Errata for the Corrective Action Decision Document for the Area 9 UXO Landfill, Tonopah Test Range, Nevada

Revision 0
March 1998

Please incorporate the following changes into the subject document:

1.) Page ES-2 of ES-2; Paragraph 2; Sentence 1:

Replace "...future land use..." with "...future use..."

2.) Page 13 of 22; Line 1:

Replace "...future land use..." with "...future use..."

3.) Page 13 of 22; Bullet 6; Sentence 1:

Replace "...potential land use..." with "...potential use..."

4.) Page 14 of 22; Section 3.3.2; Sentence 2:

Replace "...land-use restrictions..." with "...use restrictions..."

5.) Page 14 of 22; Section 3.3.3; Paragraph 2; Sentence 2:

Replace "Land-use restrictions..." with "Use restrictions..."

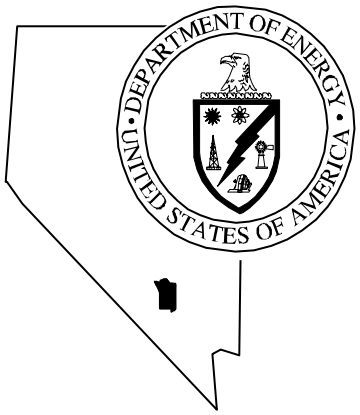
6.) Page 20 of 22; Paragraph 3:

Replace paragraph with the following:

"The future use of any land related to this CAU, as described by the surveyed location in the Closure Report, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the State of Nevada and identified in the CAU Closure Report or other CAU documentation unless appropriate concurrence is obtained in advance."

Nevada
Environmental
Restoration
Project

DOE/NV--497
UC-700



Corrective Action Decision Document for the Area 9 UXO Landfill, Tonopah Test Range, CAU 453

Controlled Copy No.: **UNCONTROLLED**

Revision No.: 0

March 1998

Approved for public release; further distribution is authorized.

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

DOE/NV-497
UC-700

CORRECTIVE ACTION DECISION DOCUMENT FOR THE AREA 9 UXO LANDFILL, TONOPAH TEST RANGE, CAU 453

DOE Nevada Operations Office
Las Vegas, Nevada

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Uncontrolled When Printed

CORRECTIVE ACTION DECISION DOCUMENT
FOR THE AREA 9 UXO LANDFILL,
TONOPAH TEST RANGE, CAU 453

Approved by: /s/ Janet Appenzeller-Wing Date: 3/5/98

Janet Appenzeller-Wing, Project Manager
Industrial Sites Subproject

Approved by: /s/ Michael O. Giblin Date: 3/5/98

Michael O. Giblin, Acting Project Manager
Nevada Environmental Restoration Project

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Appendix A - Corrective Action Investigation Report for CAU 453: Area 9 UXO Landfill, Tonopah Test Range

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List of Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
bgs	Below ground surface
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site(s)
CAU	Corrective Action Unit(s)
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter(s)
COA	Certificate(s) of Analysis
COC	Contaminant(s) of Concern
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DQO	Data quality objective(s)
dpm	Disintegrations per minute
EDT	Electronic data transfer
EPA	U.S. Environmental Protection Agency
FFACO	*Federal Facility Agreement and Consent Order*
ft	Foot (feet)
ICP	Inductively coupled plasma
in.	Inch(es)
IT	IT Corporation
LCS	Laboratory control sample
km	Kilometer(s)
m	Meter(s)

List of Acronyms and Abbreviations *(Continued)*

mg/kg	Milligram(s) per kilogram
mi	Mile(s)
MS/MSD	Matrix spike/matrix spike duplicate
NAC	*Nevada Administrative Code*
NDEP	Nevada Division of Environmental Protection
O&M	Operation and maintenance
ORERP	Offsite Radiation Exposure Review Project
PCB	Polychlorinated biphenyls
pCi/g	Picocurie(s) per gram
ppm	Part(s) per million
PRG	Preliminary remediation goal(s)
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	*Resource Conservation and Recovery Act*
RPD	Relative percent difference(s)
SASW	Spectral Analysis of Surface Waves
SDG	Sample delivery group
SVOC	Semivolatile organic compound
TPH	Total Petroleum Hydrocarbon
TTR	Tonopah Test Range
UXO	Unexploded Ordnance
VOC	Volatile organic compound(s)
yd^3	Cubic yard(s)
%R	Percent recovery
µg/kg	Microgram(s) per kilogram

List of Acronyms and Abbreviations *(Continued)*

µR/hr	Microroentgen(s) per hour
5X	Five times
10X	Ten times

Executive Summary

This Corrective Action Decision Document (CADD) has been prepared for the Area 9 Unexploded Ordnance (UXO) Landfill (Corrective Action Unit [CAU] 453) in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) of 1996.

Corrective Action Unit 453 is located at the Tonopah Test Range (TTR), Nevada, and is comprised of three individual landfill cells located northwest of Area 9. The cells are listed as one Corrective Action Site (CAS) 09-55-001-0952. The landfill cells have been designated as:

- Cell A9-1
- Cell A9-2
- Cell A9-3

The purpose of this CADD is to identify and provide a rationale for the selection of a recommended corrective action alternative for CAU 453.

The scope of this CADD consists of the following tasks:

- Develop corrective action objectives.
- Identify corrective action alternative screening criteria.
- Develop corrective action alternatives.
- Perform detailed and comparative evaluations of the corrective action alternatives in relation to the corrective action objectives and screening criteria.
- Recommend and justify a preferred corrective action alternative for the CAU.

In June and July 1997, a corrective action investigation was performed that consisted of activities set forth in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 1997). Subsurface investigation of the soils surrounding the cells revealed no contaminants of concern (COCs) above preliminary action levels. The cell contents were not investigated due to the potential for live UXO. Details concerning the analytical and investigation results can be found in Appendix A of this CADD.

Based on the potential exposure pathways, the following corrective action objectives have been identified for CAU 453:

- Prevent or mitigate human exposure to subsurface soils containing COCs, solid waste, and/or UXO.
- Prevent adverse impacts to groundwater quality.

Based on the review of existing data, future land use, and current operations at the TTR, the following alternatives have been developed for consideration at the Area 9 UXO Landfill CAU:

- Alternative 1 - No Further Action
- Alternative 2 - Closure in Place by Administrative Controls
- Alternative 3 - Closure in Place by Capping
- Alternative 4 - Clean Closure by Removal

The corrective action alternatives were evaluated based on four general corrective action standards and five remedy selection decision factors. Based on the results of this evaluation, Alternative 2, Closure in Place by Administrative Controls, was selected as the preferred corrective action alternative. The preferred corrective action alternative was evaluated on its technical merits, focusing on performance, reliability, feasibility, and safety. The alternative was judged to meet all requirements for the technical components evaluated and to represent the most cost-effective corrective action. The alternative meets all applicable state and federal regulations for closure of the site and will reduce potential future exposure pathways to the contents of the landfill.

During corrective action implementation, this alternative will present minimal potential threat to site workers. However, appropriate health and safety procedures will be developed and implemented.

1.0 Introduction

This Corrective Action Decision Document (CADD) has been prepared for the Area 9 Unexploded Ordnance (UXO) Landfill (Corrective Action Unit [CAU] 453) in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) of 1996 that was agreed to by the U.S. Department of Energy, Nevada Operations Office (DOE/NV), the Nevada Division of Environmental Protection (NDEP), and the U.S. Department of Defense (FFACO, 1996). The CADD provides or references the specific information necessary to recommend possible corrective actions for the single Corrective Action Site (CAS), 09-55-001-0952, within CAU 453.

Corrective Action Unit 453 is located at the Tonopah Test Range (TTR), Nevada. The TTR, included in the Nellis Air Force Range, is approximately 255 kilometers (km) (140 miles[mi]) northwest of Las Vegas, Nevada (Figures 1-1 and 1-2). Corrective Action Unit 453 is comprised of three individual landfill cells located northwest of Area 9 on the TTR (Figure A.2-1). The landfill cells have been designated as:

- Cell A9-1
- Cell A9-2
- Cell A9-3

1.1 Purpose

This CADD identifies and provides a rationale for the selection of a recommended corrective action alternative for the CAU. The need for these alternatives is based on process knowledge and the results of investigative activities conducted in accordance with the *Corrective Action Investigation Plan for CAU No. 453: Area 9 Landfill, Tonopah Test Range, Nevada* (DOE/NV, 1997).

1.2 Scope

The scope of this CADD consists of the following:

- Develop corrective action objectives.
- Identify corrective action alternative screening criteria.
- Develop corrective action alternatives.

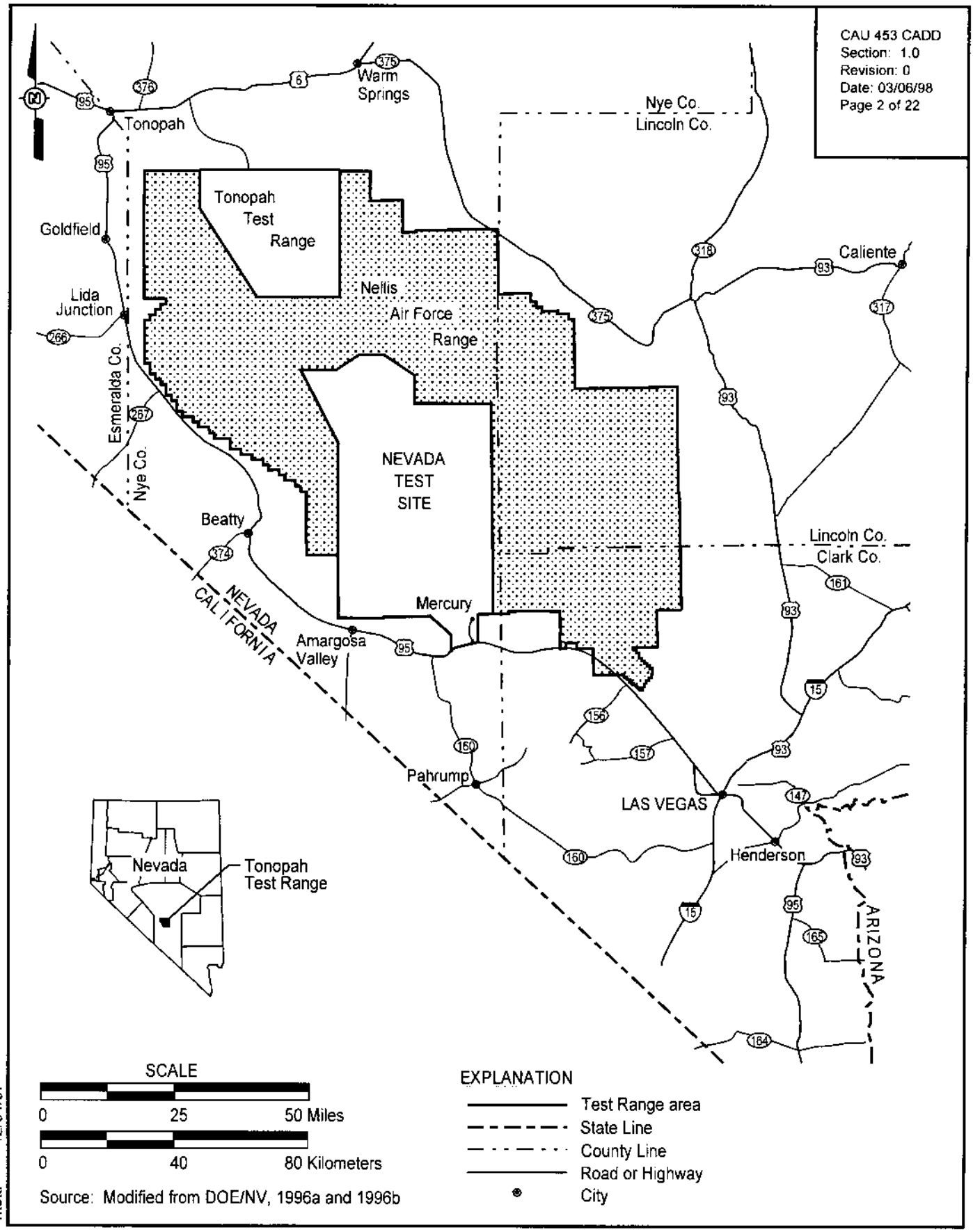

Figure 1-1
Tonopah Test Range Location Map

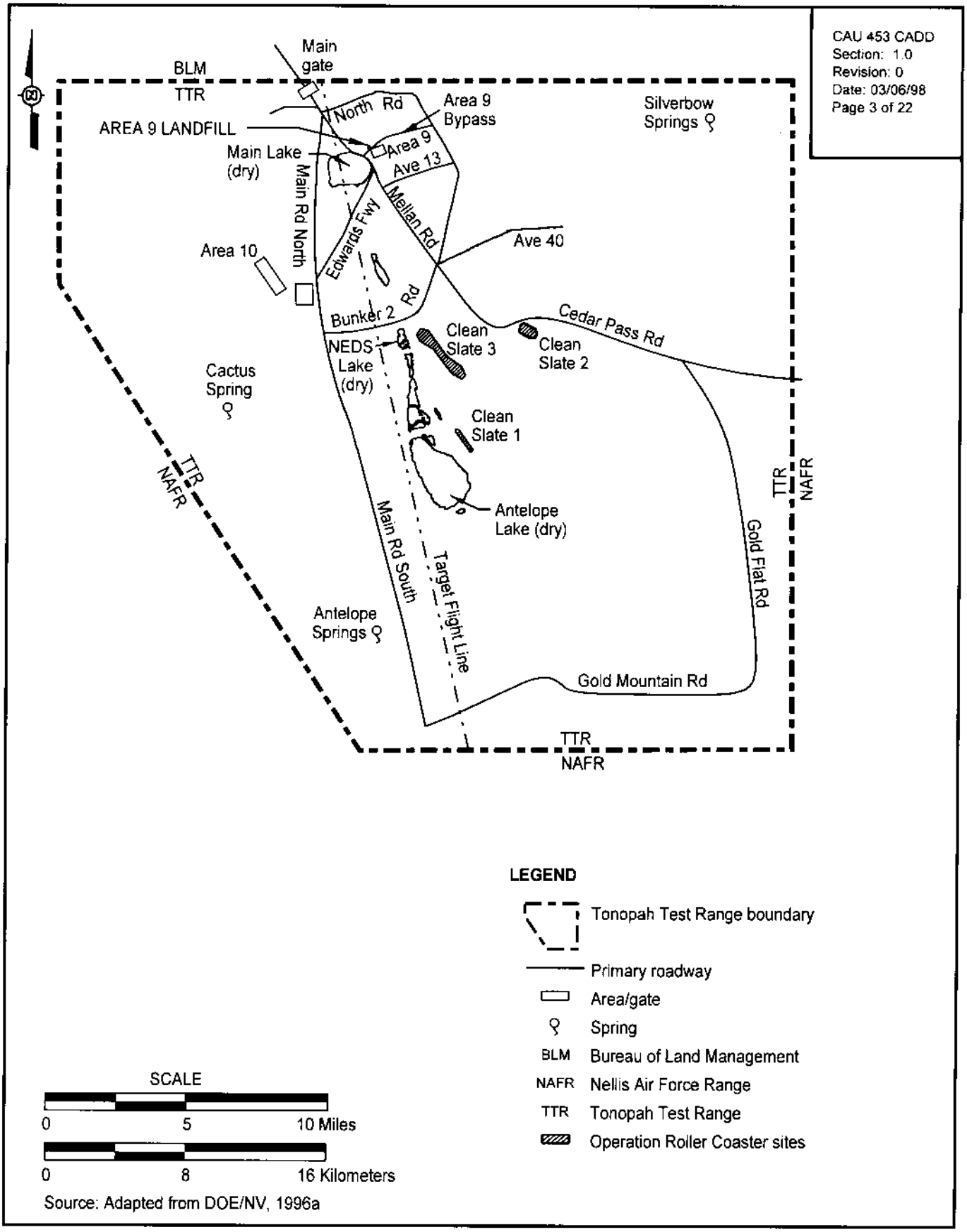

Figure 1-2
Range Layout and Location of the Area 9 Landfill, Tonopah Test Range

- Perform detailed and comparative evaluations of corrective action alternatives in relation to corrective action objectives and screening criteria.
- Recommend and justify a preferred corrective action alternative for the CAU.

1.3 CADD Contents

This CADD is divided into the following sections:

Section 1.0 - Introduction: summarizes the purpose, scope, and contents of this CADD

Section 2.0 - Corrective Action Investigation Summary: summarizes the investigation field activities, the results of the investigation and the need for corrective action.

Section 3.0 - Evaluation of Alternatives: documents steps taken to determine a preferred corrective action alternative

Section 4.0 - Recommended Alternative: presents the preferred corrective action alternative and the rationale for its selection based on the corrective action objectives and alternative screening criteria

Section 5.0 - References: provides a list of all referenced documents

All work was performed in accordance with the following documents:

- *Corrective Action Investigation Plan for CAU No. 453: Area 9 Landfill, Tonopah Test Range, Nevada* (DOE/NV, 1997)
- *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996c)
- Draft, *Corrective Action Unit Work Plan, Tonopah Test Range* (DOE/NV, 1996a)
- FFACO (FFACO, 1996)
- *Project Management Plan*, (DOE/NV, 1994)
- Appendix A: *Corrective Action Investigation Report for CAU 453: Area 9 Landfill, TTR*
- Appendix B: Cost estimates as developed by Bechtel Nevada

2.0 Corrective Action Investigation Summary

The following sections describe and summarize the results of the investigation activities conducted at CAU 453. For detailed investigation results, please refer to Appendix A.

2.1 Investigation Activities

In June and July 1997, a corrective action investigation was performed that consisted of activities as set forth in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 1997). The purpose of the investigation was to identify the nature and extent of contaminants of concern (COCs) beneath the landfill cells. The cell contents were not investigated due to potential live UXO. The following items summarize the investigation activities:

- Drilled 14 boreholes surrounding the landfill for borehole geophysical surveys
- Conducted borehole geophysical and surface-wave surveys to determine landfill depths
- Drilled three vertical borings in undisturbed areas in the landfill vicinity for background data
- Drilled 11 angled (45°) investigation borings beneath the landfill cells to total vertical depths of 7.6 meters (m) (25 feet [ft]) and collected samples for field screening and laboratory analysis (Figure A.2-1 in Appendix A shows boring locations)
- Field-screened soil samples using headspace analysis for volatile organic compounds (VOCs), colorimetric testing for total petroleum hydrocarbons (TPH), and radiological screening for alpha and beta/gamma emitters
- Analyzed environmental samples from the investigation borings for total VOCs, semivolatile organic compounds (SVOCs), *Resource Conservation and Recovery Act* (RCRA) metals, nitroaromatic and nitroamines, TPH, polychlorinated biphenyls (PCB), and gamma-emitting radionuclides
- Analyzed background samples for total RCRA metals and gamma-emitting radionuclides
- Analyzed geotechnical samples from investigation borings for initial moisture content, dry bulk density, calculated porosity, saturated/unsaturated hydraulic conductivity, particle size distribution, and water-release curve

In addition, historical documents, interviews, and process knowledge assisted the potential contaminant identification process at each of the landfills (see Appendix A).

2.2 Results

The corrective action investigation results indicated the following:

- No contaminants above preliminary actions levels were identified in soil below the landfill cells.
- Visual inspection and moisture testing indicated that soil below the cells is not saturated. Leachate was not discovered below the cells and is not expected to be present in the future as process knowledge does not indicate the disposal of any hazardous materials to the landfill.
- Most VOCs were not detected. Detected VOCs were below the preliminary action levels outlined in the CAIP (DOE/NV, 1997). Those detected are all common laboratory contaminants.
- Soil sample TPH levels were below the NDEP-established action level of 100 parts per million (ppm) in all cells.
- A single SVOC, Bis(2-Ethylhexyl)Phthalate, was detected at a concentration below the preliminary action level. It is a common laboratory contaminant.
- Reported levels for all total RCRA metal samples (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) were below the preliminary action levels established in the CAIP (DOE/NV, 1997). The analytical results for all detected metals are indicative of the naturally occurring background levels for this area based on results from the background samples collected as part of this investigation.
- No PCBs were detected.
- Radiological results are within preliminary action levels as established in the CAIP.

Details of the methods used and results found during the investigation are presented in Appendix A.

2.3 Need for Corrective Action

Analytes detected during the corrective action investigation were evaluated to determine potential COCs for CAU 453. This evaluation did not identify any constituents above applicable regulatory limits (i.e., EPA Region 9 Preliminary Remediation Goals Table [EPA, 1996] and *Off-site*

Radiation Exposure Review Project, Phase II Soil Program [McArthur and Miller, 1989]) or naturally occurring background levels; therefore, no COCs were identified in the soil beneath the landfill. However, site process knowledge indicates it was used for solid waste disposal, including disposal of UXO. An earlier action to remove exposed debris encountered inert UXO, rocket motor casings, rocket motor shipping containers, and construction debris. Although Cells A9-2 and A9-3 received waste prior to the regulations pertaining to Class III solid waste facilities (e.g., *Nevada Administrative Code* [NAC] 444 [NAC, 1996a]), Cell A9-1 may have been in operation on the effective date of these regulations. While this landfill was never permitted under these regulations, comparison of site conditions with regulatory requirements provides criteria for evaluating the need for capping and/or monitoring at the site. A Class III site is defined as a site which accepts only industrial waste (NAC, 1996a). Under NAC 444.731.3.a, b, and c, the landfill demonstrates all the characteristics necessary to qualify for a waiver from the requirements for a Class III site as follows:

- All waste placed in the landfill was incidental to the operator's industrial operations.
- The landfill is located on property controlled by the operator of the industrial operation.
- The landfill will not receive any hazardous materials and is unlikely to produce pollutants or contaminants that may degrade waters of the state.

Based on these criteria, a permitted landfill would be eligible for a waiver of both capping and monitoring requirements. Therefore, monitoring is not required at the CAU. Measures should be taken, however, to prevent inadvertent contact with potentially live UXO.

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 453, describe the general standards and decision factors used to screen the corrective action alternatives, and develop and evaluate a set of corrective action alternatives that could be used to meet the corrective action objectives.

3.1 Corrective Action Objectives

The corrective action objectives are media-specific goals for protecting human health and the environment. Based on the potential exposure pathways (see Section 3.1.2), the following corrective action objectives have been identified for CAU 453:

- Prevent or mitigate human exposure to subsurface soils containing COCs, solid waste, and/or UXO.
- Prevent adverse impacts to groundwater quality.

3.1.1 Contaminants of Potential Concern

Analytical results obtained from the corrective action investigation were evaluated to determine COCs for CAU 453. No constituents were identified in the soil beneath the landfill at concentrations above preliminary action levels (see Section A.3.0 of Appendix A). Therefore, no COCs were identified for these soils. No samples were taken of the cell contents; process knowledge does not indicate the disposal of any hazardous materials to the landfill.

3.1.2 Potential Exposure Pathways

As part of the CAIP (DOE/NV, 1997), a conceptual model for CAU 453 was developed which identified the potential exposure pathway as ingestion of soils under residential and occupational scenarios (see Figure 3-1 in the CAIP). This pathway includes inhalation of vapors and dermal contact. Exposure pathways to contaminants are not considered further because no COCs were identified. However, accidents associated with potentially live UXO could result from inadvertent intrusion into the landfill cells or from surface activities.

3.2 Screening Criteria

The screening criteria used to evaluate and select the preferred corrective action alternatives are identified in the U.S. Environmental Protection Agency (EPA) *Guidance on Resource Conservation and Recovery Act Corrective Action Decision Documents* (EPA, 1991) and the *Final Resource Conservation and Recovery Act Corrective Action Plan* (EPA, 1994).

Corrective action alternatives will be evaluated based on four general corrective action standards and five remedy selection decision factors. All corrective action alternatives must meet the general standards to be selected for evaluation using the remedy selection decision factors.

The general corrective action standards are:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

The remedy selection decision factors are:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

3.2.1 Corrective Action Standards

The following text describes the corrective action standards used to evaluate the corrective action alternatives:

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any protective measures that are needed. These measures may or may not be directly related to media cleanup, source control, or management of wastes. The corrective action alternatives are evaluated for the ability to meet corrective action objectives as defined in Section 3.1.

Compliance with Media Cleanup Standards

Each corrective action alternative must have the ability to meet the proposed media cleanup standards as set forth in applicable state and federal regulations (NAC 444 [NAC, 1996a] and 445A [NAC, 1996b]). Preliminary action levels were not exceeded; therefore, only media cleanup standards related to NAC 444 apply (NAC, 1996a). See Section A.3.0 of Appendix A for analytical results.

Control the Source(s) of the Release

An objective of corrective action remedy is to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, each corrective action alternative must use an effective source control program to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

During implementation of any corrective action alternative, all waste management activities must be conducted in accordance with applicable state and federal regulations (e.g., *Nevada Revised Statutes* 459.400 - 459.600 [NRS, 1995]; RCRA 40 CFR 261 - 281 [CFR, 1996]; 40 CFR 268, "Land Disposal Restrictions;" NAC 444, "Solid Waste Disposal" [NAC, 1996a]; and NAC 459.9974, "Disposal and Evaluation of Contaminated Soil" [NAC, 1996c]). The requirements for management of the waste, if any, derived from the corrective action will be determined based on applicable state and federal regulations, field observations, process knowledge, characterization data, and data collected and analyzed during corrective action implementation. Administrative controls (e.g., decontamination procedures and corrective action strategies) will minimize waste generated during site corrective action activities. Decontamination activities will be performed in accordance with approved procedures as specified in the NDEP-approved TTR work plan (DOE/NV, 1996a) and will be designated according to the COCs present at the site.

3.2.2 Remedy Selection Decision Factors

The following describe the remedy selection decision factors used to evaluate the corrective action alternatives:

Short-Term Reliability and Effectiveness

Each corrective action alternative must be evaluated with respect to its effects on human health and the environment during the construction and implementation phase of the corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation such as fugitive dusts, transportation of hazardous materials, explosion
- Protection of workers during construction and implementation
- Environmental impacts that may result from construction and implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each corrective action alternative must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by the use of corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each corrective action alternative must be evaluated in terms of risk remaining at the CAU after the corrective action alternative has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the controls that may be required to manage risk posed by treatment residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a corrective action alternative and the availability of various services and materials needed during implementation. Each corrective action alternative must be evaluated for the following criteria:

- Construction and Operation: This refers to the feasibility of implementing a corrective action alternative given the existing set of waste and site-specific conditions.
- Administrative Feasibility: This refers to the administrative activities needed to implement the corrective action alternative (e.g., permits, public acceptance, rights of way, off-site approval).
- Availability of Services and Materials: This refers to the availability of adequate off-site and on-site treatment, storage capacity, disposal services, needed technical services and materials, and availability of prospective technologies for each corrective action alternative.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each corrective action alternative includes both capital and operation and maintenance (O&M) costs, as applicable. The following is a brief description of each component:

- Capital Costs: These costs include both direct and indirect costs. Direct costs may consist of materials, labor, mobilization, demobilization, site preparation, construction materials, equipment purchase and rental, sampling and analysis, waste disposal, and health and safety measures. Indirect costs include such items as engineering design, permits and/or fees, start-up costs, and any contingency allowances.
- Operation and Maintenance: These costs include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures.

Costs associated with potential O&M activities are considered to be minimal for all alternatives and were, therefore, not estimated. Cost estimates were developed by Bechtel Nevada (BN); details of the estimated costs for this CADD are provided in Appendix B.

3.3 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the corrective action alternatives considered for the affected media. Based on the review of existing

data, future land use, and current operations at the TTR, the following alternatives have been developed for consideration at the Area 9 UXO Landfill CAU:

- Alternative 1 - No Further Action
- Alternative 2 - Closure in Place by Administrative Controls
- Alternative 3 - Closure in Place by Capping
- Alternative 4 - Clean Closure by Removal

The following information supports the protection of groundwater and eliminates the need for groundwater monitoring:

- The depth to groundwater at the site is estimated to be 43 meters (m) (131 ft) (DOE/NV, 1996a).

- The soil below the cells is native soil consisting of alluvial materials. The geotechnical analysis determined that the alluvial/fill material has very low hydraulic conductivity and soil moisture content within the low range. Both of these factors limit the migration potential through the soils.

- Annual precipitation averages 13 to 15 centimeters (cm) (5 to 6 inches [in.]) at TTR (DOE/NV, 1996a). Annual evaporation is between 147 and 168 cm (58 and 66 in.) (DOE/NV, 1996a). The high evaporation and low precipitation create a negative water balance for the area; therefore, no driving force associated with precipitation is available to mobilize contaminants to groundwater.

- No evidence of COCs above regulatory limits was found in the soils beneath the landfill cells.

- Based on the investigation, the extent of the contamination is limited to the solid waste in the trenches with no identified COCs. Soil moisture and sampling results show no indication of downward migration of contaminants.

- The CAU is located in a government-controlled facility with the potential land use similar to current use. The TTR is a restricted area that is guarded on a 24-hour, 365-day-per-year basis; unauthorized personnel are not admitted to the facility.

- No COCs were identified at levels with the potential for a hazard related to fire, vapor, or explosion. The potential for explosion exists if live UXO is located in the cells.

No other site-specific information is available to substantiate the potential for contaminant migration. Based on this information, neither vadose nor groundwater monitoring is considered necessary for this site.

3.3.1 Alternative 1 - No Further Action

Under the No Further Action alternative, no corrective action activities will be implemented with one exception; the open portion of Cell A9-1 should be backfilled and graded to minimize surface depressions. This alternative is used as a starting point to establish a baseline for comparison with the other corrective action alternatives. This alternative does not meet the corrective action objectives because no actions are taken to prevent human contact with the solid waste or the UXO. This alternative will not be compared to the other alternatives using the selection decision factors.

3.3.2 Alternative 2 - Closure in Place by Administrative Controls

Administrative controls are used to prevent inadvertent contact with contaminated media. Administrative controls would consist of land-use restrictions to prevent intrusive activities. In addition, signs and/or fencing could be used to further restrict access. The open portion of Cell A9-1 should be backfilled and graded to minimize surface depressions. Administrative controls are commonly used and can effectively eliminate potential pathways. Administrative controls are effective because the TTR, which includes CAU 453, is a restricted access facility. The implementation of administrative controls requires the coordination of all entities at a site to ensure that the restrictions are enforced.

3.3.3 Alternative 3 - Closure in Place by Capping

Alternative 3 consists of constructing an engineered cap over the landfill to prevent inadvertent intrusion to the solid waste and UXO and to protect against detonation accidents associated with surface or intrusive activities. This will include backfilling the open portion of Cell A9-1 and grading to minimize surface depressions.

A fence will be constructed and signs will be placed around the perimeter of the landfill to prohibit unauthorized access and illegal dumping. Land-use restrictions will be implemented to prevent intrusive activities.

3.3.4 Alternative 4 - Clean Closure by Removal

Alternative 4 consists of removing the solid waste and UXO from the landfill cells and disposing of this waste in an approved disposal facility. If live UXO is found, detonation may be required. Due

to the inherent dangers associated with the handling of UXO, the removal action would be done either by hand on a piece-by-piece basis or with remotely operated equipment. The excavation must proceed slowly to reduce the potential for accidents associated with detonation of any UXO.

The excavated areas will be backfilled with uncontaminated soils and recontoured to eliminate topographic depressions. Excavation would be used to remove clean borrow soil from an on-site location for placement at the landfills as necessary.

3.4 Evaluation and Comparison of Alternatives

The general corrective action standards and remedy selection decision factors described in Section 3.2 were used to conduct a detailed evaluation of each corrective action alternative. An analysis compared each corrective action alternative to the other alternatives. In this way, the advantages and disadvantages of each alternative are assessed in order to select a preferred alternative for CAU 453. Table 3-1 presents a summary of the detailed analysis of the alternatives. Table 3-2 presents the comparative analysis of alternatives. Cost estimate details are provided in Appendix B as developed by Bechtel Nevada.

Table 3-1
Detailed Evaluation of Alternatives
(Page 1 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place by Administrative Controls	Alternative 3 Closure in Place by Capping	Alternative 4 Clean Closure by Removal
Closure Standards				
Protection of Human Health and the Environment	• No COCs identified • UXO in landfill • Does not meet corrective action objective of preventing inadvertent intrusion into solid waste and potential UXO • No worker exposure associated with implementation	• No COCs identified • Meets corrective action objectives • Prevents inadvertent intrusion to landfill • No worker exposure associated with implementation • Low risk to public because of remote location and controlled access to the TTR	• No COCs identified • Meets corrective action objectives • Prevents inadvertent intrusion • Cover maintenance ensures integrity • High risk to workers during implementation because of potential for disturbance of live UXO • Low risk to public because of remote location and controlled access to the TTR	• No COCs identified • Meets corrective action objectives • Potentially, very high risk to workers associated with UXO removal and detonation • Low risk to public because of remote location and controlled access to the TTR
Compliance with Media Cleanup Standards	Complies with media cleanup standards because no COCs were identified	Complies with media cleanup standards	Complies with media cleanup standards	Complies with media cleanup standards
Control the Source(s) of Release	• No COCs identified below the landfill cells • No indication of migration of contaminants below the cells • Hazardous materials not expected in cells based on process knowledge	• No COCs identified below the landfill cells • No indication of migration of contaminants below the cells • Contaminants of concern not expected in cells based on process knowledge	• No COCs identified below the landfill cells • No indication of migration of contaminants below the cells • Hazardous materials not expected in cells based on process knowledge • Cap limits infiltration • Cap maintenance ensures integrity	• No COCs identified below the landfill cells • No indication of migration of contaminants below the cells • Hazardous materials not expected in cells based on process knowledge • Solid waste and UXO removed
Comply with Applicable Federal, State, and Local Standards for Waste Management	No waste generated	• No waste generated • Minor construction debris and sanitary waste may be generated by fencing activities.	• No waste generated • Minor construction debris and sanitary waste may be generated by fencing activities.	• Significant volume of waste generated • Will be handled and disposed of per applicable standards

Table 3-1
Detailed Evaluation of Alternatives
(Page 2 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place by Administrative Controls	Alternative 3 Closure in Place by Capping	Alternative 4 Clean Closure by Removal
Remedy Selection Decision Factors				
Short-Term Reliability and Effectiveness	Not evaluated	• Minimal impacts to workers during implementation; associated only with construction of fence and installation of signs • Public protected by remote location and TTR site access controls	• Potential for worker risk associated with construction of engineered cap over UXO • Public protected by remote location and TTR site access controls	• High risk to workers associated with removal of UXO • Potential for detonation during removal • May require controlled detonation for disposal • Public protected by remote location and TTR site access controls
Reduction of Toxicity, Mobility, and/or Volume	Not evaluated	• No COCs identified under cells; no hazardous materials expected in cells based on process knowledge • No evidence of migration of contaminants beneath cells • Volume of solid waste not reduced	• No COCs identified under cells; no hazardous materials expected in cells based on process knowledge • No evidence of migration of contaminants beneath cells • Cap limits infiltration and subsequent migration; maintenance ensures cap integrity • Volume of solid waste not reduced	• No COCs identified under cells; no hazardous materials expected in cells based on process knowledge • No evidence of migration of contaminants beneath cells • Volume would be reduced by segregating the wastes and recycling recyclable materials • Live UXO would be rendered inert on site
Long-Term Reliability and Effectiveness	Not evaluated	• Controls inadvertent intrusion • Maintenance of fence required	• Controls inadvertent intrusion • Maintenance of cap required • Maintenance of fence required	• All risk will be eliminated upon completion. • No maintenance required

Table 3-1
Detailed Evaluation of Alternatives
(Page 3 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place by Administrative Controls	Alternative 3 Closure in Place by Capping	Alternative 4 Clean Closure by Removal
Feasibility	Not evaluated	• Easily implementable • Coordination of all entities is necessary to ensure compliance	• Suitable capping material and installation method will have to be identified • Hazards associated with construction of cap over UXO • Coordination of all entities is necessary to ensure compliance with administrative controls to prevent intrusion into the cells.	• May require piece-by-piece removal or remote control equipment • Very slow process with potential for high risk • Availability of remote control equipment for use at site is uncertain. • Will require specially skilled workers to handle UXO • May require detonation of UXO
Cost	$94,464	$230,396	$463,564	$2,796,430

Table 3-2
Comparative Evaluation of Alternatives

Evaluation Criteria	Comparative Evaluation
Closure Standards	
Protection of Human Health Environment	Alternatives 2, 3, and 4 meet corrective action objectives; Alternative 1 does not. Worker exposure to risks increases from no risk associated with Alternative 1, to minor risk associated with Alternative 2, to high risk associated with Alternative 3, to very high risk associated with Alternative 4. Protection of waters of the state from COCs is not an issue because COCs above preliminary action levels were not identified.
Compliance with Media Cleanup Standards	All alternatives comply with media cleanup standards.
Control the Source(s) of the Release	Alternatives 3 and 4 would most effectively control the source of a release; however, the presence of a source was not identified.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Alternative 1 does not generate any waste. Alternatives 2 and 3 would generate minor construction debris and sanitary waste during fencing activities. Alternative 4 generates significant amounts of waste. All waste will be managed and disposed per applicable standards.
Remedy Selection Decision Factors	
Short-Term Reliability and Effectiveness	Worker exposure to risks increases from minor risk associated with Alternative 2, to high risk associated with Alternative 3, to very high risk associated with Alternative 4.
Reduction of Toxicity, Mobility, and/or Volume	Alternative 3 results in a reduction of mobility of any potential COCs by capping. Alternative 4 reduces all three parameters by removal from the site.
Long-Term Reliability and Effectiveness	Residual risk for all alternatives is low. Alternatives 2 and 3 require some maintenance over time.
Feasibility	Alternatives 2 and 3 are feasible; for Alternative 3 a suitable capping material and construction methods must be identified prior to construction. Alternative 4 requires disposal capacity and availability for significant volumes of waste. Alternative 4 may also require equipment and personnel that may be difficult to obtain.
Cost	The cost for Alternative 1 is $94,464 to backfill the open portion of Cell A9-1 and grade it to minimize surface depressions. The cost for Alternative 2 is $230,396 for implementation of administrative controls. Alternative 3 is estimated to cost $463,564 for construction of a cap. Uncertainties include the type of capping material and construction of a test cap section. The cost for Alternative 4 is $2,796,430 for removal and disposal of UXO and other construction debris.

4.0 Recommended Alternative

Based on the results of the detailed and comparative analysis of the potential corrective action alternatives presented in this document, the preferred corrective action alternative selected for implementation at CAU 453 is Alternative 2, Closure in Place by Administrative Controls. Alternative 2 was chosen for the following reasons:

- No COCs were identified in the soils beneath the landfill; no hazardous materials are known to have been disposed in the landfill.
- Short-term risks to workers are minimal and considerably lower than for the capping and removal alternatives.
- Long-term risks are minimized by controlling access to the site.
- Only minimal construction debris and sanitary waste will be generated during fencing activities.
- It is easily implementable using existing resources and technologies with minimal disturbances to surrounding areas.
- It provides the most cost-effective method for achieving protection and for meeting closure requirements.

The preferred corrective action alternative was evaluated on its technical merits, focusing on performance, reliability, feasibility, and safety. During corrective action implementation, this alternative will present minimal potential threat to site workers. However, appropriate health and safety procedures will be developed and implemented. The alternative was judged to meet all requirements for the technical components evaluated. The alternative meets all applicable state and federal regulations for closure of the site and will reduce potential future exposure pathways to the contents of the landfills.

The future use of any land related to this CAU, as described by this CADD, is restricted from any activity that may alter or modify the containment control as approved by the State and identified in the CAU Closure Report or other CAU documentation unless appropriate concurrence is obtained in advance.

5.0 References

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Appendix A

Corrective Action Investigation Report for CAU 453: Area 9 UXO Landfill, Tonopah Test Range

A.1.0 Introduction

The report contained in this appendix presents the investigation activities and analytical results from the corrective action investigation conducted at the three individual landfill cells which comprise the Area 9 Unexploded Ordnance (UXO) Landfill, Corrective Action Unit (CAU) 453. The CAU 453 consists of a single Corrective Action Site (CAS), Number 09-55-001-0952. The cells are referred to as Cells A9-1, A9-2, and A9-3 as presented in Table 3-1 of the *Corrective Action Unit Work Plan, Tonopah Test Range, Nevada* (DOE/NV, 1996a) (hereafter referred to as the TTR Work Plan). The corrective action investigation was conducted in accordance with the requirements set forth in the *Corrective Action Investigation Plan for CAU No 453: Area 9 Landfill, Tonopah Test Range* (DOE/NV, 1997a) as developed under the *Federal Facility Agreement and Consent Order* (FFACO, 1996).

The CAU is located in Area 9 of the Tonopah Test Range (TTR), Nye County, Nevada (see Figure 1-1 and Figure 1-2 of the Corrective Action Decision Document). The landfill cells associated with CAU 453 were excavated to receive waste generated from daily operations conducted at Area 9 and from range cleanups which occurred after weapons testing activities (DOE/NV, 1996a). The landfill cells were operated during different time intervals spanning from the early 1960s (Karas, 1993) to approximately 1993 (DOE/NV, 1997a). Process knowledge regarding the contents of the cells is limited due to the unregulated disposal practices commonly associated with early landfill operations (DOE/NV, 1997a).

Additional information relating to the site history, planning, and scope of the investigation is presented in the *Corrective Action Investigation Plan for CAU No. 453: Area 9 Landfill, Tonopah Test Range* (DOE/NV, 1997a) and the TTR Work Plan (DOE/NV, 1996a) and is not repeated in this report.

A.1.1 Project Objectives

The primary objectives for this project were to identify the vertical and lateral extent of possible contaminant migration from the landfill cells, to ascertain the potential impact to human health and

the environment, and to provide sufficient information and data to develop appropriate corrective action alternatives for the landfill.

As part of the Data Quality Objectives (DQO) process outlined in the CAIP (DOE/NV, 1997a), potential routes of migration for possible contaminant sources within the landfill cells were proposed. The soil surrounding the cells was investigated by conducting a subsurface drilling program and by collecting environmental samples for both field screening and laboratory analysis. To optimize the sampling program, the drilling locations were selected based on geophysical results indicating the depth and areal extent of the cells. Because of the potential for live UXO in the cells, no drilling or sampling was conducted within the cells. The following tasks were performed to meet project objectives:

- Conducted borehole geophysical and surface seismic surveys to determine the depths of landfill cells
- Drilled angle (slant) boreholes to investigate soils beneath landfill cells
- Drilled vertical boreholes in undisturbed areas to obtain background data
- Field screened unsaturated soils beneath landfill cells
- Collected environmental samples for laboratory and geotechnical analysis

Eleven slant boreholes were drilled at the three landfill cells to investigate the subsurface soils. Three vertical boreholes were drilled in the undisturbed area surrounding the landfill for background data. Hollow-stem auger drilling methods were used for sample collection. Soil samples were collected from specified core intervals for laboratory- and field-screening analyses, as well as for detailed field observations and lithologic description of the subsurface soil conditions.

A.1.2 Report Content

This corrective action investigation report is intended to provide information and data in sufficient detail to support the selection of one of the preferred corrective action alternatives in the CADD. The contents of this report are as follows:

- Section A.1.0 describes the investigation background, objectives, and the report content.
- Section A.2.0 provides information regarding the field activities and sampling method.
- Section A.3.0 summarizes the results of the laboratory analysis from the investigation sampling.

- Section A.4.0 discusses the quality assurance (QA) and quality control (QC) procedures that were followed as well as the results of the QA/QC activities.

- Section A.5.0 is a summary of the significant results pertaining to the Area 9 Landfill corrective action investigation program.

- Section A.6.0 cites the references.

- Attachment 1 includes the soil boring logs and information pertinent to the corrective action decision process.

To make this report a concise summary, the complete field documentation and laboratory data, including Field Activity Daily Logs, Sample Collection Logs, Analysis Request/Chain-of-Custody Forms, soil sample descriptions, laboratory certificates of analyses, analytical results, and surveillance results are not contained in this report. These documents are retained in project files as both hard copy files and electronic media and will be supplied upon request.

A.2.0 Field Investigation and Sampling Activities

Field investigation and sampling activities were divided into two separate phases. Because live UXO may exist within the landfill cells, the first phase of the field investigation involved determining the depths of the landfill cells in order to safely drill beneath the cells. Two geophysical surveys were performed by the University of Nevada, Las Vegas Department of Civil and Environmental Engineering and Bechtel Nevada and Powder River Geophysical from June 23 to June 25, 1997, and from July 21 to July 31, 1997, respectively. The second phase of the investigation activities involved drilling background and slant borings from August 11 to August 21, 1997, to collect environmental and geotechnical samples. The primary elements of the field investigations and sampling program included:

- Conducting a nonintrusive seismic measurement technique called the Spectral Analysis of Surface Waves (SASW) method to determine depth of the cells
- Drilling 14 vertical borings along the sides of the trenches to run Ground Penetrating Radar Borehole Tomography in two phases across each cell as well as in the area between the cells to determine the cell depths
- Drilling three background vertical boreholes and eleven slant investigation boreholes
- Conducting continuous field screening for total petroleum hydrocarbons (TPH), radiological constituents, and volatile organic compounds (VOCs)
- Collecting environmental samples for laboratory analysis
- Collecting soil samples directly beneath the landfill cells for geotechnical analysis
- Logging the soil cuttings to assess soil characteristics

The investigation and sampling program was managed in accordance with the requirements set forth in the CAIP (DOE/NV, 1997a). The field activities were performed in accordance with an approved Site-Specific Health and Safety Plan (IT, 1997b). The samples were collected and documented by following approved sampling, field activity documentation, sample collection documentation, decontamination, chain of custody, shipping, and radiation screening protocols, procedures, and field sampling instructions as indicated in the CAIP (DOE/NV, 1997a). Quality control samples (e.g., field blanks, rinsate blanks, trip blanks, and sample duplicates) were collected as required by the

Industrial Sites Quality Assurance Project Plan (QAPP) (DOE/NV, 1996b) and approved procedures (IT, 1993). During field activities, waste minimization practices were followed according to approved contractor procedures, including segregation of the waste from the two investigation phases and from each cell, segregation of suspected contaminated items from suspected uncontaminated items, and separation of personal protective equipment into bags (DOE/NV, 1995).

A.2.1 Site Description and Conditions

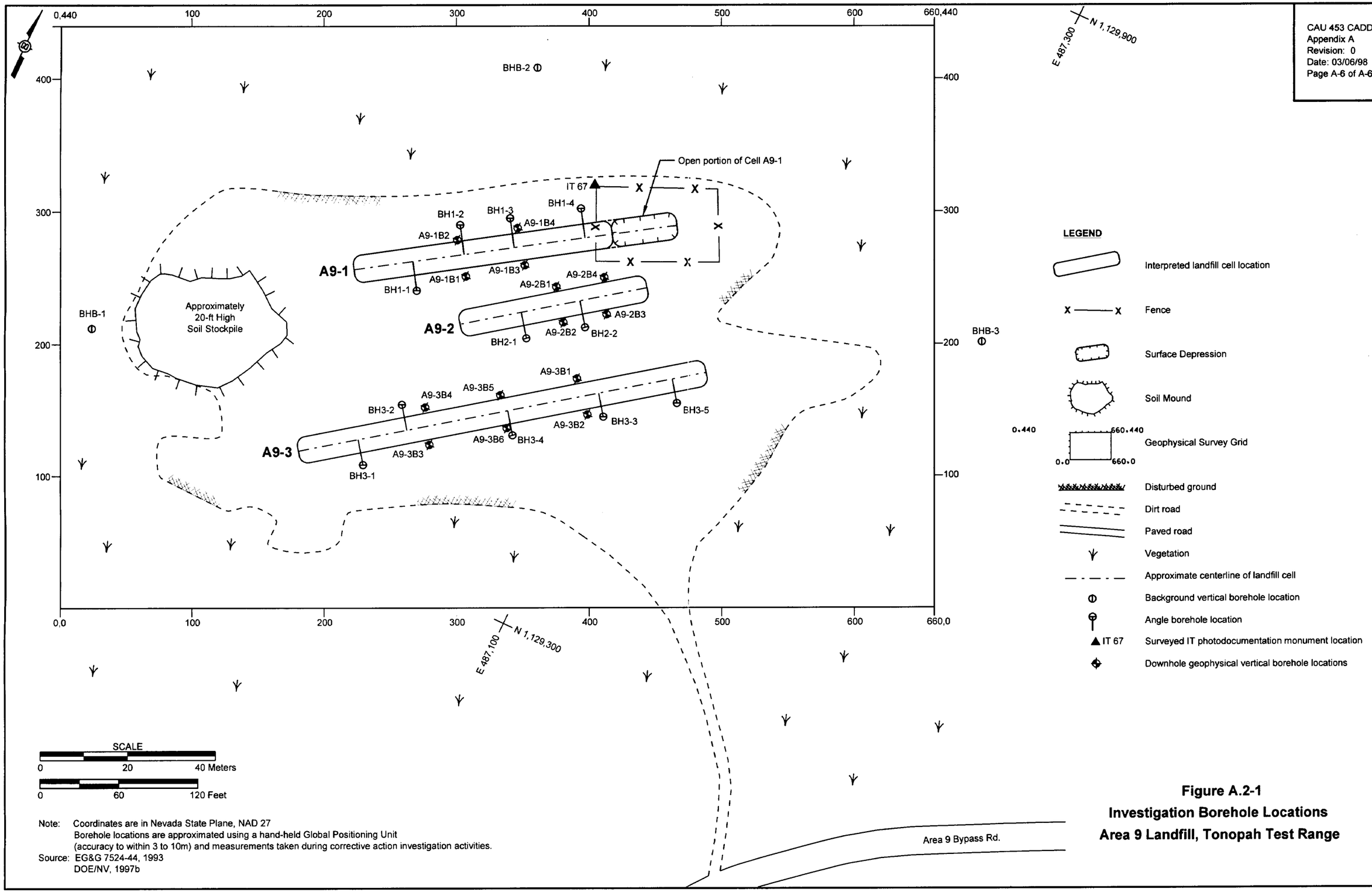
The Area 9 Landfill is located along the Area 9 Bypass road northwest of Area 9 on the TTR. The locations of the landfill cells were approximated from information obtained from results of a surface geophysical study performed in 1993 (DOE/NV, 1997b), interviews with former and current employees, and historical aerial photographs (DOE/NV, 1997a).

A.2.2 Geophysical Activities

The SASW method was conducted by personnel from the University of Nevada, Las Vegas Department of Civil and Environmental Engineering. The SASW method consisted of seismic surface wave measurements collected at the three landfill cells and one undisturbed site near the landfill. Bechtel Nevada and Powder River Geophysical performed a Ground Penetrating Radar Borehole Tomography survey. This required fourteen vertical boreholes to be drilled in the native soil along the north and south sides of each landfill cell to a minimum vertical depth of 13.7 m (45 ft) (see Figure A.2-1). Based on the results of both studies, the maximum depths of Cells A9-1, A9-2, and A9-3 were determined to be approximately 3.0, 2.7, and 2.0 m (9.8, 8.8, and 6.6 ft), respectively, from ground surface. The average shear velocity of the caps ranged from 100 to 150 meters per second, and the thickness ranged from 0.2 to 0.3 m (0.6 to 1.0 ft). The upper surface of the landfill covers was loose and unconsolidated, with the exception of the center portion of Cell A9-1, which had a hard crust, likely due to natural cementation (Luke et al., 1997).

A.2.3 Sampling Logistics

This section describes the boring locations and sample collection activities for the Area 9 Landfill corrective action investigation.



Note: Coordinates are in Nevada State Plane, NAD 27
Borehole locations are approximated using a hand-held Global Positioning Unit
(accuracy to within 3 to 10m) and measurements taken during corrective action investigation activities.
Source: EG&G 7524-44, 1993
DOE/NV, 1997b

Figure A.2-1
Investigation Borehole Locations
Area 9 Landfill, Tonopah Test Range

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area9

A.2.3.1 Drilling

The hollow-stem auger method was selected to directionally advance the drill holes beneath the landfill cells. Three vertical background borings and eleven directional investigation borings were drilled from ground surface. The three background borings were each drilled to 7.6 m (25 ft) below ground surface (bgs) (Figure A.2-1). The eleven directional investigation borings were drilled at a 45-degree angle to a minimum depth at which the borehole intersected the center line of each cell beneath the landfill cells (Figure A.2-2). The borehole locations are shown on Figure A.2-1.

A.2.3.2 Field Screening

Field-screening methods were used to collect semiqualitative data and to determine if drilling should continue deeper than the established minimum angle depth of investigation (Figure A.2-2). Field screening was performed at 1.5-m (5-ft) intervals from ground surface for all boreholes including those drilled for the downhole geophysical activities. The screening methods included:

- Radiological screening for alpha and beta/gamma radiation using an Electra and a Ludlum Model l19 instrument
- Headspace screening for VOCs using a Photoionization Detector
- TPH screening using the Hanby field testing kit manufactured by Hanby Environmental Laboratory Procedures, Inc. (phase two investigation activities only)

The field-screening results recorded at the background borehole locations were designated as "background" levels and used as a baseline for investigation sampling. The background levels established by the VOC field screening fluctuated between 0 and 2.8 parts per million (ppm). There was no TPH detected at the background borings. The background level for alpha radiation detected from the core and headspace samples was 0 disintegrations per minute (dpm). Background levels for beta radiation fluctuated around 950 dpm; background levels from gamma radiation fluctuated around 20 microroentgens per hour (µR/hr).

The preliminary action level for TPH field-screening results was established at 100 ppm in accordance with the Nevada Division of Environmental Protection screening levels for TPH (NAC, 1996). The preliminary action level for VOC field-screening results was determined to be 20 ppm or 2.5 times background, whichever was higher. The preliminary action level for radiation

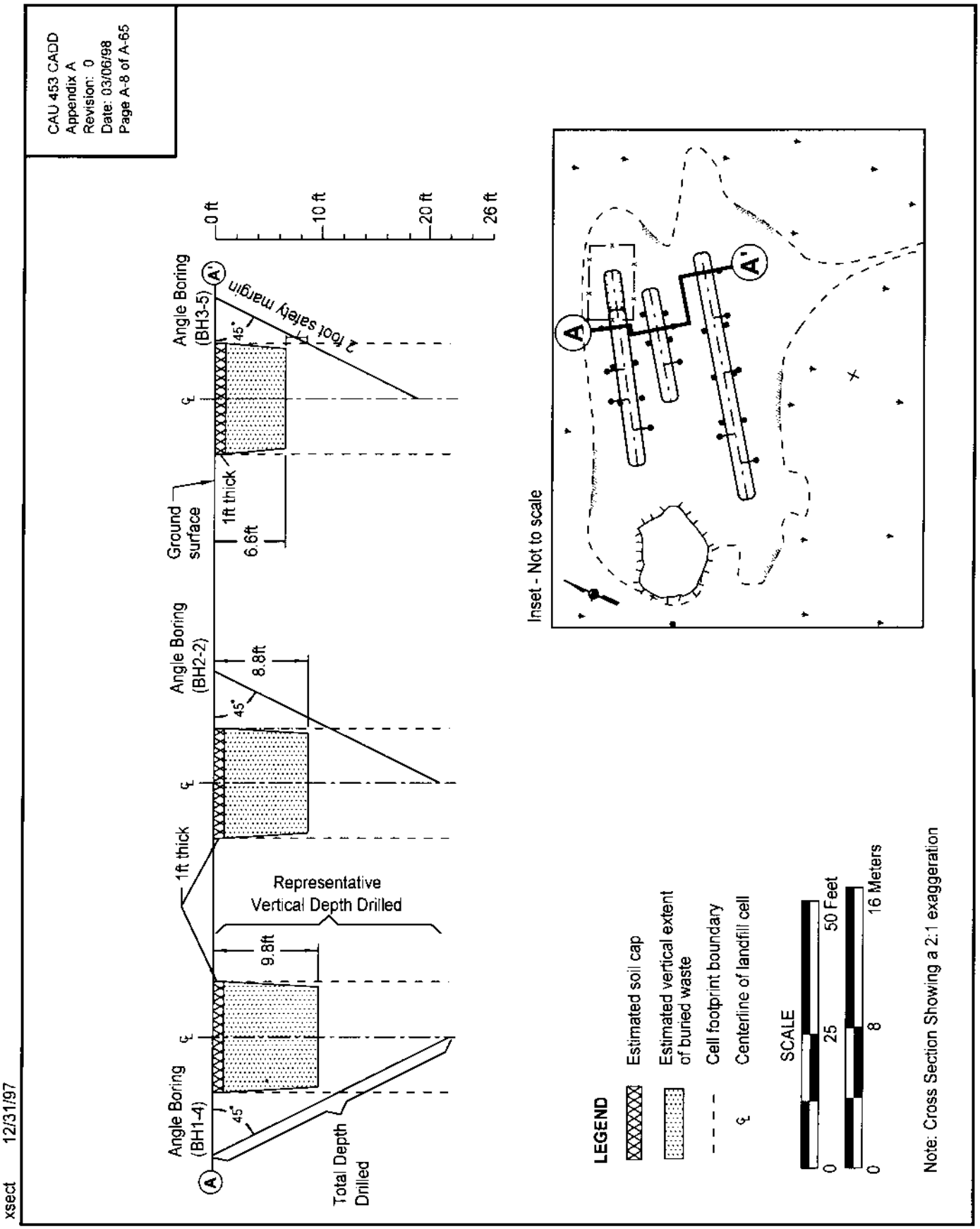

Figure A.2-2
Cross-Sectional Schematic of the
Area 9 Landfill Cells with Angle Boreholes

monitoring results was established at two times background levels (DOE/NV, 1997a). Field-screening preliminary action levels were established to guide the advancement of the borehole and to provide a basis for collecting unplanned environmental samples or drilling additional boreholes.

A.2.3.3 Sample Collection

Samples were collected beginning at the bottom depth of the landfill cell and continued to a minimum depth at which the boreholes intersected the center line beneath the landfill cells (Figure A.2-3). Soil samples were collected for laboratory and geotechnical analysis using a stainless steel, 0.6-m (2-ft) long, California Modified split-barrel ("split-spoon") sampler fitted with 1.1-centimeter (cm) (3-inch [in.]) brass sleeves for sample retention. The content of the split-spoon sampler was field screened for alpha and beta/gamma radiological contamination and VOC contamination prior to sample aliquot collection. Sample collection followed the procedures specified in the CAIP (DOE/NV, 1997a).

Upon sample collection, sample labels preprinted with the sample number, sample collection date/time, chain-of-custody number, sampling team members, container preservative, medium type, and requested analysis were attached to each of the sample containers. Each sample container was then sealed with custody tape, wrapped in protective bubble wrap (if applicable), placed into a Ziploc™ bag, and placed in an iced cooler with a trip blank (if applicable).

A.2.3.4 Background Boreholes

Three vertical boreholes were drilled at undisturbed locations near the Area 9 Landfill (Figure A.2-1) to assess the background variability of radiological and inorganic parameters. Background field-screening results for TPH, VOCs, and radiological levels were collected along with analytical samples for total *Resource Conservation and Recovery Act* (RCRA) metals and radiological parameters. Field-screening was performed every 1.5 m (5 ft). Soil samples were collected for laboratory analysis from 3.0 and 4.6 m (10 and 15 ft) below ground surface (bgs). Samples were collected at these depths to represent background levels at and below the anticipated cell depths. Sample numbers TTR00779 through TTR00784 are associated with the subsurface background investigation. Geologic field descriptions were performed by the field geologist and recorded on a Visual Classification of Soil Log (Attachment 1).

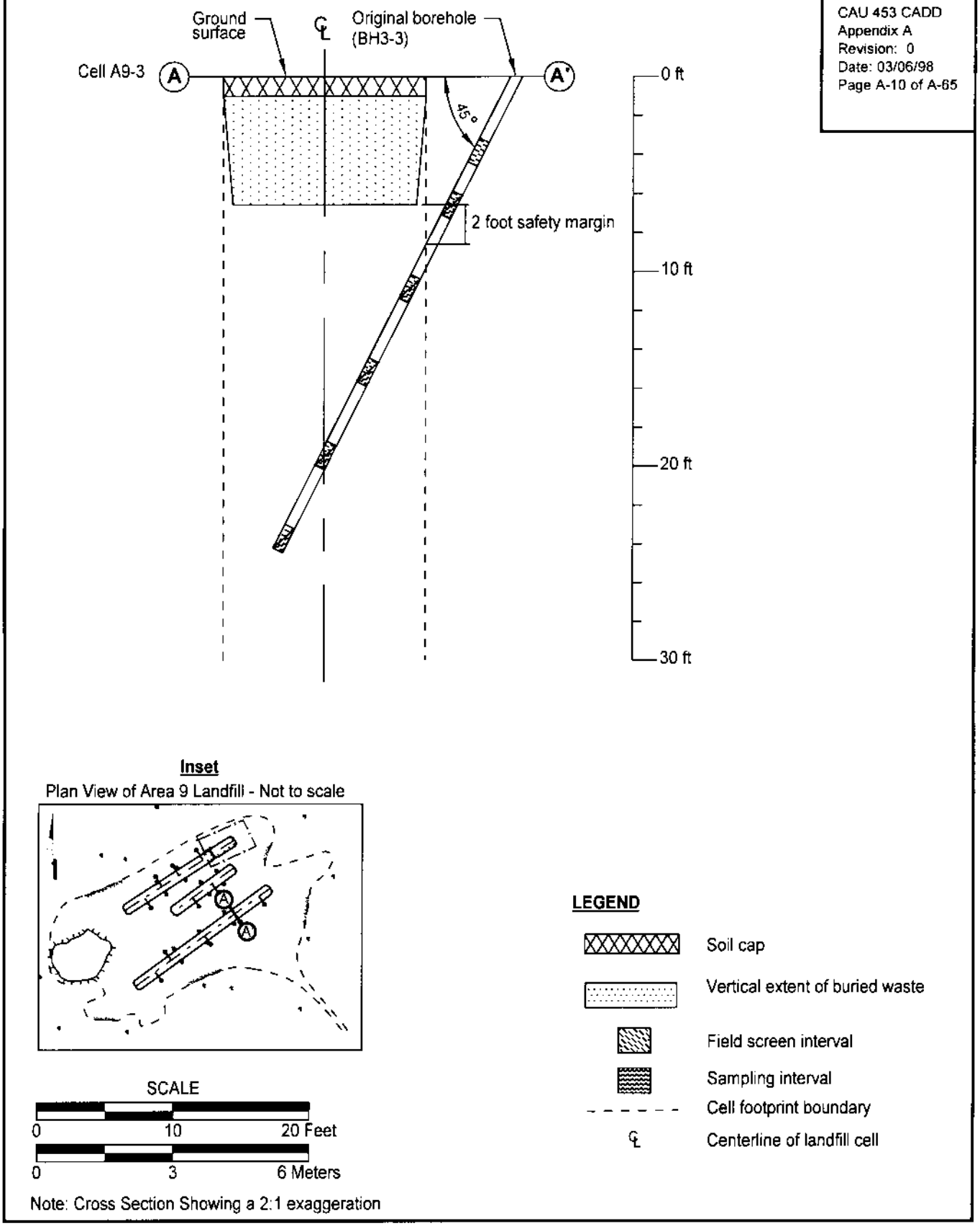

Figure A.2-3
Conceptual Schematic of Angle Borehole and Sample Collection at the Area 9 Landfill, Tonopah Test Range

A.2.3.5 Landfill Cell A9-1

Landfill Cell A9-1 is the youngest of the three landfill cells and was operational between 1986 and 1993 (DOE/NV, 1997a). In 1995 a voluntary cleanup of the contents of the open portion of Cell A9-1 was performed by IT Corporation. Contamination was not observed within the open portion (DOE/NV, 1997a). Four directional boreholes (borehole numbers BH1-1 to BH1-4) were drilled to investigate the soil beneath this cell (Figure A.2-1). Each boring was drilled at a 45-degree angle beneath the cell to a minimum vertical depth of 7.6-m (25-ft) bgs (Figure A.2-2). Borings BH1-2, BH1-3, and BH1-4 were drilled from the northwest side of the cell. Boring BH1-1 was drilled from the southeast side of the cell. Eighteen soil samples were collected from beneath the cell. Sample numbers TTR00819 through TTR00842, including quality control samples, are associated with the subsurface investigation.

A.2.3.6 Landfill Cell A9-2

Landfill Cell A9-2 was believed to be operational after the close of Cell A9-3 between 1986 and 1988, prior to the opening of Cell A9-1 (DOE/NV, 1997a). Two boreholes (borehole numbers BH2-1 and BH2-2) were drilled to investigate this cell (Figure A.2-1). Each boring was drilled at a 45-degree angle beneath the cell to a minimum vertical depth of 7.6-m (25-ft) bgs (Figure A.2-2). Borings were drilled from the southeast side of the cell. Ten soil samples were collected from beneath the cell. Two contigency boreholes located on the northwest and the southeast sides of the cell were not drilled because the field screening results from BH2-1 and BH2-2 indicated no contamination. Sample numbers TTR00843 through TTR00855, including quality control samples, are associated with the subsurface investigation.

A.2.3.7 Landfill Cell A9-3

Landfill Cell A9-3 was the first operational cell and is believed to have been in use in the early 1960s and closed between 1986 and 1988 (DOE/NV, 1997a). Five boreholes (borehole numbers BH3-1 to BH3-5) were drilled to investigate this cell (Figure A.2-1). Each boring was drilled at a 45-degree angle beneath the cell to a minimum vertical depth of 7.6-m (25-ft) bgs (Figure A.2-2). Borings BH3-1, BH3-3, BH3-4, and BH3-5 were drilled from the southeast side of the cell. Boring BH3-2 was drilled from the northwest side of the cell. Twenty-six soil samples were collected from

beneath Cell A9-3. Ten quality control (liquid) samples were collected during investigation activities at cell A9-3. Sample numbers TTR00777, TTR00778, and TTR00785 through TTR00818, including quality control samples, are associated with this subsurface investigation.

A.2.4 Geology

The Area 9 Landfill is located on Cactus Flat within TTR. Cactus Flat is a northwest-southeast elongated, closed basin bounded by exposed Tertiary volcanics. The Area 9 Landfill is located upon a layer of alluvial sediments greater than 200 m (700 ft) thick which is underlain by Tertiary volcanics (Ekren et al., 1971). Surface deposits consist of well-sorted, moderately consolidated alluvial silty sands with gravel and cobble sized volcanic detritus. The soils are typical of lake and shoreline deposits found at the TTR and are associated with the Main Lake playa located to the southwest of the landfill cells. Field descriptions were performed by the field geologist for each boring and recorded on a Visual Classification of Soil Log (Attachment 1). Cell contents were not investigated because of the potential for live UXO. The strata encountered below each cell are summarized below:

- Cell A9-1
  Grades from an unconsolidated, slightly moist to dry, silty sand to a well-sorted, loose sand. Gravel becomes prevalent beneath the cell.

- Cell A9-2
  Grades from an unconsolidated, slightly moist, silty sand to a well-sorted, loose sand

- Cell A9-3
  Grades from an unconsolidated, dry, silty sand to a well-sorted, loose sand. Lens of well-graded gravel were encountered in the center borings.

A.2.5 Hydrology

The Area 9 Landfill lies within an internally drained valley delineated as the Cactus Flat Hydrographic Basin. The overall surface of the Area 9 Landfill is flat, but has a gentle drainage direction to the west. The depth to water in Area 9 is approximately 40 m (131 ft) (DOE/NV, 1996a). No perched water was found around the landfill cells. Groundwater flow within the basin is generally to the west/northwest.

A.3.0 Investigation Results

The analytical results of samples collected from the Area 9 Landfill CAU have been compiled and evaluated to determine the presence and/or extent of contamination. The analytical results are summarized in the following subsections. The complete laboratory result data packages are available in the project files.

During the investigation activities, 57 soil samples and 19 liquid samples were collected and sent in for laboratory analysis. Three soil samples were sent in for geotechnical analysis. A list of the sample numbers (including field duplicate and other quality control samples) and their relationship to the boreholes is presented in Table A.3-1. The analytical parameters and laboratory analytical methods requested for this investigation are presented in Table A.3-2. The analytical parameters were selected through the application of site process knowledge according to the U.S. Environmental Protection Agency's (EPA) *Guidance for the Data Quality Objectives Process* (EPA, 1994a). Preliminary action levels for off-site laboratory analytical methods were determined during the DQO process and are based on the EPA Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a) for chemical parameters and either background levels or levels listed in the Offsite Radiation E*xposure Review Project (ORERP) Phase II Soil Program* report (McArthur and Miller, 1989) for radiological constituents. The results of the DQO process are documented in the CAIP (DOE/NV, 1997a) with the remainder of the documentation retained in the project files. Sampling activities were conducted to either confirm or disprove the speculations made in the DQO process. Samples collected from Area 9 Landfill were analyzed by Quanterra Environmental Services in St. Louis, MO, with the exception of the nitroaromatic and nitroamine samples. These samples were analyzed by Quanterra Environmental Services in Knoxville, TN. The geotechnical samples were analyzed by Converse Consultants Southwest, Inc., in Las Vegas, Nevada.

A.3.1 Total Volatile Organic Compound Analytical Results

The total VOC analytical results above method detection limits, along with the associated preliminary action levels, are presented in Table A.3-3 Scrutiny of the laboratory data indicates that constituents were either not present above the method detection limits or, if present, were present below the preliminary action levels. Low levels of acetone and methylene chloride were detected above method

Table A.3-1
Samples Collected During the Area 9 UXO Landfill Corrective Action Investigation Activities
(Page 1 of 2)

Borehole Number	Sample Number	Sample Depth[a](feet)	Sample Type
Cell A9-1			
	TTR00820	NA	Trip Blank
	TTR00825	NA	Equipment Rinsate Blank
	TTR00826	NA	Trip Blank
	TTR00831	NA	Trip Blank
	TTR00841	NA	Field Blank
	TTR00842	NA	Trip Blank
BH1-1	TTR00819	29	Soil
	TTR00821	34	Soil
	TTR00822	34	Duplicate of TTR00821
	TTR00823	39	Soil
	TTR00824	44	Soil
BH1-2	TTR00827	30	MS/MSD
	TTR00828	35	Soil
	TTR00829	39	Soil
	TTR00830	44	Soil
BH1-3	TTR00832	29	Soil
	TTR00833	34	Soil
	TTR00834	39	Soil
	TTR00835	44	Soil
BH1-4	TTR00836	29	Soil
	TTR00837	32	Geotechnical
	TTR00838	34	Soil
	TTR00839	39	Soil
	TTR00840	44	Soil
Cell A9-2			
	TTR00843	NA	Trip Blank
	TTR00850	NA	Trip Blank
	TTR00851	NA	Equipment Rinsate Blank
BH2-1	TTR00852	29	MS/MSD
	TTR00853	34	Soil
	TTR00854	39	Soil
BH2-1	TTR00855	44	Soil
BH2-2	TTR00844	29	Soil
	TTR00845	32	Geotechnical
	TTR00846	34	Soil
	TTR00847	34	Duplicate of TTR00846
	TTR00848	39	Soil
	TTR00849	42	Soil
Cell A9-3			
	TTR00777	NA	Trip Blank
	TTR00778	NA	Trip Blank
	TTR00786	NA	Trip Blank
	TTR00787	NA	Field Blank
	TTR00792	NA	Equipment Rinsate Blank
	TTR00793	NA	Trip Blank
	TTR00809	NA	Trip Blank
	TTR00810	NA	Trip Blank
	TTR00811	NA	Trip Blank
	TTR00812	NA	Trip Blank
BH3-1	TTR00794	20	Soil
	TTR00795	25	MS/MSD
	TTR00796	30	Soil
	TTR00797	35	Soil
	TTR00798	40	Soil
BH3-2	TTR00799	20	Soil
	TTR00800	20	Duplicate of TTR00799
	TTR00801	25	Soil
	TTR00802	30	Soil
	TTR00803	40	Soil
BH3-3	TTR00804	20	Soil
	TTR00805	25	Soil
	TTR00806	30	Soil
	TTR00807	35	Soil

Table A.3-1
Samples Collected During the Area 9 UXO Landfill
Corrective Action Investigation Activities
(Page 2 of 2)

Borehole Number	Sample Number	Sample Depth[a](feet)	Sample Type
Cell A9-3			
BH3-3	TTR00808	40	Soil
BH3-4	TTR00785	20	Soil
	TTR00788	25	Soil
	TTR00789	30	Soil
	TTR00790	35	Soil
	TTR00791	40	Soil
BH3-5	TTR00813	20	Soil
	TTR00814	22	Geotechnical
	TTR00815	25	Soil
BH3-5	TTR00816	30	Soil
	TTR00817	35	Soil
	TTR00818	40	Soil
Background Borings			
BH-B1	TTR00779	10 TVD	Soil
	TTR00780	15 TVD	Soil
BH-B2	TTR00781	10 TVD	Soil
	TTR00782	15 TVD	Soil
BH-B3	TTR00783	10 TVD	Soil
	TTR00784	15 TVD	Soil

[a]Measured drilling depth

MS/MSD = Matrix Spike/Matrix Spike Duplicate
TVD = True vertical depth
NA = Not applicable

detection levels, but below the preliminary action levels. These samples do not correspond to any other elevated constituents detected during this investigation. These constituents are common laboratory contaminants. An indication of laboratory contamination was an acetone detect of 140 micrograms per kilogram (µg/kg) (sample number TTR00779) collected from background boring BHB-1. Chloromethane was detected at 10 and 13 µg/kg in sample numbers TTR00810 (a trip blank) and TTR00823, respectively. The toluene detects, each at the method detection limit of 5 µg/kg, were detected in samples TTR00783 (a background sample), TTR00790, and TTR00795. Both the chloromethane and toluene detects were well below the preliminary action levels (EPA, 1996a).

A.3.2 Total Semivolatile Organic Compound Analytical Results

Elevated levels of bis(2-ethylhexyl)phthalate were detected in sample numbers TTR00821, TTR00822, and TTR00827 at 630, 1700, and 360 µg/kg, respectively. None of these levels exceed the preliminary action level of 140,000 µg/kg parameters (EPA, 1996a). Bis(2-ethylhexyl)phthalate is recognized as a common laboratory contaminant.

Table A.3-2
Laboratory Analytical Methods Used for
Area 9 UXO Landfill Investigation Samples

Analytical Parameter	Analytical Method
Total volatile organic compounds	EPA 8260[a]
Total petroleum hydrocarbons - gasoline and diesel	EPA 8015 (modified)[a]
Total semivolatile organic compounds	EPA 8270[a]
Total nitroaromatics and nitroamines	EPA 8330[a]
Total RCRA metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, and mercury)	EPA 6010/7470[a]
Total polychlorinated biphenyls	EPA 8080[a]
Gamma emitters	HASL 300, 4.5.2.3[b]
Isotopic uranium	NAS-NS-3050[c]
Geotechnical Requirements	**Method**
Initial moisture content	ASTM[d] D 2216
Dry bulk content	EM[e]-110-2-1906
Calculated porosity	EM[e]-110-2-1906
Saturated/unsaturated hydraulic conductivity	ASTM[d] D 5084
Particle-size distribution	ASTM[d] D 422
Water-release (retention) curve	ASTM[d] D 3152

[a] EPA Test Methods for Evaluating Solid Waste, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996b)
[b] *Environmental Measurements Laboratory Procedures Manual*, HASL-300, U.S. Department of Energy (DOE, 1992)
[c] National Academy of Science, Nuclear Science Series, September 1, 1963
[d] *Annual Book of American Society for Testing and Materials* (ASTM) *Standards*, Section 4, "Construction", Volume 04.08, "Soil and Rock (1)", and Volume 04.09, "Soil and Rock (11)", 1996
[e] United States Army Corps of Engineers (USACE), *Engineer Manual* (EM) 1110-2-1906, "Laboratory Soils Testing," Appendix II, 1970

A.3.3 Total Nitroaromatic and Nitroamine Analytical Results

Total nitroaromatic and nitroamine constituents were not detected above method detection levels.

A.3.4 Total Petroleum Hydrocarbon Results

Total Petroleum Hydrocarbons were not detected in the gasoline and diesel ranges above action levels.

Table A.3-3
Soil Sample Results for Total Volatile Organic Compounds Detected Above Method Detection Limits, Area 9 UXO Landfill, TTR

Borehole Number	Sample Number	Sample Depth[a] (feet)	Constituents of Concern in micrograms per kilogram (µg/kg)			
			Acetone	Chloromethane	Methylene Chloride	Toluene
	Preliminary Action Levels (µg/kg) (Industrial Soil PRG)[b]		8,800,000	2,600	18,000	880,000
BH-B1	TTR00779	10	140	--	--	--
BH-B3	TTR00783	10	--	--	--	5
BH3-4	TTR00788	25	34	--	--	--
	TTR00789	30	81	--	--	--
	TTR00790	35	74	--	--	5
	TTR00791	40	180	--	--	--
BH3-1	TTR00795	25	--	--		5
	TTR00798	40	51	--	--	--
BH3-2	TTR00799	20	71	--	--	--
	TTR00800	20	85	--	--	--
	TTR00801	25	110	--	--	--
	TTR00802	30	69	--	--	--
BH3-3	TTR00805	25	--	--	16	--
BH1-1	TTR00821	34	--	--	15	--
	TTR00822	34	--	--	15	--
	TTR00823	39	--	13	12	--
	TTR00824	44	--	--	11	--
BH1-2	TTR00828	25	--	--	8	--
	TTR00829	39	--	--	15	--
	TTR00830	44	--	--	17	--

[a]Measured drilling depth
[b]U.S. Environmental Protection Agency, Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a)

--Not detected above method detection levels.

A.3.5 Total PCB Analytical Results

There were no PCBs detected above method detection limits.

A.3.6 Total RCRA Metals Results

The total RCRA metals detected above the method detection limits are presented in Table A.3-4. The total RCRA metals results were all below the preliminary action levels for the metal constituents except for arsenic (EPA, 1996a). Arsenic was detected above the Industrial PRG (2.4 µg/kg) in many samples; however, arsenic was not detected above the maximum background concentration of 6.8 µg/kg which was detected in background sample TTR00783 collected from BHB-3. Borehole BHB-3 was located approximately 125 m (240 ft) east-southeast of Landfill Cell A9-1. Based on this information, the concentrations of arsenic are believed to be representative of ambient conditions.

A.3.7 Gamma Spectroscopy Results

The gamma spectroscopy results for the TTR Area 9 Landfill soil samples are listed in Table A.3-5. The results demonstrate that the concentration of gamma emitters was not different from background locations. In addition, if the gamma spectroscopy results demonstrated radionuclide concentrations greater than the preliminary action levels, then uranium-specific analysis of the samples would have been performed. All gamma spectroscopy results are below the preliminary action levels established by background sample collection during this investigation and lower than background levels established for the State of Nevada (McArthur and Miller, 1989). As a result, no samples were analyzed for isotopic uranium.

A.3.8 Geotechnical Results

A geotechnical sample was collected for each of the landfill cells: sample TTR00814 from boring BH3-5, TTR00837 from boring BH1-4, and TTR00845 from boring BH2-2. The data were collected to provide input for closure options. The results of the geotechnical observations suggest that the subsurface soil is comprised of a fine silt to clay, comprised mostly of silts. This is typical of alluvial materials found near playas at the TTR. The results of the laboratory analysis of the geotechnical samples are presented in Tables A.3-6 to A.3-8.

Table A.3-4
Soil Sample Results for Total RCRA Metal Constituents Detected Above Method Detection Limits, Area 9 UXO Landfill, TTR

Borehole Number	Sample Number	Sample Depth[a] (feet)	Parameters in milligrams per kilogram			
			Lead	Arsenic	Barium	Chromium
Industrial PRG[b] (mg/kg)			400	2.4	5300	210
BH-B1	TTR00779	10 TVD	5	4.4	90.3	7.2
	TTR00780	15 TVD	2.2	1.5	71.2	2.8
BH-B2	TTR00781	10 TVD	6.9	3.6	121	9.9
	TTR00782	15 TVD	5.4	4	126	6.9
BH-B3	TTR00783	10 TVD	7.7	6.8	108	6.3
	TTR00784	15 TVD	3.7	3.5	112	7
BH3-4	TTR00785	20	3.7	2	84.4	6.9
	TTR00788	25	2.3	1.6	49.2	2.4
	TTR00789	30	4.6	3.2	121	8.9
	TTR00790	35	3.2	3	65.9	2.8
	TTR00791	40	3.6	2.8	90.1	13.3
BH3-1	TTR00794	20	4.6	4.7	67.6	14.3
	TTR00795	25	2.7	2.1	66.8	3.2
	TTR00796	30	3.4	2.2	74.7	7.2
	TTR00797	35	3.9	2.5	88.1	10.1
	TTR00798	40	5.6	2.9	153	5
BH3-2	TTR00799	20	3.6	3.7	69.5	6.6
	TTR00800	20	3.2	3.2	54.6	12.3
	TTR00801	25	2	1.5	49.6	2.5
	TTR00802	30	3.3	2.2	82.5	3.3
	TTR00803	40	3.1	2	80.1	6.5
BH3-3	TTR00804.	20	2.4	1.6	48.3	3.2
	TTR00805	25	4.7	3.2	112	8.4
	TTR00806	30	4.4	3.4	90.6	11.2
	TTR00807	35	3.5	2.3	88.6	3
	TTR00808	40	4.5	2.2	102	6.3
BH3-5	TTR00813	20	4.8	4.3	76.6	7.6
	TTR00815	25	6	3.5	84.5	11
	TTR00816	30	3.2	1.2	100	4.1

Borehole Number	Sample Number	Sample Depth[a] (feet)	Parameters in miligrams per kilogram (mg/kg)			
			Lead	Arsenic	Barium	Chromium
Industrial PRG[b] (mg/kg)			400	2.4	5300	210
BH3-5	TTR00817	35	2.1	2.5	72.9	2.4
	TTR00818	40	7.6	3.4	127	5.4
BH1-1	TTR00819	29	5.9	4.3	73.2	6.1
	TTR00821	34	6.4	4	85	16.1
	TTR00822	34	5.1	2.8	119	5.6
	TTR00823	39	4.2	3	80.9	6.5
	TTR00824	44	5.3	2.9	119	7.2
BH1-2	TTR00827	30	2.1	1.7	39.4	3.2
	TTR00828	35	4.2	3.2	111	6.1
	TTR00829	39	4	2.4	69.3	42.2
	TTR00830	44	3.7	2	85	5.6
BH1-3	TTR00832	29	3.9	4	69.1	7.7
	TTR00833	34	3.6	2.2	98.4	5.9
	TTR00834	39	5.8	2.8	144	4.3
	TTR00835	44	3.9	2.6	83.9	7.5
BH1-4	TTR00836	29	3.7	4.8	55.9	8.7
	TTR00838	34	2.7	2	61.1	3
	TTR00839	39	6.7	1.4	147	14.2
	TTR00840	44	6.6	1.9	120	9.5
BH2-2	TTR00844	29	2.5	1.9	44.5	2.1
	TTR00846	34	4.4	1.6	112	4.2
	TTR00847	34	4.4	1.4	128	6.9
	TTR00848	39	3.8	1.7	93.1	4.8
	TTR00849	44	6.6	1.3	108	12.9
BH2-1	TTR00852	29	4	2.8	89	6.3
	TTR00853	34	1.9	1.6	39.2	5.4
	TTR00854	39	6	1.7	147	5.4
	TTR00855	44	5.8	1.6	137	7.1

[a]Measured drilling depth
[b]U.S. Environmental Protection Agency, Region 9 Preliminary Remediation Goals (PRGs), 1996 (EPA,1996a)

TVD = True vertical depth

Table A.3-5
Gamma Spectroscopy Results Detected Above Method Detection Limits, Soil Sample Results, Area 9 UXO Landfill, TTR
(Page 1 of 2)

Borehole Number	Sample No.	Sample Depth[a] (feet)	Constituents (pCi/g)					
			Lead-210	Lead-212	Lead-214	Potassium-40	Radium-226	Thallium-208
BH-B1	TTR00779	10 TVD	--	1.58±0.46	--	36.0±8.1	--	--
	TTR00780	15 TVD	--	2.20±0.54	1.84±0.65	36.4±8.2	--	--
BH-B2	TTR00781	10 TVD	--	1.8±0.58	--	35.6±8.4	--	0.88±0.33
	TTR00782	15 TVD	--	1.84±0.40	1.31±0.47	33.4±7.7	--	0.67±0.24
BH-B3	TTR00783	10 TVD	--	1.99±0.57	1.56±0.65	34.9±7.7	--	--
BH3-4	TTR00785	20	--	2.21±0.75	--	28.2±7.88	--	--
	TTR00788	25	--	2.65±0.72	--	37.8±8.4		0.72±0.28
	TTR00790	35	--	2.19±0.50	2.00±0.61	30.5±7.42	8.11±4.34	--
	TTR00791	40	--	1.68±0.61	1.95±0.80	35.7±9.3	--	--
BH3-1	TTR00794	20	--	1.84±0.47	0.96±0.45	30.8±7.8	--	0.69±0.28
	TTR00795	25	--	2.18±0.51	1.77±0.57	34.1±8.3	--	0.78±0.35
	TTR00796	30	--	1.58±0.84	1.68±1.04	44.1±10.5	--	--
	TTR00797	35	--	--	--	42.0±11.8	--	--
	TTR00798	40	--	1.47±0.54	1.82±0.62	32.3±7.7	--	--
BH3-2	TTR00799	20	--	2.00±0.51	1.91±0.65	33.0±9.6	--	--
	TTR00800	20	--	3.90±1.48	--	52.1±20.5	--	--
	TTR00801	25	--	2.19±0.56	1.68±0.49	33.8±7.1	--	--
	TTR00802	30	--	--	--	34.6±8.1	--	0.82±0.31
	TTR00803	40	--	2.12±0.49	1.71±0.52	35.0±8.2	--	0.65±0.32
BH3-3	TTR00804	20	--	1.74±0.47	1.32±0.49	30.2±7.4	--	--
	TTR00805	25	--	1.75±0.69	1.86±0.61	33.0±8.2	--	--
	TTR00806	30	--	--	2.43±1.11	36.2±10.0	--	--
	TTR00807	35	--	2.24±0.54	1.86±0.64	35.3±7.3	--	--
	TTR00808	40	--	2.12±0.47	2.08±0.53	27.9±7.66	6.43±2.95	--
BH3-5	TTR00813	20	--	1.74±0.43	--	32.3±8.1	--	--
	TTR00815	25	--	1.71±0.55	1.73±0.76	29.0±7.4	--	--
	TTR00816	30	--	--	--	34.4±9.6	--	--
	TTR00817	35	--	2.07±0.48	1.36±0.48	32.0±6.9	--	--
	TTR00818	40	--	2.12±0.53	1.64±0.64	31.9±8.0	--	0.88±0.35
BH1-1	TTR00819	29	--	--	--	33.4±8.0	--	--
	TTR00821	34	--	1.97±0.55	1.67±0.60	37.1±9.2	--	--
	TTR00822	34	--	1.61±0.61	1.51±0.50	34.9±7.5	--	--
	TTR00823	39	--	--	--	38.4±8.7	--	--
	TTR00824	44	--	2.32±0.56	1.75±0.57	34.6±7.6	--	0.76±0.31
BH1-2	TTR00827	30	--	2.27±0.51	--	31.5±7.3	--	--

Table A.3-5
Gamma Spectroscopy Results Detected Above Method Detection Limits, Soil Sample Results, Area 9 UXO Landfill, TTR
(Page 2 of 2)

Borehole Number	Sample No.	Sample Depth[a] (feet)	Constituents (pCi/g)					
			Lead-210	Lead-212	Lead-214	Potassium-40	Radium-226	Thallium-208
BH1-2	TTR00828	35	--	1.84±0.46	1.60±0.49	24.6±6.3	--	--
	TTR00829	39	--	1.57±0.47	1.25±0.55	34.3±9.0	--	--
	TTR00830	44	--	1.86±0.49	1.46±0.49	38.2±8.0	--	--
BH1-3	TTR00832	29	7.02±3.57	2.57±0.56	1.14±0.50	27.8±7.6	--	--
	TTR00833	34	--	1.99±0.49	1.72±0.60	32.6±8.0	--	--
	TTR00834	39	--	--	--	34.2±7.8	--	--
	TTR00835	44	--	1.75±0.63	1.58±0.56	32.6±7.1	--	0.63±0.27
BH1-4	TTR00836	29	--	2.09±0.49	1.37±0.61	37.6±8.6	--	--
	TTR00838	34	--	2.35±0.52	1.44±0.58	36.5±8.3	--	--
	TTR00839	39	--	1.97±0.66	2.42±0.73	42.1±9.4	--	0.87±0.33
	TTR00840	44	--	--	--	24.6±6.5	--	--
BH2-2	TTR00844	29	--	--	1.56±0.53	34.0±8.1	--	--
	TTR00846	34	--	1.96±0.48	1.47±0.53	38.1±7.8	--	0.88±0.31
	TTR00847	34	--	--	--	29.4±7.2	--	--
	TTR00848	39	--	1.48±0.64	1.26±0.51	32.1±7.0	--	--
	TTR00849	44	6.40±3.02	2.28±0.51	1.23±0.52	32.3±8.6	--	--
BH2-1	TTR00852	29	--	1.66±0.63	1.68±0.54	38.0±7.6	--	0.58±0.21
	TTR00853	34	--	1.57±0.52	--	31.7±7.7	--	--
	TTR00854	39	--	2.22±0.56	2.06±0.56	29.0±8.0	--	--
	TTR00855	44	--	--	--	30.0±7.8	--	--

[a]Measured drilling depth

pCi/g = Picocurie(s) per gram
TVD = True vertical depth
-- Constituent not detected above method detection limits.

Table A.3-6
Summary of Particle Size Characterization Using Hydrometer Analysis

Borehole Number	Sample Number	Sample Depth[a] (feet)	d_{10} (mm)[b]	d_{15} (mm)	d_{30} (mm)	d_{50} (mm)	d_{60} (mm)	d_{85} (mm)	C_u	C_c	Gravel %	Sand%	Silt & Clay %
BH3-5	TTR00814	22	c	c	0.2	0.4	0.5	1.2	--	--	1	79	21
BH1-4	TTR00837	32	c	c	0.1	0.1	0.2	0.6	--	--	0	72	27
BH2-2	TTR00845	32	c	c	0.1	0.1	0.2	0.3	--	--	0	84	16

[a]Measured drilling depth
[b]Millimeter(s)
[c]Particle not detected at specified sieve size (i.e., d_{10})

d_{10} = Median particle size
$Cu = d_{60}/d_{10}$
$Cc = (d_{30})^2/(d_{10})(d_{60})$
-- Value not calculated due to no detected sieve value.

Table A.3-7
Summary of Initial Moisture Content, Dry Bulk Density, Wet Bulk Density, and Calculated Porosity Results

Borehole Number	Sample Number	Sample Depth[a] (feet)	Initial Moisture Content	Dry Bulk Density (g/cm^3)[c]	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)[c]
			Gravimetric (%, g/g)[b]			
BH3-5	TTR00814	22	9.8	1.52	1.68	32
BH1-4	TTR00837	32	3.2	1.72	1.77	40
BH2-2	TTR00845	32	4.8	1.29	1.35	44

[a]Measured drilling depth
[b]Percent, gram per gram
[c]Gram(s) per cubic centimeter
[d]Percent

Table A.3-8
Summary of Hydraulic Conductivity Test Results

Borehole Number	Sample Number	Sample Depth[a] (feet)	Ksat[b] (cm/s)[c]
BH3-5	TTR00814	22	1.02E-06
BH1-4	TTR00837	32	2.43E-05
BH2-2	TTR00845	32	9.34E-05

[a]Measured drilling depth
[b]Saturated permeability
[c]Centimeter(s) per second

A.4.0 Quality Assurance

The results of quality assurance and quality control activities for the Area 9 Landfill corrective action investigation sampling event are summarized in the following text. Also included is a discussion about measurement of the QA/QC objectives and documentation of nonconformances. The QA/QC procedures related to the geotechnical samples and analyses are contained in the *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* (AASHTO, 1995) and are not discussed further in this text. Detailed information on the QA program for this sampling event is contained in the Industrial Sites QAPP, Revision 1 (DOE/NV, 1996b).

Quality control results are typically looked at in terms of the five PARCC parameters (precision, accuracy, representativeness, completeness, and comparability), as described in the following sections.

A.4.1 Precision

Precision is a quantitative measure of the variability of a group of measurements from their average value. Precision is assessed by collecting and analyzing duplicate field samples and comparing the results with the original sample. Precision is also assessed by creating, analyzing, and comparing laboratory duplicates from one or more field samples. Precision is reported as relative percent difference (RPD) which is calculated as the difference between the measured concentrations of duplicate samples, divided by the average of the two concentrations, and multiplied by 100. Any deviations from these requirements have been documented in project files and explained and the related data qualified accordingly. The qualification process is described in Section A.4.8.

A.4.2 Accuracy

Analytical accuracy is defined as the nearness of a measurement to the true or accepted reference value. It is the composite of the random and systematic components of the measurement system and measures bias in a measurement system. The random component of accuracy is measured and documented through the analyses of spiked samples. Sampling accuracy is assessed by evaluating the results of spiked samples and laboratory control samples. Accuracy measurements are calculated as

percent recovery (%R) by dividing the measured sample concentration by the true concentration and multiplying the quotient by 100.

Field accuracy is assessed by confirming that the documents of record track the sample from its origin, through transfer of custody, to its disposal. The goal of field accuracy is for all samples to be collected from the correct locations at the correct time, placed in a correctly labeled container with the correct preservative, and sealed with custody tape to prevent tampering. All samples in this sampling event were properly collected and forwarded to the laboratory as described above.

A.4.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EPA, 1987). Sample representativeness is achieved through the implementation of a sampling program designed to ensure proper sampling locations, number of samples, and the use of validated analytical methods. Representativeness may also be assessed through analysis of duplicate samples. Any deviations from these requirements have been documented and explained in project files and the related data qualified accordingly. Representativeness of the samples taken in this sampling event was assured by collecting the required samples shown in Chapter A.2.0 and by analyzing them by the approved methods shown in Table A.3-2.

A.4.4 Completeness

Completeness is defined as a percentage of measurements made that are judged to be valid. A sampling and analytical requirement of 80% completeness was established for this project (DOE/NV, 1996b). The Area 9 Landfill sampling data exhibit a high degree of completeness. The sampling and analytical program was executed in accordance with approved field sampling instructions (DOE/NV, 1997a). The specified sampling locations were drilled as planned. All specified samples were collected, and all sample containers reached the laboratory intact and properly preserved (if applicable). For all samples, sample temperature was maintained during shipment to the laboratory, and sample chain of custody was maintained during sample storage and/or shipment (DOE/NV, 1996b).

A.4.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another (EPA, 1987). A standardized sampling approach and analytical methodology are used to achieve data comparability. To ensure comparability, the Area 9 Landfill field and laboratory activities were performed and documented in accordance with approved contractor procedures, and all samples were collected per the CAIP (DOE/NV, 1997). Approved standardized methods and procedures were also used to analyze and report the data (e.g., Contract Laboratory Program [CLP] and/or CLP-like data packages). This approach ensures that the data from this project can be compared to other data sets. Based on the minimum comparability requirements specified in the Industrial Sites QAPP (DOE/NV, 1996), all requirements were met.

Sample handling documentation, laboratory nonconformance reports, and the precision and accuracy of quality control sample results were evaluated for their effect on the results of the associated environmental soil samples. The environmental sample results were then qualified according to processes outlined in the following section. Documentation of the data qualifications resulting from these reviews is retained in project files as both hard copy and electronic media and will be supplied upon request.

A.4.6 Tier I and Tier II Data Evaluations

All laboratory data from samples collected at TTR Area 9 Landfill have been evaluated for data quality, according to contractor-approved procedures (DOE/NV, 1996b). These procedures, performed in a tiered process, based upon U.S Environmental Protection Agency data validation guidelines and presented in the following text, resulted in modifications to the laboratory-generated qualifiers or results. No data rejected during the data evaluation process were used to draw the conclusions presented in Section A.3.0. Only detections, whether estimated (i.e., J-qualified) or not, were used.

The changes resulting from the data evaluation process were documented in project files and were summarized in memoranda for each sample delivery group (SDG). These memoranda are maintained with the SDGs in the contractor’s project files and are available for inspection upon request.

Tier I evaluation for both chemical and radiological analysis examines (but is not limited to):

- Sample count/type consistent with chain of custody
- Analysis count/type consistent with chain of custody
- Correct sample matrix
- Significant problems stated in cover letter or case narrative
- Completeness of certificates of analysis (COAs)
- Completeness of CLP or CLP-like packages
- Completeness of signatures, dates, and times on chain of custody
- Condition-upon-receipt variance form included
- Requested analyses performed on all samples
- Date received/analyzed given for each sample
- Correct concentration units indicated
- Correct detection limits achieved
- Electronic data transfer (EDT) supplied
- Results reported for field and laboratory QC samples
- Whether or not the deliverable met the overall objectives of the project

Tier II evaluation for both chemical and radiological analysis examines (but is not limited to):

Chemical:

- Sample date, preparation date, and analysis date for each sample
- Holding time criteria met
- QC batch association for each sample
- Cooler temperature upon receipt
- Sample pH for aqueous samples, as required
- Detection limits properly adjusted for dilution, as required
- Blank contamination evaluated and applied to sample results/qualifiers
- Matrix spike/matrix spike duplicate %R and RPDs evaluated and applied to laboratory results/qualifiers
- Field duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Laboratory duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Surrogate %Rs evaluated and applied to laboratory results/qualifiers
- Laboratory control sample (LCS) %Rs evaluated and applied to laboratory results/qualifiers

Radioanalytical:

- Whether or not blank contamination evaluated and applied to sample results/qualifiers
- Whether or not COA is consistent with data package documentation
- QC sample results (duplicates, laboratory control samples, matrix spikes and matrix spike duplicates) evaluated and applied to laboratory result qualifiers
- Whether or not sample results, error, and minimum detectable activity was evaluated and applied to laboratory result qualifiers

- Whether or not the detector system was calibrated to National Institute for Standards and Technology (NIST) traceable sources
- Whether or not calibration sources preparation was documented, and whether or not it demonstrates proper preparation and was appropriate for sample matrix, emission energies, and concentrations
- Detector system response to daily, weekly, and monthly background and calibration checks for peak energy, peak centroid, peak full width half maximum, and peak efficiency
- Whether or not tracers were NIST-traceable, were appropriate for the analysis performed, and had recoveries that met QC requirements
- Whether or not documentation of all QC sample preparation was complete and properly performed
- Whether or not spectra lines, emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration

Other data quality considerations that are included in Environmental Protection Agency data review functional guidelines are evaluated as a Tier III review. Tier III review of chemical and radioanalytical results would include the following additional evaluations.

Chemical:

- Mass spectrometer tuning criteria
- Initial and continuing calibration verification
- Internal standard evaluation
- Organic compound quantitation
- Inductively coupled plasma (ICP) interference check sample evaluation
- Graphite furnace atomic absorption quality control
- ICP serial dilution effects
- Recalculation of all laboratory results from raw data

Radioanalytical:

- QC sample results (e.g., calibration source concentration, %R and RPD) verified
- Radionuclides and their concentration appropriate considering their decay schemes, half-lives, and process knowledge and history of the facility and site
- Each identified line in spectra verified against emission libraries and calibration results
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results

Tier I and II data evaluations are summarized in a memorandum for each sample delivery group showing which results and qualifiers were changed and why these changes were made.

A Tier III review of five percent of all the analytical data is currently being performed by Lockheed Analytical Services in Las Vegas, NV. A report of the findings will be issued and included in the

project files. If the Tier III review results in additional qualified results, the conclusions in Section A.3.0 will be reexamined and revised accordingly. If this occurs after the CADD has been finalized, a letter stating the changed data will be issued.

A.4.7 Quality Control Samples

Twenty-five quality control samples (i.e., trip blanks, field blanks, rinsate blanks, matrix spike/matrix spike duplicates, and field duplicates) were collected and submitted for laboratory analysis as shown in Table A.3-1. The samples and duplicates were assigned individual sample numbers and sent to the laboratory as blind samples. Additional samples were selected by the laboratory to be analyzed as laboratory duplicates. Documentation related to the collection and analysis of these samples is retained in project files and will be supplied upon request.

A.4.7.1 Field Quality Control Samples

All blanks (i.e., field blanks, rinsate blanks, and trip blanks) were analyzed for the parameters listed in Table A.3-2 (trip blanks were analyzed for VOCs only) and showed only contamination associated with common laboratory contaminants (acetone, methylene chloride, 2-butanone, toluene, and phthalate esters as defined in the EPA Functional Guidelines). These blank detections were used to qualify the results of the associated environmental samples according to EPA Functional Guidelines (EPA, 1994b; 1994c).

The EPA Functional Guidelines state that no qualification action is taken if a compound is found in an associated blank but not in the sample, or if a compound is found in the sample but not in an associated blank. The action taken when a compound is detected in both the sample and the associated blank varies depending upon the analyte involved and is known as “The 5X/10X Rule.”

For most VOCs, SVOCs, pesticides, and PCBs, an analyte detected in the sample that was also detected in an associated blank is qualified as undetected (U) if the sample concentration is less than five times (5X) the blank concentration. For the common laboratory contaminants (methylene chloride, acetone, 2-butanone [methylethyl ketone or MEK], toluene, and phthalate esters [especially bis(2-ethylhexyl)phthalate]), the factor is raised to ten times (10X) the blank concentration. The sample result is elevated to the quantitation limit if it is not already reported at that level.

For inorganics (metals), sample results greater than the instrument detection limit but less than five times (5X) the amount found in an associated blank are qualified as undetected (U). There are no metallic common laboratory contaminants, so there is no "10X Rule" for metals, and the sample result is never altered.

Documentation of the data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media and will be supplied upon request.

During the sampling event, three field duplicate soil samples were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.3-2. For these samples, the duplicate results precision (i.e., relative percent differences between the environmental sample results and their corresponding field duplicate sample results) were compared to criteria set forth in EPA Functional Guidelines (EPA, 1994b; 1994c), and the associated environmental sample results were qualified accordingly.

The EPA Functional Guidelines give no required review criteria for field duplicate analyses comparability, but allow the data reviewer to exercise professional judgement. Both detections and nondetections have been qualified as estimated (J and UJ, respectively) if the relative percent difference between an environmental sample and its field duplicate fell outside established criteria.

Three field samples were selected for use as MS/MSD samples. The %R of these samples (a measure of accuracy) and the RPDs in these sample results (a measure of precision) were compared to EPA Functional Guideline (EPA, 1994b; 1994c) criteria, and the results were used to qualify associated environmental sample results accordingly.

The EPA Functional Guidelines for review of organic data state that no data qualification action is taken on the basis of MS/MSD results alone. The data reviewer exercises professional judgment in considering these results in conjunction with the results of laboratory control samples and other QC criteria in applying qualifiers to the data. Generally, if recovery criteria are greater than the upper acceptance limit, then positive sample results for the affected compounds are qualified as estimated (J), and nondetections are not qualified. If recovery criteria are less than the lower acceptance limit, then positive sample results for the affected compounds are qualified as estimated (J), and nondetections are qualified as unusable (R). The relative percent difference results of matrix

spike/matrix spike duplicate samples that fall outside established criteria are applied to qualify detections and nondetections as estimated (J and UJ, respectively).

The EPA Functional Guidelines for inorganic data review allow professional judgment to be applied in evaluating the results of both matrix spikes and laboratory duplicates. Generally, if spike recoveries are greater than the upper acceptance limit or less than the lower acceptance limit, positive results are qualified as estimated (J), and nondetections are either unqualified or qualified as estimated (UJ), respectively. If spike recoveries are grossly low (less than 30%), positive results are unqualified, and nondetections are unusable (R). The relative percent difference between the environmental sample and its laboratory duplicate are compared to established criteria to qualify detections and nondetections as estimated (J and UJ, respectively).

A.4.7.2 Laboratory Quality Control Samples

Analysis of method QC blanks and laboratory control samples was performed for each parameter analyzed by Quanterra Laboratory. In addition, laboratory duplicate analysis was performed on one metals analysis environmental sample per sample delivery group (SDG). The results of these analyses were used to qualify associated environmental sample results according to EPA functional guidelines (EPA, 1994b; 1994c).

A.4.8 Field Deficiencies/Nonconformance

During the Area 9 UXO Landfill corrective action investigation activities, no field deficiencies or nonconformances were cited.

A.5.0 Summary

Analysis of the data generated from sampling activities conducted during corrective action investigation activities conducted at the Area 9 Landfill indicates the following:

- With the exception of arsenic, the industrial preliminary remediation goal levels were not exceeded in any of the samples collected from the Area 9 Landfill for total VOCs, total SVOCs, TPH (gasoline or diesel), total PCBs, total RCRA Metals, and total Nitroaromatics/Nitroamines analyses.

- Arsenic concentrations were detected above the industrial PRG levels in several samples collected; however, these concentrations were below the maximum background concentrations detected for arsenic. Based on historical evidence (DOE/NV, 1997a) and the background concentrations, it is felt that arsenic is naturally occurring at these concentrations.

- Gamma spectroscopy results indicate that there is no uranium contamination in the Area 9 Landfill. As a result, samples were not analyzed for isotopic uranium. All results are below the preliminary action levels established through background sample collection during this investigation and background levels established for the State of Nevada (McArthur and Miller, 1989). Radionuclide concentrations from the samples collected from beneath the landfill cells are consistent with concentrations found at background locations.

- The geologic, hydraulic, and geotechnical results revealed that the soil beneath the Area 9 Landfill is comprised of a silty, sandy, unconsolidated, unsorted gravel which grades to a moderately indurated, moderately graded, silty gravel with a low migration potential.

A.6.0 References

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Attachment 1
Soil Boring Logs

SOIL BORING LOG	BORING NUMBER: BH-B1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/11/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/11/97
HOLE SURFACE ELEVATION (feet): 5355.58	EASTING: 174024.60
TOTAL DEPTH DRILLED (feet):25.00	NORTHING: 1131383.20
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SW	Sand, fine to coarse, mostly fine, well graded, loose, dry, light brown.			
	1.0						
5.0			SM	Sandy silt, fine to coarse, mostly fine, well graded, loose, dry, light brown.			
	2.0						
							TTR00799
10.0	3.0				2.8		
				Sandy silt, fine to coarse, mostly fine, well graded, loose, dry, light brown.			
	4.0						
							TTR00780
15.0					2.8		
				Same as above, very slightly moist.			
	5.0						
	6.0						
20.0				Same as above			
	7.0				2.7		

SOIL BORING LOG	BORING NUMBER: BH-B2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/11/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/11/97
HOLE SURFACE ELEVATION (feet): 5352.26	EASTING: 174216.00
TOTAL DEPTH DRILLED (feet):25.00	NORTHING: 1131662.60
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SW	Silty sand, fine to coarse, mostly fine, well graded, loose, dry.			
	1.0						
5.0			SM	Sandy silt, fine to coarse, mostly fine, well graded, loose, dry.			
	2.0						
							TTR00781
10.0	3.0			Silt, loose, light brown, dry.			
	4.0						
							TTR00782
15.0				Same as above			
	5.0						
	6.0						
20.0			SP	Sand, fine to coarse, mostly fine, partially graded, loose, light brown, dry.			
	7.0						

SOIL BORING LOG	BORING NUMBER: BH-B3
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/12/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/12/97
HOLE SURFACE ELEVATION (feet): 5349.01	EASTING: 174556.50
TOTAL DEPTH DRILLED (feet):25.00	NORTHING: 1131604.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM-ML	Silty sand to sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	2.0						
10.0	3.0			Sandy silt, fine coarse, mostly fine, well graded, loose, light brown, dry.	2.8		TTR00783
	4.0						
15.0				Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	2.7		TTR00784
	5.0						
	6.0						
20.0			SM-ML	Sandy silt-silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.	2.8		
	7.0						

SOIL BORING LOG	BORING NUMBER: BH1-1	CAU 453 CADD Appendix A Revision: 0 Date: 03/06/98 Page A-40 of A-65
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/18/97	
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/19/97	
HOLE SURFACE ELEVATION (feet): 5355.57	EASTING: 174196.60	
TOTAL DEPTH OF HOLE (feet): 42.00	NORTHING: 1131465.90	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley	
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird	
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.	
ELEVATION DATUM: Mean Sea Level		
ANGLE BORING - 45 degree angle		

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine-coarse, mostly fine, well graded, light brown, dry.			All TPH results were nondetects.
	1.0						
5.0			ML	Sandy silt, fine-coarse, mostly fine, well graded, loose, light brown, dry.	2.9		
	2.0						
10.0	3.0			Silt, very fine, loose, low plasticity, trace sand, light brown, dry.	2.9		
	4.0						
15.0				Same as above	2.9		
	5.0						
20.0	6.0		SM-ML	Silty sand-sandy silt, fine-coarse, mostly fine, well graded, loose, light brown, dry.	2.8		
	7.0						
25.0				Same as above	2.9		TTR00819
	8.0						
30.0	9.0		SM	Silty sand, fine-coarse, mostly fine, well graded, hard, compact, light brown, dry.	2.9	8.0	TTR00821, TTR00822
	10.0						
35.0				Silty sand, fine-coarse, well graded, light brown, dry.	2.9		TTR00823
	11.0						
	12.0						
40.0			ML	Silt, compact, light brown, dry.	2.7		TTR00824

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH1-2
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/19/97
HOLE SURFACE ELEVATION (feet): 5358.85	DATE HOLE COMPLETED: 08/19/97
TOTAL DEPTH DRILLED (feet):42.00	EASTING: 174197.30
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1131511.80
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, well graded, loose, light brown, dry.			
	1.0						
5.0			SM-ML	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.	2.9		
	2.0						
10.0	3.0		ML	Same as above	2.9		
	4.0						
15.0				Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	3.0		
	5.0						
20.0	6.0			Same as above	2.9		
	7.0						
25.0			SM	Same as above	2.9		
	8.0			Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.	2.9		TTR00827 (MS/MSD)
30.0	9.0			Same as above			
	10.0				2.8		TTR00828
35.0			SW	Sand, fine to coarse, well graded, loose, little silt, light brown, dry.			
	11.0				3.0		TTR00829
40.0	12.0			Same as above	3.1		TTR00830

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH1-3
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/20/97
HOLE SURFACE ELEVATION (feet): 5342.45	DATE HOLE COMPLETED: 08/20/97
TOTAL DEPTH DRILLED (feet):43.00	EASTING: 174217.80
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1131564.10
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine-coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine-coarse, mostly fine, well graded, loose, light brown, dry.	2.0		
	2.0						
10.0	3.0			Silt, very fine, low density, trace fine-coarse sand, light brown, dry.	2.6		
	4.0						
15.0				Same as above	6.6		
	5.0						
20.0	6.0			Same as above	2.0		
	7.0						
25.0				Same as above	2.2		
	8.0		SM-ML	Silty sand-sandy silt, fine-coarse, mostly fine, well graded, light brown, dry, compact.	2.0		TTR00832
30.0	9.0						
			ML-SM	Sandy silt - silty sand, fine to coarse, mostly fine, well graded, light brown, dry, compact.	1.9		TTR00833
35.0	10.0						
	11.0		ML	Silt, very fine, slightly compact, trace-little fine coarse sand, lt brown, dry.	1.3		TTR00834
40.0	12.0						
				Same as above, dry to very slightly moist.	1.3		TTR00835

SOIL BORING LOG	BORING NUMBER: BH1-4
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/20/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/20/97
HOLE SURFACE ELEVATION (feet): 5414.63	EASTING: 174276.40
TOTAL DEPTH DRILLED (feet):43.00	NORTHING: 1131536.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Potey
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird√
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ELEVATION DATUM: Mean Sea Level	
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Silt, loose, light brown, trace fine to coarse sand, dry.	1.5		
	2.0						
10.0	3.0			Same as above	1.3		
	4.0						
15.0				Same as above	0.7		
	5.0						
20.0	6.0			Same as above	1.4		
	7.0						
25.0					1.5		
	8.0		ML-SM	Silty sand-sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	1.7		TTR00836 - TTR00837 (GEOTECH)
30.0	9.0						
	10.0			Sandy silt-silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.	1.7		TTR00838
35.0	11.0			Same as above	1.5		TTR00839
	12.0						
40.0				Same as above	1.6		TTR00840

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH2-1
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/21/97
HOLE SURFACE ELEVATION (feet): 5362.14	DATE HOLE COMPLETED: 08/21/97
TOTAL DEPTH DRILLED (feet):42.00	EASTING: 487089.80
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1129516.20
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine-coarse, well graded, loose, slightly moist, light brown, dry.			
	1.0						
5.0			ML	Silt, very fine, trace fine sand, loose, light brown, very slightly moist.	0.8		
	2.0						
10.0	3.0						
	4.0						
15.0				Silty sand, fine-coarse, mostly fine, well graded, loose, light brown, very slightly moist to slightly moist.	0.2		
	5.0						
20.0	6.0		SM	Same as above, very slightly moist to slightly moist.	1.9		
	7.0						
25.0				Same as above, slightly moist to moist.	1.4		
	8.0			Same as above, very slightly moist to dry.			TTR00852
30.0	9.0						
	10.0			Silty sand, fine to coarse, mostly medium to course, well graded, loose, lt brown, dry to very slightly moist.			TTR00853
35.0	11.0		ML	Sandy silt, very fine, fine sand, loose-semicompact, light brown/yellow, dry to very slightly moist.			TTR00854
	12.0						
40.0				Same as above.			TTR00855

SOIL BORING LOG	BORING NUMBER: BH2-2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/20/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/21/97
HOLE SURFACE ELEVATION (feet): 5345.73	EASTING: 174335.00
TOTAL DEPTH DRILLED (feet):45.00	NORTHING: 1131499.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ELEVATION DATUM: Mean Sea Level	
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	1.4		
	2.0						
10.0	3.0			Same as above, very slightly moist.	1.5		
	4.0						
15.0				Same as above.	1.5		
	5.0						
20.0	6.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, very slightly moist to slightly moist.	1.4		
	7.0						
25.0				Same as above.	1.4		
	8.0		SW	Sand, fine-coarse, well graded, loose, light brown, slightly moist.	2.3		TTR00844, TTR00845(GEOTECH)
30.0	9.0						
			ML	Sandy silt, fine-coarse, mostly fine, well graded, compact, very slightly moist, light yellow/brown.	1.8		TTR00846, TTR00847(DUPLICATE)
35.0	10.0						
	11.0			Sandy silt, same as above.	1.9		TTR00848
	12.0			Silty sand, fine-coarse, mostly fine, well graded, loose, slightly moist, light brown.			
40.0			SM		1.6		TTR00849

SOIL BORING LOG	BORING NUMBER: BH3-1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/13/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/13/97
HOLE SURFACE ELEVATION (feet): 5331.63	EASTING: 174178.30
TOTAL DEPTH DRILLED (feet):38.00	NORTHING: 1131341.40
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ELEVATION DATUM: Mean Sea Level	
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	3.1		
	2.0						
10.0	3.0			Silt, low plasticity, light brown, dry, loose.	3.0		
	4.0						
15.0			SC	Clayey sand, fine to coarse, mostly fine, well graded, loose, low plasticity, clay, light brown, slightly moist.	3.2		
	5.0				3.0		TTR00794
20.0	6.0		SM-SW	Silty sand, fine to coarse, mostly fine to medium, well graded, loose, light brown, very slightly moist.			
	7.0				3.0		TTR00795(MS/MSD)
25.0				Same as above.			
	8.0				2.9		TTR00796
	9.0						
30.0			SM	Silty sand, fine-course, mostly fine, well graded, loose, light brown, very slightly moist.			
	10.0				3.0		TTR00797
35.0							
	11.0						
				Same as above.	2.8		TTR00798

SOIL BORING LOG	BORING NUMBER: BH3-2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 08/13/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 08/13/97
HOLE SURFACE ELEVATION (feet): 5375.26	EASTING: 486981.10
TOTAL DEPTH DRILLED (feet):38.00	NORTHING: 1129414.80
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: D. Poley
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ELEVATION DATUM: Mean Sea Level	
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0		ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	3.0		
5.0	2.0		ML-SM	Sandy silt-silty sand, fine to coarse, mostly fine, well graded, light brown, dry			
10.0	3.0				3.1		
	4.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry to very slightly moist.			
15.0	5.0				3.1		
			SW	Sand, fine to coarse, mostly fine, well graded, loose, dry to slightly moist.	3.0		TTR00799, TTR00800
20.0	6.0						
	7.0			Same as above.	2.9		TTR00801
25.0	8.0						
			SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry to very slightly moist.			TTR00802
30.0	9.0						
	10.0			Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry to very slightly moist.			NO SAMPLE LOST PLUG
35.0	11.0						
				Same as above.			TTR00803

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH3-3
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/14/97
HOLE SURFACE ELEVATION (feet): 5414.63	DATE HOLE COMPLETED: 08/14/97
TOTAL DEPTH DRILLED (feet):38.00	EASTING: 174337.60
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1131457.20
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.	3.4		
	2.0						
10.0	3.0			Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, very slightly moist.	3.3		
	4.0						
15.0				Sandy silt, same as above.	3.5		
	5.0				3.1		TTR00804
20.0	6.0			Sandy silt, same as above, slightly moist.			
	7.0				3.0		TTR00805
25.0	8.0						
			SM	Silty sand, fine to coarse, well graded, light brown, very slightly moist.	2.8		TTR00806
30.0	9.0						
	10.0			Silty sand, fine to coarse, mostly fine, well graded, trace gravel, light brown, dry.	2.8		TTR00807
35.0	11.0			Same as above.	3.3		TTR00808

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH3-4
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/12/97
HOLE SURFACE ELEVATION (feet): 5358.86	DATE HOLE COMPLETED: 08/12/97
TOTAL DEPTH DRILLED (feet):38.00	EASTING: 174264.40
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1131392.60
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SW-SM	Silty sand, fine to coarse, mostly fine, well graded, loose, dry, light brown.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry.			
	2.0						
10.0	3.0		SM	Silty sand, fine to coarse, mostly fine, well graded, light brown, very slightly moist.			
	4.0						
15.0				Same as above.			
	5.0						
			ML	Sandy silt, fine to coarse, mostly fine, well graded, light brown, very slightly moist.	3.1		TTR00785
20.0	6.0						
	7.0						TTR00788
25.0				Same as above.	2.6		
	8.0						TTR00789
30.0	9.0			Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, very slightly moist.	3.1		
	10.0						TTR00790
35.0			SM	Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, very slightly moist.			
	11.0						TTR00791

SOIL BORING LOG

PROJECT NAME: AREA 9 LANDFILL	BORING NUMBER: BH3-5
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE STARTED: 08/18/97
HOLE SURFACE ELEVATION (feet): 5345.73	DATE HOLE COMPLETED: 08/18/97
TOTAL DEPTH DRILLED (feet):38.00	EASTING: 487152.00
ENVIRONMENTAL CONTRACTOR: IT Corporation	NORTHING: 1129483.10
DRILLING METHOD: Hollow Stem Auger/Split Spoon	GEOLOGIST: D. Poley
DRILLING CONTRACTOR: Soils Exploration	QA CHECK: F. Baird
ELEVATION DATUM: Mean Sea Level	COMMENTS: Only values >0.0 are shown for the VOC and TPH onsite monitoring results. Depth is total depth drilled.
ANGLE BORING - 45 degree angle	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	VOC (ppm)	TPH (mg/kg)	Remarks
0.0	0.0		SM	Silty sand, fine to coarse, mostly fine, well graded, light brown, dry.			
	1.0						
5.0			ML	Sandy silt, fine to coarse, mostly fine, well graded, loose, light brown, dry to very slightly moist.	3.6		
	2.0						
10.0	3.0			Same as above.	3.2		
			SM				
	4.0			Silty sand, fine to coarse, mostly fine, well graded, loose, light brown, dry to very slightly moist.			
15.0					3.3		
	5.0						
				Silty sand, fine to coarse, mostly fine, well graded, light brown loose, very slightly moist.	3.1		TTR000813. TTR000814 (GEOTECH)
20.0	6.0						
				Silty sand, fine to coarse, mostly fine, well graded, light brown loose, moist.	3.4		TTR00815
25.0	8.0						
				Silty sand, fine to coarse, mostly fine, well graded, light brown loose, very slightly moist.	3.1		TTR00816
30.0	9.0						
	10.0		SW	Sand, fine to coarse, mostly medium, well graded, loose, light brown, very slightly moist.	3.2		TTR00817
35.0							
	11.0			Silt, very fine, loose, grey, dry.			
			ML				TTR00818

SOIL BORING LOG	BORING NUMBER: A9-1B1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/21/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/21/97
HOLE SURFACE ELEVATION (feet): 5342.45	EASTING: 174226.60
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131498.30
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown-light brown, dry, fine to very fine, minor fine gravels.	
	1.0				
5.0				Silty sand, light to medium brown-gray brown, dry, soft, fine to very fine.	
	2.0				
10.0	3.0			Silty sand becoming slightly moist, silty, sandy, with minor fine grayish gravel.	
	4.0				
15.0			GM	Silty sand to sandy silt, medium brown, with medium gray to dark gray, fine, rounded gravel, slightly moist.	
	5.0				
20.0	6.0			Silty sand to sandy slit, increasing fine gravel, light to medium gray angular to round, gravely to sandy, silt, light to medium gray.	
	7.0				
25.0				Silty sand to sandy silt, light to medium gray, fine to medium. increasing gray sand, and fine to medium gravels.	
	8.0				
30.0	9.0			Same as above.	
	10.0				
35.0				Gravelly sandy silt, gray brown, fine to medium gravels, medium gray to dark gray, grading to fine to very fine sandy silt.	Hard drilling with soft interbeds.
	11.0				
	12.0				
40.0				Gravelly sandy silt, medium gray slightly moist, hard red-brown fragments; volcanics visable quartz, rounded gravels, medium to coarse.	
	13.0				Total depth at 45 ft. Pull augers to determine depth. Hole open to 37 ft.

SOIL BORING LOG	BORING NUMBER: A9-1B2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/22/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/22/97
HOLE SURFACE ELEVATION (feet): 5342.45	EASTING: 174210.20
TOTAL DEPTH DRILLED (feet): 50.00	NORTHING: 1131498.50
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:

ELEVATION DATUM: Mean Sea Level

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown to light brown, dry, fine to very fine, minor fine gravels.	
	1.0				
5.0				Silty sand, light to medium brown to gray brown, dry soft, fine to very fine.	
	2.0				
10.0	3.0			Silty sand, becoming slightly moist, silty, sandy, with increasing fine grayish gravel.	
	4.0				
15.0				Silty sand to sandy silt, medium brown, with medium gray to dark gray, fine, rounded gravel, slightly moist.	
	5.0				
20.0	6.0		GM	Silty sand to sandy silt, increasing gravel, light to medium gray angular to round, gravely, sandy silt, light to medium gray.	
	7.0				
25.0				Silty sand to sandy silt, light to medium brown, minor gravels, light to medium gray, fine to medium, increasing gray, sand, and fine to medium gravels.	
	8.0				
30.0	9.0			Gravelly sandy silt, gray brown, fine to medium gravels, medium gray to dark gray, grading to fine to very fine sandy silt, medium brown to gray brown, gravels are angular to round.	
	10.0				
35.0					
	11.0			Same as above.	
	12.0			Gravelly sandy silt, medium gray slightly moist, hard, red-brown fragments, volcanics?, visable quartz, rounded gravels medium to coarse.	
40.0					
	13.0				
45.0				Gravelly sandy silt, medium gray to medium brown, poorly sorted medium to dark gray gravels, coarse light to medium gray rounded gravels.	
	14.0				
	15.0				Pull augers. Hole open to 42.8 ft.

SOIL BORING LOG	BORING NUMBER: A9-1B3
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/22/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/22/97
HOLE SURFACE ELEVATION (feet): 5335.89	EASTING: 174249.90
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131520.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown to light brown, fine to very fine, well sorted, minor fine gravels.	
	1.0				
5.0				Silty sand, light brown to gray brown, dry, soft, fine to very fine, well sorted.	
	2.0				
10.0	3.0			Silty sand, slightly moist, silty, sandy, increasing fine grayish gravel.	
	4.0				
15.0				Silty sand to sandy silt, medium brown, interbedded with medium gray to dark gray, fine, rounded gravel, increasing moisture.	
	5.0				
20.0	6.0		GM	Silty sand to sandy silt, increasing gravel, light to medium gray, angular to round, gravely sandy silt, light to medium gray.	
	7.0				
25.0				Silty sand to sandy silt, light to medium brown, minor gravels, light to medium gray, fine to medium, well sorted, increasing sand, gray, medium, increasing gravels, fine to medium, subrounded to angular.	
	8.0				
	9.0				
30.0				Gravelly silty sand to sandy silt, light to medium brown to gray brown, gravels light to medium gray, fine to medium with well sorted sand.	
	10.0				
35.0				Same as above, hard gravel layer at 11.3 meters (37 feet).	
	11.0				
	12.0				
40.0				Gravelly silty sand, medium gray moist, hard, increasing gravels, fine to medium. At 12.8 to 13.1 m (42 to 43 ft) medium to coarse gravels, light to medium gray, rounded to angular.	
	13.0				Total depth to 45 ft. Pull augers. hole open to 36 ft.

SOIL BORING LOG	BORING NUMBER: A9-1B4
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/22/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/22/97
HOLE SURFACE ELEVATION (feet): 5326.05	EASTING: 174250.00
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131524.20
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown to light brown, dry, fine to very fine, well sorted, minor amount of fine gravels.	
	1.0				
5.0				Silty sand, light brown to gray brown, dry, fine to very fine, well sorted.	
	2.0				
10.0	3.0			Silty sand, slightly moist, silty, sandy, increasing fine grayish gravel.	
	4.0				
15.0				Silty sand to sandy silt, medium brown, interbedded with medium gray to dark gray, fine, rounded gravel, increasing moisture.	
	5.0				
20.0	6.0		GM	Silty sand to sandy silt, increasing gravel, light to medium gray, angular to round gravel, sandy silt, light to medium gray.	
	7.0				
25.0				Silty sand to sandy silt, light to medium brown, minor gravels, light to medium gray, fine to medium, well sorted. Increasing sand, gray, medium. Increasing gravels, fine to medium, angular.	
	8.0				
	9.0				
30.0				Gravelly silty sand, light brown to gray brown, moderate gravels. Gravels, light to medium gray, fine to medium with well sorted sand.	
	10.0				
35.0				Silty sand, medium to dark brown with light to dark gray angular gravels, increasing moisture.	
	11.0				
	12.0				
40.0				Gravelly silty sand, medium to dark gray brown. Gravels, medium to dark gray, subround to angular chips.	
	13.0				Pull augers. Hole open to 39 ft.

SOIL BORING LOG	BORING NUMBER: A9-2B1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/23/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/23/97
HOLE SURFACE ELEVATION (feet): 5352.30	EASTING: 174299.50
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131543.10
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, light to medium gray, dry, fine to very fine, well sorted, minor fine gravels.	
	1.0				
5.0				Silty sand, light to medium gray, light brown to medium brown, minor gravels, fine light gray. Increasing fine gray gravel.	
	2.0				
10.0	3.0			Silty sand, light to medium gray, light brown, light gray gravels increase, fine to medium, light to medium gray, well consolidated.	
	4.0				
15.0			GM	Silty sandy gravels, light to medium gray, fine to medium, very sandy, fine to medium grained very sandy.	
	5.0				
20.0	6.0			Silty sandy gravels, light gray to gray brown, gravels are angular "chips", increasing course gravels.	
	7.0				
25.0				Same as above.	
	8.0				
	9.0				
30.0				Silty sandy gravels, dark gray to gray brown, fine to medium grained, interbedded with a light to medium gray, medium to coarse grained gravel (carbonate?, evaporite?).	
	10.0				
35.0					
	11.0				
	12.0				
40.0					
	13.0				Total depth to 45 ft, pull augers Hole open to 39 ft.

SOIL BORING LOG	BORING NUMBER: A9-2B2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/24/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/24/97
HOLE SURFACE ELEVATION (feet): 5358.86	EASTING: 174305.70
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131520.00
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown to green gray, fine to medium grained, well sorted quartz, subrounded to subangular.	
	1.0				
5.0				Silty sand, light brown to gray brown, fine to medium grained. Increasing clay, medium brown, soft, moist, moderately plastic.	
	2.0				
10.0	3.0			Silty sand to sandy silt, medium brown to dark brown, moist, with clay and increasing medium to dark gray, fine to medium grained gravels.	
	4.0				
15.0			GM	Same as above	
	5.0				
20.0	6.0			Sandy silt, medium gray, brown to green gray, fine to course, subangular to subrounded, with gravels, medium to dark gray, subrounded and light gray angular gravels.	
	7.0				
25.0				Same as above.	
	8.0				
30.0	9.0			Sandy, silty gravels, sandy light brown to gray brown to gray green, fine to coarse grained angular gravels, medium to dark gray, fine to medium grained, subangular to subrounded. Increasing light to medium gray gravel "chips", medium to coarse, angular.	
	10.0				
35.0				Same as above.	
	11.0				
	12.0				
40.0				Same as above, at 12.8 to 13.1 meters (42 to 43 feet) "hard drilling" (carbonate/evaporite layer?).	
	13.0				Total depth at 45 ft Hole open to 39 ft.

SOIL BORING LOG	BORING NUMBER: A9-2B3
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/24/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/24/97
HOLE SURFACE ELEVATION (feet): 5358.86	EASTING: 174338.20
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131496.60
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Silty sand, gray brown to greenish, fine to medium grained, moderate to well sorted, angular quartz, gravel, minor, light to medium gray, fine to medium grained.	
5.0	1.0			Same as above.	
10.0	2.0			Silty sand, greenish gray to gray brown, fine to medium grain, moderate to well sorted angular clay, minor, medium brown, sticky, moist, increasing gravel; light gray to dark gray gravel; subangular to subround.	
15.0	4.0		GM	Gravel; moderate light gray, angular "chip" fine to medium grain, with moderate dark gray gravel, subangular to subrounded, in medium to coarse sand, minor clay, moist, slightly plastic.	
20.0	6.0			Same as above	
25.0	7.0			Silty, sandy gravel; gray brown moist, minor clay, moderate chip gravel, light to medium gray, fine to medium with fine to coarse gark gray gravel, subangular to subround.	
30.0	9.0			Gravelly silty sand; green gray to brown gray, very fine to medium, angular quartz, moderate to well sorted, minor clay, moist, slightly plastic, with gravels; light to medium gray, fine to medium angular and medium to dark gray fine to medium, rounded	
35.0	11.0			Same as above.	
40.0	12.0			Silty sandy gravel; light to dark gray, fine to medium, subround, silty sand, medium to dark brown, medium to coarse grain, subangular to subround with gravels, moderately dark gray, medium grain, rounded and fine to medium grain, light to medium gray angular "chips".	Total depth at 45 ft. Hole open to 37 ft

SOIL BORING LOG	BORING NUMBER: A9-2B4
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/28/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/28/97
HOLE SURFACE ELEVATION (feet): 5339.17	EASTING: 487103.10
TOTAL DEPTH DRILLED (feet): 30.00	NORTHING: 1129575.20
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt; light brown to gray brown, very fine to fine grain, moderate to well sorted, subangular.	
	1.0				
5.0				Sandy silt; light to medium brown, fine to medium grain, moderately sorted, subangular.	
	2.0				
10.0	3.0			Sandy silt; light to medium brown, very fine to fine, well sorted gravel; minor, medium to dark gray, fine to coarse, subrounded to angular, and light gray, fine to medium, subangular to subrounded, increasing coarse, rounded dark gray gravel.	
	4.0				
15.0					
	5.0				
20.0	6.0		GM	Gravelly sandy silt to silty sand; medium brown, fine to coarse, increasing gravels, dark gray, fine to coarse, angular to subangular, increasing moisture.	
	7.0				
25.0					
	8.0				Twisted off center rod at plug. Decision made to move rig and redrill.
	9.0				

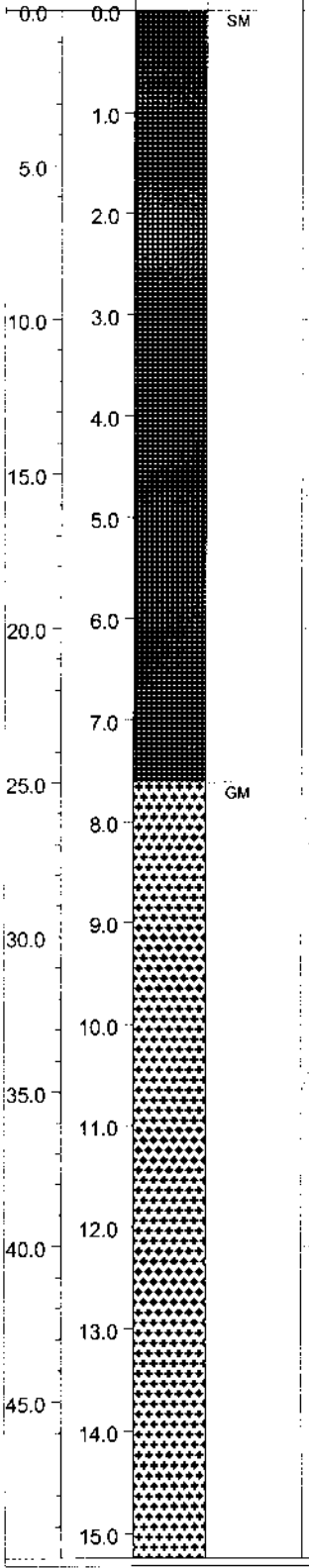
SOIL BORING LOG	BORING NUMBER: A9-2B4 RD#1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/28/98
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/28/98
HOLE SURFACE ELEVATION (feet): 5339.17	EASTING: 487070.30
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1129575.30
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird√
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt; light brown to gray brown, very fine to fine grain, moderate to well sorted, subangular.	
5.0	1.0				
	2.0			Sandy silt; light to medium brown, fine to medium grain, moderately sorted, subangular.	
10.0	3.0			Sandy silt; light to medium brown, very fine to fine, well sorted gravel; minor, medium to dark gray, fine to coarse, subrounded to angular, and light gray, fine to medium, subangular to subrounded, increasing coarse, rounded dark gray gravel.	
15.0	4.0				
	5.0				
20.0	6.0		GM	Gravelly sandy silt to silty sand; medium brown, fine to coarse, increasing gravels, dark gray, fine to coarse, angular to subangular, increasing moisture.	
25.0	7.0				
	8.0				
30.0	9.0			Gravelly silty sand; green gray to brown gray, very fine to medium, angular quartz, moderate to well sorted, minor clay, moist slightly plastic with gravels; light to medium gray, fine to medium grain, angular, and medium to dark gray, fine to medium grain, rounded.	
	10.0				
35.0	11.0			Silty sandy gravel; light to dark gray, fine to medium grain, subround, silty sand; medium to dark brown, medium to coarse grain, subangular to subround with gravels; moderately dark gray, medium grain, rounded, and fine to medium grain, light to medium gray angular "chip".	
	12.0				
40.0	13.0				Total depth at 45 ft. Hole open to 35 ft

SOIL BORING LOG	BORING NUMBER: A9-3B1
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/29/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/29/97
HOLE SURFACE ELEVATION (feet): 5516.35	EASTING: 174322.40
TOTAL DEPTH DRILLED (feet): 45.00	NORTHING: 1131539.50
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt; light brown to gray brown, very fine, well sorted, dry.	
	1.0				
5.0				Sandy silt to silty sand; light brown to gray brown, very fine to fine grain, well sorted, slightly moist.	
	2.0				
10.0	3.0			Silty sand; light to medium brown gray brown, fine to coarse grain, moderately well sorted, moist, minor gravels; light to medium gray, fine to medium and dark gray, fine to coarse grain, round to subround.	
	4.0				
15.0				Gravelly sand; medium brown, medium to coarse grain, moderately well sorted, moist, gravel; medium gray to dark gray, fine to coarse grain, round to subround.	
	5.0				
20.0	6.0		GM	Gravelly sand; medium brown, medium to coarse grain, moderately well sorted, moist, gravel; medium gray to dark gray, fine to coarse grain, subround to subangular.	
	7.0				
25.0					
	8.0				
				Gravelly sand; medium brown, medium to coarse grain, well sorted moist, minor to moderate gravels; medium to dark gray, medium to coarse grain, subangular to subround.	
30.0	9.0				
	10.0				
35.0				Gravelly sand; medium brown, medium to coarse grain, well sorted with gravel; fine to coarse grain; light to dark gray, subangular to round.	
	11.0				
	12.0				
40.0				Gravelly sand; medium brown - gray brown, medium to coarse grain, well sorted, moist, interbedded with gravel, light to dark gray, fine to coarse grain, subangular to round.	
	13.0				
					Total depth at 45 ft. Pulled augers. Hole open to 37 ft.

SOIL BORING LOG	BORING NUMBER: A9-3B2
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/29/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/29/97
HOLE SURFACE ELEVATION (feet): 5349.01	EASTING: 174315.00
TOTAL DEPTH DRILLED (feet): 50.00	NORTHING: 1131480.50
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	



Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt, light brown-gray brown, very fine to fine grained, well sorted, dry, minor gravels.	
	1.0				
5.0				Silty sand, light brown to gray brown, fine to medium grained, well sorted, slightly moist, minor gravels,	
	2.0				
10.0	3.0			Silty sand, medium brown to gray brown, medium to coarse grained, moderately well sorted, Increasing gravels, light to medium gray, fine grained, subrounded. Clay, brown gray, moist, slightly plastic.	
	4.0				
15.0					
	5.0			Silty sand, gray brown, fine to medium gray, well sorted, minor gravel, moist.	
20.0	6.0			Silty sand, gray brown to medium brown, fine to medium grained, moist, minor gravels, fine grained, dark gray, subrounded with clay, medium brown, plastic. Sand, medium brown, coarse, Gravel, light gray to dark gray, fine to coarse	
	7.0				
25.0			GM		
	8.0			Same as above.	
30.0	9.0			Silty gravel-sand, medium brown, medium grained, moderately well sorted, gravels, dark gray, fine to coarse, subrounded. Increasing coarse sand and gravel.	
	10.0				
35.0	11.0			Sandy gravel, medium brown, medium to course sand, angular, moist, moderately well sorted. increasing gravel, light to dark gray, fine to coarse, subangular to subrounded.	
	12.0				
40.0	13.0			Sandy gravel, medium brown to gray brown, medium to coarse sand, angular, moderately well sorted, moist. Increasing gravel, light to dark gray, fine top course, subangular to subround.	
45.0	14.0				
	15.0				Total depth at 50 ft. Pulled augers. Hole open to 44 ft.

SOIL BORING LOG	BORING NUMBER: A9-3B3
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/29/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/29/97
HOLE SURFACE ELEVATION (feet): 5339.17	EASTING: 174324.50
TOTAL DEPTH DRILLED (feet): 50.00	NORTHING: 1131460.70
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt, light brown to green gray, very fine, well sorted, dry.	
	1.0				
5.0				Sandy silt, light brown to green brown, very fine to fine grained, well sorted.	
	2.0				
10.0	3.0			Silty sand, light brown to gray brown, very fine to fine grained, well sorted, increasing moisture, minor gravels.	
	4.0				
15.0				Silty sand, medium brown, fine to coarse, predomantly coarse grained, well sorted, slightly moist, minor gravels.	
	5.0				
20.0	6.0		GM	Gravelly silty sand, medium to dark brown, fine to coarse, moderately sorted, moist, with gravel, medium to dark gray fine to coarse, subangular to subrounded.	
	7.0				
25.0				Increasing sand, medium brown coarse grained, subangular , well sorted.	
	8.0				
30.0	9.0			Gravelly silty sand, medium brown, medium to coarse grained, moderate to well sorted, moist, with gravel, medium to dark gray, fine to course, subangular to round.	
	10.0				
35.0	11.0			Same as above.	
	12.0				
40.0				Sandy gravel, brown gray, fine to coarse grained, subangular to subrounded, moist, increasing coarse gravel.	
	13.0				
45.0	14.0			Same as above.	
	15.0				Total depth at 50 ft. Pull augers. Hole open to 45 ft.

SOIL BORING LOG	BORING NUMBER: A9-3B4
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/30/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/30/97
HOLE SURFACE ELEVATION (feet): 5332.61	EASTING: 174231.40
TOTAL DEPTH DRILLED (feet): 50.00	NORTHING: 1131380.00
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt, light brown to green gray, very fine, well sorted, dry.	
	1.0				
5.0				Sandy silt, light brown to green brown, very fine to fine grained, well sorted.	
	2.0				
10.0	3.0			Silty sand, light brown to green brown, very fine to fine grained, well sorted.	
	4.0				
15.0				Silty sand, medium brown, fine to coarse grained, well sorted, slightly moist, minor gravels.	
	5.0				
20.0	6.0		GM	Gravelly, silty sand, gray brown to medium brown, fine to coarse, moderately sorted, subangular to subrounded quartz, moist, with gravel, medium to dark gray, fine to coarse, subangular to round.	
	7.0				
25.0				Same as above.	
	8.0				
	9.0				
30.0				Gravelly silty sand, medium brown, medium to coarse grained, moderate to well sorted, moist, with gravel, medium to dark gray, fine to coarse, subangular to round.	
	10.0				
35.0				Same as above.	
	11.0				
	12.0				
40.0				Gravelly silty sand, medium brown, medium to coarse grained, moderately sorted, moist, interbeded with gravel, light gray to medium dark gray, fine to coarse subangular to round.	
	13.0				
45.0				Same as above.	
	14.0				
	15.0				Total depth 50 ft. Pull augers. Hole open to 45.5 ft.

SOIL BORING LOG	BORING NUMBER: A9-3B5
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/30/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/30/97
HOLE SURFACE ELEVATION (feet): 5345.73	EASTING: 487046.90
TOTAL DEPTH DRILLED (feet): 48.00	NORTHING: 1129470.40
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt, light brown, very fine to fine grained, well sorted.	
	1.0				
5.0				Sandy silt to silty sand, brown gray, very fine to medium, well sorted, dry with gravels, light to dark gray, predominately fine grained, increasing coarse brown sand.	
	2.0				
10.0	3.0			Silty sand, medium brown, fine to coarse grained, moderately well sorted, increasing moisture with minor to moderate gravels, predominately light gray, fine to coarse grained, moderately sorted, moist gravel, light to dark gray, fine to coarse, subangular to rounded.	
	4.0				
15.0					
	5.0			Same as above.	
20.0	6.0		GM	Gravelly silty sand, medium brown to gray brown, fine to coarse grained, moderately sorted, moist. Gravel, light to dark gray, fine to coarse, subangular to round minor clay.	
	7.0				
25.0				Gravelly silty sand, medium brown to gray brown, fine to medium grained, moderately sorted, moist with gravel, light to dark gray, fine to coarse, subangular to rounded, increasing clay.	
	8.0				
30.0	9.0			Gravelly silty sand, medium brown to gray brown, fine to coarse grained, subangular moderately sorted, moist with gravel, light to dark gray, fine to coarse grained, subangular to rounded, increasing clay, light brown, slightly plastic.	
	10.0				
35.0					
	11.0			Same as above.	
40.0	12.0		CL	Gravelly silty sand, gray brown to medium brown, fine to coarse grained, subangular moderately sorted, moist with gravels, light to dark gray, fine to course, subangular to round, and clay, gray brown, firm, slightly plastic, slightly moist.	
	13.0				
45.0					
	14.0				Total depth 48ft. Sloughing gravels.

SOIL BORING LOG	BORING NUMBER: A9-3B6
PROJECT NAME: AREA 9 LANDFILL	DATE HOLE STARTED: 07/30/97
PROJECT NUMBER: 771053.04.02.02.00	DATE HOLE COMPLETED: 07/30/97
HOLE SURFACE ELEVATION (feet): 5339.17	EASTING: 174274.80
TOTAL DEPTH DRILLED (feet): 55.00	NORTHING: 1131428.60
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST:D. Cox
DRILLING METHOD: Hollow Stem Auger/Split Spoon	QA CHECK: F. Baird
DRILLING CONTRACTOR: Soils Exploration	COMMENTS:
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Remarks
0.0	0.0		SM	Sandy silt light brown to brown gray, very fine to medium grained, moderately sorted, dry minor gravels.	
	1.0			Sandy silt, gray brown, very fine to medium grained, moderately sorted, dry, minor fine gravels.	
5.0	2.0				
	3.0			Silty sand, medium brown, fine to coarse grained, moderately well sorted, increasing moisture with minor to moderate gravels, predominantly light gray, fine to coarse, subangular to subrounded.	
10.0	4.0				
	5.0			Gravelly silty sand, medium brown to gray brown, fine to coarse grained, moderately sorted, moist with gravel, light to dark gray, fine to coarse, subangular to rounded, increasing clay.	
15.0	6.0		GM		
20.0	7.0			Gravelly silty sand, gray brown to medium brown, fine to coarse grained, moderately sorted, moist. Gravel, light to dark gray, fine to coarse, subangular to subrounded, clay medium brown, firm, slightly plastic.	
	8.0			Same as above.	
25.0	9.0			Gravelly silty sand, gray brown, fine to medium, minor coarse grained, poorly sorted, subangular to subrounded, increasing moisture with gravels, light to dark gray, fine to coarse, subrounded. Clay, medium brown, firm, slightly plastic.	
30.0	10.0				
	11.0			Same as above.	
35.0	12.0		CL	Gravelly silty sand, gray brown to medium brown, fine to course grained, moderately sorted, subangular to subrounded, with clay, medium brown, firm, slightly plastic.	
40.0	13.0				
	14.0		GM	Gravels, predominately light grays, fine to course, angular to rounded, with sand, gray brown, fine to course grained, moderately well to poorly sorted, subangular to subrounded, and minor clay, gray brown, dry, nonplastic.	
45.0	15.0				
50.0	16.0			Same as above	Total depth 55 ft. Pull augers. Hole open to 44.5 ft.

Appendix B

Cost Estimates

(As received from Bechtel Nevada)

EST: A-9UXO.XLS	**BN ENVIRONMENTAL RESTORATION** **COST ESTIMATE SUMMARY**	**Prep Date:** 2/24/98 **Print Date:** 2/24/98

TO: DAVE MADSEN - Environmental Restoration Task Manager **FROM:** ABDEL AGALLOUCH - ER Project Controls

SUBJECT: REMEDIAL ALTERNATIVES **TEC:** (see totals below)

WORK PKGE: CAU 453 - A-9 UXO LANDFILL ASSESSMENT (CADD SUPPORT) **WBS:** 104010213070201

TAP: ORDNANCE SITES SOURCE GROUPING **LOCATION:** TTR

TYPE OF ESTIMATE			TYPE OF WORK	
X	ORDER OF MAGNITUDE	PRELIMINARY TITLE II		RI / FS
	PLANNING/STUDY	WORK ORDER	X	REMEDIATION
	CONCEPTUAL/BUDGET	COMPARATIVE	X	CONSTRUCTION
	TITLE I / PRELIMINARY	OTHER		OTHER

BN REMEDIATION PROJECT			WORK TO BE PERFORMED BY			
ESTIMATOR:	Abdel Agallouch	702-295-5275	X	DOE PRIME CONTRACTOR		NATIONAL LAB
TASK MGR:	Dave Madsen	702-295-7211		NTS GENERAL		SUBCONTRACT
PROGRM MGR:	Dave Cowser	702-295-1632		NTS MAINTENANCE		OTHER

STATEMENT OF WORK :

This estimate has been prepared at the request of DOE/NV to provide remedial alternative costs for the closure of Corrective Action Unit (CAU) 453, an environmental restoration site listed in the Federal Facilities and Consent Order (FFACO). CAU 453 is specifically described as the Area 9 Unexploded Ordnance (UXO) Landfill Trenches located at the Tonopah Test Range (TTR). The project consists of three covered trenches (A9-1, A9-2, A9-3) that were used between 1960 and 1993 (approximate) to dispose of construction debris, debris from the A-9 TTR Facility, and ordnance related debris from range cleanup activities . Assume one of following alternatives will be used for closure of the site: No Further Action; Closure In Place (CIP) by Administrative Controls; Closure In Place by Capping; Clean Closure by Removal. This estimate will be used to identify the most cost effective alternative for closure of the site while being protective of human health and the environment. Total Estimated Costs are intended for comparative analysis of remedial field work and field management only. Costs for Project Management, project support, or other overhead functions are not included. Assume additional documentation will be required for Clean Closure alternative including extended HASP, Construction Work Plan, and UXO/EOD Handling and Procedures Plan.

SCOPE

Provide site closure using one of the following alternatives:

- NO FURTHER ACTION:
  A depression at the eastern end of cell A9-1 will be filled with native soil.
- CIP by ADMINISTRATIVE CONTROLS: A depression at the eastern end of cell A9-1 will be filled with native soil. 8' high chain link fencing will be installed around the perimeter of the site. Survey and Engineering support will be required for as-built drawing preparation. Landmarks and signs will be installed. Land Use Restrictions for the fenced area will be recorded.
- CIP by ENGINEERED COVER: A depression at the eastern end of cell A9-1 will be filled with native soil. A 3 ft. thick layer of loose pit run material will be pushed over the contiguous trench area followed by a 1ft. thick top layer which will be lightly compacted using water and heavy equipment. A "T" post and 4 strand barbed wire fence will be installed around the perimeter of the site. Landmarks and signs will be installed. Survey and Engineering support will be required for as-built drawing preparation. Land Use Restrictions for the fenced area will be recorded.

See following page/s for continuation and cost summary

Review / Concurrence:

/s/ Signature on File	2/24/98	/s/ Signature on File	2/24/98
Estimator	Date	Checked By	Date

EST: A-9UXO.XLS	**BN ENVIRONMENTAL RESTORATION** **COST ESTIMATE SUMMARY**	**Prep Date:** 2/24/98 **Print Date:** 2/24/98

SCOPE - continued

- CLEAN CLOSURE BY REMOVAL: A crew of 6 EOD trained personnel will excavate the contents of each trench by hand. Loaders, backhoes, and a small crane will support the crew for removal of cover material and debris from the trenches. Construction and ordnance debris will be examined, separated, and removed from the site. Continuous RCT and hot line support will be required. Scrap metal will be stockpiled for on-site salvage sale. Sanitary debris will be hauled to Nye County landfill for disposal. Trenches will be backfilled with barrow soil from a nearby pit. Survey and Engineering support will be required for as-built drawing preparation. No fencing, landmarks, revegetation, or signage will be required.

BASIS OF ESTIMATE

- Three trenches are present at the site. All three contain a mix of construction, TTR Area-9 Facility and ordnance related debris.
- An exploratory cleanup of exposed materials in Trench A9-1 was conducted in 1995. Only inert UXO was encountered.
- Investigation activities were conducted in 1997. Angled sampling bore holes were drilled from the sides of the trenches into the soil below the trenches (to prevent contact of drilling and sampling equipment with potential UXO). Trench contents were not intersected or sampled. Results from sample analysis indicate no constituents of concern above regulatory action levels were detected.
- NOTE: To date, only a summary of the sample analysis data has been received by BN for review.
- Some debris is exposed at the surface and may be mixed with the cover material.
- Minor areas of "soil collapse" attributed to voids in the landfill cells were observed during cleanup and investigation activities.
- An assumption was made that the material removed from Trench A9-1 during preliminary cleanup activities would be representative of the debris in all three trenches.
- Trench A9-1 appears to be approximately 155 ft long by 24 ft. wide by 15 ft. deep (2100 cy). The trench is covered by approximately .6 to 2.1 ft. of soil with a "crust-like" surface. The trench was open from 1986 to 1993.
- Trench A9-2 appears to be approximately 120 ft long by 24 ft. wide by 15 ft. deep (1600 cy). The trench is covered by approximately 1 ft. of loose and unconsolidated soil. The trench was open from 1986 to 1988.
- Trench A9-3 appears to be approximately 300 ft long by 24 ft. wide by 10 ft. deep (2700 cy). The trench is covered by approximately 1 ft. of loose and unconsolidated soil. The trench was open from the early 1960's to 1988.
- Site inspections were not conducted as part of this estimate, therefore some costs may not be included based on site specific conditions/characteristics (utilities, adjacent structures/facilities, etc.).

GENERAL ASSUMPTIONS :

- There is a potential of encountering UXO and depleted Uranium (dU) in all three landfill cells (trenches).
- EOD trained personnel will be required to identify all surface debris and to perform any excavation activities.
- No RCRA hazardous waste will be encountered at the site.
- No TPH impacted soils will be encountered requiring characterization or remediation.
- RCT and hot line support will be required for any excavation activity. RCTs will survey any materials removed from the cells.
- Survey and engineering support will be required for as-built drawing preparation.
- Labor costs are based on a 10 hr day, 5 day week schedule. 10 hours overtime per week will be paid. Personnel will be paid round trip mileage between NTS and TTR once per month during construction activities.
- Equipment and personnel will be mobed/demobed to the TTR from the Nevada Test Site. One mobe/demobe activity is estimated for the CAU closure.
- Assume lodging and meals are available for personnel at the TTR USAF facilities.
- Assume the USAF will accept Land Use Restrictions for the site.
- Non-hazardous and sanitary excavated wastes will be disposed at the Nye County Landfill located near Tonopah. Access to the landfill will be normal work week hours.
- Construction water can be obtained from a well within 7 miles of the site.
- Soil used for backfill or cap construction can be obtained from a borrow pit approximately 6 miles from the site.
- Assume revegetation will not be required for any one of the four alternatives.

See following page/s for continuation and cost summary

EST: A-9UXO.XLS	**BN ENVIRONMENTAL RESTORATION** **COST ESTIMATE SUMMARY**	**Prep Date:** 2/24/98 **Print Date:** 2/24/98

ESCALATION:

Escallation is not included in this estimate. All costs are in FY98 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

COST SUMMARY - TOTAL ESTIMATED COST PER REMEDIAL ALTERNATIVE

- NO FURTHER ACTION: **$94,464**
- CIP by ADMINISTRATIVE CONTROLS: **$230,396**
- CIP by ENGINEERED COVER: **$463,564**
- CLEAN CLOSURE BY REMOVAL **$2,796,430**

See MPM print out for official detailed estimated costs.

Appendix C

Nevada Division of Environmental Protection
Document Review Sheet

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number Corrective Action Decision Document for the Area 9 UXO Landfill, TTR, Nevada, CAU 453	2. Document Date December 1997
3. Revision Number Draft Rev. 0	4. Originator/Organization IT Corporation
5. Responsible DOE/NV ERP Subproject Mgr. J. Appenzeller-Wing	6. Date Comments Due
7. Review Criteria	
8. Reviewer/Organization/Phone No. NDEP	9. Reviewer's Signature

10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
1. Page 7		This site was never permitted as a Class III landfill, therefore, your request for a waiver from the requirements for a Class III landfill cannot be granted. Comparisons can be made between this landfill and a Class III landfill with justification for not capping or monitoring based on these comparisons.	The following sentence will be added to Page 7, before the sentence preceding the bullets: "While this landfill was never permitted under these regulations, comparison of site conditions with regulatory requirements provides criteria for evaluating the need for capping and/or monitoring at the site." Rewrite the last two paragraphs on Page 7 as follows: "Based on these criteria, a permitted landfill would be eligible for a waiver of both capping and monitoring requirements. Therefore, monitoring is not considered necessary at the CAU. Measures should be taken, however, to prevent inadvertent contact with potentially live UXO."	
2. Page A-7		The statement was made that "the preliminary action level for radiation monitoring results was established at two times background levels." Since the "background levels for beta radiation fluctuated from approximately 950 to 2000 dpm," what number was utilized to calculate twice background from?	Daily background readings for beta radiation fluctuated around 950 dpm; this was the value used to calculate 2X background and to drive both health and safety concerns and sampling points. This is clarified in the text by modifying the Page A-7, Section A.2.3.2, Second Paragraph, fifth sentence, as follows: "Background levels for beta radiation fluctuated around 950 dpm;. . ."	
3. Page A-13		This document utilizes the "Offsite RAdiation Exposure Review Project (ORERP) Phase II Soils Programs. NDEP needs to obtain a copy of this report.	A copy of this document was provided to NDEP on April 10, 1997, per the same request for the Cactus Spring Waste Trenches CADD comment resolution.	

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Corrective Action Decision Document for the Area 9 UXO Landfill, TTR, Nevada, CAU 453

Revision Number Draft Rev. 0

Reviewer/Organization NDEP

10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
4. Pages A-15, A-18, and A-19 Comparison		On Page A-15, BHB-2 is stated as being sample number TTR00781 and TTR00782 and BHB-3 is stated as being sample TTR00783 and TTR00784. On Page A-18 (A3.6) BHB-2 is stated as being sample number TTR00783 with associated justification for elevated arsenic level. BHB-2 is north of A9-1 as stated in the justification, however, the elevated arsenic concentration is in sample TTR00783 (BHB-3) which is east of A9-1. These pages need to clarify these inconsistencies.	The tables are correct. Appropriate corrections will be made to the text to accurately reflect the data presented in the tables.	

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to DOE/NV Environmental Restoration Division, Attn: QAC, M/S 505.

Distribution

*Provide copy on initial distribution of Rev. 0; remainder of list gets Rev. 0 if approved without changes, and entire list receives distribution of Rev. 1, if issued.

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