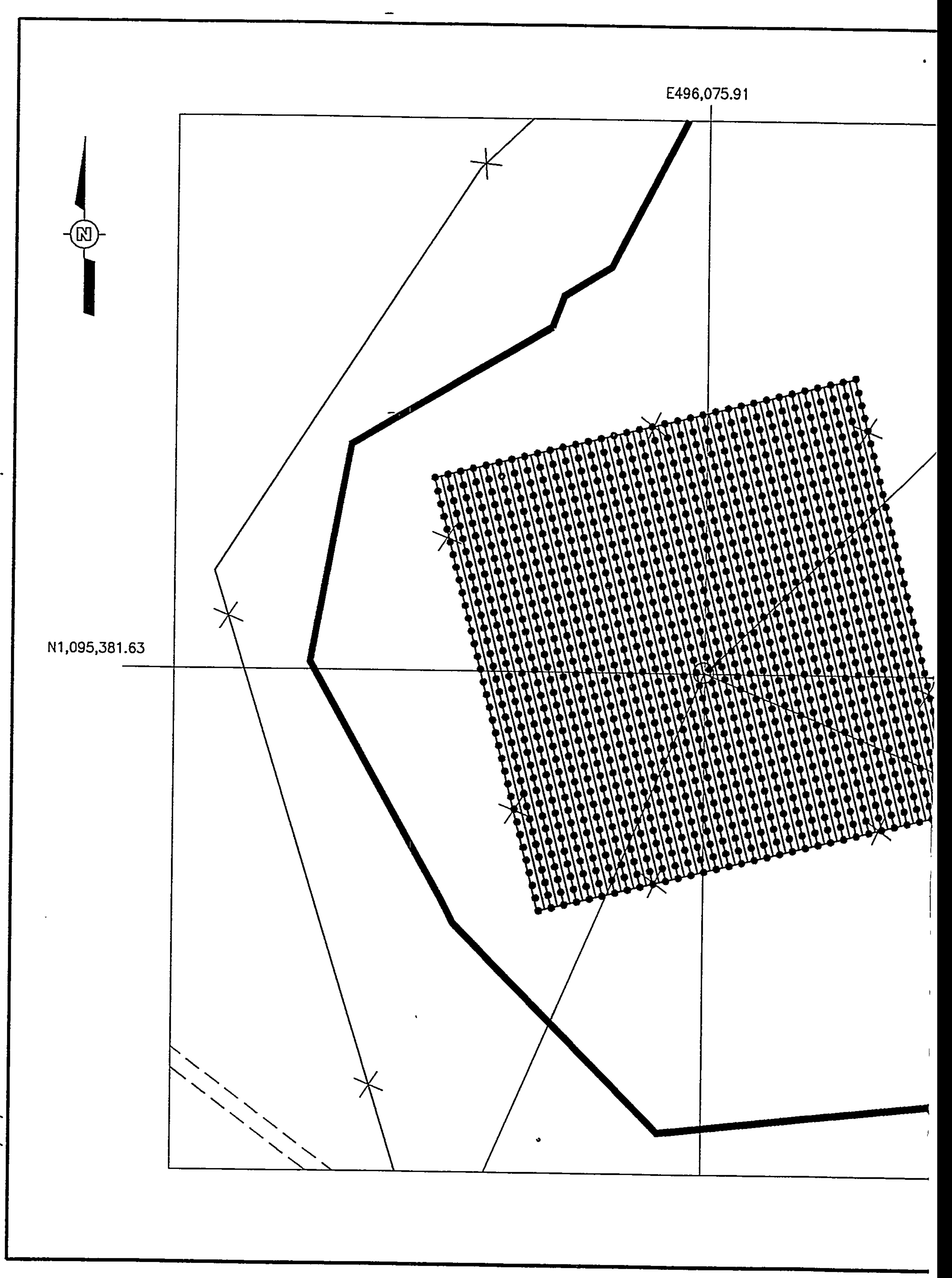
200-pCi/g contour based on Proctor and Hendrix, 1994.

SCALE

0 200 400 Feet

0 50 100 Meters

Figure 4-7
Clean Slate #3
GZ Geophysical Survey Grid



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4.3.5.2 Electromagnetic Conductivity Survey

IT will survey the GZ areas of each CS site utilizing a Geonics EM31 terrain conductivity meter (EM31) coupled to a digital data logger to record EM data during this investigation. The objective of this survey is to refine the results of the magnetic survey in an effort to locate burial areas containing metallic debris. It is anticipated that burial areas will indicate EM measurements anomalously higher in value as compared to EM readings recorded over native, relatively undisturbed soil areas. The EM31 can be utilized to measure two components of the terrain conductivity: (1) the quadrature component, which provides a direct measurement of the ground conductivity in units of millisiemens per meter (mS/m), and (2) the in-phase component, which is sensitive to the presence of metallic debris and is measured in parts per thousand (ppt) of the primary EM field.

Prior to the acquisition of geophysical data, the survey area will be cleared of all surficial objects which may interfere with the EM measurements (e.g., scrap metal, wire, and other miscellaneous debris). The same grid coordinate system utilized for the magnetics survey will be utilized to provide spatial control during the collection of EM data. The grid nodes will be identified by nonconductive pin flags (or spray paint, as appropriate). It is anticipated that the grid nodes will be marked at intervals of 6.1 m (20 ft), which should provide sufficient control for the EM operator as he traverses along the grid. However, this interval may be tightened at the discretion of the project geophysicist.

Prior to actual data collection, the instrument operator will ensure that he is free of metallic objects which potentially could interfere with the EM measurements. The EM31 will then be zeroed at a location known to be free of metallic debris and representative of background soil conditions. Several readings will then be recorded at this location and checked to verify data repeatability. After the geophysicist confirms that the EM31 is functioning properly, and has programmed the instrument to accept the site-specific grid coordinates, the operator will occupy the first point on the established grid and activate the instrument. Both the quadrature phase and in-phase components will be recorded and stored in the digital data logger. The operator will then proceed to the next grid coordinate and again activate the instrument to record the EM parameters. This procedure will be repeated at each grid coordinate until the entire study area has been surveyed.

Upon completion of the EM data acquisition, the data will be transferred to a portable field computer and "backed-up" on a computer diskette. The data will then be reviewed for completeness and accuracy; spurious data (e.g., data collected near obvious surface or cultural interferences) will be rejected. The final data set will be processed using the Geosoft Mapping System, which produces color-enhanced contour maps of the EM data. The preliminary EM maps generated in the field with the magnetic isoconductivity maps will be reviewed and an interpretation made as to the probable limits of the burial area(s) as indicated by the EM data. Based on these figures, traverse locations for the performance of GPR will be selected and additional EM grid points will be identified, if required.

4.3.5.3 Ground Penetrating Radar Survey

Based on the results of the magnetic and EM surveys, a GPR survey will be conducted in the areas identified as potential debris burial sites. The objective of these surveys is to attempt to more clearly define the limits of the burial areas.

GPR uses an electromagnetic pulse source, a receiver antennae, and a graphic recorder to map reflections from subsurfaces associated with buried objects or distinct stratigraphic horizons (e.g., excavated versus unexcavated soils). Depth penetration is a function of antennae frequency and the electrical conductivity of the soils in the survey area. Depth of penetration in the alluvial soils at the sites may range from 1 to 2.4 m (3 to 8 ft) using 300 and 500 megahertz (MHz) antennae.

The GPR survey at each CS site will consist of towing the selected antenna across the ground surface along predetermined traverses. For these sites, the parallel traverse lines will be placed at 3-m (10-ft) centers. The traverse locations will be determined based on the results of the magnetic and EM survey results. After completion of each traverse, the GPR graphic record will be reviewed in the field and any anomalous features detected will be marked on the ground surface by plastic pin flags.

4.3.5.4 Hand Auger Borings

Based on the data generated from the GPR and magnetic surveys, general surface topography, and surface expressions of excavation activities, confirmation borings will be completed in identified anomalous areas. At CS-1, the primary objective of completing auger borings will be to confirm the presence of the concrete pad and its depth below the ground surface. Auger borings at CS-2 and CS-3 will be used to explore identified anomalies to determine the composition of the materials causing the anomaly and the depths of these materials.

Hand-auger borings will be drilled with a two-man, gasoline-powered auger with a 7.6-cm (3-in.) outside diameter (od) solid-stem auger. The maximum drilling depth of this power auger is 1.5 to 3.0 m (5 to 10 ft), depending on subsurface conditions. The types of materials encountered at each auger boring location will be logged in the field notebook. Any metal debris encountered will be scanned with a hand-held FIDLER unit to determine if it is contaminated with radioactive materials.

In an effort to determine the depth of radioactive contamination within the GZ, *in situ* radioactivity measurements will be completed in each auger boring. After the boring has been completed, a small NaI or plastic scintillator detector will be lowered into the hole and readings will be collected at approximately 0.3-m (1-ft) intervals. Readings will be collected until two consecutive readings of 0 are achieved. The depth of the first 0 reading will be recorded as the depth of contamination at that location.

After completion, each auger boring will be backfilled with the excavated soils and marked with a stake identifying the auger boring number. Each auger boring location will be determined with a GPS backpack unit carried by sampling personnel.

4.3.5.5 Topographic Survey

After completion of the geophysical survey and auger borings, a topographic survey will be conducted at each GZ area to provide accurate data with respect to surface topography. This survey will also provide the following data:

- Accurate locations of surface expressions of debris burial areas identified by the geophysical survey

- Locations of elevations of auger borings used to verify depths of contaminated materials

Based on the results of the geophysical investigation, a central location for the buried debris at each GZ will be identified and marked in the field. The coordinates for this location will be obtained using the portable GPS equipment. A total of eight reference lines will be marked outward from this location at approximately 45° arcs and elevations will be obtained at 10-m (34-ft) intervals along each line with a station rod and transit located at a reference point. The topographic measurements will continue along each line beyond the limits of the burial areas and the ground surface has become level or to the inner GZ fence, whichever occurs first.

Additional topographic measurements of intervals less than 10 m (34 ft) may be obtained depending on the site topographic features (i.e., depressions and or mounds).

Augur borings will be located by measuring the perpendicular distance from the nearest reference line and the distance from that intersection to the central reference point. Ground surface elevations will also be rescinded at each augur boring location.

After collection of the topographic information from each GZ area, the information will be plotted and a topographic map generated for each GZ area. Topographic maps will be generated leaving a contour interval of 0.3 m (1 ft) with elevations based on a site datum elevation selected at the time of the survey. If necessary, additional elevation measurements will be obtained to improve definition of the GZ burial areas.

4.3.6 Soil Sample Collection

Soil samples will be collected at 30 locations at the CS sites for the purpose of verifying the disposal requirements for contaminated materials. All soil samples will be collected from within the >200 pCi/g area identified during earlier CAI activities. The intent of this sampling effort is to confirm that mixed waste is not present and to use the laboratory results from the analytical program identified in Section 4.4 to conduct statistical analysis. The statistical analysis will be used to determine how many additional soil samples will be required for waste characterization during later site characterization activities.

Soil sample locations will be selected by dividing the greater than 200 pCi/g area into 36.5-m by 36.5-m (100-ft by 100-ft) numbered grids. A random number generator program will identify the numbers of the grids to be sampled. The sample locations will be identified by latitude and longitude prior to initializing soil sampling activities. Soil sample locations will be located in the field using a backpack-mounted GPS unit.

Soil samples will be collected at the vertical soil profile locations discussed in Section 4.3.4 using a properly decontaminated sampling scoop, or shovel. Samples will be collected from the ground surface to a maximum depth of 5 cm (2 in.) in areas outside of the inner GZ fence at each site. For areas within the inner GZ fence, the depth of soil samples will be determined by the results of the soil borings completed within the GZ area.

At each sample location, approximately four liters of soil will be excavated and placed in a decontaminated container. Approximately half of this material will then be passed through a Jones Splitter which will divide the soil material into two equal portions. One of the split portions will be discarded, and the other placed in a decontaminated container. This process will be repeated for the remaining portion of the excavated soil material. The soil material retained from this splitting process will be passed through the splitter a final time, then placed in appropriately labeled, 1-liter, wide-mouth plastic sample containers. Prior to the splitting of samples, plant material and any pebbles larger than 1.25 cm (0.5 in.) will be removed from the sample material. The lid will be placed on the container, and the container will be placed into a cooler with "Blue ice" packs to maintain a temperature of 4 degrees Centigrade (°C) (±2°C). If only radiological analysis are to be performed, sample cooling is not required.

Sample QC requirements; sample custody; sample handling, packaging, and shipment requirements; field documentation; and equipment decontamination procedures are provided in the following sections.

4.3.6.1 Field Quality Control Samples

Field QC shall be maintained by performing all field activities in accordance with standardized operating procedures, quality practices, and the procedures established in the QAPP. QC samples shall be collected to analyze for possible contamination and to evaluate precision and accuracy of analysis associated with sample collection activities. The sampling team shall collect QC samples to estimate and document the error or uncertainty associated with soil sample collection activities. Field duplicate, equipment rinsate blank, and field blank samples shall be collected according to approved contractor procedures. Each type of field QC sample shall be collected and analyzed at a frequency of 1 per CS site or 1 per 20 soil samples at each CS site. Field QC samples are discussed in more detail in the QAPP (DOE, 1996).

4.3.6.2 Sample Handling, Packaging, and Shipping

Soil samples shall be handled, packaged, and shipped in accordance with approved contractor procedures. The required sample containers and volumes, preservation procedures, and holding times for analyzing soil samples are given in Table 4-1, and requirements for equipment rinsate

Table 4-1
Soil Samples Sample Container, Preservation, and Holding-Time Requirements

Parameter	Container Type/ Sample Volume	Preservation[a]	Maximum Holding Time[b]
Radionuclides	500-mL glass or polyethylene, wide-mouth	none required	180 days
TCLP Metals	500-mL glass or polyethylene, wide-mouth	cool, 4°C	180 days[c]
Mercury	1,000-mL glass or polyethylene, wide-mouth	cool, 4°C	180 days
TCLP VOCs	40 mL glass	cool, 4°C	14 days[d] 14 days
SVOCs	500-mL glass wide-mouth, amber	cool, 4°C	14 days 7 days 40 days
Herbicides	500-mL glass	cool, 4°C	14 days 40 days
Pesticides	500-mL glass	cool, 4°C	14 days 40 days
PCBs	500-mL glass	cool, 4°C	14 days 14 days

[a]Temperature Note: All samples requiring temperature preservation stated at 4°C will be acceptable within the range of 4° ± 2°. The laboratory should note on the sample Chain-of-Custody Form that temperature requirements were met by noting the receipt temperature. For all samples received outside the range of 4° ± 2°C, the sample(s) and the temperature (in 1°C increments) will be noted on the Chain-of-Custody Form, and the Project Manager shall be notified immediately.

[b]Holding times are calculated from time of sample receipt at laboratory.

[c]For TCLP, except for mercury, holding time from field collection to extraction is 180 days, and holding time from extraction to analysis is 180 days (360 days total elapsed time). For TCLP mercury, corresponding holding times are 28 and 28 days (56 days total elapsed time).

[d]TCLP procedures require that extracts for analyses be completed within 14 days. The second requirement is that the analysis be performed within a required number of days after extraction. In the case of semivolatile organic compounds (SVOCs), an additional extraction must be performed within 7 days of completing the TCLP extraction and prior to analysis.

mL - milliliter
TCLP - Toxicity Characteristic Leaching Procedure

and field blank samples are given in Table 4-2. Sample containers shall be obtained from an approved laboratory and certified clean per EPA protocol. The containers shall remain sealed until they are used.

Immediately after collection, the sample containers shall be labeled with black, waterproof markers with the following information, at a minimum:

- Unique identification number (assigned by program sample coordinator)
- Project name and number
- Date and time (military) of the sample collection
- Sample location (e.g., CS___-SS___)
- Sample depth interval (e.g., 0 inch to 3 inches)
- Sample medium
- Requested analyses
- Preservation
- Bottle number (e.g., 1 of 2)
- Name(s) of the initial sample custodians (collectors)

Filled sample containers shall be packaged in a shipping container as described in approved contractor procedures. The shipping container and the outside surface of filled sample bottles shall be screened either in the field or at a designated location by a radiological control technician (RCT) before removal from the site. Radiological screening shall be in compliance with U.S. Department of Transportation regulations. Documentation of sample handling, packaging, and shipping shall be completed daily, in ink, by the soil sampling team in accordance with approved contractor procedures.

4.3.6.3 Sample Custody

The validity of environmental measurement data is dependent upon the ability to demonstrate that samples have been obtained from the locations stated and that they have reached the laboratory without alteration except by required preservation. An Analysis Request and Chain of Custody (AR/COC) form shall be used to record custody transfers by field personnel responsible for transporting samples. The term "chain of custody" refers to the method by which the sample history is tracked and continuous possession of a sample by approved personnel (custodian) is documented. The AR/COC form makes the sample a legally defensible entity. Chain of custody shall be initiated in the field by the person collecting the samples. Without exception, the use of the AR/COC form is required to create a written record of sample custody from the time of collection through laboratory analysis. All samples, including field QC samples, shall be

Table 4-2
Equipment Rinsate and Field Blank Samples
Sample Container, Preservation, and Holding-Time Requirements

Parameter	Container Type/ Sample Volume	Preservation[a]	Maximum Holding Time[b]
Radionuclides	1,000-mL polyethylene	cool, 4°C; pH $\leq$2 with HNO_3	180 days
Metals	1,000-mL polyethylene	cool, 4°C; $\leq$2 with HNO_3	180 days
Mercury	1,000-mL polyethylene	cool, 4°C; $\leq$2 with HNO_3	26 days
VOCs	40 mL glass	cool, 4°C $\leq$2 with HCL[e]	14 days
SVOCs	1 gallon amber glass	cool, 4°C	14 days 7 days 40 days
Herbicides	1 gallon glass	cool, 4°C	14 days 40 days
Pesticides	1 gallon glass	cool, 4°C	14 days 40 days
PCBs	1 gallon glass	cool, 4°C	14 days 14 days

[a]Temperature Note: All samples requiring temperature preservation stated at 4°C will be acceptable within the range of 4° $\pm$2°C. The laboratory should note on the sample Chain-Of-Custody Form that temperature requirements were met by noting the receipt temperature. For all samples received outside the range of 4° $\pm$2°C, the sample(s) and the temperature (in 1°C increments) will be noted on the Chain-Of-Custody Form, and the Project Manager shall be notified immediately.
[b]Holding times are calculated from time of sample receipt at laboratory.

HCL - Hydrochloric acid
HNO_3 - Nitric acid
mL - milliliter

recorded on the AR/COC form. Samples shall not be analyzed by the laboratory without a correctly prepared AR/COC form. Materials that shall be used in the chain-of-custody process for sample tracking and field activities are:

- Sample identification labels
- AR/COC forms
- Sample collection logs
- Custody seal tape
- Field Activity Daily Logs (FADL)

4.3.6.4 Field Documentation

Field activities and sample collection shall be documented in accordance with approved contractor procedures. At a minimum, field documentation for the soil sampling effort shall be comprised of the following:

- FADL
- Tailgate Safety Briefing form
- Equipment Calibration forms (for health and safety monitoring instruments)
- Sample collection logs
- AR/COC form
- Sample identification labels
- Master Sample ID log

Sample collection logs shall be completed immediately after sample collection and contain the following information, at a minimum:

- Unique identification number (assigned by program sample coordinator)
- Project name and number
- Date and time (military) of the sample collection
- Sample location (e.g., CS__ - SS__) with a drawing, if appropriate
- Sample depth interval (e.g., 0 inch to 3 inches)
- Sample type (e.g., duplicate or rinsate)
- Physical description of sample
- Area name
- Amount of sample collected and container type
- Signature(s) of the sample collectors

If duplicate samples are collected, the unique identification number of the other sample shall be recorded on the sample collection log. The general physical description of the sample may include the following, as applicable:

- Overall sample grain size
- Soil color
- Lithology of float at the sample site
- Sedimentary environment (e.g., active wash, channel, inactive surface, and desert varnish)
- Presence of distinct or unusual soil layers or horizons
- Suspected contamination
- Disturbed sample site

All field documentation shall be completed daily, in ink, by the soil sampling team. Field records shall be collected and maintained by the Project Manager, or designee, until completion of the field program or until they are submitted to the project files.

4.3.6.5 Decontamination

Decontamination of sampling equipment shall be performed according to approved contractor procedures. The procedure specified for decontaminating equipment used to collect organic samples shall be followed for all equipment. If sampling equipment is decontaminated in the field, the waste from decontamination shall be disposed of according to the procedure discussed in Section 5.4 of this document. Personnel decontamination requirements are specified in the DOE/NV Environmental Restoration Project Health and Safety Plan (DOE, 1994) and the Site-Specific Health and Safety Plan (SSHASP).

4.4 Analytical Program

The analytical program for soil samples collected at the three CS sites has been designed to meet the following objectives:

- Determine the isotopic concentrations of selected radionuclides.
- Provide confirming data regarding soil toxicity characteristics as hazardous waste for disposal characterization of soils.
- Conduct treatability tests to determine the potential for volume reduction of contaminated soils.

To meet these objectives, the analytical program described in the following sections has been developed.

4.4.1 Analytical Parameters

The analytical testing program will be the same for each of the CS sites. A total of 37 samples will be collected from the CS sites. This includes 8, 10, and 12 samples from CS-1, CS-2, and CS-3, respectively. In addition, duplicate samples will be collected at a rate of one duplicate sample per 20 soil samples collected at each site; also, one field blank will be obtained from each site. The soil samples will be analyzed for the constituents identified in Table 4-3. Water samples for QA/QC requirements will be analyzed for the constituents identified in Table 4-4.

The treatability testing will be conducted by the IT Process Development Laboratory located in Knoxville, Tennessee, and Toxicity Characteristic Leaching Procedure and radionuclide analysis will be completed by the Quanterra Laboratory in Earth City (St. Louis), Missouri.

4.4.2 Sample Analyses

Samples will be analyzed according to the analytical procedures specified for the methods identified in Table 4-3. The samples submitted for treatability testing will be analyzed according to the following procedure.

Each treatability sample will initially be wet-screened to develop a bulk soil characterization profile. The soil volume required for this procedure is approximately 1 liter (L). After screening, the coarse sample fraction (i.e., soil particles retained on the 100 mesh (0.149 millimeters [mm]) will be oven dried and submitted for gamma spectroscopy. After completing this analysis, the coarse fraction will be submitted to attrition scrubbing for 15 minutes at approximately 70 to 75 percent solids. Attrition scrubbing consists of violent agitation of the coarse fraction forcing finer material to separate from the coarse material. After scrubbing, the sample is again wet-sieved. The final coarse fraction and the combined fine fractions are then submitted for gamma spectroscopy and/or americium and isotopic plutonium analysis.

Table 4-3
Soil Sample Analytical Program

Analyte	Analytical Method	Sample Volume	Sample Preservation	Holding Times	Anticipated[a] Number of Analyses		
					CS-1	CS-2	CS-3
Radionuclides gross alpha gross beta Isotopic Plutonium Americium 241 Isotopic Uranium Total Uranium	SM 7110 SM 7110 NAS-NS-3058 NAS-NS-3006 NAS-NS-3050 ASTM-5174-91	8-ounce amber glass or polyethylene wide-mouth	None	180 days	11	13	15
TCLP VOCs[b] Benzene, Carbon Tetrachloride, Chlorobenzene, Chloroform, 1,2-dichloroethane, 1,1-dichloroethylene, Methyl ethyl ketone, Tetrachloroethylene, Trichloroethylene, Vinyl Chloride	1311[c]/8240	4-ounce amber glass	Cool to 4°C	14 days to TCLP extraction, 14 days to analysis	11	13	15
TCLP Metals[b] Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver	1311/ 6010/7000	8-ounce amber glass	Cool to 4°C	180 days to TCLP extraction 180 days to analysis (except mercury which is 28 days to TCLP extraction and 28 days to analysis)	11	13	15
TCLP SVOCs[b] o-cresol, m-cresol, p-cresol, cresol, 1,4-dichlorobenzene, 2,4-dinitrotoluene, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, nitrobenzene, pentachlorophenol, pyridine, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol	1311/ 8270		Cool to 4°C	14 days to TCLP extraction, 7 days for SVOC extraction, 40 days for analysis	11	13	15
TCLP Pesticides, Herbicides[b] Chlordane, Endrin, Heptachlor, Heptachlor epoxide, Lindane, Methoxychlor, Toxaphene, 2.4 D, 2,4,5-TP	1311/ 8080/8150		Cool to 4°C	14 days to TCLP extraction, 40 days to analysis	11	13	15
PCBs[b]	EPA 8080	8-ounce amber glass	Cool to 4°C	14 days to extraction, 40 days to analysis	11	13	15
Treatability Testing Attrition scrubbing, wet screening[d]	N/A	1-liter polyethylene	None	N/A	10	10	40

[a]Number of sample to be collected will depend on *in situ* radiation measurements. The number shown is the anticipated number of samples to be collected by an existing site knowledge.
[b]These parameters will be analyzed in accordance with SW-846 methods as indicated by the analytical method number provided.
[c]SW 846 method 1311 is utilized to prepare extract for analysis.
[d]After attrition scrubbing and wet screening each soil fraction will be analyzed for radionuclides.

Note: Total number of analyses includes quality control samples

Table 4-4. Water Sample Analytical Program

Analyte	Analytical Method	Sample Volume	Sample Preservation	Holding Times
Radionuclides Gross alpha/beta Total Uranium Isotopic Plutonium Americium 241 Isotopic Uranium	 EPA 900.0 ASTM-5174-91 NAS-NS-3058 NAS-NS-3050 NAS-NS-3050	 1 liter 1 liter 1 liter 1 liter 1 liter	 HNO_3 to pH<2 N/A HNO_3 to pH<2 HNO_3 to pH<2 HNO_3 to pH<2	 180 days 180 days 180 days 180 days 180 days
TCLP VOCs[a] Benzene, Carbon Tetrachloride, Chlorobenzene, Chloroform, 1,2-dichloroethane, 1,1-dichloroethylene, Methyl ethyl ketone, Tetrachloroethylene, Trichloroethylene, Vinyl Chloride	1311[b]/8240	(2) 40-mL VOA	HCl to pH<2, Cool to 4°C	14 days to TCLP extraction, 14 days to analysis
TCLP Metals[a] Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver	1311/ 6010/7000	500 mL	HNO_3 to pH<2 Cool to 4°C	180 days to TCLP extraction 180 days to analysis (except mercury which is 28 days to TCLP extraction and 28 days to analysis)
TCLP SVOCs[a] o-cresol, m-cresol, p-cresol, cresol, 1,4-dichlorobenzene, 2,4-dinitrotoluene, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, nitrobenzene, pentrachlorophenol, pyridine, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol	1311/ 8270	(2) 1-liter amber glass	Cool to 4°C	14 days to TCLP extraction, 7 days for SVOC extraction, 40 days for analysis
TCLP Pesticides, Herbicides[a] Chlorodane, Endrin, Heptachlor, Heptachlor epoxide, Lindane, Methoxychlor, Toxaphene, 2.4 D, 2,4,5-TP	1311/ 8080/8150	(2) 1-liter amber glass	Cool to 4°C	14 days to extraction, 40 days to analysis
PCBs[a]	EPA 8080	1-liter amber glass	Cool to 4°C	7 days to extraction, 40 days to analysis

[a] These parameters will be analyzed in accordance with SW-846 methods as indicated by the analytical method number provided.
[b] SW 846 method 1311 is utilized to prepare extract for analysis.

4.4.3 Method Detection Limits

The detection limits for the constituents listed in Table 4-3 are based on the method detection limits specified in the referenced analytical methods to be performed. Method detection limits for each analyte will be included in the laboratory data packages. Once method detection limits have been calculated, they will be evaluated in regard to regulatory requirements.

5.0 Waste Management Plan

The requirements for management of the wastes derived from site characterization activities will be determined based on regulatory requirements, field observations, and the results of laboratory analysis of site characterization samples. Administrative controls (e.g., decontamination procedures and characterization strategies) will minimize waste generated during site investigation activities. Hazardous, radioactive, and/or mixed waste, if generated, shall be managed and disposed of in accordance with DOE Orders and Resource Conservation and Recovery Act (RCRA) regulations. Decontamination activities will be performed in accordance with approved procedures and will be designated according to the COCs present at the site.

5.1 Waste Minimization

The characterization activities have been designed to minimize the amount of IDW produced. The majority of site characterization activities consist of *in situ* soil surveys and will not produce any IDW. Minimal quantities of IDW will be produced from the disposal of personnel protective equipment (PPE) and decontamination water. Vertical soil profiles and hand-auger boring activities will produce some excavated soil materials which will remain at the boring location.

For materials sent to the approved laboratory for analysis, contaminated soil which is not RCRA-regulated and banned from land disposal (i.e., above Land Disposal Restriction [LDR]) will be disposed of by the laboratory.

5.2 Potential Waste Streams

Based on preliminary sampling results and process knowledge, no hazardous wastes or mixed wastes are anticipated. It is possible some LLW may be generated as a result of CAI activities.

Wastes generated during the characterization of the CS sites may include, but are not limited to, the following:

- Decontamination rinsate
- Contaminated sample management equipment (e.g., plastic, paper, aluminum foil, and sample containers)

- Personal protective equipment
- Contaminated and uncontaminated soil

5.3 Waste Determination

The status of IDW (e.g., RCRA-hazardous, LLW, mixed waste) will be determined through the application of statistical analyses of sample data as described in Chapter 9 of SW-846 (EPA, 1986) for the determination of the RCRA status of waste. Similar procedures will be used to evaluate the radioactive status of the IDW. The characterization levels for IDW contaminants are presented in Table 5-1.

Table 5-1
Characterization Levels for Investigation-Derived Waste Contaminants

Parameter	Characterization Level	Source	Comments
TC VOCs	TC List	40 CFR 261.24	-
TC Metals	TC List	40 CFR 261.24	-
TC SVOCs	TC List	40 CFR 261.24	-
TC Pesticides	TC List	40 CFR 261.24	-
Total PCBs	50 ppm	TSCA	-
Radiological	Component specific	NTS PO[a]	-
Paint Filter	Fail	NVO-325[b]	-

[a]Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste (BNC, 1996)
[b]Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements (DOE, 1992b)

CFR - *Code of Federal Regulations*
ppm - parts per million
SVOC - semivolatile organic compounds
TC - toxicity characteristic
TSCA - Toxic Substances Control Act
VOC - volatile organic compounds

5.4 Waste Management

The appropriate data for each identified waste must be obtained with respect to the contaminants encountered during sample analysis. From the data generated as a result of contaminant characterization, it should be possible to assign the appropriate waste type (i.e., hazardous, mixed, LLW, or unregulated) to the IDW.

If mixed waste is produced, the appropriate data on the status of the waste must also be obtained or developed in accordance with the Transuranic Pad waste acceptance criteria. The number of samples necessary to satisfy the various mixed waste management requirements (e.g., RCRA, NVO-325, etc.) will depend on the number of containers of IDW produced, the volume of IDW produced, and/or the variability in the analytical values for the IDW produced.

Solid materials other than soil wastes are waste only by virtue of contact with contaminated media. The same is true of decontamination rinsate. Therefore, sampling and analysis of the IDW (other than excavated soil, piping, etc.), separate from site characterization analyses, will not be required. Administrative controls, such as those presented in this CAIP, will ensure that no additional contaminants are added to the waste. For administrative purposes, the waste will be managed as at least three waste streams: soil, contaminated solid trash, and liquid wastes such as decontamination rinsate. Each waste stream will be segregated, and additional segregation may occur within each waste stream. For example, the soil waste produced from each separate study area will be segregated. Wastes will be managed on site within the defined site boundaries until analytical results are received to determine the disposition of the waste. Liquid low-level or mixed wastes, to the extent possible, will be allowed to evaporate on site. Any residual liquids will be absorbed or solidified prior to disposal or storage. Access to wastes temporarily staged at the project site will be controlled through placing the waste packages or waste soil piles within an access-controlled area. All waste containers (e.g., drums) will be covered, locked, and appropriately labeled. Waste containers shall be periodically inspected while awaiting laboratory results to verify that the waste containers are not leaking or damaged.

Most IDW streams will be placed in waste containers such as DOT-approved drums (e.g., for contaminated PPE, decontamination rinsates, and small quantities of soil). The contents of each container will be recorded, and each container will be appropriately marked and labeled in accordance with RCRA, DOE, and contractor approved procedures.

Soil waste will be segregated according to the conceptual model study area from which it is removed (see Section 3.1). If analysis indicates that the staged soil is contaminated with RCRA (i.e., above TC or LDR levels) and/or radioactive COCs, then the soil shall be containerized and staged to await disposal. The anticipated volume of waste contaminated soil to be generated during the characterization is less than 0.25 cubic meters.

In the unlikely event that mixed waste is generated, it will be stored on site in appropriate containers after having met the appropriate waste acceptance criteria. Low-level waste may be generated from sampling and/or decontamination activities. If generated, these wastes will be disposed of at the NTS under the Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements (DOE, 1992b). Hazardous waste, if generated, will be shipped off site to a permitted treatment storage, disposal, or recycling facility, whichever is most cost effective.

6.0 Schedule and Reporting Requirements

6.1 Project Schedule

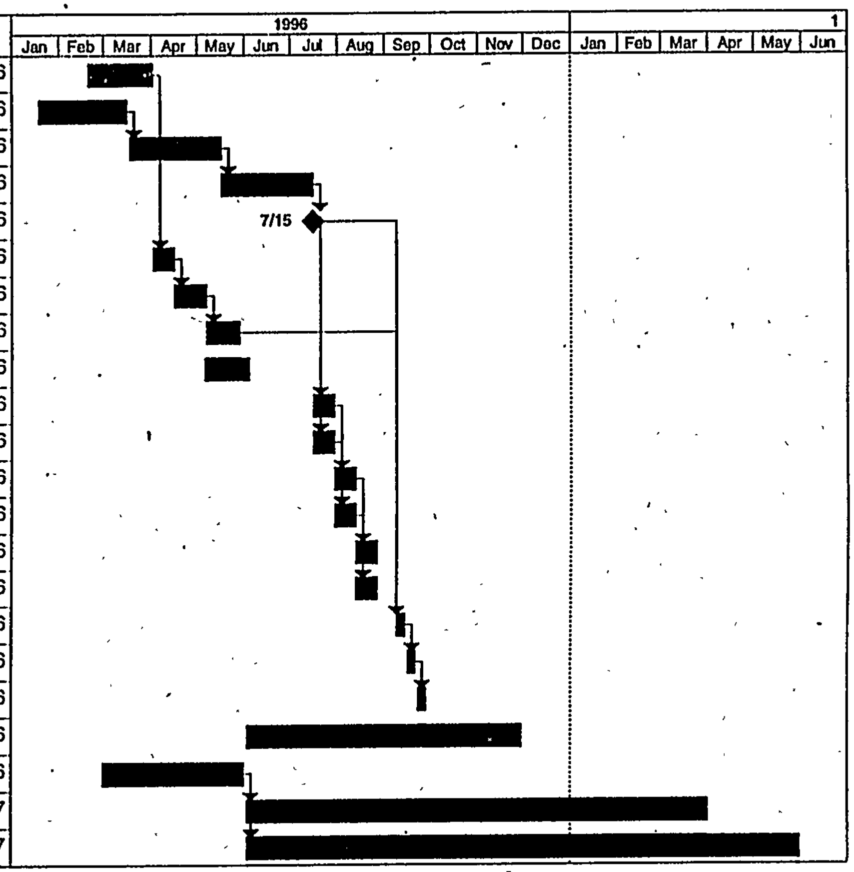
A detailed project schedule has been developed and is shown in Figure 6-1. This schedule provides information regarding the start times and durations for the tasks to be completed as part of the CAI. This schedule also identifies dates for submittals of progress reports and other reporting requirements for CS-1 with CS-2 and CS-3 schedules left intermittent depending on budget and NVO-325 considerations.

6.2 Reporting Requirements

Upon completion of the field activities and receipt of the sample analytical and data validation results (as applicable), a Characterization Report will be produced. The report will, at a minimum, include the following:

- Drawings of the site, including appropriate site boundaries, sampling locations, boundaries of the contamination removed (if applicable), estimated boundaries of remaining contamination (if applicable), and other relevant features
- Discussions of the characterization methods used, including soil sampling methods, materials, and logs
- Information about the presence and concentrations of constituents of concern
- Tables summarizing laboratory and field screening data
- A discussion about the adequacy of the characterization of the site
- A discussion about the quality control data obtained for the characterization
- Recommendations for further assessment, remediation, or closure of the site

ID	Task Name	Start	Finish
1	Prepare CX Document	2/20/96	4/1/96
2	CS1-3 Prepare Draft CAIP	1/19/96	3/15/96
3	CS1-3 CAIP Rvw/Comment Resolution (DOE)	3/18/96	5/16/96
4	CS1-3 CAIP Rvw/Comment Resolution (NDEP)	5/17/96	7/15/96
5	CS1-3 CAIP Approved	7/15/96	7/15/96
6	CS1 Preliminary Field KIWI Surveying	4/2/96	4/15/96
7	CS2 Preliminary Field KIWI Surveying	4/16/96	5/6/96
8	CS3 Preliminary Field KIWI Surveying	5/7/96	5/28/96
9	CS1, CS2 and CS3 Depth Profile Surveying	5/6/96	6/3/96
10	CS1 Sampling for RCRA & NVO-325 Constituents	7/16/96	7/29/96
11	CS1 Burial Areas Geophysical Investigations	7/16/96	7/29/96
12	CS2 Sampling for RCRA & NVO-325 Constituents *	7/30/96	8/12/96
13	CS2 Burial Areas Geophysical Investigations	7/30/96	8/12/96
14	CS3 Sampling for RCRA & NVO-325 Constituents *	8/13/96	8/26/96
15	CS3 Burial Areas Geophysical Investigations	8/13/96	8/26/96
16	CS1 Final KIWI Surveying	9/9/96	9/13/96
17	CS2 Final KIWI Surveying	9/16/96	9/20/96
18	CS3 Final KIWI Surveying	9/23/96	9/27/96
19	Field Reporting and Documentation, CS1	6/3/96	11/29/96
20	Preliminary Evaluation of Corrective Measures, CS1	3/1/96	5/31/96
21	Corrective Action Decision Document (CADD), CS1	6/3/96	3/31/97
22	Corrective Action Plan (CAP), CS1	6/3/96	5/30/97



* The CS2 and CS3 waste characterization sampling schedules may be adjusted one to two years in order for sampling and analysis to be within a "reasonable" proximity to disposal, as required by NVO 325.
Documentation schedule for CS2 and CS3 are problematical and therefore not include.

Figure 6-1
Project Schedule

6.3 Corrective Action Decision Document

The following outline is the proposed table of contents for the Corrective Action Decision Document:

7.0 References

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Appendix A
Environmental Setting

A.1.0 Environmental Setting

A.1.1 Site Description

The Tonopah Test Range is located in Nye County in southern Nevada, on the northwestern portion of the Nellis Air Force Range. The relative location of the TTR is indicated on Figure 1-1 (Section 1.0 of Clean Slate CAIP). The locations of the Clean Slate (CS) sites are approximately 224 km (140 mi) northwest of Las Vegas by air, and approximately 64 km (40 miles) southeast of Tonopah. The TTR is federally owned and occupies approximately 925 km^2 (360 mi^2), and access is restricted. The TTR is bordered on the south, east, and west sides by the NAFR and on the north side by sparsely populated public land administered by the U.S. Bureau of Land Management and the U.S. Forest Service. The nearest community is Goldfield, Nevada, which is located approximately 42 km (26 mi) west of the TTR/NAFR boundary.

A.1.2 Physical Setting

The topography and terrain of the TTR is typical of the basin-and-range physiographic province of Nevada, Arizona, and Utah, consisting of numerous north-south trending, linear mountain ranges separated by broad, flat-floored and gently sloping valleys.

A.1.2.1 Topography and Terrain

TTR is situated in the high desert region of south-central Nevada between two mountain ranges. Figure A-1 shows the major topographic features of the TTR. Along the west side of the TTR is the Cactus Range, a series of low rocky mountains with a peak elevation of about 2,300 m (7,500 ft) average mean seal level (amsl). Along the eastern boundary is the Kawich Range with elevations ranging from 2,000 to 2,850 m (6,500 to 9,400 ft) amsl. The highest elevations are found on Kawich Peak, 2,866 m (9,404 ft) amsl and Cactus Peak, 2,280 m (7,482 ft) amsl. The lowest elevation is found on the valley floor approximately midway between Cactus Flat and Gold Flat at 704 m (2,310 ft) amsl.

A.1.2.2 Geology

The geology of the TTR is comprised of three major rock units (ERDA, 1977): (1) complexly folded and faulted sedimentary rocks of Paleozoic age; (2) volcanic tuffs, ashflows, and rhyolitic lavas of Tertiary age; and (3) alluvium of late Tertiary and Quaternary age derived from the surrounding exposures of Tertiary and Paleozoic rock.

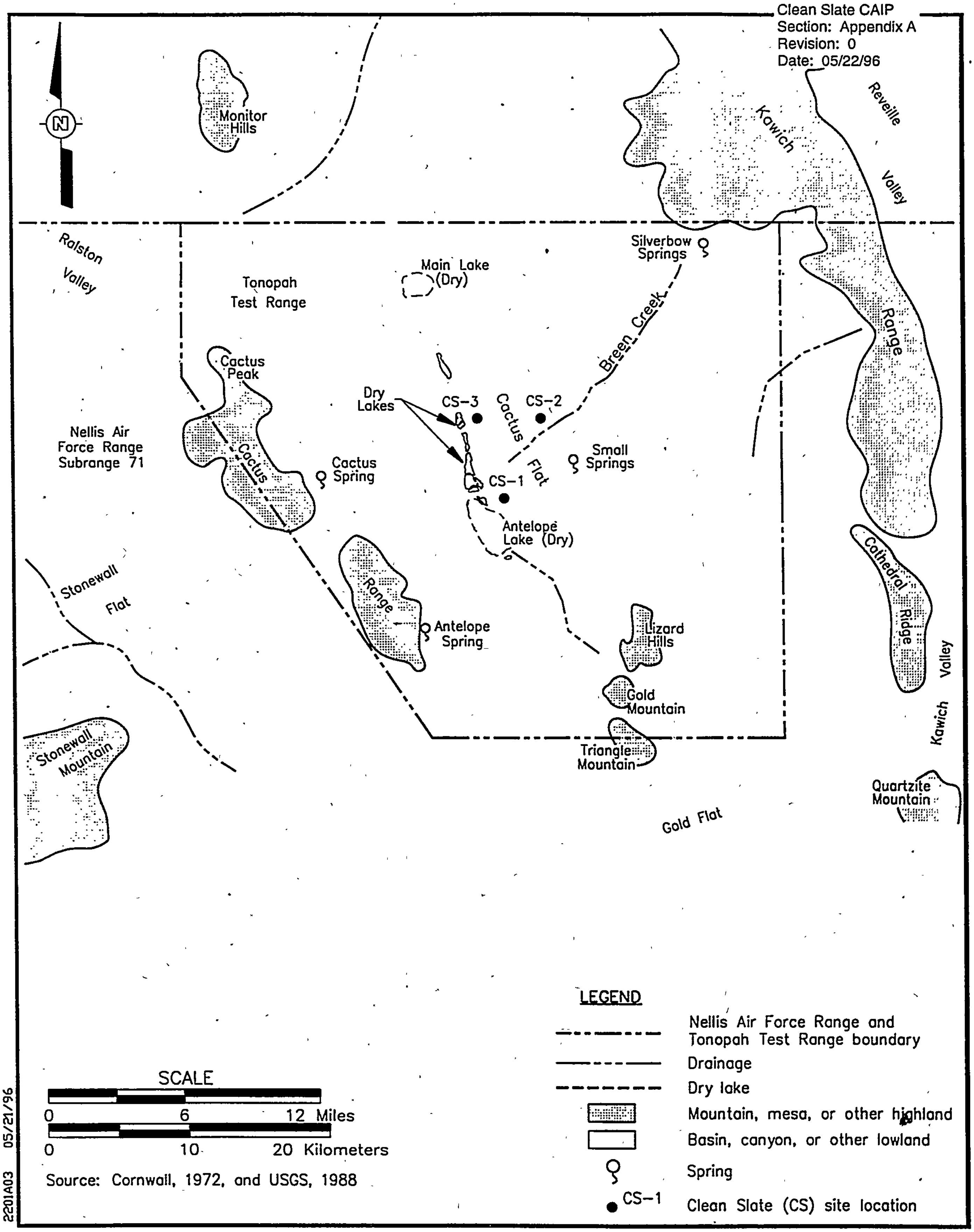


Figure A-1
Tonopah Test Range Geographic Features

The Paleozoic sedimentary rocks are comprised of three major distinct sequences. The lower portion varies from 3,040 to 3,340 m (10,000 to 11,000 ft) thick and is composed chiefly of quartzite, siltstone, and shale formations of late Precambrian to middle Cambrian in age. This is overlaid by a middle part which may be greater than 4,255 m (14,000 ft) thick. This sequence is composed mostly of limestones and dolomites of middle Cambrian to Devonian in age. The upper portion of this sequence is estimated at over 1,215 m (4,000 ft) in thickness. This sequence represents sporadic depositional periods mostly during late Devonian and Mississippian time. The formations are mostly clastics composed of argillite, siltstone, quartzite and conglomerate units.

The Tertiary volcanic rocks are predominantly ash flow tuffs and include some silicic lavas that erupted from five major volcanic centers and parts of two others. The thickness of the volcanic rocks is estimated to form a composite section of approximately 6,075 m (20,000 ft), with the age of rocks ranging from 27 to 7 million years old.

Surficial deposits at the TTR consist of late Tertiary- and Quaternary-age fluvial deposits, alluvial fans, playa deposits, colluvium, and eolian deposits that veneer volcanic and sedimentary bedrock. Alluvium is transported from the tectonically developing highlands onto piedmont slopes and intermontane basins. The piedmont slopes are mosaics of dissected and undissected alluvial surfaces commonly veneered with eolian fines that are armored by desert pavement. The alluvium may attain thicknesses of over 1,370 m (4,500 ft) in the central portions of the valleys (Ekren et al., 1971). Alluvium at the TTR is characteristic of young immature soils consisting of poorly graded sand with silt, gravel, and cobbles. The alluvium is deposited in series of coalescing fans which contain talus on the upper piedmont slopes varying to finer-grained material in the lowlands. The finest material, consisting of silt and clay, is deposited in the playas, normally situated at the lowest point in the flats. The lithology of the alluvium on the piedmont slopes closely reflects the adjacent bedrock. As the alluvium is transported to the lowlands, mixing with material from other fans occurs making the lithology variable over relatively short distances. Surficial geology is discussed in more detail in Section B.1.2.2.1.

The geology of areas where investigations will be conducted at the TTR is described below.

Cactus Flat is located in the center of the TTR approximately 16 km (10 mi) north of Pahute Mesa. Cactus Flat is a part of a larger area of interconnecting flats that form a large intermontane basin. Mountains surrounding Cactus Flat are the Kawich Range to the east, Gold Mountain to the south, and the Cactus Range to the west. Figure A-1 shows the relative location of CS1, 2, and 3 to the local geographic features. The north side of Cactus Flat is open to other flats. Cactus Flat has little variation in elevation, with Main Lake, a playa at the north end, being close to the same elevation as Antelope Lake at the south end, approximately 1,620 m (5,330 ft) amsl.

The mountains surrounding Cactus Flat are highly complexed volcanic rock consisting of rhyolite, dacite, rhyodacite, quartz latite, and andesite lava flows and intrusive masses and rhyolitic ash-flows and ash-fall tuffs. The volcanic rocks bordering Cactus Flat are of Tertiary age (Cornwall, 1972).

A.1.2.2.1 Surficial Geology

The surficial deposits at the TTR consist mostly of alluvial sediments of Quaternary age. The surficial deposits have been categorized into landslide and talus, fan alluvium, valley-fill alluvium, lake and shoreline deposits (Ekren et al., 1971) and eolian deposits (DOE, 1988). The different types of surficial deposits are discussed in detail below. No soil surveys have been performed at The TTR (Raglund, 1994).

Landslide and Talus Deposits

Landslide and talus deposits are found at the base of steep mountain slopes. They typically consist of large boulders (greater than 1 m [3 ft] in diameter) to centimeter-sized rubble shed from slopes.

Fan Alluvium

The fan alluvium has been deposited on pediment surfaces that slope radially away from the mountain ranges. Typically, this alluvium is coarsest near the base of the mountain slope and finest at the distal edge of the fan. The composition of the fan alluvium grades from boulders and cobbles to coarse gravel to coarse sand. This material is largely uncompacted and uncemented. Laterally, alluvial fans coalesce; basinward, they grade into valley-fill alluvium.

Valley-Fill Alluvium

The valley-fill alluvium has been deposited near the margins of the basin and basinward onto the valley floor. The valley-fill sediments typically consist of thick sequences of gravel, sandy gravel, and sand. Locally, these thick units may be separated by thin silt and clay intervals. These finer-grained units seem to have a limited lateral extent (DOE, 1988). The thickness of the valley-fill alluvium varies widely, with the thickest deposits in the central portions of the major basins. The composition of the alluvium varies according to the distance from the source and the type of source rock. The degree of cementation and the percentage of clay and compaction vary according to location. Basinward, the valley-fill alluvium grades into lake and shoreline deposits.

Lake and Shoreline Deposits
Regionally, lake and shoreline deposits (playas) are found in the central portions of the intermontane basins. These are typically coarser grained (gravel to coarse-grained sand) on the margin of the playa and grade to silt- and clay-sized material in the central part. Desert pavement is found throughout the lake and shoreline depositional environment. These pavements are surfaces of tightly packed gravels that overlie a thin layer of silt. Desert pavements are often found near playas. The clay deposits readily take on and expel water during wet to dry climatic cycles and, as a result, desiccation polygons (mud-crack polygons) are often found in playa deposits in the basin-and-range desert region.

Eolian Deposits
Eolian deposits occur as dunes and sand sheets. Fluvial sand sheets often occur along downstream drainages as a result of erosion of the wind-blown sand.

A.1.2.2.2 Hydrogeology
Hydrogeologic data at the TTR is limited to water wells that were drilled to support activities at the TTR. There are no detailed studies of hydrogeologic conditions at the TTR.

The water supply wells at the TTR were completed in the alluvium. The depth to groundwater at the site varies greatly ranging from 0 m (0 ft) where springs are present to over 120 m (400 ft). The uppermost aquifer, located in the alluvium, appears to be unconfined with no laterally continuous confining units (Ekren et al., 1971).

A.1.2.3 Surface Water
Several dry lake beds (playas) exist at the TTR, most notably Main and Antelope Lakes on Cactus Flat. The playas retain surface water after heavy rains, but are normally dry again within a few days due to evaporation.

Numerous stream channels that remain dry most of the year and only discharge water after rain are present throughout the sites.

A.1.2.4 Climate and Meteorology

The climate and meteorology of the TTR can vary significantly over short distances due to complex orographic influences. Extremes of climate are exemplified by conditions on the high plateaus that support pine forests in contrast to the dry desert lake beds in valleys.

The Sierra Nevada Mountain Range to the west, blocks most Pacific-originated storms, and the intervening desert area to the east exhausts moisture from storms arising from that area. The infrequent storms that deposit substantial moisture usually come from the southwest in the form of summer thunderstorms. Annual precipitation at the TTR is 13 to 15 cm (5 to 6 inches) in Cactus Flat (French, 1985).

Temperature over the valley floors is characterized by a large daily range due to nocturnal air drainage, which has a pronounced influence on nighttime temperatures. Diurnal temperature oscillations on the plateaus are much less than those in the valleys. Average temperatures for the warmest and coldest hours in January for from the TTR weather station are 7°C (44°F) and -8°C (18°F), respectively. Corresponding temperatures in July are 32°C (90°F) and 14°C (58°F) (Schaeffer, 1967).

Winds at the TTR are generally light to moderate. In the winter, winds are more frequent than at other times of the year and are predominantly from the northwest. In the summer, the wind direction is predominantly south to southeast trending with the linear mountain ranges and at times creating strong dust devils in the valleys. The highest wind speeds occur in midafternoon in all seasons, especially in the spring when dust storms are common (Schaeffer, 1967).

Appendix B
Previous Investigation Results

B.1.0 Previous Investigation Results

Numerous investigations have been completed at the Clean Slate (CS) sites to evaluate environmental conditions. These investigations can be divided into two major groups: Group 1: investigations directly related to Operation Roller Coaster and Group 2: investigations conducted after completion of Operation Roller Coaster to monitor potential migration of contamination and monitoring of the environmental conditions.

B.1.1 Operation Roller Coaster Investigations

Many investigations were completed as part of the Operation Roller Coaster experiment with each investigation dealing with a specific aspect of the experiment. Investigation topics included: air sampling, fallout collection, special particulate analysis, special particulate characteristics, soil analysis, and technical photography. A summary of the study results was issued as Operation Roller Coaster Project Officers Reports (Shreve, 1965).

Several general conclusions were reached as a result of the experiment investigations. Investigation results included:

- The majority of highly contaminated material was found relatively close to GZ.
- When shots were covered with overburden, the highly contaminated areas were reduced.
- Some sorting of radioactive particles took place in the debris cloud due to atmospheric turbulent diffusion.
- Uranium and plutonium particles became attached to soil particles by melting of the soils to form a silicate glass.

At the conclusion of the test, highly contaminated soil and debris from each experiment were collected at the respective GZ and covered with clean soil material to minimize the potential for direct contact with these materials. In addition, fences were installed around each GZ to prevent accidental intrusion by personnel and/or roaming wildlife from coming in direct contact with these materials.

B.1.2 Environmental Monitoring Investigations

In the years following the completion of Operation Roller Coaster, numerous studies and monitoring programs have been completed to monitor the environmental conditions in the CS-1, CS-2, and CS-3 areas. These programs, which dealt with monitoring of site radiological conditions, were conducted using both overland and aerial survey techniques and various types of radiological measurement equipment (Burnett, 1964).

For several years following the completion of Operation Roller Coaster, Reynolds Electrical and Engineering Co., Inc. (REECo) conducted semiannual radiological surveys at CS-1, CS-2, and CS-3 (ERDA, 1975 and ERDA, 1977). Surveyed areas included the fenced GZ areas as well as extensive areas outside the GZ fences. Sampling activities included collection of air samples, surface and groundwater samples, and selected soil and vegetation samples. Results of this monitoring program did not indicate any significant migration of radioactive materials by wind and/or surface water infiltration (Gilbert et al., 1975) (Environmental Surveillance Group, 1966).

In 1973, a field instrument for the deteetion of low energy radiation (FIDLER) survey was conducted inside the fenced areas and over large areas outside the fence using a 61-m grid spacing for instrument measurements. Using a detection level of 1,000 counts per minute (cpm), additional contaminated areas were identified at each CS location and enclosed with a barbed wire fence (Gilbert et al., 1975 and Gilbert et al., 1977).

Annual FIDLER measurements were collected at the CS sites by REECo in the early 1970s, but were later discontinued since migration of plutonium was not detected.

In 1977, an aerial survey of the CS areas was completed by EG&G utilizing a helicopter equipped with a light weight radiation and environmental data acquisition and recorder (REDAR) system. This survey used the same grid as the 1973 FIDLER survey (Jobst, 1977).

Comparing the results of the 1973 and 1977 surveys indicated a good correlation of survey results and that most of the contaminated areas were enclosed within the fences. Survey results did show that some radiological contamination in the CS-2 area was outside the fence boundaries.

Routine environmental surveillance activities are conducted by SNL as part of their operation requirements for the Tonopah Test Range (TTR) facility. SNL has been operating this facility for the government since 1957. The activities are reported in annual Environmental Monitoring Reports which are currently being submitted to the U.S. Department of Energy (DOE) (SNL, 1987-1992). Monitoring activities include collection and analysis of air and groundwater samples and, during selected years, analysis of soil samples. The results of these monitoring activities indicate no significant changes in environmental conditions in the CS areas (Essington et al., 1977).

In August 1993, an aerial survey was completed for the CS and Double Track sites for IT Corporation by the Remote Sensing Laboratory (RSL) (Proctor and Hendrix, 1994). The primary objective of this survey was to locate depleted uranium (U-238) at three locations originating from the Operation Roller Coaster experiments. The results of this survey showed that no significant concentrations of depleted U-238 could be located. The survey also indicated substantial Am-241 around the CS sites. This Am-241 material is a daughter isotope of Pu-241 which was used in the original Operation Roller Coaster simulated weapons (Proctor and Hendrix, 1994).

Appendix C
Clean Slate Sites Characterization, Data Quality Objectives Development

C.1.0 Data Quality Objectives (DQO) Development

These DQOs have been developed specifically to meet the Clean Slate sites characterization activities. The specific information for development of the DQOs is provided in the following sections.

C.1.1 Problem Statement (Step 1)

The following problem statement applies to the characterization of the three CS sites throughout the planned and proposed characterization activities.

Potential Resource Conservation and Recovery Act-regulated hazardous and/or low-level radioactive wastes are present at the CS sites to be characterized. The horizontal and vertical extent of this contamination must be determined and the contaminated materials properly characterized so that the sites can be closed under applicable FFACO, NDEP and DOE requirements. In addition, the identification of "hot spots," the determination of the geometry and concentration of contaminants in the GZ areas, and the feasibility of volume reduction of waste materials must be established so that contaminated materials can be cost-effectively disposed of at an appropriate disposal facility.

C.1.2 Identification of Decisions (Step 2)

The principal study question to be resolved through the results of the characterization activities can be expressed as follows:

> "Is the conceptual model for the site correct with respect to contaminant types and extent of contamination? In addition, has sufficient data been obtained to determine disposal options and feasibility of soil volume reduction?" (EPA, 1992)

The question can be divided into three primary components: contaminant characterization, contaminant migration, and disposal options. This division is reflected throughout the DQO process, and the question is best addressed through the application of a decision process for the characterization strategy based on the conceptual model. The following sections discuss the decision process.

C.1.2.1 The Decision Process

The decision process for this site characterization plan includes decisions to be used in resolving the principle study questions asked in the previous section and which generally guide the progress of the characterization activities during each phase of the characterization. The decision process is designed to guide the field sampling program to successful completion and result in the collection of data that support recommendations for further characterization activities or closure/remedial action plans for the site. The process has been broken down into four groups (i.e., Decision Groupings): one involving the investigation of contaminant types, two involving the assessment of the extent of contaminant migration, and one involving soil volume reduction. The Decision Groupings are as follows:

- Contaminant characterization
- Vertical contaminant migration
- Lateral contaminant migration
- Soil volume reduction

The DQO process has been applied to each of these Decision Groupings. More quantitative DQOs, such as the numbers of samples to be collected, sample intervals, and analytical requirements, will be provided in the Corrective Action Investigation Plan (CAIP) (Section 4.0) and in site-specific instructions to the sampling and analysis field teams. These are initially determined by the conceptual model, but will ultimately be determined by the amount of contaminated soil identified at the CS sites. DQOs have been developed to adhere to the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters as discussed in the Quality Assurance Project Plan (QAPP) (DOE, 1994).

The scope of this characterization is currently limited to the areas enclosed by the perimeter exclusion fences with some limited investigation outside the fences at CS-1 and CS-2. Decisions will be made during implementation of the field sampling program on the basis of survey data. The individual Decision Groupings are discussed in the following sections.

C.1.2.1.1 Contaminant Characterization Decision Grouping

The object of this grouping is to determine whether the type of contamination that exists was predicted in the conceptual model for the site. The results of this grouping affect both IDW issues as well as future closure issues. To satisfy this grouping, soil samples must be obtained and analyzed for the identified radionuclides (i.e., Pu-239/240, Am-241, and U-238), toxicity characteristic leaching procedure parameters, and physical characteristics of the soil matrix.

C.1.2.1.2 Vertical Contaminant Migration Decision Grouping

The object of the questions in this grouping is to determine whether the vertical extent of contamination at the site exceeds what was predicted in the conceptual model and whether it has been adequately evaluated. The result of the questions is the continuation of subsurface investigation activities downward to the vertical extent predicted by the model. If contamination exceeds the depths predicted by the model, then the model shall be revised, and investigations will continue until the vertical extent of contamination is identified.

The initial test of the conceptual model under this Decision Grouping will come during the vertical profiling of soils. If the depth of the contamination exceeds the predicted depth, then the conceptual model will need to be revised and contingent investigation techniques considered.

An additional test will be the determination of the volume and concentration of contaminants in the GZ areas. If the depth of contamination exceeds the predicted depth using the selected investigation methods, then the conceptual model should be revised and contingent investigation techniques considered.

C.1.2.1.3 Lateral Contaminant Migration Decision Grouping

The objective of the questions in this grouping is to determine whether the lateral extent of contamination at the site exceeds what was predicted in the conceptual model and whether it has been adequately evaluated. The result of the questions is the continuation of surface and subsurface investigation activities to the lateral extent predicted by the model. If contamination exceeds the lateral extent predicted by the model, then the model shall be revised and a determination will be made as to whether the current investigation activities should continue further, whether the results indicate the necessity of additional characterization activities, or whether to develop additional characterization phases to fully evaluate the lateral migration.

To answer the questions in this grouping, sample data must be generated that adequately indicate the absence of or concentration of surface contaminants at the site. This data will need to be applied to the entire site through the production of maps showing the aerial distribution of contamination.

C.1.2.1.4 Soil Volume Reduction

The objectives of the questions in this grouping is to determine the engineering feasibility of reducing the volume of soil material requiring disposal. The result of this question may affect the remedial alternative selected for the sites and/or the cost of remediation of the areas. If soil volume cannot be reduced sufficiently, then the closure strategy identified in the conceptual model may need to be revised and other closure strategies considered.

C.1.3 Decision Inputs (Step 3)

To resolve the decision statements, the environmental variables to be measured during the site characterization include physical characteristics as well as chemical and radiological parameters for soil and/or debris. Table C-1 summarizes the parameters to be analyzed. All the variables to be analyzed will be the result of the analysis of samples obtained during the site characterization activities. In addition, sample locations and depths, soil types, and other field measurements will be collected and/or documented during the characterization activities to support contaminant modeling efforts that may be conducted upon receipt of the on-site and/or off-site laboratory analytical results. Samples for the analysis of physical parameters (e.g., grain-size analysis) may also be collected to support possible remedial feasibility evaluation for the site.

Table C-1
Environmental Variables to be Analyzed as Decision Inputs

Media	Chemical and Radiological Parameters
Soil/Debris	Toxicity Characteristic VOCs TC Semivolatile Organic Compounds TC Metals Gross Alpha/Beta Gamma Scan Physical Characteristics

The chemical parameters chosen for analysis are based on the chemicals known and/or suspected to have been dispersed at the CS sites and the results of previous evaluations at the site. Also influencing the choice of chemical analyses are the requirements of RCRA and the various lists of hazardous wastes contained therein. The selected radiological parameters are based on standard Nevada Test Site (NTS) requirements for substantiating the absence of radiological contaminants from NTS sources. The analytical parameters selected may be modified (i.e., expanded or reduced) based on the results of completed sampling and modification of the conceptual model.

C.1.4 Study Boundaries (Step 4)

The following section identifies the characteristic study boundaries (i.e., those which define the population of interest), spatial study boundaries (i.e., those which limit the lateral and vertical extent of the characterization), and temporal study boundaries (i.e., those which constrain the time frame during which the generated data will be considered valid for the current condition of the site) for the characterization. With these boundaries in mind, the scale of decision-making for the DQOs is also determined (e.g., populations or subpopulations for which decisions will be made based on the spatial or temporal boundaries).

Based on the conceptual model for the sites, each CS site has been divided into three different study areas (i.e., areas within the GZ fences, areas identified as having contamination more than 200 pCi/g, and areas enclosed by the outside perimeter fence having contamination less than 200 pCi/g). The separation of these study areas is based on the previous investigation data for each CS area. The spatial study boundaries vary, as depicted in Figures 3-1, 3-2, and 3-3 of the CS CAIP, for each study area to be characterized during the planned activities.

The temporal boundary for the characterization shall begin at the time at which the characterization plan is implemented and end when all planned characterization activities are complete. This boundary may be extended to include additional characterization activities which are not currently planned, depending on the amount of time necessary to implement additional activities. The characteristic boundaries (as defined in the conceptual model) are similar for each of the three CS sites and are defined as follows:

<u>Study Area 1</u> - This area is identified as being within the GZ fence at each location. The area within the GZ fences are believed to contain the majority of highly contaminated soil and debris from the Operation Roller Coaster experiment.

<u>Study Area 2</u> - This area is based on previous aerial survey results (Gilbert, 1975) and consists of the area having concentrations of radioactivity greater than 200 pCi/g. These areas are defined in Figures 3-1, 3-2, and 3-3 of the CS CAIP. Data for CS-1 and CS-2 indicate some areas of greater than 200 pCi/g outside the perimeter fences as shown on the figures.

<u>Study Area 3</u> - This area is based on previous aerial survey results (Proctor and Hendrix, 1994) and is defined by the area inside the perimeter fence at each CS site. These areas were believed to be the extent of any significant contamination after the completion of the aerial survey completed in 1993 with some minor exceptions at CS-1 and CS-2 as indicated above.

The scale of decision-making is based on the study areas into which the CS sites have been divided. Decisions will be made to provide data to support or refute the characteristic and spatial study boundaries for each of the study areas indicated.

The overall spatial boundary for the characterization activities are the currently designated site boundaries (Figures 3-1, 3-2, and 3-3). The specific vertical, lateral, and sample-bounded spatial boundaries for the characterization are discussed in the following sections.

C.1.4.1 Vertical Study Boundaries

The vertical study boundaries are equal to the depths of contamination for each of the CS study areas outside the GZ area predicted in the conceptual model, plus or minus 50 percent (i.e., 10 ± 5 cm). The ground surface represents the minimum depth of the vertical study boundaries. Within this range, the conceptual model will not need to be modified to remain valid.

If the vertical extent of contamination exceeds that predicted in the model, the vertical study boundary may be modified to equal 100 percent of that predicted in the conceptual model or a maximum of 20 ± 10 cm. The decision to extend the vertical boundary will be based on the vertical profile sampling results completed at selected locations.

In the GZ areas, the initial study boundaries are equal to the depth of contamination predicted in the conceptual model plus or minus 50 percent (i.e., 1.5 m ± 0.75 m [5 ± 2.5 ft] at CS-1 and CS-2, and 3 m ± .5 m [1 ± 5 ft] at 50 percent [i.e., 1.5 ± 0.75 m (5 ± 2.5 ft) at CS-1 and CS-2 and 3 ± 1.5 m (10 ± 5 ft) at CS-3]). If the vertical extent of contamination in the GZ areas exceeds that predicted in the model, the vertical study boundary may be modified to 100 percent of that predicted in the conceptual model. The decision to extend the vertical boundary will be based on the vertical soil profile sampling results completed within each GZ area.

C.1.4.2 Lateral Study Boundaries

The lateral spatial boundaries are equal to the maximum lateral extent of contamination for each of the study areas as predicted in the conceptual model plus 91.5 m (300 ft) outside the 200 pCi/g contour established in the 1993 aerial survey. Within this range, the conceptual model will not need to be modified to remain valid. The following are the maximum lateral extents of each of the study areas based on the conceptual model.

If the lateral extent of contamination exceeds that predicted in the model, the lateral study boundary may be modified to extend 183 m (600 ft) from the established 200 pCi/g contour predicted in the conceptual model. The decision to extend the lateral boundary will be based on the concentration of contaminants identified at the site boundaries.

C.1.4.3 Sample-Bounded Study Areas

An important subset of the vertical and lateral study areas is the sample-bounded study area. For the purpose of this site characterization, sample-bounded study areas of the site which are surrounded by vertical and/or lateral sample locations which are no greater than a designated distance (See Sections 4.3.1 through 4.3.4) apart, based on the type of evaluations being conducted (i.e., survey results versus vertical profiling results). Although there are maximum distances set for the purpose of these study areas, there are no set distances or minimum distances set below these maximums. The purpose of determining the maximum size of sample-bounded study areas is to assign limits on the distance over which data from one sample location may be used to extrapolate the type and extent of contamination in the surrounding area.

C.1.5 Decision Rules (Step 5)

Decision rules have been developed for these site characterizations to define the parameters of interest, specify the characterization levels, and integrate previous DQO outputs into statements that describe a logical basis for choosing among alternative actions. The following sections discuss the statistical parameters and characterization levels that are used in the decision rules.

C.1.5.1 Statistical Parameters

Statistical data analysis will be conducted on sample data to substantiate the conceptual model with respect to the contaminants of interest within each CS study area. The statistical parameter to be used will be the mean of the applicable COC concentration values for each study area. Based on the conceptual model and the characteristic study boundaries (See Section 3.1), the applicable COCs for substantiating the conceptual model for the three CS study areas are as follows:

- Pu-239, Pu-240
- Am-241
- U-238 (Du)

C.1.5.2 Characterization Contaminant Levels

The characterization contaminant levels for COCs are based on different sources depending on the parameter of interest as defined in the conceptual model, the characteristic study boundaries, and the purpose of the analysis. Table C-2 presents the sources for the contaminant levels that will be used for the different COCs during this characterization.

Table C-2
Contaminant Levels for Identified COCs

Media	Parameter	Contaminant Level	Source
Soil	TC VOCs[a]	TC List[b]	40 CFR 261.24[c]
	TC Metals	TC List	40 CFR 261.24
	TC SVOC's	TC List	40 CFR 261.24
	Pesticides, PCBs	TC List	40 CFR 261.24
	TC Herbicides	TC List	40 CFR 261.24
	Radiological	Component specific	NTS PO[d]

[a]Volatile organic compounds
[b]Toxicity characteristic
[c]Code of Federal Regulations
[d]Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste (BNC, 1996)

C.1.5.3 Rules

The decision rules for the characterization phases and the Decision Groupings are presented in the form of questions. The answers to these questions are based on the characterization data which has been evaluated using the statistical parameters and/or the characterization levels and site boundaries. The decision rule questions are provided below:

- Has the 200 pCi/g contour outside the GZ areas been defined?
- Have the depth profile measurements provided adequate data to determine limits of contamination?
- Have waste materials been adequately characterized to specify disposal requirements?
- Have suspected burial areas within the GZ been characterized with respect to contents and volumes?
- Is waste volume reduction feasible, and is it cost effective?

C.1.6 Decision Error Limits (Step 6)

The following sections present the definition of the tolerable limits on decision errors for the site characterization. To do this, the possible range of the parameters of interest (e.g., contaminant extent, contaminant concentrations, and waste volumes) must be estimated, the decision errors identified, the null and alternate hypotheses (H_0 and H_a) chosen, and the resultant false positive and false negative (F+ and F-) decisions determined.

C.1.6.1 Range of the Parameters

Where possible, the range of parameters will be based on historic sampling data. However, because these data are limited, it is possible that the ranges may be exceeded and/or additional parameters (e.g., contaminants) may be identified during the characterization.

The range for parameters to be identified during the characterization are as follows:

- Identification of the 200 pCi/g contour ± 25 pCi/g
- Identification of the depth of contamination outside the GZ areas ± 7 cm (3 in.) and within the GZ areas ± 30 cm (12 in.)
- RCRA constituents below action levels with 95 percent confidence limits
- Volume of soil to be excavated outside the GZ areas ± 10 percent of the total volume
- Volume of soil to be excavated inside the GZ areas ±100 cubic meters
- Nontransuranic waste characterized to define the level of activity below 10^5 pCi/g and the quantity of waste above this level
- Volume reduction of waste feasible, reduction volumes greater than 50 percent
- All RCRA constituents below required action levels

C.1.6.2 Identification of Decision Errors and Assignment of Hypotheses

Decision errors have been identified and used to assign the null and alternate hypotheses. To identify the primary potential decision errors for the characterization, the four Decision Groupings have been consolidated into the two primary decision error(s) for contaminant characterization and contaminant migration. The following summarizes the decision errors and hypotheses:

Contaminant Characterization

Decision Errors: The contamination does/does not exceed the 10^5 pCi/g level to identify TRU waste and contains RCRA constituents.

H_o - Contamination above 10^5 pCi/g has not been identified, and no TRU waste or RCRA constituents have been identified.

H_a - Contamination above 10^5 pCi/g has been identified, and RCRA constituents above action levels have been identified.

F+ - Sampling results indicate contamination above 10^5 pCi/g and/or RCRA constituents above action levels have been identified.

F- - Sampling results indicate contamination above 10^5 pCi/g and/or RCRA constituents above action levels have not been identified.

Contaminant Migration

Decision Errors: The volume of soil does/does not exceed 110 percent of the volume estimated in the conceptual model, and volume reduction is within 10 percent of the percentage predicted.

H_o - The conceptual model has identified the volume of soil to be removed within 10 percent, and that soil volume reduction is achievable within 10 percent of the predicted volume.

H_a - The volume of soil to be excavated is greater than 110 percent of the predicted volume, and soil volume reduction is greater than 10 percent below the predicted volume.

F+ - Sample results indicate soil volumes are greater than 10 percent of the predicted value, and soil volume reduction is greater than 10 percent below the predicted value.

F- - Sample results indicate soil volumes are within 10 percent of the predicted value, and soil volume reduction is within 10 percent of the predicted value.

C.1.6.3 Identification of Decision Error Limits

Tolerable error limits for the site characterizations will be based on DOE orders defining TRU waste and RCRA definitions of hazardous waste using TCLP analyses. The gray region has been established as concentrations identified within 20 percent of the RCRA definition of hazardous waste.

Since determination of RCRA waste is based on laboratory results of a statistical analysis based sampling program, a gray region does not exist. When data indicates activity levels within the gray area and/or above the action level, then the *in situ* measurement procedures will be modified to increase instrument sensitivity in an attempt to obtain a more precise reading. For example, instrument count times could be increased by a maximum of 100 percent or by specifying a different detector.

No decision error limits have been established for waste volumes or waste volume reduction estimates. Data obtained during site characterization activities regarding waste volumes and reduction of waste will be evaluated on a cost benefit analysis basis and could affect the final closure strategy selected.

C.1.7 Optimization of the Design (Step 7)

The information developed in the first six steps of the DQO process has been used to establish the criteria for the Sampling and Analysis Plan contained in Section 4.0 of the CAIP. This plan specifies the types of data collection activities to be completed, the number and types of samples to be collected, and the expected results.

Appendix D
Site-Specific Health and Safety Plan

Site-Specific Health and Safety Plan

Project Name: Soils Assessment- Tonopah Test Range Clean Slates Test Site CAIP

Project Number: 764022.01.01.02.00

Site: Clean Slates 1, 2, & 3

Lead Organization: IT Corporation

Proposed Dates of Project: **Beginning Date:** April 15, 1996 **Ending Date:** Oct. 30, 1996

Lead Organization
Project Manager: J. Richard McKinley **Signature:** [signature] **Date:** 4/11/96

Author: Jeff Whitesides **Signature:** [signature] **Date:** 4/11/96

Concurrences:

Name: Monica Sanchez **Signature:** [signature] **Date:** 4/10/96
Organization: DOE/NV Sub-project Manager

Name: Thomas Greene **Signature:** [signature] **Date:** 4/10/96
Organization: DOE Nevada ERP H&S Manager

Name: Robert L. Dodge **Signature:** [signature] **Date:** 4/10/96
Organization: Bechtel Nevada Project Manager

Name: Thomas Bastian **Signature:** [signature] **Date:** 4/11/96
Organization: Bechtel Nevada Health Protection

I have read and approved this Health and Safety Plan (HASP) with respect to present hazards, regulations, requirements, and site procedures.

Name: Brian G. Klenk, CIH, CSP, CEM **Signature:** [signature] **Date:** 4/11/96
Lead Organization
Health & Safety Representative

DECLARATION OF UNDERSTANDING
Site Health and Safety Plan Acknowledgment

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number (or Badge #)	Date
1) Jeff L. Whiteside	[signature]	IT Corporation	72460	4/22/96
2) Steven Riedhauser	[signature]	Bechtel Nevada	180690	4/22/96
3) Lowell Wille	[signature]	IT Corporation	72598	4/22/96
4) Craig Lyons	[signature]	BNC	182967	4/22/96
5) Linda J. Hansen	[signature]	Bechtel NV	180711	4/22/96
6) David P. Colton	[signature]	Bechtel NV	180560	4/22/96
7) James L. Butler	[signature]	Bechtel NV	IA13314	4/22/96
8) Alan Proctor	[signature]	Bechtel NV	184676	4/22/96
9) Gary R. Schmidt	[signature]	Bechtel NV	IA13010	4/22/96
10) Robert Smith	[signature]	Bechtel NV	IA15573	4/22/96

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization.*
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgment

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
1) KEITH R ROESNER	[signature]	BECHTEL NEVADA	18 0656	4/22/96
2) George Allen	[signature]	BEChtel	183505	4/22/96
3) Sharon Laster	[signature]	BNC	183928	4/22/96
4) GREGORY FIELDS	[signature]	BNC	183596	4-22-96
5) Sherri Fain	[signature]	IT	129666	4-30-96
6)				
7)				
8)				
9)				
10)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization.*
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgment

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization.*
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

Section A General Project Information

Investigative Objective/Activity Description:

The primary objective of work to be performed is to collect sufficient data to characterize the extent of contamination from previous on-site activities. The activities that will take place are as follows:

Collection of radiological data with *in situ* radiation detection equipment
Subsurface soil sampling to determine vertical extent of contamination
Location of ground zero burial areas and/or metal debris by geophysical methods
Verification of the depth of contaminated soils at ground zero with hand auger borings
Collection of soil samples for geotechnical, wet chemistry and radiological analysis, and NVO-325 Waste Acceptance Criteria

---

Project Background Review: ☒ Complete ☐ Not Available ☐ Preliminary ☐ Further Study Required

---

29 CFR §1910.120 Regulated Site: ☒ Yes ☐ No ☐ Unknown

Project HASP Summary

Level(s) of Protection: ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Overall Hazard Estimate: ☐ High ☐Moderate ☒ Low ☐ Unknown

Additional Documentation Attached:

☐ TLV Table ☐ Full HASP ☐ Sampling Methods ☒ Radiological Work Permit
☒ Other: Bioassay Program

Section B Site/Material Characteristics

Material/Waste Type(s): ☐ Liquid ☒ Solid IN ☐ Drums ☐ Tanks ☒ Soil ☐ Surface Water ☐ Gas ☐ Sludge ☐ Groundwater ☐ Other ____________

Characteristics: ☐ Ignitable ☐ Corrosive ☒ Toxic ☐ Reactive ☒ Radioactive

Facility: Type: ____________

☐ Open? ☒ Closed? When? 1964

Size: CS-1 = 200 acres CS-2 = 420 acres CS-3 = 445 acres

Terrain: Mostly flat

Indoors? ☐ Yes ☒ No

Confined Spaces (Describe):

N/A

NOTE: ***Inspection/Test form completion required if confined space involved.***
☐ Additional Information Attached

Investigation Derived Waste (IDW) handling: Investigation Derived Waste will include but not be limited to gloves, boot covers, disposable coveralls, wipes, foil, and sampling trowels. The IDW will be placed in plastic bags, the bags sealed (i.e., tied shut), and each bag tagged. The information on the tag will include sample location and sample number(s) so that each bag of waste is traceable to the samples and locations. The bags will be accumulated at a central accumulation area in DOT-approved containers pending analysis results. Decontamination liquids will be accumulated in plastic pails. After analysis results have been received, the waste will be appropriately dispositioned according to applicable waste acceptance criteria for radioactive, hazardous, or sanitary landfills. As part of the surface and subsurface sampling activities, it is likely that plutonium encrusted metal fragments will be encountered. Care shall be taken when handling to lessen the potential for exposure. Ensure that personnel work "upwind" while handling metal fragments. Do not work with fragments in an enclosed area. These fragments will be treated as radioactive material and managed accordingly.

Site History: The Clean Slate sites were part of Operation Roller Coaster. Operation Roller Coaster was conducted to provide data to establish criteria for transportation and storage of plutonium-bearing weapons. In May and June 1963, experiments were conducted at three locations, Clean Slate 1, 2 and 3. The primary function of this project was to study the dispersion of plutonium from non-nuclear explosions of plutonium weapons. The experiments required the detonation of various numbers of simulated weapons from a variety of near-surface structures. Surface air sampling, deposition sampling, and some animal exposure studies were completed to study the distribution of plutonium from these detonations.

Evaluation of the principal hazards for each site and operation identified in the operational planning document(s).

Chemical Substances:

The only chemical substances anticipated, are those which are brought on site during the performance of work and may include Alconox, isopropanol, a 10% HNO_3 solution, and a 1% HCl solution. Liquid Nitrogen will be used for the germanium detectors.

Physical Agents:

Heat and cold stress (seasonal), and sunburn.
IT Corporation has received verbal assurance from Sandia National Lab and the U.S. Air Force that it is extremely unlikely that ordnance will be encountered. IT will assign UXO trained personnel to accompany the endangered species survey team while they are performing a complete walkover of Clean Slates 1,2, and 3.

Some of the radiological instruments require cooling by liquid nitrogen. During the work period, liquid nitrogen will need to be transferred from one container. Exposure to the liquid can cause frostbite. Personnel performing the liquid nitrogen transfer are to wear appropriate gloves and goggles. Other personnel will maintain a safe distance from the area until the containers are secured.

Radiological:

The Clean Slate sites are known to be contaminated with plutonium and uranium; much of the Clean Slate ground contamination is enclosed in a fence. Samples are to be screened for external contamination prior to transporting them. Dust suppression with amended DI water and a sprayer will be performed at the direction of the Site Supervisor. Personnel will wear sturdy gloves while handling contaminated debris. Personnel are to stay upwind of any soil disturbing activity. Vehicles shall not be driven in the Exclusion Zone, with the exception of *in situ* survey vehicles.

Biological:

Snakes, spiders, and scorpions may be encountered; personnel are to use care when placing hands and feet in sheltered areas. A small percentage of the deer mice at higher elevations (>5000 feet) of TTR are known to carry hantavirus, which causes a potentially fatal lung disease; personnel are to avoid all contact with rodents and rodent excreta and notify the Site Supervisor if any rodents/excreta are found on site. Personnel are to exercise special care when driving on site due to the presence of wild horses which may act unpredictably around vehicles.

Environmental: ("Physical" elements contributing to the potential for accidents)

Site terrain will vary per sampling location; personnel are to avoid walking on steep hills whenever possible. Debris may be present and should be avoided since it may present slip, trip, and fall hazards and a ready shelter for rodents, snakes, scorpions, and spiders.

Section D Site Control

Personal Protection Required:

☒ Anti-C ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Note: *Minimum Level D equipment is hardhat, safety-toe boots, safety glasses, and substantial work clothing. All glasses, boots, etc. must be ANSI approved. Anti-C PPE will be worn in contamination area.*

Mixed (Areas/Levels):

Personnel outside contamination areas will wear level D protection.

Modified (Action Levels/Modifications):

Personnel in contamination area will wear Anti-C modified level D.

Nitrile over surgical or doubled surgical gloves will be worn whenever sampling or handling samples. Nitrile gloves will be worn when decontaminating equipment. Work gloves shall be worn over doubled gloves when handling sampling equipment where contact with sharp edges is likely.

Personnel will wear boot covers and Tyvek or Anti-C's when entering the Exclusion Zone (EZ); openings will be taped. Hardhats will be worn only in presence of overhead hazards.

Personnel will handle contaminated metal fragments with tongs only.

Additional Personal Protective Equipment Information:

Personnel shall wear full-face respirators with HEPA cartridges or PAPR with HEPA filters and hoods when performing dust generating activities. Personnel performing non-invasive work in the EZ shall be prepared to upgrade to full-face respirators with HEPA cartridges (clean shaven, fit-tested) based upon particulate sampling/monitoring, field radiation measurements, and the discretion of the Site Supervisor.

A first-aid kit, fire extinguisher, and portable eye wash will be present on site during all phases of operation. Sun screen will be available on site. Personnel may wear cotton glove liners underneath their surgical gloves for warmth if needed.

Surveillance Equipment:

☐ PID (9.8eV ☐ 10.2eV ☐ 11.7eV ☐) ☐ FID ☐ Detector Tubes ☐ Types: ________

☐ Oxygen ☐ Explosimeter ☒ TLD ☒ Radiation ☒ Types: See RWP

☐ Diffusion ☐ Toxic Gas (Gas:) ☒ Particulate Sampling ☒ Heat Stress (Area ☒ Personal ☐)

☐ Other: ________

NOTES: TLDs will be provided by the Bechtel Nevada Corporation Health Protection Department. Miniature Real Time Aerosol Monitor (MINIRAM) equipped with a cyclone will be provided by IT Corporation. The Bechtel Nevada Health Protection Department will provide breathing zone air samplers, cascade impactor, and portable instruments.

Site Surveillance/Monitoring

Instrument	Surveillance Frequency	Monitoring Location	Calibration
• Electra - alpha/beta	Every minutes ☐ Hourly ☒ Daily at Shift End ☐ Daily at Shift Start Other: Exit of contamination area	☐ Breathing Zone Other: Equipment, samples and soil	☒ Manufacturer Specs Per SOP #: ☒ Start of Shift ☐ End of Shift Check ☒ Source Check
• MINIRAM with cyclone • Low-volume sampling pump	Every minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start Other: **Continuous**	☒ Breathing Zone Other: Personnel Area	☒ Manufacturer Specs Per SOP #: ☒ Start of Shift ☒ End of Shift Check ☐ Source Check
•Cascade Impactor	Every minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start Other: **Continuous**	☐ Breathing Zone Other: Work area.	☒ Manufacturer Specs Per SOP #: ☒ Start of Shift ☐ End of Shift Check ☐ Source Check
• Swipe scaler	Every minutes ☐ Hourly ☐ Daily at Shift End ☒ Daily at Shift Start Other:	☐ Breathing Zone Other: Equipment, samples and soil	☒ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☒ Source Check
Heat Stress Monitor	Every minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start Other: Daily or as needed	☐ Breathing Zone Other: Work Area	☒ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check

NOTES: (1) Frisking surveys will be conducted for the hands and face for water breaks. Whole body frisks shall be conducted upon exit from the radiological area (Exclusion Zone). No work area exposure rate or contamination surveys are required. (2) A MINIRAM equipped with a cyclone will be worn by a member of a work group during any dust generating activity. Additional MINIRAMS may be issued depending on the dust generated by specific activities. A breathing zone air sample pump and filter holder will be worn by one member of a work group during any dust generating activity. Additional air samplers may be issued depending on the dust generated by specific activities. A cascade impactor will be used to obtain size distribution of resuspended particles in the areas of highest anticipated contamination.

Section E Site Operations/Documentation

Initial Hotline Location: To be determined by Site Supervisor

Initial Command Post Location: To be determined by Site Supervisor

NOTES:

Decontamination:

Light Equipment	1	Identify contaminated spots	4	Re-survey
	2	Wash with water	5	Re-wash or release item
	3	Wipe dry	6	

Heavy Equipment	1		4	
	2		5	
	3		6	

Personnel Decon:	1	Remove tape	6	Remove inner gloves
	2	Remove boot covers	7	Radiation survey for alpha/beta with an Electra meter prior to exiting EZ: if working outside of EZ, survey will be performed prior to breaks or leaving the site.
	3	Remove outer gloves	8	Wash hands, face, neck, and forearms with soap and tap water; shower as soon as practical
	4	Remove hood then remove coveralls	9	Repeat survey if **any** radiological contamination above background is detected on personnel
	5	Remove respirator (if applicable)	10	Repeat wash as necessary

Special Facilities Required:

Soap, potable water, and wash basins. Receptacles for PPE. Plastic sheets or tables to place clean equipment on. Restroom facilities will be provided. Break area.

Site Entry Procedure:

Check in with Site Supervisor and conduct/review the site Tailgate Safety Briefing. Enter the Contamination Reduction Corridor only after having signed the Radiation Work Permit (RWP).
Once personnel have donned protective clothing and entered the Contamination Reduction Corridor, they are not to exit area even if they have not entered the contamination area.

Team Size: 10-20 **Pre-field Briefing Date:** April 12, 1996

Work Schedule: Daylight hours only. Regardless of temperature, personnel are strongly encouraged to drink more than is necessary to satisfy thirst. IT employees shall not work/drive more than 15 hours continuously without sleep.

Other Information: All personnel entering the site shall participate in the Tailgate Safety Briefing, or be given the Tailgate Safety Briefing upon arrival on site if work is already in progress.

Personnel wearing respirators are to leave the EZ and change/have changed their HEPA cartridges if they are having difficulty breathing.

Section E (continued)
Action Levels

Parameter	Value	Action
Alpha/beta Meter (equipment)	☒ Greater than 300dpm/100 cm^2 (above bkg.) ☐ Less than ____ ☐ Equal to ____	☐ Upgrade to: ____ ☐ Downgrade to: ____ ☐ Evacuate: ____ ☐ Stop and notify: ____ ☒ Other action: Decontaminate equipment
Mini-scaler	☒ Greater than 20 dpm alpha/100 cm^2 (above bkg.) ☐ Less than ____ ☐ Equal to ____	☐ Upgrade to: ____ ☐ Downgrade to: ____ ☐ Evacuate: ____ ☐ Stop and notify: ____ ☒ Other action: Decontaminate equipment
Alpha/beta Meter (personnel)	☒ Greater than background levels ☐ Less than ____ ☐ Equal to ____	☐ Upgrade to: ____ ☐ Downgrade to: ____ ☐ Evacuate: ____ ☐ Stop and notify: ____ ☒ Other action: Decontaminate personnel/re-survey
BZA Sampler	☒ Greater than 1/10 DAC ☐ Less than ____ ☐ Equal to ____	☒ Upgrade to: Full face respirator ☐ Downgrade to: ____ ☐ Evacuate: ____ ☐ Stop and notify: ____ ☐ Other action: ____

Section F Emergency Procedures

Emergency Actions:

Fire: Fight small fires with fire extinguisher. If fire cannot be contained, evacuate the site to an upwind location and summon assistance. Assist any injured.

Note: Evacuation routes and assembly areas will be communicated to site personnel during Tailgate Safety Briefings

PPE: NA

Explosion: Evacuate site to a distance of at least 1200 feet. Call emergency services and fire department. Assist any injured personnel.

PPE: NA

Weather: In inclement weather (i.e., lightning, heavy rain, high wind), cease operations, evacuate site, and seek shelter in fixed structures. In heavy rainfall, seek high ground in case of flash flooding.

If wind causes increase in airborne particulates, all personnel in EZ are to upgrade to Level C at the discretion of the Site Supervisor.

PPE: NA

Injury: Render aid to injured personnel and contact emergency services if injury is severe. Follow emergency services instructions for treatment and transport of injured. Implement attached accident checklist.

PPE: Mouth shield if giving assisted breathing; wear surgical gloves if any body fluids are present.

Spill: Notify Site Supervisor of all spills on site. No significant quantities of chemicals will be used on site; small quantities will be absorbed with vermiculite. Small spills of acids can be neutralized with baking soda or alconox diluted with water. If potentially radiologically contaminated water has been spilled, contain the spill, notify the lead RCT, and decontaminate the area. If fuel is spilled, shut off the source of spill, if it can be done safely and without causing any sparks, and absorb spilled fuel with absorbents that are on site. The Site Supervisor will consult with the Site Health and Safety Coordinator prior to remediating any gasoline, kerosene, or methanol spills.

PPE: Nitrile or surgical gloves will be worn whenever handling chemicals.

Primary Hospital/Infirmary - NAFR/TTR

Name: Area 3 Medic

Telephone No.: (702) 295-8345 or 911 (emergency)

Address: Building 0369, Area 3

Specific Directions:

Clean Slates 1: Follow access road to Brownes Road, turn left, traveling west on Brownes Road, continue to Main Road South. Turn right on Main Road South; travel north approximately 4 miles. Turn left into the Area 3 compound; the medical facility will be on the immediate right; building 0369.

Clean Slates 2: Follow access road to **Mellan Road** / Cedar Pass Road (Cedar Pass Road travels south only). Turn left on Mellan Road, travel north approximately 4 miles to Bunker 2 Road and turn left, travel west approximately 5 miles until reaching Main Road South. Turn right on Main Road South and travel a short distance; turn left into the Area 3 compound; the medical facility will be on the immediate right; building 0369.

Clean Slates 3: Follow access road to Bunker 2 Road; turn left on Bunker 2 Road, travel west for approximately 1 mile until reaching Main Road South. Turn right on Main Road South and travel a short distance; turn left into the Area 3 compound; the medical facility will be on the immediate right; building 0369.

Alternate Hospital/Infirmary - NAFR/TTR

Name: Nye County Regional Medical Center

Telephone No.: (702) 482-6233

Address: 825 S. Main Street, Tonopah, Nevada

Specific Directions: Go NW from TTR main gate for 32 miles to Highway 6, go west 12 miles to Highway 95, go north approximately 1/2 mile, turn left to Nye Regional Medical Center.

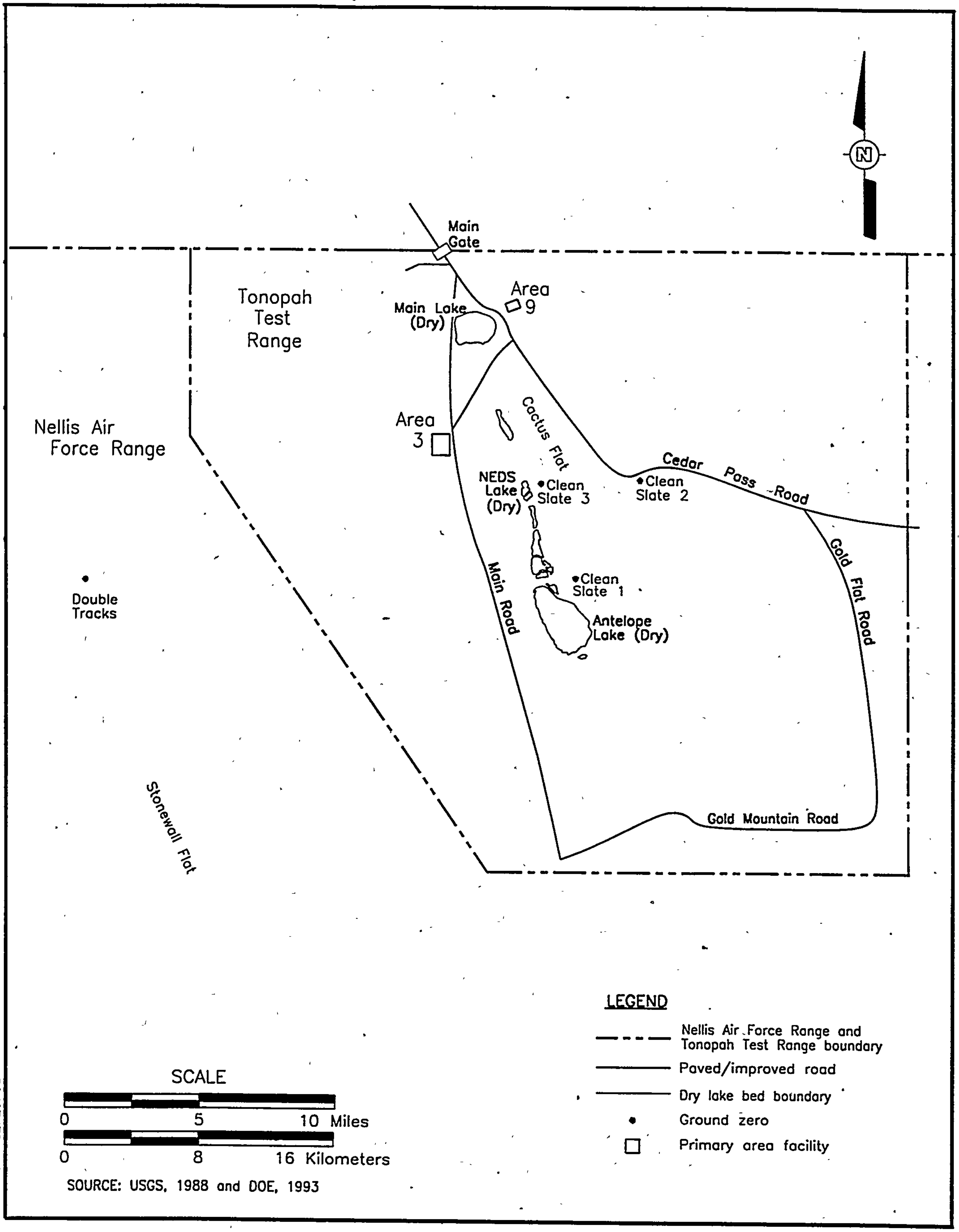
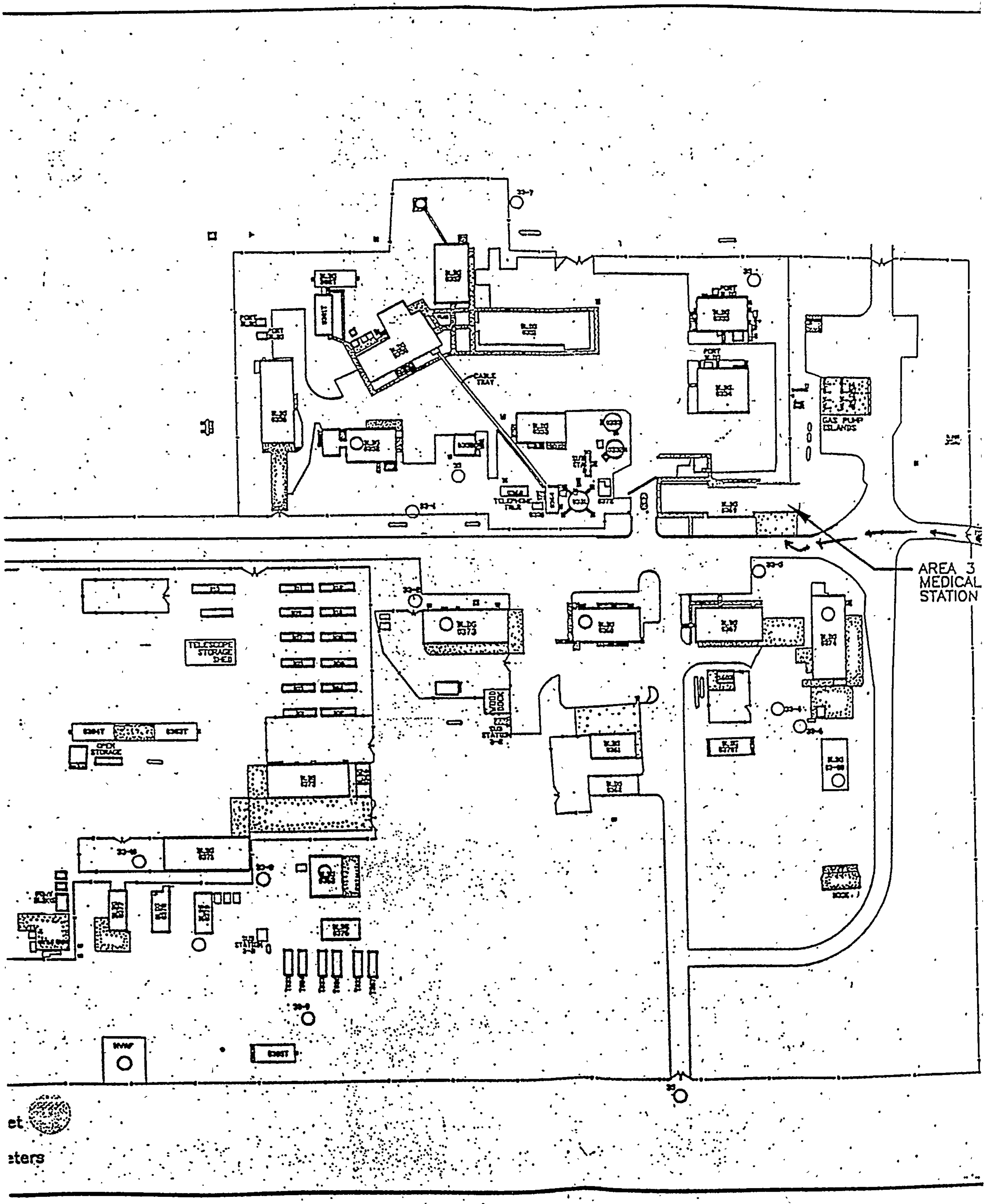


Figure 2-1
Clean Slate Site Location Map


AREA 3
MEDICAL
STATION
TELESCOPE STORAGE SHED
GAS PUMP ISLANDS
CABLE TRAY
WOOD DOCK
OPEN STORAGE

EMERGENCY COMMUNICATIONS

Name/Telephone

Police: 911 or "Mayday" three times by radio

Fire: 911 or "Mayday" three times by radio

Medical: 911 of "Mayday" three times by radio

DOE NV ERP H&S Manager: Thomas Greene/295-0513

DOE Subproject Manager: Monica Sanchez/295-0160

Other: IT Health and Safety Manager Brian Klenk/794-1716
Other: ______ ______ Pager 794-6241
Title Name

* Evacuate Site - One long air horn blast - Evacuate to assembly point.

Exposure Actions:

Substance	Symptoms of Exposure	Treatment	TWA	STEL	*Source	IDLH
Alconox	⊠ Acute: Inhalation of powder may cause local irritation to mucous membranes. Ingestion may cause discomfort and/or diarrhea.	Eyes: Irrigate immediately for 15 minutes Skin: Water flush immediately Breath: Remove victim to fresh air; respiratory support if needed. Swallow: Immediate medical attention	NA	NA	PEL TLV REL	NA
Nitric Acid	⊠ Acute: Delayed pulmonary edema; irritation of eyes, mucous membranes, and skin ⊠ Chronic: Pneumonitis; bronchitis; dental erosion.	Eyes: Irrigate immediately for 15 minutes Skin: Water flush immediately Breath: Remove victim to fresh air; respiratory support if needed. Swallow: Immediate medical attention	5 mg/m³ 5 mg/m³ 5 mg/m³	10 mg/m³	PEL TLV REL	100 ppm
Hydrochloric Acid	⊠ Acute: Severe burning of contacted tissues; strong irritation of respiratory tract from vapor.	Eyes: Irrigate immediately for 15 minutes Skin: Water flush immediately Breath: Remove victim to fresh air; respiratory support if needed. Swallow: Immediate medical attention	7 mg/m³ C 7.5 mg/m³ C 7 mg/m³ C	NA	PEL TLV REL	100 ppm
Plutonium (^{238}Pu and ^{239}Pu)	Radioactive. Extremely poisonous if enters bloodstream. Potential associated increased risk of cancer $<10^{-7}$ per person per lifetime per 1 mrem/yr. No symptoms.	Eyes: Irrigate immediately Skin: Soap wash immediately Breath: Remove victim to fresh air; give assisted breathing if necessary Swallow: Seek medical attention	DAC 2 E-12 μCi/ml	Not Given	PEL TLV REL	Not Given
Liquid Nitrogen	Acute: Vapors may cause dizziness or suffocation. Contact with liquid may cause frostbite.	Eyes; Irrigate immediately Skin: Thaw frosted parts with water Inhalation: Remove victim to fresh air, respiratory support of needed.	NA	NA	PEL TLV REL	Simple Asphyxiant Oxygen Depletion
Uranium (^{238}U)	Radioactive substance. Exposure limits for soluble compounds based upon chemical toxicity while limits for insoluble compounds is based upon radiotoxicity. ⊠ Chronic: Kidney damage; acute arterial lesion; shortness of breath, coughing; nausea; vomiting.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Remove victim to fresh air; give assisted breathing if necessary Swallow: Immediate medical attention	DAC 6 E-10 μCi/ml	0.6 mg/m³	PEL TLV REL	20 mg/m³
Isopropanol	⊠ Acute: Irritation of eyes, nose and throat. Dry skin, mild narcosis, flushing, headache, dizziness, mental depression, nausea, vomiting. ⊠ Chronic: Toxic by ingestion.	Eyes: Irrigate immediately. Skin: Water flush immediately Breath: Remove victim to fresh air and give respiratory support if needed Swallow: Immediate medical attention	400 ppm	500 ppm	PEL TLV REL	12,000 ppm

TWA = Time Weighted Average (8 hour) ***PEL (OSHA)**
STEL = Short Term Exposure Limit
IDLH = Immediately Dangerous to Life or Health

TLV (ACGIH)
REL (NIOSH)

Section F Emergency Procedures (continued)

Other Emergency Information:

By radio, can either broadcast "Mayday" or contact Range Control, "Blackjack", or Range Security, "Cactus".

ASI Security handles all emergencies and can be reached by telephone at 5-8285

If one long blast of the air horn is sounded - evacuate site.

Section G Personnel Information

1) Name: Robert Sobocinski	2) Position/Title: Sampling Team Member
3) Duties: Collect soil samples	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 11/13/87	12) Special Training: Radiation Training (DOE 5480.11) 4/15/93 First Aid/Adult CPR 5/24/94 General Employee Radiological Training 5/26/94
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --	
9) Last Physical Date: Update — 10) Restrictions? ☒ Yes ☐ No	**11) Restriction: Hearing - Must wear hearing protection whenever noise levels exceed 85 dB: Must be escorted by RWII or RCT personnel in EZ; cannot perform hands-on work in EZ**

1) Name: Cheryl Rodriquez	2) Position/Title: Sampling Team Member
3) Duties: Collect soil samples	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 5/25/90	12) Special Training: Desert Tortoise Conservation 6/11/93 Radiological Worker II 731/95 Safe Driver Training 7/1/93 First Aid 5/13/93 CPR 4/26/95 Blood Borne Pathogens Training 10/29/93 ITLV 16 hr. Sampling Workshop 4/6/95
7) Refresher Training in the last 12 months Type: 8-Hour Refresher Date Completed: 7/12/95	
8) Site Supervisor Training Required? ☒ Yes ☐ No Date Completed: 3/26/91	
9) Last Physical Date: 6/26/95 — 10) Restrictions? ☐ Yes ☒ No	**11) Restriction:**

Section G Personnel Information

1) Name: Lynn Easterly	2) Position/Title: Alternate Sampling Team Members /alternate site safety officer
3) Duties: Assist Site Supervisor in H&S compliance/Collect samples	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 10/30/92	12) Special Training: Radiological Worker II 7/7/93 Adult CPR 3/30/94 First Aid 4/15/93 General Employee Radiological Training 3/25/93 Desert Tortoise Conservation 12/2/92 Safe Driver Training 9/9/92 Blood Borne Pathogens Training
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed: 10/2/95	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 8/19/92	
9) Last Physical Date: 7/14/95 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction: NA

1) Name: Jeff Whitesides	2) Position/Title: Site Supervisor
3) Duties: Supervising Radiological Characterization and Soil Sampling	4) Reports to: Project Manager
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 5/8/89	12) Special Training: Radiological Worker II 10/2/95 First Aid 4/24/92 CPR 3/16/94 Desert Tortoise Conservation 8/5/92 Safe Driver Training 6/29/92 Site Remediation 7/17/92
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed: 2/2/96	
8) Site Supervisor Training Required? ☒Yes ☐No Date Completed: 11/8/94	
9) Last Physical Date: 5/19/95 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction: NA

Section G Personnel Information

1) Name: Doug Thompson	2) Position/Title: Site Supervisor Asst./Sampling Team Member
3) Duties: monitor site activities / collect soil samples	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 6/24/94	12) Special Training: Radiological Worker II 7/27/94 First Aid 6/1/95 CPR 5/31/95 Desert Tortoise Conservation 4/4/94 Safe Driver Training 4/19/94 ITLV 16 hr. Sampling Workshop 6/8/95
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed: 7/12/95	
8) Site Supervisor Training Required? ☒ Yes ☐ No Date Completed: 8/8/91	
9) Last Physical Date: 7/7/95 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction: NA

1) Name: Steve Hellemann	2) Position/Title: Sampling Team Member
3) Duties: Perform Radiological Monitoring/Collect Soil Samples	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 6/18/93	12) Special Training: Radiological Control Technician First Aid 9/14/94 CPR 5/31/95 Safe Driver Training 5/4/95
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed: 7/12/95	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 11/8/94	
9) Last Physical Date: ? | 10) Restrictions? ☐ Yes ☒ No	11) Restriction: NA

Section G Personnel Information

1) Name: Mike Doe		2) Position/Title: Site Supervisor Asst./ Field Team Member
3) Duties: Collect Soil Samples		4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No		
6) Initial Training Date: 6/24/94		12) Special Training: Desert Tortoise Conservation 6/2/94 Radiological Worker II 10/10/94 First Aid 4/2/94 CPR 4/25/95 Safe Driver Training 6/6/94
7) Refresher Training in the last 12 months ☒ Yes ☐ No Type: Hazards and Protection Limited Date Completed: 6/17/95		
8) Site Supervisor Training Required? ☒ Yes ☐ No Date Completed: 11/8/94		
9) Last Physical Date: 6/9/95	10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: J. Richard McKinley		2) Position/Title: IT Project Manager
3) Duties: Project Management		4) Reports to: Supervisor on site
5) 24 hours Supervised Field Experience? ☐Yes ☒No		
6) Initial Training Date: --		12) Special Training: General Employee Radiological Training 4/20/93
7) Refresher Training in the last 12 months Type: -- Date Completed: --		
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --		
9) Last Physical Date: 1/26/96	10) Restrictions? ☒ Yes ☐ No	11) Restriction: **Cannot enter EZ without proof of current training/physical**

Section G Personnel Information

1) Name: Jonathan Saavedra		2) Position/Title: / Field Team Member
3) Duties: Collect Soil Samples		4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No		
6) Initial Training Date: 4/11/88		12) Special Training: Desert Tortoise Conservation 8/5/92 Radiological Worker II 5/5/94 First Aid 3/31/94 CPR 4/25/95 Safe Driver Training 9/11/95
7) Refresher Training in the last 12 months Type: Hazards and Protection Limited Date Completed: 2/16/96		
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 11/8/94		
9) Last Physical Date: 5/3/95	10) Restrictions? ☒ Yes ☐ No	11) Restriction: **Hearing protection required**

1) Name: Monica Sanchez		2) Position/Title: DOE Sub-Project Manager
3) Duties: Visitor / Observe site operations		4) Reports to: Supervisor onsite
5) 24 hours Supervised Field Experience? ☐Yes ☒No		
6) Initial Training Date: 10/21/94		12) Special Training:
7) Refresher Training in the last 12 months Type: -- Date Completed: --		
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --		
9) Last Physical Date: -	10) Restrictions? ☒ Yes ☐ No	11) Restriction: **Cannot enter EZ without proof of current physical and radiological training**

Section G Personnel Information

1) Name: Long, Danny S.	2) Position/Title: Assistant Project Manager
3) Duties: Visitor/oversight	4) Reports to: Supervisor on site
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 10/93	12) Special Training: RADWORKER II - 11/15/95 EOD Training 7-95 Resp. Fit Test
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 08/95	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 09/94	
9) Last Physical Date: / 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: Lyons Craig L.	2) Position/Title: Site Health & Safety Coordinator
3) Duties: Health & Safety Coordinating/RCT Supervision	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 12/94	12) Special Training: Resp. Fit Test - 09/25/95 RADWORKER II - 01/17/95 EOD Training
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 03/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 04/95	
9) Last Physical Date: / 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

Section G Personnel Information

1) Name: Riedhauser, Steven R.	2) Position/Title: Survey Team Leader
3) Duties: Radiological Assessment Survey Leader	4) Reports to: Site Supervisor, Danny Long
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 02/95	12) Special Training: Resp. Fit Test - 01/25/96 RADWORKER II - 05/01/95 EOD Training
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 01/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 03/95	
9) Last Physical Date: May 9, 1995 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: Colton, David P.	2) Position/Title: Rad Survey Team Member
3) Duties: In-situ and mobile surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐Yes ☒No	
6) Initial Training Date: 02/95	12) Special Training: RADWORKER II - 04/03/95 Resp. Fit Test - 02/02/95 EOD Training
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 01/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 01/96	
9) Last Physical Date: May 10, 1996 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

Section G Personnel Information

1) Name: Hansen, Linda J.	2) Position/Title: Rad Survey Team Member
3) Duties: In-situ and mobile radiological surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐Yes ☒No	
6) Initial Training Date: 02/95	12) Special Training: RADWORKER II - 05/01/95 Resp. Fit Test - 02/02/95 EOD Training
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 01/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 10/95 — 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: Berry, Hollis A.	2) Position/Title: RSL Survey Team Member
3) Duties: In-situ and mobile surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐Yes ☒No	
6) Initial Training Date: 04/96	12) Special Training: RADWORKER II - 04/20/95 Resp. Fit Test - 01/12/96 EOD Training
7) Refresher Training in the last 12 months? N/A Type: H&PL Date Completed: N/A	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 10/24/95 — 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

Section G Personnel Information

1) Name: Proctor, Alan E.	2) Position/Title: Rad Survey Team Member
3) Duties: In-situ and mobile radiological surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐ Yes ☒ No	
6) Initial Training Date: 02/95	12) Special Training: RADWORKER II - 04/20/95 Resp. Fit Test - 02/02/95 EOD Training
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 2/12/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 02/96	
9) Last Physical Date: 1/95 — 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: Roesner, Keith R.	2) Position/Title: RSL Survey Team Member
3) Duties: In-situ and mobile radiological surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 02/95	12) Special Training: RADWORKER II - 04/03/95 Resp. Fit Test - 01/11/95 EOD Training - 02/21/96
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 02/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 6/95 — 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

Section G Personnel Information

1) Name: Dave Anderson		2) Position/Title: Endangered Species Surveyor	
3) Duties: Endangered species survey		4) Reports to: Site Supervisor	
5) 24 hours Supervised Field Experience? ☐Yes ☒No			
6) Initial Training Date: 03/01/96		12) Special Training:	RADWORKER II - 10/01/95 Resp. Fit Test. - 02/96 EOD Training - 03/27/96
7) Refresher Training in the last 12 months? N/A Type: H&PL Date Completed: N/A			
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:			
9) Last Physical Date: 2/96	10) Restrictions? ☐ Yes ☒ No	11) Restriction:	

1) Name: Gregory Fields		2) Position/Title: RCT II	
3) Duties: RCT		4) Reports to: Site Supervisor/Health & Safety Officer	
5) 24 hours Supervised Field Experience? ☐Yes ☐No			
6) Initial Training Date: 05/13/94		12) Special Training:	Resp. Fit Test - 07/17/95 8-hr Refresher 1910.120 - 6/95 EOD Briefing - 04/08/96 Hantavirus Briefing - 04/08/96
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 06/95			
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:			
9) Last Physical Date: 07/95	10) Restrictions? ☐ Yes ☒ No	11) Restriction:	

Section G Personnel Information

1) Name: Lukens, Michael G.	2) Position/Title: RSL Survey Team Member
3) Duties: In-situ and mobile surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐ Yes ☒ No	
6) Initial Training Date: 02/10/95	12) Special Training: RADWORKER II - 04/30/95 Resp. Fit Test. - 02/02/95 EOD Training - 02/21/96
7) Refresher Training in the last 12 months? ☒ Yes ☐ No Type: H&PL Date Completed: 02/12/96	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 7/95 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name: Schmidt, Gary R.	2) Position/Title: RSL Survey Team Member
3) Duties: In-situ and mobile surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐ Yes ☐ No	
6) Initial Training Date: 03/01/96	12) Special Training: RADWORKER II - 04/30/95 Resp. Fit Test. - 02/02/96 EOD Training - 03/06/96
7) Refresher Training in the last 12 months? N/A Type: H&PL Date Completed: N/A	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 9/95 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

Section G Personnel Information

1) Name: Smith, Robert	2) Position/Title: RSL Survey Team Member
3) Duties: In-situ and mobile radiological surveys	4) Reports to: Steve Riedhauser
5) 24 hours Supervised Field Experience? ☐Yes ☐No	
6) Initial Training Date: 03/01/96	12) Special Training: RADWORKER II - 02/08/96 Resp. Fit Test. - 01/11/96 EOD Training - 03/06/96
7) Refresher Training in the last 12 months? N/A Type: H&PL Date Completed: N/A	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed:	
9) Last Physical Date: 6/9/95 | 10) Restrictions? ☐ Yes ☒ No	11) Restriction:

1) Name:	2) Position/Title:
3) Duties:	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☐Yes ☐No	
6) Initial Training Date:	12) Special Training:
7) Refresher Training in the last 12 months? ☐ Yes ☐ No Type: Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☐ No Date Completed:	
9) Last Physical Date: | 10) Restrictions? ☐ Yes ☐ No	11) Restriction:

Section G Personnel Information

1) Name: James L. Butler		2) Position/Title:
3) Duties: Data Analyst/Survey Team		4) Reports to:
5) 24 hours Supervised Field Experience? ☒Yes ☐No		
6) Initial Training Date:		12) Special Training:
7) Refresher Training in the last 12 months? Will not work in field Type: Date Completed:		
8) Site Supervisor Training Required? ☐ Yes ☐ No Date Completed:		
9) Last Physical Date:	10) Restrictions? ☐ Yes ☐ No	11) Restriction:

1) Name:		2) Position/Title:
3) Duties:		4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☐Yes ☐No		
6) Initial Training Date:		12) Special Training:
7) Refresher Training in the last 12 months? ☐ Yes ☐ No Type: Date Completed:		
8) Site Supervisor Training Required? ☐ Yes ☐ No Date Completed:		
9) Last Physical Date:	10) Restrictions? ☐ Yes ☐ No	11) Restriction:

Section G Personnel Information

1) Name: Sherri Fain	2) Position/Title:
3) Duties: Sample collection	4) Reports to:
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 1-18-92	12) Special Training:
7) Refresher Training in the last 12 months? Type: Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☐ No Date Completed:	
9) Last Physical Date: | 10) Restrictions? ☐ Yes ☐ No	11) Restriction:

1) Name:	2) Position/Title:
3) Duties:	4) Reports to: Site Supervisor
5) 24 hours Supervised Field Experience? ☐Yes ☐No	
6) Initial Training Date:	12) Special Training:
7) Refresher Training in the last 12 months? ☐ Yes ☐ No Type: Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☐ No Date Completed:	
9) Last Physical Date: | 10) Restrictions? ☐ Yes ☐ No	11) Restriction:

Accident/Injury/Near Miss Checklist

Name of Person(s): ____________________

Date of Incident: ____________________ Time: ____________

Exact Location of Incident: ____________________

Job Title: ____________________ Job Number: ____________

Supervisor : ____________________ ____________

Printed Name Signature

Site Supervisor's Accident/Injury/Near Miss Checklist		
Step	**Action/Requirement**	**Date/Time** (24 hr clock)
1	Perform first aid/CPR, as appropriate, and get injured/ill to medical care immediately, if required.	
2	Isolate and protect scene of accident (non-automobile). If automobile accident, clear personnel and vehicles from roadway and/or place warning devices.	
3	Report incident by phone to Lead Organization Project Manager and NV ERP H&S Manager, and Employer immediately after situation is under control.	
4	Complete appropriate form(s) as required by Employer/DOE	
5	Perform Accident/Incident Investigation as soon as possible, and complete accident investigation report.	
6	Submit accident investigation report to DOE-NV via required reporting mechanisms (ORPS, etc.)	
7	Turn this form in to Nevada ERP Health and Safety Manager	

NOTE: All workers are required to report all injuries, illnesses, accidents, and near misses.

EMERGENCY NOTIFICATION

In the event of an emergency (serious injury, serious illness, fatality, serious property damage, serious spill, etc.) notify the following personnel at once in the following order:

Contractor Project Manager:

NAME:	J. Richard McKinley
OFFICE PHONE:	(702) 794-1703
HOME PHONE:	(702) 794-6351

(Project Manager to assess the severity of incident and notify DOE Subproject Manager)

DOE Subproject Manager:

NAME:	Monica Sanchez
OFFICE PHONE:	(702) 295-0160
HOME PHONE:	(702) 254-3643

(DOE Subproject Manager to notify NV ERP Project Manager and NV ERP H&S Manager)

DOE NV ERP H&S Manager:

NAME:	Thomas Greene
OFFICE PHONE:	(702) 295-0513
HOME PHONE:	(702) 898-1712

(DOE NV ERP H&S Manager to advise Contractor and DOE NV ERP Subproject Managers on proper course of action and coordinate notification of other governmental agencies, as necessary)

Other:

TITLE:	IT Health and Safety Manager
NAME:	Brian Klenk
OFFICE PHONE:	(702) 794-1716
HOME PHONE:	(702) 794-6241(pager) 271-9756 cellular (both 24 hours)
RESPONSIBILITIES:	Oversight of IT Health and Safety program. To advise IT Project Manager on proper course of action per technical expertise and IT policies.

TITLE:	BN Project Manager
NAME:	Robert Dodge
OFFICE PHONE:	702-295-1632
HOME PHONE:	702-363-2749
RESPONSIBILITIES:	

Bioassay Program for Clean Slates Assessment

This document is a description of the bioassay program to be implemented during assessment activities at the Clean Slates sites on the Tonopah Test Range. The radionuclides of concern at the Clean Slates sites are plutonium and depleted uranium; due to the age of the sites and the fact that they are outdoor sites, these elements are expected to be oxidized. It is highly recommended that a laboratory be selected and notified before field activities are commenced.

1. All individuals who will perform sampling or soil disturbing activities within the Contamination Area/Exclusion Zone will submit 24-hour baseline urine and fecal samples. These samples will be archived for two weeks after project completion by freezing fecal samples and both types of samples will be kept under Chain of Custody. These samples will be analyzed only if there is a need to collect and analyze further samples from an individual.

2. Due to the nature of the activities to be performed during the assessment, a routine bioassay program is not necessary; samples will be collected from personnel only if there is a reason to suspect that an intake of radionuclides has occurred, such as if personnel frisking shows nasal contamination. This will allow a dose to the individual to be ascertained. To reduce confusion and make the process more convenient to the person submitting the samples, it is suggested that urine and fecal samples be collected at the same sampling time. The following sampling schedule will be used:

   A. A 24-hour fecal sample and a 24-hour urine sample will be collected for the first day following a potential intake. The fecal sample will be analyzed for plutonium and the urine sample will be analyzed for uranium.

   B. The next three sets of 24-hour urine and fecal samples will be collected at two-day intervals.

   C. The next two sets of 24-hour urine and fecal samples will be collected at three-day intervals.

   D. If necessary, weekly fecal samples may continue to be taken until a dose can be assessed.

3. Due to the nature of the biological model and the uncertainty of particle size (respirable versus ingested), no preliminary estimate of a dose will be made until at least four samples have been analyzed. Analytical results that are greater that two sigma will be considered positive. Positive bioassay results will be forwarded to the Radiological Services Prime Contractor for inclusion in the individual's dose records. Because these are nonroutine samples, all results of the bioassay will be communicated to the individual involved and their employer.

ADDENDUM TO THE CLEAN SLATE CORRECTIVE ACTION INVESTIGATION PLAN

DOE Nevada Operations Office
Las Vegas, Nevada

Controlled Copy No.: ____

Revision: 0

September 1996

ETER G. MORROS, Director
.H. DODGION, *Administrator*
'02) 687-4670
DD 687-4678

dministration
ining Regulation and Reclamation
Vater Pollution Control
acsimile 687-5856

ddress Reply to:
apitol Complex
arson City, NV 89710

STATE OF NEVADA
BOB MILLER
Governor

Waste Management
Corrective Actions
Federal Facilities
Facsimile 885-0868

Air Quality
Water Quality Planning
Facsimile 687-6396

Located at:
333 W. Nye Lane
Carson City, NV 89710

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

Capitol Complex
Carson City, Nevada 89710

July 5, 1996

David S. Shafer, Acting Director
Environmental Restoration Division
U.S. Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

RE: Clean Slate Corrective Action Investigation Plan (CAIP), Revision 0, May 1996

Dear Mr. Shafer:

The Nevada Division of Environmental Protection has received and evaluated the above referenced Plan.

Throughout the document, references are made to information and documentation that has not been provided to NDEP. NDEP will be unable to concur with the CAIP until review of this additional information has been completed. NDEP is not requesting all referenced material that has been listed in the back of the CAIPs. If DOE is basing the investigation or corrective action on the conclusions of another document by reference in the text of the CAIP, NDEP needs to evaluate that document (or pages of the document) to determine if we can also concur with these conclusions. One example is on page 3-2. The TTR Project Managers Report is referenced for defining the vertical contamination.

The Plan also makes reference to documents that are unpublished. NDEP needs to be provided clarification of status on these documents. NDEP may potentially need to review these documents to concur with assumptions stated.

This Plan has presented closure strategy. NDEP has not concurred with any proposed closure of DOE contaminated sites on the Nellis Range. All "Soils" remediation activities conducted by DOE at TTR will be reviewed on a case by case basis subject to RESRAD modeling, land use, and other site specific issues prior to NDEP concurring as to what an acceptable radionuclide concentration in soil for clean closure might be. This CAIP will not be

ACTION
INFO ERD EPD
MGR
OBFS
AMTS

concurred with as presented with a proposed closure of Clean Slates I, II, and/or III.

Pg. 3-2 What form of documentation do you have to support the contention that the ground water has not been contaminated?

Pg. 3-6 Is excess radioactive contamination defined as any contamination above 200 pCi/g?

Pg. 3-6 The DQOs have been addressed in a separate letter by NDEP. DOE needs to ensure that the comments in that letter are incorporated into this CAIP. A copy of the letter has been faxed to the project manager.

Pg. 4-1 Should DOE encounter unexpected site conditions which require modifications of the CAIP or the conceptual model for Clean Slates I, II, or III, NDEP must be notified.

Pg. 4-1 The Soils Media Quality Assurance Project Plan is being reviewed by NDEP. Any changes to that Plan may necessitate changes to this CAIP.

Pg. 4-7 A 200 pCi/g concentration limit has been set in paragraph 3, however, a range of 200 pCi/g $\pm$ 25 pCi/g is referenced in the range of parameters in C.1.6.1. If 200 pCi/g is a limit, it may not be appropriate to consider a range that exceeds the limit.

Pg. 4-8 What is the rational for dividing CS site 1 and 2 into 50-ft by 50-ft grids and CS-3 into 100-ft by 100-ft grids for random sampling activities?

Pg. 4-25 Field documentation is to be conducted in accordance with "approved contractor procedures". Who approved these procedures? If DOE changes contractors prior to completion of the project, DOE must ensure incorporation of these procedures into the next contractor's operations or into DOE SOP/ORDERS.

Pg. 5-3 If mixed waste is produced, NDEP must be notified.

If you have any questions, please contact Karen K. Beckley at 687-4670 extension 3033.

Sincerely,

Paul J. Liebendorfer, P.E.
Chief
Bureau of Federal Facilities

PJL/KKB

JUL 5 2 13 PM '95

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DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

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June 25, 1996

David S. Shafer, Acting Director
Environmental Restoration Division
U.S. Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

RE: Data Quality Objectives for Corrective Action Investigation Plans

Dear Mr. Shafer:

The Nevada Division of Environmental Protection is in the process of reviewing various CAIPs that have been submitted by DOE. A common deficiency in each of these Plans is the description of DQOs that are being discussed. NDEP would like to establish a minimum of information that must be discussed in DQOs to alleviate the perceived deficiencies in a CAIP and the time required for document comment and revision.

The DQOs, at the very least, should enable highly reliable and consistent field decisions to be made by the field supervisors based on these predefined objectives. They should also include the level of effort (ie. manpower, equipment, staging, timing, budgets, etc.) necessary to satisfy both the DQOs and, for CAIPs, the Quality Assurance Objectives.

EPA presents the DQO process as a planning tool. The EPA's seven steps are progressions in crafting or inventing a Plan, with each step's success dependent on its predecessor's validity. In developing the Plan, all problems which might arise during its implementation must be considered and the means to resolve each must be in the Plan. All of the CAIPs submitted to date use the EPA's outline.

ACTION
INFO EPD ERD
MGR ✓
OBFS
AMTS ✓
AMNS
AMEM ✓

STEP 1 Problem Statement (State the Problem)
Define the problem and state why it is a problem. State as much as can be stated about the problem from present information. Include any knowledge of gaps in the information, any modeling or concepts, a list of contaminants known, resources and logistics, any process knowledge, existing data, releases, previous cleanup activity, maps, designs, aerials, any obvious receptors, sources, media type, and any uncertainties. Not all of the information above will be available, but they should be considered for inclusion if known. Poorly worded or vague statements in Step 1 could confuse or invalidate Step 2. All pertinent information may only need to be synopsized in this section and must be referenced as to its origin and availability, (ie. section 1.1 of CAIP).

STEP 2 Identification of Decisions (Identify the Decisions)
What has been identified in the problem statement that is driving the type of decisions made at this site (presumed waste type ie. characteristic, hazardous, solid, listed, etc.)? How do you know that you can get from the problem to the solution? The resolution of each problem requires that an important decision is made. The decision is whether "yes", the problem is defined adequately to be able to evaluate pre-established remediation options or "no" the CAIP did not produce information in the quantity and quality necessary to confidently decide that the problem has been defined. Step 2 of the DQO must establish those decisions which must be made and express exactly what management level is responsible for each decision level.

STEP 3 The Decision Inputs (Identify the Inputs to the Decision)
What are those properties which are unique to the location? Everything which has specificity or might help remove doubt should be listed. Specifically, what decisions have to be made as a basis for closure. Planning establishes what information is lacking now that stops the making of credible decisions about the conditions of closure.

STEP 4 Study Boundaries (Define the Boundaries of the Problem)
Boundaries are both spatial and temporal. Only the spatial dimensions of the CAU have been addressed so far. The boundaries must be defined such that everywhere inside the boundaries contributes input to a decision of the problem. Overlarge boundaries require unnecessary expenditures of time and resources and undersized boundaries can invalidate an otherwise credible decision.

STEP 5 Decision Rules (Develop a Decision Rule)
In general, each input demands a very explicit rule for determining when each input has been acquired or is deficient. These are usually "if...then" statements or "if...then...or" statements. These statements should provide an escape provision.

The most important property of a decision rule is its rigidity. It must force acceptance or rejection of an input and must be void of interpretation.

STEP 6 Decision Error Limits (Specify Tolerable Limits on Decision Errors)
How do you know that the data you obtained is meaningful? What is it validating? Every step of the way requires decisions and each of the decisions has error potential. What are the acceptable error values? The final decision must define the initial problem and should address items such as false positives and false negatives.

STEP 7 Optimization of the Design (Optimize the Design for Obtaining Data)
If the Problem (step 1) has been defined (step 2) because the inputs (step 3) survived steps 4, 5, and 6, no optimization (step 7) is required and the results from the execution of the approved CAIP are a major contribution to the proposed CADD & CAP. If the Problem is not defined, project must return to step 3 and reframe the inputs, boundaries, rules and error levels. These steps must be repeated until the problem has been defined. If the project completely falls apart, steps 1 through 6 must be re-established and be repeated until the problem is defined.

During the Planning process, the missing or incomplete information necessary to define the problem is postulated. Planning must anticipate failure and provide means or instruction for correcting the problem. Modification in the Planning process by the planning team can produce a flexible Plan, enabling the correction of deficiencies by the field supervisors except for those deficiencies expressly reserved by the DQO to the executive managers. Once planned, the CAIP should be empowered to be self guiding in accordance with the DQO and the QAPjP.

Also, the HELP model was established by EPA as a tool and is used primarily for determining the need for monitoring at solid waste disposal sites in high rainfall areas of the country. If this model is to be used, DOE must present justification as to the appropriateness of this model in the arid climate of each site.

If you have any questions, please call Harry van Drielen at 486-2866, Karen K. Beckley at 687-4670 extension 3033 or myself at 687-4670 extension 3039.

Sincerely,

Paul Liebendorfer, P.E.
Chief
Bureau of Federal Facilities

PL/KKB/db

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CLEAN SLATE CORRECTIVE ACTION INVESTIGATION PLAN
REVISION 0
RESPONSE TO COMMENTS FROM
NEVADA DEPARTMENT OF ENVIRONMENT PROTECTION
LETTERS DATED JUNE 25, 1996 AND JULY 5, 1996

1. GENERAL COMMENTS

REFERENCED DOCUMENTS:

When preparing the *Clean Slate Corrective Action Implementation Plan* (CAIP), a literature search was conducted of public domain (unclassified) documents. Several of the documents that were found were unpublished, drafts or preliminary as stated in the reference section. All of these documents are available and can be forwarded to the Nevada Department of Environmental Protection (NDEP), if requested. As requested by the NDEP, pertinent sections, tables, and figures from these documents, as determined by the authors of the CAIP, are presented in Appendix E. The unpublished soil analytical data base from soil sampling activities conducted in the mid 1970s is not included in the attached. If the NDEP requires this database, or a referenced document that is not included in the appendix, a special request should be submitted to the U.S. Department of Energy (DOE).

DATA QUALITY OBJECTIVES:

A separate section of comment responses (Section 3) has been prepared for the CAIP Data Quality Objectives (DQOs).

CLOSURE STRATEGY:

The CAIP is a site characterization document and the intent was not to propose closure strategies. However, as part of the DQO process, the data uses have to be discussed, and one of the data uses may be to propose site cleanup activities. Therefore, anticipated closure strategies are mentioned. The intent of mentioning these strategies is to follow the DQO process and not to propose closure strategies or site cleanup activities at this time. Closure strategies and clean-up activities will be presented in the *Clean Slate Corrective Action Decision Document* (CADD).

2. SPECIFIC COMMENTS

COMMENT 1:

Pg. 3-2: What form of documentation do you have to support the contention that the ground water has not been contaminated?

RESPONSE:

Previous site characterization conducted at the Operation Roller Coaster sites indicate that the radiological contamination has not significantly migrated. It has been shown that the depth of contamination at the Double Tracks site was only 2 to 3 centimeters (cm) in the general plume area and approximately 1 meter (m) in the ground zero area (Double Tracks Site Characterization Report, 1996). Data at the Clean Slate Sites indicate that radiological contamination is less than 15 cm (6 inches).(Gilbert, 1977). Other reports prepared for the TTR indicate groundwater is 100 to 120 meters below the ground surface at the Clean Slate sites (Tonopah Test Range RCRA Facility Investigation work Plan, 1994). Because it has been approximately 33 years since the Operation Roller Coaster experiment was conducted and it has been documented that the radiological contamination at the sites is not significantly migrating, it has been concluded that groundwater is not contaminated.

Whereas the CAIP will not be reissued with incorporated comments, a revision to Section 3.1.3, "Potential Receptors" of the CAIP concerning groundwater at the Clean Slate sites will not be made. Therefore, a discussion will be added to the potential receptors section of the CADD that discusses groundwater.

COMMENT 2:

Pg. 3-6: Is excess radioactive contamination defined as any contamination above 200 pCi/g?

RESPONSE:

The context of this section of the CAIP is that an activity of 200 pCi/g is a starting point to target areas of the site that may require remediation. The actual clean-up activity will be determined using RESRAD after site characterization is complete. The characterization results, RESRAD, site closure strategies and proposed cleanup activity will be presented in the CADD.

COMMENT 3:

Pg. 3-6: The DQOs have been addressed in a separate letter by NDEP. DOE needs to ensure that the comments in that letter are incorporated into this CAIP. A copy of the letter has been faxed to the project manager.

RESPONSE:

The DQO comments and responses are attached.

COMMENT 4:

Pg. 4-1: Should DOE encounter unexpected site conditions which require modifications of the CAIP or the conceptual model for Clean Slate I, II or III, NDEP must be notified.

RESPONSE:

Whereas the CAIP will not be reissued with incorporated comments, a response cannot be added to Section 4.1.1.1; of the CAIP, "DOE/NV Project Manager," stating that if there are any changes in the conceptual site model that require modification to the CAIP, the NDEP will be notified. All significant changes to the conceptual model will be discussed in the CADD. It is understood that DOE will notify the NDEP as soon as possible if there are significant changes to the conceptual model.

COMMENT 5:

Pg. 4-1: The Soils Media Quality Assurance Project Plan is being reviewed by NDEP. Any changes to that Plan may necessitate changes to this CAIP.

RESPONSE:

The Soils Project Quality Assurance Project Plan (QAPP) is referenced as a procedure document in the Clean Slate CAIP. Therefore, any changes in the QAPP will automatically be incorporated into activities conducted as part of the CAIP. Because the Soils Project QAPP is a controlled document, and the NDEP is on the distribution list, the NDEP will be notified of any changes made to the document. As direct by the NDEP, the CAIP will not be reissued so any changes to the QAPP that affect the CAIP will be submitted to the NDEP as addendums and appendices.

COMMENT 6:

Pg. 4-7: A 200 pCi/g concentration limit has been set in paragraph 3, however, a range of 200 pCi/g ± 25 pCi/g is referenced in the range of parameters in C.1.6.1. If 200 pCi/g is a limit, it may not be appropriate to consider a range that exceeds the limit.

RESPONSE:

The 200 pCi/g activity referenced on page 4-7 of the text was not to propose a site cleanup activity limitation, but refers to the activity that will be used as the starting point to define the area of contamination. The 200 pCi/g activity in DQO section C.1.6.1 refers to instrument capabilities that are part of the Clean Slate CAIP. The two uses of the 200 pCi/g activity are not related.

In response to the second part of this comment, area averaging is required for any *in situ* radiation measurement because the detector measures an activity over the field of view of the instrument. For example, the field of view for the KIWI detector system is 3 m by 1.2 m (3.6 m^2) and the extended mast HPGe detector ranges from less than a 1-m diameter to a 13-m diameter, full extension of the mast (approximately 0.8 m^2 to 133 m^2, respectively). With any detector system, there will be some areas in the detector's field of view that are above and below the activity measured.

COMMENT 7:

Pg. 4-8: What is the rational for dividing CS site 1 and 2 into 50-ft by 50-ft grids and CS-3 into 100-ft by 100-ft grids for random sampling activities?

RESPONSE:

The rationale for changing the grid size between CS-1 and 2 and CS-3 is that the area of CS-3 is much larger. It should be noted that this is only the grid size that is being marked in the field that will be used to find the random sample locations. The grid size does not affect the number of samples to be collected, only the relative accuracy and precision of finding the random sample location in the field. A Global Positioning System (GPS) will be employed to record the sample location in latitude and longitude.

COMMENT 8:

Pg. 4-25: Field documentation is to be conducted in accordance with "approved contractor procedures." Who approved these procedures? If DOE changes contractors prior to completion of the project, DOE must ensure incorporation of these procedures into the next contractor's operations or into DOE SOP (SQP)/Orders.

RESPONSE:

The NDEP has a controlled copy of the *ITLV Program Procedures Manual* that contains the *Standard Quality Practices* (SQPs) referenced in the field sampling instructions. The procedures are typically signed by the IT Office Manager (Mary Lou Brown), the Office QA Manager (Cheryl Prince), and IT Corporate QA Manager (David Troxell). If a new contractor takes over site characterization activities, the DOE project manager has the responsibility of ensuring that all applicable procedures are followed by the new contractor. If changes are required to the procedures, the NDEP will be notified either as a change to the SQP, through the controlled copy revision process, or a project specific revision to the CAIP will be submitted as an addendum or appendix.

COMMENT 9:

Pg. 5-3: If mixed waste is produced, NDEP must be notified.

RESPONSE:

It is currently not anticipated that mixed waste will be generated during site characterization activities. All activities have been planned and procedures reviewed to minimize the possibility of generating mixed waste. Whereas the CAIP will not be reissued with incorporated comments, a statement cannot be added to Section 5.3 of the CAIP, "Waste Determination," of the CAIP stating that if mixed waste is generated during site characterization activities, NDEP will be notified.

It is understood that DOE will notify NDEP as soon as possible if mixed is generated during site characterization activities.

3. DATA QUALITY OBJECTIVES COMMENTS

Data quality objective comments from the NDEP were received under a separate cover letter dated June 25, 1996. This letter address general comments concerning several CAIPs that are under review by NDEP, and the Clean Slate CAIP was one of the CAIPs referred to in the letter. There were many general comments concerning the respective DQO sections that were not directed to one document; therefore, the Clean Slate CAIP authors interpreted which comments referred to the Clean Slate CAIP and which did not. In addition, the NDEP does not want DOE to reissue corrected revisions of the CAIP, but rather to attach addendums and appendices to the existing documents that address their general comments. In addition to the discussion of DQO comments that follow, additional addendums and appendices are attached for the Clean Slate CAIP.

GENERAL COMMENT RESPONSE DISCUSSION:

When preparing the Clean Slate CAIP, the U.S. EPA 1993 *"Data Quality Objectives Process for Superfund, Interim Final Guidance"* and the associated Workbook was the primary guidance. An effort was also made to format the Clean Slate CAIP in the same manner as other CAIPs that are being reviewed by NDEP. The DQO process for the Clean Slate CAIP involved working through the DQO seven-step process in the Workbook and abbreviating the Workbook results into Appendix C of the CAIP. The DQO discussion in Appendix C was than summarized in Section 3.2 of the CAIP text. On several occasions, the NDEP indicated that they did not want the DQO Workbook results included as an attachment to the CAIP, but wanted the Workbook results summarized with the concerns in the NDEP DQO comment letter. In the attached addendums and appendices, the Clean Slate CAIP authors have included sections and parts of the NDEP generalized DQO comment letter that they thought applied to the Clean Slate CAIP, and they did not respond to those that they thought did not apply.

While the NDEP and CAIP authors realize that there should be consistency between the CAIP documents, it must be understood that each CAIP and its respective site(s) are different. Therefore, the DQO process in each CAIP will vary somewhat from the standardized DQO format. The Clean Slate CAIP authors deviated from the standard DQO process, based primarily on experience and knowledge gained characterizing and remediating the Double Tracks site and because there is a considerable amount of historical data available for each Clean Slate site. Specific items that were incorporated into the Clean Slate CAIP DQO process include the following,

- Each Clean Slate site was ground-surveyed and sampled immediately following the respective experiments. Each site was ground-surveyed and sampled again in the mid 1970s, and aerial radiation surveys were conducted in 1977 and in 1992. Therefore the extent and type of radiologic contamination are known and documented.

- Experience gained at the Double Tracks site, another Operation Roller Coaster site, included determining the nature and extent of contamination as well as understanding the contaminant fate and transport. In addition, field methods and procedures were developed and detector systems were modified to effectively characterize the radiological contamination at the site.

- Most of the site characterization data collected at the Clean Slate sites will be *in situ* radiation measurements. This is real-time data that is evaluated in the field as site characterization activities proceed. This is very different from standard site investigations where the project team collects samples which are submitted to a laboratory, and analytical results are received at a later date. The real-time data allow for it to be interpreted in the field to a confidence level so that an answer to the "if ... then...or" statements in Step 5 of the DQO can be made. This iterative process takes place in the field as the data is being collected instead of receiving analytical results after the field team has demobilized.

- Because of the experience gained during the Double Tracks site remediation, the field team has gone through the site remediation process, and the data needs are clearly defined. For example, it has been assumed that all the waste (soil) generated during site remediation will be classified as low-level radioactive waste. Historical data indicated that there was not enough radioactive material present during the original experiments to generate high-level radioactive waste. Therefore, it is not necessary during site characterization to accurately determine the upper activity levels of the soil in the center of the contaminant plume. Only the outer edge of the contaminant plume needs to be determined.

Based on this experience and knowledge, the CAIP authors were able to elevate the DQO process to a level where they knew the approximate nature and extent of contamination at each Clean Slate site, they knew what field methods and procedures would work (and which detector systems would not work) and finally, they knew the uses of the data. An attempt was made in the CAIP document to communicate this experience and knowledge to the readers so that when they read the DQO section, they would be at the same level as the authors.

The in-depth discussion of the Clean Slate CAIP DQOs is presented in Appendix C; most of the NDEP comments will be addressed though this Appendix. The CAIP text, Section 3.2, will not change because the final DQO results do not change. To assist in presenting the Clean Slate CAIP DQO process, a working matrix table, prepared when the project team first worked though the DQO process, has been formalized and is presented as attached Table C-1.

<u>SECTION C.1.1 PROBLEM STATEMENT (STEP 1)</u>:

Section C 1.1 will basically remain unchanged but will be interpreted to include the following to respond to comments thought to pertain to the Clean Slate CAIP. Section 2.0, "Facility Description," describes activities conducted during Operation Roller Coaster; and Appendix B, "Previous Investigation Results," summarizes *in situ* radiation and environmental media sampling conducted starting several years after the experiment and continuing to the present.

Appendix B summarized only the activities conducted and does not present the results from these investigations. The results from these investigations have been presented throughout the Clean Slate CAIP document and have been combined with experienced gained characterizing the Double Tracks site last year. The NDEP has a copy of the Double Tracks Characterization Report, so this document will continue to be referenced. Previous investigation results that the Clean Slate CAIP authors feel are important to understanding the nature and extent of contamination as well as contaminant fate and transport are presented as Appendix E.

In response to the NDEP DQO comment letter, Table C-1 presents six problem statements that need to be addressed during site characterization. These statements are presented in the Clean Slate CAIP and are discussed in the following text.

- **Determine the horizontal extent of contamination.**

  The horizontal extent of contamination was determined immediately after the experiment was conducted through *in situ* radiation measurements and soil sampling. The Clean Slate sites were again sampled and *in situ* measurements taken in the mid 1970 as part of the NTS waste inventory program. Aerial radiological surveys were conducted in 1977 and 1992 by the Remote Sensing Laboratory (RSL). Based on experience from the Double Tracks site characterization, the Clean Slate CAIP used the 1992 aerial survey to define the general area that will be investigated. Experience has shown that the 1992 aerial survey results were a good starting point to estimate the area of contamination.

- **Determine the vertical extent of contamination.**

  The vertical extent of contamination had been previously determined, through soil samples, to be generally less than 15 cm (6 inches). *In situ* depth profile measurements will be taken throughout the plume area to confirm and supplement the historical data.

  In addition, results from the *in situ* depth radiation measurements are used to calculate the depth that surface *in situ* radiation measurements are viewing. For example, at the Double Tracks site, it was calculated that the KIWI was viewing contamination to a depth of 2 to 3 centimeters. Because it is known that the soil type is different at the Clean Slate sites, and the contaminant distribution may also be different, this value needs to be recalculated at each Clean Slate site.

- **Determine if RCRA constituents are present.**

  Historical records of Operation Roller Coaster indicate that only radioactive contaminants were released. In addition, RCRA constituents were not detected at the Double Tracks site. To confirm that RCRA constituents are not present at the Clean Slate sites, soil samples will be collected from inside the radiological plume area. It has been assumed that if RCRA constituents were released at the site, they would be present within the radiological plume area. Results from the soil samples will also be used for waste characterization.

- **Identify radiological hot spots.**

Experience gained during the Double Tracks site characterization was that relatively small areas of high activity were biasing *in situ* radiation measurements. To better characterize the site, these hot spots need to be located and removed. The removed hot spot material will be stored at a central location at each Clean Slate site until disposal requirements are determined.

The hot spot material at the Double Tracks site consisted of small metal fragments coated with radioactive material. In addition, at some sites, the soil surrounding the metal fragment also had high activities. If high activity soil surrounded the metal fragment, typically one or two shovels of soil (2 to 4 liters) was all that was required to remove the hot spot. At the Double Tracks site, the soil and metal fragments are stored at the same location. It is anticipated that the same type of hot spots will be encountered at the Clean Slate 1, which was an open experiment similar to Double Tracks. The Clean Slate 2 and 3 experiments were conducted inside bunkers (igloos) so it is anticipated that there will be fewer hot spots and metal fragments encountered.

- **Characterize ground zero and suspected burial areas.**

Historical documents indicate that some debris from the Operation Roller Coaster experiments was buried at ground zero. At the Double Tracks site, in addition to the contaminated soil, only the concrete pad that the device rested on was in the ground zero mound. All other material used at the Double Tracks site appears to have been taken to the Roller Coaster Rad-Safe area (currently being investigated as an industrial site). It is assumed that this will be the same for the Clean Slate 1 site. The Double Tracks and Clean Slate 1 experiments were conducted in the open. The Clean Slate 2 and 3 experiments were conducted in bunkers, and additional debris may be present in the ground zero mound. To confirm that concrete and/or bunker debris is in the ground zero mounds, geophysical surveys will be conducted, and soil borings will be advanced. Historical photographs and documents indicate that only debris that could not be easily removed was buried in the vicinity of ground zero. Other suspect areas have been identified based on historical records and surface topographic expression and will be investigated.

- **Determine if volume reduction is feasible.**

Volume reduction was determined to not be economically feasible for the Double Tracks site, and preliminary observations indicated it will probably not be feasible for the Clean Slate 1 site. However, the Clean Slate 2 and 3 sites are much larger than Double Tracks and Clean Slate 1 so volume reduction may be feasible because of size economy. A phased approach will be employed to determine if volume reduction is feasible. The first phase will be to collect several samples from each site and conduct geotechnical analysis to evaluate what volume reduction processes are available for the type of soil present. The second phase will be to conduct bench scale tests of the volume reduction process and review anticipated costs. The third phase will be to conduct a pilot study (mockup) of the volume reduction process prior to a full scale startup.

SECTION C.1.2 IDENTIFICATION OF DECISIONS (STEP 2):

Section C.1.2 will remain unchanged but will be interpreted to have the following additions to respond to comments thought to pertain to the Clean Slate CAIP. The focus of this step in the NDEP comment letter is to identify the waste type, to determine if the CAIP can adequately define the decisions to be made concerning site closure, and to know who is responsible for making these decisions. The EPA (1993) DQO guidance used to prepare the Clean Slate DQOs takes a broader approach to this step. The guidance document focuses on identifying the decisions that will use the collected data and state the actions that could result from the resolution of each decision statement. Step 2 for the Clean Slate CAIP DQOs is discussed in Appendix C, Section C.1.2, and is presented in a more focused manner in Table C-1 and the following text.

- **What are the radiological contaminants and what is their horizontal and vertical extent?**

  Based on experience gained at the Double Tracks site, it has been assumed that the extent of significant radiological contamination will not exceed the 200 pCi/g contour defined in the 1992 aerial survey and that the depth of contamination is not greater than 15 cm (6 inches) except in the vicinity of ground zero. Historical documents indicate that plutonium and depleted uranium were the major isotopes released.

- **What are the clean up and disposal options?**

  For the DQO process, it was assumed that the contaminated soil will be transported to a licensed, government-owned (NTS), or commercial, disposal facility. The NTS has very rigorous waste characterization requirements, so the DQO process assumed that if the data met the NTS waste characterization requirements, they would meet any other disposal option waste characterization requirement.

  A risk analysis (RESRAD, including future land use scenarios) will be used to base the proposed cleanup activities at the Clean Slate sites. The proposed cleanup activity assumes that RCRA constituents are not detected. The risk analysis and proposed cleanup activities will be presented in the CADD. For the DQO process, contaminated soil above the proposed cleanup activities will be removed from the site and disposed of at a licensed facility.

- **What are the disposal options if RCRA constituents are present?**

  Experience at the Double Tracks site and information in historical documents indicate it is extremely unlikely that RCRA constituents will be detected at the Clean Slate sites. To confirm and document that RCRA constituents are not present, soil samples will be collected and analyzed. For the DQO process, it was thought that if RCRA constituents were present, they would occur within the radiological plume. If RCRA constituents are detected above regulatory limits, the disposal options will change and as required, other licensed disposal facilities will be investigated.

- **Where are the hot spots, what are they composed of, and are they removable?**

  Based on experience gained at the Double Tracks site, there will probably be hot spots at the Clean Slate sites, and the hot spot material should be similar to what was encountered at the Double Tracks site. The hot spots at Double Tracks consisted of discrete, high activity metal fragments and minor amounts of surrounding soil. This material was easily removed.

- **What is in the ground zero burial areas and what is their geometry (volume)?**

  Based on experience gained at the Double Tracks site, only radioactive soil and large pieces of debris will be encountered in the ground zero mound. Based on historical photos, it appears that all the easily removed radioactive debris from the experiments was taken to the Roller Coaster Rad-Safe area. Geophysical surveys and boreholes (with *in situ* radiation measurements taken with depth) will be used to confirm these assumptions, as required. When assessing the ground zero mounds, their geometry will be determined so volume estimates can be made. It is anticipated that more debris will be encountered in the Clean Slate 2 and 3 ground zero mounds than was encountered in the Double Tracks ground zero mound. It is anticipated that only contaminated soil and the concrete pad will be present in the Clean Slate 1 ground zero mound.

- **Is volume reduction feasible, can the volume of soil requiring disposal be reduced?**

  Based on existing knowledge of the Clean Slate sites, it is known that the soils at these sites are fine grained, which will make volume reduction more difficult than at the Double Tracks site. To assess volume reduction options, small quantities of soil are being collected and analyzed for geotechnical and radiological parameters to identify potential volume reduction options.

SECTION C.1.3 DECISION INPUTS (STEP 3):

Section C.1.3 will remain unchanged as presented in Appendix C and Section 3.2. The NDEP letter states that this step should focus on identifying all data gaps and propose methods to fill them. The discussion presented in Step 3 in the Clean Slate CAIP followed the EPA (1993) DQO guidance and focuses on providing the information needs for the decisions identified in Step 2. These included identifying data needs for site characterization as well as information needs for contaminant-specific action levels and proposed investigation approaches. Based on experience gained characterizing and corrective action taken at the Double Tracks site and historical information available at the Clean Slate sites, all perceived data gaps will be filled after site characterization activities are completed as presented in the Clean Slate CAIP. Table C-1 further summarizes the inputs to the decisions for the Clean Slate CAIP DQO Step 3.

SECTION C.1.4 STUDY BOUNDARIES (STEP 4):

Section C.1.4 will remain unchanged. There appears to be general agreement between the EPA DQO and the NDEP comment letter. The spacial and temporal boundaries presented in the Clean Slate CAIP will remain the same. Table C-1 summarizes these boundaries as they relate to the other DQO steps and the six identified problems.

SECTION C.1.5 DECISION RULES (STEP 5):

Section C.1.5 will remain unchanged but will be interpreted to include the following additions to respond to comments thought to pertain to the Clean Slate CAIP. This step in the NDEP comments states that there should be "if...then...or" statements that have rigid rules that force acceptance or rejection of an input. This step in the Clean Slate CAIP followed the EPA (1993) DQO guidance which is less rigid and allows for the input to be evaluated so it can guide the characterization on which direction to proceed. The "if...then...or" statements for Step 5 are summarized in Table C-1 and presented here.

- If the 200 pCi/g contour is not defined to ±25 pCi/g, then either the detector system needs to be reevaluated or the area resurveyed.

- If the depth profile measurements do not appear to adequately determine the depth of radiological contamination, then more depth profile measurements will be taken than originally planned. If an excessive number of depth profile measurements are required, then the conceptual site model is not correct, and a different characterization strategy will need to be implemented.

- If background cannot be adequately defined with the detector systems employed, then either the detectors need to have longer counting time to reduce their error, or a more sensitive detector needs to be employed.

- If the isotopic ratio cannot be accurately calculated with the detector systems employed, then either the detectors need to have longer counting times to reduce their error or a more sensitive detector should be employed.

- If the depth profile measurements cannot adequately determine the depth at which surface radiation measurements are being made, then either the detectors need to have longer counting times or a more sensitive detector should be employed.

- If RCRA constituents are detected, then the conceptual site model is in error, and historical documents will be reviewed to determine how, when, and where the release may have occurred. Additional soil samples will not be collected until the release source has been identified.

- If all hot spots (metal fragments) cannot be located and removed prior to other *in situ* measurements being taken, then the biased results will be evaluated to determine if the hot spot significantly increases the uncertainty. If the uncertainty is not significantly changed, then site characterization will continue. If the uncertainty is unacceptable, additional *in situ* measurements will be made to reduce the uncertainty. Moving large quantities of soil to remove hot spots will not be undertaken.

- If the ground zero and suspected burial areas cannot be adequately characterized with the proposed methods, then the site conceptual site model is in error, and a different strategy will need to be employed. Based on historical data and experience from the Double Tracks site characterization, it has been assumed that all of the ground zero mounds are contaminated and will require corrective action taken at. The goal of this phase of the characterization is to estimate the volume of contaminated soil and debris present in the mound and ensure that all the buried material is low-level waste.

- If it is determined that volume reduction is not technically and economically feasible, then other disposal options will need to be evaluated.

SECTION C.1.6 DECISION ERROR LIMITS (STEP 6):

Section C.1.6 will remain unchanged but will be interpreted in include the following additions to respond to comments thought to pertain to the Clean Slate CAIP. The discussion presented in this section followed the EPA (1993) DQO guidance and addressed not only numerical errors, as stated in the NDEP comment letter, but also addressed the type of error and the impact on the final decisions and conclusions. Table C-1 summarizes the decision error limits for the Clean Slate CAIP.

SECTION C.1.7 OPTIMIZATION OF THE DESIGN (STEP 7):

Section C.1.7 remains unchanged but will be interpreted to include the following to respond to comments thought to pertain to the Clean Slate CAIP. The Clean Slate CAIP Step 7 of the DQO process is the Sampling and Analysis Plan and field activity instructions. The Clean Slate CAIP strategy is that if a DQO step is not achieved, then the procedure will be to evaluate the existing data and data error, the corresponding error in the conceptual site model, and determine what affect the error will have on the final data use. Based on this evaluation, the DQO procedure can either proceed forward, move in a different direction, or go back to a previous step. Table C-1 summarizes Step 7 for the Clean Slate CAIP.

Addendum Table
Summary of Clean Slate CAIP
Data Quality Objectives
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Step 1 State the Problem	Determine the horizontal extent of radiologic contamination.	Determine the vertical extent of radiologic contamination.	Determine if RCRA constituents are present.	Identify radiologic hot spots	Characterize ground zero and suspected burial areas.	Determine if volume reduction is feasible.
Step 2 Identify the Decision	What are the radiological contaminants? What is the extent of radiological contamination? What are the disposal options?[a,b,c] Based on future land use, what are the clean-up options?[a]		Are RCRA constituents present?[c]	Where are the hot spots? What are they composed of? Are they removable?	What type of debris is in the burial areas? What is the activity of this debris?[c] What is the burial area geometry?	Can the volume of soil requiring disposal be reduced?
Step 3 Identify the Inputs to the Decision	Historical data *In situ* radiation measurements[d] Background measurements[d,e,f] Isotopic ratio measurements[e,f] Discrete soil samples	Historical data Depth profile measurements[e] Background measurements[d,e,f] Isotopic ratio measurements[e,f] Discrete soil samples	Historical data Discrete soil sample	Historical Data *In situ* radiation measurements[d,g] Background measurement[d,e,f] Isotopic ratio measurements[e,f]	Historical data Geophysical surveys[h] Soil borings *In situ* radiation measurements[d,e,i]	Historical Data Physical properties of the soil and contaminants Treatability study (bench scale and pilot study) Industry data from other sites
	Disposal Options[a,b,c] Environmental Assessment[a,b,c] Position document concerning clean-up activities[a] Applicable DOE Orders Promulgated and proposed clean-up options through risk assessment[a,c] Future land use[a] DOE schedule and budget constraint					
Step 4 Define the Study Boundaries	The outer fence and/or the aerial survey 200 pCi/g contour line (CS 1 and 2 have some suspected areas outside the outer fence) Contaminants are less than 15-cm deep, except in suspected burial areas Suspected burial areas are inside the contaminant plume (areas being investigated) Characterization work to be initiated this fiscal year Characterization work does not conflict with Double Tracks corrective action activities					Volume of soil requiring disposal based on historical data
Step 5 Develop a Decision Rule	Is the 200 pCi/g contour defined?	Are the Depth profile measurements adequate?	If identified, are RCRA constituents detected above regulatory limits?	Are all hot spots located and removed?[d,g]	Have all suspected burial areas been located and their contents and geometry defined?	Is volume reduction feasible? Is volume reduction cost effective?
	Is background adequately defined?[d,e,f] Are the Isotopic ratios defined?[e,f] Are activity of contaminants at depth adequately defined so their affect on surface measurements can be calculated?[d,e,f]					

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Step 6 Specify Limits on Decision Errors	Lower limit or threshold 200 pCi/g ±25 pCi/g of radiological contamination	Depth of radiological contamination is ± 7 cm outside of the suspected burial areas	RCRA constituents are below actions levels with 95 % confidence limits	All hot spot material has been removed to an activity that is not 25 percent greater than the activity surrounding the removed hot spot	Depth of burial areas ± 1 foot Volume of soil ±100 cubic meters Activity of contents indicate low level waste, TRU waste is not present[b,c]	Volume reduction has to reduce the volume of soil requiring disposal by 50% ±10%[b]
	Volume of soil ±10 percent of the total volume of soil[b] Soil is low level radioactive waste[c] Significant TRU waste is not present[c]					
Step 7 Optimize the Design for Obtaining Data	Estimate volume of soil by the following *In situ* radiation measurements[d] Depth profile[e] Background[d,e,f] Isotopic ratios[e,f] Discrete Soil sampling		Discrete soil sampling, the number of samples will be determined statistically	*In situ* radiations surveys[d,g]	Geophysical surveys[h] Boreholes *In situ* radiations surveys[d,e,f] Topographic land survey Investigating will be conducted using the SAFER approach	Treatability studies (preliminary screening analysis, bench scale and pilot study)

[a] For the DQO process, a soil clean up activity of 200 pCi/g was assumed. After site characterization, a clean up activity will be proposed in the CADD.
[b] The volume of soil requiring clean up is estimated to be 2,500m³ for CS 1, 10,200m³ for CS 2, and 21,200m³ for CS 3.
[c] For soil disposal option evaluations, it has been assumed that only low level radioactive waste will be generated. RCRA and high level radioactive waste is not present.
[d] Suburban mounted NaI detector system (referred to as the KIWI detector system).
[e] Tripod mounted HPGe detector system.
[f] Suburban (extended mast) mounted HPGe detector system.
[g] All terrain vehicle (ATV) mounted NaI detector system.
[h] Geophysical surveys consist of magnetic, electromagnetic and ground penetrating radar surveys.

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