02-011

TA-21

ENVIRONMENTAL RESTORATION PROJECT

Los Alamos National Laboratory/University of California
Risk Reduction & Environmental Stewardship (RRES)
Environmental Restoration (ER) Project, MS M992
Los Alamos, New Mexico 87545
(505) 667-0808/FAX (505) 665-4747

U.S. Department of Energy
Office of Los Alamos Site Operations, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
(505) 667-7203/FAX (505) 665-4504

Date: July 1, 2002
Refer to: ER2002-0420

Mr. John Young, Corrective Action Project Leader
Permits Management Program
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building 1
Santa Fe, NM 87505-6303

JUL 2002

SUBJECT: SUBMITTAL OF REVISION 1 OF THE VOLUNTARY CORRECTIVE MEASURES (VCM) PLAN FOR SOLID WASTE MANAGEMENT UNIT (SWMU) 21-011(k), AT TECHNICAL AREA (TA) 21

Dear Mr. Young:

Enclosed please find two copies of the "Voluntary Corrective Measures Plan for Solid Waste Management Unit (SWMU) 21-011(k) at Technical Area (TA) 21, Revision 1". The revised VCM Plan is submitted in response to the "Notice of Technical Incompleteness – Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k)" received from the New Mexico Environment Department Hazardous Waste Bureau (NMED-HWB) on May 16, 2002, and on preliminary electronic comments NMED sent to John Hopkins on May 7, 2002. Los Alamos National Laboratory would like to thank Vickie Maranville, Kirby Olson, and Dave Cobrain for taking the time to meet with the Environmental Restoration Project staff on May 8, 2002 to discuss NMED's comments and our responses. We believe that because of this meeting, LANL is able to concisely provide the additional information and make the revisions to the VCM plan requested by NMED.

If you have any questions, please contact John Hopkins at (505) 667-9551 or Woody Woodworth at (505) 667-5820

Sincerely,

David McInroy, Acting Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

Sincerely,

Everett Trollinger, Project Manager
Department of Energy
Office of Los Alamos Site Operations

10646

DM/ET/PB/vn

Enclosure: 1) VCM Plan for SWMU 21-011(k) at TA-21, Revision 1

Cy:(w/enclosure)
P. Bertino, RRES-R, MS M992
J. Hopkins, RRES-R, MS M992
M. Kirsch, RRES-R, MS 992
M. Wetovsky, RRES-R, MS M992
W. Woodworth, OLASO, MS A906
V. Maranville, NMED-HWB
S. Yanicak, NMED-OB
L. King, EPA Region 6
IM-5, MS A150
RPF MS M707
RRES-CT#839 File MS M992

Cy:(w/o enclosure)
D. McInroy, RRES-R, MS M992
B. Ramsey, RRES-DO, MS J591
J. Bearzi, NMED-HWB
J. Davis, NMED-SWB
J. Parker, NMED-OB
RRES-ER File, MS M992

TA 21

ENVIRONMENTAL RESTORATION PROJECT

A Department of Energy
Environmental Cleanup Program

LA-UR-02-3807
July 2002
ER2002-0411

Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21

Revision 1

Los Alamos
NATIONAL LABORATORY
Los Alamos NM 87545

Prepared by the MDA Focus Area

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the Regents of the University of California, the United States Government nor any agency thereof, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the Regents of the University of California, the United States Government, or any agency thereof.

Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

EXECUTIVE SUMMARY

This Voluntary Corrective Measure (VCM) plan presents the approach for remediation of Solid Waste Management Unit (SWMU) 21-011(k) located within Technical Area (TA) 21 at Los Alamos National Laboratory (LANL or the Laboratory).

SWMU 21-011(k) consists of an inactive National Pollutant Discharge Elimination System (NPDES)-permitted outfall (NPDES outfall no. EPA 050050) for treated industrial wastewater from the former wastewater treatment plants (WWTPs) (Buildings 21-35 and -157) at TA-21. Components of the SWMU include a 4-in. cast iron drainline and outfall area on the north-facing slope of DP Canyon. The initial drainline from holding tanks 21-112 and -113 consisted of a 4-in. vitrified-clay pipe (VCP) that reportedly discharged to an "outfall ditch" excavated into soil and tuff (LANL 1991, 07528.1). The VCP was replaced in 1976 with a 4-in. cast iron drainline that was installed within the VCP drainline excavation and outfall ditch. The discharge end of the 4-in. cast iron drainline is located approximately 80 ft north of the TA-21 perimeter road where the outfall ditch previously ended. A gently sloping, rocky surface extends from the end of the outfall drainline approximately 30 ft to the south rim of DP Canyon. The effluent discharged at SWMU 21-011(k) was comprised of process wastewater generated from the purification of plutonium and contained a variety of radioactive and chemical constituents. SWMU 21-011(k) received industrial effluent from the WWTP in Building 21-35 from 1952 until 1967 and from the WWTP in Building 21-257 (that replaced the treatment plant at Building 21-35) from 1967 to July 1986 (LANL 2002, 73115). The inactive outfall was not included in the subsequent LANL NPDES permit renewal, which took effect in 1994. The drainline was not plugged until January 2001 (LANL 2001, 72667).

SWMU 21-011(k) was investigated in 1988 by the Department of Energy (DOE) and by the Laboratory's Environmental Restoration (ER) Project in 1992 and 1993 after use of the outfall had been discontinued. Previous investigation results indicate the presence of radionuclide contamination. An interim action (IA) was performed in 1996 to 1) divert storm water away from the outfall area, and 2) remove a portion of the radionuclide source term from the hillside by excavating and removing the most highly contaminated soil with activity exceeding the gross gamma level of approximately 100,000 counts per minute (cpm). Approximately 390 yd^3 of radioactively contaminated soil was removed from the site and disposed of at the Laboratory's low-level radioactive waste landfill, Area G at TA-54. Post-excavation radiation survey and soil sampling showed a reduction in gross gamma count levels from greater than 500,000 cpm to 100,000 cpm. The IA Report recommended the development of a VCM to effect a final remedy at the site (LANL 1997, 55648.2).

In November 2000, an extensive in situ gamma spectrometry survey was conducted over the entire site. In March 2001, 48 surface and subsurface soil, tuff, and/or sediment samples were collected from eleven of the in situ gamma survey locations. Twenty-six of the samples were analyzed specifically for waste characterization purposes. The data from the in situ gamma survey and characterization samples was used to confirm the location of remaining areas within the boundary of SWMU 21-011(k) with concentrations above the VCM target cleanup level of 150 picocuries per gram (pCi/g) of cesium-137 (Cs-137), and establish a correlation between Cs-137 concentrations, the primary radionuclide at the site, and the concentrations of other radionuclides present at the site. Review of the data from the November 2000 and March 2001 sampling events indicate the following:

- Based on the average concentration of radionuclides present, the site meets dose criterion protective of an individual using the area for recreational trail use. However, there are areas where the target cleanup level described in this plan of 150 pCi/g Cs-137 is exceeded.

- The chemicals of potential concern (COPCs) are radionuclides including primarily Cs-137 (half-life 30 yrs.) and americium-241 (half-life 432 yrs.).
- Contaminated material at the site would not be considered hazardous waste upon generation.
- Several inorganic chemicals were detected just above background values and will be included in human health and ecological screening assessments to be performed as part of the VCM Completion Report.
- Completion of the VCM will result in a dose lower than the dose below that required to satisfy DOE's "As Low As Reasonably Achievable" (ALARA) requirement for corrective measures.

The objectives of this VCM are to

- control the radionuclide contamination remaining at the site;
- reduce the potential dose associated with the remaining contaminated material; and
- prevent future contaminant migration.

To meet these objectives, the Laboratory's ER Project will conduct the following activities:

- excavate and dispose of the outfall drainline;
- excavate and solidify contaminated soil, tuff and sediment from areas at the site with Cs-137 concentrations above 150 pCi/g;
- place solidified material in a stabilization cell to be excavated near the center of the SWMU;
- restore the site by installing an engineered cover over the stabilization cell and areas where soil, tuff, and sediment with Cs-137 concentrations above 150 pCi/g was removed, followed by the placement of a vegetative cover over the entire site;
- install stormwater run-on and runoff controls.

As the details of this VCM plan are presented in the body of this document, the following should be taken into account:

- The site is located on the hillside above DP Canyon where the average slope is 21%, which is too steep for a building site.
- The planned land use for this site is industrial, with the site remaining under DOE control for at least the next 100 years; however, access by TA-21 workers for recreational use makes the trail-user land use scenario more practical.
- The principle radionuclides contributing to trail-user exposure are Cs-137 (~78% of the dose, half-life 30 yr) and americium-241 (~13% of the dose, half-life 432 yr). Over the next 100 years, radioactive decay alone will cause dose rates to decline to 26% of current levels under the recreational trail-user scenario assuming pre-remediation average site concentrations.

Table of Contents

EXECUTIVE SUMMARY ..... **III**

1.0 INTRODUCTION **1**
- 1.1 Purpose and Scope 1
- 1.2 Regulatory History 4
- 1.3 Rationale for Proposed Corrective Measure 4

2.0 PREVIOUS SITE CHARACTERIZATION AT SWMU 21-011(K) **5**
- 2.1 Site Description and Operational History 5
- 2.2 Previous Field Investigations 6
  - 2.2.1 1996 Interim Action Soil Removal 8
  - 2.2.2 2000 Chemrad and In Situ Surveys and 2001 Pre-VCM Characterization Sampling 10

3.0 BASIS FOR CLEANUP LEVELS **15**

4.0 PROPOSED CORRECTIVE MEASURE **17**
- 4.1 Conceptual Model 17
- 4.2 Supplemental Sampling 19
  - 4.2.1 Surveys and Sampling 19
  - 4.2.2 Radiological Sampling 19
  - 4.2.3 Western Drainage Pre-Excavation Screening 20
- 4.3 Technology Evaluation/Literature Search 20
- 4.4 Solidification Bench Scale Study 22
- 4.5 Remedial Approach 24
  - 4.5.1 Site Restoration 27

5.0 CONFIRMATION SURVEYS AND SAMPLING **28**
- 5.1 Confirmation Sampling beneath the Outfall Drainline at SWMU 21-011(k) 28
- 5.2 Confirmation Surveys and Sampling of Soil Removal Areas 30
- 5.3 Short-Term Maintenance and Monitoring 30

6.0 WASTE MANAGEMENT **30**
- 6.1 Estimated Types and Volumes of Waste 30
- 6.2 Method of Management and Disposal 32

7.0 PROPOSED SCHEDULE AND UNCERTAINTIES **32**

8.0 REFERENCES **33**

APPENDICES

Appendix A Acronyms and Abbreviations A-1

Appendix B VCM Checklist B-1

Appendix C Standard Operating Procedure 2.01 ..... C-1

Appendix D Ecological Scoping Checklist D-1

Appendix E Estimated Costs E-1

Appendix F Data Analysis, RESRAD Inputs, Results, Single Radionuclide Soil Guidelines F-1

Appendix G Previous InvestigationS G-1

Appendix H 2001 Pre-excavation Characterization Sampling Details H-1

Attachments

Attachment 1 2001 Release/Discharge Notification

Attachment 2 Treatment Technologies Evaluation Information

Attachment 3 Federal Express Shipping Receipts and IT Laboratory Receipt Letter for Benchscale Study Samples from SWMU 21-011(k)

Attachment 4 IT Corporation Benchscale Study Report

Attachment 5 90% Design Package – Plans and Specifications for the Engineered Cover

Attachment 6 Notice of Intent Application for Pug Mill

Attachment 7 Draft Construction Quality Control Plan

List of Figures

Figure 1.0-1. Location of TA-21 with respect to Laboratory TAs and surrounding land holdings. 2

Figure 1.0-2. Location of SWMU 21-011(k) within Laboratory TA-21. 3

Figure 1.3-1. Present-day dose vs. time for trail-user scenario at SWMU 21-011(k) 5

Figure 2.2-1. 1988, 1992, and 1993 sampling locations at SWMU 21-011(k) 7

Figure 2.2-2. 1996 interim action soil removal area and confirmation sample locations at SWMU 21-011(k) 9

Figure 2.2-3. July 2000 Chemrad gross gamma survey results at SWMU 21-011(k) 11

Figure 2.2-4. November 2000 in situ gamma survey results and March 2001 Pre-VCM characterization sample locations at SWMU 21-011(k) 12

Figure 3.0-1. Dose vs. time for trail-user scenario at SWMU 21-011(k) after excavation, solidification, and reburial prior to installation of engineered cover 16

Figure 3.0-2. November 2000 in situ gross gamma survey results at SWMU 21-011(k) with circled areas planned for removal and stabilization 18

Figure 4.4-1. December 2001 bench scale sample locations at SWMU 21-011(k) 23

Figure 4.5-1. Schematic of stabilization cell 26

Figure 5.1-1. Outfall pipe to be removed and proposed confirmation sample locations at SWMU 21-011(k) 29

List of Tables

Table 1.2-1 Regulatory Activity for SWMU 21-011(k) 4

Table 2.2-1 1996 Interim Action Confirmation Sample Results 10

Table 2.2-2 2001 Pre-VCM Characterization Sample Organic Chemical Concentrations 14

Table 2.2-3 2001 Pre-VCM Characterization Sample Radionuclide Concentrations above Background/Fallout 145

Table 3.0-1 SRSGs Derived for the Recreational Trail-User Scenario 16

Table 6.1-1 Waste Streams, Types, and Volumes at SWMU 21-011(k) 31

Table 7.0-1 VCM Field Work Schedule 33

1.0 INTRODUCTION

This VCM plan presents the approach for remediating SWMU 21-011(k) located at TA-21, at Los Alamos National Laboratory (Figures 1.0-1 and 1.0-2). SWMU 21-011(k) is an inactive drainline and outfall listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585.2).

1.1 Purpose and Scope

The objectives of this VCM are source reduction/control, dose reduction, and prevention of contaminant migration. To meet these objectives, the Laboratory's ER Project will conduct the following activities:

- supplemental sampling;
- staged solidification of approximately 500 yd^3 of contaminated soil;
- reburial of the solidified soil within the SWMU boundary;
- confirmation sampling;
- engineered site restoration;
- post-VCM radiation survey and/or sampling;
- removal of the inactive and plugged drainline extending from the wastewater treatment tanks to the outfall area and confirmation sampling beneath the line; and
- installation of stormwater run-on and runoff controls.

The DOE requires that corrective measures implemented at sites with radionuclide contamination strive to reduce radiation levels to "As Low As Reasonably Achievable" (ALARA). This VCM plan incorporates the principle of ALARA (DOE 1990, 58980.1). ALARA features include isolating radioactive materials from the environment, removal of areas with elevated radioactivity (above 150 pCi/g of Cs-137), and avoidance of risk related to off-site transportation of radioactive materials. The COPCs at SWMU 21-011(k) are cesium-137 (Cs-137), strontium-90 (Sr-90), americium-241 (Am-241), and plutonium-239 (Pu-239). While the site, on average, meets the 15 mrem/yr dose limit for a recreational trail-user scenario (Appendix F), this dose limit is exceeded within some areas of the site. Soil from these areas will be removed, solidified, and placed in a stabilization cell on site, below an engineered cover (see Figure 3.0-2). Implementation of the VCM will reduce exposure to a trail-user below the 15 mrem/yr dose limit over the entire site consistent with ALARA. Long-term monitoring of the site will be discussed in the VCM completion report for SWMU 21-011(k).

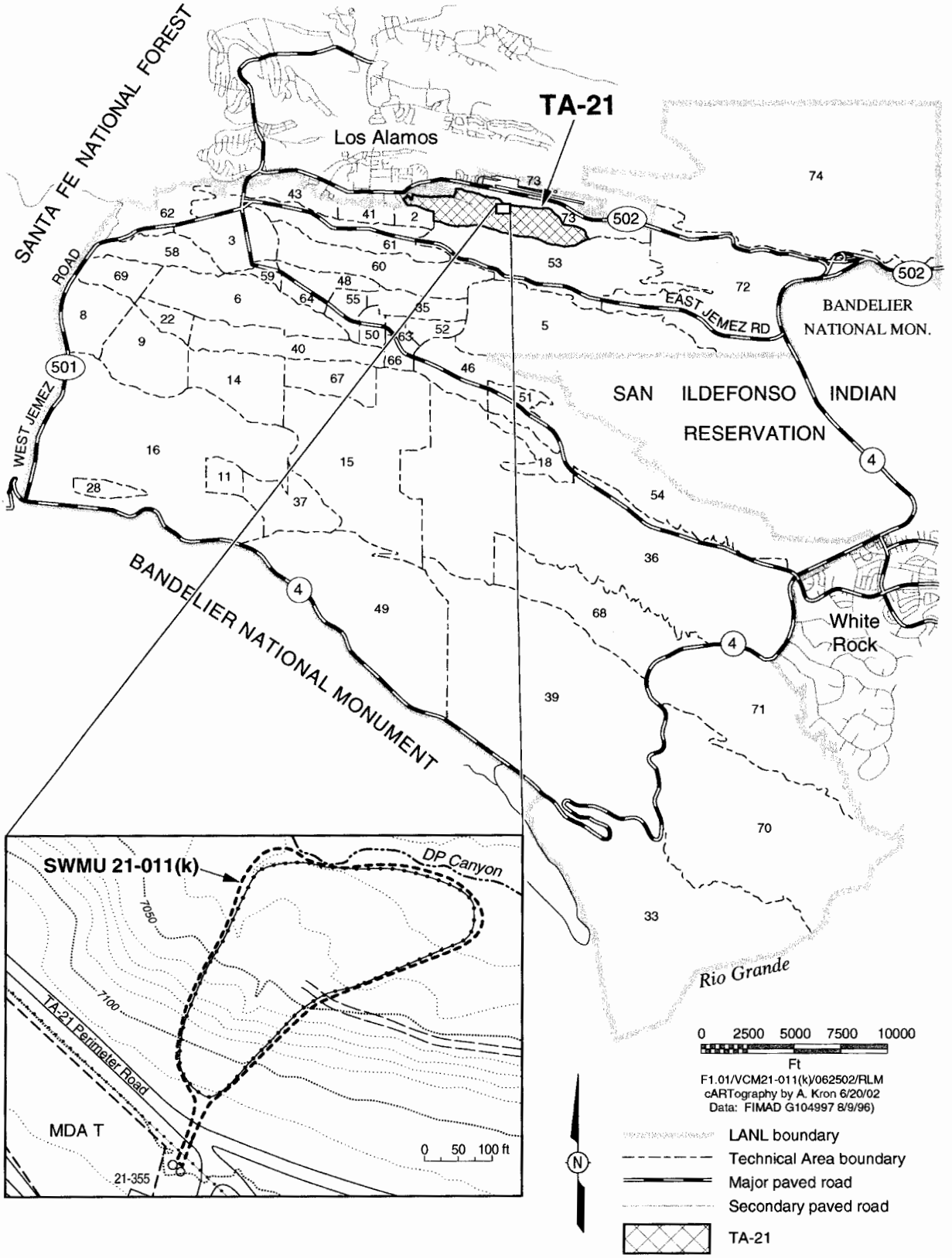


Figure 1.0-1. Location of TA-21 with respect to Laboratory TAs and surrounding land holdings

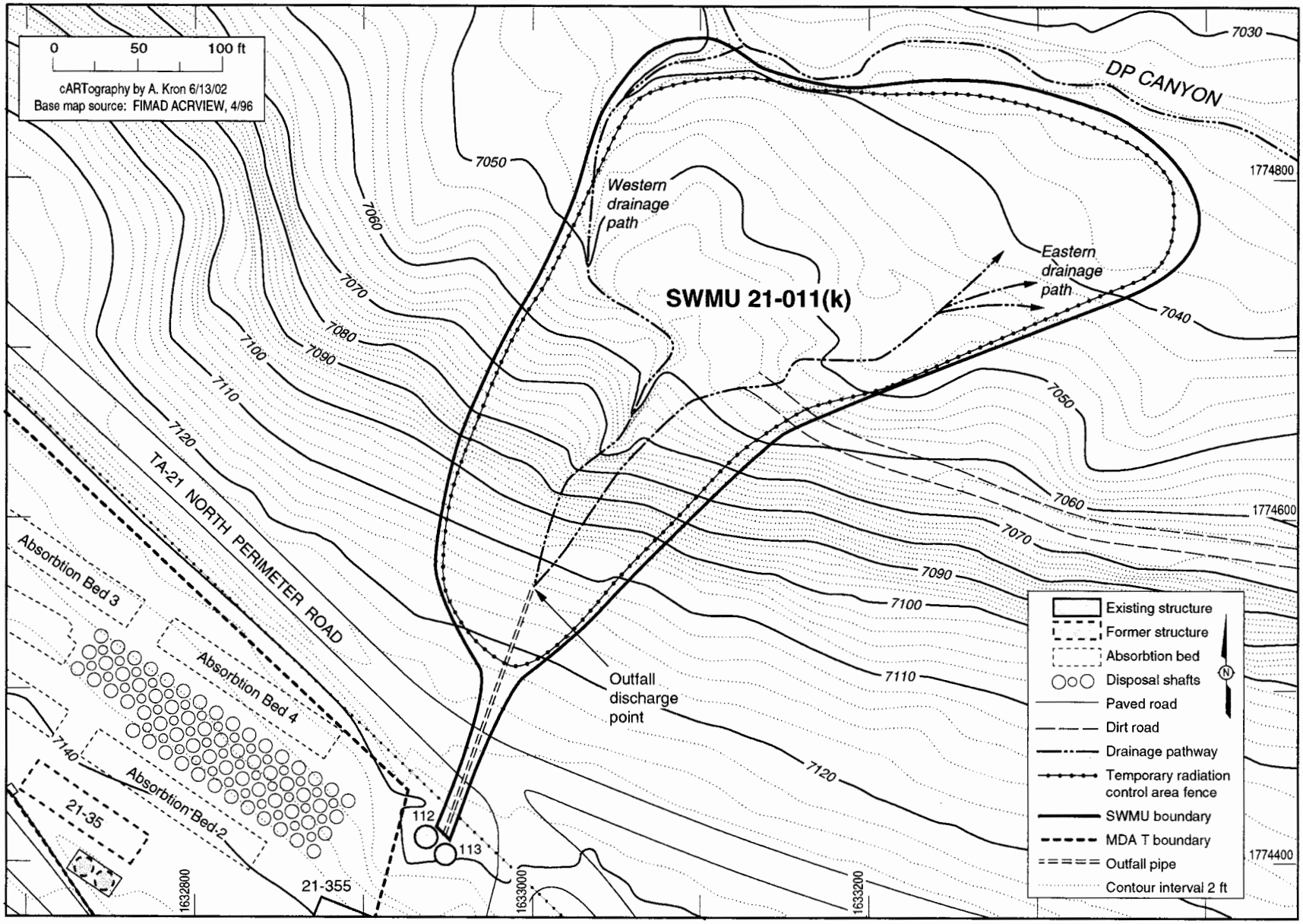


Figure 1.0-2. Location of SWMU 21-011(k) within Laboratory TA-21

1.2 Regulatory History

The regulatory activities conducted at SWMU 21-011(k) are summarized in Table 1.2-1.

Table 1.2-1
Regulatory Activity for SWMU 21-011(k)

Date	Activity	Document
1988	DOE Reconnaissance Sampling	1994 TA-21 OU RFI Phase Report 1C (LANL 1994, 31591.1)
1991	LANL TA-21 RFI Work Plan	1991 TA-21 Operable Unit RFI Work Plan for Environmental Restoration (LANL 1991, 07528.1)
1992-93	RFI Site Characterization	1994 Addendum to TA-21 Phase Reports 1B and 1C (LANL 1994, 52350.1)
1996/1997	Interim Action	1996 Interim Action Plan for PRS 21-011(k) (LANL 1996, 54790.2); 1997 Interim Action Report for PRS 21-011(k) (LANL 1997, 55648.2)
2001	LANL proposes soil stabilization/solidification to DOE and NMED	Communication Record (LANL 2001, 70217)

1.3 Rationale for Proposed Corrective Measure

SWMU 21-011(k) is located on the north side of DP Mesa on a hillside that leads to DP Canyon. The northern SWMU boundary is within the high-water table of the DP Canyon streambed. SWMU 21-011(k) has been identified as the primary source of radionuclide contamination in sediments in the Los Alamos (LA) Canyon watershed (LANL 1999, 63915). Approximately one-third of a curie of Cs-137 has been identified in the LA Canyon watershed inventory and exists within DP Canyon and LA Canyon. The existing radionuclide inventory in surface soils, tuff, and sediment at the site is estimated at one-fourth of a curie of Cs-137. Because of the site's high potential for erosion (erosion matrix score of 72 out of 100, Appendix C), there is the potential for radionuclides from the site to increase the radionuclide inventory in the LA Canyon watershed. Therefore, remediation of the site is considered a priority by the Laboratory, DOE, and the New Mexico Environment Department (NMED).

SWMU 21-011(k) is located on DOE property and will remain under DOE control for at least the next 100 years. Land use for TA-21 is, and will continue to be, industrial under DOE ownership and control. However, SWMU 21-011(k) is not a typical industrial site as it is located on a steep hillside that slopes to the bottom of DP Canyon. Although there are no plans by Los Alamos County to develop any hiking trails in the canyon, the area is accessible to LANL employees and potentially to the public. Consequently, the trail-user land use scenario is proposed for this VCM (LANL 2001, 70217) and used to screen soil and sediment areas with potentially elevated radionuclide activity exceeding acceptable human health dose levels.

The intent of the proposed VCM is to remove localized areas of elevated contamination (greater than 150 pCi/g Cs-137) and place this material into a stabilized condition (Section 4.5) that prevents migration for a period of time (approximately 100 years) over which the Cs-137 will decay to acceptable levels. The present day, calculated dose rate of 7 mrem/yr is mostly (78%) due to Cs-137, which has a half-life of about 30 years. The dose rate is projected to decline to less than 2 mrem/yr within 100 years due solely to decay of Cs-137 (Figure 1.3-1).

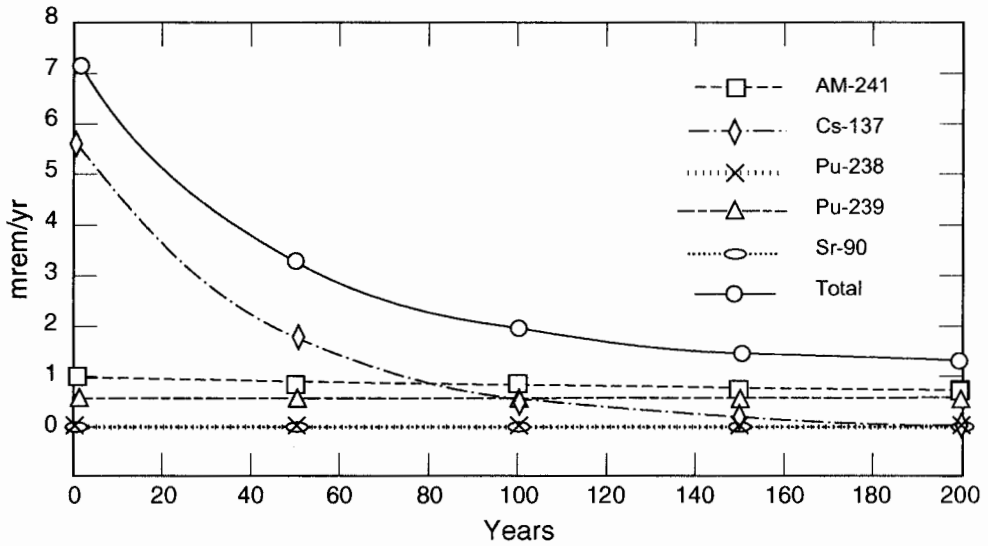


Figure 1.3-1 Present-day dose vs. time for trail-user scenario at SWMU 21-011(k)

Bench-scale solidification testing, using tuff, soil, and sediment from SWMU 21-011(k), verified that this stabilization technology can be successfully implemented at the site (LANL 2002, 72638 and Attachment 4). Site restoration will include the placement of an engineered compacted cover over the stabilized/solidified material and excavated areas and soil over the entire site to accommodate revegetation. The engineered cover over the stabilization cell will provide additional shielding and protection of the solidified material, and will be approximately 4 ft thick based on the need to protect the solidified soil, sediment, and tuff from freezing. A freeze depth of 16 in. was calculated for the site and a safety factor of 3 was then applied to bring the engineered cover depth to 4 ft due to the north-facing slope location of the stabilization cell, which increases the calculated depth of freezing (LANL 2002, 73217). This remediation approach is a cost-effective and proactive remedial alternative, and is preferred over no action, fencing of the site, and/or excavation and disposal of contaminated material at Area G at TA-54. This VCM approach will protect LANL employees and the public and minimize the amount of waste generated. The estimated cost savings of on-site stabilization compared to transportation and disposal at Area G is approximately $2 million due to the elimination of the costs associated with coordination and implementation of transporting low level radioactively contaminated waste over public roadways and through public areas for disposal at Area G.

2.0 PREVIOUS SITE CHARACTERIZATION AT SWMU 21-011(K)

2.1 Site Description and Operational History

SWMU 21-011(k) was the NPDES-permitted outfall (NPDES outfall no. EPA 050050) for treated industrial wastewater from the former WWTPs (Buildings 21-35 and -157) at TA-21. The SWMU consists of a drainline from two treated wastewater holding tanks (structures 21-112 and -113) and an outfall area on the north-facing slope of DP Canyon. The initial drainline from tanks 21-112 and -113 consisted of a 4-in. VCP that reportedly discharged to an "outfall ditch" excavated into soil and tuff (LANL 1991, 07528.1). The VCP was replaced in 1976 with a 4-in. cast iron drainline that was installed within the VCP drainline excavation and outfall ditch. The discharge end of the 4-in. cast iron drainline is located approximately 80 ft north of the TA-21 perimeter road where the outfall ditch previously ended. A gently sloping, rocky surface extends from the end of the outfall drainline approximately 30 ft to the south rim of DP Canyon.

TA-21 is the former plutonium processing facility at the Laboratory. The first WWTP (Building 21-35) was activated in 1952 and operated until 1967 when the new industrial WWTP (Building 21-257) came on line. Both facilities treated wastes from DP West and DP East consisting of liquids remaining after plutonium extraction and processing of radioactive materials for nuclear weapons and aeronautical research projects. The treatment process mixed the raw waste with lime, ferric sulfate, and coagulant aids. The waste was then pumped to a flocculator and on to a settling tank. Settled effluent was pumped through a pressure filter and sampled to verify adequate treatment. When the effluent was determined to be adequately treated, it was pumped to two final holding tanks (structures 21-112 and -113). From the tanks, the effluent was piped northeast toward DP Canyon and discharged on the north side of DP Mesa to what is now SWMU 21-011(k). This effluent contained a variety of radioactive and chemical constituents. Discharges of treated industrial wastewater to the outfall were discontinued in July 1986 (LANL 2002, 73115). Building 21-257 has been used since 1986 for the treatment of tritiated wastewater from the Tritium Systems Test Assembly (TSTA) facility (Building 21-155). The wastewater is stored in holding tanks 21-112 and -113 and is routinely transported by tanker truck to the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50.

Approximately 55 gal. of partially treated tritiated wastewater was released from holding tank 21-113 through the SWMU 21-011(k) drainline in January 2001 when a faulty gauge caused the tank to over fill. The wastewater in the tank originated from the TSTA facility (LANL 2002, 73116). The released wastewater was absorbed into the ground within 50 ft of the end of the 4-in. cast iron drainline within the outfall area of SWMU 21-011(k). The Release/Discharge Notification (Attachment 1) submitted to NMED and EPA Region 6, indicates that the wastewater did not reach a watercourse. The area impacted was approximately 2 ft x 50 ft and was covered with snow. After the discharge was stopped, a sample of wastewater from the tank was immediately collected and screened for tritium and for gross alpha and beta activity. The results were reported as tritium = 630 nCi/L, gross alpha = 0.14 nCi/L, gross beta = 2.2 nCi/L (LANL 2001, 72667). Tritium is exclusively a beta emitting radionuclide (with a half-life of approximately 12 yr), which accounts for the elevated gross beta activity result. These results are from the liquid wastewater that remained in the tank and are not indicative of the residual concentrations in the soil. Residual tritium concentrations in the area of the spill were initially diluted with the snow pack and then reduced through sublimation from the snow surface. Tritium concentrations were further reduced by evapotranspiration during the spring and summer. Subsequent drought conditions have resulted in the evaporation of most of the available near-surface moisture along with the residual tritium. Therefore, this release should have no noticeable impact on the proposed corrective measure for this SWMU. The outfall line from holding tanks 21-112 and -113 was permanently plugged as part of the release response in January 2001 (LANL 2001, 72667).

2.2 Previous Field Investigations

SWMU 21-011(k) was sampled during a 1988 DOE Headquarters Environmental Survey of the Laboratory (DOE 1988, 15363). In 1992, SWMU 21-011(k) was characterized in accordance with the TA-21 Operable Unit (OU) RFI Work Plan, which involved a radiological field survey and collection of soil samples (LANL 1991, 07528.1). Additional site characterization consisting of a second radiological survey and collection of additional soil samples was conducted in 1993 to confirm the elevated radioactivity levels measured in 1992 and because holding times were missed for samples submitted for analysis of volatile organic compounds (VOCs) from the 1992 sampling effort (Figure 2.2-1) (LANL 1994, 52350.1). All of the above efforts post-date inactivation of the outfall in July 1986 (LANL 2002, 73115). Data from the previous field investigations is summarized in Appendix G.

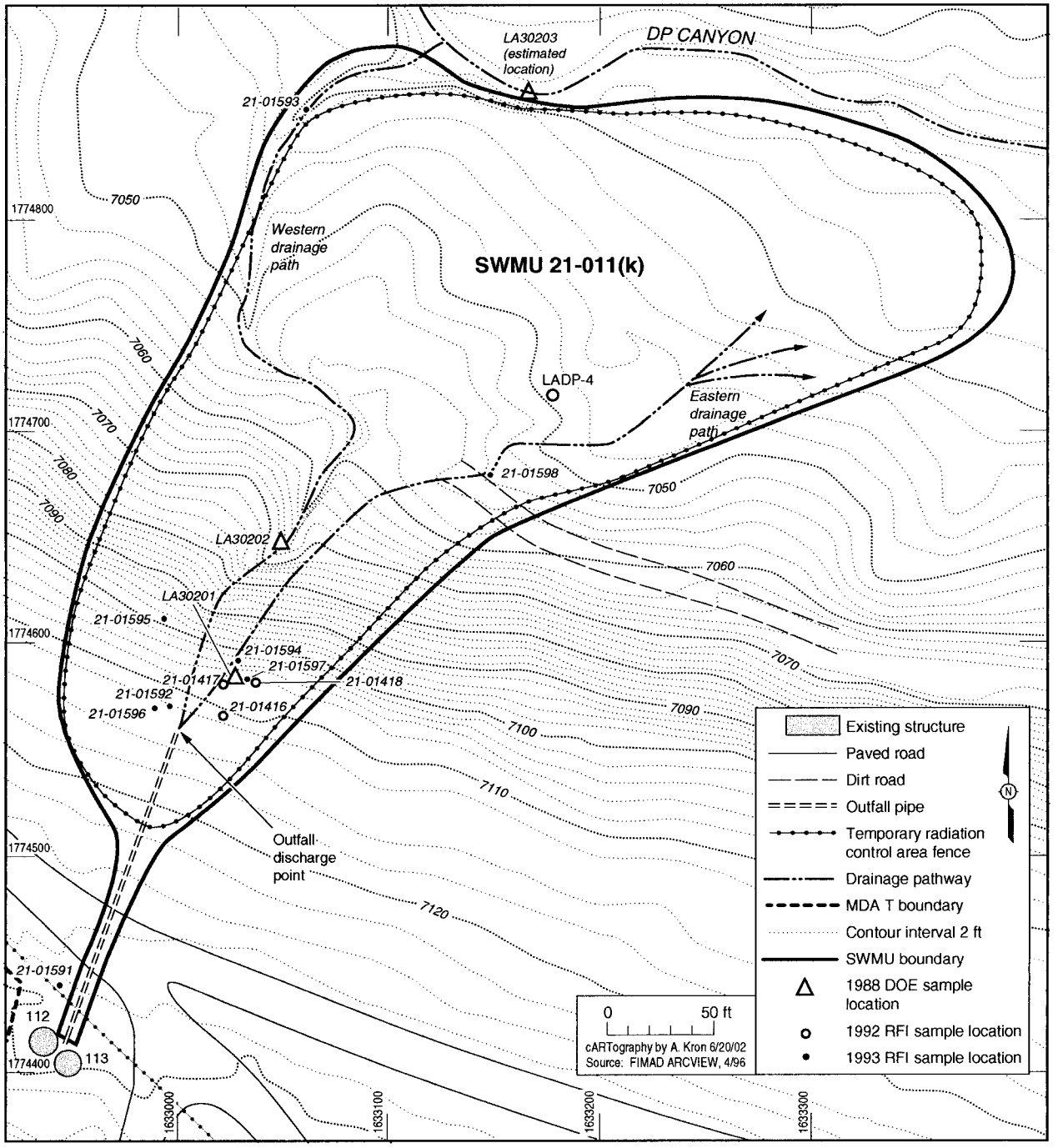


Figure 2.2-1. 1988, 1992, and 1993 sampling locations at SWMU 21-011(k)

2.2.1 1996 Interim Action Soil Removal

In 1996, an IA plan was prepared (LANL 1996, 54790.2). The IA was conducted in 1996 and reported in the Interim Action Report for Potential Release Site 21-011(k) (LANL 1997, 55648.2).

The IA had two objectives:

- remove a significant portion of the source term from the areas of the outfall exhibiting the greatest levels of radioactivity.
- install storm water control measures as a best management practice (BMP) to mitigate the migration of contaminated soil and sediment into the main channel of DP Canyon by preventing stormwater run-on and runoff.

During the 1996 IA, approximately 390 yd^3 of soil over an area of approximately 11,600 ft^2 were removed from the upper drainage/outfall area of SWMU 21-011(k) (Figure 2.2-2). Results of a post-excavation radiological survey indicated that the gross gamma activity in soil, sediment, and tuff was reduced from greater than 500,000 cpm to less than 100,000 cpm over the entire upper drainage area.

Upon completion of the soil removal in November 1996, ten surface confirmation samples (from 0 to 6 in.) were collected from the excavated area (Figure 2.2-2). The samples were analyzed for isotopic Pu, Sr-90, Cs-137 and Am-241. Analytical results for the ten surface confirmation samples are presented in Table 2.2-1 (LANL 1997, 55648.2). Analytical results in the table are compared to background or fallout values as presented in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments and Bandelier Tuff at Los Alamos National Laboratory," (Ryti et al. 1998, 59730.2). Results are also compared to risk-based screening action levels (SAL) that are protective of human health. The SALs used in these comparisons are based on a residential land use scenario presented in "Derivation and Use of Radionuclide Screening Action Levels," (LANL 2001, 69683.1). Americium -241, Cs-137, Pu-239, and Sr-90 exceeded their respective fallout values and SALs, as shown in Table 2.2-1.

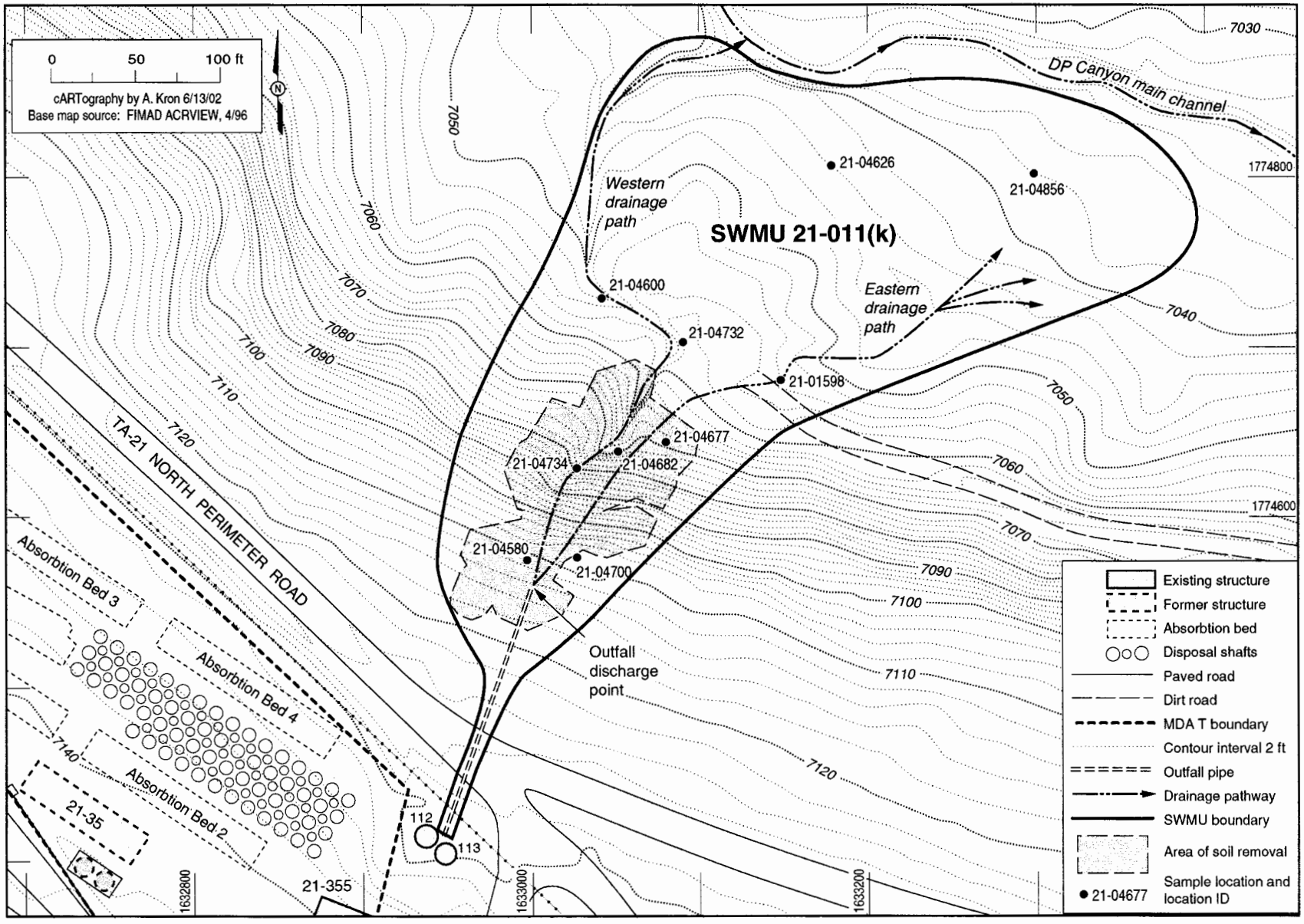


Figure 2.2-2. 1996 interim action soil removal area and confirmation sample locations at SWMU 21-011(k)

Table 2.2-1
1996 Interim Action Confirmation Sample Results

Sample ID	Location ID	Depth (ft)	Media	Am-241 (pCi/g)	Cs-137 (pCi/g)	Pu-238 (pCi/g)	Pu-239 (pCi/g)	Sr-90 (pCi/g)
Soil Fallout Value[a]				**0.013**	**1.65**	**0.023**	**0.054**	**1.31**
SAL[b]				**39**	**5.3**	**49**	**44**	**5.7**
0121-96-0801	21-04734	0-0.5	Soil	10.6	**351**	0.78	20.29	**74**
0121-96-0802	21-04682	0-0.5	Soil	32.3	**621**	5.30	**45.96**	**240**
0121-96-0803	21-04600	0-0.5	Soil	**125**	**72.1**	7.10	25.14	**30.7**
0121-96-0804	21-04677	0-0.5	Soil	10.5	**85.3**	1.22	8.73	**33.8**
0121-96-0805	21-01598	0-0.5	Soil	0.28	**7.05**	0.10	0.79	1.4
0121-96-0806	21-04732	0-0.5	Soil	2.06	**19.7**	0.24	1.83	**7.1**
0121-96-0807	21-04700	0-0.5	Soil	**601**	**66.5**	27.89	**75.15**	**63**
0121-96-0808	21-04580	0-0.5	Soil	20.2	**877**	1.01	**50.95**	**219**
0121-96-0809	21-04856	0-0.5	Soil	2.9	**327**	0.96	6.23	**24.9**
0121-96-0810	21-04626	0-0.5	Soil	14.3	**222**	4.87	23.76	**60**

Note: Results in bold face indicate concentrations above SALs.
[a]Fallout values for soil (Ryti and Longmire 1998, 59730.2)
[b]SALs (LANL 2001, 69683.10)

2.2.2 2000 Chemrad and In Situ Gross Gamma Surveys and 2001 Pre-VCM Characterization Sampling

A walkover gross gamma survey of SWMU 21-011(k) was performed by Chemrad in July 2000. Review of the resulting data (Figure 2.2-3) indicated that the nature and extent of radionuclide contamination at the site had been defined and areas with gross gamma activity above 105,000 cpm had been clearly identified. An in situ gamma survey and screening of grab samples (Figure 2.2-4) was conducted at the site in November 2000 to gather more detailed information about the nature and extent (including depth profiles) of the radionuclide contamination at the site.

During the in situ gamma surface radiation survey, 650 locations were measured for gross gamma radiation. Approximately 77% of these values were below 50,000 cpm. Approximately 91% of the measurements taken were below 100,000 cpm and 100% of the measurements were below 400,000 cpm (Figure 2.2-4). In March 2001, 11 in situ gamma survey locations were selected with concurrence from NMED (LANL 2001, 70217) to conduct depth profiling of the primary radionuclides at the site and to complete waste and site characterization activities prior to the proposed VCM (Figure 2.2-4 and Table H-1 in Appendix H). Two locations with in situ gamma survey results in the low range (less than or equal to 50,000 cpm) were chosen for sample collection, in addition to four locations exhibiting mid-range survey results (greater than 50,000 cpm but less than 100,000 cpm), and five locations exhibiting high-range survey results (greater than 100,000 cpm). The following guidance established by the Laboratory ER Project with input from NMED was followed for the pre-VCM sample collection: a minimum of one discrete grab sample was collected from each auger hole location; if no elevated radioactivity was detected, then the discrete sample was collected from the bottom of the auger hole; and two discrete samples were collected from any auger hole advanced to a depth of 5 ft or deeper with sample collection intervals based on field screening results and/or the bottom of the hole (see Appendix H).

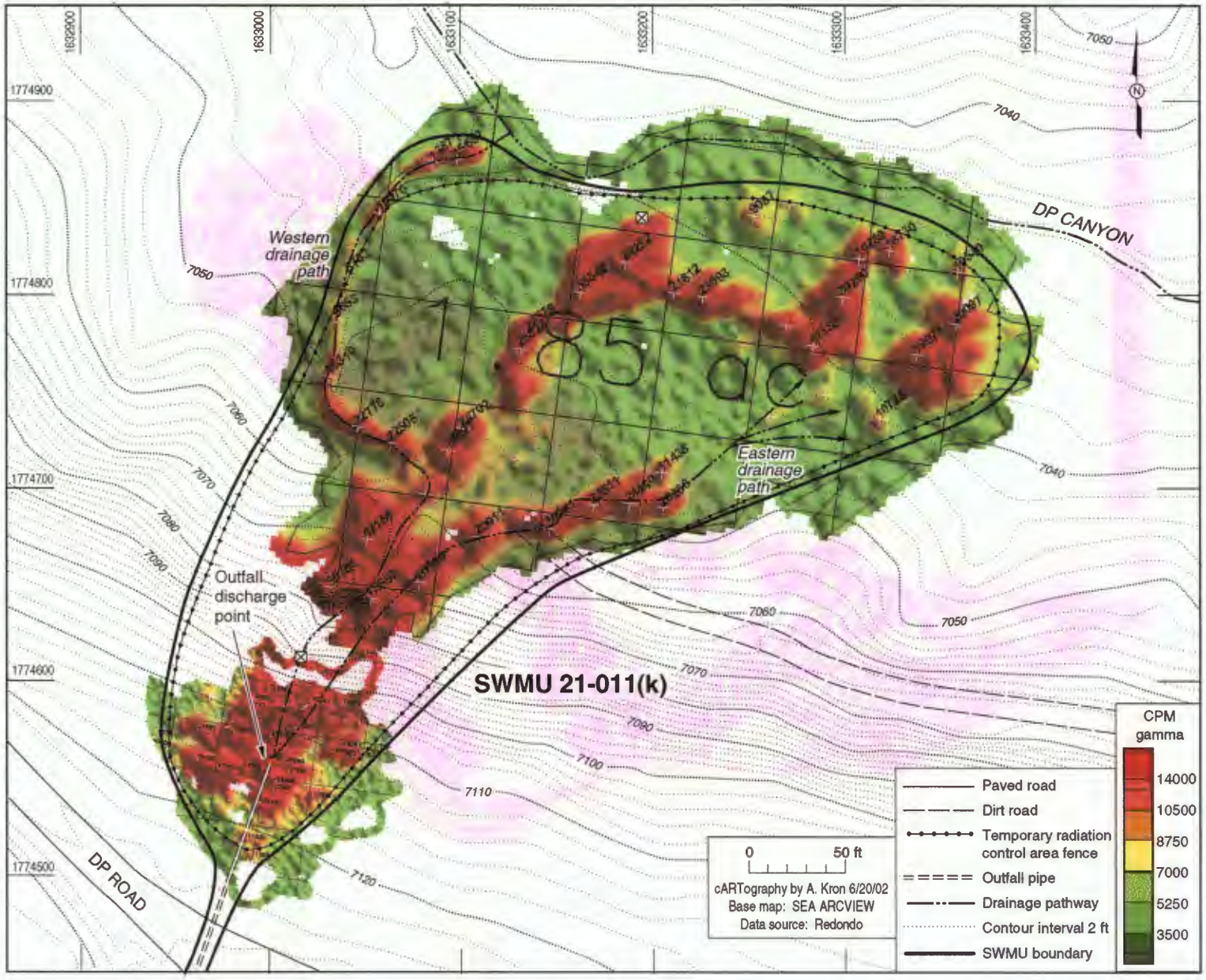


Figure 2.2-3 July 2000 Chemrad gross gamma survey results at SWMU 21-011(k)

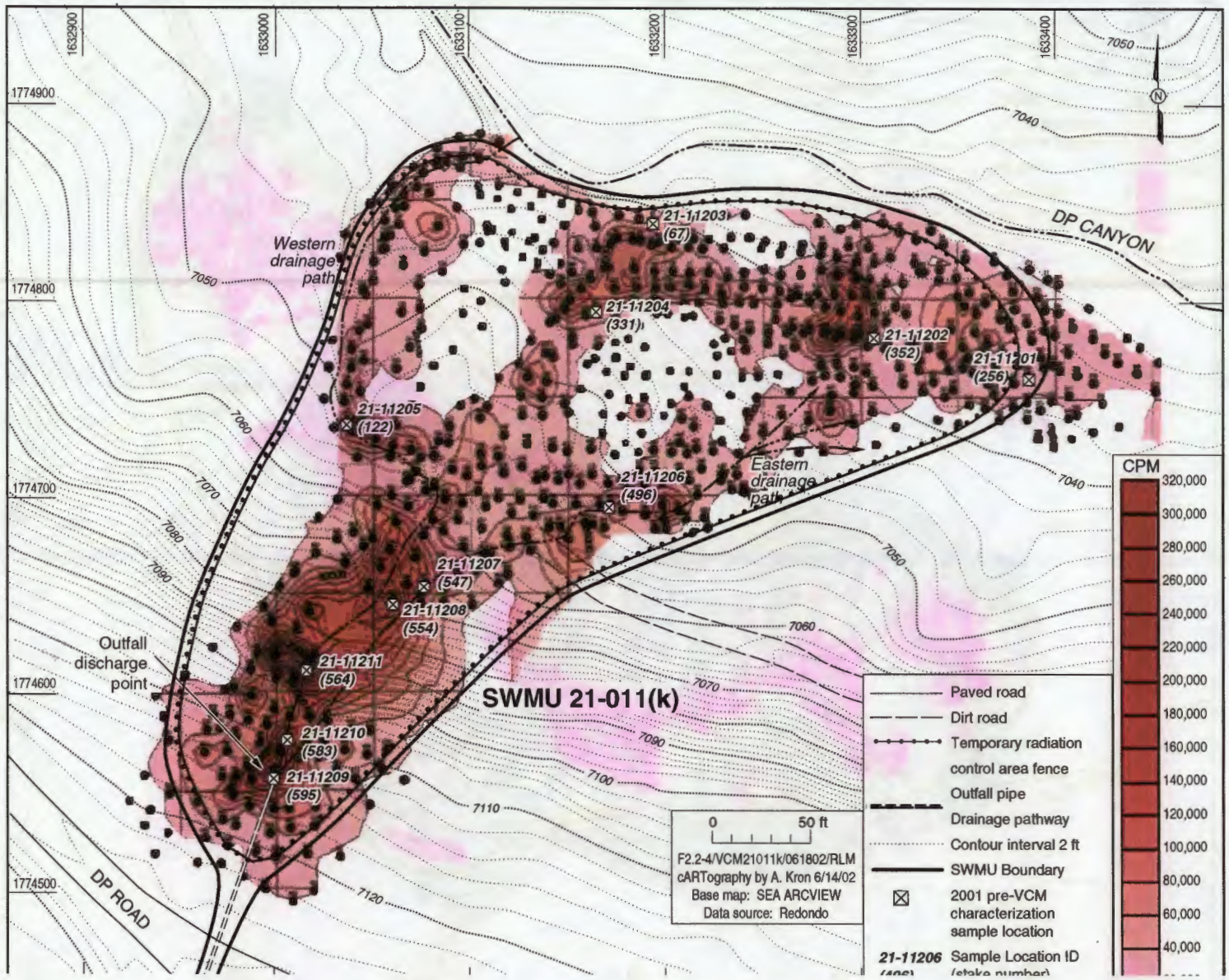


Figure 2.2-4 **November 2000 in situ gamma survey results and March 2001 pre-VCM characterization sample locations at SWMU 21-011(k)**

Samples submitted for VOC analysis were collected from the depth intervals with the highest radioactivity screening results and/or the bottom of the auger hole and not from the top six-in. sample interval. A composite sample, for waste characterization purposes, was collected from the remaining core at each of the 11 sample locations. A sample from each location was screened for gross alpha, beta and gamma radiation, Cs-137 and Am-241. The analytical suite for discrete samples collected at each location to confirm nature and extent and for site and waste characterization purposes included the following: perchlorate, gamma spectroscopy, isotopic Pu, Sr-90, Am-241, Cs-137, target analyte list (TAL) metals, toxicity characteristic leaching procedures (TCLP) metals, TCLP VOCs, TCLP semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), VOCs via Encore samplers, and screening for gross alpha beta and gamma radiation. The analytical suite for composite waste characterization samples collected at each location included all of the same analytes as the discrete samples except TAL metals.

Pre-VCM characterization sample summaries including the in situ gamma survey ID, sample location ID, sample depth, sample ID, date and time of sample collection, sample type, and the analytical suite specific to each type of sample, are shown in Table H-1 in Appendix H. The samples were collected between March 6 and 9, 2001. Field screening data were used to develop an instrument correlation curve (correlating cpm with Cs-137 activity levels), which was presented to NMED in May 2001 and is presented in Appendix F. The 2000 in situ gross gamma survey map and corresponding pre-VCM characterization sample locations are shown in Figure 2.2-4.

Sample results for discrete 2001 pre-VCM characterization samples are compared to SALs and to Ecological Screening Levels (ESLs) as presented in LANL's ECORISK database (LANL 2002, 72802).

Mercury was the single inorganic chemical detected in discrete pre-VCM characterization samples. Mercury was detected at one sample location (21-11209) at a concentration of 0.14 mg/kg, (the background value for mercury is 0.1 mg/kg). Mercury was not detected above the SAL (23 mg/kg) but was detected above the minimum ESL (earthworm) at sample location 21-11209. However, the concentration of mercury was less than the ESL for all other receptors; therefore, mercury does not pose a potential unacceptable risk to human or ecological receptors. The SALs used in these comparisons are derived according to the approach in the human health screening methodology document (LANL 2002, 72639), which is based on guidance in NMED (2000, 68554.1) and EPA (2001, 71466). The ESLs are derived based on the screening level ecological risk assessment approach document (LANL1999, 64783.1) and the latest version (R1.4) of the ECORISK database (LANL 2002, 72802). Mercury was not detected in any of the other discrete pre-VCM characterization samples.

Table 2.2-2 presents sample results for organic chemicals detected in discrete pre-VCM characterization samples. The analytical results for sample location MD21-0034 were suspect because no organics were detected in the samples collected directly above and below this sample. Therefore, three additional discrete samples (MD21-01-0519, -0520, and -0521) were collected from three depths at the same location in October 2001. The organic chemicals detected were at concentrations below their respective SALs except for trichloroethylene (TCE), which was detected at a concentration approximately equivalent to its SAL in one sample (Table 2.2-2). However, the total cancer risk and noncarcinogenic hazard is less than NMED's target level of 10^{-5} cancer and a hazard index of 1.0 (NMED 2000, 68554.1). The organic chemical concentrations were also less than the minimum ESLs (Table 2.2-2). The TCE concentration of 1.8 mg/kg is just below the minimum ESL of 1.9 mg/kg and less than the ESLs for the other receptors. Therefore, the organic chemicals do not pose a potential unacceptable risk to human or ecological receptors.

Table 2.2-2
2001 Pre-VCM Characterization Sample Organic Chemical Concentrations

Sample ID	Location Id	Date collected	Depth Interval	4,4'-DDT (mg/kg)	Acetone (mg/kg)	Methylene chloride (mg/kg)	4-Isopropyltoluene[1] (mg/kg)	2-Hexanone (mg/kg)	Trichloroethylene (mg/kg)	Toluene (mg/kg)
SAL				**1.7**	**1600**	**65**	**160[a]**	**7300[b]**	**1.6**	**180**
Minimum ESL				**0.0026**	**3.8**	**7.1**	**NA[c]**	**NA**	**1.9**	**70**
MD21-01-0025	21-11202	3/01	0-1 ft	0.00044 (J)[d]	—[e]	—	—	—	—	—
MD21-01-0022	21-11202	3/01	4–5 ft	—	0.013 (J)	—	0.0073	—	—	—
MD21-01-0033	21-11205	3/01	1–2 ft	0.00057 (J)	—	—	—	—	—	—
MD21-01-0034	21-11205	3/01	4–5 ft	—	0.050	0.072	0.026	—	—	—
MD21-01-0036	21-11206	3/01	0–1 ft	0.00039 (J)	—	—	—	—	—	—
MD21-01-0039	21-11207	3/01	0–1 ft	—	—	0.0076	—	—	—	—
MD21-01-0041	21-11208	3/01	1–2 ft	—	—	0.0082	—	—	—	—
MD21-01-0042	21-11208	3/01	4–5 ft	—	—	0.0092	—	—	—	—
MD21-01-0519	21-11205	10/01	0–1 ft	—	—	—	—	—	—	—
MD21-01-0520	21-11205	10/01	4–5 ft	—	—	—	—	—	—	—
MD21-01-0521	21-11205	10/01	1–2 ft	—	—	—	—	—	**1.8(J)**	1.0(J)

Note: Results in bold face indicate concentrations above SALs.

[a]isopropylbenzene was used as a surrogate for isopropyltoluene (EPA 2001, 71466)

[b] methyl ethyl ketone used as a surrogate for 2-hexanone (EPA 2001, 71466)

[c] "NA" denotes not available

[d] "J" denotes estimated value between the MDL and PQL

[e] "–" denotes not detected.

Table 2.2-3 presents the radionuclide values detected in discrete pre-VCM characterization samples at concentrations greater than fallout values for Am-241, Cs-137, Pu-238, Pu-239, and Sr-90. Of these radionuclides, Cs-137 and Sr-90 were detected at concentrations greater than their respective SALs. Cesium-137 was detected above its SAL in seven discrete samples and Sr-90 was detected above its SAL in five discrete samples. When compared to ESLs, Sr-90, Am-241, Pu-238, and Pu-239 were detected at concentrations less than their respective minimum ESL. Cs-137 was detected at a maximum concentration of 445 pCi/g, below the minimum ESL of 680 pCi/g. These results indicate that current radionuclide concentrations at SWMU 21-011(k) do not pose potential adverse ecological effects.

Table 2.2-3
2001 Pre-VCM Characterization Sample
Radionuclide Concentrations above Background/Fallout

Sample ID	Location ID	Depth (ft)	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Am-241 (pCi/g)	Pu-238 (pCi/g)
Fallout Soil Value[a]			**1.65**	**1.31**	**0.054**	**0.013**	**0.023**
SAL			**5.3**	**5.7**	**44**	**39**	**49**
Minimum ESL			680	560	47	44	44
MD21-01-0021	21-11201	1-2	1.43	1.7	0.12	—[b]	0.044
MD21-01-0022	21-11202	4-5	1.67	—	0.09	—	—
MD21-01-0025	21-11202	0-1	**40.5**	**7.1**	1.93	2.2	0.29
MD21-01-0027	21-11203	1-2	**8.7**	2.56	0.37	—	0.31
MD21-01-0029	21-11203	4-5	1.03	—	0.04	—	0.05
MD21-01-0030	21-11204	2-3	2.6	0.9	0.11	—	0.07
MD21-01-0033	21-11205	1-2	**150**	**26.1**	13.2	13.7	0.63
MD21-01-0034	21-11205	4-5	3.78	1.02	1.01	6.9	0.21
MD21-01-0036	21-11206	0-1	**29**	3.75	1.18	—	0.12
MD21-01-0037	21-11206	4-5	1.52	0.51	0.12	—	—
MD21-01-0039	21-11207	0-1	**109**	**30.8**	11.3	7.9	0.74
MD21-01-0041	21-11208	1-2	**445**	**132**	20.5	19	1.64
MD21-01-0042	21-11208	4-5	**56.7**	**15.8**	4.33	21	1.2

Note: Results in bold face indicate concentrations above SALs.
[a] (Ryti et al. 1998, 59730.2)
[b] "—" denotes not detected

Summary

The 1996 post-IA confirmation sample data, 2000 Chemrad and in situ gamma survey data, and 2001 pre-VCM characterization data confirm that radionuclides are the primary COPCs at the site, and identified areas with elevated activities that will be addressed during this VCM. The Chemrad and in situ gamma survey results show a clear boundary between the northern edge of SWMU 21-011(k) and the DP Canyon stream channel and indicate that radionuclides have not migrated to the channel since the completion of the 1996 IA. The proposed VCM will address only source control and dose reduction of the radionuclide contamination at SWMU 21-011(k). Assessment of the contamination in the canyon floor is being conducted as part of the Los Alamos/Pueblo Canyon Surface Aggregate Report currently in preparation by the Canyons Focus Area.

3.0 BASIS FOR CLEANUP LEVELS

The land use scenario considered most appropriate for derivation of cleanup levels is a recreational trail use for TA-21 employees. The recreational trail-user scenario represents an individual working at TA-21 who regularly walks on the site, as it currently exists, prior to implementation of the VCM. The recreational user is assumed to visit the site 140 times per year for 30 yrs and stay for one hour per visit. Over thirty years, this results in a total annual dose to this user of approximately 7 mrem/yr as shown in Figure 1.3-1 and is projected to decline to less than 2 mrem/yr within 100 years due to decay of Cs-137. This is compared to the acceptable annual radiation dose limit of 15 mrem/yr. (DOE 2000, 67489 and EPA 1997,

58693). The dose-based radiological cleanup levels for the trail-user scenario are derived using RESRAD 6.1, as shown in Appendix F, Exhibit F.2, and are presented in Table 3.0-1 as the single radionuclide soil guidelines (SRSGs). The SRSG for each radionuclide is based on a target dose limit of 15 mrem/yr.

Table 3.0-1
SRSGs Derived for the Recreational Trail-User Scenario

Radionuclide	SRSG (pCi/g)
Am-241	427
Cs-137	294
Pu-238	496
Pu-239	447
Sr-90	8,288

By comparison, the calculated dose to a hypothetical recreational trail user following implementation of the proposed excavation, solidification, and reburial of contaminated material with concentrations of Cs-137 greater than 150 pCi/g (prior to installation of the engineered cover) is between 2 and 3 mrem/yr or about 1/5 the criterion of 15 mrem/yr for the free-release of real property (DOE 2000, 67489). The estimated dose rate is still primarily due to Cs-137, which has a half-life of approximately 30 years. The total dose rate is projected to decline to less than 2 mrem/yr within approximately 30 years due solely to the decay of Cs-137, thereby decreasing the dose within 1/8 the time without VCM implementation. Figure 3.0-1 is a dose versus time plot produced by RESRAD 6.1 (Appendix F, Exhibit F.C) for the recreational trail user following implementation of the proposed excavation, solidification and reburial of contaminated material with concentrations of Cs-137 greater than 150 pCi/g (prior to installation of the engineered cover).

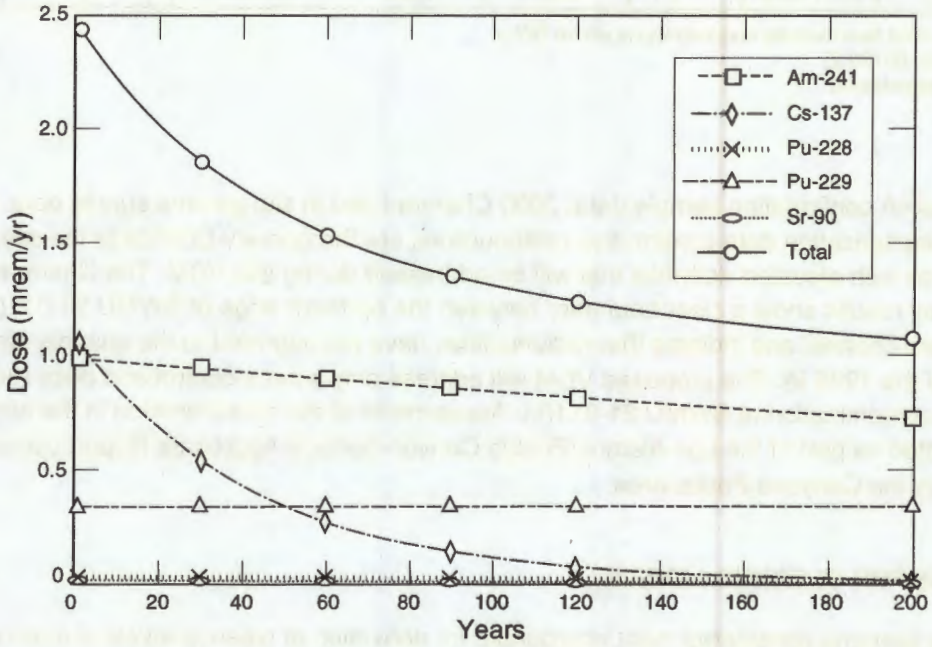


Figure 3.0-1. Dose vs. time for trail-user scenario at SWMU 21-011(k) after excavation, solidification, and reburial prior to installation of engineered cover

Because SWMU 21-011(k) has a mixture of radionuclides present at the site, the SRSGs do not apply independently. To account for the mixture of radionuclides at the site and the uncertainty inherent in the estimates, a decision was made to reduce the SRSG for Cs-137 to a target level of 150 pCi/g. Reducing SRSGs by approximately one-half provides a margin of safety to account for the mixture of radionuclides present at the site. This target level meets the goal for Cs-137 as well as the other radionuclide COPCs because of the collocation within the SWMU (i.e., cleanup of areas with Cs-137 levels exceeding 150 pCi/g will also result in cleanup of other radionuclides in these areas). This correlation was documented by the 2000 in situ gamma survey and 2001 pre-VCM characterization results.

Areas of elevated activity, where the sum of activities from all radionuclides and the associated dose may approach or exceed the allowable dose limit, are the focus of the VCM. Soil will be removed from these locations with the goal of meeting the target level of 150 pCi/g Cs-137. In addition, an elevated activity criterion in DOE Order 5400.5 (Chapter 4, section 4.A.1) must be satisfied once these areas have been remediated (DOE 1990, 58980.1). The DOE Order 5400.5 criterion is presented in the Appendix A glossary and is further discussed in Appendix F.

The areas of elevated concentrations (Figure 3.0-2) were identified based on 1999 and 2001 analytical data and 2000 gross gamma surveys. These results were used to determine volume estimates of contaminated soil, sediment, and tuff to be excavated and solidified that are presented in Appendix F.

Based on the preliminary assessment of potential impacts to ecological receptors (Section 2.2.2), corrective measures for protection of human health will also be protective of ecological receptors. Present radiological activity is not expected to result in any ecological effects as discussed in Section 2.2. A final Ecological Screening Assessment will be presented in the VCM Completion Report.

4.0 PROPOSED CORRECTIVE MEASURE

4.1 Conceptual Model

SWMU 21-011(k) is an outfall where treated industrial wastewater was discharged onto the north side of DP Mesa. The wastewater remaining after the plutonium extraction contained a variety of radioactive and chemical constituents. The COPCs in the effluent would have been largely in solution, but because of their geochemical characteristics, most would have adsorbed onto sediment particles or organic colloids (Langmuir 1997, 56037).

COPCs in effluent that were deposited onto the colluvial slope would have preferentially adsorbed to organic matter in the soil and finer-grained particles because of their greater surface area and, in the case of clay minerals and solid organic matter, their high-cation exchange capacity. COPCs in effluent that were deposited onto the toe of the slope would have encountered mainly coarse-grained sediment. Adsorption of the radionuclides would likely have been onto small amounts of other components within the coarse-grained sediment (e.g., organic matter, iron oxide coatings on larger grains, or clay particles adhered to larger grains).

During the period of effluent releases, contaminant inventories would have built up incrementally. Later development of a gully on the slope below SWMU 21-011(k) allowed erosion of some of the contaminated sediments into the DP Canyon channel (LANL 1999, 63915).

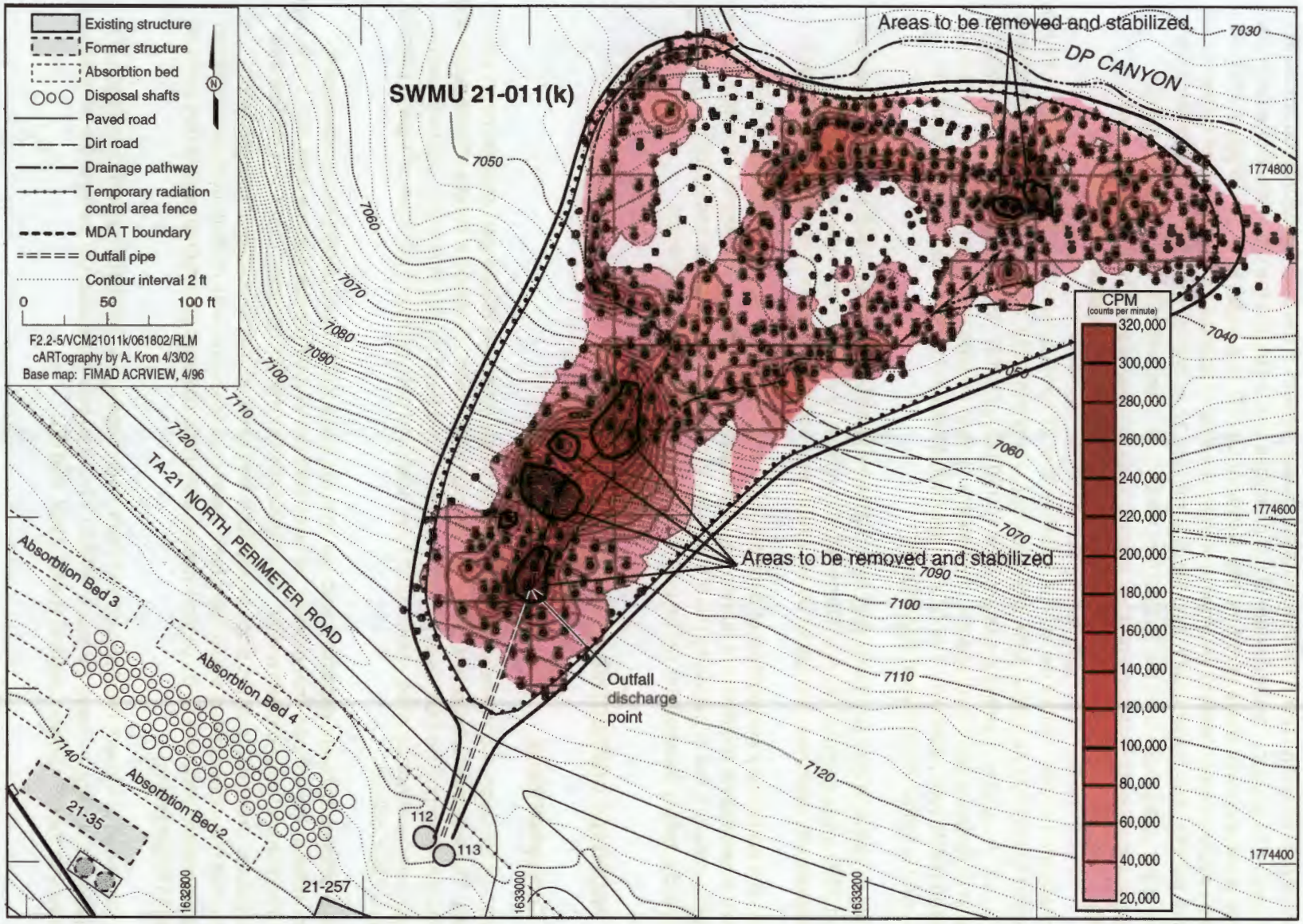


Figure 3.0-2 **November 2000 in situ gross gamma survey results at SWMU 21-011(k) with circled areas planned for removal and stabilization**

The surface water, air, and mass wasting transport pathways do not contribute significantly to current contaminant transport. The site is currently protected by stormwater run-on and runoff controls so the only water contacting the contaminated soil is rain or snow falling directly on the SWMU. Therefore, contaminant transport via stormwater or snowmelt run-on and runoff has been controlled and on-site infiltration reduced to the absolute minimum by the BMPs. The SWMU is vegetated and portions of it are covered with plant litter, thereby minimizing any contaminant transport via wind and fugitive dust. Contaminant transport via mass wasting is unlikely because the slope is quite stable with no new evidence of erosion since the stormwater run-on and runoff controls were installed in 1996 and upgraded in 1999.

There are three complete pathways for potential human contact. The first is direct radiation from gamma emitting COPCs such as Cs-137, the second is direct contact with contaminated soil, and the third is inhalation of particulates, which is considered of low potential for any substantial exposure.

The ecological conceptual site model and rationale are presented in Part C of the ecological scoping checklist in Appendix D. The ecological model depicts the potential transport and exposure pathways of significance to terrestrial receptors. Major and minor exposure pathways for plants include uptake and external gamma (Appendix D). Major exposure pathways for animals include food web transport, incidental ingestion, and external gamma, while minor exposure pathways include inhalation/deposition, dermal contact, food web transport, and external gamma. There are no aquatic receptors.

The Canyons Focus Area has completed the characterization of reaches in DP Canyon, including Reach DP-2, which straddles the contaminated hillside portion of SWMU 21-011(k). Sediment and water data from the DP Canyon investigation is being incorporated into an ecological and human health risk assessment that addresses the entire Los Alamos and Pueblo Canyon watershed. That assessment will be included in the Los Alamos/Pueblo Canyon Surface Aggregate Report, which is currently scheduled for completion in late fiscal year 2003.

4.2 Supplemental Sampling

A target cleanup level of 150 pCi/g has been calculated for Cs-137 (Appendix F). The discussions that follow in Sections 4.2.1, Surveys and Sampling, and 4.2.2, Radiological Sampling, describe supplemental screening and sampling for field instrument accuracy and for determining areas requiring excavation in the western drainage.

4.2.1 Surveys and Sampling

Gross gamma surveys will be performed in the field to guide the excavation of materials with elevated activities at the site. In the western drainage, an Eberline PG-2 sodium iodide analyzer will be used to screen and guide excavation, as described in Section 4.2.3. This data will be supplemented by screening for Cs-137 in an on-site trailer using single-channel or multi-channel analysis with a sodium iodide scintillation detector. Due to the variation of instrument efficiencies, it will be necessary to collect samples for fixed laboratory analysis to validate the screening measurements for Cs-137.

4.2.2 Radiological Sampling

Gross gamma survey and Cs-137 measurements performed with instrumentation in the on-site trailer during the VCM will guide excavation in all areas to be remediated, except for the drainage in the western portion of the site. A total of six soil, sediment, and/or tuff samples will be collected from areas of the site that have gross gamma count rates less than the 150,000 cpm level as defined in the in situ gamma survey map presented in Figure 2.2-4 to ensure accuracy of the screening within the range of activities

from background to roughly 150 pCi/g Cs-137. Samples will be screened in the field with a gamma-screening instrument to ensure that a range of count rates are collected. Accuracy at higher soil activity levels (i.e., greater than 150,000 cpm) is not needed since this soil and tuff will be excavated and solidified. All six samples will be submitted to American Radiation Services (ARS) for gamma spectrometry and gross alpha, beta, and gamma radiation screening for Department of Transportation (DOT) shipping purposes and for off-site fixed laboratory gamma spectrometry. The samples used for DOT shipping purposes will be returned to the site from ARS and used as benchmarks for the validation of on-site measurements. This sampling event will take place one month prior to removal and stabilization activities to ensure that data are available when needed.

There is a general lack of data points within the western drainage. To supplement the data for comparison to the 2000 in situ gamma survey in the western drainage, additional samples will be collected for screening and analysis at an off-site fixed analytical laboratory. Screening for Am-241 in an on-site trailer on soil grab samples collected from the western drainage will occur using a single channel analyzer with a PG-2 detector. Activity levels for Pu-238/239 are below the SRSG (447 pCi/g) required for the recreational trail-user scenario and, therefore, will not be correlated to the field instruments.

4.2.3 Western Drainage Pre-Excavation Screening

As stated above, there is insufficient data throughout the western drainage to accurately identify areas to be excavated. Of the five sample locations with analytical data, two are essentially co-located. Only one sample location, 21-11205, (Figure 2.2-4) has data at depth sufficient for volume characterization. As part of the pre-excavation radiological characterization described in Section 4.2.2, samples will be collected from nine locations distributed throughout the length of the western drainage and sampled every foot until auger refusal or a total depth of 5 ft is reached. The auger holes will be advanced to a depth greater than 5 ft bgs if field screening and ARS data do not indicate a decreasing trend in activity levels. The samples will be screened with a PG-2 analyzer in the field trailer to identify areas of elevated activity (i.e., greater than 150,000 cpm) in sediments in the drainage. Aliquots of the samples will also be sent to ARS for gamma spectroscopy and to an off-site fixed laboratory for analysis of Cs-137, Am-241, isotopic Pu, and Sr-90. This sampling event will take place one month prior to removal and solidification activities to ensure the data are available when needed to identify areas to be excavated. The data will be reviewed with NMED prior to beginning any excavation activities and will be included in the VCM Completion Report for SWMU 21-011(k).

4.3 Technology Evaluation/Literature Search

At the request of the LANL ER Project in December 2001, Argonne National Laboratory's Environmental Assessment Division (ANL-EAD) evaluated potential remediation technologies for the treatment of soils with elevated levels of Cs-137 at SWMU 21-011(k) as an alternative to excavation and disposal of the soil at Area G at TA-54. The proposed VCM requires that mobility of the radionuclides of concern be reduced and that the site be returned to a condition safe for potential human recreational use, while protecting ecological resources.

The technology evaluation for SWMU 21-011(k) considered only those remedial technologies that have demonstrated an ability to separate, concentrate, or immobilize radionuclide constituents in a soil matrix. In addition, the maturity of the potential remedial technology was considered.

The data and supporting information for the technology evaluation were obtained from the Federal Remediation Technologies Round Table (FRTR) Remediation Technologies Screening Matrix, www.frtr.gov/matrix2/top_page.html, provided as Attachment 2.

After a review of the FRTR Remediation Technologies Screening Matrix, five remedial technologies with the potential of treating the radionuclides of concern in a soil matrix were identified. These technologies include the following:

- Stabilization/solidification
- Electrokinetic separation
- Chemical extraction
- Phytoremediation
- Soil washing

Stabilization/solidification was rated the highest of all the potential remedial technologies evaluated for radionuclides in a soil matrix. Stabilization/solidification remedial technologies immobilize radionuclides by physically enclosing or chemically binding them within the soil matrix. This is a mature technology with demonstrated success with radionuclides. The long-term performance and durability of the stabilized soil can be predicted based on currently available models (Rocksol 2002, 73119).

Electrokinetic separation was listed in the FRTR Remediation Technologies Screening Matrix as having the potential to remove radionuclides from a soil matrix. In many cases, radionuclides act as heavy metals. Electrokinetic separation technologies employ a direct current between electrodes that mobilizes metal ions towards and causes them to deposit or plate onto the electrodes. This technology is not applicable to SWMU 21-011(k) for two reasons. First, Cs-137 ions would migrate to the electrodes, but unlike heavy metals, would not plate to the electrode. This would create areas of localized concentrations of Cs-137 that would have to be removed. Second, for this technology to succeed, constant soil moisture would have to be maintained at around 15%, which would be difficult to achieve in an arid environment. Electrokinetic separation was removed from consideration for these reasons.

Chemical extraction was listed in the FRTR Remediation Technologies Screening Matrix as having the potential to remove radionuclides from a soil matrix. This separation technology utilizes either a solvent or acid to extract heavy metals from soils, sediments, or sludge. This technology tends to be equipment intensive and creates residual waste streams that must be managed. Given the small quantity of material to be stabilized at SWMU 21-011(k) and the limited record of accomplishment of this technology on radionuclide-containing soils, this technology was removed from consideration.

Phytoremediation has been successfully employed to treat soils contaminated with radionuclides on both a pilot and full-scale basis (Attachment 2). It has been demonstrated that several species of plants bioaccumulate Cs-137 and Sr-90. Successful deployment of a phytoremediation system depends largely on soil characteristics. Generally, the lower the clay content of the soils, the greater the bioavailability of Cs-137 for plant uptake. This remedial approach has two potential disadvantages. First, the biomass would have to be continually harvested until the site cleanup criteria are met, and secondly, the biomass disposal may be problematic because of the radioactive contamination. Phytoremediation was removed from consideration because of these two disadvantages.

Soil washing was evaluated for SWMU 21-011(k) because it has been successfully employed to remove heavy metals from contaminated soils. However, Cs-137 presents a particular challenge to this technology because of its nature to bind tightly to soils. The ability of this technology to effectively and economically remove Cs-137 from soil has not been demonstrated on a full-scale basis. Given the uncertainty of this technology to effectively remove Cs-137, this technology was removed from consideration.

4.4 Solidification Bench Scale Study

Bench-scale (laboratory-scale) testing to develop a soil solidification grout mix for the contaminated tuff and soil (including sediment) material was performed by IT Corporation at their lab in Kingston, Tennessee, to identify the most appropriate grout formulation for long-term solidification and on-site burial of the materials. Solidification grout mix testing was performed on soil, sediment, and tuff samples collected in December 2001 from ten locations and a range of activity levels at the site (Figure 4.4-1). Six soil/sediment samples and four tuff samples were collected and analyzed for use in the bench scale testing. Five of the six soil/sediment samples were composited to provide a representative sample of the soils/sediments at the site. The sixth soil/sediment sample had much higher radionuclide activity levels and was used in separate bench scale tests. The four tuff samples were then composited to provide a representative sample of the tuff on site.

Stabilization formulation development was conducted on the sediment composite, the tuff composite, the high-activity soil sediment sample, and a 60/40 blend of the sediment/tuff composites. A total of eight reagent mixtures were tested on each of these four samples. Reagents added to the four samples were Portland cement, sodium bentonite, and sodium silicate in different proportions. The reagents and mixtures are similar to those used at other similar solidification/stabilization projects within the DOE complex (Attachment 2).

The cured treated materials were subjected to the performance criteria testing and standard test methods listed in Table 2.1 of the Bench Scale Testing report (Attachment 4). Results of the testing indicate a 60/40 soil/tuff mixture combined with 10 percent (by weight) Portland cement and 3 percent (by weight) sodium bentonite mixture consistently performed better than any of the other mixtures tested (Attachment 4). (As a reagent, none of the mixes containing sodium silicate exhibited enhanced performance; therefore, it is not one of the final additives).

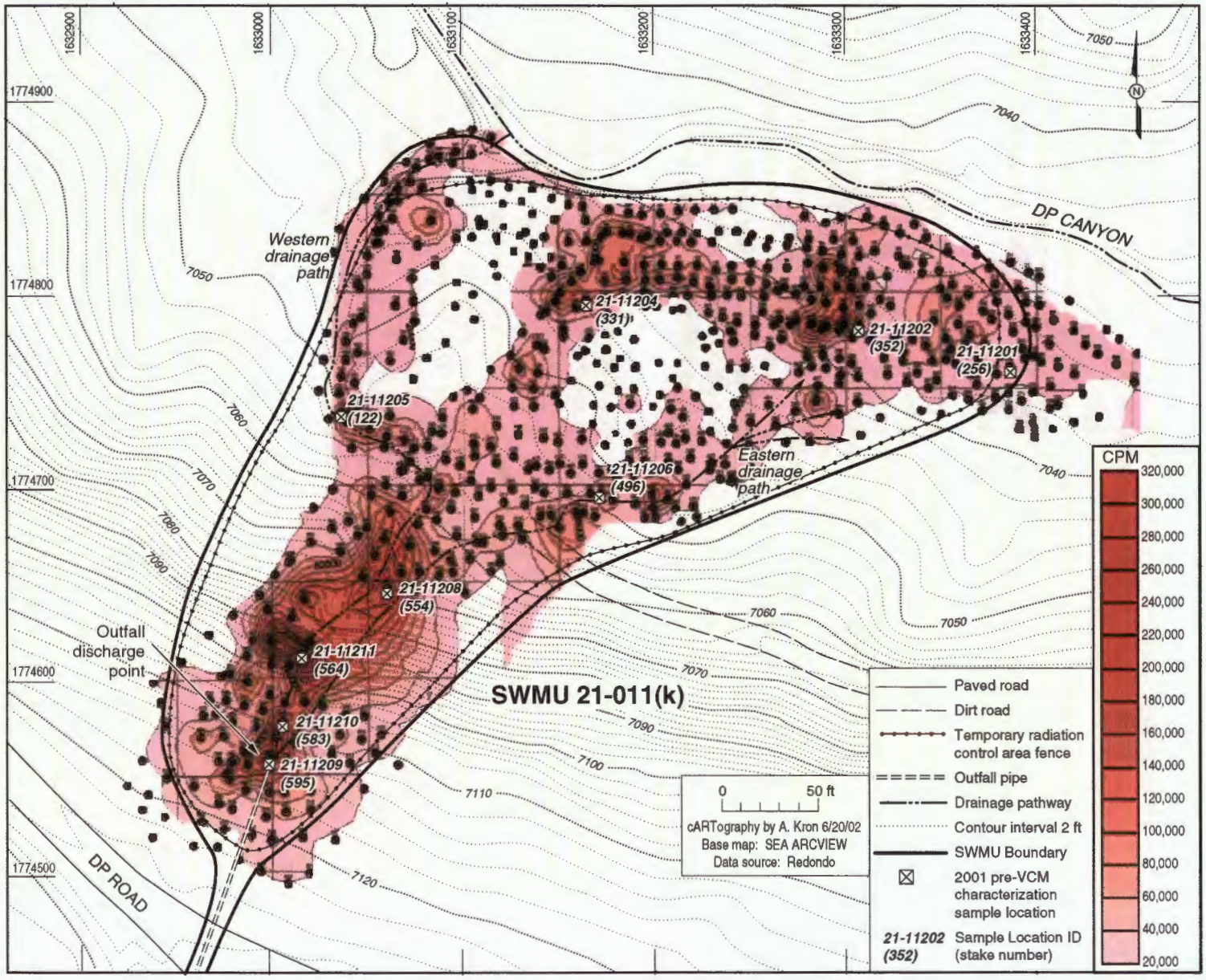


Figure 4.4-1. December 2001 bench scale sample locations at SWMU 21-011(k)

4.5 Remedial Approach

Following the readiness review, mobilization and site preparation for remedial activities will commence. Mobilization activities will include the delivery of site trailers, materials, and heavy equipment. Site preparation activities will include clearing and grubbing of vegetation in areas to be excavated and in the process area; set-up of site trailers; survey and staking of areas to be excavated, process area, stabilization cell location, etc.; construction of site support zones and process area; installation of sanitary facilities; tree removal and chipping; improvement and extension of existing haul road; fence removal; installation of temporary fencing; and installation of stormwater BMPs.

Tree trunks over 8 in. in diameter will be cut into nominal 15-ft lengths for subsequent use as stormwater run-on and runoff control diversion barriers. Prior to clearing and grubbing, on-site vegetation was sampled for waste characterization purposes as described in detail in Section 6.0. The material will be cleared and stored in rolloff containers pending waste characterization results. The drainline from the two holding tanks (structures 21-112 and -113) to the outfall at the southern end of the SWMU will be removed. This 4-in. diameter, cast iron drainline extends 80 ft from the south side of the North Perimeter Road to a discharge point just below the canyon rim. The soil above the cast iron drainline will be excavated and the drainline removed. The drainline excavation trench will be field screened using a gamma instrument and PG-2 detector in the same manner to be followed for guiding the soil removal. Following collection of confirmation samples, the trench will be backfilled and the road repaired as described in Section 5.

Concurrent with the drainline removal, the process area will be prepared north and west of the access road. A pug mill will be set up in this area. The pug mill is the mechanical mixing device that will be used to combine the soil, sediment, tuff, and reagents, into a homogeneous grout mass to be placed in the on-site excavation. The process area will also provide space for stockpiles of soil and a load-out area for loader and dump truck operation. The pug mill (Rapidmix 400) will provide thorough, high-speed, high-shear mixing. This apparatus is designed to generate very little dust during operation. (The pug mill mixing area is enclosed to contain dust during mixing operations. The cement silo operates under negative pressure and meters the reagent with a shearing action rather than a continuous dump, which aids in the reduction of dust generation). The Laboratory filed a Notice of Intent to Emit for operation of the pug mill to the NMED Air Quality Bureau on June 21, 2002, as described in 20 NMAC 2.7.3. Bureau approval must be received prior to commencement of any activities involving the pug mill. A copy of the Notice of Intent to Emit is included in Attachment 6.

During field activities, the Laboratory will monitor worker exposure to radionuclide-contaminated soils at SWMU 21-011(k) based on the requirements of the site-specific health and safety plan (SSHASP). The two high-volume air samplers proposed in the previous version of this VCM plan will not be used. Upon further review of the project, Laboratory Air Quality Group personnel determined that high-volume air samples located in close proximity to the site, (i.e., across the DP Canyon drainage channel to the north) would not detect contamination present in suspended particulates from the VCM, because 1) once suspended, the particulates travel a much further distance before being deposited on the ground, and 2) the high-volume samplers will not collect an aliquot of sample sufficient for analysis in a short time period. In lieu of the high-volume samplers, the Laboratory will monitor exposure to members of the public during remediation of 21-011(k) by use of existing airnet stations. The Laboratory operates four airnet stations near the Los Alamos Airport and DP Road (Airnet stations: 9 - Los Alamos Airport, 68 - Airport Road, 62 - Crossroads Bible Church, and 69 - DP Road West Entrance). These stations are downwind of SWMU 21-011(k) and in the predominant wind direction and will be used to monitor potential exposure to the public from field activities at 21-011k. The data collected from these stations during the implementation of the VCM will be reported in the VCM Completion Report for 21-011(k).

The Air Quality Group personnel conducted a new source review for the 21-011(k) VCM to determine if a new air sampling station is required by National Emissions Standards for Hazardous Air Pollutants (NESHAPs) as adopted by 20.2.78 of the New Mexico Administrative Code (NMAC), and LANL Air Quality Group criteria. The soil characterization data for radionuclides was used with the appropriate release factors, as described in Appendix D of 40 CFR Part 61, to calculate an emissions estimate from excavating, transporting and treating the contaminated material onsite (1500 yd^3 of contaminated soil). Dose assessments from the emissions estimates were calculated using CAP88, an EPA-approved dispersion-modeling program. Based on the modeling results, the potential effective dose equivalent from excavating, transporting and treating the source on site (1500 yd^3 of contaminated soil) to the nearest receptor along State Road 502 (based on predominant wind direction) is 0.07 mrem/yr, which is below the monitoring threshold of 0.1 mrem/yr specified in Title 40 of the Code of Federal Regulations (40 CFR) Part 61, Subpart H (Radionuclide-NESHAPs).

Construction of a below-grade stabilization cell for burial of the solidified materials will proceed concurrently with the excavation and solidification of soil/sediment and tuff above the target level (Appendix F). The stabilization cell will be located near the center of the site (Figure 4.5-1). The east end of the stabilization cell will have a ramp built at a 5:1 slope (drawing 05-010 in Attachment 5) to allow truck and equipment access for the placement of the solidified material.

Areas of activity above approximately 150 pCi/g Cs-137 will be surveyed and staked for excavation based on an initial walkover radiation survey prior to the start of excavation. These areas are anticipated to correspond to those shown in Figure 3.0-2. As these areas are excavated, real-time radiological screening combined with real-time mapping of gross gamma radiation will be used to determine whether enough media has been removed to achieve the established clean-up level. Excavated soil/sediment and tuff will be staged at the process area and covered with plastic sheeting and silt fences, silt dikes, and/or straw waffles will be used to control runoff as described in the Storm Water Pollution Prevention Plan for 21-011(k) (LANL 2002, 73189). As a BMP, soil/sediment currently located near the northern boundary and along the western and eastern edges of SWMU 21-011(k) with Cs-137 concentrations just below the target level, will be excavated first and staged in the process area. This material will be solidified and placed in the stabilization cell if sufficient space is available, or placed directly over the stabilization cell prior to installation of the engineered cover. Confirmation sampling and a radiological survey of the entire site will be conducted prior to installation of the cover in accordance with Section 5.0, Confirmation Surveys and Sampling.

Contaminated soil/sediment and tuff will be composited at a ratio of 60:40, respectively, and stockpiled until processing begins. Contaminated material from the composite stockpile will then be sized for processing in the pug mill. Solidification reagents (cement and bentonite) will be loaded into the reagent bins of the pug mill. A water truck will provide water to the site for filling the pug mill water tanks. Composite material will be loaded into the pug mill using a front-end loader. The pug mill is completely automated and will be adjusted to batch proportions of reagents, water, and contaminated composite material in accordance with the mix design. The planned solidification rate is 20 yd^3 per hour or 120 yd^3 per day. A batch sheet will be prepared for each run to document that the specified mix was achieved. Quality Assurance (QA) samples will be collected to document that the batches are performing as predicted by the bench scale testing. Four 6-in cylinders will be prepared each day from a single batch of material exiting the pug mill. These cylinders will be used for compressive strength testing. Tests will be run every 7 days following preparation until a compressive strength of at least 50 pounds per square inch (psi) is achieved. No additional tests will be performed after a 50-psi strength has been achieved. Paint filter tests will be performed each day on the same batch of material as cylinders are prepared from, to document that no free liquids are being generated by the stabilization mixes as described in the Construction Quality Control Plan (Attachment 7).

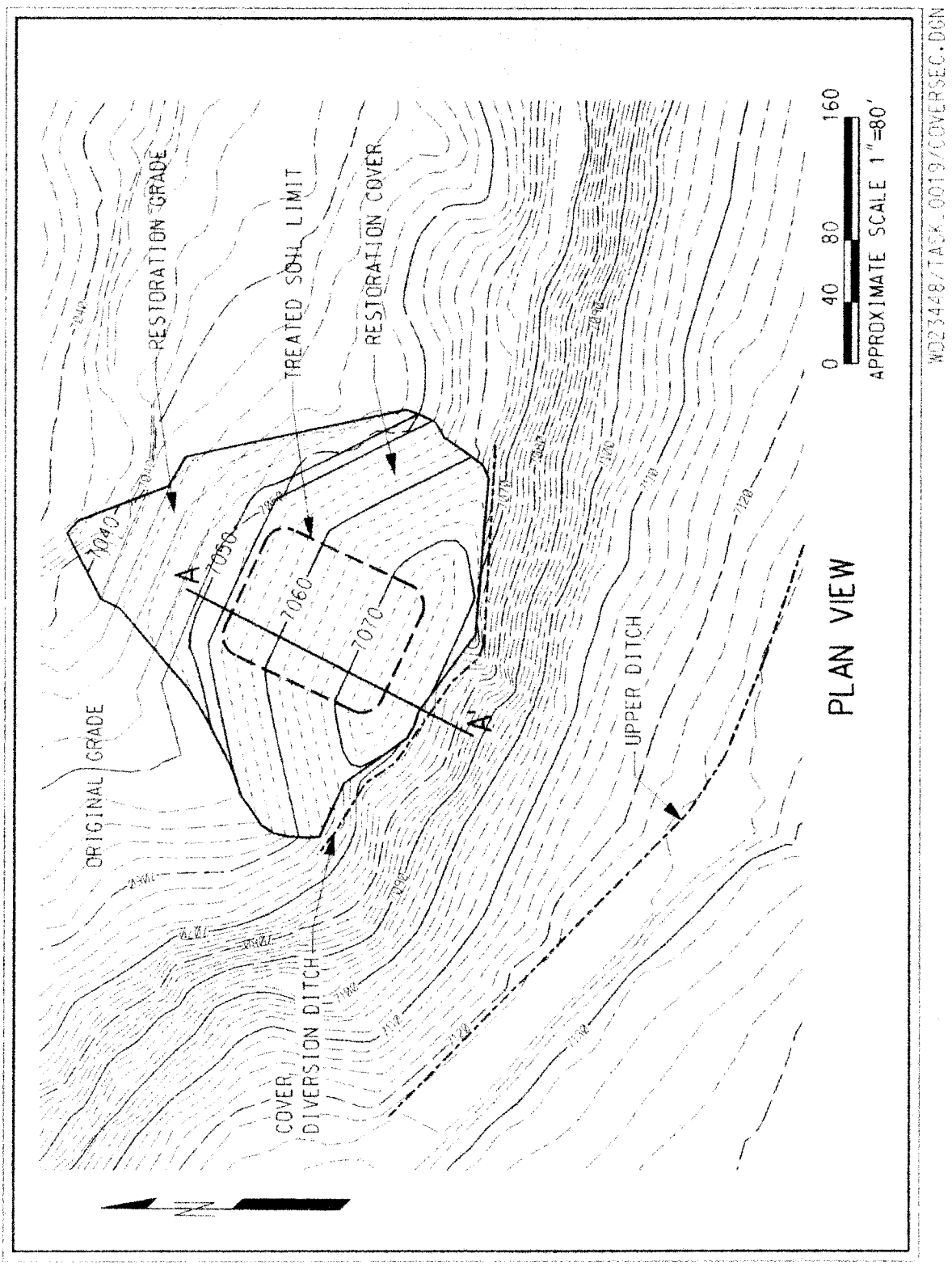


Figure 4.5-1. Schematic of stabilization cell

The solidified material will be placed in a front-end loader using the conveyor/hopper on the pug mill. The loader will then place the solidified material within the stabilization cell. Solidified material will be spread across the bottom of the cell in 8-in. lifts and compacted using a minimum 10,000-lb smooth drum-vibrating roller. Placement and compaction in this manner ensures that voids have been eliminated and that any given day's placed materials will be free of cold joints when cured. (A cold joint is created when the grout mixture is placed directly upon a previously placed and cured batch.) Once the material is compacted, no subsidence of the stabilized material is expected to occur.

Following excavation and solidification activities, project personnel will decontaminate the pug mill and all earth-moving equipment. Residual media adhering to equipment will be removed using dry decontamination methods including the use of wire brushes and scrapers (WGII SOP 1.08 Rev 1). If necessary, final equipment decontamination will be performed on a temporary wash pad with a high-density polyethylene (HDPE) liner. Cleaning solutions and wash water will be collected for proper disposal (Section 6.0). All parts of the equipment, including the undercarriage, wheels, tracks, chassis, and cab will be thoroughly cleaned. Air filters on equipment operating in the exclusion zone will be considered contaminated and will be removed and replaced before equipment leaves the site. A high-pressure sprayer along with long handled brushes and rods will be used to effectively remove contaminated material from equipment. Decontamination solutions will be containerized and sampled to determine final disposition (Section 6). Equipment will be surveyed by Environmental Safety and Health (ESH)-1 Radiological Control Technicians (RCT) prior to being released from the site.

4.5.1 Site Restoration

Upon completion of solidification operations, removal of the equipment, satisfactory completion of the site radiation survey and confirmation sample collection (described in Section 5.0), site restoration activities will be implemented. Restoration activities will involve preparing the subgrade for placement of the restoration cover over the excavated areas, placement of up to 4000 yd^3 of compacted fill material in the area of the stabilization cell, and revegetation of the excavated and cleared areas at the site.

Approximately 4,000 yd^3 of borrow material will be used in the construction of the restoration cover over the stabilization cell and as restoration materials for the areas excavated as part of the VCM. Borrow material resulting from the stabilization cell excavation and from widening the road will be size reduced on site and used first. As needed, additional borrow material will be hauled to the site. Material brought in from off site will be taken from a borrow source from an undisturbed face within the vendors pit with no history of industrial activity.

Restoration will begin with placement of the engineered restoration cover above the stabilization cell. Materials will be placed in continuous nominal 12-in. lifts. Each lift will be compacted to 90% compaction by equipment approved by the geotechnical engineer. Each lift will be placed until the cover meets the lines and grades in engineering drawing 05-031, Excavation & Final Grading Plan and Cross Section in Attachment 5. The engineering specification governing the placement of the restoration cover is Section 2300, Earthwork-General in Attachment 5.

Following construction of the restoration cover over the stabilization cell, areas excavated during the VCM will be restored. Due to the fact that the ground slopes at the site vary from steep to nearly flat, three different restoration approaches have been prepared to cover the various conditions. Diagrams of the three restoration approaches can be found in drawing 05-030, Restoration Cover sections and details (Attachment 5). Specifications for fill placement in the restoration areas are detailed in Section 2300, Earthwork-General in Attachment 5.

Restoration of the disturbed areas will be performed from the top of the slope downward (south to north). On steeply sloping excavated areas, benches will be cut into the tuff bedrock and a boulder retaining wall set in place at the toe of the restoration to eliminate creep of the placed materials. Compacted lifts will be placed until a minimum 2 ft of fill has been placed. Compaction will be achieved using a small remotely operated trench compactor or hand operated vibrating plate compactor as approved by the geotechnical engineer. The final slope of the restoration will be 2:1 or flatter. Following placement of the fill material, erosion matting will be placed over the restored area and secured per the manufacturer's instructions.

Restoration of the areas sloping approximately 2:1 will be the same as for the steeper sloped areas discussed above except that a boulder retaining wall at the toe of the restoration fill is not required. Areas with slopes flatter than 2:1 will be backfilled with a minimum 2 ft of backfill placed in compacted lifts. The up-slope edge of the backfill will be feathered into the hillside. The toe of the restoration will be sloped at a 2:1 slope. Erosion matting will be placed over the restoration materials and secured to the ground per the manufacturer's requirements to minimize stormwater runoff.

Borrow material will be placed in lifts and compacted. All grades will be finished in conformance with the lines and grade on the plans. Run-on controls will be installed at the south end of the site and above the stabilization cell to limit erosion of the engineered cover. The run-on controls will consist of water diversion ditches, one located at the top of the slope to prevent stormwater from running onto the slope, and one located directly above the solidified material to prevent any stormwater from draining onto the site. The temporary BMPs will remain at the north end of the site until vegetation is well established.

Once grading is complete, revegetation activities will commence. Revegetation activities will conform to project specifications prepared by a landscape architect licensed in the State of New Mexico. Seeded areas will be maintained in accordance with the vegetation specification (section 2680 seeding and vegetation - Attachment 5) until a well developed vegetative cover is established. Monthly inspections of the BMPs and cover will be performed as part of the LANL Surface Water Pollution Prevention Plan (SWPPP) for the ER Project (Section 5.1.3). The 90% Design Level Plans and Specifications for the engineered cover are provided as Attachment 5 to this VCM plan.

5.0 CONFIRMATION SURVEYS AND SAMPLING

5.1 Confirmation Sampling beneath the Outfall Drainline at SWMU 21-011(k)

At a minimum, five locations will be sampled below the outfall drainline leading to SWMU 21-011(k). Samples will be collected from two depths (0 to 12 in. and 24 to 36 in. below the bottom of the removed pipe). Samples will be analyzed by gamma spectroscopy for Cs-137 and alpha spectroscopy for Am-241 and isotopic Pu, and for Sr-90 by gas proportional counting at an off-site fixed laboratory and screened for gross alpha, beta, and gamma radiation for DOT shipping purposes. A sample location will be located at the joint nearest the north and south ends of the removed line. The remaining three sample locations will be distributed along the length of the line. Gamma screening will be conducted along the length of the line using the same radiological detection instrumentation used for the solidification activities to identify potential release locations. Sample locations will be biased to areas of elevated gamma radiation identified during the screening as well as locations of fractures or staining. Additional sample locations will be added as appropriate. In the event that elevated radiological screening indicates a possible release, deeper samples will be collected until background levels are reached or a clear decreasing trend is observed to ensure the determination of the nature and extent of any potential contamination. Step-out samples to define nature and extent laterally will be collected approximately 5 ft in each direction until contamination has been bounded.

Much of the line to be removed is beneath the roadbed leading to the TSTA facility. Since this is the sole access road to this operating nuclear facility, the above samples will be collected in stages. The line will be removed and samples collected so as not to completely block access to TSTA. Road repairs will be made to one side of the road prior to removal of the line and sampling the other side. The actual details of the removal and sampling will be provided in the VCM Completion Report for SWMU 21-011(k).

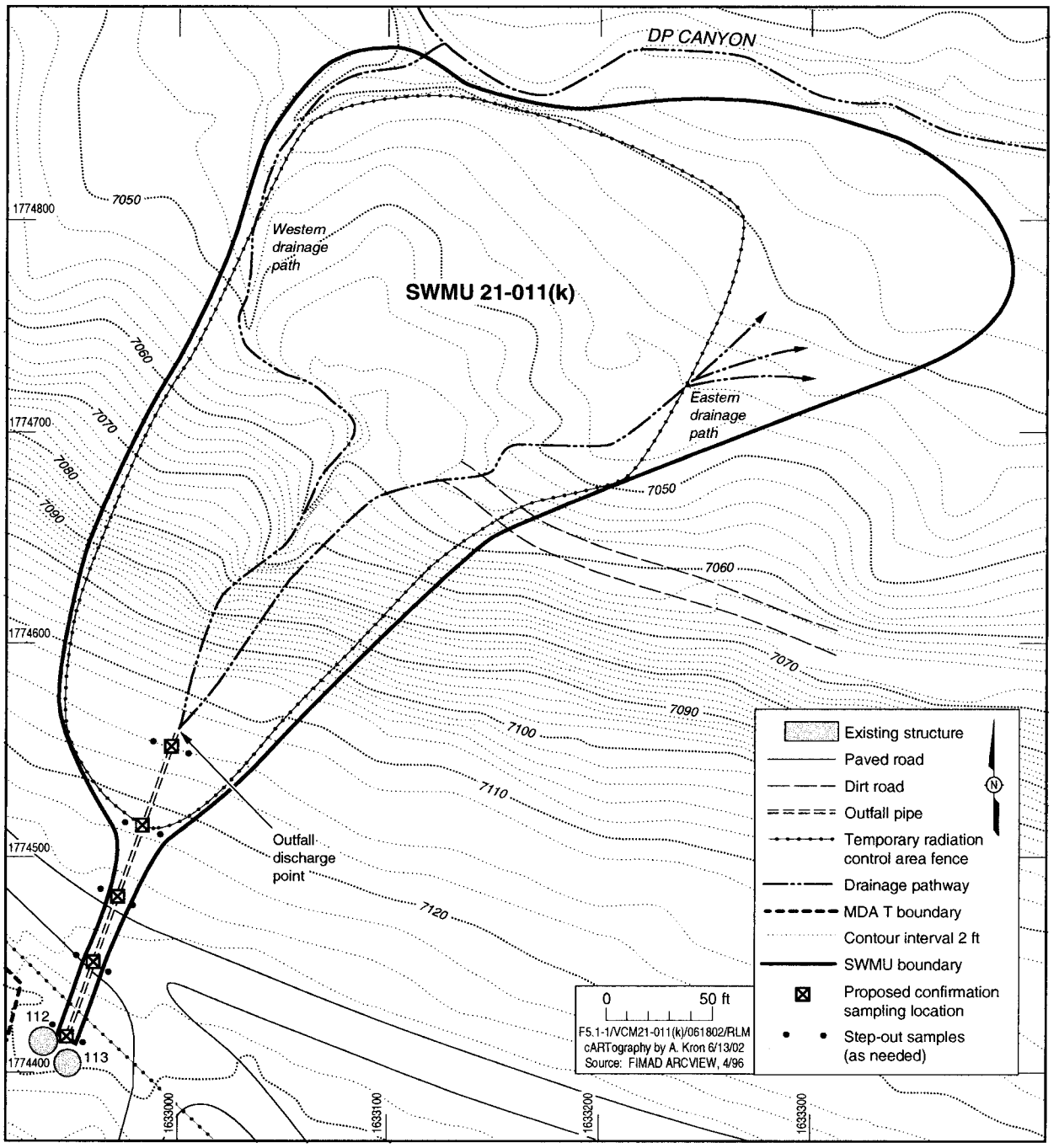


Figure 5.1-1. Outfall pipe to be removed and proposed confirmation sample locations at SWMU 21-011(k)

5.2 Confirmation Surveys and Sampling of Soil Removal Areas

Upon completion of the excavation and solidification activities but before restoration occurs, confirmation samples will be collected at a rate of at least one from each area where 25 yd^2 of contaminated material has been removed. At least one surface sample will be collected from each discrete excavated area, even if the area is smaller than 25 yd^2. A minimum of one surface sample per 500 yd^2 of areas not requiring excavation will be collected at random. Confirmation samples will be screened in the on-site trailer and then sent to an off-site fixed laboratory for further analysis. Samples will be analyzed by gamma spectroscopy for Cs-137 and by alpha spectroscopy for Am-241 and isotopic Pu, and for Sr-90 to confirm the excavated areas meet the requirements of DOE order 5400.5. A minimum of one sample from each excavated area will be collected from the surface to a depth of approximately 12 in. In excavated areas greater than 25 m^2, at least one sample per 25 m^2 will be collected.

A walkover gross gamma survey of the entire SWMU will be performed to obtain count rates across the site and will include at least one reading per yd^2 of affected area. This survey will include all affected areas as well as the particular locations where confirmation samples were collected. The standard deviation of the data set generated in the confirmation surveys should not exceed 2% of the count rate for the cleanup goal of 150 pCi/g.

After the engineered restoration cover has been installed over the stabilization cell and excavated areas of the site and revegetation of the disturbed areas of the site has been completed, a confirmation survey will be conducted to confirm the shielding action of the cover. The confirmation screening survey will consist of a walkover gross gamma survey of the entire site.

Data from both surveys and fixed laboratory results will be used to derive radionuclide concentrations to demonstrate that the site meets target levels and that the DOE 5400.5 elevated activity criterion is satisfied. Attainment of these objectives will be documented in the VCM Completion Report for SWMU 21-011(k).

5.3 Short-Term Maintenance and Monitoring

Stormwater run-on and runoff controls will be inspected weekly during implementation of the VCM and on a monthly basis as part of the LANL ER-Project BMP inspection program. Any erosion features noted during these inspections will be brought to the attention of the design engineer for evaluation. Repairs will be made at the direction of the design engineer as needed. These inspections will continue for a period of two years. After two years, a review of the necessary frequency of inspections will be made and a new frequency may be proposed based on the performance of the restoration materials. Specific details of the BMP inspections will be included in a Long Term Monitoring Plan that will be submitted with the VCM Completion Report for SWMU 21-011(k).

6.0 WASTE MANAGEMENT

6.1 Estimated Types and Volumes of Waste

Five separate waste streams are anticipated from this VCM. The waste streams, expected waste types, and volumes are summarized in Table 6.1-1. Waste stream descriptions, including the principal components of the waste and any uncertainties in volume calculations, are described in the paragraphs that follow.

Table 6.1-1
Waste Streams, Types, and Volumes at SWMU 21-011(k)

Waste Stream	Waste Type/Form	Anticipated Volume
Contact waste (PPE, plastic sheeting, disposable sampling supplies, dry decontamination waste, etc.)	Low-level radioactive waste; solid, compactable	30 yd^3 (precompacted)
Decontamination solutions	Low-level radioactive waste; liquid	1,000 gallons
Vegetation (brush, small-diameter trees, scrub oak)	Low-level radioactive waste; solid	40 yd^3
Metal pipe	Low-level radioactive waste; solid, noncompactable	5 yd^3
Municipal refuse, uncontaminated trash and debris (cardboard, paper, plastic, etc.)	Municipal solid waste (MSW); solid	25 yd^3

Contact waste. This waste stream will include various types of disposable debris including personal protective equipment (gloves, booties, filter cartridges); plastic sheeting (e.g., liners, tarps and contamination control covers); sampling supplies such as plastic scoops, plastic bags, jars, and filters; and dry decontamination waste. These wastes have the potential to be become contaminated through direct contact with contaminated environmental media. Characterization of this waste will be determined through soil contaminant concentrations and from direct radiological surveys. The volume of contact waste will be kept to a minimum by decontaminating any reusable items that come into contact with the contaminated environmental media.

Decontamination solutions. This waste stream will consist of liquids generated from on-site decontamination of process equipment; tools; excavation equipment, vehicles; sampling equipment; and personnel. The volume of decontamination solutions will be minimized using "dry" techniques and by reusing any in-process wastewater in the soil stabilization process.

Decontamination solutions will be containerized and characterized through direct sampling in order to demonstrate compliance with Waste Acceptance Criteria (WAC) at the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF).

Vegetation. Brush, small trees, and scrub oak will be cleared from the site during site preparation activities. A few large ponderosa pines will be felled, their branches cut off, and the trunks cut into nominal 15 ft lengths. These tree trunks will be used as BMPs. Disposition of the remaining vegetation will be determined by results from the waste characterization samples described in the following paragraph.

A total of three composite samples of the vegetation to be removed from the site were collected during the week of June 3, 2002; two one-gallon samples were collected for waste characterization purposes to determine if the vegetation complies with waste acceptance criteria for either disposal at Area G at TA-54 or at the TA-16 incinerator, and a third sample was collected for screening by the ARS Laboratory to ensure compliance with the 2000 pCi/g limit for transporting radioactively contaminated materials.

Each of the two characterization samples consisted of three plant species. One sample consisted of trees and bushes growing near the region with the highest levels of radioactivity within the Radiation Control Area (RCA); the second sample was collected from plants growing within the RCA. These two samples will be analyzed by gamma spectroscopy, for Sr-90 by test method 905.0. and Cs-137 by test method 901.1. In addition, they will be analyzed for Am-241, Pu-238, and Pu-239 by alpha spectroscopy following test method 300 in DOE's Environmental Measurements Laboratory Procedures Manual. A 15-day turn-around for analytical results was requested.

Metal pipe. A 4-in.-diameter, cast iron drainline from the two-wastewater treatment tanks will be removed and packaged as low-level radioactive waste. This waste stream will be characterized by survey of direct and removable contamination on the drainline. All surveys will be performed by a qualified RCT.

Municipal refuse. This waste stream will include miscellaneous uncontaminated cardboard, plastic, and paper generated during the project. Administrative controls will be established to minimize the introduction of items (e.g., packaging materials) into the exclusion zone and/or radiological control areas. As much as practicable, plastic sheeting (e.g., tarps, liners, and contamination control covers) and reusable supplies will be decontaminated, surveyed, and released by a qualified RCT. All recyclable materials will be segregated from this waste stream prior to disposal.

6.2 Method of Management and Disposal

This section describes the planned methods of managing the waste from the time of generation to final disposal.

Contact waste. This waste will be collected in 55-gallon plastic bags and deposited into metal collection boxes (approx. 90 cu ft capacity) for interim storage. The metal boxes will remain in an on-site radioactive waste staging area located until filled and prepared for transport. The contact waste will then be shipped to the low-level waste (LLW) Compaction Facility at Area G at TA-54 for disposal.

Decontamination solutions. Wastewater from the onsite decontamination pad will be pumped into plastic tuff tanks (330-gal capacity) and stored in secondary containment within a liquid radioactive waste staging area. Liquid waste samples will be collected for characterization purposes. Radioactively contaminated liquids will be transported in the tuff tanks to the TA-50 RLWTF for disposal.

Vegetation. The disposition of this waste stream will be determined upon receipt and review of the waste characterization vegetation samples. The vegetation will be shredded and stored in rolloff containers until the final disposition is determined. Results will be reported to NMED prior to disposal.

Metal pipe. The cast iron drainline will be placed into a lined rolloff container and staged in an on-site radioactive waste storage area. This waste stream will be disposed at Area G at TA-54.

Municipal refuse. Uncontaminated trash will be collected daily in plastic drum liners and staged on site in a solid waste storage area. This waste will be disposed at the Los Alamos County Landfill.

7.0 PROPOSED SCHEDULE AND UNCERTAINTIES

The fieldwork portion for this VCM is expected to begin on July 8, 2002 and is anticipated to end by October 8, 2002 (Table 7.0-1). Ten working days have been allotted for a site readiness review, training, and mobilization. Ten working days have been allotted for site preparation activities. Twenty-five working days have been scheduled for excavation of contaminated material, solidification, placement in stabilization cell, and confirmation surveys and sample collection. Ten working days have been allotted for site restoration activities. Demobilization activities are schedule to take seven working days. Fifty working days have been allotted for waste disposal activities. The VCM Completion Report will be prepared and submitted to the NMED Hazardous Waste Bureau (HWB) in March 2003.

Table 7.0-1
VCM Field Work Schedule

Activity	Workday Duration	Start	Finish
Submit VCM plan to NMED	**N/A**	**N/A**	July 1, 2002
Submit NOI (Air Permit) to NMED	**N/A**	**N/A**	June 21, 2002
Readiness review/mobilization/pre-excavation survey	15 days	July 8, 2002	July 28, 2002
Site preparation	10 days	July 29, 2002	August 9, 2002
Excavation, treatment, and confirmation sampling	25 days	August 12, 2002	September 13, 2002
Waste management/disposal	50 days	July 29, 2002	October 4, 2002
Site restoration	10 days	September 16, 2002	September 27, 2002
Demobilization	7 days	September 30, 2002	October 8, 2002
Approximate working days	62 days	July 15, 2002	October 8, 2002

8.0 REFERENCES

The following list includes all references cited in this document. Parenthetical information following each reference provides the author, publication date, and the ER identification (ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 54."

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the DOE Los Alamos Area Office; United States Environmental Protection Agency, Region 6; and the ER Project Material Disposal Areas Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

DOE (US Department of Energy) 1988. "DOE Headquarters Environmental Survey of Los Alamos National Laboratory." (DOE 1988, 15363)

DOE (US Department of Energy) 1990. "Radiation Protection of the Public and Environment," DOE Order 5400.5. (DOE 1990, 58980.1)

DOE, June 13, 2000. "Procedure for the Release of Residual Radioactive Material from Real Property," Los Alamos National Laboratory memorandum to D. Glenn (DOE Area Manager) from C. Soden (ESH Division Director), Los Alamos, New Mexico. (DOE 2000, 67489.1)

EPA (US Environmental Protection Agency), April 10, 1990. "Region 6 Hazardous Waste Permit (Hazardous and Solid Waste Amendments)," Permit NM0890010515. (EPA 1990, 01585.2)

EPA (US Environmental Protection Agency), August 22, 1997. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER No. 9200.4-18, Washington, DC (EPA 1992 58693)

EPA (US Environmental Protection Agency), November 1, 2001. "EPA Region 6 Human Health Medium-Specific Screening Levels, US EPA Region 6." (EPA 2000, 71466)

Langmuir, D., 1997. *Aqueous Environmental Geochemistry*, Prentice-Hall, Inc., ISBN 0-02-367412, Upper Saddle River, New Jersey. (Langmuir 1997, 56037)

LANL (Los Alamos National Laboratory), May 1991. "TA-21 Operable Unit RFI Work Plan for Environmental Restoration", Los Alamos National Laboratory report LA-UR-91-962, Los Alamos, New Mexico. (LANL 1991, 07528.1)

LANL (Los Alamos National Laboratory), February 28, 1994. "Phase Report 1C, TA-21 Operable Unit RCRA Facility Investigation, Outfalls Investigation," Los Alamos National Laboratory report LA-UR-94-228, Los Alamos, New Mexico. (LANL 1994, 31591.1)

LANL (Los Alamos National Laboratory), 1994. "Phase Report Addendum 1B & 1C Operable Unit 1106 RCRA Facility Investigation Phase Report," Los Alamos National Laboratory report LA-UR-94-4360, Los Alamos, New Mexico. (LANL 1994, 52350.1)

LANL (Los Alamos National Laboratory), September 1, 1996. "Interim Action Plan for Potential Release Site 21-011(K) Discharge System Field Unit 1, September 1996," Los Alamos National Laboratory report LA-UR-96-1609, Los Alamos, New Mexico. (LANL 1996, 54790.2)

LANL (Los Alamos National Laboratory), 1997. "Interim Action Report for Potential Release Site 21-011(k) Discharge System Field Unit 1, April 1997," Los Alamos National Laboratory report, Los Alamos, New Mexico. (LANL 1997, 55648.2)

LANL (Los Alamos National Laboratory), August 26, 1999. "Evaluation of Sediment and Alluvial Groundwater in DP Canyon, Reaches DP-1, DP-2, DP-3, and DP-4," Los Alamos National Laboratory document LA-UR-99-4238, Los Alamos, New Mexico. (LANL 1999, 63915)

LANL (Los Alamos National Laboratory), December 1, 1999. "Screening Level Ecological Risk Assessment Methods," Rev.1, Los Alamos National Laboratory report LA-UR-99-1405, prepared by R. Ryti, E. Kelly, M. Hooten, G. Gonzales, and L. Soholt, ER Project A3 Focus Area, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1999, 64783.1)

LANL (Los Alamos National Laboratory), January, 2001. "Release/Discharge Notification," Los Alamos National Laboratory document, Permit Number NM0028355, Los Alamos, New Mexico. (LANL 2001, 72667)

LANL, March 2001. "Derivation and Use of Radionuclide Screening Action Levels, LANL Environmental Restoration Project," Los Alamos National Laboratory report LA-UR-01-990, Los Alamos, New Mexico. (LANL 2001, 69683.1)

LANL (Los Alamos National Laboratory), October 2001. Environmental Restoration Project Communication Record, Los Alamos, New Mexico. (LANL 2001, 70217)

LANL (Los Alamos National Laboratory), March 2002. "ECORISK Database (Release 1.4), ER package #186," Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 72802)

LANL (Los Alamos National Laboratory), April 2002. "Human Health Risk-Based Screening Methodology," Los Alamos National Laboratory report LA-UR-02-1563, Los Alamos, New Mexico. (LANL 2002, 72639)

LANL (Los Alamos National Laboratory), March 2002. "Stabilization of the Contaminated Tuff and Sediment at the Los Alamos National Laboratory," prepared by IT Corporation for the Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 72638)

LANL (Los Alamos National Laboratory), 2002. "Cover Thickness Calculation," prepared by WGI, Inc., for the Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 73217)

LANL (Los Alamos National Laboratory), May 2002. "Voluntary Corrective Measure at Potential Release Site 21-011(k)," Stormwater Pollution Prevention Plan prepared by WGI, Inc., for the Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 73189)

LANL (Los Alamos National Laboratory), May 2002. Personal communication between John Crocker and Harvey Decker, Los Alamos National Laboratory telephone log, Los Alamos, New Mexico. (LANL 2002, 73115)

NMED (New Mexico Environment Department), December 18, 2000. "Technical Background Document for Development of Soil Screening Levels (Volume I Soil Screening Guidance Technical Background Document)," New Mexico Environment Department Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2000, 68554.1)

RockSol Consulting Group, Inc., 2000. "Rock Mechanics Analysis and Modeling," http://www.rocksol.com/rockmech.html (RockSol Consulting Group, Inc. 2000, 73119)

Ryti, R., P. Longmire, D.E. Broxton, S.L. Reneau, and E.V. McDonald, September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory report LA-UR-98-4847, Los Alamos, New Mexico. (Ryti et al. 1998, 59730)

Appendix A

Acronyms, Glossary, and Metric Conversion Tables

APPENDIX A ACRONYMS, GLOSSARY, AND METRIC CONVERSION TABLES

A-1.0 ACRONYMS

ALARA as low as reasonably achievable

AOC area of concern

BGS below ground surface

BMP best management practice

COPC chemical of potential concern

CST Chemical Science and Technology (Laboratory Division)

CVAA cold vapor atomic absorption

DOE US Department of Energy

DNA delayed neutron assay

EDL estimated detection limit

EPA US Environmental Protection Agency

EQL estimated quantitation limit

ER environmental restoration

ETVAA electro thermal vaporization atomic absorption

FIMAD Facility for Information Management, Analysis, and Display

GC/MS gas chromatography/mass spectrometry

GFAA graphite furnace atomic absorption

GPC gel permeation chromatography

HRMB Hazardous and Radioactive Materials Bureau (NMED)

HSWA Hazardous and Solid Waste Amendments of 1984

IA interim action

ICS interference check sample

ICPES inductively coupled plasma emission spectroscopy

Laboratory Los Alamos National Laboratory

LANL Los Alamos National Laboratory

LCS laboratory check sample

LLW low-level waste

MDA material disposal area

MDL method detection limit

NFA no further action

NMED New Mexico Environment Department (New Mexico Environmental Improvement Division before 1991)

PCB polychlorinated biphenyl

PID photoionization detector

PRS potential release site

QA quality assurance

QC quality control

RBSL risk-based screening level

RCA radiation control area

RCT radiological control technician

RLWTF radioactive liquid waste treatment facility

SAL screening action level

SOP standard operating procedure

SOW statement of work

SRCG single radionuclide soil guidline

SVOC semivolatile organic compound

SWMU solid waste management unit

SWPPP surface water pollution prevention plan

T&E threatened and endangered

TA technical area

TAL target analyte list

TPH total petroleum hydrocarbons

TPU total propagated uncertainty

TSTA tritium systems test assembly

UST underground storage tank

VCP vitrified-clay pipe

VOC volatile organic compound

WAC waste acceptance criteria

A-2.0 GLOSSARY

Administrative authority (AA). The Director of the New Mexico Environment Department, or his/her designee, or the U.S. Environmental Protection Agency.

Alluvium. Clay, silt, sand, and gravel transported by water and deposited on streambeds, flood plains, and alluvial fans.

Area of concern (AOC). An area at the Laboratory known or suspected to be contaminated with radionuclides but not contaminated by hazardous chemicals or hazardous waste.

Background value (BV). The upper tolerance limits (UTLs) of background sample results, calculated as the upper 95% confidence limit for the 95th percentile. When a UTL cannot be calculated, either the detection limit or the maximum reported value is used as a BV; BVs are used as simple threshold numbers to identify potentially contaminated site sample results that are greater than background levels in that geological sample medium (or group of media). All inorganic chemicals and radionuclides have BVs.

Baseline risk assessment (also known as risk assessment). A site-specific analysis of the potential adverse effects of hazardous substances that are released from a site in the absence of any control or mitigation actions. A baseline risk assessment consists of four steps: data collection and analysis, exposure assessment, toxicity assessment, and risk characterization.

Calibration. Process used to identify the relationship between the true (reference) analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement system.

Chemical of potential concern (COPC). Chemical, detected at a site, that has the potential to adversely affect human and/or ecological receptors due to its concentration, distribution, and mechanism of toxicity. A COPC remains a concern until exposure pathways and receptors are evaluated in a site-specific risk assessment.

Cold vapor atomic absorption (CVAA). An analytical technique used for measuring mercury; it is described in EPA Methods 7470A (Mercury in Liquid Waste) and 7471A (Mercury in Solid or Semisolid Waste). The technique is based on the absorption of radiation at 253.7-nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

Data validation. Systematic process that applies a defined set of performance-based criteria to a body of data; may result in qualification of the data. The data validation process is performed independently of the analytical laboratory that generates the data set and occurs before conclusions are drawn from the data. The process may comprise a standardized data review (routine data validation) and/or a problem-specific data review (focused data validation).

Department of Energy (DOE). Federal agency that sponsors energy research and regulates nuclear materials for weapons production.

Detection limit. Minimum concentration that can be determined by a single measurement by an instrument; implies a specified statistical confidence that the analytical concentration is greater than zero.

DOE Order 5400.5, Elevated Activity Criterion. "If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the limit or guideline by a factor of $(100/A)^{0.5}$ [where A is the area of the region in which concentrations area elevated]. Limits for "hot-spots" shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall

be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil."

Dose. Quantity of radiation that is absorbed, per unit of mass, by the body or by any portion of the body.

Ecological screening level (ESL). An organism's exposure-response threshold for a given chemical constituent. The concentration of a substance in a particular medium corresponds to a hazard quotient (HQ) of 1.0 for a given organism below which no risk is indicated.

Environmental Protection Agency (EPA). Federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, the EPA retains oversight authority to ensure protection of human health and the environment.

Ephemeral. Said of a stream or spring that flows only during and immediately after periods of rainfall or snowmelt.

Estimated detection limit (EDL). The detection limit required by the Laboratory statement of work (SOW) for analytical services (RFP No. 9-XS1-Q4257). The Laboratory value reflect the contract-required detection limits (CRDLs) of the Contract Laboratory Program (CLP) methods.

Estimated quantitation limit. The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine analytical-laboratory operating conditions. Sample estimated quantitation limits are highly matrix-dependent, and the specified estimated quantitation limits might not always be achievable.

Evapotranspiration. The combined discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration from plants.

Exposure pathway. Mode by which a receptor may be exposed to contaminants in environmental media (e.g., drinking water, ingesting food, or inhaling dust).

External standard. External standard calibration involves comparison of instrument responses from the sample to the responses from the target compounds in the calibration standards. Sample peak areas (or peak heights) are compared to peak areas (or heights) of the standards.

Fallout radionuclides. Radionuclides that are present at globally elevated levels in the environment as a result of the fallout from atomic weapons tests. The Laboratory background data sets consist of Environmental Surveillance samples taken from marginal and regional locations for the following radionuclides associated with fallout: tritium, Cs-137, americium-241, plutonium-238, plutonium-239/240, and strontium-90. Samples were collected from regional and marginal locations in the vicinity of the Laboratory that are (1) representative of geological media found within Laboratory boundaries and (2) were not impacted by Laboratory operations.

Fault. A fracture, or zone of fractures, in rock along which there has been vertical or horizontal movement; adjacent rock surfaces are displaced.

Field blank (also known as field reagent blank). A blank sample either prepared in the field or carried to the sampling site, exposed to sampling conditions (e.g., bottle caps removed, preservatives added), and returned to a laboratory for analysis in the same manner in which environmental samples are analyzed. Used to identify the presence of contamination potentially added during the sampling and analysis process.

Field duplicate. A second sample collected as near as possible to the original sample.

Gamma radiation. A form of electromagnetic, high-energy radiation emitted from a nucleus. Gamma rays are essentially the same as x-rays and require heavy shielding, such as concrete or steel, to be blocked.

Groundwater. Water in a subsurface saturated zone; water beneath the regional water table.

Hazard quotient (HQ). The ratio of a calculated exposure (E) to or dose (D) from a given contaminant (I) to a given receptor (j) over a reference value (TRV) for contaminant (I) determined to be protective of receptor (j), i.e., $HQ_{ij} = E_{ij}$ [or D_{ij}]TRV_{ij}.

Hazardous and Solid Waste Amendments (HSWA). The Hazardous and Solid Waste Amendments of 1984 (Public Law No. 98-616, 98 Stat. 3221), which amended the Resource Conservation and Recovery Act of 1976, 42 U.S.C. § 6901 et seq.

Holding time. The maximum elapse of time that one can expect to store a sample without unacceptable changes in analyte concentrations. Holding times apply under prescribed conditions and deviations from these conditions may affect the holding time. Extraction holding time refers to the time lapse from sample collection to sample preparation; Analytical holding time refers to the time lapse between sample preparation and analysis.

HSWA module. A portion of the Laboratory's permit to operate under RCRA that contains requirements specific to Los Alamos National Laboratory. It is this portion of the permit that contains the list of solid waste management units that must be cleaned up in accordance with RCRA procedures.

Hydraulic conductivity. The rate at which water moves through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow.

Hydrogeology. The science that applies geologic methods to the understanding of hydrologic phenomena.

Inductively coupled plasma emission spectroscopy (ICPES). ICPES determines trace elements, including metals, in solutions. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized, and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and photosensitive devices are used to monitor the intensities of the emission lines.

Inductively coupled plasma mass spectroscopy (ICPMS). ICPMS is applicable to the determination of sub-mg/l concentrations of a large number of elements in water samples and in waste extracts or digests. When dissolved constituents are required, samples must be filtered and acid preserved before analysis. No digestion is required before analysis for dissolved elements in water samples. The method measures ions produced by a radio-frequency inductively coupled plasma. Analyte species originating in a liquid are nebulized, and the resulting aerosol transported by argon gas into the plasma torch. The ions produced are entrained in the plasma gas and introduced, by means of an interface, into a mass spectrometer. The ions produced in the plasma are sorted according to their mass-to-change ratios and quantified with a channel electron multiplier.

Internal standards. Compounds added to the sample after sample preparation for qualitative and quantitative instrument analysis—the compounds serve as a standard of retention time and response, which is invariant from run to run with the instruments. (Handbook of Environmental Analysis, by Roy-Keith Smith, 3rd ed.)

Laboratory control sample (LCS). A known matrix that has been spiked with compound(s) representative of the target analytes. The LCS is used to document laboratory performance. The acceptance criteria for LCSs are method specific.

Laboratory qualifier (or laboratory flag). Codes applied to the data by the contract analytical laboratory to indicate, on a gross scale, a verifiable or potential data deficiency. These flags are applied using the Environmental protection Agency (EPA) contract laboratory program (CLP) guidelines.

Matrix spike. An aliquot of sample spiked with a known concentration of target analyte(s). Matrix spike samples are used to measure the ability to recover prescribed analytes from a native sample matrix. The spiking typically occurs before sample preparation and analysis.

Matrix spike duplicate. An intralaboratory duplicate sample spiked with a known amount of target analyte(s). Spiking occurs before sample preparation and analysis.

Method blank. An analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing and which is prepared and analyzed in the same manner as the corresponding environmental samples. The method blank is used to assess the potential for contamination to the sample during preparation and analysis.

Method detection limit (MDL). The minimum concentration of a substance that can be measured and reported with a known statistical confidence that the analyte concentration is greater than zero. The MDL is determined from analysis of samples of a given matrix type that contain the analyte after subjecting the sample to the usual preparation and analyses. The MDL is used to establish detection status.

Minimum detectable activity. For the *analysis* of *radionuclides*, the minimum detectable activity is the lowest detectable radioactivity for a given analytical technique. The following equation shall be used to calculate the MDA unless otherwise noted or approved by the Laboratory:

$$\mathrm{MDA} = \frac{4.65(\mathrm{BKG})^{0.5} + 2.71}{2.22 \times \mathrm{EFF} \times \mathrm{V} \times \mathrm{T_S} \times \mathrm{Y}}$$

where BKG = the total background counts,
EFF = the fraction detector efficiency,
V = the volume or unit weight,
T = the *sample* count duration, and
Y = the fractional *chemical* recovery obtained from the *tracer* recovery.

Depending on the type of *analysis*, other terms may also be required in the denominator (e.g., gamma abundance).

Model. A mathematical approximation of a physical, biological, or social system.

No further action (NFA). A recommendation that not further investigation or remediation is warranted based on specific criteria.

Nondetect. Sample result that is less than the MDL. The laboratory reports nondetects as undetected at the EQL.

Operable unit (OU). At the Laboratory, one of 24 areas originally established for administering the ER Project. Set up as groups of potential release sites, the OUs were aggregated based on geographic proximity for the purpose of planning and conducting RCRA facility assessments and RCRA facility investigations. As the project matured, it became apparent that 24 were too many to allow efficient communication and to ensure consistency in approach. Therefore, in 1994, the 24 OUs were reduced to six administrative "field units."

Perched groundwater. Groundwater that lies above the regional water table and is separated from it by an unsaturated zone.

Polychlorinated biphenyls (PCBs). Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contains such substances. PCBs are colorless, odorless compounds that are chemically, electrically, and thermally stable and have proven to be toxic to both humans and animals.

Potential release site (PRS). A site suspected of releasing or having the potential to release contaminants into the environment. PRS is a generic term that includes solid waste management units, hazardous waste sites listed in Module 7 of the Laboratory's Hazardous Waste Facility Permit, and sites that have been identified as potentially contaminated by radioactivity.

Quality assurance. All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily in service.

Quality control (QC). (1) All those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. QC is the process through which actual quality performance is measured and compared with standards. (2) All methods and procedures used to obtain accurate and reliable results from environmental sampling and analysis. Includes rules for when, where, and how samples are taken; sample storage, preservation and transport; and the use of blanks, duplicates, and split samples during the analysis.

Radionuclide. A nuclide (species of atom) that exhibits radioactivity.

RCRA facility investigation (RFI). The investigation that determines if a release has occurred and the nature and extent of the contamination at a hazardous waste facility. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA) process.

Receptor. A person, plant, animal, or geographical location that is exposed to a chemical or physical agent released to the environment by human activities.

Recharge. The process by which water is added to the zone of saturation, either directly from the overlying unsaturated zone or indirectly by way of another material in the saturated zone.

Regional aquifer. Geologic material(s) or unit(s) of regional extent whose saturated portion yields significant quantities of water to wells, contains the regional zone of saturation, and is characterized by the regional water table or potentiometric surface.

Release. Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles that contain any hazardous wastes or hazardous constituents).

Reporting limit. The numerical value that an analytical laboratory (in conjunction with its client) selects to determine if a target analyte is detected. Results below the RL are considered not detected, while results greater than the RL are considered detected. The RLs are not necessarily based on instrument sensitivity. RLs can be established at the instrument detection limit, method detection limit, estimated quantitation limit, and contract-required detection limit.

Resource Conservation and Recovery Act (RCRA). The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976. (40 CFR 270.2)

Runoff. The portion of the precipitation on a drainage area that is discharged from the area either by sheet flow or adjacent stream channels.

Run-on. Surface water flowing onto an area as a result of runoff occurring higher up the slope.

Sample. A portion of a material (e.g., rock, soil, water, air), which, alone or in combination with other samples, is expected to be representative of the material or area from which it is taken. Samples are typically sent to a laboratory for analysis or inspection or are analyzed in the field. When referring to samples of environmental media, the term field sample may be used.

Sample matrix. In chemical analysis, that portion of a sample which is exclusive of the analytes of interest. Together, the matrix and analytes of interest form the sample.

Screening action level (SAL). Medium-specific concentration level for a chemical derived using conservative criteria below for which it is generally assumed that there is no potential for unacceptable risk to human health. The derivation of a SAL is based on conservative exposure and land-use assumptions. However, if an applicable regulatory standard exists that is less than the value derived by risk-based computations, it will be used for the SAL.

Screening assessment. A process designed to determine whether contamination detected in a particular medium at a site may present a potentially unacceptable human-health and /or ecological risk. The assessment utilizes screening levels that are either human-health or ecologically based concentrations derived by using chemical-specific toxicity information and standardized exposure assumptions below which no additional actions are generally warranted.

Sediment. (1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice; or a mass that is accumulated by any other natural agent and that forms in layers on the earth's surface such as sand, gravel, silt, mud, fill, or loess. (2) A solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid.

Site characterization. Defining the pathways and methods of migration of the hazardous waste or constituents, including the media affected, the extent, direction and speed of the contaminants, complicating factors influencing movement, concentration profiles, etc. (U.S. Environmental Protection Agency, May 1994. "RCRA Corrective Action Plan, Final," Publication EPA-520/R-94/004, Office of Solid Waste and Emergency Response, Washington, DC)

Site conceptual model. A qualitative or quantitative description of sources of contamination, environmental transport pathways for contamination, and biota that may be impacted by contamination (called receptors) and whose relationships describe qualitatively or quantitatively the release of contamination from the sources, the movement of contamination along the pathways to the exposure points, and the uptake of contaminant by the receptors.

Solid waste management unit (SWMU). Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released. This definition includes regulated units (i.e., landfills, surface impoundments, waste piles, and land treatment units) but does not include passive leakage or one-time spills from production areas and units in which wastes have not been managed (e.g., product storage areas).

Spring. The site where groundwater discharges to the ground surface.

Standard operating procedure (SOP). A document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and is officially approved as the method for performing certain routine or repetitive tasks.

Stratigraphy. The science dealing with the succession, age, composition, and history of strata.

Surrogate compound or surrogate. An organic compound used in the analyses of organic target analytes that is similar in composition and behavior to target analytes but is not normally found in field samples. Surrogates are added to every blank and spike sample to evaluate the efficiency with which analytes are recovered during extraction and analysis.

Target analyte. An element, chemical, or parameter, the concentration, mass, or magnitude of which is designed to be quantified by use of a particular test method.

Technical area (TA). The Laboratory established technical areas as administrative units for all its operations. There are currently 49 active TAs spread over 43 square miles.

Tentatively identified compound (TIC). Chemical compound detected in a sample that is not a target analyte, IS, or surrogate compound. Up to 30 chromatographic peaks may be subject to mass spectral matching for identification as TICs.

Topography. The physical configuration of the land surface in an area.

Total propagated uncertainty (TPU). The range of concentrations (expressed as plus or minus the measured concentration) that include the theoretical or true concentration of an analyte with a specific degree of confidence. Radiochemical results are required to be accompanied by sample-specific uncertainty bounds (TPU) that reflect the 67% confidence level (1-sigma TPU). The TPU includes not only the measurement or counting error but also the technique-specific error term that includes uncertainty values for each contributing measurement process and a sample-specific contribution reflecting specific chemical recoveries, detectors used, etc. All radiochemical result uncertainties incorporate terms for technique-related and sample-specific measurement errors.

Tracer. A substance, usually a radioactive isotope, added to a sample to determine the efficiency (chemical or physical losses) of the chemical extraction, reaction, or analysis. The tracer is assumed to behave in the same manner as that of the target radionuclides. Recovery guidelines for tracer results are 30% to 110% under the current contract laboratory statement of work and will be 40% to 105% under the new statement of work. Correction of the analytical results for the tracer recovery is performed for each sample. The concentration of the tracer added needs to be sufficient to result in a maximum of 10% uncertainty at the 95% confidence level in the measured recovery.

Tuff. A compacted deposit of volcanic ash and dust that contains rock and mineral fragments accumulated during an eruption.

Underground storage tank [as defined in Section 9001(1) of the Solid Waste Disposal Act]. The term "underground storage tank" means any one or combination of tanks (including underground pipes connected thereto) which is used to contain an accumulation of regulated substances, and the volume of which (including the volume of the underground pipes connected thereto) is 10% or more beneath the surface of the ground. Such term does not include any

(a) farm or residential tank of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
(b) tank used for string heating oil for consumptive use on the premises where stored;
(c) septic tank;
(d) pipeline facility (including gathering lines) regulated under
  (i) the Natural Gas Pipeline Safety Act of 1968 (49 USC App. 1671 et seq.),
  (ii) the Hazardous Liquid Pipeline Safety Act of 1979 (49 USC App. 2001 et seq.), or
  (iii) which is an intrastate pipeline facility regulated under state laws comparable to the provisions of law referred to in Clause (i) or (ii) of this subparagraph;
(e) surface impoundment, pit, pond, or lagoon;
(f) storm-water or wastewater collection system;
(g) flow-through process tank;
(h) liquid trap or associated gathering lines directly related to oil or gas production and gathering operations; or
(i) storage tank situated in an underground area (such as a basement, cellar, mine working, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

US Department of Energy (DOE). Federal agency that sponsors energy research and regulates nuclear materials for weapons production.

US Environmental Protection Agency (EPA). Federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, the EPA retains oversight authority to ensure protection of human health and the environment.

Vadose zone. The unsaturated zone. Portion of the subsurface above the regional water table in which pores are not fully saturated.

Welded tuff. A volcanic deposit hardened by the action of heat, pressures from overlying material, and hot gases.

A-3.0 METRIC CONVERSION TABLES

Metric to English Conversions

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres

square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (l)	0.26	gallons (gal.)
milligrams per liter (mg/l)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

Metric Prefixes

Term	Power of 10	Symbol
mega-	10^6	M
kilo-	10^3	k
deci-	10^{-1}	d
centi-	10^{-2}	c
milli-	10^{-3}	m
micro-	10^{-6}	µ
nano-	10^{-9}	n
pico-	10^{-12}	p

Appendix B

VCM Checklist and Fact Sheet

Accelerated Corrective Action (ACA)
Checklist and Field Work Authorization Form

PRS Number: 21-011(k) ☒ HSWA ☐ Non-HSWA

Yes	No	
X		Fact sheet describing planned activities is complete and attached to checklist.
X		COPC(s) for human health risk (HH), ecological risk (ECO), or other requirements are known or will be determined during accelerated site characterization
X		Nature and extent of contamination is defined or accelerated site characterization is planned as part of this action to define nature and extent and to guide cleanup.
X		Cleanup levels/preliminary remediation goals (PRGs) are appropriate.
X		Remedy is obvious.
X		Time for removal is less than six months.
X		Remedy is final.
X		Land use assumptions are straightforward.
X		Treatment, Storage, and Disposal (TSD) Facilities are available for waste type and volume.
X		Cleanup cost is reasonable for the planned action and meets accelerated decision logic criterion for decision to proceed with ACA.
X		Briefing for NMED is required.

Explain criteria not checked above:

Los Alamos
Environmental Restoration Project

Accelerated Corrective Action (ACA) Checklist and Field Work Authorization Form

Page 2 of 2

PRS Number: 21-011(k) ☒ HSWA ☐ Non-HSWA

Upon reviewing the Accelerated Corrective Action Fact Sheet and the criteria checklist above, the appropriate Accelerated Corrective Action approach for the PRS(s) is (check one): ☐ VCA ☒ VCM

Signatures of the Representative for UC-Laboratory, DOE-LAAO, and NMED-HRMB:

UC: John Hopkins, MDA Focus Area Leader _____ (Date)
(Print Name and Title, then Sign)

DOE: Woody Woodworth, LAAO _____ (Date)
(Print Name and Title, then Sign)

NMED: Vicki Maranville, NMED-HWB _____ (Date)
(Print Name and Title, then Sign)

The undersigned have reviewed the final plan and believe that it fully satisfies the appropriate Accelerated Corrective Action Approach.

Signatures of the Representative for UC-LANL and DOE-LAAO

UC: _____ (Date)
(Print Name and Title, then Sign)

DOE: _____ (Date)
(Print Name and Title, then Sign)

Action	Date	Correspondence ID
VCA or VCM plan submitted to NMED		
NOD or RSI received from NMED		
Laboratory response to NOD or RSI		
NMED approval of VCA or VCM plan		

After reviewing the VCA or VCM plan for the site(s) listed above and believing that the ACA process and VCA or VCM criteria have been met, I authorize the fieldwork to proceed.

DOE ER Program Manager _____ (Date)
(Signature)

Los Alamos
Environmental Restoration Project

Voluntary Corrective Measure Fact Sheet for PRS 21-011(k)
Confirmation Sampling and Removal of Residual Contamination
SRS: 21-011(k) = 67
Erosion Matrix Score: 21-011(k) = 72

OPERATIONAL HISTORY

Potential Release Site (PRS) 21-011(k) was the national pollutant discharge elimination system (NPDES)-permitted outfall (NPDES outfall no. EPA050050) for treated industrial wastewater from Buildings TA-21-35 and -257, the former industrial wastewater treatment plants (WWTP) at TA-21, and is listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit. The PRS consists of a drain line from two wastewater treatment tanks that discharged to an outfall ditch, which channeled wastewater to the canyon rim, and down the hillside toward DP Canyon. The ditch is no longer visible; however, a 4-inch cast iron drain line is located approximately 55 feet north of the TA-21 perimeter road in the area where the outfall ditch would have ended. A gently sloping, rocky surface extends from the outfall pipe approximately 30 feet to the canyon rim.

TA-21,the former plutonium processing facility at LANL, began plutonium operations in 1945 and ceased operations in 1978. The first WWTP, TA-21-35 was activated in 1952 and operated until 1967 when the new WWTP, TA-21-257, came on line. Both facilities treated wastes from DP West and DP East consisting of liquids remaining after plutonium extraction and processing of radioactive materials for nuclear weapons and space rocket research projects. The treatment process mixed the raw waste with lime, ferric sulfate, and coagulant aids. The waste was then pumped to a flocculator and onto a settling tank. Settled effluent was pumped through a pressure filter and sampled to verify treatment. If the effluent was determined to be adequately treated, it was pumped to two final effluent holding tanks (tanks TA-21-112 and TA-21-113). From tanks TA-21-112 and TA-21-113, the wastewater was piped northeast toward DP Canyon and discharged on the north side of DP Mesa (Fig. 1.0-1). This wastewater contained a variety of radioactive and chemical constituents. Discharges of treated wastewater to the outfall were discontinued in the early 1990's; however, Building TA-21-257 is still used for pretreatment of wastewater prior to discharge to the TA-50 waste line.

Previous Investigations and Contaminants of Potential Concern

PRS 21-011(k) was investigated in 1988 by DOE and by the ER Project in 1992 and 1993 and reported on in 1995 in the Final Draft for the OU 1106 Addendum to Phase 1B, 1C Report (LANL 1995, 52350). The initial radiation survey and soil sampling performed at PRS 21-011(k) in FY92 indicated the presence of radionuclide contamination. Additional soil sampling and a radiation survey were performed during the FY93 field season to further define the extent of contamination found in FY92.

An interim action (IA) plan was prepared in 1996 (LANL 1996, 01-0042). The IA was implemented during 1996 and 1997 and described in the *Interim Action Report for TA-21, Potential Release Site 21-011(k)*, submitted to NMED on April 10, 1997 (LANL 1997, 55648). The objectives of the IA were to remove a portion of the radionuclide source term from the outfall area of the PRS and install storm water control measures as a best management practice (BMP). Soil excavated from PRS 21-011(k) during the 1996 IA (390 cubic yards) was characterized in the field and transported to TA-54, MDA G for disposal. Storm water controls were installed in 1997 and upgraded in August 1999. The controls are routinely inspected and maintained by LANL ESH-18 representatives.

The COPCs for this PRS include americium-241, cesium-137, plutonium-238 and -239, and strontium-90. Although analytical results from the 1988, 1992 and 1993 investigations did not identify non-radioactive, RCRA-regulated organic and inorganic chemicals as COPCs, waste characterization samples and a percentage of confirmation samples will be submitted for analysis of metals, SVOCs, and radionuclides.

VOCs are not anticipated to be present at the surface because they were not detected when 390 cubic yards of soil were excavated during the IA in 1996. However, VOCs will be included in the analytical suite for a percentage of post excavation confirmation samples and waste characterization samples.

VCM Rationale

SWMU 21-011(k) is located on the north side of DP mesa on a hillside that leads to DP Canyon. The most northern extent of the slope's toe is within the high water table of the DP Canyon streambed. SWMU 21-011(k) has been identified as the primary source of radionuclide contamination in sediments in DP Canyon (LANL 1999, 63915). The existing radionuclide inventory in surface soils and sediment at the site is approximately four times greater than the inventory in the sediments in DP Canyon. Because of the site's high potential for erosion (erosion matrix score of 72 out of 100, Appendix C), there is the potential for radionuclides from the site to increase the radionuclide inventory in DP Canyon. Therefore, remediation of the site is considered a priority for both LANL and the New Mexico Environment Department (NMED).

SWMU 21-011(k) is located on DOE property that will remain under institutional control for at least the next 100 years. Land use for TA-21 is, and will continue to be, industrial under DOE ownership and control. However, the SWMU 21-011(k) site is not a typical industrial site as it is located on a steep hillside that slopes to the bottom of a canyon. Consequently, the more realistic trail user scenario is proposed for screening soil and sediment areas with potentially elevated radionuclide activity exceeding acceptable human health and ecological risk levels.

VCM Implementation

The Laboratory's ER Project will conduct the following activities to achieve the project objectives. The 4-inch cast iron drain line that delivered the contaminating industrial effluent to the site will be excavated and disposed. A disposal cell will be excavated, below grade, and within the SWMU boundary where solidified wastes will be placed for reburial. Contaminated soils/tuff will be excavated from "hot spots" and stockpiled for solidification. Excavation and removal of contaminated material will continue until residual concentrations, averaged over 1 yd^2, do not exceed 150 pCi/g cesium-137 or 170 pCi/g americium-241 based on on-site gamma screening. The stockpiled contaminated material will be solidified, i.e., the contaminated material will be processed in a twin-shaft pugmill mixer with Portland cement, bentonite, and water, then moved and placed as a batch block of solidified material within the disposal cell. Samples will be taken from the block of material to ensure structural integrity. An estimated volume of 800 yd^3 of material will be stabilized. Upon completion, the process equipment will be decontaminated and returned to the vendor.

Post excavation sampling and radiation surveys will be conducted to ensure that the DOE 5400.5 elevated activity criterion has been achieved. After confirmation sampling, site restoration will be performed to include re-contouring all excavated areas and placing and compacting ~4000 yd^3 of clean borrow soils over the disposal cell and across the site. Following grading, placement, and compaction of clean soils, the site will be reseeded.

Anticipated Waste Types and Volumes

Three separate waste streams are anticipated from this VCA as presented in the following table.

Waste Stream	Waste Type	Anticipated Volume
Radionuclide-contaminated soil and tuff	Solid — LLW	2,000 yd^3
Radionuclide-contaminated decon water from heavy equipment	Liquid — LLW	250 gallons
PPE, plastic sheeting, disposable sampling equipment, and soil samples	Solid — LLW	10 yd^3

Estimated Cost

Based on current resource estimates, all waste generated during this VCA is expected to be disposed of at TA-54 as LLW at a cost of approximately $1.2 million for waste disposal only. However, final disposal options will be re-evaluated during the VCA implementation planning process. With anticipated subcontractor costs and analytical costs the total estimated cost of this VCA is approximately $2.2 million.

Schedule

The field work portion of this VCA is expected to begin in mid-FY01 and take approximately three months to complete. The fieldwork includes soil and tuff removal, confirmatory sample collection and analysis, waste management, and site restoration.

Reference List of Past Plans, Reports, etc.

Environmental Restoration Project, August 1999. "Evaluation of Sediment and Alluvial Groundwater in DP Canyon," Los Alamos National Laboratory report LA-UR-99-4238, Los Alamos, New Mexico. (Environmental Restoration Project 1999, 63915)

LANL (Los Alamos National Laboratory), May 1991. "RFI Work Plan for Operable Unit 1106, Section 15.4," Los Alamos National Laboratory Report LA-UR-91-962, Los Alamos, New Mexico. (LANL 1991, 07529)

LANL (Los Alamos National Laboratory), January 1995. "Final Draft for the OU 1106 Addendum to Phase 1B, 1C Report, TA-21," Los Alamos National Laboratory report LA-UR-94-4360, Los Alamos, New Mexico. (LANL 1995, 52350)

LANL (Los Alamos National Laboratory), 1996. "Interim Action Plan for TA-21: PRS 21-011(k)," Los Alamos National Laboratory report LA-UR-96-1609, Los Alamos, New Mexico. (LANL 1996, 54790.2)

LANL (Los Alamos National Laboratory), April 1997. "Interim Action Report for Potential Release Site 21-011(k) Discharge System," Los Alamos National Laboratory report, Los Alamos, New Mexico. (LANL 1997, 55648.2)

Appendix C

Standard Operating Procedure 2.01

STANDARD OPERATING PROCEDURE

Title:	Identifier:	Revision:	Effective Date:
Surface Water Site Assessments	ER-SOP-2.01	0	9/21/99
	ER Catalog Number: ER19990087		

ER PROJECT

LOS ALAMOS NATIONAL LABORATORY

Surface Water Site Assessments

Table of Contents

1.0 PURPOSE 3
2.0 TRAINING 3
3.0 DEFINITIONS 3
4.0 BACKGROUND AND PRECAUTIONS 5
5.0 EQUIPMENT 5
6.0 PROCEDURE 5
7.0 REFERENCES 8
8.0 RECORDS 8
9.0 ATTACHMENTS 9

Surface Water Site Assessments

NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled-document electronic file located at http://erinternal.lanl.gov/documents/Procedures/sops.htm. However, it is their responsibility to ensure that they are trained to and utilizing the current version of this procedure. The Quality Program Project Leader (QPPL) may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for determining whether a Los Alamos National Laboratory (Laboratory) ER Project site has the potential to adversely effect surface water quality.

Note: The ER Project at the Laboratory is responsible for the investigation and remediation of solid waste management units (SWMUs) under the Resource Conservation and Recovery Act (RCRA) and areas of concern (AOCs) under the direction of the Department of Energy (DOE). During the investigation and remediation phases, information may be gathered that indicates that contaminant conditions may be present at the site that might affect surface water quality. Depending on the contaminant found, its concentration, and the erosion/sediment transport potential, it may be necessary to develop an action plan to mitigate the problem. The mitigation could include site restoration and/or stabilization.

2.0 TRAINING

2.1 All users of this SOP are trained by self-study, and the training is documented in accordance with QP-2.2. For consistency, Water Quality and Hydrology Group (ESH-18) personnel may be contacted for assistance.

2.2 The **Field Team Leader** (FTL) will monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments in accordance with QP-2.2.

3.0 DEFINITIONS

3.1 *Area of concern (AOC)* — Any suspected release of hazardous waste or hazardous waste constituent which is not directly associated with a SWMU (EPA, 1986).

3.2 *Best Management Practices (BMPs)* — BMPs mean schedules of activities, prohibition of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States.

BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw-material storage areas.

3.3 *Canopy* — The ground cover formed by the leafy upper branches of surrounding trees and shrubs.

3.4 *Chemical of potential concern (COPC)* — A chemical detected at a specific site that has the potential to adversely affect human or animal receptors due to its concentration (e.g., above regulatory screening action levels [SALs] or upper tolerance limit [UTL] values), distribution, and mechanism of toxicity. The chemical remains a concern until exposure pathways and receptors are evaluated in a site-specific risk assessment.

3.5 *Ground cover* — The covering of naturally occurring soils by either natural or man-made mechanisms (e.g., grasses, pine needles, asphalt, concrete, etc.).

3.6 *Gully erosion* — The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, which can range from 1 ft to as much as 50 ft.

3.7 *Potential release site (PRS)* — A site suspected of releasing or having the potential to release contaminants into the environment. PRS is a generic term that includes SWMUs, hazardous-waste sites listed as Module VII of the Laboratory's Hazardous Waste Facility Permit, and sites that have been identified as potentially contaminated by radioactivity. The ER Project has the responsibility for investigating and, if necessary, cleaning up such sites on and around the Laboratory.

3.8 *Refuse* — Includes food; swill; carrion; slops; and all substances from the preparation, cooking, and consumption of food. It also includes all substances that result from the handling, storage, and sale of food products; the carcasses of animals; junked parts of automobiles and other machinery; oil; discarded furniture; paper cartons; cans; bottles; tree branches; yard trimmings; ashes; and all unwholesome material.

3.9 *Rill erosion* — An erosion process in which numerous small channels only several inches deep are formed by concentrated runoff that flows during and immediately following rain storms.

3.10 *Runoff* — The portion of the precipitation on a drainage area that is discharged from the area either by sheet flow or adjacent stream channels.

3.11 *Run-on* — Surface water flowing onto an area as a result of runoff occurring higher up the slope.

3.12 *Slope* — A slope is a ratio of units of elevation change to units of horizontal change usually expressed in degrees.

3.13 *Solid Waste Management Unit (SWMU)* — Any discernible unit where solid wastes have been or may have been placed at any time, regardless of whether the unit was intended for the management of solid or hazardous wastes. These areas include anywhere solid wastes have been routinely and systematically released. All SWMUs are listed in Module VIII of HSWA Permit.

3.14 *Watercourse* — Any river, creek, arroyo, canyon, draw, wash, or other channel that has definite banks and beds with visual evidence of occasional flow of water.

3.15 *Water pollution* — Either introducing or permitting the introduction into water, either directly or indirectly, of one or more water contaminants in such quantity and of such duration as may, with reasonable probability, injure human health, animal or plant life, or property, or to unreasonably interfere with the public welfare or the use of the property.

4.0 BACKGROUND AND PRECAUTIONS

Members of ESH-18 perform a variety of kinds of fieldwork around the Laboratory. All fieldwork conducted as part of this SOP will follow their group-specific activity hazards analysis (AHA) and additional requirements set forth by the Facility Management Unit (FMU).

5.0 EQUIPMENT

Equipment used when going into the field depends on the distance from the group office and the distance the field technician will be from the vehicle. Field personnel must have current certifications in First Aid and CPR. Additional training or specific PPE may be required; this depends on the work location. For this procedure the following equipment is needed before going into the field to perform any work:

- first aid kit in vehicle;
- radio or cellular phone communication;
- drinking water;
- camera for photodocumentation; and
- clipboard, pencils, markers, and/or white board.

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

Streams, watercourses, and groundwater quality are regulated by the New Mexico Water Quality Control Commission (WQCC) Regulations. The water quality standards developed are enforced by the New Mexico Environment Department

(NMED) Surface and Ground Water Quality Bureaus (SWQB and GWQB, respectively) (see Attachment C for Summary Table). A surface water site assessment is made at a PRS using a checklist that has been developed to assess the erosion potential of each PRS. This evaluation checklist will aid in the prioritization of water-quality corrective actions and the BMPs necessary to protect surface water quality.

6.1 Overview Of Evaluation Process

PRSs are being investigated at the Laboratory to determine if they present a threat to human health or the environment. As information becomes available, water-quality concerns associated with a PRS may become evident. If contaminants are found to exist at the site above SALs in soil samples or above WQCC standards in surface water samples collected at the site and the topographic and vegetative state of the PRS suggests that migration of those contaminants could occur, a corrective action must be implemented.

6.2 Evaluating a PRS

The process is a two part evaluation. Apply this evaluation process to all ER Project sites that have not been recommended for "no further action" (NFA) *under criteria one, two, or three* as described in the April 1996, Document of Understanding (DOU). These three NFA criteria describe situations where either the site could not be located or did not exist, no waste or contamination is associated with the site, or no release to the environment from the site has occurred (e.g. the unit is inside of a building and no pathways to the environment exist, i.e., no floor drains exist).

Because of the large number of sites remaining in the project that do not fit the NFA criteria described above, sites must be prioritized for evaluation. The first sites that will be evaluated are those adjacent to drainages and canyon systems. After those are completed, evaluate the remaining sites.

6.2.1 The **ER Project** will initiate and complete Part A (see Attachment A) of the evaluation, which consists of compiling existing PRS analytical data, site maps, and knowledge of process information.

6.2.2 **ESH-18** personnel will complete Part B (see Attachment B) of the evaluation, which involves assessing the erosion/sediment transport potential at each PRS.

6.3 Implementing Corrective Actions

6.3.1 Prioritizing Evaluated PRSs for Site Actions

Parts A and B, when completed, will provide a basis for prioritizing and scheduling site actions needed to control undesirable-constituent

surface-water runoff and constituent-laden sediments that are eroding from PRSs.

6.3.1.1 A Surface Water Assessment Team (SWAT), comprised of ER Project, ESH-18, DOE Oversight Bureau (DOE-OB), NMED SWQB, and facility representatives has been formed to evaluate the completed assessments.

6.3.1.2 To ensure the worst sites are evaluated first, the **SWAT** will prioritize sites identified as having bioaccumulators present (see Attachment D for bioaccumulator list). SWAT evaluations shall use only existing information and/or data for the PRS of interest as reported in Parts A and B of the ER-SOP-2.01 site assessment (Attachments A and B). The ability of the SWAT to efficiently evaluate a site is directly dependent upon the PRS documentation to date.

6.3.1.3 For sites where the Part B, Surface Water Site Assessment, score is higher than 50, the **SWAT** will complete an evaluation to assess the site for potential contaminant migration and to prioritize potential corrective actions for the site.

6.3.1.4 For sites where the Part B, Surface Water Site Assessment, score is equal to or less than 50, no immediate action is required. This score reflects a site where there is a low potential for constituents in surface water and/or sediment to migrate off the site. These sites may not be included in a SWAT evaluation, but shall continue, as necessary, to be evaluated for other possible unacceptable environmental risks, such as human health and ecological risks.

6.3.2 Implementing Site Actions and Tracking SWAT Recommendations

6.3.2.1 Sites with COPCs present and which have high erosion potential require the **SWAT** to write a summary to the appropriate owner of the site in which the recommended corrective action is described. These corrective actions can be either minimal activities such as BMPs, which will temporarily stabilize the site until a final remedy can be applied or the final remedy itself.

6.3.2.2 Temporary solutions require routine inspection and maintenance by the **site owner** to ensure their effectiveness. Final remedies will likely be contaminant removal or the application of an engineered solution to inhibit contamination migration while protecting state waters.

6.3.2.3 Upon completion of the corrective activities at a PRS, The **ER Project** and the **FMU** will generate an NFA report that describes the results of the actions.

6.3.2.4 **ESH-18** will review these written summaries in order to ensure all water-protection requirements are satisfied.

6.3.2.5 **ESH-18** will submit copies of these final reports to NMED and DOE-OB upon completion.

6.3.3 Financial Responsibility for Corrective Actions

6.3.3.1 The **ER Project** is responsible for ensuring that historic, inactive sites do not adversely effect the state's surface water quality. The ER Project will fund all corrective actions and stormwater BMPs at those sites.

6.3.3.2 For inactive sites that have been created since 1988 and active sites that might currently be affecting water quality, the **landlord** of those sites or **Facilities, Security, and Safeguard Division** (FSS) will fund those actions. ESH-18 will coordinate the implementation of corrective actions necessary at non-ER owned sites.

7.0 REFERENCES

The following documents have been cited within this procedure.

AP-02.1, Procedure for LANL ER Records Management

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

EPA, "RCRA Facility Assessment Guidance," (OSWER, Washington, DC, 1986).

New Mexico Water Quality Control Commission, "State of New Mexico Ground and Surface Water Quality Protection Regulations," (New Mexico Water Quality Control Commission, Santa Fe, NM, 1995).

8.0 RECORDS

The **ER Project Office** is responsible for submitting the following records (processed in accordance with AP-02.1) to the Records Processing Facility.

8.1 Completed forms identified in Section 6.0

9.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Constituent Assessment Form (form and completion instructions) (3 pages)

Attachment B: Surface Water Site Assessment (form, matrix, and completion instructions) (7 pages)

Attachment C: Table 1 - Summary of Regulatory Water Standards Used for ER Projects (5 pages)

Attachment D: Proposed ER Project Bioaccumulator List (1 page)

Constituent Assessment (Part A)

Site Information

1. PRS Number: _____ 2. Date/Time: _____

3. ER Point of Contact: _____ 4. FMU/Point of Contact: _____ / _____

5. ❑ HSWA ❑ AOC (check both if AOC is on HSWA Permit) 6. Site Ranking System (SRS) #: _____

7. Description of the historical operations of this PRS:

8. Description of the current operations of this PRS (if any):

PRS Status

9. Action/Status to Date (check all that apply)

	Date Completed or Anticipated
❑ None	
Field Investigation ❑ Phase I ❑ Phase II	_____
Interim Measures ❑ IM ❑ BMPs	_____
Accelerated Cleanup ❑ VCA ❑ VCM	_____
Other ❑ Monitoring ❑ CMs	_____
Report Status ❑ RFI Report ❑ SAP	_____

❑ NFA/DOU — If checked, supply criteria number(s): _____

Comments:

Sample Information

Y	N	
❑	❑	10. Have surface/sediment (depth less than 12 in.) samples been collected that reflect current site conditions?
		If yes: 1) Attach data. 2) Include analyte name, value, units, location ID, sample ID, SAL, depth, and media (soil, tuff, etc.). 3) Please attach existing map that shows where samples were taken, if available.
❑	❑	11. Have surface water samples been collected that reflect site conditions?
		If yes: 1) Attach data. 2) Include analyte name, value, units, location ID, filtered/nonfiltered, and flow data (if available). 3) Please attach existing map that shows where samples were taken, if available.
❑	❑	12. Is data pending? If yes: 1) List date data are anticipated: _____ 2) Provide a list of COPCs identified in RFI Work Plan as an attachment.

13. ER Representative: _____
(Print name and title, then sign)

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

Instructions for Completing a Constituent Assessment Form (Part A)

Part A of the procedure addresses both current and historic Laboratory operations that are known to have occurred at the PRS, the potential or probable constituents of concern for this PRS, and the status of work or actions taken at the PRS.

Completion of Part A shall use only existing information and/or data that are available for the PRS of interest. The form itself may be completed electronically or manually by attaching the historic and current operations description from an RFI work plan or RFI Report. Available data tables may be copied from a work plan/report or queried from Facility for Information, Management, Analysis and Display (FIMAD) but should be submitted as an attachment to the completed form. The ability to efficiently complete Part A is directly dependent upon the knowledge about the PRS of interest and the PRS documentation to date.

The FTL is responsible for the initiation and completion of the constituent-assessment process. Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained, enter "UNK" for unknown, "N/A" for not applicable, or "ND" for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Site Information:

1. PRS Number — Use the PRS identification assigned by the ER Project for each site. If a map of the PRS and adjacent buildings within the Technical Area (TA) is available, please attach to Part A form.
2. Date/Time — The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hour clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
3. ER Point of Contact — Provide the name of the individual who completed Part A or another individual who is very knowledgeable about the site and the information/data requested for Part A.
4. Facility Management Unit (FMU)/Responsible Party Contact — Provide the name of the individual who represents the facility where the PRS is located, and when coordination is necessary, is the point of contact for complying with Laboratory safety, security, or work-activity restrictions for the PRS.
5. Permit Information — Is this PRS listed on the Module VIII or is it an Area Of Concern (AOC) (potentially on the permit also)?
6. Site Ranking System Score — Provide the SRS score for this PRS from the most recent site ranking.
7. Description of the historic operations of this PRS — Provide information regarding past site activities that may typically be found in the SWMU report, an RFI work plan and/or RFI report. Include the identification of all constituents used at the PRS

as raw materials, known constituent product intermediates and product constituents for other known processes. If available, attach previous information not collected by the ER Project to Part A.

8. Description of current operations of this PRS (if any): Provide information regarding present site activities that may typically be found in the SWMU report, an RFI work plan and/or report or the current facility manager. Include the identification of all constituents used at the PRS as raw materials, known constituent-product intermediates and product constituents for other known processes. If information is available about these operations, attach the information to Part A.

PRS Status:

9. Action/Status to Date — Provide information on what type of field action has been proposed, completed, or is ongoing at a PRS. Also, provide information on the report/plan status of the site (e.g. RFI Work Plan, Sampling Analysis Plan, etc.). Check the appropriate fields on the form and provide the date that the action was completed or is anticipated to be completed. Provide additional information by circling the appropriate action (e.g., Phase I, under Field Investigation), or in the comment field.

Sample Information:

10. Soil/sediment sample descriptor information and sample data — Provide information/data that reflect only current ambient PRS field conditions which are above detection limits or background UTL values. Do not provide information/data with regard to past site conditions that no longer exist due to an action that has been taken at the PRS. Information/data are only for surface soils and sediments of less than 12 in. in depth.

    Provide additional information to support PRS data, (e.g., sample date; sample number; sample location coordinates' site map with sample locations; media — soil, sediment, tuff, etc.; data qualifiers; SALs; data detection/reporting limits; and supporting background data for the media where data is available). Editing or screening the data is not necessary at this time. All data that are available that meet the above specified identifiers should be reported.

11. Surface water sample descriptor information — If surface water sample information is available, provide information regarding sample date, location, whether sample was filtered/nonfiltered, and flow information if available. If surface water samples represent runoff from more than one PRS, the other involved PRSs and their constituents must also be identified.

12. If samples have been collected but data are not available, provide the anticipated date when the data could be available. Attach knowledge of process COPCs from RFI work plan.

13. ER Representative Identification — Print your name and position title, then sign.

Surface Water Site Assessment (Part B)

Site Information:

1a. PRS Number: _____ 1b. Structure Number: _____ 1c. FMU Number: _____

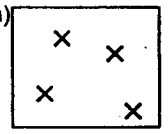
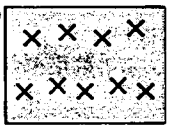
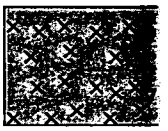
2. Date/Time: _____

Site Setting (check all that apply):

3. ❑ On mesa top (a).
❑ Within a bench of a canyon (b).
❑ In the canyon floor, but not in an established channel (c).
❑ Within an established channel in the canyon floor (d).

Explanation:

4. Estimated ground and/or canopy cover at site(deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.):

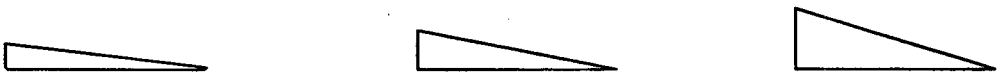
(a) 
(b) 
(c) 

Estimated percentage of ground/canopy cover: ❑ 0% to 25% ❑ 25% to 75% ❑ 75% to 100%

Explanation:

5. Steepest slope at the impacted area:

(a) (b) (c)



❑ Less than 10% ❑ 10% to 30% ❑ 30% and greater

Explanation:

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

Surface Water Site Assessment (Part B)

Runoff Factors:

Y N

☐ ☐ 6. Is there visible evidence of runoff discharging from the site? (If yes, answer questions 6a–6c below.)

☐ ☐ 6a. Is runoff channelized? If yes, describe: ☐ Man-made channel ☐ Natural channel

Explanation:

6b. Where does evidence of runoff terminate?

☐ Drainage or wetland (name) _____

☐ Within bench of canyon setting (name) _____

☐ Other (i.e., retention pond, meadow, mesa top) _____

Explanation:

☐ ☐ 6c. Has runoff caused visible erosion at the site? If yes, check type and explain below. ☐ Sheet ☐ Rill ☐ Gully

Explanation:

Run-on Factors:

Please rate the potential for stormwater to run onto this site (check either Item 7 or Item 9):

Y N

☐ ☐ 7. Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☐ ☐ 8. Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation:

☐ ☐ 9. Are natural drainage patterns directing stormwater onto the site?

Explanation:

ER-SOP-2.01, R0	Los Alamos Environmental Restoration Project

Surface Water Site Assessment (Part B)

Assessment Finding:

Y N

❑ ❑ 10. Based on the criteria above and the assessment of this site, does a soil-erosion potential exist? (Refer to erosion-potential matrix)

11. Signature:

_____

Water Quality/Hydrology Representative

_____ Initials of the independent reviewer Check here when the information is entered in the database: ❑

This section is for ESH-18 notes, recommendations, and photographs.

Y N

❑ ❑ 12a. Is there visible trash/debris on the site?

❑ ❑ 12b. Is there visible trash/debris in the watercourse?

13a. Description of existing BMPs:

❑ ❑ 13b. Are BMPs being properly maintained? Provide description in "Other Internal Notes."

Other Internal Notes:

ER-SOP-2.01, R0	Los Alamos Environmental Restoration Project

Instructions for Completing a Surface Water Site Assessment Form (Part B)

ESH-18 or ER Project Regulatory Compliance personnel will complete Part B, the Surface Water Site Assessment. Part B addresses erosion potential and is part of a systematic approach to quantify surface-water impacts at Laboratory sites. This procedure describes the process for determining whether a site has the potential to adversely affect surface-water quality by erosion from run-off.

Field teams from ESH-18 or the ER Project will evaluate the field conditions to determine the potential for erosion or sediment migration. Based on the results of field evaluation, surface water corrective actions (BMPs) and/or NMED notifications may be required.

Photographs will be taken to help document the field characteristics at some sites. A consideration of the visual site conditions is necessary to accurately provide a frame of reference for the site. Photographs are taken to visually enhance the field-site condition descriptions.

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained, enter "UNK" for unknown, "N/A" for not applicable, or "ND" for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Site Information:

1a. PRS Number — Use the PRS identification assigned by the ER Project to the site.

1b. Structure Number — Provide the nearest technical area/structure number.

1c. FMU Number — Provide the facility management unit number.

2. Date/Time — The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hour clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).

Site Setting:

3. Check the appropriate setting(s) that best describes the location, in order of increasing concern, for the listed site.
   (a) Check "On mesa top" if site is situated on a defined mesa top (e.g., Three Mile Mesa).
   (b) Check "Within a bench in a canyon" if site is located over the edge of a mesa top and is either on a defined slope or bench (the original source may be located on mesa top).

(c) Check "In the canyon floor, but not in an established channel" if site is located in the bottom of the canyon exclusive of a defined drainage or bench setting. (A drainage is defined as having a bank and channel).

(d) Check "Within established channel in the canyon floor" if site is located in the defined drainage portion of the canyon channel. (A drainage is defined as having a bank and channel).

An explanation box is provided for a description of particular circumstances/ situations. Where more than one setting is checked, the most conservative will be used in scoring this criterion on the matrix. An example would be where a septic tank was located on a mesa top (a), but the outfall from the septic discharges over the mesa onto a defined slope or bench (b), the more conservative setting (b) would be used.

4. Check the appropriate percentage of canopy and ground cover that best compares with the provided pictorial illustration for the site location.
   - Check from 0% to 25% if ground/canopy cover at site visually compares best with example (a).
   - Check 25% to 75% if ground/canopy cover at site visually compares best with example (b).
   - Check greater than 75% if ground/canopy cover at site visually compares best with example (c).

   An explanation box is provided to describe the type(s) of ground cover (e.g., pine needles, grass, asphalt, rock, etc.) and canopy cover (e.g., pine/juniper, deciduous/evergreen) observed at the site. Where more than one percentage is checked, the most conservative will be used in scoring this criterion on the matrix. An example would be where a septic tank was located in a densely vegetated area (c), but the outfall from the septic discharges over the mesa top into a less vegetated area (b), the most conservative coverage (b) would be used

5. Check the appropriate slope(s) that best compare with the provided pictorial illustration for the site location.
   - Check less than 10% if slope at site visually compares to example (a).
   - Check 10% to 30% if slope at site visually compares to example (b).
   - Check greater than 30% if slope at site visually compares to example (c).

   An explanation box is provided to describe particular circumstances/situations. Where more than one slope steepness is checked, the most conservative will be used in scoring the criteria. An example would be where a septic tank was located on a mesa top (a), but the outfall from the septic discharges over the mesa onto a very steep slope (c), the most conservative slope (c) would be used.

Runoff Factors:

6. Is there visible evidence of water and/or sediment discharging from PRS? *If yes*, complete parts a, b, and c. *If no*, proceed to question number 7.

6a. Is runoff channelized? Check whether runoff discharges through man-made or natural drainage channels or from sheet flow. An explanation box is provided to describe the type of discharge.

6b. Where does evidence of runoff terminate? Check whether visual evidence of runoff terminates into a known canyon (e.g., Pajarito), into a known sub-drainage or wetland, or into other flat lying areas (e.g., bench setting, meadows, detention ponds, etc.). If runoff can be traced to an observable endpoint or drainage, provide an adequate description of that location.

6c. Has runoff caused visible erosion at the PRS? If yes, check sheet, rill, or gully erosion. An explanation box is provided to describe the visible signs of erosion and to provide an indication of the potential for the movement of surface sediments from the site.

Run-on Factors:

7. Are structures (i.e., buildings, roof drains, parking lots) creating run-on to this PRS?

   If structures, from existing or new construction for facilities, collect and/or divert storm water run-on onto the PRS being evaluated, check yes. An explanation box is provided to describe the potential for buildings, roof drains, and/or construction project sites larger than five acres, to increase the volume of run-on to the site.

8. Are current operations adversely impacting storm water run-on to the PRS?

   If current operations (e.g., NPDES outfalls, salvage material storage areas, septic discharges) could adversely impact run-on to the site being evaluated, check yes. Nonstormwater discharges such as fire-protection devices, potable-water-system tank overflow, and dust-suppression activities are also of interest. An explanation box is provided to describe which operations may be impacting run-on.

9. Are natural drainage patterns directing stormwater onto the PRS?

   If site is located in an area in which natural drainage patterns focus stormwater run-on onto a site, check yes. An explanation box is provided to describe the natural drainage that could potentially cause erosion.

   Typically, either question 7 or 9 would be selected independent of one another. If both are selected, then only one will be rated in the matrix because the weighting is identical.

Assessment Finding:

10 Based on the above criteria and the assessment of the site, does soil-erosion potential exist?

This is a subjective decision made by the field technician based on the evidence found at the site. The "potential" for soil erosion may exist without visible evidence of erosion being observed on the day of the assessment.

Signature:

11. Name of Water Quality/Hydrology or ER Project Representative — Provide name of person who completed the surface water site assessment for this site as a representative of ESH-18 or the ER Project. After completion, provide a copy to the appropriate representatives for the site.

ESH-18 Notes and Recommendations:

12a. Is there visible trash/debris located on site? If trash/debris is observed at the site, check yes and provide comments in "Other Internal Notes."

12b. Is there visible trash/debris in a watercourse? If trash/debris is observed within a watercourse as defined earlier in Section 3.15, check yes and provide comments in "Other Internal Notes".

13a. Description of existing BMPs. Provide a brief description of BMPs that currently exist at the site.

13b. Are BMPs being properly maintained? Check either yes/no and provide a description of the effectiveness or ineffectiveness of BMPs in "Other Internal Notes."

Summary of Regulatory Water Standards Used for ER Projects[a]

Analyte Code[b]	Chemical[c]	Drinking Water Standards		NMED[d] WQCC[e] Surface Water Standards			NMED WQCC Groundwater Standards		
		US EPA MCL[f] (µg/l)	NMED MCL[g] (µg/l)	Domestic Water Supply[h] (µg/l)	Livestock Watering[i] (µg/l)	Wildlife Habitat[j] (µg/l)	Human Health[k] (µg/l)	Domestic Water Supply[k] (µg/l)	Irrigation Use[k] (µg/l)
15972-60-8	Alachlor	2.0E+00	2.0E+00	—[m]	—	—	—	—	—
Al	Aluminum	5.0E+01[n]	—	—	5.0E+03	—	—	—	5.0E+03
Sb	Antimony	6.0E+00	6.0E+00	—	—	—	—	—	—
As	Arsenic (cancer endpoint)	5.0E+01	5.0E+01	5.0E+01	2.0E+02	—	1.0E+02	—	—
1912-24-9	Atrazine	3.0E+00	3.0E+00	—	—	—	—	—	—
Ba	Barium	2.0E+03	2.0E+03	1.0E+03	—	—	1.0E+03	—	—
71-43-2	Benzene	5.0E+00	5.0E+00	—	—	—	1.0E+01	—	—
50-32-8	Benzo[a]pyrene	2.0E-01	2.0E-01	—	—	—	7.0E-01	—	—
Be	Beryllium	4.0E+00	4.0E+00	—	—	—	—	—	—
117-81-7	Bis(2-ethylhexyl)phthalate (DEHP) (Di[ethylhexyl]phthalate)	6.0E+00	6.0E+00	—	—	—	—	—	—

[a] Compiled on 01/06/97 by Linda Nonno (665-0725, lnonno@lanl.gov). **Note: Values in this table are subject to change.** Verify that you are using current values by checking the ER Project web site before use (http://erinternal.lanl.gov).

[b] In order to enable joining in the FIMAD database, analyte codes replace CAS numbers for metals, radionuclides, and ions.

[c] Chemicals include inorganics, high explosives, and organic compounds (volatile and semivolatile organic compounds, pesticides, and polychlorinated biphenyls).

[d] New Mexico Environment Department

[e] Water Quality Control Commission

[f] Maximum Contaminant Level (MCL) concentration from "Drinking Water Regulations and Health Advisories," October 1996, US Environmental Protection Agency (EPA) Office of Water, Washington, DC. (EPA 1996,1380).

[g] Maximum Contaminant Level (MCL) concentration from "Drinking Water Regulations," Title 20, Chapter 7, Part 1, NMED Drinking Water Bureau, January 1995, Santa Fe, NM (State of New Mexico 1995,1268).

[h] Domestic Water Supply Standard from "Standards for Interstate and Intrastate Streams" (i.e., New Mexico surface water standards for domestic water supply), Title 20, Chapter 6, Part I, NMED WQCC, January 1995, Santa Fe, NM (State of New Mexico 1995,1267). Based on the dissolved (i.e., filtered) portion with the exception of mercury, For radium-226 + radium-228, tritium, and gross alpha, the standard is based on the total (i.e., nonfiltered) portion.

[i] Livestock Watering Standard from "Standards for Interstate arid Intrastate Streams," Title 20, Chapter 6, Part 1, NMED WQCC, January 1995, Santa Fe, NM (State of New Mexico 1995,1264 Based on the dissolved (i.e., filtered) portion of water samples for inorganic chemicals with the exception of mercury.

[j] Wildlife Habitat Standard from "Standards for Interstate and Intrastate Streams," Title 20, Chapter 6, Part 1, NMED WQCC, January 1995, Santa Fe, NM (State of New Mexico 1995,1267). Based on total (i.e., nonfiltered) recoverable selenium and total mercury.

[k] Groundwater standard from "New Mexico Water Quality Control Commission Regulations,:" Title 20, Chapter 6, Part 2, NMED WQCC, December 1995, Santa Fe, NM (State of New Mexico 1995,1318). Based on dissolved (i.e., filtered) portion with the exception of mercury, organic chemicals, and nonaqueous phase liquids (such as oil).

[m] "—" = no standard.

[n] US EPA Secondary Maximum Contaminant Level (SMCL) concentration from "Drinking Water Regulations and Health Advisories," May 1995, US EPA Office of Water Washington, DC (EPA 1996,1380).

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

Summary of Regulatory Water Standards Used for ER Projects (continued)

Analyte Code	Chemical	Drinking Water Standards		NMED WQCC Surface Water Standards			NMED WQCC Groundwater Standards		
		US EPA MCL (µg/l)	NMED MCL (µg/l)	Domestic Water Supply (µg/l)	Livestock Watering (µg/l)	Wildlife Habitat (µg/l)	Human Health (µg/l)	Domestic Water Supply (µg/l)	Irrigation Use (µg/l)
B	Boron	—	—	—	5.0E+03	—	—	—	7.5E+02
Cd	Cadmium	5.0E+00	5.0E+00	1.0E+01	5.0E+01	—	1.0E+01	—	—
1563-66-2	Carbofuran	4.0E+01	4.0E+01	—	—	—	—	—	—
56-23-5	Carbon Tetrachloride	5.0E+00	5.0E+00	—	—	—	1.0E+01	—	—
57-74-9	Chlordane	2.0E+00	2.0E+00	—	—	—	—	—	—
Cl(-1)	Chloride	2.5E+05[n]	—	—	—	—	—	2.5E+05	—
108-90-7	Chlorobenzene (Monochlorobenzene)	1.0E+02	1.0E+02	—	—	—	—	—	—
67-66-3	Chloroform (Trichloromethane)	1.0E+02[o]	1.0E+02[o]	—	—	—	1.0E+02	—	—
Cr	Chromium (must include both trivalent and hexavalent forms)	1.0E+02	1.0E+02	5.0E+01	1.0E+03	—	5.0E+01	—	—
Co	Cobalt	—	—	—	1.0E+03	—	—	—	5.0E+01
Cu	Copper	1.3E+03[p]	1.3E+03[p]	—	5.0E+02	—	—	1.0E+03	—
Cn(-1)	Cyanide	2.0E+02	2.0E+02	2.0E+02	—	—	2.0E+02	—	—
75-99-0	Dalapon	2.0E+02	2.0E+02	—	—	—	—	—	—
96-12-8	1,2-Dibromo-3-chloropropane	2.0E-01	2.0E-01	—	—	—	—	—	—
106-93-4	1,2-Dibromoethane (Ethylene Dibromide)	5.0E-02	5.0E-02	—	—	—	1.0E-01	—	—
95-50-1	1,2-Dichlorobenzene(o)	6.0E+02	6.0E+02	—	—	—	—	—	—
541-73-1	1,3-Dichlorobenzene(m)	6.0E+02	—	—	—	—	—	—	—
106-46-7	1,4-Dichlorobenzene(p)	7.5E+01	7.5E+01	—	—	—	—	—	—
75-34-3	1,1-Dichloroethane	—	—	—	—	—	2.5E+01	—	—
107-06-2	1,2-Dichloroethane (EDC)	5.0E+00	5.0E+00	—	—	—	1.0E+01	—	—
75-35-4	1,1-Dichloroethylene (1,1-DCE)	7.0E+00	7.0E+00	—	—	—	5.0E+00	—	—
156-59-2	1,2-Dichloroethylene (cis)	7.0E+01	7.0E+01	—	—	—	—	—	—
156-60-5	1,2-Dichloroethylene (trans)	1.0E+02	1.0E+02	—	—	—	—	—	—
94-75-7	2,4-Dichlorophenoxyacetic Acid	7.0E+01	7.0E+01	—	—	—	—	—	—

[n] US EPA Secondary Maximum Contaminant Level (SMCL) concentration from "Drinking Water Regulations and Health Advisories," May 1995, US EPA Office of Water Washington, DC (EPA 1996,1380).

[o] The State (State of New Mexico 1995, 1268) and EPA (EPA 1996, 1380) MCL for chloroform is the MCL for total trihalomethanes. Total trihalomethanes is defined as the sum of the concentration of the following trihalomethane compounds: chloroform, dibromochloromethane, bromodichloromethane, and tribromomethane (bromoform).

[p] US EPA MCL is under review (EPA 1996,1380). Number presented is the EPA action level. Although the EPA MCL is under review, to NMED Drinking Water Bureau has adopted the action level.

Summary of Regulatory Water Standards Used for ER Projects (continued)

Analyte Code	Chemical	Drinking Water Standards		NMED WQCC Surface Water Standards			NMED WQCC Groundwater Standards		
		US EPA MCL (µg/l)	NMED MCL (µg/l)	Domestic Water Supply (µg/l)	Livestock Watering (µg/l)	Wildlife Habitat (µg/l)	Human Health (µg/l)	Domestic Water Supply (µg/l)	Irrigation Use (µg/l)
78-87-5	1,2-Dichloropropane	5.0E+00	5.0E+00	—	—	—	—	—	—
103-23-1	Di(2-ethylhexyl)adipate	4.0E+02	4.0E+02	—	—	—	—	—	—
88-85-7	Dinoseb	7.0E+00	7.0E+00	—	—	—	—	—	—
85-00-7	Diquat	2.0E+01	2.0E+01	—	—	—	—	—	—
145-73-3	Endothall	1.0E+02	1.0E+02	—	—	—	—	—	—
72-20-8	Endrin	2.0E+00	2.0E+00	—	—	—	—	—	—
100-41-1	Ethylbenzene	7.0E+02	7.0E+02	—	—	—	7.5E+02	—	—
F(-1)	Fluoride	4.0E+03[n]	4.0E+03	—	—	—	1.6E+03	—	—
1071-83-6	Glyphosate	7.0E+02	7.0E+02	—	—	—	—	—	—
76-44-8	Heptachlor	4.0E-01	4.0E-01	—	—	—	—	—	—
1024-57-3	Heptachlor epoxide	2.0E-01	2.0E-01	—	—	—	—	—	—
118-74-1	Hexachlorobenzene	1.0E+00	1.0E+00	—	—	—	—	—	—
58-89-9	HCH (gamma) Lindane	2.0E-01	2.0E-01	—	—	—	—	—	—
77-47-4	Hexachlorocyclopentadiene	5.0E+01	5.0E+01	—	—	—	—	—	—
Fe	Iron	3.0E+02[n]	—	—	—	—	1.0E+03	—	—
Pb	Lead	1.5E+01[p]	1.5E+01[p]	5.0E+01	1.0E+02	—	5.0E+01	—	—
Mn	Manganese	5.0E+01[n]	—	—	—	—	—	2.0E+02	—
Hg	Mercury (inorganic)	2.0E+00	2.0E+00	2.0E+00	1.0E+01	1.2E+02	2.0E+00	—	—
72-43-5	Methoxychlor	4.0E+01	4.0E+01	—	—	—	—	—	—
75-09-2	Methylene Chloride (Dichloromethane)	5.0E+00	5.0E+00	—	—	—	1.0E+02	—	—
Mo	Molybdenum	—	—	—	—	—	—	—	1.0E+03
n/a[q]	Naphthalene + monomethylnaph-thalenes	—	—	—	—	—	3.0E+01	—	—
Ni	Nickel (soluble salts)	—	1.0E+02	—	—	—	—	—	2.0E+02
NO_3(-1)	Nitrate (as N)	1.0E+04	1.0E+04	1.0E+04	—	—	1.0E+04	—	—
NO_2/NO_3	Total Nitrate + Nitrate (as N)	1.0E+04	1.0E+04	—	—	—	—	—	—

[n] US EPA Secondary Maximum Contaminant Level (SMCL) concentration from "Drinking Water Regulations and Health Advisories," May 1995, US EPA Office of Water Washington, DC (EPA 1996,1380).

[p] US EPA MCL is under review (EPA 1996,1380). Number presented is the EPA action level. Although the EPA MCL is under review, to NMED Drinking Water Bureau has adopted the action level.

[q] n/a = not applicable

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

Summary of Regulatory Water Standards Used for ER Projects (continued)

Analyte Code	Chemical	Drinking Water Standards		NMED WQCC Surface Water Standards			NMED WQCC Groundwater Standards		
		US EPA MCL (µg/l)	NMED MCL (µg/l)	Domestic Water Supply (µg/l)	Livestock Watering (µg/l)	Wildlife Habitat (µg/l)	Human Health (µg/l)	Domestic Water Supply (µg/l)	Irrigation Use (µg/l)
NO_2(-1)	Nitrite (as N)	1.0E+03	1.0E+03	—	—	—	—	—	—
23135-22-0	Oxamyl	2.0E+02	2.0E+02	—	—	—	—	—	—
87-86-5	Pentachlorophenol	1.0E+00	1.0E+00	—	—	—	—	—	—
pH	pH	6.5–8.5 pH[n]	—	—	—	—	—	—	—
n/a[q]	Phenols (Total of all phenol cmpds)	—	—	—	—	—	—	5.0E+00	—
1918-02-1	Picloram	5.0E+02	5.0E+02	—	—	—	—	—	—
1336-36-3	Polychlorinated biphenyls (PCBs)	5.0E-01	5.0E-01	—	—	—	1.0E+00	—	—
Se	Selenium	5.0E+01	5.0E+01	5.0E+01	5.0E+01	2.0E+00	5.0E+01	—	—
Ag	Silver	1.0E+02[n]	—	5.0E+01	—	—	5.0E+01	—	—
122-34-9	Simazine	4.0E+00	4.0E+00	—	—	—	—	—	—
SO_4	Sulfate	2.5E+05[n]	—	—	—	—	—	6.0E+05	—
100-42-5	Styrene	1.0E+02	1.0E+02	—	—	—	—	—	—
1746-01-6	2,3,7,8-TCDD (Dioxin)	3.0E-05	3.0E-05	—	—	—	—	—	—
79-34-5	1,1,2,2-Tetrachloroethane	—	—	—	—	—	1.0E+01	—	—
127-18-4	Tetrachloroethylene (PCE)	5.0E+00	5.0E+00	—	—	—	2.0E+01	—	—
Tl	Thallium	2.0E+00	2.0E+00	—	—	—	—	—	—
108-88-3	Toluene	1.0E+03	1.0E+03	—	—	—	7.5E+02	—	—
TDS	Total Dissolved Solids	5.0E+05[n]	—	—	—	—	—	1.0E+06	
8001-35-2	Toxaphene	3.0E+00	3.0E+00	—	—	—	—	—	—
120-82-1	1,2,4-Trichlorobenzene	7.0E+01	7.0E+01	—	—	—	—	—	—
71-55-6	1,1,1-Trichloroethane	2.0E+02	2.0E+02	—	—	—	6.0E+01	—	—
79-00-5	1,1,2-Trichloroethane	5.0E+00	5.0E+00	—	—	—	1.0E+01	—	—
79-01-6	Trichloroethylene (TCE)	5.0E+00	5.0E+00	—	—	—	1.0E+02	—	—
93-72-1	2-(2,4,5-Trichlorophenoxy)propionic Acid (2,4,5-TP)	5.0E+01	5.0E+01	—	—	—	—	—	—
$U^{SOLUBLE}$	Uranium (soluble salts)	—	—	5.0E+03	—	—	5.0E+03	—	—
V	Vanadium	—	—	—	1.0E+02	—	—	—	—
75-01-4	Vinyl Chloride	2.0E+00	2.0E+00	—	—	—	1.0E+00	—	—

[n] US EPA Secondary Maximum Contaminant Level (SMCL) concentration from "Drinking Water Regulations and Health Advisories," May 1995, US EPA Office of Water Washington, DC (EPA 1996,1380).

[q] n/a = not applicable

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

Summary of Regulatory Water Standards Used for ER Projects (concluded)

Analyte Code	Chemical	Drinking Water Standards		NMED WQCC Surface Water Standards			NMED WQCC Groundwater Standards		
		US EPA MCL (µg/l)	NMED MCL (µg/l)	Domestic Water Supply (µg/l)	Livestock Watering (µg/l)	Wildlife Habitat (µg/l)	Human Health (µg/l)	Domestic Water Supply (µg/l)	Irrigation Use (µg/l)
1330-20-7	Xylene (mixed)	1.0E+04	1.0E+04	—	—	—	6.2E+02	—	—
Zn	Zinc	5.0E+03[n]	—	—	2.5E+04	—	—	1.0E+04	—
ALPHA	Gross Alpha (Does not include Radon or Uranium.)	1.5E+01	1.5E+01	1.5E+01	1.5E+01	—	—	—	—
$^{226/228}Ra$	Radium-226 + Radium-228	5.0E+00	5.0E+00	3.0E+01	.0E+01		.0E+01	—	—
^{90}Sr	Strontium-90	—	8.0E+00	—	—	—	—	—	—
U	Uranium (radionuclide)	2.0E+01 µg/l[r]	sect. 207(b)[f]	—	—	—	—	—	—
^{3}H	Tritium	—	2.0E+04	2.0E+04	2.0E+04	—	—	—	—

[f] Maximum Contaminant Level (MCL) concentration from "Drinking Water Regulations and Health Advisories," October 1996, US Environmental Protection Agency (EPA) Office of Water, Washington, DC. (EPA 1996,1380).

[n] US EPA Secondary Maximum Contaminant Level (SMCL) concentration from "Drinking Water Regulations and Health Advisories," May 1995, US EPA Office of Water Washington, DC (EPA 1996,1380).

[r] Proposed US EPA MCL (EPA 1996,1380). Number presented is the EPA action level.

ER-SOP-2.01, R0

Los Alamos
Environmental Restoration Project

ER Project List of Potential Bioaccumulation Compounds

The priority list of compounds with a potential for bioaccumulation at the Laboratory is provided with the stipulation that the list is still under development. Compounds are being evaluated based on

1) toxicity,
2) frequency of occurrence at the Laboratory including the use of the co-occurrence of a bioaccumulator with another chemical as a marker for the bioaccumulator when supported by historical data or site sampling data,
3) potential for receptors including sensitive species and habitat at the Laboratory, and
4) bioconcentration factor (BCF) adjusted for environmental factors at the Laboratory or based on site-specific data.

Use the following list of compounds—currently in the category of "high priority" bioaccumulators—in assessing SOP 2.01 concerns at the Laboratory.

- Cadmium
- Cesium-137
- Mercury
- Strontium-90
- All arochlors (PCBs)

Appendix D

Ecological Scoping Checklist

APPENDIX D ECOLOGICAL SCOPING CHECKLIST

Part A—Scoping Meeting Documentation

Site ID	SWMU 21-011(k)
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.) and describe potential areas of release. Reference locations on a map as appropriate.	Site was a former outfall associated with two 12,700 gal. effluent-holding tanks (TA-21-112 and TA-21-113) that discharged treated effluent from an industrial liquid waste treatment facility into DP Canyon via 21-011(k) outfall. Releases at the outfall were to the surface. The discharge flowed down the slope and eventually into the DP Canyon drainage, which is not part of this SWMU.
List of Primary Impacted Media **(Indicate all that apply.)**	**Surface soil – XX –** impacted by discharges at the outfall. **Surface water/sediment – X –** potentially impacted from the discharge into the canyon; sediment in bottom of canyon and possibly surface water including ephemeral stream channel in bottom of canyon. **Subsurface –** **Groundwater – XX –** alluvial groundwater impacted by discharges at the outfall. **Other, explain –**
FIMAD vegetation class based on Arcview vegetation coverage **(Indicate all that apply.)**	**Water – XX –** An ephemeral stream channel exists in the bottom of DP Canyon below the SWMU and flows eastward. It is located approximately 100 to 200 yards from outfall. **Bare Ground/Unvegetated – XX –** There are few areas of bare ground between vegetated areas. These areas are either exposed tuff or dirt often covered with pine needles and other plant litter. **Spruce/fir/aspen/mixed conifer –** **Ponderosa pine – XX-** Primary vegetation community; also ground cover of grasses and shrubs. **Piñon juniper/juniper savannah –** **Grassland/shrubland – XX –** in the bottom of DP Canyon, below the SWMU, with small patches of bare ground. **Developed –.**
Is T&E Habitat Present? **If applicable, list species known or suspected to use the site for breeding or foraging.**	The site is on the border of the core habitat for the Mexican spotted owl and peregrine falcon. This site is within an area that the owl may be assumed to forage with a moderate to low frequency.
Provide list of Neighboring/ Contiguous/ Up-gradient sites, include a brief summary of COPCs and form of releases for relevant sites and reference map as appropriate. **(Use information to evaluate need to aggregate sites for screening.)**	Neighboring/Contiguous/Up-gradient from SWMU 21-011(k) are: 21-001, 21-011(a), 21-019(g), 21-011(h), 21-011(j), 21-011(i), 21-011(e), 21-011(d), 21-011(g), 21-010(e), 21-011(f), 21-016(a), 21-010(f), 21-010(a), 21-010(c), 21-011(c), 21-028(a), 21-016(b), 21-010(b), 21-016(c), 21-010(h), and 21-010(g). The majority of the contamination contributing to SWMU 21-011(k) would have come from SWMUs 21-011(g) and (f), two 12,700 gal. effluent-holding tanks (TA-21-112 and TA-21-113) that discharged treated effluent from an industrial liquid waste treatment facility into DP Canyon. Additionally, SWMUs 21-016(a-c) (MDA T) where liquid radioactive waste was disposed is upgradient from SWMU 21-011(k).
Surface Water Erosion Potential Information **Summarize information from SOP 2.01, including the run-off subscore (maximum of 46); terminal point of surface water transport; slope; and surface water runon sources.**	The Erosion Matrix score for this SWMU is 72, with a score of 46 for runoff [visible evidence of runoff discharging (5.0), runoff terminates in a drainage/wetland (19.0), and runoff in a gully (22.0)] and a score of 0.0 for run-on (natural drainages onto site) scores. The score also reflects it is within the canyon floodplain, but not watercourse (13.0), ground cover is 25-75% (6.5), and slope is >10-30%. (6.5). Potential exists for soil erosion at this site. The runoff terminates in DP Canyon.

Part B—Site Visit Documentation

Site ID	SWMU 21-011(k)
Date of Site Visit	10/26/2000
Site Visit Conducted by	Rich Mirenda, Linda Causey, Jayne Jones

Receptor Information:

Estimate cover	Relative vegetative cover (high, medium, low, none) = high Relative wetland cover (high, medium, low, none) = none Relative structures/asphalt, etc. cover (high, medium, low, none) = none
Field notes on the FIMAD vegetation class to assist in ground-truthing the Arcview information	Site visit confirms that this SWMU is a combination of open areas and ponderosa pine. In some places the tuff is on the surface, in others it is several inches below the surface. Ground cover consists of grasses, shrubs, and young trees. As one goes from DP Road to the mesa top edge of DP Canyon, the vegetation increases and older ponderosa pine predominates. The ground is also covered with pin needles and litter from other plants.
Field notes on T&E Habitat, if applicable. Consider the need for a site visit by a T&E subject matter expert to support the use of the site by T&E receptors.	Site provides good to excellent habitat for foraging. While there is generally no habitat for nesting for T&E species, there are a few nearby dead trees that would make for excellent nesting of birds. The Mexican spotted owl and the peregrine falcon may forage in DP Canyon (Koch 1999, 63599)
Are ecological receptors present at the site? **(yes/no/uncertain)** **Describe the general types of receptors present at the site (terrestrial and aquatic), and make notes on the quality of habitat present at the site.**	Yes. Terrestrial receptors are present in and around the SWMU. Various songbirds were observed in the trees and circling raptors were observed. There was evidence of burrowing was observed in this area. Bear tracks were seen in the dry stream bed. Other large mammals such as deer, elk, coyotes and raccoons would be in the area. Plant life is abundant and healthy. No aquatic receptors are present in the canyon reach below the SWMU.

Contaminant Transport Information:

Surface water transport **Field notes on the erosion potential, including a discussion of the terminal point of surface water transport (if applicable).**	Previously, the runoff flowed into a man-made (3 to 4 ft deep) gully and into DP Canyon. Runoff flow to this gully has been diverted during the 1996 Interim Action in order to prevent contaminants from being moved via water. The surface water runoff has now been diverted into DP Canyon via a drainage to the east and another to the far west of the site. Rain water that falls directly on the outfall portion of the SWMU would flow into DP Canyon via sheet flow. The terminal point of surface water transport is the intermittent stream channel in the bottom of DP Canyon. There is evidence of erosion into the canyon.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation**	Surface water transport is the primary off-site transport pathway. Air transport via particulates or fugitive dust would be a possibility due to surface contamination, however, there are no barren patches of ground that would be subjected to wind, there is ground cover and plant litter covering the dirt, and the area is protected from wind by trees. Ground water is a viable pathway because the alluvial aquifer is less than 5 ft from ground surface and it is suspected to be the source for DP Spring.
Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/ recommendation to project lead for IA SMDP.**	An Interim Action has already occurred at this SWMU. Contaminated soil has been removed and runoff has been diverted from the contaminated west drainage and from the surface of the SWMU.

Ecological Effects Information:

Physical Disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	The physical disturbances are the west drainage which shows signs of past remedial activities and BMPs.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No. The area from the top of the mesa to the stream channel in the canyon bottom appear to be no different from the surrounding area.
Interim action needed to limit apparent ecological effects? **(yes/no/uncertain)** **Provide explanation and recommendations to mitigate apparent exposure pathways to project lead for IA SMDP.**	No. Current data does not support the implementation of an interim action at this SWMU. An Interim Action was implemented in 1996.

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors onsite and no transport pathways to offsite receptors, the remainder of the checklist should not be completed. Stop here and provide additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport. Not applicable.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if the maximum value was captured by existing sample data.)**	**Nature** – Yes, full suite samples from past sampling adequately defines the nature of contamination. **Rate** – Yes, aerial photographs show that gamma shine starts in DP Canyon at SWMU 21-011(k) and continues down canyon, and sampling down stream of SWMU 21-011(k) in the canyon has been done by the Canyons Focus Area. **Extent** – Yes. Sampling has been conducted laterally vertically and downstream which is not part of this SWMU.
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	Yes. The sampling proposed in the VCM will address the major potential transport pathway, i.e., surface water runoff down the drainage and into DP Canyon.

Part C—Ecological Pathways Conceptual Exposure Model

Question A:

Could soil contaminants reach receptors via vapors?

- **Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant >10^{-5} atm-me/mol and molecular weight <200 g/mol).**

Answer (likely/unlikely/uncertain): unlikely

Provide explanation: No volatile organic chemicals were detected in the samples collected before 2001. In the 2001 samples volatile organic chemicals (acetone, methylene chloride, 4-isopropyltoluene, 2-hexanone, and trichloroethene) were detected sporadically and in concentrations in the low part per billion range. One sample location (21-11205) was re-sampled and the volatile organic chemicals were not detected. Therefore, it is very possible that the volatile organic chemicals were analytical laboratory contaminants.

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual surface of the soil to become available for dust.**
- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.**

Answer (likely/unlikely/uncertain): likely

Provide explanation: Soil contamination is on the surface of the soil and is available to become dust where there are bare areas. However, most of the ground is covered with pine needles and litter from the overstory so fugitive dust would be rare or unlikely to occur. However, there is evidence of burrowing animals and they would have to burrow through the contamination at the surface.

Question C:

Can contaminated soil be transported to aquatic ecological communities (use SOP 2.01 run-off score and terminal point of surface water runoff to help answer this question)?

- **If the SOP 2.01 run-off score* for each SWMU included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (* Note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points).**
- **If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The major off-site transport pathway is surface water runoff into DP Canyon. However, there are no aquatic ecosystems in this reach of the canyon that would receive this runoff.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

- **Known or suspected presence of contaminants in groundwater.**
- **The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: Alluvial water is close to the surface in the canyon, which is not part of the SWMU. Alluvia wells LAUZ-1 [located on the eastern edge of SWMU 21-011(k) next to the stream bed] and LAUZ-2 [located approximately 250 ft downgradient from LAUZ-1] encountered alluvial water at approximately 4.5 ft below the surface. The saturated zone at the time was approximately 3.5 ft thick. This alluvial water is thought to be a source for DP Spring. This spring flows from the south-facing slope of DP Canyon, approximately 3,000 ft downstream to the east from SWMU 21-011(k). The shallow alluvial water on site can discharge into the ephemeral stream at the canyon bottom. Contaminants are available to be taken up by terrestrial plants with roots in contact with the alluvial water. Terrestrial wildlife receptors can contact this alluvial water when it surfaces into the ephemeral stream at the bottom of DP Canyon. There are no seeps or springs up canyon from the SWMU.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **Suspected ability of contaminants to migrate to groundwater.**
- **The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: Plutonium-239/240, strontium-90, tritium, uranium-234, and uranium -235 are present in SWMU 21-011(k) soil. Plutonium-239/240, strontium-90, and uranium-234 have been observed in alluvial groundwater from LAUZ-1 and LAUZ-2 to DP Spring. Tritium and uranium-235 were detected in the alluvial groundwater from LAUZ-1 and LAUZ-2 (LANL 1999, 63915).

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is only applicable to release sites located on or near the mesa edge.**
- **Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: While the slope is well vegetated, there is evidence of erosion. Mass wasting is not considered a potential release mechanism because the slope appears stable and vegetated.

Question G:

Could airborne contaminants interact with receptors through respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of inhalation of vapors for burrowing animals.**
- **Foliar uptake of organic vapors is typically not a significant exposure pathway.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No volatile organics are expected to be present.

Question H:

Could airborne contaminants interact with plants through deposition of particulates or with animals through inhalation of fugitive dust?

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 2

Provide explanation: Although there is contamination on the surface, the ground is well covered with pine needles and litter from the established vegetation. However, there is evidence of burrowing animals.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**

- **Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 3

Provide explanation: This is a complete pathway. The shallow nature of the contamination makes it available to roots. However, due to the ground cover rain splash is not a complete pathway.

Question J:

Could contaminants interact with receptors through food web transport from surficial soils?

- **The chemicals may bioaccumulate in animals.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3

Provide explanation: The COPEC strontium-90, which is structurally similar to calcium, is incorporated into the body as bones and teeth. Isotopic uranium is a bioaccumulator. DDT and mercury were detected sporadically and at low concentrations.

Question K:

Could contaminants interact with receptors via incidental ingestion of surficial soils?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3

Provide explanation: This could be a major pathway because of the surficial nature of the contamination.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soils?

- **Significant exposure via dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1

Provide explanation: Most suspected COPCs are not lipophilic. No organic chemicals were detected. However, the dermal pathway is a possible complete pathway for some receptors.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 3

Terrestrial Animals: 3

Provide explanation: Cesium 137, a gamma emitter, is a COPEC at this SWMU and the contamination is surficial.

Stream Channel

Question N:

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 2

Provide explanation: The contamination is surficial in nature and the alluvial ground water is close to the surface. Therefore, roots could directly uptake contaminants from alluvial ground water or sediment. Rain splash is, however, a very minor consideration because of the ground cover and plant litter on the ground surface.

Question O:

Could contaminants interact with receptors through food web transport from water and sediment?

- **The chemicals may bioconcentrate in food items.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2

Provide explanation: PCBs are not present at the site. DDT was detected sporadically, in the low part per billion levels, and the concentrations were qualified as estimated. Mercury was detected once, slightly above background. However, terrestrial animals could ingest the strontium-90 (that is preferentially taken up by plants), and isotopic uranium (a bioaccumulator).

Question P:

Could contaminants interact with receptors via ingestion of water and suspended sediments?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2

Provide explanation: Although there are no aquatic systems present on the site or in the canyon below the SWMU, there is evidence that the contaminants have moved down horizontally slope and, once in the stream bed, down stream from the SWMU. This movement is due to water transporting contaminants either in a soluble form or on particulates. Terrestrial animals could have access to this water for drinking, if only for the period of rainwater or snow melt flow.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1

Provide explanation: Although there are no aquatic systems present on the site or in the canyon reach below the SWMU, there is evidence that the contaminants have moved horizontally down slope and, once in the stream bed, down stream from the SWMU. This movement is due to water transporting contaminants either in a soluble form or on particulates. Terrestrial animals could have access to this water for drinking and wading, if only for the period of rainwater or snow melt flow. During times of dryness, the terrestrial species may be dermally exposed to contaminants in the dry gully and stream bed.

Question R:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: Cesium 137 is a COPEC at this SWMU and the contamination is surficial.

Question S:

Could contaminants bioconcentrate in free floating aquatic, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Plants/Emergent Vegetation: 0

Provide explanation: There are no aquatic systems present on site or in the canyon below the SWMU.

Question T:

Could contaminants bioconcentrate in sedimentary or water column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0

Provide explanation: There are no aquatic systems present on site or in the canyon below the SWMU.

Question U:

Could contaminants bioaccumulate in sedimentary or water column organisms?

- **Lipophilic organic contaminants and some metals may concentrate in an organism's tissues**
- **Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0

Provide explanation: There are no aquatic systems present on site or in the canyon below the SWMU.

Question V:

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Plants: 0

Aquatic Animals: 0

Provide explanation: There are no aquatic systems present on site or in the canyon below the SWMU.

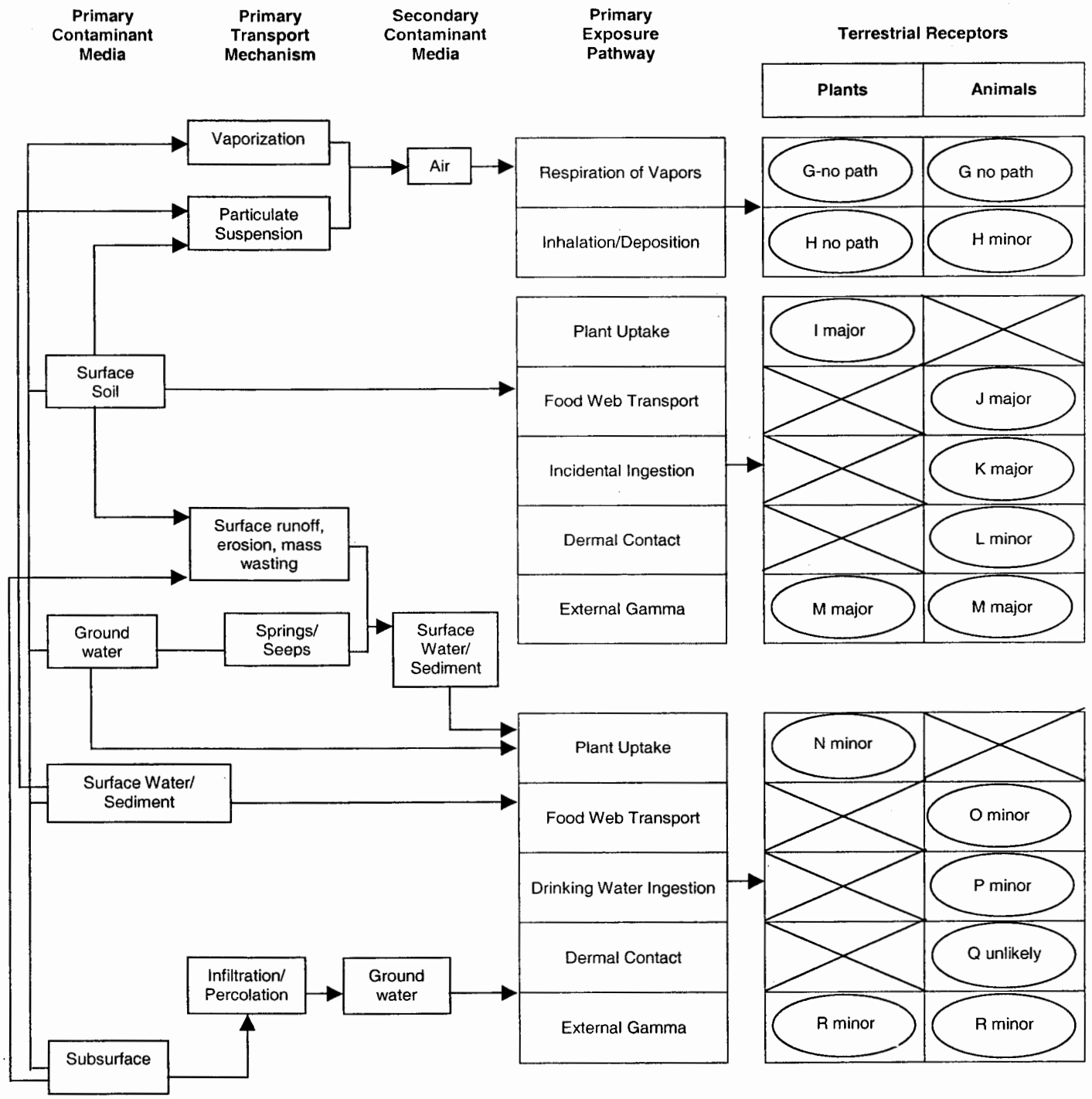
REFERENCES

Koch, S., July 15, 1999. "Memorandum to Greg McDermott: Review of Potential Release Sites for Threatened and Endangered Species Habitat for the Purpose of Ecological Screening/Risk Assessment," Los Alamos National Laboratory Memorandum ESH-20/Ecol-98-0732, Los Alamos, New Mexico. (Koch 1999, 63599)

LANL, August 26, 1999. Evaluation of Sediment and Alluvial Groundwater in DP Canyon, Reaches DP-1, DP-2, DP-3, and DP-4. LA-UR-99-4238. (LANL 1999, 63915)

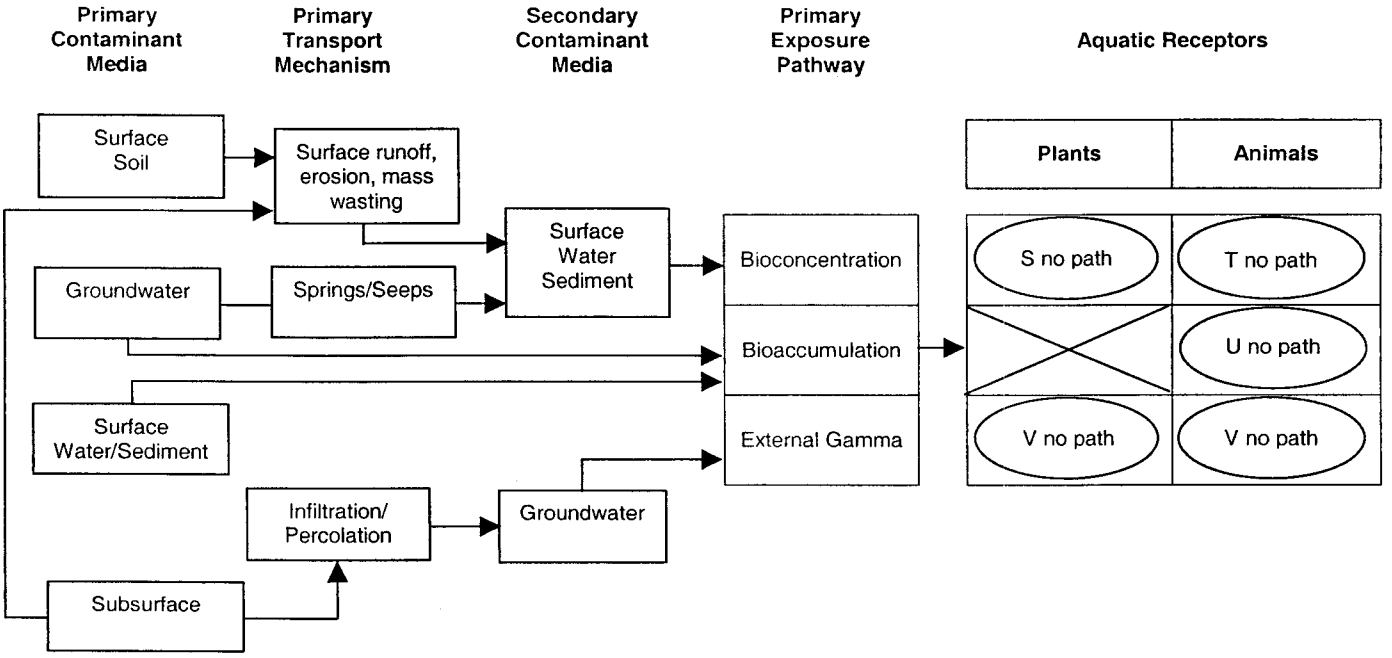
NOTE:
Letters in circles refer to questions on the Scoping Checklist

Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model



NOTE:
Letters in circles refer to questions on the Scoping Checklist

Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model



Signatures and certifications:

Checklist completed by (provide name, organization and phone number):

Name (printed): Linda Causey

Name (signature): Linda Causey

Organization: PMC Environmental

Phone number: 662-1365

Date Completed: 4/17/02

Verification by a member of ER Project Ecological Risk Task Team (provide name, organization and phone number):

Name (printed): Richard Mirenda

Name (signature): Richard Mirenda

Organization: RRES

Phone number: 665-6953

Date Completed: 4/17/02

Appendix E

Estimated Costs

APPENDIX E: ESTIMATED COSTS

ESTIMATED COST

The estimated cost of this VCM is approximately $1.4 million. This cost includes the following:

Activity	Cost
Bench Scale Testing	$200,000
VCM Plan	$90,000
VCM Construction Plans and Specifications	$80,000
Fieldwork	$770,000
Sample Collection and Analysis	$200,000
VCM Completion Report	$60,000

Total Cost: $1,400, 000.

Schedule

The field work portion of this VCM is expected to begin in July FY02 and take approximately two months to complete. The fieldwork includes soil and tuff removal, stabilization of soil/tuff with elevated activities, confirmatory radiation survey sample collection and analysis, waste management, final cover placement, and site restoration.

Appendix F

Data Analysis, RESRAD Inputs, Results, Single Radionuclide Soil Guidelines

APPENDIX F DATA ANALYSIS, RESRAD INPUTS, RESULTS, SINGLE RADIONUCLIDE SOIL GUIDELINES

Fixed Laboratory Data Used to Calculate Dose

This section presents the fixed laboratory data used to calculate doses and to determine the target cesium-137 concentration for soil, sediment, and tuff removal during this VCM. The target level of 150 pCi/g cesium-137, as estimated by field measurements, satisfies the elevated activity criterion given in DOE Order 5400.5, Chapter 4 (4)(a)(1). The data included in this analysis are the results for the confirmation samples collected following the 1996 Interim Action and the 2001 pre-VCM characterization samples. The combined data are presented in Table F-1.

Table F-1
Combined 1996 Verification and 2001 Pre-VCM Characterization Data for SWMU 21-011(k)*

Sample ID	Strontium-90 pCi/g	Plutonium-238 pCi/g	Plutonium-239 pCi/g	Americium-241 pCi/g	Cesium-137 pCi/g
21-01-0021	1.7	0.034	0.12	0	1.4
21-01-0022	0	0	0.094	0	1.7
21-01-0025	7.1	0.29	1.9	2.2	40.5
21-01-0027	2.6	0.31	0.37	0	8.7
21-01-0029	0	0.048	0.036	0	1.0
21-01-0030	0.9	0.074	0.11	0	2.6
21-01-0033	26.1	0.63	13.2	13.7	150
21-01-0034	1.0	0.21	1.0	6.9	3.8
21-01-0036	3.8	0.12	1.2	0	29
21-01-0037	0.51	0	0.12	0	1.5
21-01-0039	30.8	0.74	11.3	7.9	109
21-01-0041	132	1.6	20.5	19	445
MD21-01-0025	7.1	0.29	1.9	2.2	40.5
MD21-01-0036	3.8	0.12	1.2	0	29
MD21-01-0039	30.8	0.74	11.3	7.9	109
MD21-01-0040	10.5	0.22	3.1	5.1	59.5
MD21-01-0044	103	0.8	32.6	14.9	246
MD21-01-0045	83	0.95	51.2	22.3	343
MD21-01-0069	268	1.0	59.2	32.5	690
0121-96-0301	0	0	0	0.31	0
0121-96-0302	0	0	0	25.3	15.7
0121-96-0303	0	0	0	0.93	9.4
0121-96-0801	74	N/A	20.1	10.6	351
0121-96-0802	240	N/A	46	32.3	621
0121-96-0804	33.8	N/A	8.7	10.5	85.3
0121-96-0805	1.4	0.097	0.79	0.28	7.1
0121-96-0806	7.1	0.24	1.8	2.1	19.7

Sample ID	Strontium-90 pCi/g	Plutonium-238 pCi/g	Plutonium-239 pCi/g	Americium-241 pCi/g	Cesium-137 pCi/g
0121-96-0808	219	N/A	51	20.2	877
0121-96-0809	24.9	0.96	6.2	2.9	327
0121-96-0810	60	4.9	23.8	14.3	222
0121-96-0807	63	N/A	75.2	601	66.5
0121-96-0803	30.7	7.1	25.1	125	72.1
Average[1]	33	1	16	27	113

[1]Average concentrations were the input values for RESRAD to calculate the single radionuclide soil guidelines for each radionuclide.

* Zero values in Table F-1 represent non-detects and N/A indicates that the result is not available.

Recreational Trail-User Exposure Scenario

The recreational trail-user scenario represents an individual who regularly walks on the site; the site is currently not open to the general public (but is accessible) and is expected to remain under Laboratory control for at least another 100 years. This person visits the site 140 times per year and stays for a period of one hour per visit, which corresponds to the *fraction of time spent outdoors* (i.e., on site) of 0.016 [calculated as 140 times/yr ÷ (365 days × 24 hr)]. The soil ingestion rate while on site is assumed to be 67 mg/hr, which is approximately 2/3 of a person's daily soil ingestion rate (EPA 1997, 66596.1), and corresponds to an annual ingestion rate of 9.4 g/yr (67 mg/h x 140 hr/yr on site) of on-site soil and 587 g/yr. (67 mg/hr x 8760 hr/yr) total soil ingestion. The RESRAD *soil ingestion rate* parameter (SOIL) was set to 587 g/yr to obtain the desired soil ingestion rate, accounting for the fraction of time spent on site (587 g/yr × 0.016 = 9.4g/yr). The on-site inhalation rate is assumed to be 1.6 m^3/hr, which is the inhalation rate for moderate activity in EPA's Exposure Factors Handbook (EPA 1997, 66596.1), and corresponds to an annual on-site rate of 224 m^3/yr and 14000 m^3/yr total inhalation. The RESRAD *inhalation rate* parameter (SOIL) was set to 14,000 m^3/yr to obtain the desired inhalation rate, accounting for the fraction of time spent on site (14,000 m^3/yr × 0.016 = 224 m^3/yr). Key input parameters for the RESRAD program for this site are listed in Table F-2. The printout of the RESRAD run is presented as Exhibit F.B.

Table F-2
Input Parameters for the Dose Assessment
Under the Recreational Trail User Scenario Without Cover

Parameter	Value Used	Explanation
Pathways Active	External Gamma Inhalation (w/o radon) Soil Ingestion	
Area of contaminated zone (AREA)	10,000 m^2	This is a conservative estimate of the area affected at SWMU 21-011(k).
Thickness of contaminated zone (THICKO)	2 m	Assumption
Fraction of time spent outdoors (onsite) (FOTD)	0.016	Value that corresponds to hiking on-site for 140 hours per year.
Soil ingestion rate (SOIL)	587 g/yr	Value that corresponds to 67 mg/h while on-site. This ingestion rate is approximately 2/3 of the daily soil ingestion rate of 100 mg/day (EPA 1997, 66596.1).

Table F-2 (continued)

Parameter	Value Used	Explanation
Inhalation rate (INHAL)	14,000 m^3/yr	Value that corresponds to 1.6 m^3/h while onsite, which is the inhalation rate for moderate activity (EPA 1997, 66596.1).
Mass loading for inhalation (INHALR)	2.0 E-5 g/m^3	(LANL 2001, 69683.1)
Density of contaminated zone (DENSCZ)	1.5 g/cm^3	RESRAD default.
Exposure Duration	30 yr	(LANL 2001, 69683.1)

Dose Assessment

Doses for the site prior to VCM activities were calculated using RESRAD 6.1 (Yu et al. 2001), averages of present day radionuclide concentrations (Table F-1), and the input parameters for the recreational trail user (Table F-2). Figure F-1 is a dose versus time plot produced by RESRAD 6.1 for the recreational trail user under current conditions. This figure illustrates several important points regarding SWMU 21-011(k). The calculated dose to a hypothetical recreational trail user at the present time is less than one-half the criterion of 15 mrem/yr for the free-release of real property (DOE 2000, 67489). The present-day, calculated dose rate is mostly 78% due to cesium-137, which has a half-life of approximately 30 years. The dose rate is projected to decline to less than 2 mrem/yr within 100 years due to decay of cesium-137. The intent of the proposed corrective measure is to remove local areas of elevated contamination and place this material into a stabilized condition (see Section 4.4.2) that adds shielding and resists migration for a time period over which the short-lived cesium-137 decays to lower levels.

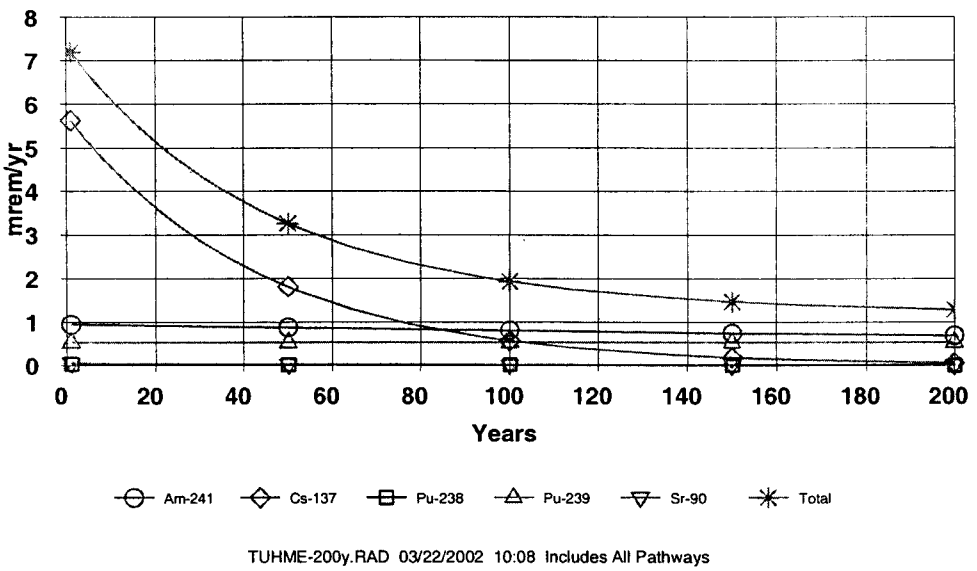


Figure F-1. RESRAD 6.1 plot of dose versus time for the recreational trail-user scenario without cover

Doses for the site were also estimated using RESRAD 6.1 (Yu et al. 2001), average estimates of radionuclide concentrations remaining after removal and stabilization, but prior to installation of the engineered cover and the input parameters for the recreational trail user (Table F-2). Figure F-2 is a

dose-versus-time plot produced by RESRAD 6.1 for the recreational trail user under post-VCM conditions. The calculated dose to a hypothetical recreational trail user following removal and stabilization is between 2–3 mrem/yr or about 1/5 the criterion of 15 mrem/yr for the free-release of real property (DOE 2000, 67489). The estimated dose rate is still mostly due to cesium-137, which has a half-life of approximately 30 years. The dose rate is projected to decline to less than 2 mrem/yr within 12–15 years due to decay of cesium-137 thereby decreasing the dose within 1/8 the time without VCM implementation. The printout of the RESRAD run is presented as Exhibit F.C.

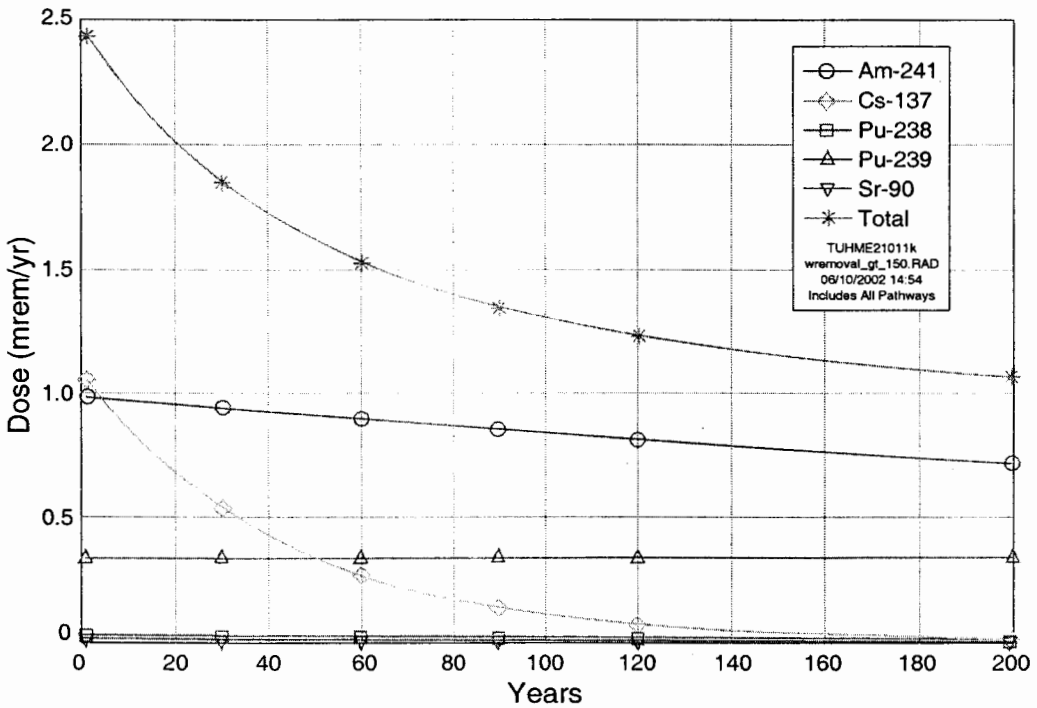


Figure F-2 **Dose vs time for trail-user scenario at SWMU 21-011(k) after excavation, solidification, and reburial prior to installation of engineered cover**

Selection of a Clean-up Goal

The Single Radionuclide Soil Guideline (SRSG) for a given radionuclide represents the site average soil concentration that corresponds to the authorized dose limit for free release of real property, which is 15 mrem/yr. The SRSGs for SWMU 21-011(k) listed in Table F-3 were calculated using RESRAD 6.1 based on the parameters listed in Table F-2. A printout of the RESRAD run is provided in Exhibit F.B.

Table F-3
SRSGs Derived Under the Recreational Trail User Scenario

Radionuclide	SRSG (pCi/g)
Americium-241	427
Cesium-137	294
Plutonium-238	496
Plutonium-239	447
Strontium-90	8,288

Because there is a mixture of radionuclides present at the site, the SRSGs cannot be applied independently. To account for the mixture of radionuclides at the site and the uncertainty inherent in the estimates, a decision was made to remove the concentrations of cesium-137 exceeding a target level of 150 pCi/g. Removal of the elevated cesium concentrations will also result in the removal of other radionuclides because they are collocated with cesium-137. This target level is approximately half the SRSG for cesium-137 and satisfies the DOE approach of reducing doses to "as low as reasonably achievable" (ALARA) (DOE 1990, 58980.1).

Estimating Soil Cesium-137 Concentrations From 2001 Gross Gamma Survey Data

This section provides the approach for estimating cesium-137 concentrations from the 2001 gross gamma survey. This survey has also been referred to as an in situ gamma survey in the plan text since it was performed using a SAM-935 multichannel analyzer. A similar survey will be used to identify areas of elevated cesium-137 and to confirm that levels of cesium-137 exceeding 150 pCi/g have been removed.

During 2001, the following data (Table F-4) was collected to correlate the gross gamma count rate for the SAM 935 multi-channel analyzer system to cesium-137 soil concentrations. Rank correlations and linear regressions were performed using a commercially available Excel spreadsheet add-in, Analyse-It 1.62, which is distributed by Analyse It Software, Ltd.

Table F-4
Data Used to Correlate Gross Gamma to Cesium-137 Using the SAM 935 Analyzer

KCPM*	Cesium-137 (pCi/g)
31.254	3.87
38.058	6.33
74.364	30.68
84.588	6.62
91.968	13.28
95.97	29.6
110.772	115.5
207.9	214.51
231.618	175.4
264.99	193.54
355.502	448.73

* KCPM = thousand counts per minute

The data point having the highest count rate in Table F-4 was not used because of the concern that system dead time may have biased the result and because this count rate is higher than necessary for field use (i.e. areas with counts this high will be excavated). A linear regression was performed for the remaining 10 data points in Table F-4. Count rate (in thousand counts per minute or KCPM) was chosen as the independent variable and cesium-137 the dependent variable.

The cesium-137 vs. count rate linear regression data is provided in Exhibit F.A. Table F-5 presents the relationship between KCPM and best estimate of the cesium-137 concentration. Two hundred KCPM is the best estimation of the removal target of 150 pCi/g cesium-137 based on the calculated regression. The coefficient of determination statistic, R^2, for this linear fit was 0.86, indicating a good regression fit for the data set. The line recommended for the best estimate of the cesium-137 concentration from count rate is the following:

0.9815 * KCPM -41.9 pCi/g cesium-137

The forecast error calculated for the prediction of cesium-137 concentrations from the KCPM is approximately 40 pCi/g. The predicted value for cesium-137 +/- the forecast error represents 67% of the distribution within which the true value is likely to fall, and the true value is 80% likely to fall below the predicted value plus the forecast error. If the target concentration is 150 pCi/g, a gross gamma count of 150 KCPM leads to an 80% confidence that the target level is achieved ([40-41.9] + 0.9815 x KCPM = 150 pCi/g cesium-137 reduces to a KCPM = 154).

Table F-5
Relationship Among of SAM-935 Gross Gamma Count Rate and Best Estimates of Radionuclide Concentrations

Count rate, KCPM	Cesium-137, Best Estimate, pCi/g	Count rate, KCPM	Cesium-137, Best Estimate, pCi/g
50	7.2	150	105.3
60	17.0	160	115.1
70	26.8	170	125.0
80	36.6	180	134.8
90	46.4	190	144.6
100	56.3	200	154.4
110	66.1	210	164.2
120	75.9	220	174.0
130	85.7	230	183.8
140	95.5	240	193.7

Estimated Volumes of Soil to be Removed

It was assumed that the removal volume of contaminated soil located in the western drainage is based on americium-241. The soil volume to be removed from the western drainage is assumed to be 100 yd^3. This assumption is necessary due to current limitations of the data from the western drainage.

Removal of soil from other parts of the site is based on cesium-137 concentration. The cesium-137 concentration is based on gross gamma count rates using a SAM 935 multi-channel analyzer (or equivalent) with a 2x2 inch sodium iodide scintillation detector. A correlation will be performed between these count rates and the count rates on the system actually used during the removal.

The aerial extent of soil removal is based on count rate data obtained during the 2001 in situ gross gamma walkover survey. ArcView GIS software is used to estimate the aerial extent for the following count rates: 100 KCPM (nominal best estimate of 56 pCi/g cesium-137, see Table F-5), 125 KCPM (nominal 81 pCi/g cesium-137), 150 KCPM (105 pCi/g cesium-137), 175 KCPM (130 pCi/g cesium-137), 200 KCPM (154 pCi/g cesium-137), 225 KCPM (179 pCi/g cesium-137) and 250 KCPM (203 pCi/g cesium-137).

The estimated volumes of soil that would be removed for various count rates are depicted in Figure F-3.

It is proposed that surface soils be removed from areas having cesium-137 soil concentrations in excess of 150 pCi/g, as estimated from screening results (150 KCPM for the 80% forecast confidence). Removal of these areas is consistent with DOE's 5400.5 ALARA policy because

- some of these elevated activity areas would already meet the DOE elevated activity criterion if it was rigorously applied, even if a cover were absent, and
- placement of restoration backfill and cover materials over contaminated soil further reduces dose.

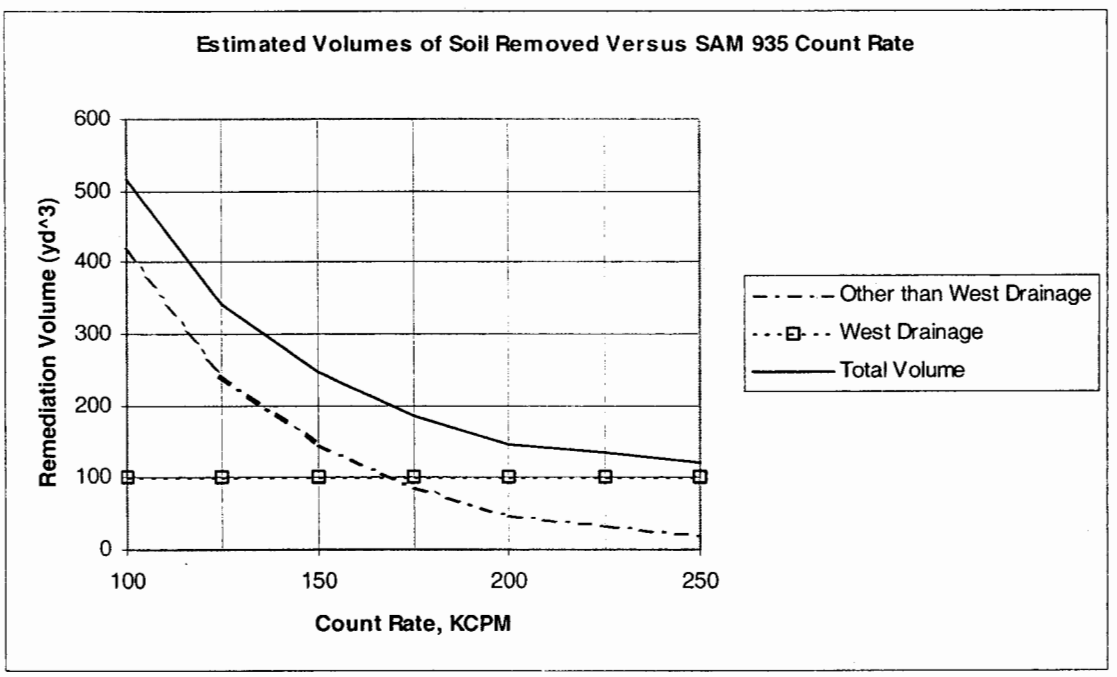


Figure F-3 Soil Volume Estimates.

This results in an estimated volume removed of approximately 250 yd^3. However, a stabilization cell with approximately double this volume will be constructed. The additional volume is provided to accommodate increased volume from stabilization reagents and from potential increases in excavation volumes due to uncertainties encountered in the field.

Summary

This voluntary corrective measure is being implemented under the authority of DOE Order 5400.5. Under this order, DOE Albuquerque has established an authorized limit of 15 mrem/yr for the release of property for unrestricted use (DOE 2000, 67489). The Laboratory proposes to take action that would reduce the potential dose to well below the 15 mrem/yr limit in order to comply with the DOE requirements to keep doses as low as reasonably achievable (ALARA).

REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER record identification (ER ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 21."

Copies of the reference library are maintained at the New Mexico Environment Department Hazardous Waste Bureau; the Department of Energy Los Alamos Area Office; United States Environmental Protection Agency, Region 6; and the ER Project MDAs Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

DOE (US Department of Energy) 1990. "Radiation Protection of the Public and Environment," DOE Order 5400.5. (DOE 1990, 58980.1)

DOE, 2000. "Procedure for the Release of Residual Radioactive Material from Real Property," Department of Energy Albuquerque Operations Office memorandum, Albuquerque, New Mexico (DOE2000, 67489)

EPA (US Environmental Protection Agency), August 1997. "Exposure Factors Handbook, Volume 1, General factors," EPA/600/P-95/002-Fa, Office of Research and Development, Washington, D.C. (EPA 1997, 66596.1)

LANL, 2001. "Derivation and Use of Radionuclide Screening Action Levels," Los Alamos National Laboratory report LA-UR-01-990, Los Alamos, New Mexico. (LANL 2001, 69683.1)

Yu, C, A.J. Zielen, J.J. Cheng, D. J. LePoire, E. Gnanapragasam, S, Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H Peterson, 2001. User's Manual for RESRAD Version 6, ANL/EAD-4, Argonne National Laboratories, Argonne, IL. (Yu et.al 2001, 71420)

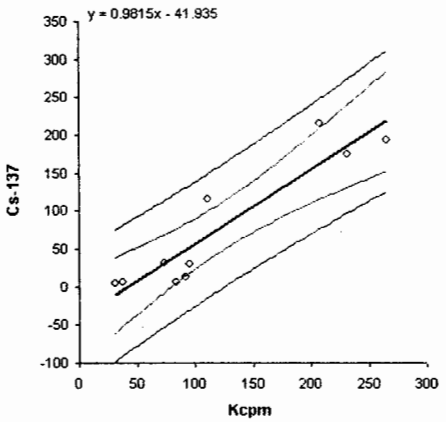
analysed with: Analyse-it • General 1.62

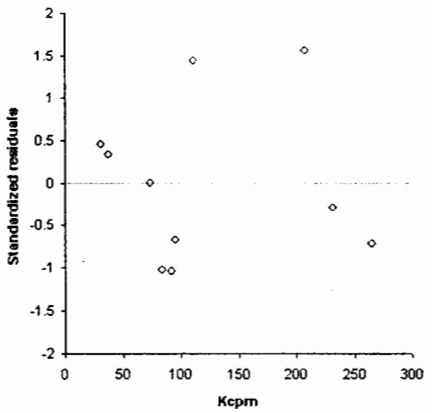
Linear regression
Data from Table 10. FSR report
Cs-137 v Kcpm
Rick Haaker 13 February 2002

n	10
R^2	0.86
Adjusted R^2	0.85
SE	33.7299

Term	Coefficient	SE	p	95% CI of Coefficient
Intercept	-41.9352	19.9759	0.0690	-87.9998 to 4.1294
Slope	0.9815	0.1372	<0.0001	0.6652 to 1.2978

Source of variation	SSq	DF	MSq	F	p
Due to regression	58264.479	1	58264.479	51.21	<0.0001
About regression	9101.669	8	1137.709		
Total	67366.148	9			





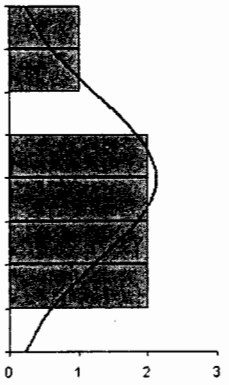


Exhibit F.A: Correlation of Cesium-137 to SAM 935 Count Rate Data

Exhibit F.B. RESRAD Summary Report for the Recreational Trail User Scenario Without Cover.

```
1RESRAD, Version 6.1      T½ Limit = 0.5 year        05/06/2002  15:46  Page   1
 Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
 File    : TUHME21011k.RAD
```

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 6
Summary of Pathway Selections 12
Contaminated Zone and Total Dose Summary 13
Total Dose Components
Time = 0.000E+00 14
Time = 1.000E+00 15
Time = 3.000E+01 16
Time = 6.000E+01 17
Time = 9.000E+01 18
Time = 1.200E+02 19
Dose/Source Ratios Summed Over All Pathways 20
Single Radionuclide Soil Guidelines 20
Dose Per Nuclide Summed Over All Pathways 22
Soil Concentration Per Nuclide 23


```
1RESRAD, Version 6.1      T½ Limit = 0.5 year        05/06/2002  15:46  Page   2
 Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
 File    : TUHME21011k.RAD
```

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	H-3	6.400E-08	6.400E-08	DCF2(4)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(5)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(6)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(7)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(8)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(9)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(10)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(11)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(12)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(13)
B-1	U-233	1.350E-01	1.350E-01	DCF2(14)
B-1	U-234	1.320E-01	1.320E-01	DCF2(15)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(16)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(17)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)
D-1	H-3	6.400E-08	6.400E-08	DCF3(4)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(5)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(6)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(7)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(8)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(9)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(10)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(11)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(12)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(13)
D-1	U-233	2.890E-04	2.890E-04	DCF3(14)
D-1	U-234	2.830E-04	2.830E-04	DCF3(15)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(16)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(17)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 3
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(4,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(4,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(4,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(5,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(6,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(6,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(7,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(7,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(7,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(9,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(10,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(11,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(11,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(11,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(12,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(12,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(12,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(13,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(14,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(14,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(14,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(15,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(15,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(15,3)
D-34				

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 4
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(16,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(16,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(16,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(17,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(17,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(17,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(3,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(4,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(4,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(5,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(5,2)
D-5				

D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(6,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(7,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(8,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(9,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(9,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(10,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(10,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(11,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(11,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(12,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(12,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(13,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(13,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(14,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(14,2)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 5
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(16,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(16,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(17,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(17,2)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 6
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	6.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	9.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.200E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	not used	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	2.700E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.130E+02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Pu-238	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.600E+01	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Sr-90	3.300E+01	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.000E+00	2.000E+00	---	WIND

R013	Humidity in air (g/m**3)	5.500E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.500E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 7
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.636E-06	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.332E-08	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.666E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.666E-08	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.097E-06	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 8
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.636E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(4)

R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.000E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.624E-07	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.321E-07	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.331E-06	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.556E-09	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 9
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.556E-09	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for daughter U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.600E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 10
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	5.870E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 11
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM

C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 12
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	suppressed

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 13
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Contaminated Zone Dimensions

Area: 10000.00 square meters
Thickness: 2.00 meters
Cover Depth: 0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	2.700E+01
Cs-137	1.130E+02
Pu-238	1.000E+00
Pu-239	1.600E+01
Sr-90	3.300E+01

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02
TDOSE(t):	7.332E+00	7.197E+00	4.372E+00	2.869E+00	2.097E+00	1.692E+00
M(t):	4.888E-01	4.798E-01	2.914E-01	1.913E-01	1.398E-01	1.128E-01

0Maximum TDOSE(t): 7.332E+00 mrem/yr at t = 0.000E+00 years

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 14
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.831E-02	0.0025	7.902E-03	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.223E-01	0.1258
Cs-137	5.705E+00	0.7780	2.351E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.246E-02	0.0072
Pu-238	2.383E-06	0.0000	2.576E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.994E-02	0.0041
Pu-239	7.252E-05	0.0000	4.528E-03	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.320E-01	0.0726
Sr-90	1.284E-02	0.0018	2.818E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.686E-02	0.0064
Total	5.736E+00	0.7823	1.272E-02	0.0017	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.584E+00	0.2160

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.485E-01	0.1294
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.757E+00	0.7852
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.020E-02	0.0041
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.366E-01	0.0732
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.972E-02	0.0081
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.332E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 15
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.828E-02	0.0025	7.889E-03	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.208E-01	0.1279
Cs-137	5.574E+00	0.7745	2.297E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.126E-02	0.0071
Pu-238	2.364E-06	0.0000	2.555E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.970E-02	0.0041
Pu-239	7.252E-05	0.0000	4.528E-03	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.319E-01	0.0739
Sr-90	1.253E-02	0.0017	2.752E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.576E-02	0.0064
Total	5.605E+00	0.7788	1.270E-02	0.0018	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.579E+00	0.2195

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.470E-01	0.1316
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.626E+00	0.7816
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.996E-02	0.0042
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.365E-01	0.0745
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.832E-02	0.0081
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.197E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 16
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.745E-02	0.0040	7.530E-03	0.0017	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.789E-01	0.2010
Cs-137	2.852E+00	0.6525	1.175E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.623E-02	0.0060
Pu-238	1.881E-06	0.0000	2.032E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.362E-02	0.0054
Pu-239	7.246E-05	0.0000	4.524E-03	0.0010	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.315E-01	0.1216
Sr-90	6.284E-03	0.0014	1.380E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.294E-02	0.0052

Total	2.876E+00	0.6579	1.227E-02	0.0028	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E+00	0.3393

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.038E-01	0.2068
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.879E+00	0.6585
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.382E-02	0.0054
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.361E-01	0.1226
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.924E-02	0.0067
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.372E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 17
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 6.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.663E-02	0.0058	7.175E-03	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.375E-01	0.2919
Cs-137	1.426E+00	0.4970	5.876E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.311E-02	0.0046
Pu-238	1.484E-06	0.0000	1.603E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.864E-02	0.0065
Pu-239	7.240E-05	0.0000	4.520E-03	0.0016	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.310E-01	0.1851
Sr-90	3.077E-03	0.0011	6.755E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.123E-02	0.0039
Total	1.446E+00	0.5039	1.186E-02	0.0041	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.411E+00	0.4919

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 6.000E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.613E-01	0.3002
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.439E+00	0.5016
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.880E-02	0.0066
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.356E-01	0.1867
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.432E-02	0.0050
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.869E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 18
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.585E-02	0.0076	6.837E-03	0.0033	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.980E-01	0.3805
Cs-137	7.131E-01	0.3400	2.938E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.557E-03	0.0031
Pu-238	1.172E-06	0.0000	1.265E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.470E-02	0.0070
Pu-239	7.235E-05	0.0000	4.516E-03	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.306E-01	0.2530
Sr-90	1.506E-03	0.0007	3.307E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.499E-03	0.0026
Total	7.305E-01	0.3483	1.148E-02	0.0055	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.355E+00	0.6462

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.000E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.207E-01	0.3913
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.196E-01	0.3431
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-02	0.0071
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.352E-01	0.2552
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.009E-03	0.0033
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.097E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 19
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion - 21-0011k mean concentr
File : TUHME21011k.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.200E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.511E-02	0.0089	6.515E-03	0.0039	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.605E-01	0.4495
Cs-137	3.565E-01	0.2108	1.469E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.278E-03	0.0019
Pu-238	9.253E-07	0.0000	9.983E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.160E-02	0.0069
Pu-239	7.229E-05	0.0000	4.512E-03	0.0027	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.301E-01	0.3134
Sr-90	7.375E-04	0.0004	1.619E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.692E-03	0.0016
Total	3.725E-01	0.2202	1.113E-02	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.308E+00	0.7733

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.200E+02 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.821E-01	0.4623
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.598E-01	0.2127
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.170E-02	0.0069
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.347E-01	0.3161
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.431E-03	0.0020
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.692E+00	1.0000

*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 20
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02
Am-241	Am-241	1.000E+00	3.513E-02	3.507E-02	3.348E-02	3.190E-02	3.040E-02	2.896E-02
Am-241	Np-237	1.000E+00	9.506E-09	2.850E-08	5.662E-07	1.097E-06	1.602E-06	2.084E-06
Am-241	U-233	1.000E+00	6.666E-16	4.664E-15	1.831E-12	7.090E-12	1.561E-11	2.725E-11
Am-241	Th-229	1.000E+00	3.538E-19	5.305E-18	3.966E-14	3.056E-13	1.010E-12	2.354E-12
Am-241	§DSR(j)		3.513E-02	3.507E-02	3.348E-02	3.190E-02	3.040E-02	2.897E-02
Cs-137	Cs-137	1.000E+00	5.095E-02	4.978E-02	2.547E-02	1.274E-02	6.368E-03	3.184E-03
Pu-238	Pu-238	1.000E+00	3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02
Pu-238	U-234	1.000E+00	3.890E-09	1.163E-08	2.114E-07	3.751E-07	5.042E-07	6.060E-07
Pu-238	Th-230	1.000E+00	2.284E-14	1.595E-13	5.903E-11	2.156E-10	4.490E-10	7.431E-10
Pu-238	Ra-226	1.000E+00	8.336E-17	1.248E-15	8.903E-12	6.545E-11	2.068E-10	4.616E-10
Pu-238	Pb-210	1.000E+00	1.946E-19	5.992E-18	6.737E-13	8.475E-12	3.506E-11	9.236E-11
Pu-238	§DSR(j)		3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02
Pu-239	Pu-239	1.000E+00	3.353E-02	3.353E-02	3.351E-02	3.348E-02	3.345E-02	3.342E-02
Pu-239	U-235	1.000E+00	6.953E-12	2.086E-11	4.239E-10	8.405E-10	1.257E-09	1.673E-09
Pu-239	Pa-231	1.000E+00	3.588E-16	2.511E-15	1.001E-12	3.935E-12	8.801E-12	1.559E-11
Pu-239	Ac-227	1.000E+00	4.776E-18	7.116E-17	4.350E-13	2.797E-12	7.902E-12	1.606E-11
Pu-239	§DSR(j)		3.353E-02	3.353E-02	3.351E-02	3.348E-02	3.345E-02	3.342E-02
Sr-90	Sr-90	1.000E+00	1.810E-03	1.767E-03	8.861E-04	4.338E-04	2.124E-04	1.040E-04

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
§ is used to indicate summation; the Greek sigma is not included in this font.
The DSR includes contributions from associated (half-life <= 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02
Am-241	4.270E+02	4.277E+02	4.481E+02	4.702E+02	4.935E+02	5.178E+02
Cs-137	2.944E+02	3.013E+02	5.888E+02	1.178E+03	2.355E+03	4.711E+03
Pu-238	4.968E+02	5.007E+02	6.296E+02	7.980E+02	1.011E+03	1.282E+03
Pu-239	4.473E+02	4.473E+02	4.477E+02	4.481E+02	4.485E+02	4.488E+02
Sr-90	8.288E+03	8.488E+03	1.693E+04	3.458E+04	7.063E+04	1.443E+05

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 21
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	2.700E+01	0.000E+00	3.513E-02	4.270E+02	3.513E-02	4.270E+02

Cs-137	1.130E+02	0.000E+00	5.095E-02	2.944E+02	5.095E-02	2.944E+02
Pu-238	1.000E+00	0.000E+00	3.020E-02	4.968E+02	3.020E-02	4.968E+02
Pu-239	1.600E+01	0.000E+00	3.353E-02	4.473E+02	3.353E-02	4.473E+02
Sr-90	3.300E+01	0.000E+00	1.810E-03	8.288E+03	1.810E-03	8.288E+03

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 22
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02
Am-241	Am-241	1.000E+00	9.485E-01	9.470E-01	9.038E-01	8.613E-01	8.207E-01	7.820E-01
0Np-237	Am-241	1.000E+00	2.567E-07	7.695E-07	1.529E-05	2.961E-05	4.326E-05	5.626E-05
0U-233	Am-241	1.000E+00	1.800E-14	1.259E-13	4.944E-11	1.914E-10	4.216E-10	7.358E-10
0Th-229	Am-241	1.000E+00	9.553E-18	1.432E-16	1.071E-12	8.250E-12	2.727E-11	6.357E-11
0Cs-137	Cs-137	1.000E+00	5.757E+00	5.626E+00	2.879E+00	1.439E+00	7.196E-01	3.598E-01
0Pu-238	Pu-238	1.000E+00	3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02
0U-234	Pu-238	1.000E+00	3.890E-09	1.163E-08	2.114E-07	3.751E-07	5.042E-07	6.060E-07
0Th-230	Pu-238	1.000E+00	2.284E-14	1.595E-13	5.903E-11	2.156E-10	4.490E-10	7.431E-10
0Ra-226	Pu-238	1.000E+00	8.336E-17	1.248E-15	8.903E-12	6.545E-11	2.068E-10	4.616E-10
0Pb-210	Pu-238	1.000E+00	1.946E-19	5.992E-18	6.737E-13	8.475E-12	3.506E-11	9.236E-11
0Pu-239	Pu-239	1.000E+00	5.366E-01	5.365E-01	5.361E-01	5.356E-01	5.352E-01	5.347E-01
0U-235	Pu-239	1.000E+00	1.112E-10	3.337E-10	6.783E-09	1.345E-08	2.011E-08	2.676E-08
0Pa-231	Pu-239	1.000E+00	5.740E-15	4.018E-14	1.601E-11	6.297E-11	1.408E-10	2.495E-10
0Ac-227	Pu-239	1.000E+00	7.642E-17	1.139E-15	6.961E-12	4.475E-11	1.264E-10	2.569E-10
0Sr-90	Sr-90	1.000E+00	5.972E-02	5.832E-02	2.924E-02	1.432E-02	7.009E-03	3.431E-03

BRF(i) is the branch fraction of the parent nuclide.
§ is used to indicate summation; the Greek sigma is not included in this font.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 05/06/2002 15:46 Page 23
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-0011k mean concentr
File : TUHME21011k.RAD

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02
Am-241	Am-241	1.000E+00	2.700E+01	2.696E+01	2.573E+01	2.452E+01	2.336E+01	2.226E+01
0Np-237	Am-241	1.000E+00	0.000E+00	8.738E-06	2.561E-04	5.002E-04	7.327E-04	9.543E-04
0U-233	Am-241	1.000E+00	0.000E+00	1.911E-11	1.694E-08	6.667E-08	1.476E-07	2.584E-07
0Th-229	Am-241	1.000E+00	0.000E+00	6.017E-16	1.605E-11	1.267E-10	4.224E-10	9.888E-10
0Cs-137	Cs-137	1.000E+00	1.130E+02	1.104E+02	5.650E+01	2.825E+01	1.412E+01	7.062E+00
0Pu-238	Pu-238	1.000E+00	1.000E+00	9.921E-01	7.890E-01	6.225E-01	4.912E-01	3.875E-01
0U-234	Pu-238	1.000E+00	0.000E+00	2.824E-06	7.572E-05	1.354E-04	1.826E-04	2.197E-04
0Th-230	Pu-238	1.000E+00	0.000E+00	1.273E-11	1.063E-08	3.945E-08	8.263E-08	1.371E-07
0Ra-226	Pu-238	1.000E+00	0.000E+00	1.839E-15	4.678E-11	3.526E-10	1.123E-09	2.517E-09
0Pb-210	Pu-238	1.000E+00	0.000E+00	1.421E-17	9.249E-12	1.203E-10	5.029E-10	1.332E-09
0Pu-239	Pu-239	1.000E+00	1.600E+01	1.600E+01	1.599E+01	1.597E+01	1.596E+01	1.594E+01
0U-235	Pu-239	1.000E+00	0.000E+00	1.576E-08	4.725E-07	9.446E-07	1.416E-06	1.887E-06
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.667E-13	1.500E-10	5.995E-10	1.348E-09	2.395E-09
0Ac-227	Pu-239	1.000E+00	0.000E+00	1.755E-15	3.822E-11	2.518E-10	7.170E-10	1.463E-09
0Sr-90	Sr-90	1.000E+00	3.300E+01	3.222E+01	1.616E+01	7.910E+00	3.873E+00	1.896E+00

BRF(i) is the branch fraction of the parent nuclide.
§ is used to indicate summation; the Greek sigma is not included in this font.
0RESCALC.EXE execution time = 2.36 seconds

Exhibit F.C. RESRAD Summary Report for the Recreational Trail User Scenario Removal of Areas of Elevated Activity.

Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary ... 6
Summary of Pathway Selections ... 12
Contaminated Zone and Total Dose Summary ... 13
Total Dose Components
Time = 0.000E+00 ... 14
Time = 1.000E+00 ... 15
Time = 3.000E+01 ... 16
Time = 6.000E+01 ... 17
Time = 9.000E+01 ... 18
Time = 1.200E+02 ... 19
Time = 2.000E+02 ... 20
Dose/Source Ratios Summed Over All Pathways ... 21
Single Radionuclide Soil Guidelines ... 21
Dose Per Nuclide Summed Over All Pathways ... 23
Soil Concentration Per Nuclide ... 24

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 2
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Mortality

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	H-3	6.400E-08	6.400E-08	DCF2(4)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(5)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(6)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(7)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(8)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(9)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(10)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(11)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(12)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(13)
B-1	U-233	1.350E-01	1.350E-01	DCF2(14)
B-1	U-234	1.320E-01	1.320E-01	DCF2(15)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(16)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(17)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)
D-1	H-3	6.400E-08	6.400E-08	DCF3(4)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(5)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(6)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(7)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(8)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(9)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(10)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(11)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(12)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(13)
D-1	U-233	2.890E-04	2.890E-04	DCF3(14)
D-1	U-234	2.830E-04	2.830E-04	DCF3(15)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(16)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(17)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 3

Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Mortality

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(4,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(4,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(4,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(5,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(6,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(6,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(7,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(7,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(7,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(9,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(10,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(11,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(11,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(11,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(12,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(12,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(12,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(13,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(14,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(14,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(14,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(15,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(15,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(15,3)
D-34				

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 4
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Mortality

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(16,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(16,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(16,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(17,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(17,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(17,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(3,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(4,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(4,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(5,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(5,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(6,2)
D-5				

D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(7,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(8,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(9,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(9,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(10,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(10,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(11,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(11,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(12,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(12,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(13,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(13,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(14,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(14,2)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 5
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion --21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Mortality

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(16,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(16,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(17,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(17,2)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 6
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	6.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	9.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.200E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	2.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	2.810E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Cs-137	2.120E+01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Pu-238	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.010E+01	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Sr-90	8.100E+00	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	5.500E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.500E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI

R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 7
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.636E-06	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.332E-08	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.666E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.666E-08	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.097E-06	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 8
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.636E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.000E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.624E-07	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.321E-07	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.331E-06	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.556E-09	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 9
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.556E-09	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for daughter U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.862E-06	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.600E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 10
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	5.870E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 11
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR

C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 12
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	suppressed

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 13
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Am-241	2.810E+01
Thickness:	2.00 meters	Cs-137	2.120E+01
Cover Depth:	0.00 meters	Pu-238	1.000E+00
		Pu-239	1.010E+01
		Sr-90	8.100E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02	2.000E+02
TDOSE(t):	2.451E+00	2.424E+00	1.850E+00	1.527E+00	1.344E+00	1.232E+00	1.069E+00
M(t):	1.634E-01	1.616E-01	1.233E-01	1.018E-01	8.957E-02	8.210E-02	7.130E-02

0Maximum TDOSE(t): 2.451E+00 mrem/yr at t = 0.000E+00 years

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 14
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.905E-02	0.0078	8.224E-03	0.0034	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.599E-01	0.3917
Cs-137	1.070E+00	0.4367	4.410E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.841E-03	0.0040
Pu-238	2.383E-06	0.0000	2.576E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.994E-02	0.0122
Pu-239	4.578E-05	0.0000	2.858E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.358E-01	0.1370
Sr-90	3.151E-03	0.0013	6.917E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.150E-02	0.0047
Total	1.092E+00	0.4458	1.135E-02	0.0046	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.347E+00	0.5496

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

0 Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.872E-01	0.4028
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.080E+00	0.4407
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.020E-02	0.0123
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.387E-01	0.1382
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.466E-02	0.0060
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.451E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 15
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.902E-02	0.0078	8.210E-03	0.0034	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.583E-01	0.3954
Cs-137	1.046E+00	0.4314	4.309E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.617E-03	0.0040
Pu-238	2.364E-06	0.0000	2.555E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.970E-02	0.0123
Pu-239	4.578E-05	0.0000	2.858E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.358E-01	0.1385
Sr-90	3.076E-03	0.0013	6.754E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.123E-02	0.0046
Total	1.068E+00	0.4406	1.133E-02	0.0047	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.345E+00	0.5547

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

0 Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.856E-01	0.4066
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.055E+00	0.4354
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.996E-02	0.0124
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.387E-01	0.1397
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.431E-02	0.0059
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.424E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 16
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.816E-02	0.0098	7.836E-03	0.0042	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.147E-01	0.4944
Cs-137	5.351E-01	0.2892	2.205E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.921E-03	0.0027
Pu-238	1.881E-06	0.0000	2.032E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.362E-02	0.0128
Pu-239	4.574E-05	0.0000	2.856E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.355E-01	0.1813
Sr-90	1.542E-03	0.0008	3.386E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.631E-03	0.0030
Total	5.549E-01	0.2999	1.090E-02	0.0059	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.284E+00	0.6942

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.407E-01	0.5084
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.400E-01	0.2919
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.382E-02	0.0129
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.384E-01	0.1829
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.177E-03	0.0039
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.850E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 17
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 6.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.731E-02	0.0113	7.467E-03	0.0049	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.716E-01	0.5709
Cs-137	2.676E-01	0.1752	1.102E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.460E-03	0.0016
Pu-238	1.484E-06	0.0000	1.603E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.864E-02	0.0122
Pu-239	4.570E-05	0.0000	2.853E-03	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E-01	0.2196
Sr-90	7.552E-04	0.0005	1.658E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.757E-03	0.0018
Total	2.857E-01	0.1871	1.048E-02	0.0069	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.231E+00	0.8060

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 6.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.964E-01	0.5871
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.700E-01	0.1769
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.880E-02	0.0123
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-01	0.2215
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.514E-03	0.0023
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.527E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 18
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.650E-02	0.0123	7.116E-03	0.0053	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.306E-01	0.6182
Cs-137	1.338E-01	0.0996	5.512E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.230E-03	0.0009
Pu-238	1.172E-06	0.0000	1.265E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.470E-02	0.0109
Pu-239	4.567E-05	0.0000	2.851E-03	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.349E-01	0.2493
Sr-90	3.697E-04	0.0003	8.117E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.350E-03	0.0010
Total	1.507E-01	0.1122	1.009E-02	0.0075	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.183E+00	0.8803

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.542E-01	0.6358
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.350E-01	0.1005
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-02	0.0110
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.378E-01	0.2514
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.720E-03	0.0013
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.344E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 19
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137

File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.200E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.572E-02	0.0128	6.780E-03	0.0055	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.914E-01	0.6427
Cs-137	6.689E-02	0.0543	2.756E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.151E-04	0.0005
Pu-238	9.253E-07	0.0000	9.983E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.160E-02	0.0094
Pu-239	4.563E-05	0.0000	2.848E-03	0.0023	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.346E-01	0.2717
Sr-90	1.810E-04	0.0001	3.974E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.609E-04	0.0005
Total	8.284E-02	0.0673	9.729E-03	0.0079	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.139E+00	0.9248

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.200E+02 years
0 Water Dependent Pathways

0 Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.139E-01	0.6609
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.750E-02	0.0548
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.170E-02	0.0095
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.375E-01	0.2741
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.423E-04	0.0007
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.232E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 20
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.384E-02	0.0129	5.962E-03	0.0056	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.959E-01	0.6507
Cs-137	1.053E-02	0.0099	4.341E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.687E-05	0.0001
Pu-238	4.944E-07	0.0000	5.308E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.167E-03	0.0058
Pu-239	4.554E-05	0.0000	2.842E-03	0.0027	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.339E-01	0.3122
Sr-90	2.695E-05	0.0000	5.917E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.840E-05	0.0001
Total	2.444E-02	0.0229	8.857E-03	0.0083	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.036E+00	0.9689

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.000E+02 years
0 Water Dependent Pathways

0 Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.157E-01	0.6692
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.063E-02	0.0099
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.220E-03	0.0058
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.368E-01	0.3149
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.254E-04	0.0001
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.069E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 21
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02	2.000E+02
Am-241	Am-241	1.000E+00	3.513E-02	3.507E-02	3.348E-02	3.190E-02	3.040E-02	2.896E-02	2.547E-02
Am-241	Np-237	1.000E+00	9.506E-09	2.850E-08	5.662E-07	1.097E-06	1.602E-06	2.084E-06	3.260E-06
Am-241	U-233	1.000E+00	6.666E-16	4.664E-15	1.831E-12	7.090E-12	1.561E-11	2.725E-11	7.240E-11
Am-241	Th-229	1.000E+00	3.538E-19	5.305E-18	3.966E-14	3.056E-13	1.010E-12	2.354E-12	1.049E-11
Am-241	§DSR(j)		3.513E-02	3.507E-02	3.348E-02	3.190E-02	3.040E-02	2.897E-02	2.547E-02
0Cs-137	Cs-137	1.000E+00	5.095E-02	4.978E-02	2.547E-02	1.274E-02	6.368E-03	3.184E-03	5.015E-04
0Pu-238	Pu-238	1.000E+00	3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02	6.220E-03
Pu-238	U-234	1.000E+00	3.890E-09	1.163E-08	2.114E-07	3.751E-07	5.042E-07	6.060E-07	7.843E-07
Pu-238	Th-230	1.000E+00	2.284E-14	1.595E-13	5.903E-11	2.156E-10	4.490E-10	7.431E-10	1.734E-09
Pu-238	Ra-226	1.000E+00	8.336E-17	1.248E-15	8.903E-12	6.545E-11	2.068E-10	4.616E-10	1.847E-09
Pu-238	Pb-210	1.000E+00	1.946E-19	5.992E-18	6.737E-13	8.475E-12	3.506E-11	9.236E-11	4.678E-10
Pu-238	§DSR(j)		3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02	6.220E-03
0Pu-239	Pu-239	1.000E+00	3.353E-02	3.353E-02	3.351E-02	3.348E-02	3.345E-02	3.342E-02	3.334E-02
Pu-239	U-235	1.000E+00	6.953E-12	2.086E-11	4.239E-10	8.405E-10	1.257E-09	1.673E-09	2.780E-09

Pu-239	Pa-231	1.000E+00	3.588E-16	2.511E-15	1.001E-12	3.935E-12	8.801E-12	1.559E-11	4.311E-11
Pu-239	Ac-227	1.000E+00	4.776E-18	7.116E-17	4.350E-13	2.797E-12	7.902E-12	1.606E-11	5.341E-11
Pu-239	$DSR(j)		3.353E-02	3.353E-02	3.351E-02	3.348E-02	3.345E-02	3.342E-02	3.334E-02
0Sr-90	Sr-90	1.000E+00	1.810E-03	1.767E-03	8.861E-04	4.338E-04	2.124E-04	1.040E-04	1.548E-05

*Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
§ is used to indicate summation; the Greek sigma is not included in this font.
The DSR includes contributions from associated (half-life <= 0.5 yr) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02	2.000E+02
Am-241	4.270E+02	4.277E+02	4.481E+02	4.702E+02	4.935E+02	5.178E+02	5.889E+02
Cs-137	2.944E+02	3.013E+02	5.888E+02	1.178E+03	2.355E+03	4.711E+03	2.991E+04
Pu-238	4.968E+02	5.007E+02	6.296E+02	7.980E+02	1.011E+03	1.282E+03	2.411E+03
Pu-239	4.473E+02	4.473E+02	4.477E+02	4.481E+02	4.485E+02	4.488E+02	4.499E+02
Sr-90	8.288E+03	8.488E+03	1.693E+04	3.458E+04	7.063E+04	1.443E+05	9.688E+05

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 22
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	2.810E+01	0.000E+00	3.513E-02	4.270E+02	3.513E-02	4.270E+02
Cs-137	2.120E+01	0.000E+00	5.095E-02	2.944E+02	5.095E-02	2.944E+02
Pu-238	1.000E+00	0.000E+00	3.020E-02	4.968E+02	3.020E-02	4.968E+02
Pu-239	1.010E+01	0.000E+00	3.353E-02	4.473E+02	3.353E-02	4.473E+02
Sr-90	8.100E+00	0.000E+00	1.810E-03	8.288E+03	1.810E-03	8.288E+03

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 23
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02	2.000E+02
Am-241	Am-241	1.000E+00	9.872E-01	9.856E-01	9.407E-01	8.963E-01	8.541E-01	8.139E-01	7.156E-01
0Np-237	Am-241	1.000E+00	2.671E-07	8.008E-07	1.591E-05	3.082E-05	4.502E-05	5.855E-05	9.161E-05
0U-233	Am-241	1.000E+00	1.873E-14	1.311E-13	5.145E-11	1.992E-10	4.388E-10	7.658E-10	2.034E-09
0Th-229	Am-241	1.000E+00	9.942E-18	1.491E-16	1.114E-12	8.586E-12	2.838E-11	6.616E-11	2.949E-10
0Cs-137	Cs-137	1.000E+00	1.080E+00	1.055E+00	5.400E-01	2.700E-01	1.350E-01	6.750E-02	1.063E-02
0Pu-238	Pu-238	1.000E+00	3.020E-02	2.996E-02	2.382E-02	1.880E-02	1.483E-02	1.170E-02	6.220E-03
0U-234	Pu-238	1.000E+00	3.890E-09	1.163E-08	2.114E-07	3.751E-07	5.042E-07	6.060E-07	7.843E-07
0Th-230	Pu-238	1.000E+00	2.284E-14	1.595E-13	5.903E-11	2.156E-10	4.490E-10	7.431E-10	1.734E-09
0Ra-226	Pu-238	1.000E+00	8.336E-17	1.248E-15	8.903E-12	6.545E-11	2.068E-10	4.616E-10	1.847E-09
0Pb-210	Pu-238	1.000E+00	1.946E-19	5.992E-18	6.737E-13	8.475E-12	3.506E-11	9.236E-11	4.678E-10
0Pu-239	Pu-239	1.000E+00	3.387E-01	3.387E-01	3.384E-01	3.381E-01	3.378E-01	3.375E-01	3.368E-01
0U-235	Pu-239	1.000E+00	7.023E-11	2.107E-10	4.282E-09	8.490E-09	1.269E-08	1.689E-08	2.807E-08
0Pa-231	Pu-239	1.000E+00	3.624E-15	2.536E-14	1.011E-11	3.975E-11	8.889E-11	1.575E-10	4.354E-10
0Ac-227	Pu-239	1.000E+00	4.824E-17	7.187E-16	4.394E-12	2.825E-11	7.981E-11	1.622E-10	5.394E-10
0Sr-90	Sr-90	1.000E+00	1.466E-02	1.431E-02	7.177E-03	3.514E-03	1.720E-03	8.423E-04	1.254E-04

BRF(i) is the branch fraction of the parent nuclide.
§ is used to indicate summation; the Greek sigma is not included in this font.

1RESRAD, Version 6.1 T½ Limit = 0.5 year 06/13/2002 07:18 Page 24
Summary : Trail User, Hiker, 140 hrs/yr, 67 mg/hr soil ingestion---21-011k mean concentration after removal of >150 pCi/g Cs-137
File : TUHME21011kwremoval_gt_150.RAD

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+01	6.000E+01	9.000E+01	1.200E+02	2.000E+02
Am-241	Am-241	1.000E+00	2.810E+01	2.805E+01	2.678E+01	2.551E+01	2.431E+01	2.317E+01	2.037E+01
0Np-237	Am-241	1.000E+00	0.000E+00	9.094E-06	2.666E-04	5.206E-04	7.626E-04	9.932E-04	1.556E-03
0U-233	Am-241	1.000E+00	0.000E+00	1.989E-11	1.763E-08	6.939E-08	1.537E-07	2.689E-07	7.168E-07
0Th-229	Am-241	1.000E+00	0.000E+00	6.262E-16	1.670E-11	1.319E-10	4.396E-10	1.029E-09	4.609E-09
0Cs-137	Cs-137	1.000E+00	2.120E+01	2.072E+01	1.060E+01	5.300E+00	2.650E+00	1.325E+00	2.087E-01
0Pu-238	Pu-238	1.000E+00	1.000E+00	9.921E-01	7.890E-01	6.225E-01	4.912E-01	3.875E-01	2.060E-01
0U-234	Pu-238	1.000E+00	0.000E+00	2.824E-06	7.572E-05	1.354E-04	1.826E-04	2.197E-04	2.848E-04
0Th-230	Pu-238	1.000E+00	0.000E+00	1.273E-11	1.063E-08	3.945E-08	8.263E-08	1.371E-07	3.211E-07
0Ra-226	Pu-238	1.000E+00	0.000E+00	1.839E-15	4.678E-11	3.526E-10	1.123E-09	2.517E-09	1.012E-08
0Pb-210	Pu-238	1.000E+00	0.000E+00	1.421E-17	9.249E-12	1.203E-10	5.029E-10	1.332E-09	6.789E-09
0Pu-239	Pu-239	1.000E+00	1.010E+01	1.010E+01	1.009E+01	1.008E+01	1.007E+01	1.007E+01	1.004E+01
0U-235	Pu-239	1.000E+00	0.000E+00	9.947E-09	2.983E-07	5.963E-07	8.940E-07	1.191E-06	1.983E-06
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.052E-13	9.466E-11	3.784E-10	8.510E-10	1.512E-09	4.194E-09
0Ac-227	Pu-239	1.000E+00	0.000E+00	1.108E-15	2.412E-11	1.589E-10	4.526E-10	9.234E-10	3.084E-09
0Sr-90	Sr-90	1.000E+00	8.100E+00	7.909E+00	3.966E+00	1.942E+00	9.506E-01	4.654E-01	6.930E-02

```
 BRF(i) is the branch fraction of the parent nuclide.
 § is used to indicate summation; the Greek sigma is not included in this font.
0RESCALC.EXE execution time =     2.33 seconds
```

Appendix G

Summary of Previous Field Investigations

APPENDIX G SUMMARY OF PREVIOUS FIELD INVESTIGATIONS

G-1.0 PREVIOUS FIELD INVESTIGATIONS

The results of previous investigations at SWMU 21-011(k) in 1988, 1992, and 1993 are presented and summarized. The data are compared to current Laboratory-wide background values (Ryti et al. 1998, 59730.2) and human health screening action levels (SALs) for chemicals and radionuclides. The chemical SALs are based on a residential exposure scenario and are derived according to the approach presented in "Human Health Risk-Based Screening Methodology" (LANL 2002, 72639), which is based on NMED and EPA Region 6 guidance (NMED 2000, 68554.1; EPA 2001, 71466.1). The radionuclide SALs are also based on a residential exposure scenario and are derived according to the methodology presented in the Derivation and Use of Radionuclide Screening Action Levels (LANL 2001, 69683.1).

G1.1 1988 DOE Reconnaissance Sampling

PRS 21-011(k) was sampled during a 1988 DOE Headquarters Environmental Survey of the Laboratory. One surface sample (0–3 in.) was collected from each of three locations (Figure G1.1-1). Sample LA30201 was collected 23 ft from the end of the outfall pipe, Sample LA30202 was located approximately 30 ft below the edge of the mesa, and Sample LA30203 was located approximately 35 ft north of the beginning of the flat area in the canyon bottom. Samples were analyzed for metals and radionuclides. The areas of Sample LA30201 (23 ft from the end of the outfall pipe) and Sample LA30202 (30 ft from the edge of the mesa) were excavated during the 1996 interim action (IA). Therefore, the soil sampled in these areas is no longer present at the site and the contaminant concentrations are not represented by later sample data. The results of this sampling effort are discussed in more detail in the TA-21 OU RFI Phase Report 1C (LANL 1994, 31591.1).

G1.2 Results of 1988 DOE Reconnaissance Sampling

Table G1.2-1 presents the inorganic chemical results above current soil background values from the 1988 DOE Headquarters Environmental Survey of the Laboratory. Uranium was detected above its background value in the sample collected from below the edge of the mesa (LA30202).The sample collected from near the end of the outfall pipe (LA30201) had six inorganic chemicals detected at concentrations greater than their background value. Two of those chemicals, lead and zinc, were detected at values within the range of the background data set are therefore similar to background. The remaining four chemicals, cadmium, copper, nickel, and uranium, were above the range of the background data set. None of the inorganic chemicals exceeded their SALs.

Americium-241, plutonium-238, -239, strontium-90 and uranium-235 were detected at concentrations greater than the background/fallout values in Sample LA30201 located 23 ft from the outfall pipe (Table G1.2-2). The concentrations of each of these radionuclides decreased at the two sample locations located below the canyon rim (LA30202 and LA 30203) with the exception of americium-241, which increased in LA30202 then decreased in LA30203, and cesium-137, which was not detected above background in LA30201 was above fallout in LA30202 then decreased to below fallout in LA30203. Plutonium-238, plutonium-239, and strontium-90 were detected at concentrations greater than SAL in Sample LA30201, while strontium-90 and cesium-137 were present at concentrations greater than SAL in Sample LA30202; 30 ft from the edge of the mesa (Table G1.2-2). None of the radionuclides were detected at a concentration greater than SAL in Sample LA30203, approximately 35 ft north of the beginning of the flat area in the canyon bottom.

Table G1.2-1
Inorganic Chemicals Detected Above Background in 1988 DOE Reconnaissance Samples

Sample/Location ID	Analyte	Sample Interval (inches)	Sample Value (mg/kg)	Soil Background Values (mg/kg)	Soil SAL (mg/kg)
LA30201	Cadmium	0–3	24.7	0.4	70
LA30201	Copper	0–3	45.8	14.7	2800
LA30201	Lead	0–3	26.1	22.3	400
LA30201	Nickel	0–3	64.3	15.4	1500
LA30201	Uranium	0–3	8.0	1.82	230[1]
LA30202	Uranium	0–3	9.0	1.82	230
LA30201	Zinc	0–3	60.5	48.8	23000

[1]USEPA 4/2/2002 Region III Risk Based Concentration Table (Website: www.EPA.gov/reg3hwmd/risk/index.htm)

Table G1.2-2
Radionuclides Detected Above Background in 1988 DOE Reconnaissance Samples

Sample/Location ID	Radionuclide	Sample Interval Depth (in.)	Sample Value (pCi/g)	Soil Background Values (pCi/g)	Soil SALs (pCi/g)
LA30201	Uranium-235	0–3	1.7	0.2	17
LA30201	Plutonium-238	0–3	105	0.023	49
LA30201	Plutonium-239	0–3	377	0.054	44
LA30201	Americium-241	0–3	1.4	0.013	39
LA30201	Strontium-90	0–3	414	1.31	5.7
LA30202	Uranium-235	0–3	0.21	0.2	17
LA30202	Plutonium-238	0–3	0.34	0.023	49
LA30202	Plutonium-239	0–3	1.9	0.054	44
LA30202	Americium-241	0–3	2.6	0.013	39
LA30202	Strontium-90	0–3	17	1.31	5.7
LA30202	Cesium-137	0–3	51.8	1.65	5.3
LA30203	Plutonium-238	0–3	0.046	0.023	49
LA30203	Plutonium-239	0–3	0.25	0.054	44
LA30203	Americium-241	0–3	0.52	0.013	39

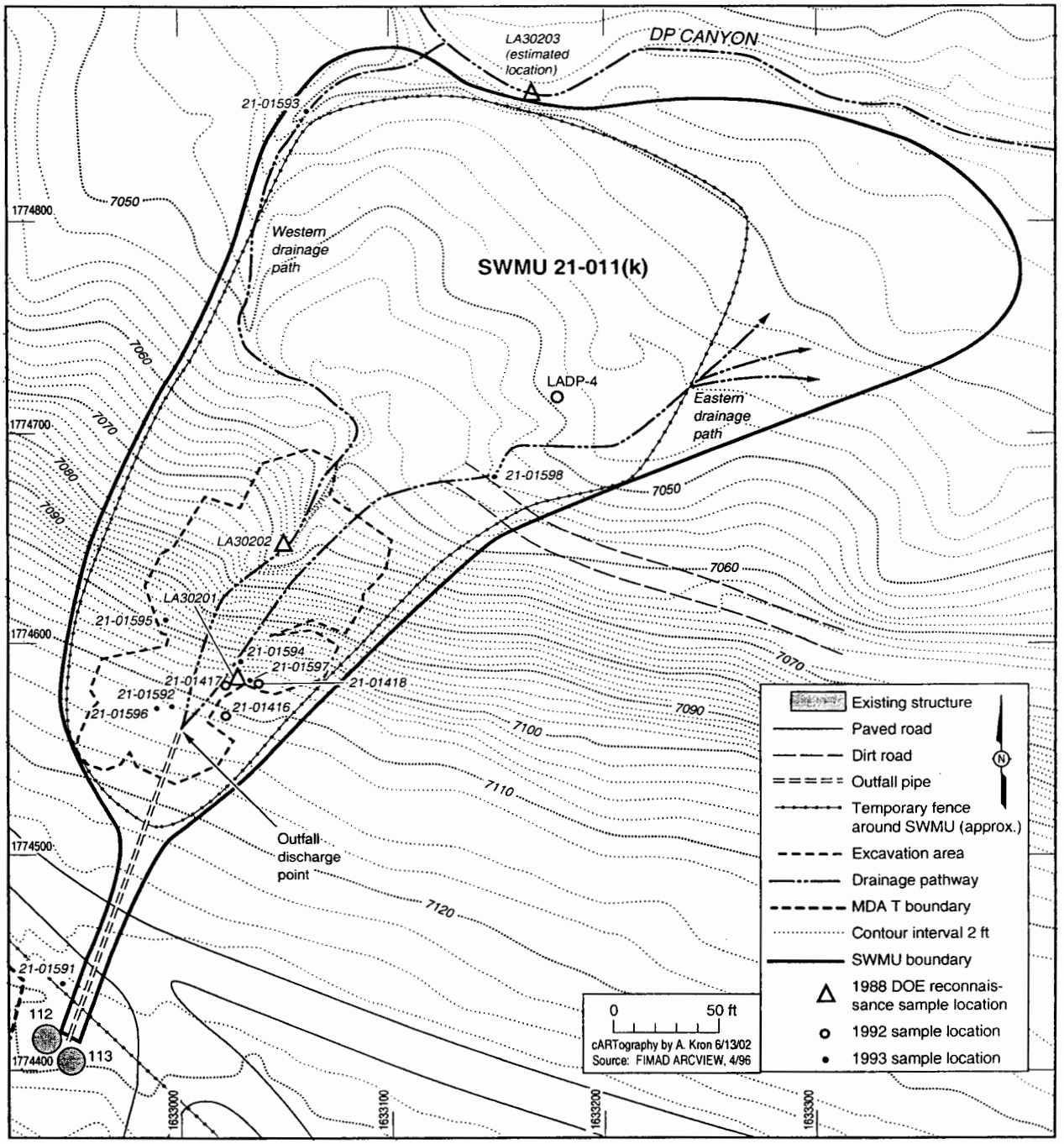


Figure G1.1-1 Sample locations at PRS 21-011(k)

G1.3 1992 RFI Sampling

Characterization of SWMU 21-011(k) was performed in 1992 as prescribed in the TA-21 Operable Unit RFI Work Plan (LANL 1991, 07528.1). The 1992 investigation consisted of a radiological field survey and the collection of soil samples at three locations: 21-01416, 21-01417, and 21-01418 (Figure G1.1-1). One surface sample (0–6 in.) and two near surface samples (6-12 in. and 12-18 in.) were collected at each location except location 21-1416 where refusal was encountered at 5 in. Samples were analyzed for semivolatile organic compounds (SVOCs), metals, and radionuclides. The areas of Sample Locations 21-01416, 21-01417 and 21-01418 were excavated during the 1996 IA. Therefore, the soil sampled in these areas is no longer present at the site and the contaminant concentrations are not represented by later sample data. These data are presented in the Phase Report Addendum 1B and 1C Operable Unit 1106, RCRA Facility Investigation (LANL 1994, 52350.1).

G1.4 Results of 1992 RFI Sampling

Tables G1.4-1 (SVOCs), G1.4-2 (inorganic chemicals), and G1.4-3 (radionuclides) present the results of the 1992 RFI sampling. Two organic chemicals, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, were detected slightly above the estimated quantitation limits (EQLs) and well below their respective SALs at Sample Location 21-01418 (Table G1.4-1). Cadmium, calcium, copper, lead, nickel, silver, thallium, uranium, and zinc were detected above their soil background values or had detected limits above their background values. In addition, lithium and strontium, which do not have background values, were detected in the soil. None of the inorganic chemicals were detected above their SALs, however, thallium had detection limits slightly above its SAL at all three sample locations The radionuclides americium-241, plutonium-238, plutonium-239, strontium-90, and tritium were detected above their soil background/fallout values. The concentrations for americium-241 (locations 21-01416 and 21-01417), plutonium-239/240 (locations 21-01417 and 21-01418), and strontium-90 (locations 21-01416, -01417, -01418) were detected greater than their respective SALs.

Table G1.4-1
SVOCs Detected in the 1992 RFI Samples

Location ID	Sample ID	Media	Depth (in)	Analyte	Sample Value (mg/kg)	SAL (mg/kg)
21-01418	AAA0908	Soil	6-12	Bis(2-ethylhexyl)phthalate	0.34	35
21-01418	AAA0909	Soil	0-6	Di-n-butylphthalate	0.6	6100

Table G1.4-2
Inorganic Analytes Detected Above Background Values in 1992 RFI Samples[1]

Sample ID	Location ID	Depth (ft)	Media	Cadmium	Calcium	Copper	Lead	Lithium	Nickel	Silver	Strontium	Thallium	Uranium	Zinc
Soil Background Value				0.4	6120	14.7	22.3	N/a[2]	15.4	1	N/a	0.73	1.82	48.8
Soil SAL				70	N/A[3]	2800	400	1600	1500	380	37000	6.1	230[4]	23000
AAA0833	21-01416	0–0.42	Soil	52	46000	132.2	50.4	6.92	224.4	20.6	157	7.3 (U)	54.2	196.6
AAA0906	21-01417	0–0.5	Soil	9.6	—[5]	34.8	—	6.2	44.4	2.5 (U)	39.2	5.2 (U)	6.9	—
AAA0907	21-01417	0.50–1.0	Soil	9.8 (U)	—	—	—	5.1	21.4	3.2 (U)	14.2	—	4.5	—
AAA0908	21-01418	0.00–0.5	Soil	9.8 (U)	—	—	—	6.1	25.1	3.1 (U)	41.4	6.4 (U)	5.3	—
AAA0909	21-01418	0.50–1.0	Soil	10 (U)	—	—	—	4.9	18.7	3.2 (U)	25.5	6.5 (U)	4.3	—

[1]All soil values are in units of mg/kg
[2] "N/a" denotes "not available" because these chemicals were not included in the background study
[3] "N/A" denotes "not applicable" because calcium is an essential nutrient
[4]USEPA 4/2/2002 Region III Risk Based Concentration Table (Website: www.EPA.gov/reg3hwmd/risk/index.htm)
[5] "—"denotes a value not exceeding the background value

Table G1.4-3
Radionuclides Detected Above Fallout Values in 1992 RFI Sampling

Sample ID	Location ID	Depth (ft)	Media	Americium-241 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239 (pCi/g)	Strontium-90 (pCi/g)	Tritium[1] (pCi/g)
Soil FalloutValue				0.013	0.023	0.054	1.31	0.075
Soil SAL				39	49	44	5.7	880
AAA0833	21-01416	0.00–0.42	Soil	2600	—[2]	—	1800	0.023
AAA0906	21-01417	0.00–0.50	Soil	289	—	—	600	0.02
AAA0907	21-01417	0.50–1.00	Soil	38	2.2	53	220	0.001
AAA0908	21-01418	0.00–0.50	Soil	29.8	2.8	49	170	0.0005
AAA0909	21-01418	0.50–1.00	Soil	29.8	0.77	14	180	0.0009

[1]Tritium soil background value and sample results were converted to pCi/g using an average percent moisture of 9% from the Phase Report Addendum 1B and 1C (LANL 1994, 52350.1)
[2]"—" denotes that the radionuclide was not detected.

G1.5 1993 RFI Sampling

Additional characterization of SWMU 21-011(k) was conducted in 1993 due to the elevated radionuclide concentrations encountered in the 1992 RFI sampling. The additional sampling included a radiological survey with direct reading instruments to further delineate the extent of contamination and to guide the placement of sampling locations. Eight additional sampling locations (Location IDs 21-01591 through -1598) (Figure G1.1-1) were selected based on the radiological survey. The survey extended to the bottom of DP Canyon including small drainage channels leading from the discharge point. Surface samples (0-6 in.) were collected at all eight locations and near-surface samples (6–12 and 12–18 in.) were collected at three locations and analyzed for radionuclides. The results of this sampling effort are also discussed in more detail in the TA-21 Addendum to OU RFI Phase Reports 1B and 1C (LANL 1994, 52350.1)

G1.6 Results of 1993 RFI Sampling

Americium-241, cesium-137, plutonium-238, -239, strontium-90, thorium-228, tritium, uranium-234 and -235 were all detected at levels above background (Table G1.6-1). Of these radionuclides, americium-241, cesium-137, plutonium-239, strontium-90, and thorium-228 exceeded their respective SALs. Americium-241 was only detected above SAL at Sample Location 21-01593, plutonium-239 was detected above SAL at two locations (Location IDs 21-01594 and 21-01597), and thorium-228 was detected once above SAL at Location ID 21-01597. Cesium-137 and strontium-90 were detected above SAL at all 1993 sample locations (Location IDs 21-01591 through 21-01598). The soils at Location IDs 21-01592 and 21-01594 through -1597 were excavated during the 1996 IA. Therefore, the soil sampled in these areas is no longer present at the site and the contaminant concentrations are not represented by later sample data.

Table G1.6-1
Radionuclides Detected Above Background/Fallout In The 1993 Rfl Samples[1]

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Cesium-137	Plutonium-238	Plutonium-239	Strontium-90	Thorium-228	Tritium[3]	Uranium-234	Uranium-235
Soil Background/Fallout Value				0.013	1.65	0.023	0.054	1.31	2.28	0.075	2.59	0.2
SAL				39	5.3	49	44	5.7	2.0	880	63	17
AAA4009	21-01591	0.00-0.50	Soil	9	42.6	0.86	12.8	8.6	—[2]	0.011	—	—
AAA4010	21-01592	0.00-0.50	Soil	12.8	753	0.88	27.6	238	—	0.017	—	—
AAA4011	21-01593	0.00-0.50	Soil	125.2	81.3	7.9	21.5	47.5	—	0.019	6.3	0.27
AAA4012	21-01594	0.00-0.50	Soil	28	510	1.8	53.9	174	—	0.059	-	—
AAA4013	21-01595	0.00-0.50	Soil	0.83	259	0.078	3.2	202	—	0.023	-	—
AAA4015	21-01596	0.00-0.50	Soil	5.7	268	0.28	13.8	85.6	—	0.016	-	—
AAA4016	21-01596	0.50-1.00	Soil	3.8	418	0.23	10.1	245	—	0.08	-	—
AAA4017	21-01596	1.00-1.50	Soil	0.84	414	0.065	3.3	178	—	0.041	-	—
AAA4018	21-01597	0.00-0.50	Soil	—	2675	47.8	773	1234	2.4	0.21	4	—
AAA4019	21-01597	0.50-1.00	Soil	—	3226	19.8	283	1155	—	0.25	2.8	—
AAA4021	21-01597	1.00-1.50	Soil	—	1648	32.6	196	431	—	0.55	7.9	0.26
AAA4022	21-01598	0.00-0.50	Soil	3.7	190	1.5	7.8	31.2	—	0.017	—	—
AAA4023	21-01598	0.50-1.00	Soil	1.0	234	0.39	2.9	32.3	—	0.037	—	—
AAA4024	21-01598	1.00-1.50	Soil	0.4	32.1	0.098	2.3	21.7	—	0.021	—	—

[1]All soil values are in units of pCi/g
[2]"—" denotes a value not exceeding the background/fallout value
[3]Tritium soil background value and sample results were converted to pCi/g using an average percent moisture of 9% from the Phase Report Addendum 1B and 1C (LANL 1994, 52350.1)

REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER record identification (ER ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 21."

Copies of the reference library are maintained at the New Mexico Environment Department Hazardous Waste Bureau; the Department of Energy Los Alamos Area Office; United States Environmental Protection Agency, Region 6; and the ER Project MDAs Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

EPA (US Environmental Protection Agency), 2001. "EPA Region 6 Human Health Medium-Specific Screening Levels, US EPA, November 2001. (EPA 2001, 71466.1)

LANL (Los Alamos National Laboratory) 1991, "TA-21 Operable Unit RFI Work Plan for Environmental Restoration," May 1991. Volume 1A. Department of Energy Environmental Clean-up Program, Los Alamos National Laboratory report LA-UR-91-962, Los Alamos, New Mexico. (LANL 1991, 07528.1)

LANL (Los Alamos National Laboratory), February 28, 1994. "Phase Report 1C, TA-21 Operable Unit RCRA Facility Investigation, Outfalls Investigation," Los Alamos National Laboratory report LA-UR-94-228, Los Alamos, New Mexico. (LANL 1994, 31591.1)

LANL (Los Alamos National Laboratory), 1994. "Phase Report Addendum 1B & 1C Operable Unit 1106 RCRA Facility Investigation Phase Report," Los Alamos National Laboratory report LA-UR-94-4360, Los Alamos, New Mexico. (LANL 1994, 52350.1)

LANL (Los Alamos National Laboratory), March 2001. "Derivation and Use of Radionuclide Screening Action Levels, LANL Environmental Restoration Project," Los Alamos National Laboratory report LA-UR-01-990, Los Alamos, New Mexico. (LANL 2001, 69683.1)

LANL (Los Alamos National Laboratory), April 2002. "Human Health Risk-Based Screening Methodology," Los Alamos National Laboratory report LA-UR-02-1563, Los Alamos, New Mexico. (LANL 2002, 72639)

NMED (New Mexico Environment Department), December 18, 2000. "Technical Background Document for Development of Soil Screening Levels (Volume I Soil Screening Guidance Technical Background Document)," New Mexico Environment Department Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2000, 68554.1)

Ryti, R., P. Longmire, D. Broxton, S. Reneau, and E.V. McDonald, September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory report LA-UR-98-4847, Los Alamos, New Mexico. (Ryti et al. 1998, 59730)

Appendix H

2001 Pre-Excavation Characterization Sampling

APPENDIX H 2001 PRE-EXCAVATION CHARACTERIZATION SAMPLING

Table H-1 presents the summary of the samples collected during the pre-VCM characterization effort performed at SWMU 21-011(k) in March of 2001. Eleven sample locations were selected with input from NMED and were based on preliminary results from the in situ gamma spectrometry survey conducted in November 2000.

Table H-1 2001 Waste Characterization Sample Summaries

In Situ GammaSurvey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
256 (Low)	21-11201	0-1	256-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0021	3/6/01 10:05	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	256-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	256-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0023	3/6/01 10:30	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0024	3/6/01 9:55	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
352 (Mid)	21-11202	0-1	MD21-01-0025	3/6/01 11:11	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs(Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete

Table H-1 (continued)

In Situ GammaSurvey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
		1-2	352-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	352-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	352-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0022	3/6/01 12:33	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0026	3/6/01 12:20	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
67 (Low)	21-11203	0-1	67-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0027	3/7/01 9:31	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	67-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	67-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0029	3/7/01 9:44	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0028	3/7/01 9:36	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
331 (Mid)	21-11204	0-1	331-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening

Table H-1 (continued)

In Situ GammaSurvey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
		1-2	331-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	MD21-01-0030	3/7/01 10:18	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		3-4	331-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0031	3/7/01 10:27	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0032	3/7/01 10:23	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
122 (Mid)	21-11205	0-1	122-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0033	3/7/01 12:29	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	122-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	122-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0034	3/7/01 12:57	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0035	3/7/01 12:38	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite

Table H-1 (continued)

In Situ GammaSurvey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
496 (Mid)	21-11206	0-1	MD21-01-0036	3/8/01 10:30	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		1-2	496-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	496-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	496-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0037	3/8/01 10:52	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0038	3/8/01 22:44	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
547 (High)	21-11207	0-1	MD21-01-0039	3/8/01 11:41	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		1-1.5	547-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		0-1.5	MD21-01-0040	3/8/01 11:41	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
554 (High)	21-11208	0-1	554-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0041	3/8/01 13:09	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	554-2		Gross alpha/beta, Gross gamma,	Field

Table H-1 (continued)

In Situ GammaSurvey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
					Cesium-137, Americium-241	Screening
		3-4	554-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0042	3/8/01 13:49	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0043	3/8/01 13:49	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
595 (High)	21-11209	0-1	MD21-01-0044	3/9/01 9:35	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs(Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
583 (High)	21-11210	0-1	MD21-01-0045	3/9/01 9:55	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
564 (High)	21-11211	0-1	MD21-01-0069	3/9/01 10:20	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite

Sample locations were chosen by performing a rank and percentile analysis of the survey data as shown in Figure H-1. Samples were selected from low, mid, and high ranges as shown in Table H-2.

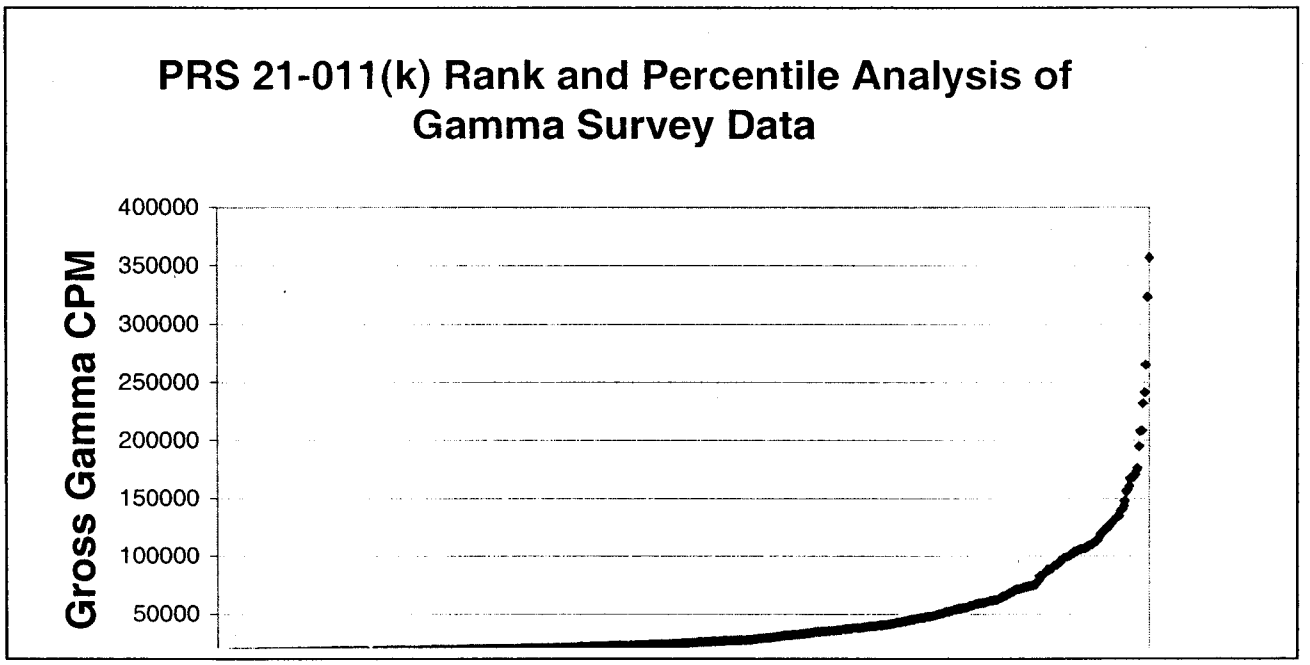


Figure H-1 Rank and Percentile Analysis of Gamma Radiation Survey Data

During the in situ gamma surface radiation survey, 650 locations were measured for gross gamma radiation. Approximately 77% of these values were below 50,000 counts per minute (CPM). Approximately 91% of the measurements taken were below 100,000 CPM and 100% of the measurements were below 400,000 CPM. Eleven in situ gamma survey locations were chosen to conduct depth profiling of the primary radionuclides at the site and to complete waste characterization activities prior to the planned VCM. As shown in Table H-2, two locations with in situ gamma survey results in the low range were chosen for waste characterization sample collection, in addition to four locations exhibiting mid-range survey results, and five locations exhibiting high range survey results. The guidance established for waste characterization sample collection specified that a minimum of one discrete sample was to be collected from each auger hole location. If no elevated radioactivity was detected, then the discrete sample would be collected from the bottom of the auger hole. Two discrete samples were to be collected from any auger hole advanced to a depth of 5 feet or deeper with sample collection intervals based on field screening results and/or the bottom of the hole. Samples submitted for VOC analyses were to be collected from the depth intervals with the highest radioactivity screening results and/or the bottom of the auger hole and not from the top six-inch sample interval. A composite sample, also for waste characterization purposes, was then to be collected from the remaining core at each of the 11 locations.

Table H-2 Sample Location Selection Criteria

Survey ID	X_Coordinate	Y_Coordinate	Elevation	Gross CPM	Range
256	1633386.108	1774761.007	7046.355	31254	Low
67	1633193.959	1774839.47	7049.203	38058	Low
352	1633307.191	1774782.117	7049.189	74364	Mid
331	1633164.585	1774795.306	7050.476	84588	Mid
496	1633172.271	1774695.58	7052.654	91968	Mid
122	1633036.628	1774737.631	7058.224	95970	Mid
547	1633076.448	1774654.923	7067.518	110772	High
554	1633059.719	1774646.382	7072.723	231618	High
583	1633005.769	1774577.311	7114.731	207900	High
595	1632998.255	1774557.402	7113.792	264990	High
564	1633015.987	1774612.395	7099.214	356502	High

2001 Waste Characterization Discrete Sample Results

The analytical results of the waste characterization sampling for discrete intervals are listed in Tables H-3 through H-6.

Table H-3
Target Analyte List (TAL) for Inorganics Screening against Sediment and Soil Background (Discrete Sample Intervals Only)*

Sample Id	*Location Id*	*Depth Interval*	*Aluminum*	*Antimony*	*Arsenic*	*Barium*	*Beryllium*	*Cadmium*	*Calcium*	*Chromium*	*Cobalt*	*Copper*	*Iron*	*Lead*
Soil Background	**NA**	**NA**	**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**21500**	**22.3**
Sediment Background	**NA**	**NA**	**15400**	**0.83**	**3.98**	**127**	**1.31**	**0.4**	**4420**	**10.5**	**4.73**	**11.2**	**13800**	**19.7**
MD21-01-0021	21-11201	1-2 ft	3800	0.34 B	2.3	66	0.47 B	0.11 B	970	6	4.1	3.1	7100	8.6
MD21-01-0023	21-11201	4-5 ft	2000	0.28 B	1.3	30	0.29 B	0.06 B	520	2.7	2	1.5	5900	6.4
MD21-01-0025	21-11202	0-1 ft	4800	-	2.8	86	0.56 B	0.13 B	1600	5.4	4.3	4.7	8300	11
MD21-01-0022	21-11202	4-5 ft	6200	0.34 B	2.7	110	0.78	0.092 B	1800	7.1	5.9	5	11000	12
MD21-01-0027	21-11203	1-2 ft	5300	0.28 B	2.3	89	0.62	0.1	1000	5.7	4.2	5	8600	8.8
MD21-01-0029	21-11203	4-5 ft	4400		2.3	63	0.49 B	0.081 B	870	4.5	2.1	3.2	8100	8
MD21-01-0030	21-11204	2-3 ft	8300	0.62 B	3.8	120	0.88	0.14 B	1300	8.5	5.5	7.9	13000	12
MD21-01-0031	21-11204	4-5 ft	8100	0.4 B	3.5	130	0.89	0.16 B	1900	8.6	5.4	8	13000	12
MD21-01-0033	21-11205	1-2 ft	5300	0.4 B	2.4	55	0.69	0.33	1800	5.2	2.7	4.8	7700	9.1
MD21-01-0034	21-11205	4-5 ft	5000	-	2.1	43	0.98	0.11 B	760	6.5	1.4	3.5	6500	7.1
MD21-01-0036	21-11206	0-1 ft	4800	-	2.4	89	0.55 B	0.11 B	1700	4.5	3.8	3.9	7700	9.8
MD21-01-0037	21-11206	4-5 ft	7100	0.35 B	2.6	64	1.3	0.08 B	1500	12	1.7	5.9	8400	7.7
MD21-01-0039	21-11207	0-1 ft	7100	0.48 B	3.5	74	0.9	0.18 B	1500	7.9	3.5	6.3	10000	10
MD21-01-0041	21-11208	1-2 ft	3500	-	2.5	32	0.73	0.87	1500	4	1.6	5.5	5900	7.8
MD21-01-0042	21-11208	4-5 ft	3100	-	1.7	17	0.99	0.56 B	670	3.5	0.8 B	3.8	4600	4.4
MD21-01-0044	21-11209	0-1 ft	4500	0.38 B	2.8	82	0.56 B	0.55 B	9000	5.9	5.4	8.7	7600	17
MD21-01-0045	21-11210	0-1 ft	4900	0.39 B	2.6	54	0.55 B	1.2	3600	8.8	2.5	10	8300	15
MD21-01-0069	21-11211	0-1 ft	6000	-	2.1	58	0.53 B	1.1	9300	6	2.3	7.7	8500	16

Table H-3 - Continued

Sample Id	Location Id	Depth Interval	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc	Mercury
Soil Background	NA	NA	4610	671	15.4	3460	1.52	1	915	39.6	48.8	0.1
Sediment Background	NA	NA	2370	543	9.38	2690	0.3	1	1470	19.7	60.2	0.1
MD21-01-0021	21-11201	1-2 ft	710	300	5.1	710	-	-	470	12	17	0.012 B
MD21-01-0023	21-11201	4-5 ft	360	210	2.2	360	-	-	160	7.2	22	-
MD21-01-0025	21-11202	0-1 ft	1000	320	5.2	1200	-	0.091 B	290	14	23	0.019 B
MD21-01-0022	21-11202	4-5 ft	1400	380	6.4	1200	0.32 B	-	370	18	25	-
MD21-01-0027	21-11203	1-2 ft	890	310	5.1	1700	-	-	1300	14	22	0.0078 B
MD21-01-0029	21-11203	4-5 ft	810	190	3.3	920	-	-	610	11	24	0.0064 B
MD21-01-0030	21-11204	2-3 ft	1600	310	7.6	2000	0.41 B	-	1300	21	28	0.0081 B
MD21-01-0031	21-11204	4-5 ft	1900	390	9.7	1600	-	-	860	18	34	-
MD21-01-0033	21-11205	1-2 ft	940	240	5.6	1700	-	-	610	10	24	0.1 B
MD21-01-0034	21-11205	4-5 ft	710	260	6.2	1300	-	-	550	7.4	30	-
MD21-01-0036	21-11206	0-1 ft	930	260	4.4	1200	-	-	65 B	13	20	0.0099 B
MD21-01-0037	21-11206	4-5 ft	1200	130	9.4	1200	-	-	600	9.7	36	0.0079 B
MD21-01-0039	21-11207	0-1 ft	1400	250	9.7	2400	0.58 B	-	900	14	26	0.057 B
MD21-01-0041	21-11208	1-2 ft	560	180	6.7	1200	-	0.16 B	330	7.8	24	0.061 B
MD21-01-0042	21-11208	4-5 ft	410	140	4.5	850	-	-	270	5.2	21	0.022 B
MD21-01-0044	21-11209	0-1 ft	1000	330	9.8	1500	-	-	130 B	13	24	0.14 B
MD21-01-0045	21-11210	0-1 ft	930	240	13	1300	-	0.15 B	78 B	11	29	0.76
MD21-01-0069	21-11211	0-1 ft	1500	260	11	2100	-	0.21 B	190	9.9	33	1.8

Table H-3 - Key

= greater than sediment background value

= greater than soil background value

= greater than sediment and soil background value

Table H-4
TCLP Metals Analysis Results (Discrete Sample Intervals Only)*

Sample Id	Location Id	Depth Interval	Arsenic	Barium	Cadmium	Chromium	Lead
MD21-01-0021	21-11201	1-2 ft	0.021 B	0.6 B	-	0.005 B	-
MD21-01-0022	21-11202	4-5 ft	0.019 B	0.6 B	-	-	-
MD21-01-0023	21-11201	4-5 ft	-	0.49 B	-	-	-
MD21-01-0025	21-11202	0-1 ft	-	0.81 B	-	0.0099 B	-
MD21-01-0027	21-11203	1-2 ft	-	1.5	-	0.034 B	0.026 B
MD21-01-0029	21-11203	4-5 ft	-	0.72 B	-	0.0056 B	-
MD21-01-0030	21-11204	2-3 ft	-	0.66 B	-	-	-
MD21-01-0031	21-11204	4-5 ft	-	0.63 B	-	0.0075 B	-
MD21-01-0033	21-11205	1-2 ft	-	0.52 B	-	-	-
MD21-01-0034	21-11205	4-5 ft	-	0.53 B	-	-	-
MD21-01-0036	21-11206	0-1 ft	-	0.64 B	-	-	-
MD21-01-0037	21-11206	4-5 ft	-	0.57 B	-	-	-
MD21-01-0039	21-11207	0-1 ft	-	0.48 B	-	0.013 B	-
MD21-01-0041	21-11208	1-2 ft	-	0.45 B	0.0043 B	0.014 B	0.011 B
MD21-01-0042	21-11208	4-5 ft	-	-	0.0031 B	-	-
MD21-01-0044	21-11209	0-1 ft	-	0.87 B	0.0079 B	0.013 B	-
MD21-01-0045	21-11210	0-1 ft	-	0.82 B	0.012 B	-	0.27
MD21-01-0069	21-11211	0-1 ft		0.56 B	0.0052 B	-	-

*All Units in mg/L

Table H-5
Organic Detects (Analyte Suites include Pesticides, PCBs, VOCS (Encore), TCLP SVOCs, TCLP VOCs) (Discrete Sample Intervals Only)*

Sample Id	Location Id	Depth Interval	4,4'-DDT(ug/Kg)	Acetone (ug/Kg)	Methylene chloride (ug/Kg)	4-Isopropyltoluene (ug/Kg)	2-Hexanone (ug/Kg)	Trichloroethene (mg/L)
MD21-01-0021	21-11201	1-2 ft	-	-	-	-	-	-
MD21-01-0023	21-11201	4-5 ft	-	-	-	-	-	-
MD21-01-0025	21-11202	0-1 ft	0.44 J	-	-	-	-	-
MD21-01-0022	21-11202	4-5 ft	-	13 J	-	7.3	-	0.007 J
MD21-01-0027	21-11203	1-2 ft	-	-	-	-	-	-
MD21-01-0029	21-11203	4-5 ft	-	-	-	-	-	-
MD21-01-0030	21-11204	2-3 ft	-	-	-	-	-	-
MD21-01-0031	21-11204	4-5 ft	-	-	-	-	-	-
MD21-01-0033	21-11205	1-2 ft	0.57 J	-	-	-	-	-
MD21-01-0034	21-11205	4-5 ft	-	50	72	26	-	-
MD21-01-0036	21-11206	0-1 ft	0.39 J	-	-	-	-	-
MD21-01-0037	21-11206	4-5 ft	-	-	-	-	-	-
MD21-01-0039	21-11207	0-1 ft	-	-	7.6	-	-	-
MD21-01-0041	21-11208	1-2 ft	-	-	8.2	-	-	-
MD21-01-0042	21-11208	4-5 ft	-	-	9.2	-	-	-
MD21-01-0044	21-11209	0-1 ft	0.69 J	-	-	-	-	-
MD21-01-0045	21-11210	0-1 ft	0.51 J	-	-	-	26 J	-
MD21-01-0069	21-11211	0-1 ft	0.88 J	21 J	-	-	-	-

Table H-5 - Continued

Sample Id	Location Id	Depth Interval	2-Butanone (mg/L)
MD21-01-0021	21-11201	1-2 ft	-
MD21-01-0023	21-11201	4-5 ft	-
MD21-01-0025	21-11202	0-1 ft	-
MD21-01-0022	21-11202	4-5 ft	-
MD21-01-0027	21-11203	1-2 ft	-
MD21-01-0029	21-11203	4-5 ft	-
MD21-01-0030	21-11204	2-3 ft	0.031 J
MD21-01-0031	21-11204	4-5 ft	-
MD21-01-0033	21-11205	1-2 ft	-
MD21-01-0034	21-11205	4-5 ft	-
MD21-01-0036	21-11206	0-1 ft	-
MD21-01-0037	21-11206	4-5 ft	-
MD21-01-0039	21-11207	0-1 ft	-
MD21-01-0041	21-11208	1-2 ft	-
MD21-01-0042	21-11208	4-5 ft	-
MD21-01-0044	21-11209	0-1 ft	-
MD21-01-0045	21-11210	0-1 ft	-
MD21-01-0069	21-11211	0-1 ft	-

Table H-6
2001 Discrete Sample Radionuclide Concentrations Screened against Sediment Background Values

Sample ID	Location ID	Depth Interva	Cs-137	Sr-90	Pu-239	Am-241	Pu-238
Background sediment	NA	NA	0.9	1.04	0.068	0.04	0.006
MD21-01-0021	21-11201	1-2 ft	1.43	1.7	0.122	-	0.034
MD21-01-0022	21-11202	4-5 ft	1.67	-	0.094	-	-
MD21-01-0023	21-11201	4-5 ft	0.51	-	0.051	-	-
MD21-01-0025	21-11202	0-1 ft	40.5	7.1	1.93	2.2	0.293
MD21-01-0027	21-11203	1-2 ft	8.76	2.56	0.37	-	0.31
MD21-01-0029	21-11203	4-5 ft	1.03	-	0.036	-	0.048
MD21-01-0030	21-11204	2-3 ft	2.6	0.9	0.111	-	0.074
MD21-01-0031	21-11204	4-5 ft	0.74	-	-	-	-
MD21-01-0033	21-11205	1-2 ft	150	26.1	13.2	13.7	0.63
MD21-01-0034	21-11205	4-5 ft	3.78	1.02	1.01	6.9	0.21
MD21-01-0036	21-11206	0-1 ft	29	3.75	1.18	-	0.122
MD21-01-0037	21-11206	4-5 ft	1.52	0.51	0.118	-	-
MD21-01-0039	21-11207	0-1 ft	109	30.8	11.3	7.9	0.74
MD21-01-0041	21-11208	1-2 ft	445	132	20.5	19	1.64
MD21-01-0042	21-11208	4-5 ft	56.7	15.8	4.33	21	1.2
MD21-01-0044	21-11209	0-1 ft	246	103	32.6	14.9	0.8
MD21-01-0045	21-11210	0-1 ft	343	83	51.2	22.3	0.95
MD21-01-0069	21-11211	0-1 ft	690	268	59.2	32.5	1.02

= greater than sediment background value

2001 Waste Characterization Composite Sample Results

The composite waste characterization samples were analyzed for perchlorates, TCLP metals, TCLP VOCs, TCLP SVOCs, pesticides, PCBs, gamma spec (Cs-137 and Am-241), isotopic plutonium, and strontium-90 (Table H-7 and H-8). Only detects are reported. No TCLP VOCS or SVOCs were detected above reporting limits in the composite waste characterization samples.

Table H-7
Composite Waste Samples - TCLP Metals Results

Sample ID	Location Id	Depth Interval	Arsenic mg/L	Barium mg/L	Cadmium mg/L	Chromium mg/L	Lead mg/L	Selenium mg/L
MD21-01-0024	21-11201	0-5 ft	-	0.79 B	-	-	-	-
MD21-01-0026	21-11202	0-5 ft	-	0.74 B	-	0.0069 B	-	-
MD21-01-0028	21-11203	0-5 ft	0.019 B	1.2	-	0.036 B	0.033	-
MD21-01-0032	21-11204	0-5 ft	-	0.65 B	-	-	-	-
MD21-01-0035	21-11205	0-5 ft	0.022 B	0.5 B	0.0063 B	-	-	0.031 B
MD21-01-0038	21-11206	0-5 ft	-	0.68 B	-	-	-	-
MD21-01-0040	21-11207	0-1.5 ft	-	0.61 B		0.009 B	-	-
MD21-01-0043	21-11208	0-5 ft	-	0.27 B	0.006 B	0.0048 B	-	-

Table H-8
Composite Waste Samples - Radionuclide Concentrations

Sample ID	Location Id	Depth Interval	Cs-137 pCi/g	Sr-90 pCi/g	Pu-239 pCi/g	Am-241 pCi/g	Pu-238 pCi/g
MD21-01-0024	21-11201	0-5 ft	1.48	1.1	0.225	-	0.035
MD21-01-0026	21-11202	0-5 ft	9.3	1.42	0.46	-	-
MD21-01-0028	21-11203	0-5 ft	3.3	1.46	0.245	-	0.165
MD21-01-0032	21-11204	0-5 ft	3.49	2.28	0.374	0.61	0.115
MD21-01-0035	21-11205	0-5 ft	22.5	10.4	13.4	67.8	3.08
MD21-01-0038	21-11206	0-5 ft	6	1.93	0.226	-	-
MD21-01-0040	21-11207	0-1.5 ft	59.5	10.5	3.07	5.1	0.22
MD21-01-0043	21-11208	0-5 ft	150	52.8	8.6	28.3	2.18

Attachment 1

2001 Release/Discharge Notification
PRS 21-011k

RELEASE / DISCHARGE NOTIFICATION

LOS ALAMOS NATIONAL LABORATORY

Permit Number: NM0028355

Calendar Year: 2001

NPDES or Operational Spill/Release ☑
ER Spill/Release ☐
Other Spill/Release ☐
Indicate with "X" in appropriate box.

Release ID Number: 100

Responsible Facility/User Group: FWO-WFM

Contact Person: Dennis McLain

Pager #: NA

Phone #: 665-5099

Cell Phone #: NA

Release/Discharge Location:

TA: 21

Building: 113

The inadvertant release of partially treated rad. waste water was from holding tank 21-113 to deleted NPDES outfall 050.

If the release/discharge is associated with a NPDES Outfall, Potential Release Site (PRS) or Solid Waste Management Unit (SWMU), indicate the site/unit number and its relationship to the release/discharge:

NPDES Outfall: ☐ PRS: ☑ SWMU: ☑ PRS/SWMU Number: 21-011(k)

ndicate with "X" in appropriate box(es

Relationship of the Discharge to a SWMU or PRS:

The overflow eminated from the deleted EPA NPDES 050 rad waste outfall onto the SWMU area.

	Date	Time
Discharge Occurred:	1/4/2001	1:30 p.m.
Discharge Discovered:	1/4/2001	1:30 p.m.
Discharge Stopped:	1/4/2001	1:45 p.m.
Cleanup Started:	NA	
Cleanup Completed:	NA	

Material(s) Released / Discharged:

Less than 50 gallons of partially treated rad waste water was inadvertantly discharged from the holding tank at TA-21 prior to pumping the effluent to the TA-50 radioactive liquid waste water treatment facility for final treatment.

Release/Discharge Mitigation Method:

The operator noticed that the level gauge appeared to be incorrect, the tank was inspected immediately and the operator halted the work. Upon immediate inspection of the tank the operator observed the waste water entering the tank overflow. At that time the operator put a portable pump into the tank and pumped the waste water back to the TA-21-257 treatment plant which stopped the inadvertant overflow. The total time from initial observation of waste water discharge to the stopping of the discharge was approximately 15 minutes.

Weather Conditions:

clear/cold

Duration of Release/ Discharge, in HOURS: 0.25

Est. Volume Released/ Discharged, in GAL: 50

Est. Volume Recovered, in GAL: 0

Corrective Actions Taken (ie, type of BMPs, etc):

The discharge was halted within 15 minutes of discovery by placing a portable pump into the tank and pumping the water back to the TA-21-257 treatment plant. A permanent plug will be placed into the overflow pipe from the tank(s). The Environmental Restoration (ER) group has SWMU 21-011(k) slated for cleanup in the spring/summer of 2001. The level gauge will be repaired.

Nearest Watercourse (Canyon Name): DP Canyon

Report Printed 1/9/01 3:09:24 PM

If the release/discharge reached a watercourse, describe the estimated surface area affected, presence of release/discharge now in the watercourse, and the media the release/discharge was detected in:

The discharge did not reach a water course. The area impacted is approximately 2 feet wide by 50 feet in length. Photographs of the site will be sent electronically.

Depth to Groundwater, in FT, if known: 750

Distance to Nearest Drinking Water Well, in FT, if known: 2000 **Well ID#** OW-4

24-HOUR RELEASE / DISCHARGE NOTIFICATIONS

	Contact Person	Phone	Fax	Date & Time (or Comment)	
EPA:	E. Spencer	214-665-6475	214-665-6490	1/5/2001	3:40 p.m. (v-mail)
NMED/SWQB:	N. Wells	827-0572	827-0160	1/5/2001	3:26 p.m. (v-mail)
NMED/GWQB:	Jim Mullany	827-0212	8272965	1/5/2001	3:12 p.m.
NMED/HRMB:	Eliza Frank	827-1558	827-1544	1/5/2001	3:08 p.m.
NMED/DOE-OB:	S. Yanicak	672-0448	672-0466	1/5/2001	3:00 p.m. (v-mail)
ESH-18:	H. Decker	665-2014	665-9344	1/5/2001	7:00 a.m.
DOE:	Grace Roybal	667-9875	665-4872	1/5/2001	3:03 p.m.
OTHER:	Anthony Grieggs	665-0451	667-5224	1/5/2001	3:30 p.m.
OTHER:	Daniel Holmquist	661-5229	NA	1/5/2001	9:03 a.m.

Comments: The water soaked into the ground within ten feet of the outfall discharge point. This SWMU area is slated for cleanup by the ER program in 2001.

Form Completed By: H. Decker

7 DAY RELEASE / DISCHARGE ACTIONS

7 Day Notice ☑ **7 Day Notice Date:** 1/10/2001 **7 Day Notice By:** H. Decker

Mark "X" when done.

Comments: A sample of the water was collected immediately,analytical screening values for the first sample of waste water were; tritium 660 nCi/l Gross Alpha = 412 pCi/l, Gross Beta = 2400 pCi/l, pH = 11.58. The bench sheets are included as enclosures 1. A second sample was collected from the waste waterfor a longer count, the values for this second count are Gross Alpha = 140 pCi/l, Gross Beta = 2.2 nCi/l and Tritium as 630 nCi/l, the bench sheet for this second sample set are included as enclosure 2.

15 DAY RELEASE / DISCHARGE ACTIONS

15 day Follow-up Due: **15-day Follow-Up By:** H. Decker

Comments:

NMED 30 DAY APPROVAL / DISAPPROVAL

NMED 30 Day Response Date:

Comments:

David Gurule, Area Manager
Los Alamos Area Office
Department of Energy
Los Alamos, New Mexico 87544
(505) 667-5105

Dennis J. Erickson, ESH Division Director
University of California
Los Alamos National Laboratory
P.O. Box 1663, MS K491
Los Alamos, New Mexico 87544
(505) 667-4218

LABORATORY ANALYSES

SAMPLE SUBMITTED BY:		D. Moss				DATE: 01/04/01			
ORIGIN OF SAMPLE(S)		DP Effluent Tank 113							
		West Tank FINAL.							
DATE SAMPLED		DATE BEGUN	METHOD	ANALYZED BY	DESCRIPTION		DATE BEGUN	METHOD	ANALYZED BY
Test/Analysis	Result/Conc				Test/Analysis	Result/Conc			
pH	11.58 ± 0.2	1/4/01	pH	wrb					
gross α	412 pci/L	1/4	LSC						
gross β	2400 pci/L	1/4	LSC						
REMARKS:									

APPROVED: _____ DATE: _____
Chief Chemist Lab Copy

H7-LAB-35A

ENCLOSURE 1

TANK-113

ENCLOSURE 1

Assay Definition-

Assay Description:
Basic single DPM assay

Assay Type: DPM (Single)
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\Filer\3h_dpm
Raw Results Path: C:\Packard\Tricarb\Results\Filer\3h_dpm
Count Conditions-

Nuclide: 3H
Quench Indicator: tSIE/AEC
External Std Terminator (sec): 0.5 2s%
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: 3H LOW
Count Time (min): 15.00
Count Mode: Normal
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	Bkg Subtract	2Sigma % Terminator
A	0.0	18.6	1st Vial	2.00
B	2.0	18.6	1st Vial	0.00
C	0.0	0.0	1st Vial	0.00

Count Corrections-

Static Controller: On Luminescence Correction: Off
Colored Samples: Off Heterogeneity Monitor: Off
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	SMPL_ID	Count Time	tSIE	CPMA	DPM1	H-3 nCi/L	H-3:2S%
1	1st Vial Bkgnd	15.00	298	13.8	0.0	0.0	13.90
2	QA	3.46	265	2884.5	11294.9	508.8	2.01
3	DPEFF TANK113 1/5	2.60	271	3842.7	14657.7	660.3	2.01

LABORATORY ANALYSES

AMPLE SUBMITTED BY:	D Moss					DATE: 1/9/00			
RIGIN OF SAMPLE(S)	TA-21-257								
ATE SAMPLED		DATE BEGUN	METHOD	ANALYZED BY	DESCRIPTION		DATE BEGUN	METHOD	ANALYZED BY
Test/Analysis	Result/Conc				Test/Analysis	Result/Conc			
~~gross~~ α	140 ± 30 pCi/L								
β	2.2 ± 0.2 nCi/L								
^3H	620 ± 60 nCi/L								

REMARKS:

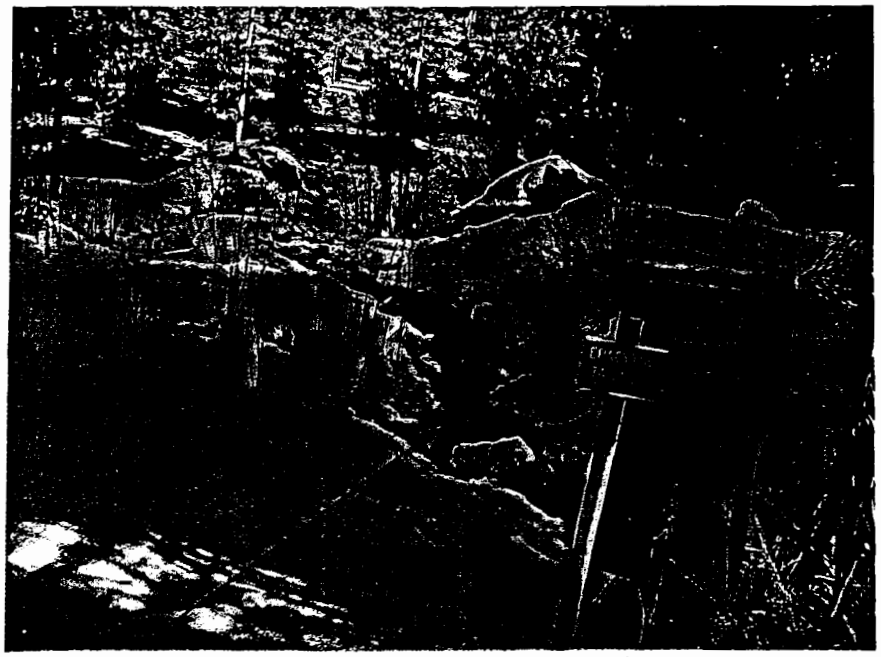
APPROVED: SM Chief Chemist DATE: 1/9/01

H7-LAB-35A Lab Copy

ENCLOSURE 2

Los Alamos National Laboratory
NPDES Permit No. NM0028355

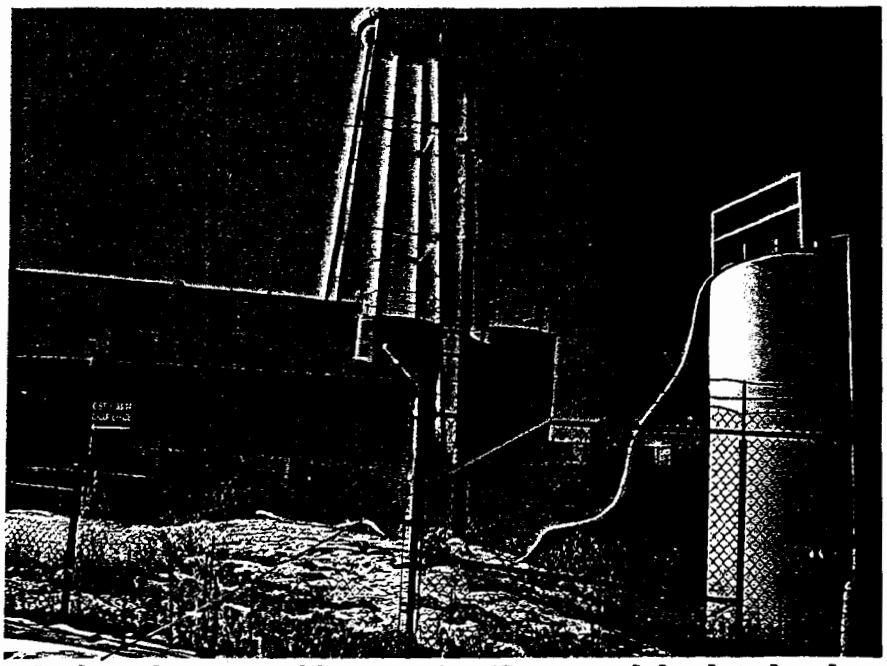
January 4, 2001, TA-21-113 Rad Waste Water Tank Overflow Photographs



Melted snow from released waste water used as evidence for area impacted.

Deleted NPDES 050 outfall pipe.

Los Alamos National Laboratory
NPDES Permit No. NM0028355



Transfer hose from portable pump in effluent tank back to head works.

ATTACHMENT 2
TREATMENT TECHNOLOGIES EVALUATION INFORMATION

Attachment 2 includes a printout of data on the treatment of radionuclides from the Federal Remediation Technologies Round Table Remediaiton Technologies Screening Matrix website www.frtr.gov/matrix2/top_page.html.

TABLE 2-7 TREATMENT TECHNOLOGIES SCREENING MATRIX: TREATMENT OF RADIONUCLIDES

NOTE: Specific site and contaminant characteristics may limit the applicability and effectiveness of any of the technologies and treatments listed below. This matrix is optimistic in nature and should always be used in conjunction with the referenced text sections, which contain additional information that can be useful in identifying potentially applicable technologies.

*The following rankings are discussed on Table 3-1 and Figure 3-1.

	Technology (Section & Title)	Development Status	Use Rating	Applicability*	Reliability*	Cleanup Time*	Technology Function*
SOIL, SEDIMENT AND SLUDGE							
3.2 IN SITU PHYSICAL/CHEMICAL TREATMENT							
	4.10 Solidification /Stabilization	Full	Limited	Better	Average	Average	Immob.
3.5 EX SITU PHYSICAL/CHEMICAL TREATMENT							
	4.24 Solidification /Stabilization	Full	Limited	Better	Better	Better	Extract/ Immob.
GROUND WATER, SURFACE WATER AND LEACHATE							
3.12 EX SITU PHYSICAL/CHEMICAL TREATMENT (ASSUMING PUMPING)							
	4.52 Ion Exchange	Full	Wide	Average	Better	Average	Extract
	4.53 Precipitation/ Coagulation /Flocculation	Full	Wide	Average	Better	Average	Extract
	4.54 Separation	Full	Limited	Refer to profile	Average	Better	Extract
3.13 CONTAINMENT							
	4.57 Deep Well Injection	Full	Limited	Average	Average	NA	Immob.

NA = Not Available.

FRTR
Remediation Technologies Screening Matrix
and Reference Guide, Version 4.0

3.2 In Situ Physical/Chemical Treatment for Soil, Sediment, Bedrock and Sludge

Home
Table of Contents
Introduction
Contaminants
Treatments/Profiles
References
Appendices
Navigation

The main advantage of in situ treatment is that it allows soil to be treated without being excavated and transported, resulting in potentially significant cost savings. However, in situ treatment generally requires longer time periods, and there is less certainty about the uniformity of treatment because of the variability in soil and aquifer characteristics and because the efficacy of the process is more difficult to verify.

Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), separate, or contain the contamination. Soil vapor extraction uses the contaminant's volatility to separate it from the soil. Soil flushing uses the contaminant's solubility in liquid to physically separate it from the soil. Surfactants may be added to the flushing solution to chemically increase the solubility of a contaminant. Solidification/stabilization also uses both physical and chemical means. Solidification encapsulates the contaminant, while stabilization physically alters or binds with the contaminant. Pneumatic fracturing is an enhanced technique that physically alters the contaminated media's permeability by injecting pressurized air to develop cracks in consolidated materials.

Physical/chemical treatment is typically cost effective and can be completed in short time periods (in comparison with biological treatment). Equipment is readily available and is not engineering or energy-intensive. Treatment residuals from separation techniques will require treatment or disposal, which will add to the total project costs and may require permits. Extraction fluids from soil flushing will increase the mobility of the contaminants, so provisions must be made for subsurface recovery.

Available in situ physical/chemical treatment technologies include electrokinetic separation, fracturing (blast-enhanced, pneumatic, and lasagna process), soil flushing, soil vapor extraction, and solidification/stabilization. These treatment technologies are discussed in Section 4. Completed in situ physical/chemical treatment projects for soil, sediment, bedrock and sludge are shown in Table 3-5 and additional information on completed demonstration projects are shown on the FRTR Web Site.

Certain in situ physical/chemical treatment technologies are sensitive to certain soil parameters. For example, the presence of clay or humic materials in soil causes variations in horizontal and vertical hydraulic parameters, which, in turn, cause variations in physical/chemical process performance. Stabilization/solidification technologies are less sensitive to soil parameters than other physical/chemical treatment technologies.

FRTR
Remediation Technologies Screening Matrix
and Reference Guide, Version 4.0

3.5 Ex Situ Physical/Chemical Treatment for Soil, Sediment, Bedrock and Sludge

Home
Table of Contents
Introduction
Contaminants
Treatments/Profiles
References
Appendices
Navigation

The main advantage of ex situ treatment is that it generally requires shorter time periods than in situ treatment, and there is more certainty about the uniformity of treatment because of the ability to homogenize, screen, and continuously mix the soil. Ex situ treatment, however, requires excavation of soils, leading to increased costs and engineering for equipment, possible permitting, and material handling/worker exposure conditions.

Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), separate, or immobilize the contamination. Chemical reduction/oxidation and dehalogenation (APEG, BCD or glycolate) are destruction technologies. Soil washing, SVE, and solvent extraction are separation techniques, and Solidification/Stabilization (S/S) is an immobilization technique.

Physical/chemical treatment is typically cost effective and can be completed in short time periods (in comparison with biological treatment). Equipment is readily available and is not engineering or energy-intensive. Treatment residuals from separation techniques will require treatment or disposal, which will add to the total project costs and may require permits.

Available ex situ physical/chemical treatment technologies include chemical extraction, chemical reduction/oxidation, dehalogenation (APEG, BCD or glycolate), separation, soil washing, and solidification/stabilization. These technologies are discussed in Section 4. Completed ex situ physical/chemical treatment projects for soil, sediment, bedrock and sludge are shown in Table 3-8 and additional information on completed demonstration projects is shown on the FRTR Web Site.

Technology>> Soil, Sediment, Bedrock and Sludge

>>3.5 Ex Situ Physical/Chemical Treatment (assu excavation)

>>4.20 Solidification/Stabilization

Introduction>> Contaminants are physically bound or enclosed within a stabilized ma (solidification), or chemical reactions are induced between the stabiliz agent and contaminants to reduce their mobility (stabilization).

Description:

Figure 4-20: Typical Ex Situ Solidification/ stabilization Process Flow Diagram

As for in situ solidification/stabilization (S/S) (see Technology Profile No. 4.9), ex situ S/S contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex situ S/S, however, typically requires disposal of the resultant materials. Under CERCLA, material can be replaced on site.

There are many innovations in the stabilization and solidification technology. Most of the innovations are modifications of proven processes and are directed to encapsulation or immobilizing the harmful constituents and involve processing of the waste or contaminated soil. Nine distinct innovative processes or groups of processes include: (1) bituminization, (2) emulsified asphalt, (3) modified sulfur cement, (4) polyethylene extrusion, (5) pozzolan/Portland cement, (6) radioactive waste solidification, (7) sludge stabilization, (8) soluble phosphates, and (9) vitrification/molten glass.

Typical ex situ S/S is a short- to medium-term technology.

➢ *Bituminization*

In the bituminization process, wastes are embedded in molten bitumen and encapsulated when the bitumen cools. The process combines heated bitumen and a concentrate of the waste material, usually in slurry form, in a heated extruder containing screws that mix the bitumen and waste. Water is evaporated from the mixture to about 0.5% moisture. The final product is a homogenous mixture of extruded solids and bitumen.

➢ *Emulsified Asphalt*

Asphalt emulsions are very fine droplets of asphalt dispersed in water that are stabilized by chemical emulsifying agents. The emulsions are available as either cationic or anionic emulsions. The emulsified asphalt process involves adding emulsified asphalts having the appropriate charge to hydrophilic liquid or semiliquid wastes at ambient temperature. After mixing, the emulsion breaks, the water in the waste is released, and the organic phase

forms a continuous matrix of hydrophobic asphalt around the waste solids. In some cases, additional neutralizing agents, such as lime or gypsum, may be required. After given sufficient time to set and cure, the resulting solid asphalt has the waste uniformly distributed throughout it and is impermeable to water.

➢ *Modified Sulfur Cement*

Modified sulfur cement is a commercially-available thermoplastic material. It is easily melted (127° to 149° C (260° to 300° F)) and then mixed with the waste to form a homogenous molten slurry which is discharged to suitable containers for cooling, storage, and disposal. A variety of common mixing devices, such as, paddle mixers and pug mills, can be used. The relatively low temperatures used limit emissions of sulfur dioxide and hydrogen sulfide to allowable threshold values.

➢ *Polyethylene Extrusion*

The polyethylene extrusion process involves the mixing of polyethylene binders and dry waste materials using a heated cylinder containing a mixing/transport screw. The heated, homogenous mixture exits the cylinder through an output die into a mold, where it cools and solidifies. Polyethylene's properties produce a very stable, solidified product. The process has been tested on nitrate salt wastes at plant-scale, thereby establishing its viability, and on various other wastes at the bench and pilot scale.

➢ *Pozzolan/Portland Cement*

Pozzolan/Portland cement process consists primarily of silicates from pozzolanic-based materials like fly ash, kiln dust, pumice, or blast furnace slag and cement-based materials like Portland cement. These materials chemically react with water to form a solid cementious matrix which improves the handling and physical characteristics of the waste. They also raise the pH of the water which may help precipatate and immobilize some heavy metal contaminants. Pozzolanic and cement-based binding agents are typically appropriate for inorganic contaminants. The effectiveness of this binding agent with organic contaminants varies.

➢ *Radioactive Waste Solidification*

In radioactive waste solidification (Grouting/Other) treatment, solidification additives are used to form a uniform and stable matrix to encapsulate radioactive waste materials. Assemblies include pumps for liquids or slurries, conveyors for sludges or solids, storage silos, weigh feeders, piping, mixers and disposal or storage.

➢ *Sludge Stabilization*

The sludge stabilization process is the addition of a reagent, either slags or cementitious materials, to sludge to transform the material so that the hazardous constituents are in their least mobile or toxic form. Sludges which leach heavy metals or other contaminants are often stabilized to immobilize the hazardous constituents.

➢ *Soluble Phosphates*

The soluble phosphates process involves the addition of various forms of phosphate and alkali for control of pH as well as for formation of complex metal molecules of low-solubility to immobilize (insolubilize) the metals over a wide pH range. Unlike most other stabilization processes, soluble phosphate processes do not convert the waste into a hardened, monolithic mass. One application of soluble phosphates and lime is in stabilizing fly ash by immobilizing the lead and cadmium in the ash.

➢ *Vitrification/Molten Glass*

Vitrification, or molten glass, processes are solidification methods that employ heat up to 1,200° C to melt and convert waste materials into glass or other glass and crystalline products. The high temperatures destroy any organic constituents with very few byproducts. Materials, such as heavy metals and radionuclides, are actually incorporated into the glass structure which is, generally, a relatively strong, durable material that is resistant to leaching. In addition to solids, the waste materials can be liquids, wet or dry sludges, or combustible materials. Borosilicate and soda-lime are the principal glass formers and provide the basic matrix of the vitrified product.

TOP

Synonyms:

DSERTS Code:

M13 (Vitrification)
N11 (Solidification/Stabilization)

TOP

Applicability:

The target contaminant group for ex situ S/S is inorganics, including radionuclides. Most S/S technologies have limited effectiveness against organics and pesticides, except vitrification which destroys most organic contaminants.

TOP

Limitations:

Factors that may limit the applicability and effectiveness of the process include:

- Environmental conditions may affect the long-term immobilization of contaminants.
- Some processes result in a significant increase in volume (up to double the original volume).
- Certain wastes are incompatible with different processes. Treatability studies are generally required.
- Organics are generally not immobilized.
- Long-term effectiveness has not been demonstrated for many contaminant/process combinations.

TOP

Data Needs:

A detailed discussion of these data elements is provided in Subsection 2.2.1 (Data Requirements for Soil, Sediment, and Sludge). Soil parameters that must be determined include particle size, Atterberg limits, moisture content, metal concentrations, sulfate content, organic content, density, permeability, unconfined compressive strength, leachability, microstructure analysis, and physical and chemical durability.

TOP

Performance Data:

The performance of ex situ S/S is dependent on the type of S/S process used.

DOE has demonstrated the Polyethylene Encapsulation of Radionuclides and Heavy Metals (PERM) process at the bench scale. The process is a waste treatment and stabilization technology for high-level mixed waste. Specific targeted contaminants include radionuclides (e.g., cesium, strontium, and cobalt), and toxic metals (e.g., chromium, lead, and cadmium). Scale-up from bench-scale tests has demonstrated the feasibility to process waste at approximately 2,000 lb/hr. The scale-up feasibility tests have successfully demonstrated the potential to encapsulate at least 60% by weight nitrate salt in polyethylene. Polyethylene waste forms have been demonstrated to exceed Nuclear Regulatory Commission, EPA, and Department of Transportation waste form criteria. Waste forms containing up to several thousand ppm of toxic-metal contaminants have passed the EPA's TCLP.

DOE also demonstrated the arc melter vitrification process, which is capable of melting soil and metals, pyrolizing or oxidizing residual organics, melting structural metals from melted slag (silica and metal oxides), and partitioning transuranic (TRU) waste into slag phase. Durability tests with the resultant slag showed an approximately order of magnitude reduction in leachability when compared with high-level borosilicate glass.

TOP

Cost:

Ex situ solidification/stabilization processes are among the most mature remediation technologies. Representative overall costs from more than a dozen vendors indicate an approximate cost of under $110 per metric ton ($100 per ton), including excavation.

TOP

References:

Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Tenth Edition, EPA 542-R-01-004

Innovative Remediation Technologies: Field Scale Demonstration Project in North America, 2nd Edition

Remediation Technology Cost Compendium - Year 2000

Abstracts of Remediation Case Studies, Volume 4, June, 2000, EPA 542-R-00-006

Guide to Documenting and Managing Cost and Performance Information for Remediation Projects - Revised Version, October, 1998, EPA 542-B-98-007

Battelle Memorial Institute, 1995. *ReOpt. V3.1*, by Battelle Memorial Institute for DOE under Contract DE/AC06/76RLO 1830.

Bricka, R.M., et al., 1988. *An Evaluation of Stabilization/Solidification of Fluidized Bed Incineration Ash (K048 and K051)*, USAE-WES Technical Report EL-88-24.

California Base Closure Environmental Committee (CBCEC), 1994. *Treatment Technologies Applications Matrix for Base Closure Activities, Revision 1*, Technology Matching Process Action Team, November, 1994.

DOE, 1993. "Technology Name: Polyethylene Encapsulation", Technology Information

Profile (Rev. 2) for *ProTech, DOE ProTech Database*, TTP Reference No. BH-321201.

DOE, 1995. *Technology Catalogue, Second Edition*, Office of Environmental Management and Office of Technology Development, DOE/EM-0235.

EPA, 1989. *Chemfix Technologies, Inc. Chemical Fixation/Stabilization*, EPA RREL, Technology Evaluation Vol. I, EPA/540/5-89/011a, PB91-127696; and Technology Evaluation Vol. II, EPA/540/5-89/011b, PB90-274127.

EPA, 1989. *Harcon Solidification*, EPA RREL, series includes Technology Evaluation Vol. I, EPA/540/5-89/001a, PB89-158810; Technology Evaluation Vol. II, EPA/540/5-89/001b, PB89-158828; Applications Analysis, EPA/540/A5-89/001; and Technology Demonstration Summary, EPA/540/S5-89/001.

EPA, 1989. *Solidtech, Inc. Solidification*, EPA RREL, series includes Technology Evaluation Vol. I, EPA/540/5S-89/005a; Technology Evaluation Vol. II, EPA/540/5S-89/005b, PB90-191768; Applications Analysis, EPA/540/A5-89/005; Technology Demonstration Summary, EPA/540/S5-89/005; and Demonstration Bulletin, EPA/540/M5-89/005.

EPA, 1989. *Stabilization/Solidification of CERCLA and RCRA Wastes - Physical Tests, Chemical Testing Procedures, Technology Screening and Field Activities*, EPA, ORD, Washington, DC, EPA/625/6-89/022.

EPA, 1992. *Silicate Technology Corporation Solidification/Stabilization of Organic/Inorganic Contaminants*, EPA RREL, Demonstration Bulletin, EPA/540/MR-92/010; Applications Analysis, EPA/540/AR-92/010, PB93-172948.

EPA, 1993. *Solidification/Stabilization and Its Application to Waste Materials*, Technical Resource Document, EPA, ORD, Washington, DC, EPA/530/R-93/012.

EPA, 1993. *Solidification/Stabilization of Organics and Inorganics*, Engineering Bulletin, EPA, ORD, Cincinnati, OH, EPA/540/S-92/015.

EPA, 1994. *Innovative Site Remediation Technology: Solidification/Stabilization*, Vol. 4, EPA OSWER 542/B-94/001.

EPA, 1997. *Best Management Practices (BMPs) for Soil Treatment Technologies: Suggested Operational Guidelines to Prevent Cross-media Transfer of Contaminants During Clean-UP Activities*, EPA OSWER, EPA/530/R-97/007.

EPA, 1997. *Technology Alternatives for the Remediation of Soils Contaminated with As, Cd, Cr, Hg, and Pb*, Engineering Bulletin, EPA540/R-97/008.

Federal Remediation Technologies Roundtable, 1997. *Remediation Case Studies: Soil Vapor Extraction and Other In Situ Technologies*, EPA/542/R-97/009.

- In Situ Enhanced Soil Mixing at the U.S. Department of Energy's Portsmouth Gaseous Diffusion Plant, X-231B Unit, Piketon, Ohio

Federal Remediation Technologies Roundtable, 1998. *Remediation Case Studies: Debris and Surface Cleaning Technologies, and Other Miscellaneous Technologies*, EPA/542/R-98/017.

- Polyethylene Macroencapsulation at Envirocare of Utah, Inc., Salt Lake City, Utah

USAEC, 1997. "Plasma Arc Technology Evaluation" in *Innovative Technology Demonstration, Evaluation and Transfer Activities, FY 96 Annual Report,* Report No. SFIM-AEC-ET-CR-97013, pp. 107-110.

Wittle, J.K., et.al., 1995. *Graphite Electrode DC Arc Technology Program for Buried Waste Treatment,* Electro-Pyrolysis, Inc. Wayne, Penn.

TOP

Site Information:

- EPA *SITE* Demo: Robins AFB, Macon, GA
- EPA *SITE* Demo: Selma Pressure Treating Selma, CA
- EPA *SITE* Demo: Portable Equip. Salvage Co. Clackamas, OR
- Navy Demo: Naval Const. Battalion Ctr. Port Hueneme, CA
- Imperial Oil Co./Champion Chemical Co. Superfund Site Morganville, NJ
- Small Arms Range, Naval Air Station Mayport, FL
- Davis-Monthan AFB
- DOI Demo: Salt Lake City Research Center
- DOI Demo: Albany Metallurgy Research Center, OR
- EPA & DOE Demo: Component Development & Integration Facility, MT
- NEL Demo: NAS North Island Installation Restoration (IR) Site 11, CA
- Envirocare of Utah, Inc., Salt Lake City, Utah
- DOE's Portsmouth Gaseous Diffusion Plant, X-231B Unit, Piketon, OH
- **Additional site information on the FRTR web site**

Points of Contact:

TOP

General FRTR Agency Contacts

Technology Specific Web Sites:

Government Web Sites

Non Government Web Sites

Vendor Information:

TOP

A list of vendors offering Ex Situ Physical/Chemical Soil Treatment is available from EPA REACH IT which combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications.

Government Disclaimer

Health and Safety:

TOP

Hazard Analysis

TOP

Technology>> Soil, Sediment, Bedrock and Sludge

>>3.2 In Situ Physical/Chemical Treatment

>>4.5 Electrokinetic Separation

Introduction>> The Electrokinetic Remediation (ER) process removes metals and or contaminants from low permeability soil, mud, sludge, and marine dre ER uses electrochemical and electrokinetic processes to desorb, and remove, metals and polar organics. This in situ soil processing techn primarily a separation and removal technique for extracting contamin soils.

Description:

Figure 4-5: Typical In Situ Electrokinetic Separation System The principle of electrokinetic remediation relies upon application of a low-intensity direct current through the soil between ceramic electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes. Metal ions, ammonium ions, and positively charged organic compounds move toward the cathode. Anions such as chloride, cyanide, fluoride, nitrate, and negatively charged organic compounds move toward the anode. The current creates an acid front at the anode and a base front at the cathode. This generation of acidic condition in situ may help to mobilize sorbed metal contaminants for transport to the collection system at the cathode.

The two primary mechanisms transport contaminants through the soil towards one or the other electrodes: electromigration and electroosmosis. In electromigration, charged particles are transported through the substrate. In contrast, electroosmosis is the movement of a liquid containing ions relative to a stationary charged surface. Of the two, electromigration is the main mechanism for the ER process. The direction and rate of movement of an ionic species will depend on its charge, both in magnitude and polarity, as well as the magnitude of the electroosmosis-induced flow velocity. Non-ionic species, both inorganic and organic, will also be transported along with the electroosmosis induced water flow.

Two approaches are taken during electrokinetic remediation: "Enhanced Removal" and "Treatment without Removal".

"Enhanced Removal" is achieved by electrokinetic transport of contaminants toward the polarized electrodes to concentrate the contaminants for subsequent removal and ex-situ treatment. Removal of contaminants at the electrode may be accomplished by several means among which are: electroplating at the electrode; precipitation or co-precipitation at the electrode; pumping of water near the electrode; or complexing with ion exchange resins. Enhanced removal is widely used on remediation of soils contaminated metals.

"Treatment without Removal" is achieved by electro-osmotic transport of contaminants through treatment zones placed between electrodes. The polarity of the electrodes is reversed periodically, which reverses the direction of the contaminants back and forth through treatment zones. The frequency with which electrode polarity is reversed is

determined by the rate of transport of contaminants through the soil. This approach can be used on in-situ remediation of soils contaminated with organic species.

TOP

Synonyms:

Electrokinetics; Electromigration.

TOP

Applicability:

Targeted contaminants for electrokinetics are heavy metals, anions, and polar organics in soil, mud, sledge, and marine dredging. Concentrations that can be treated range from a few parts per million (ppm) to tens of thousands ppm. Electrokinetics is most applicable in low permeability soils. Such soils are typically saturated and partially saturated clays and silt-clay mixtures, and are not readily drained.

TOP

Limitations:

Factors that may limit the applicability and effectiveness of this process include:

- Effectiveness is sharply reduced for wastes with a moisture content of less than 10 percent. Maximum effectiveness occurs if the moisture content is between 14 and 18 percent.
- The presence of buried metallic or insulating material can induce variability in the electrical conductivity of the soil, therefore, the natural geologic spatial variability should be delineated. Additionally, deposits that exhibit very high electrical conductivity, such as ore deposits, cause the technique to be inefficient.
- Inert electrodes, such as carbon, graphite, or platinum, must be used so that no residue will be introduced into the treated soil mass. Metallic electrodes may dissolve as a result of electrolysis and introduce corrosive products into the soil mass.
- Electrokinetics is most effective in clays because of the negative surface charge of clay particles. However, the surface charge of the clay is altered by both charges in the pH of the pore fluid and the adsorption of contaminants. Extreme pH at the electrodes and reduction-oxidation changes induced by the process electrode reactions many inhibit ER's effectiveness, although acidic conditions (i.e., low pH) may help to remove metals.
- Oxidation/reduction reactions can form undesirable products (e.g., chlorine gas).

TOP

Data Needs:

A detailed discussion of data elements is provided in Subsection 2.2.1 (Data Requirements for Soil, Sediment and Sludge).

TOP

Performance Data:

There have been few, if any, commercial applications of electrokinetic remediation in the

United States. The electrokinetic technology has been operated for test and demonstration purposes at the pilot scale and at full scale at the following sites: (1) Louisiana State University, (2) Electrokinetics, Inc., (3) Geokinetics International, Inc., and (4) Battelle Memorial Institute. Geokinetics International, Inc.(GII) has successfully demonstrated the in situ electrokinetic remediation process in five field sites in Europe.

In 1996, a comprehensive demonstration study of lead extraction at a U.S.Army firing range in Louisiana was conducted by DoD's Small Business Innovative Research Program and Electrokinetics, Inc. The EPA taking part in independent assessments of the results, found pilot-scale studies have demonstrated that concentrations of lead decreased to less than 300 mg/kg in 30 weeks of electrokinetic processing when the soils where originally contaminated as high as 4,500 mg/kg of lead.

TOP

Cost:

Costs will vary with the amount of soil to be treated, the conductivity of the soil, the type of contaminant, the spacing of electrodes, and the type of process design employed. Ongoing pilot-scale studies using "real-world" soils indicate that the energy expenditures in extraction of metals from soils may be 500 kWh/m^3 or more at electrode spacing of 1.0m to 1.5m. Direct costs estimates of about \$15/m^3 for a suggested energy expenditure of \$0.03 per kilowatt hours, together with the cost of enhancement, could result in direct costs of \$50/m^3 or more. A recent study estimated full scale costs at \$117 per cubic meter. If no other efficient in situ technology is available to remediate fine-grained and heterogeneous subsurface deposits contaminated with metals, this technique would remain potentially competitive.

TOP

References:

Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Tenth Edition, EPA 542-R-01-004

Innovative Remediation Technologies: Field Scale Demonstration Project in North America, 2nd Edition

Abstracts of Remediation Case Studies, Volume 4, June, 2000, EPA 542-R-00-006

Guide to Documenting and Managing Cost and Performance Information for Remediation Projects - Revised Version, October, 1998, EPA 542-B-98-007

EPA, 1996. *Recent Development for In Situ Treatment of Metal Contaminated Soil*, EPA Office of Solid Waste & Emergency Response, Technology Innovative Office, Washington, DC.

USAEC, 1997. "In-situ Electrokinetic Remediation for Metal Contaminated Soils" in *Innovative Technology Demonstration, Evaluation and Transfer Activities, FY 96 Annual Report*, Report No. SFIM-AEC-ET-CR-97013, pp. 87-88.

U.S. DOE, 1995. "Electrokintic Remediation of Heavy Metals and Radionuclides," in *Technology Catalogue, Second Edition*, Office of Environmental Management Office of Technology Development, DOE/EM-0235, pp. 201-203.

TOP

Site Information:

- Army Demo, U.S. Army Waterways Experiment Station, Baton Rouge Louisiana
- An Underground Storage Tank Spill
- DOE Demo, Oak Ridge K-25 facility, Tennessee
- DOE Demo: Sandia National Laboratories Chemical Waste Landfill
- EPA/DOE Demo: DOE Gaseous Diffusion Plant, Paducah, Kentucky
- DOE Demo, Old TNX Basin, Savannah River Site, South Carolina
- U.S. Army, firing range, LA
- **Additional site information on the FRTR web site**

Points of Contact:

TOP

General FRTR Agency Contacts

Technology Specific Web Sites:

Government Web Sites

Non Government Web Sites

Vendor Information:

TOP

A list of vendors offering In Situ Physical/Chemical Soil Treatment is available from EPA REACH IT which combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications.

Government Disclaimer

Health and Safety:

TOP

To be added

TOP

Technology>> Soil, Sediment, Bedrock and Sludge

>>3.5 Ex Situ Physical/Chemical Treatment (assu excavation)

>>4.15 Chemical Extraction

Introduction>> Waste contaminated soil and extractant are mixed in an extractor, the dissolving the contaminants. The extracted solution is then placed in separator, where the contaminants and extractant are separated for t and further use.

Description:

Figure 4-15
Typical Chemical Extraction Process

Chemical extraction does not destroy wastes but is a means of separating hazardous contaminants from soils, sludges, and sediments, thereby reducing the volume of the hazardous waste that must be treated. The technology uses an extracting chemical and differs from soil washing, which generally uses water or water with wash-improving additives. Commercial-scale units are in operation. They vary in regard to the chemical employed, type of equipment used, and mode of operation.

Physical separation steps are often used before chemical extraction to grade the soil into coarse and fine fractions, with the assumption that the fines contain most of the contamination. Physical separation can also enhance the kinetics of extraction by separating out particulate heavy metals, if these are present in the soil.

➢ *Acid Extraction*

Acid can also be used as the extractant. Acid extraction uses hydrochloric acid to extract heavy metal contaminants from soils. In this process, soils are first screened to remove coarse solids. Hydrochloric acid is then introduced into the soil in the extraction unit. The residence time in the unit varies depending on the soil type, contaminants, and contaminant concentrations, but generally ranges between 10 and 40 minutes. The soil-extractant mixture is continuously pumped out of the mixing tank, and the soil and extractant are separated using hydrocyclones.

When extraction is complete, the solids are transferred to the rinse system. The soils are rinsed with water to remove entrained acid and metals. The extraction solution and rinse waters are regenerated using comercially available precipitants, such as sodium hydroxide, lime, or other proprietary formulations, along with a flocculent that removes the metals and reforms the acid. The heavy metals are concentrated in a form potentially suitable for recovery. During the final step, the soils are dewatered and mixed with lime and fertilizer to neutralize any residual acid.

➢ *Solvent Extraction*

Solvent extraction is a common form of chemical extraction using organic solvent as the extractant. It is commonly used in combination with other technologies, such as solidification/stabilization, incineration, or soil washing, depending upon site-specific conditions. Solvent extraction also can be used as a stand alone technology in some instances. Organically bound metals can be extracted along with the target organic contaminants, thereby creating residuals with special handling requirements. Traces of solvent may remain within the treated soil matrix, so the toxicity of the solvent is an important consideration. The treated media are usually returned to the site after having met Best Demonstrated Available Technology (BDAT) and other standards.

The duration of operations and maintenance for chemical extraction is medium-term.

TOP

Synonyms:

DSERTS Codes:

N16 (Acid Extraction)
N17 (Solvent Extraction)

TOP

Applicability:

Solvent extraction has been shown to be effective in treating sediments, sludges, and soils containing primarily organic contaminants such as PCBs, VOCs, halogenated solvents, and petroleum wastes. The process has been shown to be applicable for the separation of the organic contaminants in paint wastes, synthetic rubber process wastes, coal tar wastes, drilling muds, wood-treating wastes, separation sludges, pesticide/insecticide wastes, and petroleum refinery oily wastes.

Acid extraction is suitable to treat sediments, sludges, and soils contaminated by heavy metals.

TOP

Limitations:

Factors that may limit the applicability and effectiveness of the process include:

- Some soil types and moisture content levels will adversely impact process performance.
- Higher clay content may reduce extraction efficiency and require longer contact times.
- Organically bound metals can be extracted along with the target organic pollutants, which restricts handling of the residuals.
- The presence of detergents and emulsifiers can unfavorably influence the extraction performance.
- Traces of solvent may remain in the treated solids; the toxicity of the solvent is an important consideration.
- Solvent extraction is generally least effective on very high molecular weight organic and very hydrophilic substances.
- After acid extraction, any residual acid in treated soil needs to be neutralized.

- Capital costs can be relatively high and the technology may be more economical at larger sites.
- Meeting highly stringent heavy metals criteria (e.g., passing the California WET test) may prove uneconomical.

TOP

Data Needs:

A detailed discussion of these data elements is provided in Subsection 2.2.1 (Data Requirements for Soil, Sediment, and Sludge). It is important to determine whether mass transfer or equilibrium will be controlling. The controlling factor is critical to the design of the unit and to the determination of whether the technology is appropriate for the waste.

Soil properties that should be determined include particle size; pH; partition coefficient; cation exchange capacity; organic content; TCLP; moisture content; and the presence of metals, volatiles, clays, and complex waste mixtures.

TOP

Performance Data:

The performance data currently available are mostly from Resource Conservation Company (RCC). The ability of RCC's full-scale B.E.S.T.™ process to separate oily feedstock into product fractions was evaluated by EPA at the General Refining Superfund site near Savannah, Georgia, in February 1987. The treated soils from this unit were backfilled to the site, product oil was recycled as a fuel oil blend, and the recovered water was pH-adjusted and transported to a local industrial wastewater treatment facility.

TOP

Cost:

Cost estimates for this technology range from $110 to $440 per metric ton ($100 to $400 per ton), depending on the volume of soil treated.

TOP

References:

Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Tenth Edition, EPA 542-R-01-004

Innovative Remediation Technologies: Field Scale Demonstration Project in North America, 2nd Edition

Remediation Technology Cost Compendium - Year 2000

Groundwater Cleanup: Overview of Operating Experience at 28 Sites, September 1999, EPA 542-R-99-006,

Potential Applicability of Assembled Chemical Weapons Assessment Technologies to RCRA Waste Streams and Contaminated Media, August 2000, EPA 542-R-00-004

Treatment Experiences at RCRA Corrective Actions, December 2000, EPA 542-F-00-020

Abstracts of Remediation Case Studies, Volume 4, June, 2000, EPA 542-R-00-006

Guide to Documenting and Managing Cost and Performance Information for Remediation Projects - Revised Version, October, 1998, EPA 542-B-98-007

California Base Closure Environmental Committee (CBCEC), 1994. *Treatment Technologies Applications Matrix for Base Closure Activities, Revision 1*, Technology Matching Process Action Team, November, 1994.

DOE, April 1995. *Technology Catalogue, Second Edition*, Office of Environmental Management & Office of Technology Development, DOE/EM-0235.

EPA, 1988. *Evaluation of the B.E.S.T.™ Solvent Extraction Sludge Treatment Technology Twenty-Four Hour Test*, EPA/600/2-88/051.

EPA, 1988. *Technology Screening Guide for Treatment of CERCLA Soils and Sludges Appendix B.1: Chemical Extraction*, EPA, Washington, DC, EPA/540/2-88/004.

EPA, 1989. *Innovative Technology: B.E.S.T.™ Solvent Extraction Process*, OSWER Directive 9200.5-253FS.

EPA, 1990. *CF Systems Organics Extraction Process New Bedford Harbor, MA, Applications Analysis Report*, Superfund Innovative Technology Evaluation, Washington, DC, EPA/540/A5-90/002. Available from NTIS, Springfield, VA, Order No. PB91-1133845.

EPA, 1990. *CF Systems Corp. Solvent Extraction*, EPA RREL, series includes Technology Evaluation Vol. I, 540/5-90/001; Technology Evaluation Vol. II, EPA/540/5-90/002a, PB90-186503; Application Analysis, EPA/540/A5-90/002; and Technology Demonstration Summary, EPA/540/S5-90/002.

EPA, 1990. *Solvent Extraction Treatment*, Engineering Bulletin, EPA, OERR and ORD, Washington, DC, EPA/540/2-90/013.

EPA, 1993. *Terra Kleen Solvent Extraction Technology Terra Kleen Response Group, Inc.*, EPA RREL, Demonstration Bulletin, EPA/540/MR-94/521.

Federal Remediation Technologies Roundtable, 1998. *Remediation Case Studies: Ex Situ Soil Treatment Technologies (Bioremediation, Solvent Extraction, Thermal Desorption)*, EPA/542/R-98/011.

- Solvent Extraction at the Sparrevohn Long Range Radar Station, Alaska

Raghavan, R., D.H. Dietz, and E. Coles, 1988. *Cleaning Excavated Soil Using Extraction Agents: A State-of-the-Art Review*, EPA Releases Control Branch, Edison, NJ, EPA Report EPA 600/2-89/034.

TOP

Site Information:

- EPA Removal Action: Traband Warehouse PCBs, OK
- EPA Removal Action: Stanford Pesticide Site No. 1, AZ
- EPA Remedial Action: Palmetto Wood Preserving, SC

- EPA Removal Action: PBM Enterprises, MI
- EPA Removal Action: Zhiegner Refining Company
- EPA Demo: Midwest, California, Australia
- EPA Demo: Grand Calumet River Site, IL
- EPA SITE Demo: Research Facility, Edison, NJ
- United Creosoting, Conroe, TX
- DOE pilot-scale test, Idaho National Engineering Laboratory
- SUPERFUND Remedial Action, Arrowhead Refinery Co.
- EPA SITE Demo: Naval Air Station North Island Site 4, San Diego, CA
- EPA Removal Action: General Refining Company, GA
- EPA Removal Action: Vineland Chemical Company, NJ
- EPA Removal Action: Avtex Fibers, VA
- EPA & Navy Demo: EPA Lab, NJ
- EPA Demo: Douglassville, PA
- EPA Demo
- Star Enterprise, Port Arthur, TX
- EPA Demo: New Bedford Harbor, MA & O'Connor Site, ME
- Sparrevohn Long Range Radar Station, AK
- **Additional site information on the FRTR web site**

Points of Contact:

TOP

General FRTR Agency Contacts

Technology Specific Web Sites:

Non Government Web Sites

Vendor Information:

TOP

A list of vendors offering Ex Situ Physical/Chemical Soil Treatment is available from EPA REACH IT which combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications.

Government Disclaimer

Health and Safety:

TOP

Hazard Analysis

TOP

Technology>> Soil, Sediment, Bedrock and Sludge

>>3.1 In Situ Biological Treatment

>>4.3 Phytoremediation

Introduction>> Phytoremediation is a process that uses plants to remove, transfer, st and destroy contaminants in soil and sediment. Contaminants may be organic or inorganic.

Description:

Figure 4-3:
Typical In Situ Phytoremediation System Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction (also called phyto-accumulation), phyto-degradation, and phyto-stabilization.

➢ *Enhanced Rhizosphere Biodegradation*

Enhanced rhizosphere biodegradation takes place in the soil immediately surrounding plant roots. Natural substances released by plant roots supply nutrients to microorganisms, which enhances their biological activities. Plant roots also loosen the soil and then die, leaving paths for transport of water and aeration. This process tends to pull water to the surface zone and dry the lower saturated zones.

The most commonly used flora in phytoremediation projects are poplar trees, primarily because the trees are fastgrowing and can survive in a broad range of climates. In addition, poplar trees can draw large amounts of water (relative to other plant species) as it passes through soil or directly from an aquifer. This may draw greater amounts of dissolved pollutants from contaminated media and reduce the amount of water that may pass through soil or an aquifer, thereby reducing the amount of contaminant flushed though or out of the soil or aquifer.

➢ *Phyto-accumulation*

Phyto-accumulation is the uptake of contaminants by plant roots and the translocation/accumulation (phytoextraction) of contaminants into plant shoots and leaves.

➢ *Phyto-degradation*

Phyto-degradation is the metabolism of contaminants within plant tissues. Plants produce enzymes, such as dehalogenase and oxygenase, that help catalyze degradation. Investigations are proceeding to determine if both aromatic and chlorinated aliphatic compounds are amenable to phyto-degradation.

➢ *Phyto-stabilization*

Phyto-stabilization is the phenomenon of production of chemical compounds by plant to immobilize contaminants at the interface of roots and soil.

TOP

Synonyms:

Vegetation-enhanced bioremediation.

TOP

Applicability:

Phytoremediation may be applicable for the remediation of metals, pesticides, solvents, explosives, crude oil, PAHs, and landfill leachates.

Some plant species have the ability to store metals in their roots. They can be transplanted to sites to filter metals from wastewater. As the roots become saturated with metal contaminants, they can be harvested.

Hyper-accumulator plants may be able to remove and store significant amount of metallic contaminants.

Currently, trees are under investigation to determine their ability to remove organic contaminants from ground water, translocate and transpiration, and possibly metabolize them either to CO_2 or plant tissue.

TOP

Limitations:

Limitations to phytoremediation in soil include:

- The depth of the treatment zone is determined by plants used in phytoremediation. In most cases, it is limited to shallow soils.
- High concentrations of hazardous materials can be toxic to plants.
- It involves the same mass transfer limitations as other biotreatments.
- It may be seasonal, depending on location.
- It can transfer contamination across media, e.g., from soil to air.
- It is not effective for strongly sorbed (e.g., PCBs) and weakly sorbed contaminants.
- The toxicity and bioavailability of biodegradation products is not always known.
- Products may be mobilized into ground water or bioaccumulated in animals.
- It is still in the demonstration stage.
- It is unfamiliar to regulators.

TOP

Data Needs:

A detailed discussion of these data elements is provided in Subsection 2.2.1 (Data Requirements for Soil, Sediment, and Sludge). In addition, detailed information is needed to determine the kinds of soil used for phytoremediation projects. Water movement,

reductive oxygen concentrations, root growth, and root structure all affect the growth of plants and should be considered when implementing phytoremediation.

TOP

Performance Data:

Currently, the Superfund Innovative Technology Evaluation (SITE) Program is attempting to demonstrate and evaluate the efficacy and cost of phytoremediation in the field at sites in Oregon, Utah, Texas, and Ohio.

USAEC is also leading the team of experts from EPA, Tennessee Valley Authority (TVA) and the Waterways Experimental Station (WES) to successfully demonstrate phytoremediation of explosive contaminated sites in Milan Army Ammunition Plant in Milan, TN.

AFCEE is currently conducting several phytoremediation demonstrations, including the following:

A "mature tree" study has been completed at Cape Canaveral Air Station. Live Oak, Saw-tooth Palmetto and Scrub Oak species in the midst of a TCE plume were evaluated for TCE transpiration and TCE transformation rates. Evapotranspiration rates were also measured. Mature trees were used in this study to obviate the waiting period for whips to grow into mature trees.

An initial planting of 110 trees in 1998 was followed by 200 (early 2000) and 150 (spring 2000) additional trees at Travis AFB, CA. The plantings are being used as hydraulic control for a TCE plume. This is a long-term test of the ability of trees to control the movement of groundwater.

A similar study is taking place at Altus AFB, OK. One hundred ten non seed-bearing hybrid cottonwood trees were planted in the fall of 1998. The plantings are being used as hydraulic control for a TCE plume. Soil moisture, groundwater levels, climatic conditions and sap flow rates are monitored remotely in this demonstration. A report on the results of the study will be released in the summer 2001.

A new effort was launched in the summer 2000, with five large-scale plantings planned for Fairchild, Offutt, Hill and Whiteman AFBs. Plantings should be complete by early 2001. More information can also be located at http://www.afcee.brooks.af.mil/er/ert/phytorem.htm.

TOP

Cost:

US AEC estimated that the cost for phytoremediation of one acre of lead-contaminated soil to a depth of 50 cm was $60,000 to $100,000, whereas excavating and landfilling the same soil volume was $400,000 to $1,700,000.

TOP

References:

AFCEE, "An overview of Phytoremediation, including installation protocols", provided by the Air Force Center for Environmental Excellence (AFCEE).

Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Tenth Edition, EPA 542-R-01-004

Innovative Remediation Technologies: Field Scale Demonstration Project in North America, 2nd Edition

Treatment Experiences at RCRA Corrective Actions, December 2000, EPA 542-F-00-020

Abstracts of Remediation Case Studies, Volume 4, June 2000, EPA 542-R-00-006

Guide to Documenting and Managing Cost and Performance Information for Remediation Projects - Revised Version, October, 1998, EPA 542-B-98-007

Boyajian, G. E. and Devedjian, D. L., 1997. "Phytoremediation: It Grows on You", *Soil & Groundwater Cleanup*, February/March, pp. 22-26.

EPA, 1998. *A Citizen's Guide to Phytoremediation*, Technology Fact Sheet, EPA NCEPI, EPA/542/F-98/011.

EPA, 1996. *A Citizen's Guide to Phytoremediation*, Technology Fact Sheet, EPA NCEPI, EPA/542/F-96/014.

EPA, 1996. *Recent Developments for In Situ Treatment of Metal Contaminated Soils*, EPA/542/R-96/008.

Schnoor, J.L., L.A. Licht, S.C. McCutcheon, N.L. Wolfe, and L.H. Carreira. 1995. "Phytoremediation of organic and nutrient contaminants," *Environ. Sci. Technol.* 29:318A-323A.

USAEC, 1997. "Phytoremediation of Lead" in *Innovative Technology Demonstration, Evaluation and Transfer Activities, FY 96 Annual Report*, Report No. SFIM-AEC-ET-CR-97013, pp. 89-92.

U.S. DOE, 1995. "Bioremediation of High Explosives by Plants," in *Technology Catalogue, Second Edition*, Office of Environmental Management Office of Technology Development, DOE/EM-0235, pp. 169-172.

A comprehensive list of 850 references on phytoremediation are available at Remediation Technologies Development Forum (RTDF) Phytoremediation Action Team Web Site. Click to access

RTDF Phytoremediation Bibliography

TOP

Site Information:

- Trenton, NJ Site
- Dearing, KS
- Whitewood Creek, SD
- Brookhaven National Laboratory
- McCormick & Baxter SUPERFUND Site, Portland, OR (Wood treatment site)
- Argonne National Laboratory
- Craney Island Fuel Terminal, U.S. Navy, Portsmouth, VA
- EPA S.I.T.E. Program, Ogden, Utah
- Ohio (Former metal plating site)
- DOE Demo: Savannah River Site , SC

- DOE Savannah River Site, SC

Points of Contact:

TOP

General FRTR Agency Contacts

Technology Specific Web Sites:

Government Web Sites

Non Government Web Sites

Vendor Information:

TOP

A list of vendors offering In Situ Biological Soil Treatment is available from EPA REACH IT which combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications.

Government Disclaimer

Health and Safety:

TOP

To be added

TOP

Technology>> Soil, Sediment, Bedrock and Sludge

>>3.2 In Situ Physical/Chemical Treatment

>>4.7 Soil Flushing

Introduction>> Water, or water containing an additive to enhance contaminant solubi applied to the soil or injected into the ground water to raise the water the contaminated soil zone. Contaminants are leached into the groun which is then extracted and treated.

Description:

Figure 4-7:
Typical Soil Flushing System In situ soil flushing is the extraction of contaminants from the soil with water or other suitable aqueous solutions. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered from the underlying aquifer and, when possible, they are recycled.

➤ *Cosolvent Enhancement*

Cosolvent flushing involves injecting a solvent mixture (e.g., water plus a miscible organic solvent such as alcohol) into either vadose zone, saturated zone, or both to extract organic contaminants. Cosolvent flushing can be applied to soils to dissolve either the source of contamination or the contaminant plume emanating from it. The cosolvent mixture is normally injected upgradient of the contaminated area, and the solvent with dissolved contaminants is extracted downgradient and treated above ground.

Recovered ground water and flushing fluids with the desorbed contaminants may need treatment to meet appropriate discharge standards prior to recycle or release to local, publicly owned wastewater treatment works or receiving streams. To the maximum extent practical, recovered fluids should be reused in the flushing process. The separation of surfactants from recovered flushing fluid, for reuse in the process, is a major factor in the cost of soil flushing. Treatment of the recovered fluids results in process sludges and residual solids, such as spent carbon and spent ion exchange resin, which must be appropriately treated before disposal. Air emissions of volatile contaminants from recovered flushing fluids should be collected and treated, as appropriate, to meet applicable regulatory standards. Residual flushing additives in the soil may be a concern and should be evaluated on a site-specific basis.

The duration of soil flushing process is generally short- to medium-term.

TOP

Synonyms:

Cosolvents Enhancement; Surfactant Flooding.

DSERTS Code: M12 (Soil Flushing).

TOP

Applicability:

The target contaminant group for soil flushing is inorganics including radioactive contaminants. The technology can be used to treat VOCs, SVOCs, fuels, and pesticides, but it may be less cost-effective than alternative technologies for these contaminant groups. The addition of environmentally compatible surfactants may be used to increase the effective solubility of some organic compounds; however, the flushing solution may alter the physical/chemical properties of the soil system. The technology offers the potential for recovery of metals and can mobilize a wide range of organic and inorganic contaminants from coarse-grained soils.

TOP

Limitations:

Factors that may limit the applicability and effectiveness of the process include:

- Low permeability or heterogeneous soils are difficult to treat.
- Surfactants can adhere to soil and reduce effective soil porosity.
- Reactions of flushing fluids with soil can reduce contaminant mobility.
- The potential of washing the contaminant beyond the capture zone and the introduction of surfactants to the subsurface concern regulators. The technology should be used only where flushed contaminants and soil flushing fluid can be contained and recaptured.
- Aboveground separation and treatment costs for recovered fluids can drive the economics of the process.

TOP

Data Needs:

A detailed discussion of these data elements is provided in Subsection 2.2.1 (Data Requirements for Soil, Sediment, and Sludge). Treatability tests are required to determine the feasibility of the specific soil-flushing process being considered. Physical and chemical soil characterization parameters that should be established include soil permeability, soil structure, soil texture, soil porosity, moisture content, total organic carbon (TOC), cation exchange capacity (CEC), pH, and buffering capacity.

Contaminant characteristics that should be established include concentration, solubility, partition coefficient, solubility products, reduction potential, and complex stability constants. Soil and contaminant characteristics will determine the flushing fluids required, flushing fluid compatibility, and changes in flushing fluids with changes in contaminants.

TOP

Performance Data:

Soil flushing is a developing technology that has had limited use in the United States. Typically, laboratory and field treatability studies must be performed under site-specific

conditions before soil flushing is selected as the remedy of choice. To date, the technology has been selected as part of the source control remedy at 12 Superfund sites. This technology is currently operational at only one Superfund site; a second was scheduled to begin operation in 1991. EPA completed construction of a mobile soil-flushing system, the In Situ Contaminant/Treatment Unit, in 1988. This mobile soil-flushing system is designed for use at spills and uncontrolled hazardous waste sites. There has been very little commercial success with this technology.

TOP

Cost:

The cost of soil flushing depends greatly on the type and concentration of surfactants used, if they are used at all. Rough estimates ranging from $25 to $250 per cubic yard have been reported.

Additional cost information can be found in the Hazardous, Toxic, and Radioactive Wastes (HTRW) Historical Cost Analysis System (HCAS) developed by Environmental Historical Cost Committee of Interagency Cost Estimation Group.

TOP

References:

Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Tenth Edition, EPA 542-R-01-004

Innovative Remediation Technologies: Field Scale Demonstration Project in North America, 2nd Edition

Abstracts of Remediation Case Studies, Volume 4, June, 2000, EPA 542-R-00-006

Guide to Documenting and Managing Cost and Performance Information for Remediation Projects - Revised Version, October, 1998, EPA 542-B-98-007

AATDF, 1997. *Technology Practices Manual for Surfactants and Cosolvents*, Technical Report, Document No. TR-97-2.

EPA, 1991. *In Situ Soil Flushing*, Engineering Bulletin, EPA/540/2-91/021.

EPA, 1994. *In Situ Remediation Technology Status Report: Cosolvent*, Engineering Bulletin, EPA/542/K-94/006.

EPA, 1996. *A Citizen's Guide to In Situ Soil Flushing*, Technology Fact Sheet, EPA/542/F-96/006.

EPA, 1997. *Best Management Practices (BMPs) for Soil Treatment Technologies: Suggested Operational Guidelines to Prevent Cross-media Transfer of Contaminants During Clean-UP Activities*, EPA OSWER, EPA/530/R-97/007.

Nash J., R.P. Traver, and D.C. Downey, 1986. "Surfactant-Enhanced In Situ Soils Washing", USAF Engineering and Services Laboratory, Florida. ESL-TR-97-18, Available from NTIS, Springfield, VA, Order No. ADA188066.

Sturges, S.G., Jr., P. McBeth, Jr., R.C. Pratt, 1992. "Performance of Soil Flushing and Groundwater Extraction at the United Chrome Superfund Site," *Journal of Hazardous Materials*, El Savior Science Pub., B.V., Amsterdam, Vol. 29, pp. 59-78.

TOP

Site Information:

- Laramie Tie Plant, WY

Points of Contact:

TOP

General FRTR Agency Contacts

Technology Specific Web Sites:

Government Web Sites

Vendor Information:

TOP

A list of vendors offering In Situ Physical/Chemical Soil Treatment is available from EPA REACH IT which combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications.

Government Disclaimer

Health and Safety:

TOP

Hazard Analysis

TOP

Attachment 3
Federal Express Shipping Receipts and IT Laboratory Receipt Letter for Benchscale Study Samples from SWMU 21-011(k)

Eight sediment, soil and tuff samples were collected between December 11 and 13, 2001 from SWMU 21-011(k) for benchscale testing. The samples were held within the fenced Radiation Control Area at the site in uniquely identified, sealed 5-gallon buckets pending receipt of radiation screening data from the ARS Laboratory for DOT shipping determination. Upon receipt of the screening data, the samples were taken directly from the site Federal Express (FedEx) for shipment to IT Corporation's laboratory in Kingston, KY. The FedEx airbill receipts are attached. All samples were shipped in a sealed condition and received by IT Corporation in the same condition. Sample identification numbers, material types and radiation screening information for each sample were sent to IT Corporation prior to shipment so the receipt of samples could be verified. A copy of the email transmission is attached from Paul Lear of IT Corporation regarding receipt of the samples, to verify the condition of the samples upon receipt by IT Corporation.

The requirements for treatability studies for hazardous wastes under 40 CFR 261.4(e) and (f), Treatability Study Samples, do not address chain-of-custody for such samples. The soil, sediment and tuff samples from SWMU 21-011(k) samples contain only radionuclides as was documented in by the 2001 pre-VCA waste characterization sample results. Based on telecons with other DOE sites, some sites send treatability samples with chain-of-custody documentation and some rely on shipping documentation, such as FedEx receipts. Chain-of-custody documentation is required for samples submitted for analysis where the results are used to determination of nature and extent of contamination.

FedEx Express USA Airbill

FedEx Tracking Number 831473797320

Sender's Copy

From *Please print and press hard.*

Date 12-14-01 Sender's FedEx Account Number 1617-0991-3

Sender's Name J. Crocker Phone (505) 662-7300

Company WASHINGTON GROUP INTERNATIONAL

Address 2237 TRINITY DR BLDG 2 Dept./Floor/Suite/Room

City LOS ALAMOS State NM ZIP 87544

Your Internal Billing Reference First 24 characters will appear on invoice.

To

Recipient's Name Don Huskey Phone (865) 482-6497

Company ENV. Tech. Dev. Center

Address 1570 Bear CK Rd

To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

City Kingston State TN ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com
or call 1.800.Go.FedEx® 800.463.3339.

0192554275

4a Express Package Service *Packages up to 150 lbs.* Delivery commitment may be later in some areas.

- ☐ FedEx Priority Overnight — Next business morning
- ☑ FedEx Standard Overnight — Next business afternoon
- ☐ FedEx First Overnight — Earliest next business morning delivery to select locations
- ☐ FedEx 2Day — Second business day
- ☐ FedEx Express Saver — Third business day
- ☐ NEW FedEx Extra Hours — Later drop-off with next business afternoon delivery for select locations

FedEx Envelope rate not available. Minimum charge: One-pound rate

4b Express Freight Service *Packages over 150 lbs.* Delivery commitment may be later in some areas.

- ☐ FedEx 1Day Freight* — Next business day
- ☐ FedEx 2Day Freight — Second business day
- ☐ FedEx 3Day Freight — Third business day

* Call for Confirmation: _____

5 Packaging * Declared value limit $500

- ☐ FedEx Envelope*
- ☐ FedEx Pak* — Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak
- ☑ Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling Include FedEx address in Section 3.

- ☐ SATURDAY Delivery — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- ☐ HOLD Weekday at FedEx Location — NOT Available for FedEx First Overnight
- ☐ HOLD Saturday at FedEx Location — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- ☐ No
- ☐ Yes — As per attached Shipper's Declaration
- ☐ Yes — Shipper's Declaration not required
- ☐ Dry Ice — Dry Ice, 9, UN 1845 _____ x _____ kg

Dangerous Goods (incl. Dry Ice) cannot be shipped in FedEx packaging or with FedEx Extra Hours service.

☐ Cargo Aircraft Only

7 Payment *Bill to:* Enter FedEx Acct. No. or Credit Card No. below.

- ☑ Sender — Acct. No. in Section 1 will be billed.
- ☐ Recipient
- ☐ Third Party
- ☐ Credit Card
- ☐ Cash/Check

FedEx Acct. No. / Credit Card No. Exp. Date

Total Packages	Total Weight	Total Declared Value†
		$ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature *Sign to authorize delivery without obtaining signature.*

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

Rev. Date 7/01 • Part #1572520 • ©1994-2001 FedEx • PRINTED IN U.S.A. GBFE 8/01

Address 1570 Bear Creek Rd

To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

City Kingston State TN ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com
or call 1.800.Go.FedEx® 800.463.3339.

0192554275

☑ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

Total Packages	Total Weight	Total Declared Value†
4	200	$ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature Sign to authorize delivery without obtaining signature.

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

FedEx Express USA Airbill

FedEx Tracking Number 831473797282

1 From *Please print and press hard.*

Date 12-14-01 Sender's FedEx Account Number 1617-0991-3

Sender's Name J. Crocker Phone (505) 662-7300

Company WASHINGTON GROUP INTERNATIONAL

Address 2237 TRINITY DR BLDG 2 Dept./Floor/Suite/Room

City LOS ALAMOS State NM ZIP 87544

2 Your Internal Billing Reference First 24 characters will appear on invoice.

3 To

Recipient's Name Don Huskey Phone (865) 482-6497

Company Environmental Tech. Dev. Center

Address 1570 Bear Creek Rd

To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

City Kingston TN State ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com or call 1.800.Go.FedEx® 800.463.3339.

0192554275

Sender's Copy

4a Express Package Service *Packages up to 150 lbs.* Delivery commitment may be later in some areas.

- [x] FedEx Priority Overnight — Next business morning
- [x] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day — Second business day
- [ ] FedEx Express Saver — Third business day
- [ ] NEW FedEx Extra Hours — Later drop-off with next business afternoon delivery for select locations

FedEx Envelope rate not available. Minimum charge: One-pound rate

4b Express Freight Service *Packages over 150 lbs.* Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation:

5 Packaging * Declared value limit $500

- [ ] FedEx Envelope*
- [ ] FedEx Pak* — Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak
- [x] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling Include FedEx address in Section 3.

- [ ] SATURDAY Delivery — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] HOLD Weekday at FedEx Location — NOT Available for FedEx First Overnight
- [ ] HOLD Saturday at FedEx Location — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- [x] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 ____ x ____ kg

Dangerous Goods (incl. Dry Ice) cannot be shipped in FedEx packaging or with FedEx Extra Hours service.

- [ ] Cargo Aircraft Only

7 Payment *Bill to:* Enter FedEx Acct. No. or Credit Card No. below.

- [x] Sender — Acct. No. in Section 1 will be billed.
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check

FedEx Acct. No. / Credit Card No. Exp. Date

Total Packages Total Weight Total Declared Value† $ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature *Sign to authorize delivery without obtaining signature.*

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

Rev. Date 7/01 • Part #157252G • ©1994–2001 FedEx • PRINTED IN U.S.A. GBPE 6/01

FedEx Express USA Airbill

FedEx Tracking Number 831473797293

1 From *Please print and press hard.*

Date 12-14-01 Sender's FedEx Account Number 1617-0991-3

Sender's Name J. Crocker Phone (505) 662-7300

Company WASHINGTON GROUP INTERNATIONAL

Address 2237 TRINITY DR BLDG 2 Dept./Floor/Suite/Room

City LOS ALAMOS State NM ZIP 87544

2 Your Internal Billing Reference First 24 characters will appear on invoice.

3 To

Recipient's Name Don Huskey Phone (865) 482-6497

Company Env. Tech. Dev. Center

Address 1570 Bear CK Rd

To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

City Kingston State TN ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com or call 1.800.Go.FedEx® 800.463.3339.

0192554275

Sender's Copy

4a Express Package Service *Packages up to 150 lbs.* Delivery commitment may be later in some areas.

- [ ] FedEx Priority Overnight — Next business morning
- [x] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day — Second business day
- [ ] FedEx Express Saver — Third business day
- [ ] NEW FedEx Extra Hours — Later drop-off with next business afternoon delivery for select locations

FedEx Envelope rate not available. Minimum charge: One-pound rate

4b Express Freight Service *Packages over 150 lbs.* Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation:

5 Packaging * Declared value limit $500

- [ ] FedEx Envelope*
- [ ] FedEx Pak* — Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak
- [x] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling Include FedEx address in Section 3.

- [ ] SATURDAY Delivery — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] HOLD Weekday at FedEx Location — NOT Available for FedEx First Overnight
- [ ] HOLD Saturday at FedEx Location — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- [x] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 ____ x ____ kg

Dangerous Goods (incl. Dry Ice) cannot be shipped in FedEx packaging or with FedEx Extra Hours service.

- [ ] Cargo Aircraft Only

7 Payment *Bill to:* Enter FedEx Acct. No. or Credit Card No. below.

- [x] Sender — Acct. No. in Section 1 will be billed.
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check

FedEx Acct. No. / Credit Card No. Exp. Date

Total Packages Total Weight Total Declared Value† $ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature *Sign to authorize delivery without obtaining signature.*

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

FedEx Express USA Airbill

FedEx Tracking Number 831473797308

0215 Sender's Copy

From Please print and press hard.

Date 12-14-01 Sender's FedEx Account Number 1617-0991-3

Sender's Name J. Crocker Phone (505) 662-7300

Company WASHINGTON GROUP INTERNATIONAL

Address 2237 TRINITY DR BLDG 2 Dept./Floor/Suite/Room

City LOS ALAMOS State NM ZIP 87544

Your Internal Billing Reference
First 24 characters will appear on invoice.

To
Recipient's Name Don Huskey Phone (865) 482-6497

Company Env. Tech. Dev. Center

Address 1570 Bear CK Rd. Dept./Floor/Suite/Room
To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

City Kingston State TN ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com
or call 1.800.Go.FedEx® 800.463.3339.

0192554275

4a Express Package Service — Packages up to 150 lbs. Delivery commitment may be later in some areas.

- [ ] FedEx Priority Overnight — Next business morning
- [x] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day — Second business day
- [ ] FedEx Express Saver — Third business day
- [ ] NEW FedEx Extra Hours — Later drop-off with next business afternoon delivery for select locations

FedEx Envelope rate not available. Minimum charge: One-pound rate

4b Express Freight Service — Packages over 150 lbs. Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation: _____

5 Packaging — * Declared value limit $500

- [ ] FedEx Envelope*
- [ ] FedEx Pak* — Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak
- [x] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling — Include FedEx address in Section 3.

- [ ] SATURDAY Delivery — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] HOLD Weekday at FedEx Location — NOT Available for FedEx First Overnight
- [ ] HOLD Saturday at FedEx Location — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- [ ] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 _____ x _____ kg

Dangerous Goods (incl. Dry Ice) cannot be shipped in FedEx packaging or with FedEx Extra Hours service.

- [ ] Cargo Aircraft Only

7 Payment Bill to: Enter FedEx Acct. No. or Credit Card No. below.

- [x] Sender — Acct. No. in Section 1 will be billed.
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check

FedEx Acct. No. / Credit Card No. Exp. Date

Total Packages | Total Weight | Total Declared Value† $ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature Sign to authorize delivery without obtaining signature.

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

Rev. Date 7/01 • Part #157252G • ©1994–2001 FedEx • PRINTED IN U.S.A. GBFE 8/01

FedEx Express USA Airbill

FedEx Tracking Number 831473797319

Carrier's Copy — Sender's Copy

From Please print and press hard.

Date 12-14-01 Sender's FedEx Account Number 1617-0991-3

Sender's Name J. Crocker Phone (505) 662-7300

Company WASHINGTON GROUP INTERNATIONAL

Address 2237 TRINITY DR BLDG 2 Dept./Floor/Suite/Room

City LOS ALAMOS State NM ZIP 87544

2 Your Internal Billing Reference
First 24 characters will appear on invoice.

3 To
Recipient's Name Don Husker Phone (865) 482-6497

Company Env. Tech Dev. Center

Address 1570 Bear CK Rd Dept./Floor/Suite/Room
To "HOLD" at FedEx location, print FedEx address. We cannot deliver to P.O. boxes or P.O. ZIP codes.

City Kingston State TN ZIP 37763

Try online shipping at fedex.com

By using this Airbill you agree to the service conditions on the back of this Airbill and in our current Service Guide, including terms that limit our liability.

Questions? Visit our Web site at fedex.com
or call 1.800.Go.FedEx® 800.463.3339.

0192554275

4a Express Package Service — Packages up to 150 lbs. Delivery commitment may be later in some areas.

- [ ] FedEx Priority Overnight — Next business morning
- [ ] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day — Second business day
- [ ] FedEx Express Saver — Third business day
- [ ] NEW FedEx Extra Hours — Later drop-off with next business afternoon delivery for select locations

FedEx Envelope rate not available. Minimum charge: One-pound rate

4b Express Freight Service — Packages over 150 lbs. Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation: _____

5 Packaging — * Declared value limit $500

- [ ] FedEx Envelope*
- [ ] FedEx Pak* — Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak
- [ ] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling — Include FedEx address in Section 3.

- [ ] SATURDAY Delivery — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] HOLD Weekday at FedEx Location — NOT Available for FedEx First Overnight
- [ ] HOLD Saturday at FedEx Location — Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- [ ] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 _____ x _____ kg

Dangerous Goods (incl. Dry Ice) cannot be shipped in FedEx packaging or with FedEx Extra Hours service.

- [ ] Cargo Aircraft Only

7 Payment Bill to: Enter FedEx Acct. No. or Credit Card No. below.

- [ ] Sender — Acct. No. in Section 1 will be billed.
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check

FedEx Acct. No. / Credit Card No. Exp. Date

Total Packages | Total Weight | Total Declared Value† $ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details.

FedEx Use Only

8 Release Signature Sign to authorize delivery without obtaining signature.

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

447

Attachment 4

IT Benchscale Treatability Study Report

IT CORPORATION

A Member of The IT Group

TECHNOLOGY APPLICATIONS LABORATORIES PROJECT REPORT

Stabilization of the Contaminated Tuff and Sediment at the Los Alamos National Laboratory

prepared by:

IT Corporation
Knoxville, Tennessee

prepared for:

Washington Group International, Inc.
5555 Greenwood Plaza Boulevard, Suite 100
Englewood, CO 80111

Revision 1

May 2002

C:\MY DOCUMENTS\LANL STABILIZATION\REPORT\LANL STAB REPORT REV 1.DOC

Revision No: 1
Date: 05/30/02

TECHNOLOGY APPLICATIONS LABORATORIES PROJECT REPORT

For:

Washington Group International, Inc.

IT Project No. 831775
Revision 1

Approved by: _____ Date: 5/30/02
IT Project Manager

TABLE OF CONTENTS

LIST OF TABLES ..... **II**

LIST OF ACRONYMS ..... **II**

EXECUTIVE SUMMARY **1**

1.0 PROJECT DESCRIPTION **2**

1.1 BACKGROUND 2
1.2 EQUIPMENT 3
1.3 MATERIALS 3
1.4 FACILITIES 4
1.5 SAMPLE TRANSPORTATION 4
1.6 SAMPLE CHAIN-OF-CUSTODY 4
1.7 SAMPLE LABELING 5

2.0 STUDY AND TEST OBJECTIVES **6**

2.1 OBJECTIVES 6
2.2 STUDY PERFORMANCE STANDARDS 6

3.0 TEST OBSERVATIONS AND RESULTS **8**

3.1 SAMPLE CHARACTERIZATION TESTING 8
3.2 STABILIZATION FORMULATION DEVELOPMENT 12
3.3 PERFORMANCE TESTING 12
3.4 SEQUENTIAL EXTRACTION TESTING 23

4.0 CONCLUSIONS AND RECOMMENDATIONS **27**

4.1 UNTREATED MATERIAL CHARACTERIZATION 27
4.2 S/S TESTING 27
4.3 FULL-SCALE S/S TREATMENT 29

Appendix A – Geotechnical Testing Report
Appendix B – Performance Testing Reports
Appendix C – SEP Testing Reports

LIST OF TABLES

Table 2.1 Anticipated Performance Criteria for the LANL S/S Treated Material

Table 3.1 Description of the Six Tuff Samples for Geotechnical Testing

Table 3.2 Description of the Eight Sediment Samples for Geotechnical Testing

Table 3.3 Geotechnical Testing of LANL Tuff and Sediment Samples

Table 3.3 Physical Characterization of the Tuff and Sediment Geotechnical Composite Samples

Table 3.4 Particle Size Distribution of the Tuff and Sediment Geotechnical Composite Samples

Table 3.5 Grout Design Mixes for the LANL Tuff and Sediment Materials

Table 3.6 Performance of the LANL Sediment Formulations

Table 3.7 Performance of the LANL Tuff Formulations

Table 3.8 Performance of the LANL Soil 564 ("Hot Soil") Formulations

Table 3.9 Performance of the LANL Tuff/Sediment Formulations

Table 3.10 Sequential Extraction of Cesium from Untreated and Treated LANL Materials

Table 3.11 Sequential Extraction of Strontium from Untreated and Treated LANL Materials

LIST OF ACRONYMS

APHIS	Animal and Plant Health Inspection Services
ANS	American Nuclear Standards
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
cpm	counts per minute
CHP	Chemical Hygiene Plan
DOE	Department of Energy
DOT	U.S. Department of Transportation
ETDC	Environmental Technology Development Center
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Air

IA	Interim Action
IT	IT Corporation
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restrictions
NPDES	National Pollution Discharge Emission Standards
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PC	Portland Cement
PPE	Personal Protective Equipment
ppm	parts per million
psi	pounds per square inch
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
SEP	Sequential Extraction Procedure
SOP	Standard Operating Procedure
SRPAR	Tennessee State Regulations for Protection Against Radiation
S/S	Stabilization/Solidification
TCLP	Toxicity Characteristic Leaching Procedure
TDRH	Tennessee Division of Radiological Health
TDL	Technology Development Laboratory
UCS	Unconfined Compressive Strength
UTS/UHC	Universal Treatment Standards/Underlying Hazardous Constituents
WGI	Washington Group International, Inc.
WMP	Waste Management Plan

EXECUTIVE SUMMARY

TA-21 is the former plutonium processing facility at LANL. At TA-21, PRS 21-011(k) was the outfall for industrial wastewater from Building TA-21-257, the new industrial wastewater treatment plant. The wastewater treated at Building TA-21-257 consisted of liquids remaining after plutonium extraction. An interim action (IA) was conducted at PRS 021-011(k) site in 1996 and 1997, removing a significant portion of the radionuclide source term and installing storm water control measures as a best management practice (BMP). A corrective measure for the remaining tuff and sediment at the PRS 21-011(k) site is under consideration.

The purpose of this corrective measure is to return the site to a condition safe for human recreational use and to be acceptable from an ecological risk evaluation perspective. The tuff and sediment at the PRS 21-011(k) site was exposed to treated liquid radioactive waste effluent for a number of years. Radionuclides of concern in the treated effluent included: Cs-137, Sr-90, Pu-239, and Am-241. The cesium and strontium are the most prevalent contaminants with trace and localized "hot spots" of the heavier isotopes. In-situ stabilization/solidification (S/S) of the tuff and sediment material is required to reduce the mobility of the radiological contaminants of concern and to produce a durable and relatively impervious treated material.

A stabilization treatability study was conducted on the sediment, tuff, soil, and sediment/tuff material from PRS 21-011(k) site. The objective of this study was to develop S/S mix designs for the contaminated tuff and sediment material. Formulation development testing on the tuff, sediment, soil, and tuff/sediment composite materials involved eight formulations involving Portland cement, bentonite, and soluble silicates in various combinations. Performance testing was conducted on these formulations to determine if the treated material met the anticipated performance criteria.

The Portland cement (low)/bentonite (low) formulation should be used for the full-scale S/S treatment. This formulation met all the performance criteria for the stabilized material with the tuff and sediment/tuff composite materials and should meet all the performance criteria for the sediment and Soil 564 material with increased curing time. No other formulation had such consistent performance on all of the materials.

The SEP testing on untreated materials indicated that Cs-137 would not be considered potentially mobile in the soil environment or bioavailabile, while the Sr-90 would be considered potentially mobile and bioavilable. The stabilization treatment would alter condition of the Cs-137, but would reduce both the potential mobility and bioavailability of the Sr-90.

1.0 PROJECT DESCRIPTION

1.1 BACKGROUND

TA-21 is the former plutonium processing facility at LANL. TA-21 began plutonium operations in 1945 and ceased operations in 1978. At TA-21, PRS 21-011(k) was the outfall for industrial wastewater from Building TA-21-257, the new industrial wastewater treatment plant. This plant began operations in 1967 and treated wastes from DP West and DP East until the early 1990's. The wastewater treated at Building TA-21-257 consisted of liquids remaining after plutonium extraction. The treatment process in Building TA-21-257 mixed the raw waste with lime, ferric sulfate, and coagulant aids. The waste was then pumped to a flocculator and on to a settling tank. Settled effluent was pumped through a pressure filter and sampled to verify treatment. If the effluent was determined to be adequately treated, it was pumped to two final effluent holding tanks (presumably tanks TA-21-112 and TA-21-113). From tanks TA-21-112 and TA-21-113, the wastewater was piped northeast toward DP Canyon and discharged on the north side of DP Mesa. This wastewater contained a variety of radioactive and chemical constituents.

PRS 21-011(k) was investigated by the ER Project in 1992 and 1993 and reported on in 1995 in the Final Draft for the OU 1106 Addendum to Phase 1B, 1C Report. The initial radiation survey and soil sampling performed at PRS 21-011(k) in FY92 indicated the presence of radionuclide contamination. Additional soil sampling and a radiation survey were performed during the FY93 field season to further define the extent of contamination found in FY92. An interim action (IA) plan was prepared in 1996. The IA was conducted in 1996 and 1997, and reported on in the Interim Action Report for Potential Release Site 21-011(k) 1997.

The objectives of the IA were to remove a significant portion of the radionuclide source term and install storm water control measures as a best management practice (BMP). The results of a post-excavation radiological survey indicate that the soil activity was reduced from greater than 500,000 counts per minute (cpm) to less than 100,000 cpm over the entire upper drainage area. The 100,000 cpm is equivalent to between 400 and 500 pCi/g. In addition, storm water controls were installed in 1997 and upgraded in August 1999.

Soil excavated from PRS 21-011(k) during the 1996 IA (390 cubic yards) was characterized in the field to document that it contained greater than 100,000 cpm of contamination. It was then transported to Area G for disposal.

A corrective measure for the remaining tuff and sediment at the PRS 21-011(k) site is under consideration. The purpose of this corrective measure is to return the site to a condition safe for human recreational use and to be acceptable from an ecological risk evaluation perspective. The tuff and sediment at the PRS 21-011(k) site was exposed to treated liquid radioactive waste effluent for a number of years. Radionuclides of concern in the treated effluent included: Cs-137, Sr-90, Pu-239, and Am-241. The cesium and strontium are the most prevalent contaminants with trace and localized "hot spots" of the heavier isotopes. In-situ S/S of the tuff and sediment material is required to reduce the mobility of the radiological contaminants of concern and to produce a durable and relatively impervious treated material.

1.2 EQUIPMENT

The equipment used in the laboratory-scale S/S treatability testing included:

- 5 quart planetary mixer,
- Stainless steel mixing bowls,
- 3"x6" right cylinder plastic molds,
- 2"x4" right cylinder plastic molds,
- Stainless steel spatulas,
- helical mixer,
- Unconfined compressive strength test frame and load cell,
- Sieves,
- Permeameter,
- Triaxial cells,
- Laboratory balances, and
- Graduated cylinders.

1.3 MATERIALS

The reagents used during the laboratory-scale S/S treatability testing included:

- Type I Portland cement,
- Sodium bentonite, and
- Type N soluble silicates.

The personnel protective equipment used during the treatability study includes:

- Nitrile gloves,
- Tyvek coveralls, and
- Tyvek boot covers.

1.4 FACILITIES

IT conducted the laboratory-scale S/S treatability testing at it's Technology Development Laboratory (TDL) in Knoxville, TN. Geotechnical testing on the tuff and sediment samples and the S/S treated materials were conducted at IT's Environmental Technology Development Center (ETDC) in Oak Ridge, TN.

The TDL, at 304 Directors Drive, Knoxville, TN 37923, is the main facility for performing bench-scale treatability studies and sample chemical analyses. This facility maintains a Radioactive Materials License from the State of Tennessee and operates under the treatability exemption in 40 CFR 261.4.

The ETDC at 1570 Bear Creek Road, Oak Ridge, TN 37831, houses the Geotechnical Laboratory. The TDL utilizes this facility. ETDC maintains a Radioactive Materials License and operates under the treatability exemption.

Both facilities have an U.S. Dept. of Agriculture Animal and Plant Health Inspection Services (APHIS) agreement for the importation of foreign and domestic soils. Both facilities are monitored by a security company. Access to each facility is strictly controlled.

Treatability studies and other activities were performed under the relevant permits, licenses, or exemptions.

1.5 SAMPLE TRANSPORTATION

Washington Group International, Inc. (WGI) coordinated with LANL for the collection of four 5-gallon buckets of the contaminated tuff and four 5-gallon buckets of the sediment material. The tuff sample buckets contained material less than 3-inches in diameter. WGI also arranged for a licensed shipper to transfer the soils from LANL to IT's ETDC.

Upon receipt at the ETDC, the samples were each be given a unique sample number and logged into the ETDC sample inventory system. The unique sample number was used to track materials such as samples, test-residues, test products and reagents throughout the project.

1.6 SAMPLE CHAIN-OF-CUSTODY

A strict chain of custody record was maintained for all samples received at the TDL in Knoxville, Tennessee or the ETDC in Oak Ridge, Tennessee. Sample transfers external to the treatability facility were accompanied by an IT combined Analysis Request and Chain of Custody Record. Samples transferred to the treatability analytical department or Geotechnical

Laboratory were also accompanied by an Analysis Request and Chain of Custody Record. Copies of all Analysis Request and Chain of Custody Records are maintained in the project file.

1.7 SAMPLE LABELING

The samples collected by WGI each had a unique sample identification which described or related to specific information about the sample, including at a minimum, description of sample, date of collection, name of sample collector, and an indication of hazards associated with the sample.

Samples generated by the TDL in the course of testing were noted in laboratory notebooks with a description of the sample and a sample number or designation. The sample number applied to the sample included the laboratory notebook number followed by the notebook page number on which the sample is described and designated, and in turn followed by the sample designation, as described below.

laboratory notebook no. - notebook page no. - sample number or designation

For example, a stabilized sample designated as sample number 3 on page 36 of laboratory book number 1610 had the following sample number:

1610-36-3.

2.0 STUDY AND TEST OBJECTIVES

2.1 OBJECTIVES

The purpose of this study was to perform bench-scale (laboratory-scale) testing to develop soil S/S mix designs for the contaminated tuff and sediment material. A S/S grout mix design was required, as appropriate, for both the tuff and sediment materials. The grout mix developed and recommended during this task will be used for in-situ stabilization/solidification.

Formulation development testing on the tuff and sediment materials involved eight formulations involving Portland cement, bentonite, and soluble silicates in various combinations.

2.2 STUDY PERFORMANCE STANDARDS

The primary goal of the S/S treatment is to minimize the mobility of the radionuclides. S/S is a performance-based remedial approach since it does not reduce the total mass of the radionuclides and cannot in itself achieve concentration-based remedial objectives. The anticipated performance standards for the S/S treatment of the tuff and sediment are given in Table 2-1

Table 2.1 Anticipated Performance Criteria for the LANL S/S Treated Material

Parameter	Criteria	Standard Test Method
Unconfined Compressive Strength at 14 days Cure	>50 psi	ASTM D 2166
Unconfined Compressive Strength at 28 days Cure	>50 psi	ASTM D 2166
Hydraulic Conductivity at 28 days Cure	<1x10E-06 cm/sec	ASTM D 5084
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	ANS 16.1 modified
Temperature at Core and Surface	<100 °F	ASTM C 1064
pH	>10.0	ASTM D 4972
Bleed Fluid	<0.5%	ANS 55.1 or EPA 9095
Volume Increase	<50%	None
Freeze/Thaw Durability	<15% loss	ASTM D4842
Initial Set Time	> 6 hours	ASTM C 191
Final Set Time	< 180 days	ASTM C 191
False Set	Prohibited	ASTM C 191
Flash Set	Prohibited	ASTM C 191
Reactivity	Non-reactive	SW-846 Method 1040
Ignitability	>140°C	SW-846 Method 1050

3.0 TEST OBSERVATIONS AND RESULTS

3.1 SAMPLE CHARACTERIZATION TESTING

The tuff containers were opened and the contaminated tuff was dumped into a three foot wide by six foot long stainless steel metal tray. Tuff pieces greater than 1/2-inch in diameter were size-reduced with a 5 kg drop hammer. Six geotechnical samples of the tuff were collected (Table 3.1). An attempt was made to select samples which represent the variability of geotechnical and physical properties present in the tuff. The remaining contaminated tuff material was transferred to a 30-gallon plastic container and mixed using a double helical mixer until it was visually uniform.

Table 3.1 Description of the Six Tuff Samples for Geotechnical Testing

Geotechnical Composite	Description
Tuff #1	Moist aggregates of tuff material
Tuff #2	Random 10 point composite of the tuff material
Tuff #3	Darker colored aggregates of tuff material
Tuff #4	Random 10 point composite of the tuff material
Tuff #5	Lighter colored tuff material
Tuff #6	Whitish tuff material

A similar sampling and homogenization procedure was conducted on the containers of the sediment material. Six geotechnical samples of the sediment were collected (Table 3.2). The sediment containers for Soil 564 and Soil 554 sampling locations were individually sampled and homogenized. Geotechnical samples of these two sediment materials were also collected.

Six samples of the tuff material and eight samples of the sediment material were analyzed for grain size distribution (ASTM D422), Atterburg limits (ASTM D4138), moisture content (ASTM D2216), and bulk density (ASTM D5057) to determine the extent of variability of these parameters throughout each material (Tables 3.3 and 3.4).

The geotechnical testing indicated that the size-reduced tuff composite samples were dry, non-plastic, gravelly sand in nature. The moisture contents varied from 14% to 20% on a dry weight basis. The non-plastic nature of the tuff material indicated that the material handling properties will not be adversely impacted under high moisture conditions. The particle size distribution was consistent across the tuff geotechnical composite samples, with moderate levels of silt and little clay contents. The limited variability in the tuff geotechnical composites suggests that it should have consistent material handling properties.

Table 3.2 Description of the Eight Sediment Samples for Geotechnical Testing

Geotechnical Composite	Description
Sediment #1	Moist aggregates of sediment material
Sediment #2	Drier and lighter colored aggregated sediment material
Sediment #3	Moist and lighter colored aggregated sediment material
Sediment #4	Drier and darker colored sediment material
Sediment #5	Moist and darker colored sediment material
Sediment #6	Random 10 point composite of the sediment material
Sediment #7	Random 10 point composite of sample Soil 564 ("hot soil")
Sediment #8	Random 10 point composite of sample Soil 554

Table 3.3 Physical Characterization of the Tuff and Sediment Geotechnical Composite Samples

Soil Fraction	Moisture Content (% dwb[1])	Liquid Limit	Plastic Limit	Plasticity Index	Wet Density (lb/ft^3)
		Moisture Content (%)			
Tuff #1	14.5	NP[2]	NP	NP	71.4
Tuff #2	18.5	NP	NP	NP	72.9
Tuff #3	12.3	NP	NP	NP	77.8
Tuff #4	20.0	NP	NP	NP	71.9
Tuff #5	14.5	NP	NP	NP	71.3
Tuff #6	14.5	NP	NP	NP	74.5
Sediment #1	14.3	28	27	1	71.0
Sediment #2	5.7	27	27	0	66.2
Sediment #3	7.4	26	26	0	70.3
Sediment #4	5.1	NP	NP	NP	72.9
Sediment #5	6.4	23	25	-2	72.9
Sediment #6	6.9	25	26	-1	71.2
Sediment #7	17.2	32	36	-4	74.9
Sediment #8	5.7	38	39	-1	66.2

[1] determined on a dry weight basis
[2] NP = non-plastic

Table 3.4 Particle Size Distribution of the Tuff and Sediment Geotechnical Composite Samples

Particle Size Fraction	Tuff #1	Tuff #2	Tuff #3	Tuff #4	Tuff #5
	Percent Solids by Weight				
Gravel	17.1	24.2	22.5	24.7	31.5
Sand	56.6	52.1	52.7	51.7	49.6
Silt	23.1	20.2	20.9	20.4	17.1
Clay	3.3	3.4	3.8	3.2	1.8
Particle Size Fraction	Tuff #6	Sediment #1	Sediment #2	Sediment #3	Sediment #4
	Percent Solids by Weight				
Gravel	34.9	3.2	2.4	1.0	0.4
Sand	46.3	52.9	34.3	41.1	48.5
Silt	17.0	33.8	60.9	44.8	41.6
Clay	1.9	10.1	12.4	13.2	9.4
Particle Size Fraction	Sediment #5	Sediment #6	Sediment #7	Sediment #8	
	Percent Solids by Weight				
Gravel	2.8	1.5	2.7	7.8	
Sand	47.7	43.6	61.0	47.4	
Silt	38.9	44.4	27.0	38.8	
Clay	10.6	10.5	9.2	6.0	

The geotechnical testing on sediment composite samples (Sediment 1 through Sediment 6) indicated that the sediment was dry, loam or sandy loam soil. The moisture contents varied from 5% to 7% on a dry weight basis. Low plasticity index of the sediment composite material confirmed its sandy nature. Therefore, the material handling properties of the sediment material should not be adversely affected by high moisture conditions. The particle size distribution was consistent across the sediment composite samples, with moderate levels of silt and low clay contents. The limited variability in the sediment geotechnical composite samples suggests that it should have consistent material handling properties.

The geotechnical testing results for the Soil 564 ("hot soil") and Soil 554 composite samples indicate that these materials are similar in nature to the sediment material. The Soil 564 material did have a higher moisture content (17%) and greater portion of sand-sized particles in its particle size distribution, as compared to the sediment composite samples. These materials would have similar material handling properties to the sediment.

3.2 STABILIZATION FORMULATION DEVELOPMENT

Stabilization formulation development was conducted on the sediment composite, the tuff composite, Soil 564 ("hot soil") sample, and a 60/40 blend of the sediment/tuff composites. The stabilization formulation involved treating 4-kg aliquots of soil with four S/S grout mix designs (Table 3.5). Each formulation was mixed in a planetary mixer. A 4,000 g aliquot of reactor soil was added to the mixing bowl. The dry reagents were weighed out, blended, and mixed into an equal weight of water. Soluble silicate or an additional 200 mL of water was then added to the reagent slurry. The reagent slurry was then added to the soil in the mixing bowl. Additional water was added to the formulation as necessary to produce a moist soil-like consistency. The soil and reagent slurry was mixed at 30-40 rpm for 1 to 2 minutes to produce a homogeneous treated material.

The treated material was poured into appropriate molds for performance testing, vibrated to remove air pockets, and capped to minimize moisture loss. The molded material was allowed to cure at ambient laboratory temperature (approximately 72°F) in sealed coolers.

3.3 PERFORMANCE TESTING

The cured treated material was subjected to the performance criteria testing listed in Table 3.6 through 3.9. The testing listed in these tables was the same as anticipated performance criteria (Table 2.1) for the final stabilized waste material.

Table 3.5 Grout Design Mixes for the LANL Tuff and Sediment Materials

Contaminated Material	Formulation ID Number	Soil (g)	Portland Cement (g)	Sodium Bentonite (g)	Sodium Silicate (g)	Water (g)
Tuff	110814	4,000	400	125	0	975
	110815	4,000	400	0	100	900
	110816	4,000	400	125	50	1025
	110817	4,000	400	125	100	1025
	110818	4,000	800	250	0	1300
	110819	4,000	800	0	200	1050
	110820	4,000	800	250	100	1300
	110821	4,000	800	250	200	1300
Sediment	110806	4,000	400	125	0	725
	110807	4,000	400	0	100	400
	110808	4,000	400	125	50	525
	110809	4,000	400	125	100	525
	110810	4,000	800	250	0	1050
	110811	4,000	800	0	200	800
	110812	4,000	800	250	100	1050
	110813	4,000	800	250	200	1050
Soil 564 "Hot Spot"	110823	3,000	300	93.8	0	744
	110824	1,500	150	0	37.5	300
	110825	1,500	150	46.9	18.8	345
	110826	2,500	250	78.1	62.5	628
	110827	2,500	500	156	0	940
	110828	1,500	300	0	75.3	350
	110829	1,500	300	93.8	37.6	450
	110830	2,500	500	156	125	735
Soil/Tuff Composite 60/40 (w:w)	110832	4,000	400	125	0	945
	110833	4,000	400	0	100	900
	110834	4,000	400	125	50	1026
	110835	4,000	400	125	100	1097
	110836	4,000	800	250	0	1250
	110837	4,000	800	0	200	1100
	110838	4,000	800	250	100	1250
	110839	4,000	800	250	200	1350

Table 3.6 Performance of the LANL Sediment Formulations

Parameter	Criteria	Formulation Number			
		110806	110807	110808	110809
Unconfined Compressive Strength at 14 days Cure (psi)	>50	165	63	36	39
Unconfined Compressive Strength at 28 days Cure (psi)	>50	177	65	28	29
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	4.2x10E-07	1.4x10E-06	4.5x10E-04	1.6x10E-05
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.3/10.5	11.3/10.8	11.2/10.8	11.0/10.3
Temperature at Core and Surface (°F)	<100	25	25	25	25
pH (s.u.)	>10.0	11.9	12.1	12.0	12.0
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-19.5	-17.3	-9.19	-10.9
Freeze/Thaw Durability (% loss)	<15	25.6	SC[1]	SC	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

[1] SC = Sample crumbled

Table 3.6 (cont.) Performance of the LANL Sediment Formulations

Parameter	Criteria	Formulation Number			
		110810	110811	110812	110813
Unconfined Compressive Strength at 14 days Cure (psi)	>50	348	286	184	277
Unconfined Compressive Strength at 28 days Cure (psi)	>50	583	320	275	347
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	2.9x10E-06	9.4x10E-09	8.5x10E-07	5.0x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.0/10.3	11.0/10.2	10.9/10.2	10.4/10.1
Temperature at Core and Surface (°F)	<100	25	25	24	24
pH (s.u.)	>10.0	12.0	12.5	12.3	12.4
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-4.42	-9.14	-1.27	0.59
Freeze/Thaw Durability (% loss)	<15	9.63	26.7	SC[1]	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

[1] SC = Sample crumbled

Table 3.7 Performance of the LANL Tuff Formulations

Parameter	Criteria	Formulation Number			
		110814	110815	110816	110817
Unconfined Compressive Strength at 14 days Cure (psi)	>50	332	251	323	326
Unconfined Compressive Strength at 28 days Cure (psi)	>50	370	426	376	427
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.9x10E-06	1.8x10E-05	5.8x10E-06	3.4x10E-07
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.9/10.3	11.2/10.6	10.5/10.6	10.2/10.7
Temperature at Core and Surface (°F)	<100	23	23	22	22
pH (s.u.)	>10.0	12.1	12.3	12.2	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-13.3	-14.6	-10.4	-8.12
Freeze/Thaw Durability (% loss)	<15	5.51	6.81	7.97	7.53
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

Table 3.7 (cont.) Performance of the LANL Tuff Formulations

Parameter	Criteria	Formulation Number			
		110818	110819	110820	110821
Unconfined Compressive Strength at 14 days Cure (psi)	>50	705	578	386	578
Unconfined Compressive Strength at 28 days Cure (psi)	>50	771	736	612	467
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.9x10E-07	6.8x10E-07	5.7x10E-06	2.3x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.2/10.4	11.0/10.9	10.6/10.7	11.1/10.7
Temperature at Core and Surface (°F)	<100	22	22	22	23
pH (s.u.)	>10.0	12.1	12.4	12.3	12.4
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	0.59	-3.62	5.08	10.4
Freeze/Thaw Durability (% loss)	<15	4.60	5.69	8.02	13.11
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

Table 3.8 Performance of the LANL Soil 564 "Hot Soil" Formulations

Parameter	Criteria	Formulation Number			
		110823	110824	110825	110826
Unconfined Compressive Strength at 14 days Cure (psi)	>50	209	316	293	291
Unconfined Compressive Strength at 28 days Cure (psi)	>50	224	281	299	290
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.5x10E-06	2.2x10E-06	9.2x10E-06	1.8x10E-06
Leachability Indices for Gross Alpha/ Nonvolatile Beta	>8.0	11.0/10.0	11.0/10.3	10.8/10.0	11.2/10.3
Temperature at Core and Surface (°F)	<100	23	23	23	24
pH (s.u.)	>10.0	12.2	12.4	12.3	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-14.1	-16.7	-11.6	-9.48
Freeze/Thaw Durability (% loss)	<15	6.32	nd	nd	19.7
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

nd = not determined

Table 3.8 (cont.) Performance of the LANL Soil 564 "Hot Soil" Formulations

Parameter	Criteria	Formulation Number			
		110827	110828	110829	110830
Unconfined Compressive Strength at 14 days Cure (psi)	>50	489	499	422	410
Unconfined Compressive Strength at 28 days Cure (psi)	>50	449	356	473	347
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	2.1x10E-06	1.4x10E-06	1.1x10E-07	7.0x10E-09
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	11.0/9.9	10.9/10.0	11.0/9.8	11.0/10.2
Temperature at Core and Surface (°F)	<100	23	23	23	24
pH (s.u.)	>10.0	12.2	12.5	12.3	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	5.90	-5.28	3.89	4.07
Freeze/Thaw Durability (% loss)	<15	7.96	nd	nd	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

Table 3.9 Performance of the LANL Sediment/Tuff Composite Formulations

Parameter	Criteria	Formulation Number			
		110832	110833	110834	110835
Unconfined Compressive Strength at 14 days Cure (psi)	>50	215	183	181	186
Unconfined Compressive Strength at 28 days Cure (psi)	>50	276	291	223	209
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	3.4x10E-06	2.0x10E-06	1.1x10E-05	2.1x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.4/9.2	11.4/9.1	10.7/9.1	10.6/9.2
Temperature at Core and Surface (°F)	<100	25	24	24	25
pH (s.u.)	>10.0	11.9	12.2	12.1	12.2
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-15.1	-14.2	-9.98	-6.96
Freeze/Thaw Durability[1] (% loss)	<15	9.50	11.93	11.97	18.0
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

[1] Freeze/Thaw Durability - only through 10 cycles

Table 3.9 (cont.) Performance of the LANL Sediment/Tuff Composite Formulations

Parameter	Criteria	Formulation Number			
		110836	110837	110838	110839
Unconfined Compressive Strength at 14 days Cure (psi)	>50	509	245	297	252
Unconfined Compressive Strength at 28 days Cure (psi)	>50	607	355	380	244
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	4.7x10E-07	2.6x10E-06	4.5x10E-05	2.6x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.4/8.9	10.5/9.0	10.4/9.1	10.2/9.1
Temperature at Core and Surface (°F)	<100	25	23	23	23
pH (s.u.)	>10.0	12.3	12.5	12.5	12.7
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	0.18	0.23	5.74	9.34
Freeze/Thaw Durability[1] (% loss)	<15	7.34	14.89	10.42	27.4
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	No	No	No	No
Flash Set	Prohibited	No	No	No	No

[1] Freeze/Thaw Durability - only through 10 cycles

All of the formulations had initial set times of greater than 6 hours and less the 180 hours. There were no signs of false or flash set for any of the formulations. This suggests that the treated material will remain soil-like for at least 6 hours and provide an adequate window for obtaining and preparing samples for verification testing during full-scale treatment activities. There was no bleed water associated with the stabilized material from any of the formulations. This indicates that the treated material will not produce free liquids during full-scale placement and initial setting.

The low cement formulations (110806 through 110809) for the sediment material did not develop unconfined compressive strength (UCS) as quickly as the higher cement formulations (110810 through 110813). Two of the low cement formulations (110808 and 110809) did not attain the 50 psi UCS criteria, while all of the other sediment formulations exceeded the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The highest hydraulic conductivities were for sediment formulations 110808 and 110809. The UCS and hydraulic conductivity results for these formulations suggest that the amount of water added in these formulations was not sufficient.

The ANS 16.1 modified leach indices for the sediment formulations exceeded the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH levels of the sediment formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5

Several of the sediment formulations crumbled during freeze/thaw durability testing and others exceeded the 15% weight loss criteria. Only formulation 110810 met the freeze/thaw durability criteria of less than 15% weight loss.

All of the formulations for the tuff material developed UCS quickly and exceeded the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the tuff formulations exceeded the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH levels of the tuff formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5. None of the formulations for the tuff material crumbled during freeze/thaw durability testing and all met the criteria of less than 15% weight loss.

All of the formulations for the Soil 564 "hot soil" material developed UCS quickly and exceeded the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or

below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the Soil 564 formulations exceeded the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH levels of the Soil 564 formulations were all above the criteria of 10.0, and were generally below the RCRA hazardous characterization level of 12.5. Due to limited sample volume, freeze/thaw durability testing was only conducted on a 4 of the 8 Soil 564 formulations. One of the Soil 564 formulations (110830) crumbled during freeze/thaw durability testing and another (110826) exceeded the 15% weight loss criteria. Formulations 110823 and 110827 met the freeze/thaw durability criteria of less than 15% weight loss.

All of the formulations for the sediment/tuff composite material developed UCS quickly and exceeded the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the sediment/tuff composite formulations exceeded the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH levels of the sediment/tuff composite formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5. None of the formulations on the tuff material crumbled during freeze/thaw durability testing and most met the criteria of less than 15% weight loss.

Volume increase for each formulation was calculated using the equation:

$$Volume\ Increase\ (\%) = [\{(BD_i/BD_f)*(1+tmr)\}-1]*100$$

where BD_i was the average bulk density of the material from geotechnical testing, BD_f was the bulk density reported for the 28 day UCS testing on the treated material from the formulation, and tmr is the total mix ratio [mix ratio = (weight reagent)/(weight material) of all reagents, including water, used in the formulation. The low volume increases for most of the stabilization formulations indicate that the treated material is more compact than the untreated material. This is due to the water added as part of the stabilization formulations. Up to the optimum moisture content, the densities of soil materials increase with increased moisture content. The added water increases the moisture content and allows for more efficient compaction of the treated material.

3.4 SEQUENTIAL EXTRACTION TESTING

Sequential extraction procedures (SEPs) are used to characterize metal immobilization mechanisms and to aid in estimating bioavailability. Numerous SEPs have been developed to characterize metal fractionation into various binding phases. While these procedures cannot be used to identify the actual form of a given metal in a soil, they are useful in grouping metals into

phases or fractions. The distribution of the metal among the SEP fractions can provide information on the likely binding phases and characterize the relative stability of metal immobilization processes.

The SEP approach used for untreated and treated sediment, tuff and sediment/tuff composite samples is a form of the consensus method for extraction being calibrated by the National Institute of Standards and Technology. The following description identifies the metal immobilization phase with a description of how the metals present in each of these phases is extracted during the SEP process.

Exchangeable Phase - metals that are reversibly sorbed to soil minerals, amorphous solids, and/or organic material by electrostatic forces. These forces are overcome by using a concentrated electrolyte leach (1M $MgCl_2$) that displaces the metal ions from solid surfaces. The metals solubilized by this extraction are analyzed to determine metals present in the exchangeable phase.

Acid Extractable Phase- metals that are irreversibly sorbed or otherwise bound in carbonate minerals. These forces are overcome by using a mild acid (1M NaOAc solution in 25% HOAc at pH 5) to dissolve carbonate minerals. The metals solubilized by this extraction are analyzed to determine metals associated with the carbonate phase or other metals that are solubilized by acidic conditions.

Reducible Phase - metals bound to hydroxides of iron, manganese, and/or aluminum and easily solubilized oxides. These forces are overcome by using a solution of 0.1 M hydroxylamine hydrochloride in pH 2 nitric acid to reduce the soil or sediment sample. The metals solubilized by this extraction are analyzed to determine metals associated with the reducible phase.

Organic Phase - metals bound to soil organic matter (e.g., stable humus). These forces are overcome by oxidizing the soil organic matter with a pH 8.5, 5% NaOCl solution. The metals solubilized by this extraction are analyzed to determine metals associated with the organic matter.

Oxidizeable Phase – metals bound to sulfide minerals. The forces binding metals to sulfides are overcome by leaching with a 4M HNO_3 solution at 95°C. The metals solubilized in this extraction are analyzed to determine metals associated with sulfide minerals.

Residual Phase - The remaining metals are distributed between silicates, phosphates, and refractory oxides. SW846 Method 3052 (HNO_3/HCL/HF acid mixture) is used to extract the remaining metals.

Metals associated with the ion exchangeable and acid extractable fractions are considered to be potentially mobile in the soil environment and bioavailable if ingested. Metals associated with the reducible fraction are considered to be immobile in the soil environment, but potentially bioavailable as they can be extracted in acidic stomach fluids. Metals associated with the organic, oxidizable, and residual fractions are considered to be immobile in the soil and biologically unavailable if ingested.

The results of the SEP testing are summarized in Tables 3.10 and 3.11.

Table 3.10 Sequential Extraction of Cesium from Untreated and Treated LANL Materials

Phase	Sediment Composite		Tuff Composite		Sediment/Tuff Composite		
	Untreated	Formulation 110820	Untreated	Formulation 110812	Untreated	Formulation 110836	Formulation 118038
	Fraction of Cs-137 in each Phase (%)						
Exchangeable	<0.2	3.7	0.6	<0.2	0.3	1.0	1.0
Acid Extractable	<0.2	8.9	1.9	2.1	1.9	2.3	2.7
Reducible	0.9	2.3	1.2	<0.2	<0.2	0.5	1.0
Organic	2.5	11.9	4.4	3.3	3.2	4.8	4.4
Oxidizable	44.2	4.7	41.3	57.5	48.4	52.1	55.1
Residual	52.4	68.5	50.6	37.1	46.1	39.3	35.9

Table 3.11 Sequential Extraction of Strontium from Untreated and Treated LANL Materials

Phase	Sediment Composite		Tuff Composite		Sediment/Tuff Composite		
	Untreated	Formulation 110820	Untreated	Formulation 110812	Untreated	Formulation 110836	Formulation 118038
	Fraction of Sr-90 in each Phase (%)						
Exchangeable	55.4	23.1	71.3	22.7	63.6	34.7	34.1
Acid Extractable	1.3	16.8	4.6	11.9	<0.2	15.1	18.0
Reducible	1.4	9.4	3.7	7.9	2.1	7.6	8.2
Organic	1.3	2.7	0.5	2.1	0.9	2.2	2.2
Oxidizable	1.3	3.1	0.9	2.5	1.1	4.3	2.5
Residual	39.3	44.8	19.0	52.9	32.4	36.2	35.0

The SEP results for the untreated materials suggests that the Cs-137 in the sediment, tuff, or sediment/tuff materials would not be considered potentially mobile in the soil environment or bioavailable, as most of the Cs-137 is associated with the oxidizable and residual phases. The sr-90 in the sediment, tuff, and sediment/tuff materials would be considered potentially mobile in

the soil environment or bioavailable, as most of the Sr-90 in these materials is associated with the exchangeable phase.

The SEP results indicate that the stabilization treatment on sediment material appears to increase the portion of Cs-137 associated with the exchangeable, acid extractable, reducible phases, while reducing the portion associated with the oxidizable fraction, as compared to the untreated material. These changes could result in the Cs-137 in the sediment being slightly more potentially mobile in the soil environment or slightly more bioavailable after stabilization treatment. The stabilization treatment on the sediment material appeared to decrease the portion of Sr-90 associated with the exchangeable fraction and to increase the portions associated with the acid extractable, reducible, organic, oxidizable, and residual phases. These changes should result in the Sr-90 in the sediment material being less potentially mobile in the soil environment and less bioavailable after stabilization treatment.

The stabilization treatment on the tuff material appeared to increase the portion of Cs-137 associated with the residual phase and to increase the portion associated with the oxidizable phase, as compared to the untreated tuff material. These changes in the Cs-137 distribution would not affect the potential mobility and bioavailability after stabilization. The stabilization treatment of the tuff material appeared to decrease the portion of Sr-90 associated with the exchangeable fraction and to increase the portions associated with the acid extractable, reducible, organic, oxidizable, and residual phases. These changes should result in the Sr-90 in the tuff material being less potentially mobile in the soil environment and less bioavailable after stabilization treatment.

The stabilization treatment on the sediment/tuff composite material appeared to have no effect on the distribution of Cs-137 among the various phases, as compared to the untreated sediment/tuff composite material. Therefore, the stabilization treatment of the sediment/tuff material would not alter the potential mobility and bioavailability of the Cs-137. The stabilization treatment of the sediment/tuff material appeared to decrease the portion of Sr-90 associated with the exchangeable fraction and to increase the portions associated with the acid extractable, reducible, organic, oxidizable, and residual phases. These changes should result in the Sr-90 in the sediment/tuff material being less potentially mobile in the soil environment and less bioavailable after stabilization treatment. Comparison between the SEP results for the Portland cement (high)/bentonite (high) and Portland cement (high)/bentonite (high)/silicate (mod) indicates that the silicate has little effect on the distribution of the Cs-137 and Sr-90 among the various phases. Most of the redistribution is probably due to reaction with the Portland cement in the stabilization formulation.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 UNTREATED MATERIAL CHARACTERIZATION

4.1.1 Tuff Composite Material

The geotechnical testing of six samples from the size-reduced tuff composite samples indicated that the tuff material is a dry, non-plastic, gravelly sand in nature. The non-plastic nature of the tuff material indicates that the material handling properties will not be adversely impacted under high moisture conditions. The limited variability in the tuff geotechnical composites suggests that it should have consistent material handling properties.

4.1.2 Sediment Composite Material

The geotechnical testing on sediment composite samples indicated that the sediment is dry, loam or sandy loam soil. Low plasticity index of the sediment composite material confirms its sandy nature. Therefore, the material handling properties of the sediment material should not be adversely affected by high moisture conditions. The limited variability in the sediment geotechnical composite samples suggests that it should have consistent material handling properties.

4.1.3 Soil 564 and Soil 554 Samples

The geotechnical testing results for the Soil 564 ("hot soil") and Soil 554 composite samples indicate that these materials are similar in nature to the sediment composite material. The Soil 564 material did have a higher moisture content (17%) and greater portion of sand-sized particles in its particle size distribution, as compared to the sediment composite samples. These materials would have similar material handling properties to the sediment material.

4.2 S/S TESTING

The bench-scale treatability testing was conducted to demonstrate how the treated material from the selected S/S grout mix designs performed with respect to the performance criteria for the final stabilized waste material. The results from the performance testing provided information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material.

4.2.1 Tuff Composite Material

With the exception of the hydraulic conductivity, the treated material from all formulations on the tuff composite material met the performance criteria (Table 2.1). The hydraulic conductivity

after 28 days of curing ranged from $1.8x10^{-5}$ to $1.9x10^{-7}$ cm/s for the treated material from the tuff composite material. The Portland cement (low)/bentonite (low)/silicate (mod) (110817), Portland cement (high)/bentonite (high) (110818), and Portland cement (high)/silicate (high) (110819) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110814) and Portland cement (high)/bentonite (high)/silicate (high) (110821) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease below the performance criteria.

4.2.2 Sediment Composite Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1).

The hydraulic conductivity after 28 days of curing ranged from $4.5x10^{-4}$ to $9.4x10^{-9}$ cm/s for the treated material from the sediment composite material. The Portland cement (low)/bentonite (low) (110806), Portland cement (high)/silicate (high) (110811), and Portland cement (high)/bentonite (high)/silicate (mod) (110812) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/silicate (mod) (110807) and Portland cement (high)/bentonite (high) (110810) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease below the performance criteria.

Several of the sediment formulations crumbled during freeze/thaw durability testing and others exceeded the 15% weight loss criteria. Only the Portland cement (low)/bentonite (low) (110810) formulation met the freeze/thaw durability criteria of less than 15% weight loss.

4.2.3 Soil 564 ("Hot Soil") Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1). The hydraulic conductivity after 28 days of curing ranged from $9.2x10^{-6}$ to $7.0x10^{-9}$ cm/s for the treated material from the Soil 564 material. The Portland cement (high)/bentonite (high)/silicate (mod) (110829), and Portland cement (high)/bentonite (high)/silicate (high) (110830) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110823), Portland cement (low)/silicate (mod) (110824), Portland cement (low)/bentonite (low)/silicate (mod) (110826), Portland cement (high)/bentonite (high) (110827) and Portland cement (high)/silicate (high) (110828) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease below the performance criteria.

Due to limited sample volume, freeze/thaw durability testing was only conducted on 4 of the 8

Soil 564 formulations. The Portland cement (low)/bentonite (low) (110823) and Portland cement (high)/bentonite (high) formulations met the freeze/thaw durability criteria of less than 15% weight loss.

4.2.4 Sediment/Tuff Composite Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1).

The hydraulic conductivity after 28 days of curing ranged from 4.5×10^{-5} to 4.7×10^{-7} cm/s for the treated material from the sediment/tuff composite material. Only the Portland cement (high)/bentonite (high) (110836) formulation met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110832), Portland cement (low)/silicate (mod) (110833), Portland cement (low)/bentonite (low)/silicate (mod) (110835), Portland cement (high)/silicate (high) (110837) and Portland cement (high)/bentonite (high)/silicate (high) (110839) were close to the 1×10^{-6} cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease below the performance criteria.

The Portland cement (low)/bentonite (low) (110832), Portland cement (low)/silicate (mod) (110833), Portland cement (low)/ bentonite (low)/silicate (low) (110834), Portland cement (high)/bentonite (high) (110836), and Portland cement (high)/bentonite(high)/silicate (mod) (110838) met the freeze/thaw durability criteria of less than 15% weight loss.

4.3 FULL-SCALE S/S TREATMENT

4.3.1 S/S Formulation

The Portland cement (low)/bentonite (low) formulation should be used for the full-scale S/S treatment. This formulation met all the performance criteria for the stabilized material with the tuff and sediment/tuff composite materials and should meet all the performance criteria for the sediment and Soil 564 material with increased curing time. No other formulation had such consistent performance on all of the materials.

4.3.2 Contaminated Material Compositing

Though the selected stabilization formulation should be adequate to treat the sediment, tuff or sediment/tuff composite material, the sediment and tuff material should be composited and stockpiled prior to beginning full-scale stabilization treatment. The sediment/tuff composite material produced the most consistent treated material during bench-scale testing and should produce the most consistent treated material during full-scale processing.

4.3.3 Process Mixing Constraints

The major process mixing constraint for the Portland cement/bentonite grout mix is that the grout mix must be thoroughly mixed with the contaminated sediment, tuff, or sediment/tuff composite material. The primary source of failure during full-scale treatment is often the lack of thorough mixing of the reagent grout and the contaminated material. The sediment and tuff are sandy loam/loam materials. While the sandy nature of the these materials make mixing of the grout and contaminated material easier, high speed, high shear mixing should be utilized for full-scale treatment. Commercially-available pugmills can provide the high speed, high shear mixing required.

Mixing by excavators or rake-like attachments on excavators may not produce the high energy, high shear mixing required to thoroughly blend the grout and the contaminated materials. Jet-grouting has been effective in sandy soils and debris, but has had incomplete or inadequate mixing results in some soils. Auger mixers, mounted either on crane bodies or excavators, may be sufficient to produce the high speed, high shear mixing required.

4.3.4 Construction Tolerances

The grout should be produced in a batch plant capable of providing an individual grout batch for stabilization batch. The weights of Portland cement and bentonite and the volume of water should be recorded for each grout batch. The weights should be controlled to within ±1% of the desired value. The metering pump for the water should also control the water addition to within ±1% of the required value. The desired weights of the Portland cement and bentonite in each grout batch should be calculated from the volume of soil to be treated in the batch, the density of the stockpiled contaminated material, and the recommended S/S formulation. The amount of water should also be determined in a similar fashion, but can be modified to adjust the viscosity of the grout to match the S/S vendor's grout pumping and handling equipment.

Each grout batch should be used within a maximum of 2 hours of batching. If a set retarder is used to prolong the time between batching and injection of the grout, testing should be conducted to determine the effect of the set retarder on the performance of the treated material.

Appendix A – Geothechnical Testing Report

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville TN 37923

January 28, 2002

This is the Certificate of Analysis for the following samples:

Project ID:	**LANL**
Project Number:	**831775**
Date Received by Lab:	December 17 and 20, 2001
Number of Samples:	Ten (10)
Sample Type:	Soil

I. Introduction/Case Narrative

Five soil samples were received by the IT Geotechnical Laboratory beginning on December 17, 2001. Five additional soil samples were received on December 20, 2001. Chain-of-custody documents were not included with the samples. Test (stabilized) specimens were issued unique identification numbers that do not correspond with the raw samples received, so laboratory sample number are not referenced on the test results sheets.

Soils were combined and stabilized by treatability staff. Soils mixes were numbered sequentially for a series of sediments and a series of tuffs. Numerous stabilized cylindrical specimens were designated for various physical tests. This certificate reports the results of sample characterization tests: particle-size distribution, Atterberg limits, moisture content, and bulk density screening.

Please see Appendix A, Sample Number Cross-Reference List; Appendix B, Analysis Results; and Appendix C, Variance/Nonconformance Reports.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

- Maintenance of all past calibration records - calibration records and certification documents of all instruments, gauges and equipment are updated routinely and maintained in the Quality Control Coordinators Quality/Operations files.

- Certified and trained personnel - all technicians are certified by the National Institute for Certification of Engineering Technicians (NICET) in geotechnical soil testing, and are trained in the application of standard laboratory procedures for geotechnical analyses as well as the quality assurance measures implemented by IT.

IV. Data Qualification

None.

Appendix A
Sample Cross-Reference List

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-9830	MD 21-01-0545	Sediment
ETDC-9831	MD 21-01-054401	Sediment
ETDC-9832	MD 21-01-0546	Sediment
ETDC-9833	MD 21-01-054901	Tuff
ETDC-9834	MD 21-01-054701	Sediment
ETDC-9839	Tuff 595	Tuff
ETDC-9840	Tuff 583	Tuff
ETDC-9841	Tuff 564	Tuff
ETDC-9842	MD 21-01-0548	Sediment
ETDC-9843	564 Soil	Sediment

Appendix B
Sample Test Results

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

SCREENING OF BULK DENSITY OF WASTE
ASTM D 5057

PROJECT NAME: LANL PROJECT NUMBER: 831775.00000000

ETDC SAMPLE NUMBER:	CLIENT SAMPLE NUMBER:	AVERAGE LENGTH, INCHES:	AVERAGE DIAMETER, INCHES:	WET WEIGHT, GRAMS:	MOISTURE CONTENT, %:	BULK DENSITY, PCF:	DRY DENSITY, PCF:
	Sediment 1	4.0020	2.0117	236.97	14.3	71.0	62.1
	Sediment 2	4.0020	2.0117	221.04	5.7	66.2	62.6
	Sediment 3	4.0020	2.0117	234.82	7.4	70.3	65.5
	Sediment 4	4.0020	2.0117	243.26	5.1	72.9	69.4
	Sediment 5	4.0020	2.0117	243.52	6.4	72.9	68.5
	Sediment 6	4.0020	2.0117	237.62	6.9	71.2	66.6
	Sediment 7	4.0020	2.0117	250	17.2	74.9	63.9
	Sediment 8	4.0020	2.0117	220.95	5.7	66.2	62.6
	Tuff 1	4.0020	2.0117	238.52	11.1	71.4	64.3
	Tuff 2	4.0020	2.0117	243.49	3.1	72.9	70.7
	Tuff 3	4.0020	2.0117	259.87	2.1	77.8	76.2
	Tuff 4	4.0020	2.0117	240.02	2.4	71.9	70.2
	Tuff 5	4.0020	2.0117	237.9	1.5	71.3	70.2
	Tuff 6	4.0020	2.0117	248.67	1.4	74.5	73.5

Moisture content calculated by ASTM D 2216 based on sample dry weight.
Bulk density is the weight of wet sample divided by the volume of the wet sample (as-received).
Dry density is the weight of the dry sample solids divided by the volume of the original sample.

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME: LANL

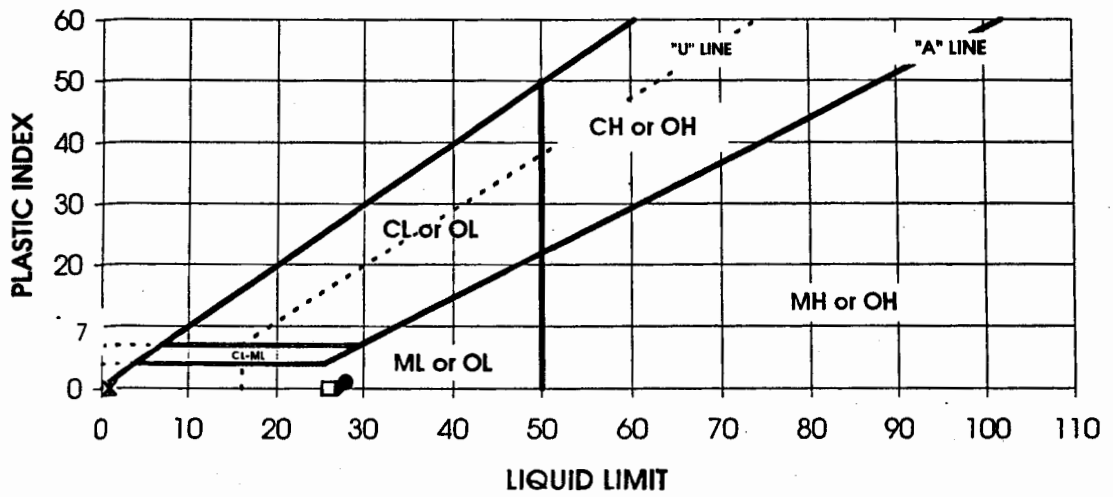
PROJECT NO. 831775.00000000

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
●	Sediment 1	28	27	1	ML
◆	Sediment 2	27	27	0	NP
□	Sediment 3	26	26	0	NP
◇	Sediment 4	NP	NP	NP	NP
+	Sediment 5	23	25	-2	NP
o	Sediment 6	25	26	-1	NP
■	Sediment 7	32	36	-4	NP
x	Sediment 8	38	39	-1	NP
▲					
★					

*NP=Nonplastic

PLASTICITY CHART



Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME: LANL

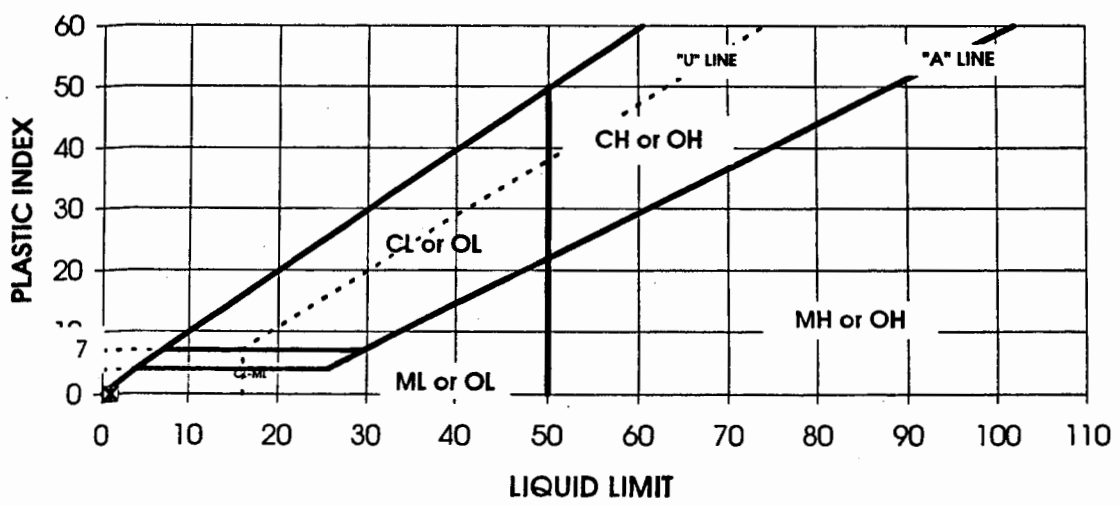
PROJECT NO. 831775.00000000

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
●	Tuff 1	NP	NP	NP	NP
◆	Tuff 2	NP	NP	NP	NP
□	Tuff 3	NP	NP	NP	NP
◇	Tuff 4	NP	NP	NP	NP
+	Tuff 5	NP	NP	NP	NP
○	Tuff 6	NP	NP	NP	NP
■					
x					
▲					
★					

*NP=Nonplastic

PLASTICITY CHART



Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #1

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 14.3%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	98.5%
	#4	4.750	96.8%
	#10	2.000	90.0%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	71.8%
	#40	0.425	60.3%
	#60	0.250	54.8%
	#100	0.149	50.4%
	#140	0.106	47.6%
	#200	0.075	43.9%

HYDROMETER ANALYSIS

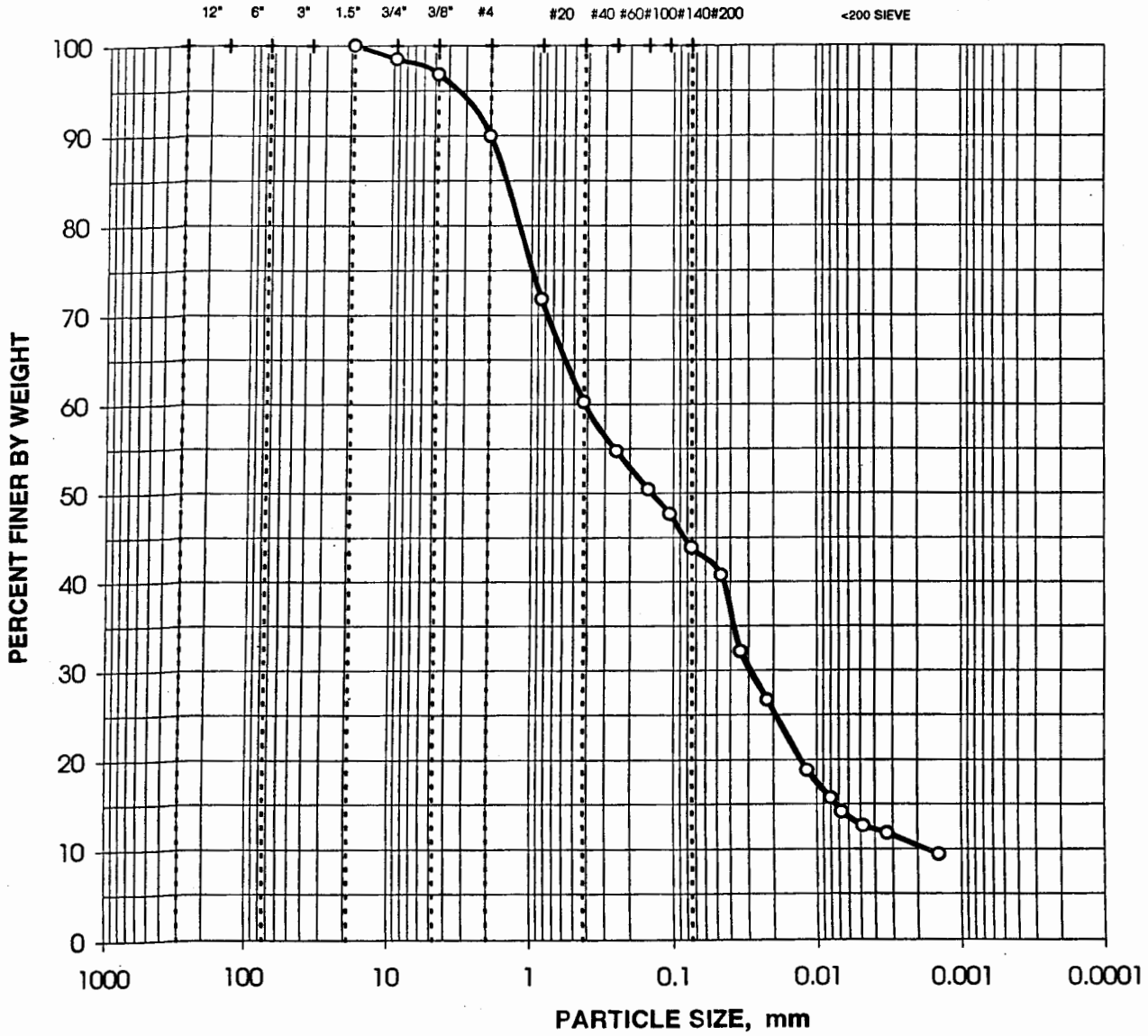
HYDROMETER	Diameter mm	Percent Finer
	0.04661	40.8%
	0.03420	32.2%
	0.02212	26.7%
	0.01170	18.8%
	0.00799	15.7%
	0.00671	14.1%
	0.00478	12.5%
	0.00328	11.8%
	0.00143	9.4%

3.2% Gravel 52.9% Sand 43.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #1

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #2

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.7%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	98.8%
	#4	4.750	97.6%
	#10	2.000	93.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.8%
	#40	0.425	78.1%
	#60	0.250	74.1%
	#100	0.149	70.5%
	#140	0.106	67.7%
	#200	0.075	63.3%

HYDROMETER ANALYSIS

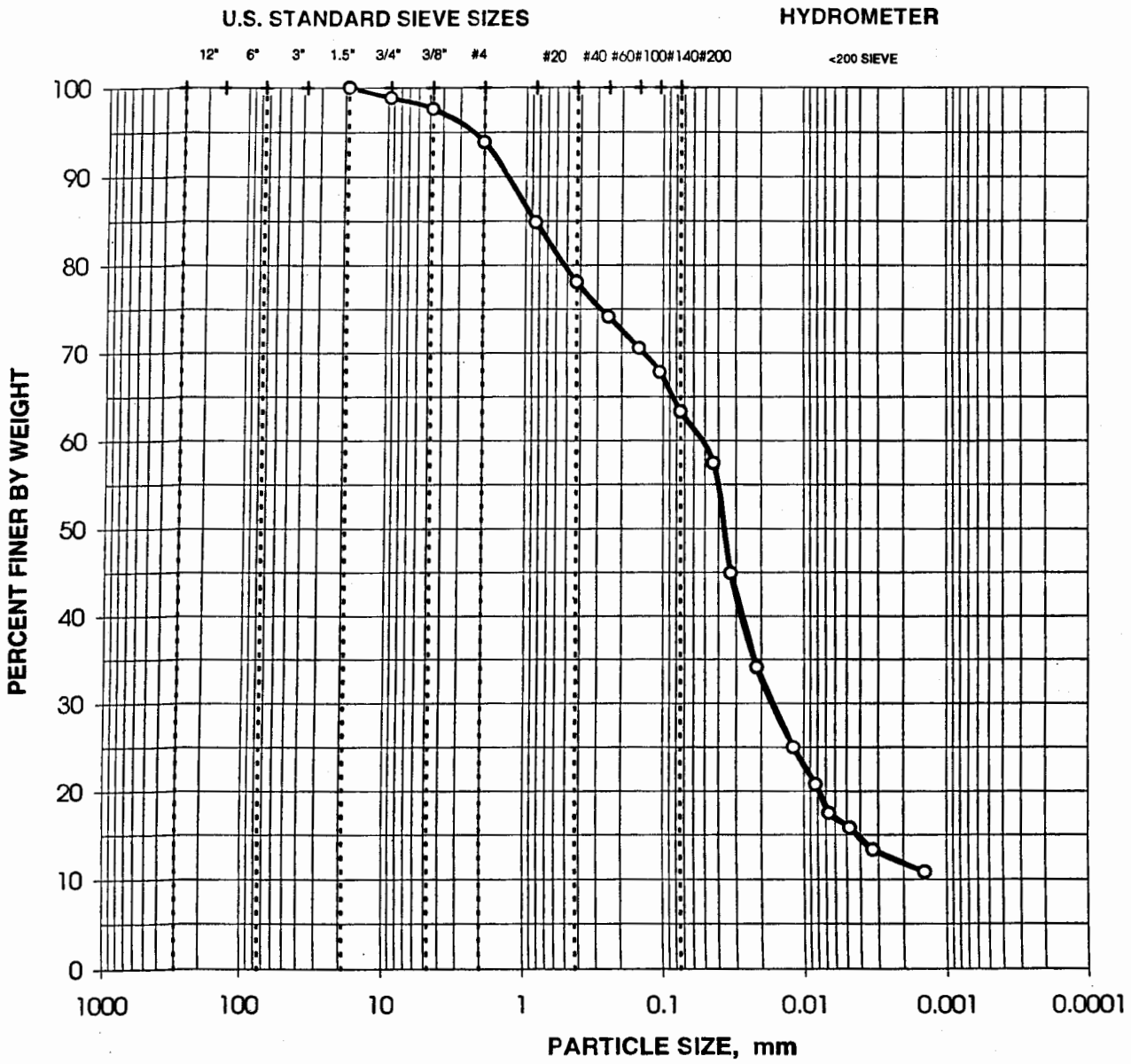
	Diameter mm	Percent Finer
HYDROMETER		
	0.04346	57.4%
	0.03266	44.9%
	0.02163	34.1%
	0.01184	25.0%
	0.00826	20.8%
	0.00666	17.5%
	0.00474	15.8%
	0.00327	13.3%
	0.00142	10.8%

2.4% Gravel 34.3% Sand 63.3% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #2

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #3

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 7.4%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.8%
	#4	4.750	99.0%
	#10	2.000	94.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.4%
	#40	0.425	75.5%
	#60	0.250	70.6%
	#100	0.149	66.4%
	#140	0.106	63.0%
	#200	0.075	58.0%

HYDROMETER ANALYSIS

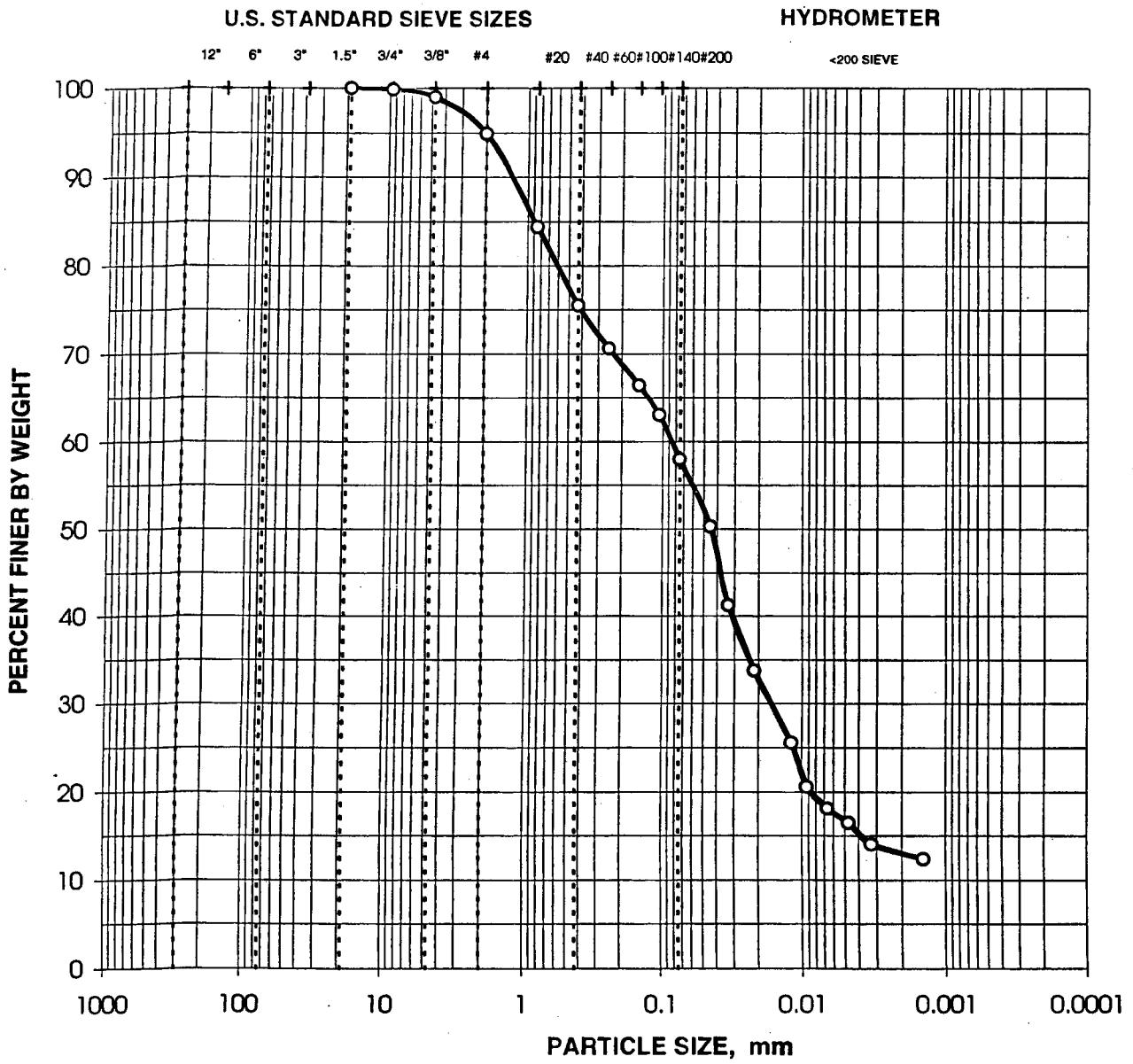
	Diameter mm	Percent Finer
HYDROMETER		
	0.04490	50.3%
	0.03311	41.2%
	0.02163	33.8%
	0.01180	25.5%
	0.00930	20.6%
	0.00664	18.1%
	0.00473	16.5%
	0.00326	14.0%
	0.00142	12.4%

1.0% Gravel 41.0% Sand 58.0% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #3

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #4

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.1%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	100.0%
	#4	4.750	99.6%
	#10	2.000	96.9%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	80.6%
	#40	0.425	67.6%
	#60	0.250	62.4%
	#100	0.149	58.7%
	#140	0.106	55.8%
	#200	0.075	51.0%

HYDROMETER ANALYSIS

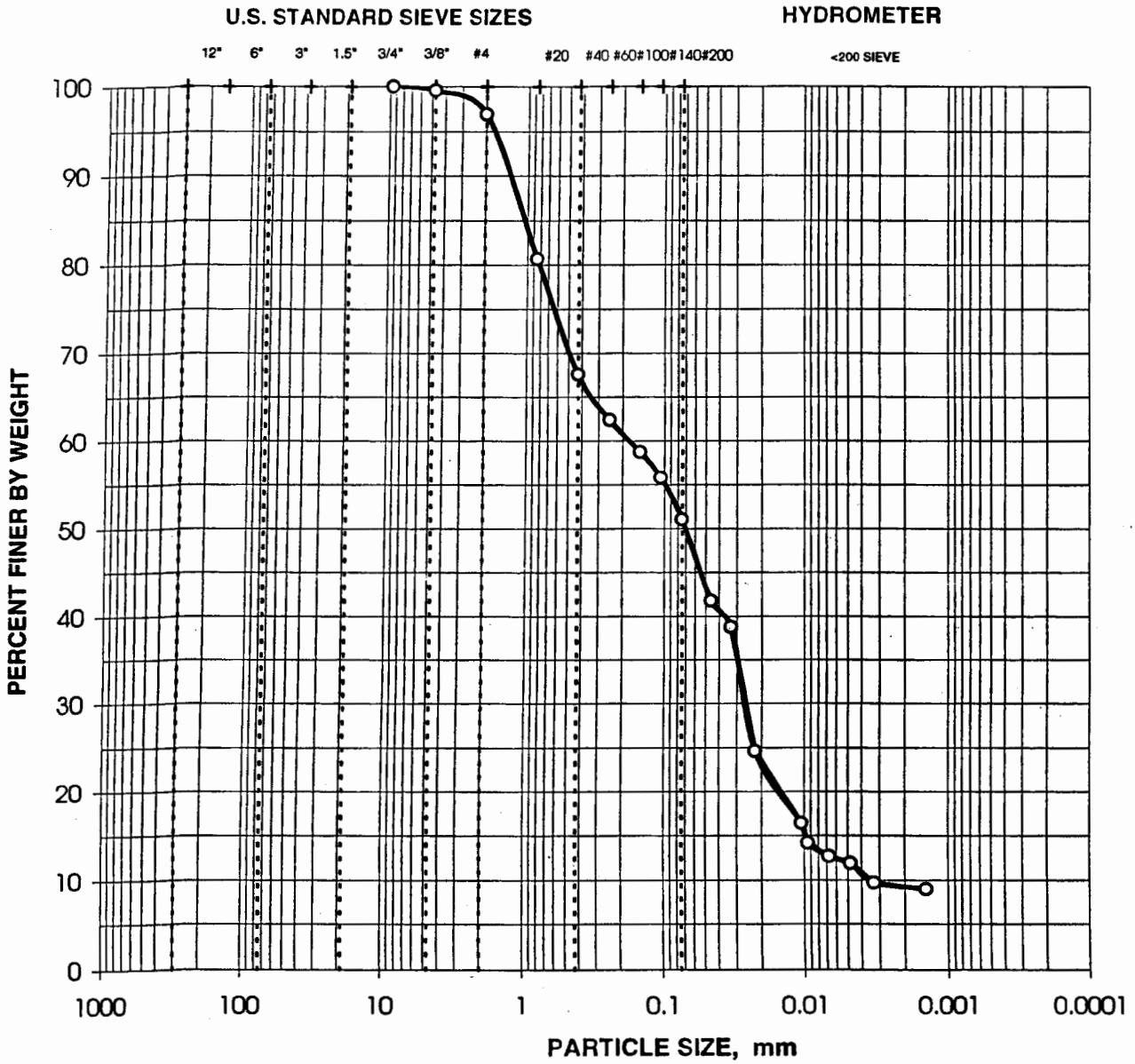
HYDROMETER	Diameter mm	Percent Finer
	0.04576	41.8%
	0.03296	38.8%
	0.02221	24.6%
	0.01049	16.4%
	0.00947	14.2%
	0.00673	12.7%
	0.00478	11.9%
	0.00328	9.7%
	0.00143	8.9%

0.4% Gravel 48.5% Sand 51.0% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #4

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #5

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 6.4%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.5%
	#4	4.750	97.2%
	#10	2.000	92.1%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	78.8%
	#40	0.425	68.1%
	#60	0.250	62.4%
	#100	0.149	57.7%
	#140	0.106	54.4%
	#200	0.075	49.5%

HYDROMETER ANALYSIS

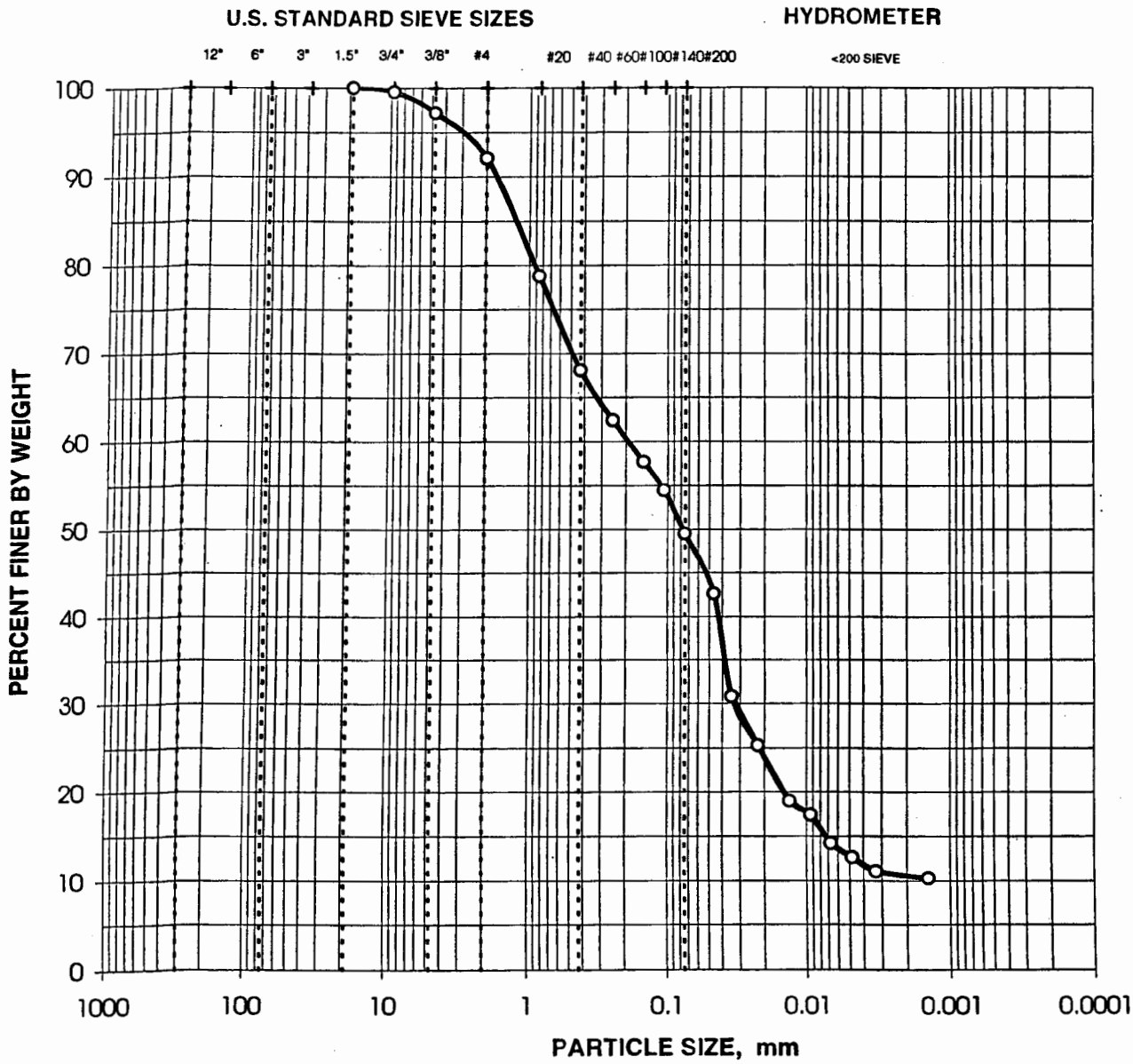
HYDROMETER	Diameter mm	Percent Finer
	0.04619	42.6%
	0.03441	30.8%
	0.02230	25.3%
	0.01317	18.9%
	0.00938	17.4%
	0.00671	14.2%
	0.00478	12.6%
	0.00329	11.1%
	0.00142	10.3%

2.8% Gravel 47.7% Sand 49.5% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #5

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #6

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 6.9%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	100.0%
	#4	4.750	98.5%
	#10	2.000	93.7%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	81.7%
	#40	0.425	72.4%
	#60	0.250	67.1%
	#100	0.149	62.5%
	#140	0.106	59.4%
	#200	0.075	54.9%

HYDROMETER ANALYSIS

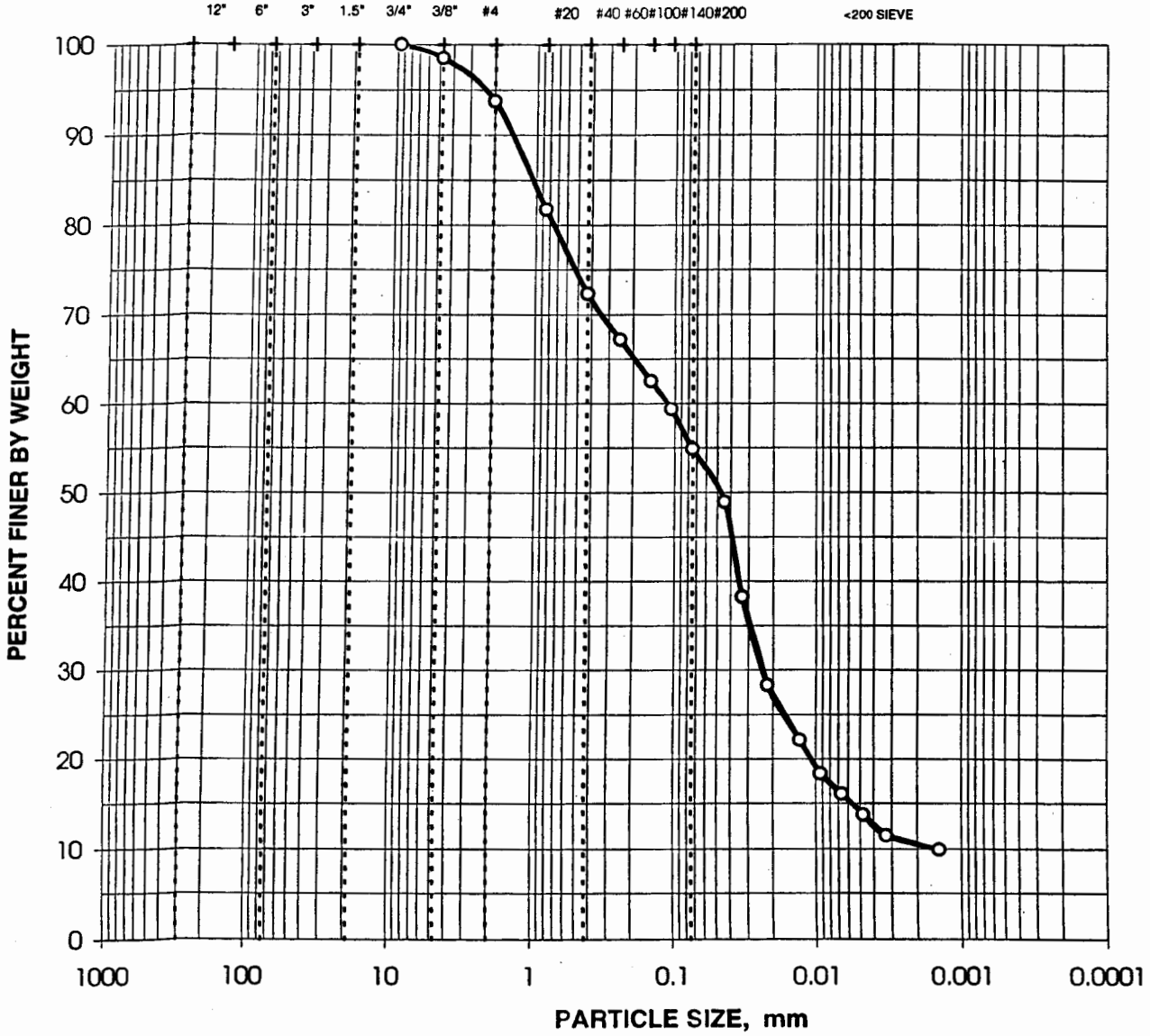
	Diameter mm	Percent Finer
HYDROMETER		
	0.04446	48.9%
	0.03311	38.2%
	0.02194	28.3%
	0.01300	22.2%
	0.00932	18.4%
	0.00666	16.1%
	0.00474	13.8%
	0.00328	11.5%
	0.00142	9.9%

1.5% Gravel 43.6% Sand 54.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #6

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #7

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 17.2%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.1%
	#4	4.750	97.3%
	#10	2.000	91.4%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	73.2%
	#40	0.425	58.8%
	#60	0.250	51.3%
	#100	0.149	45.0%
	#140	0.106	40.8%
	#200	0.075	36.2%

HYDROMETER ANALYSIS

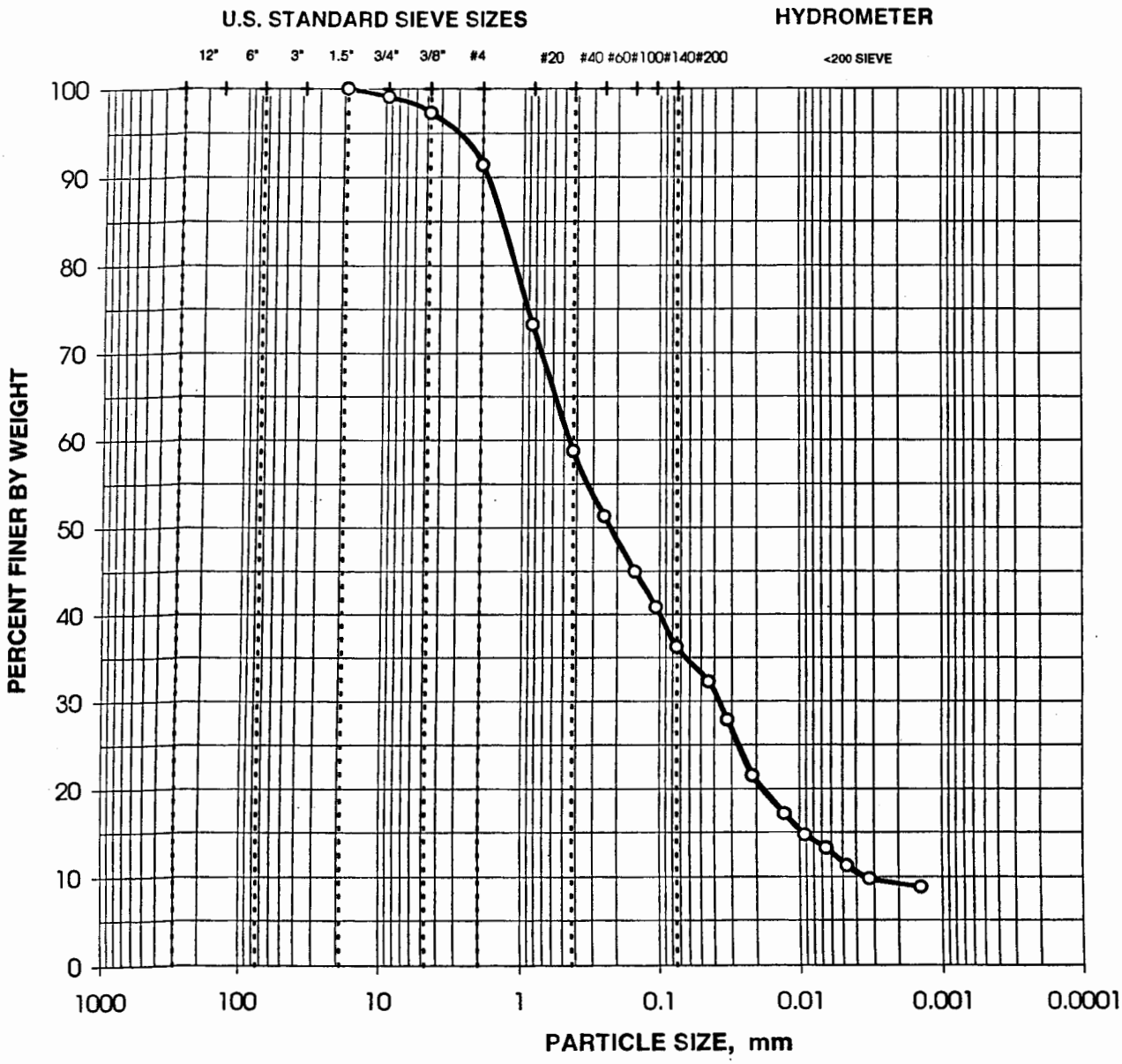
HYDROMETER	Diameter mm	Percent Finer
	0.04402	32.3%
	0.03228	27.9%
	0.02140	21.5%
	0.01275	17.1%
	0.00917	14.7%
	0.00654	13.2%
	0.00467	11.2%
	0.00324	9.8%
	0.00140	8.8%

2.7% Gravel 61.0% Sand 36.2% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #7

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #8

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.7%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	95.2%
	0.375"	9.500	95.0%
	#4	4.750	92.2%
	#10	2.000	85.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	73.4%
	#40	0.425	63.6%
	#60	0.250	58.1%
	#100	0.149	52.8%
	#140	0.106	49.0%
	#200	0.075	44.8%

HYDROMETER ANALYSIS

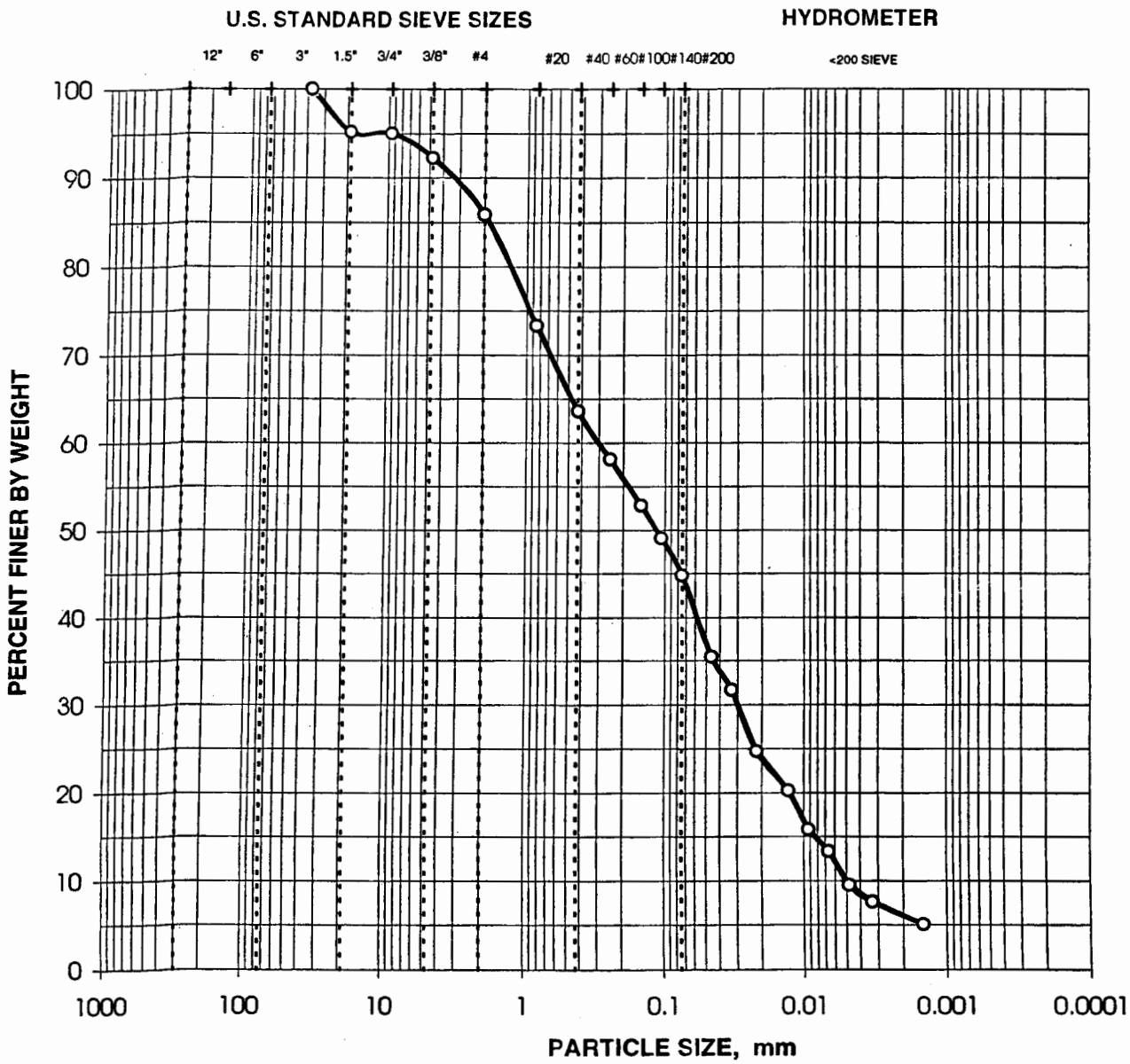
	Diameter mm	Percent Finer
HYDROMETER		
	0.04576	35.5%
	0.03311	31.7%
	0.02176	24.7%
	0.01287	20.3%
	0.00930	15.8%
	0.00666	13.3%
	0.00480	9.5%
	0.00331	7.6%
	0.00145	5.1%

7.8% Gravel 47.4% Sand 44.8% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Sediment #8

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #1

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 11.1%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.9%
	0.375"	9.500	92.6%
	#4	4.750	82.9%
	#10	2.000	72.6%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	54.7%
	#40	0.425	43.7%
	#60	0.250	38.2%
	#100	0.149	33.1%
	#140	0.106	29.9%
	#200	0.075	26.4%

HYDROMETER ANALYSIS

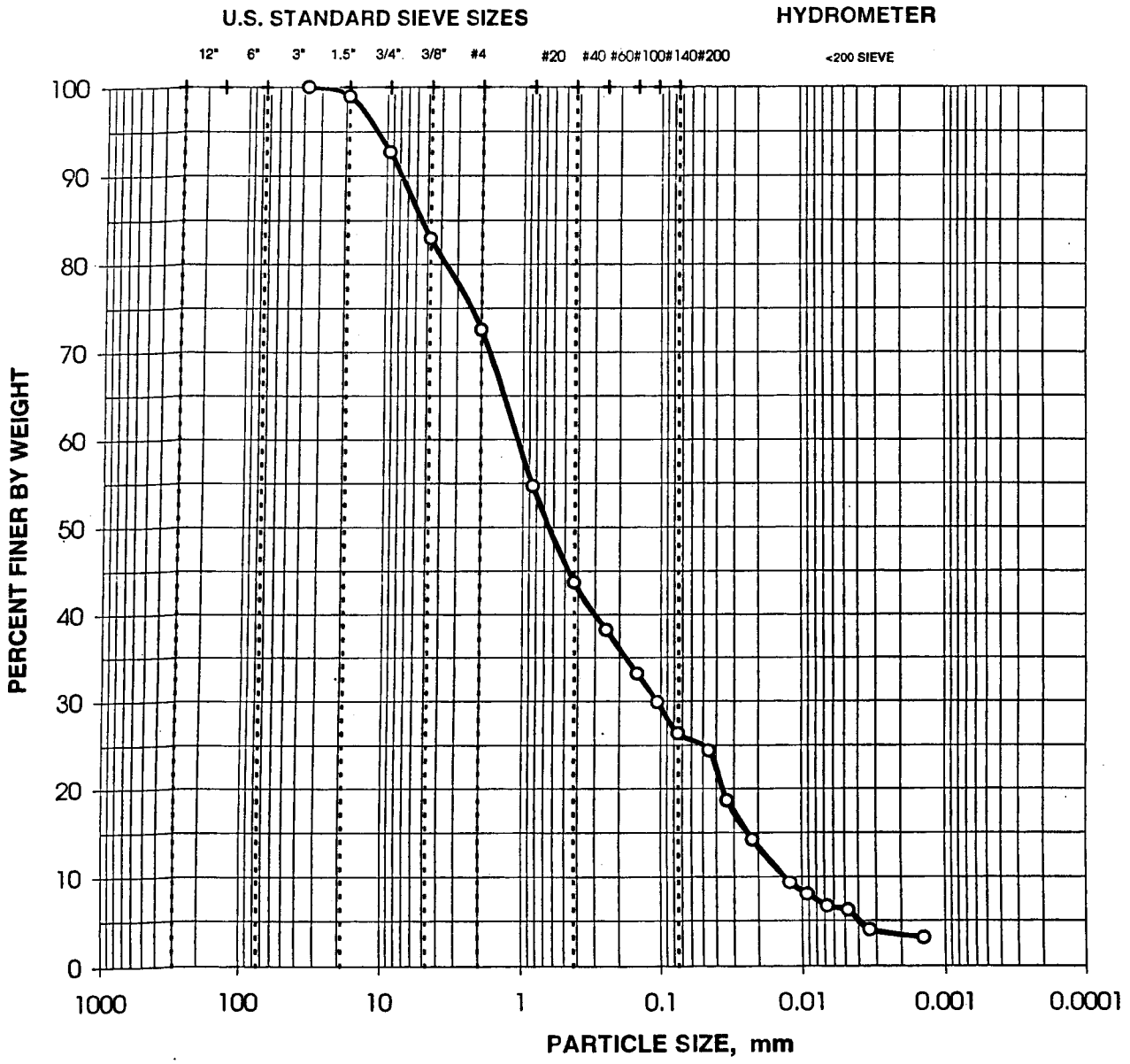
HYDROMETER	Diameter mm	Percent Finer
	0.04542	24.4%
	0.03371	18.6%
	0.02203	14.2%
	0.01201	9.3%
	0.00922	8.0%
	0.00670	6.7%
	0.00475	6.2%
	0.00334	4.0%
	0.00140	3.1%

17.1% Gravel 56.6% Sand 26.4% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #1

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #2

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 3.1%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	97.0%
	0.375"	9.500	87.6%
	#4	4.750	75.8%
	#10	2.000	63.6%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	48.4%
	#40	0.425	38.8%
	#60	0.250	34.0%
	#100	0.149	29.7%
	#140	0.106	26.8%
	#200	0.075	23.6%

HYDROMETER ANALYSIS

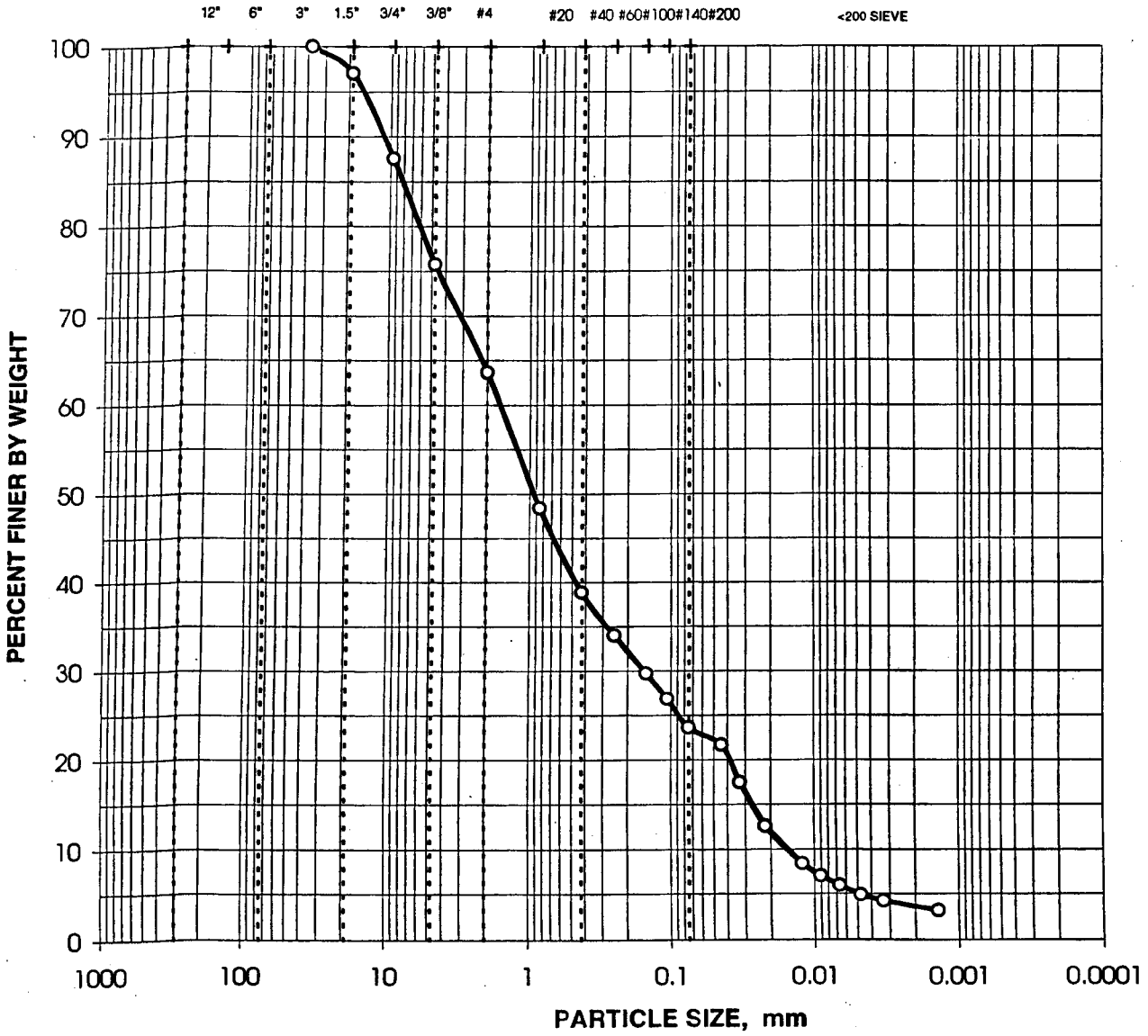
	Diameter mm	Percent Finer
HYDROMETER		
	0.04414	21.7%
	0.03270	17.5%
	0.02176	12.6%
	0.01222	8.4%
	0.00904	7.0%
	0.00665	5.9%
	0.00475	4.9%
	0.00331	4.2%
	0.00139	3.1%

24.2% Gravel 52.1% Sand 23.6% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #2

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #3

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 2.1%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	88.8%
	#4	4.750	77.5%
	#10	2.000	66.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	50.6%
	#40	0.425	40.4%
	#60	0.250	35.2%
	#100	0.149	30.7%
	#140	0.106	27.8%
	#200	0.075	24.7%

HYDROMETER ANALYSIS

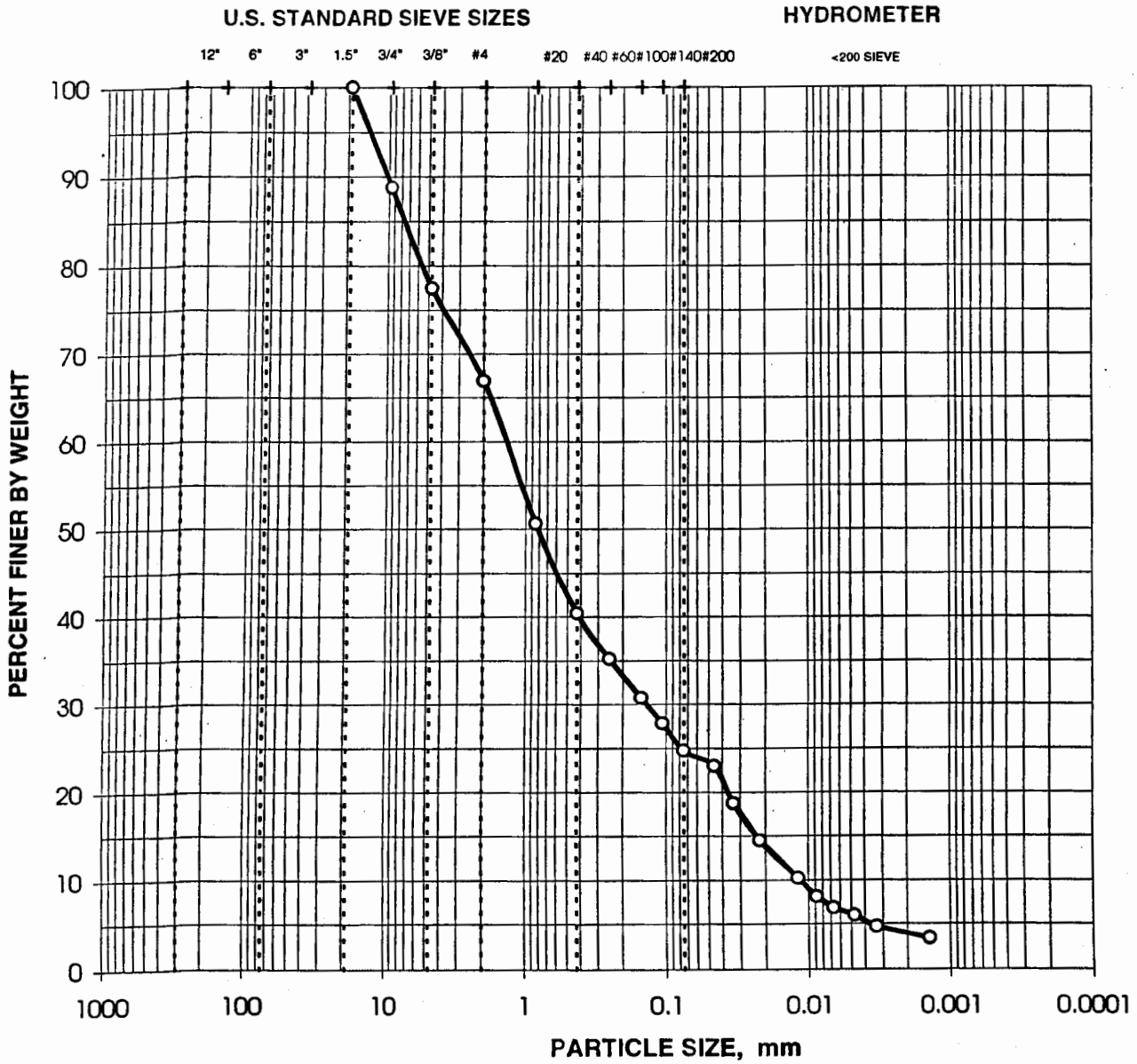
	Diameter mm	Percent Finer
HYDROMETER		
	0.04563	23.0%
	0.03343	18.8%
	0.02185	14.5%
	0.01188	10.2%
	0.00879	8.1%
	0.00668	6.8%
	0.00475	6.0%
	0.00332	4.7%
	0.00140	3.4%

22.5% Gravel 52.7% Sand 24.7% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #3

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #4

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 2.4%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	89.2%
	#4	4.750	75.3%
	#10	2.000	62.1%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	47.2%
	#40	0.425	37.9%
	#60	0.250	33.5%
	#100	0.149	29.4%
	#140	0.106	26.6%
	#200	0.075	23.6%

HYDROMETER ANALYSIS

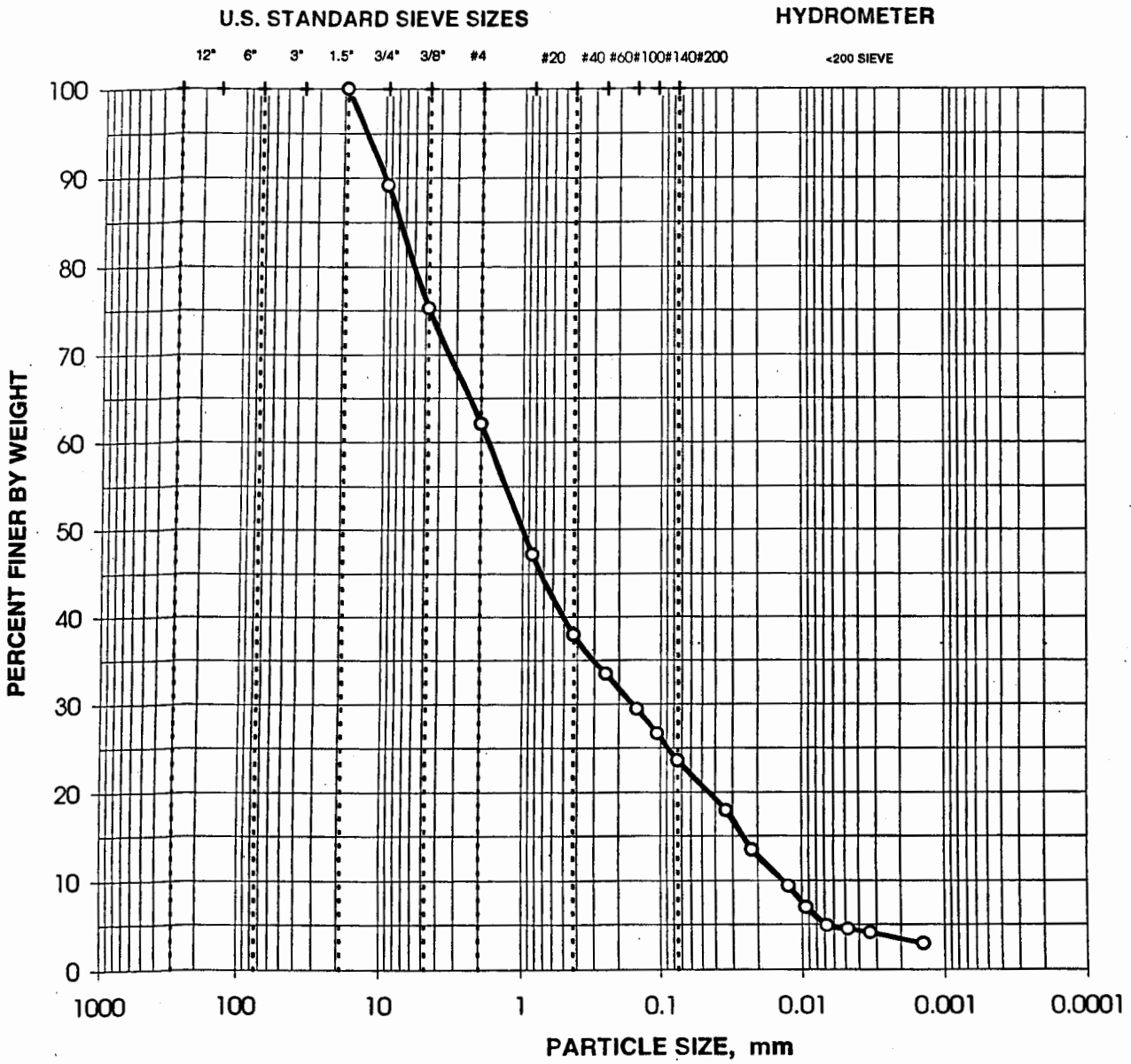
	Diameter mm	Percent Finer
HYDROMETER		
	0.03343	17.9%
	0.02194	13.4%
	0.01227	9.4%
	0.00941	6.9%
	0.00675	4.9%
	0.00479	4.5%
	0.00333	4.1%
	0.00140	2.9%

24.7% Gravel 51.7% Sand 23.6% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #4

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #5

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 1.5%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.6%
	0.375"	9.500	83.6%
	#4	4.750	68.5%
	#10	2.000	54.6%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	41.0%
	#40	0.425	32.0%
	#60	0.250	27.9%
	#100	0.149	24.1%
	#140	0.106	21.6%
	#200	0.075	18.9%

HYDROMETER ANALYSIS

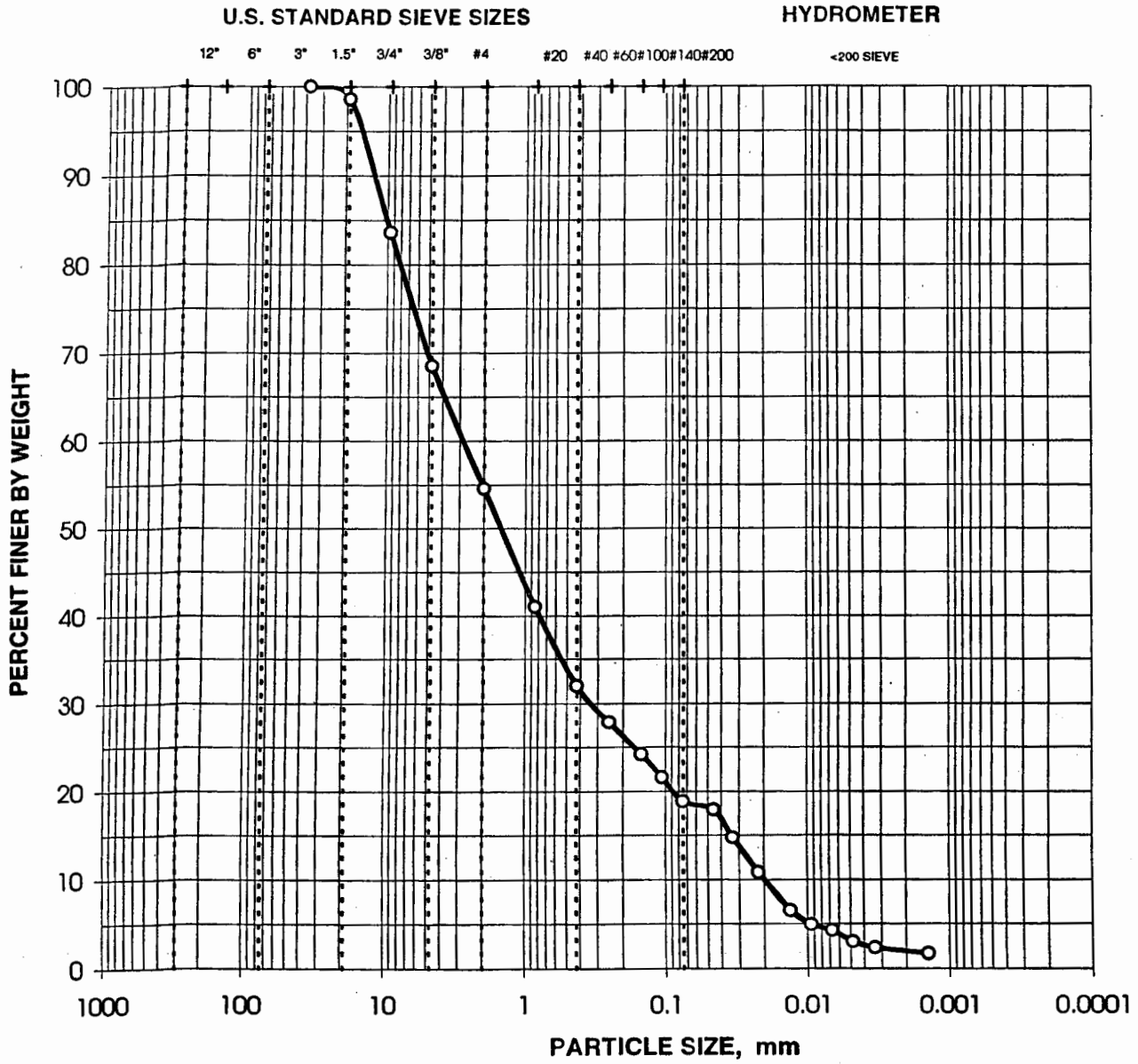
	Diameter mm	Percent Finer
HYDROMETER		
	0.04542	18.0%
	0.03328	14.7%
	0.02194	10.8%
	0.01321	6.5%
	0.00947	4.9%
	0.00670	4.2%
	0.00482	2.9%
	0.00336	2.3%
	0.00141	1.6%

31.5% Gravel 49.6% Sand 18.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #5

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #6

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 1.4%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.4%
	0.375"	9.500	81.1%
	#4	4.750	65.1%
	#10	2.000	52.5%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	38.7%
	#40	0.425	30.6%
	#60	0.250	26.9%
	#100	0.149	23.6%
	#140	0.106	21.4%
	#200	0.075	18.9%

HYDROMETER ANALYSIS

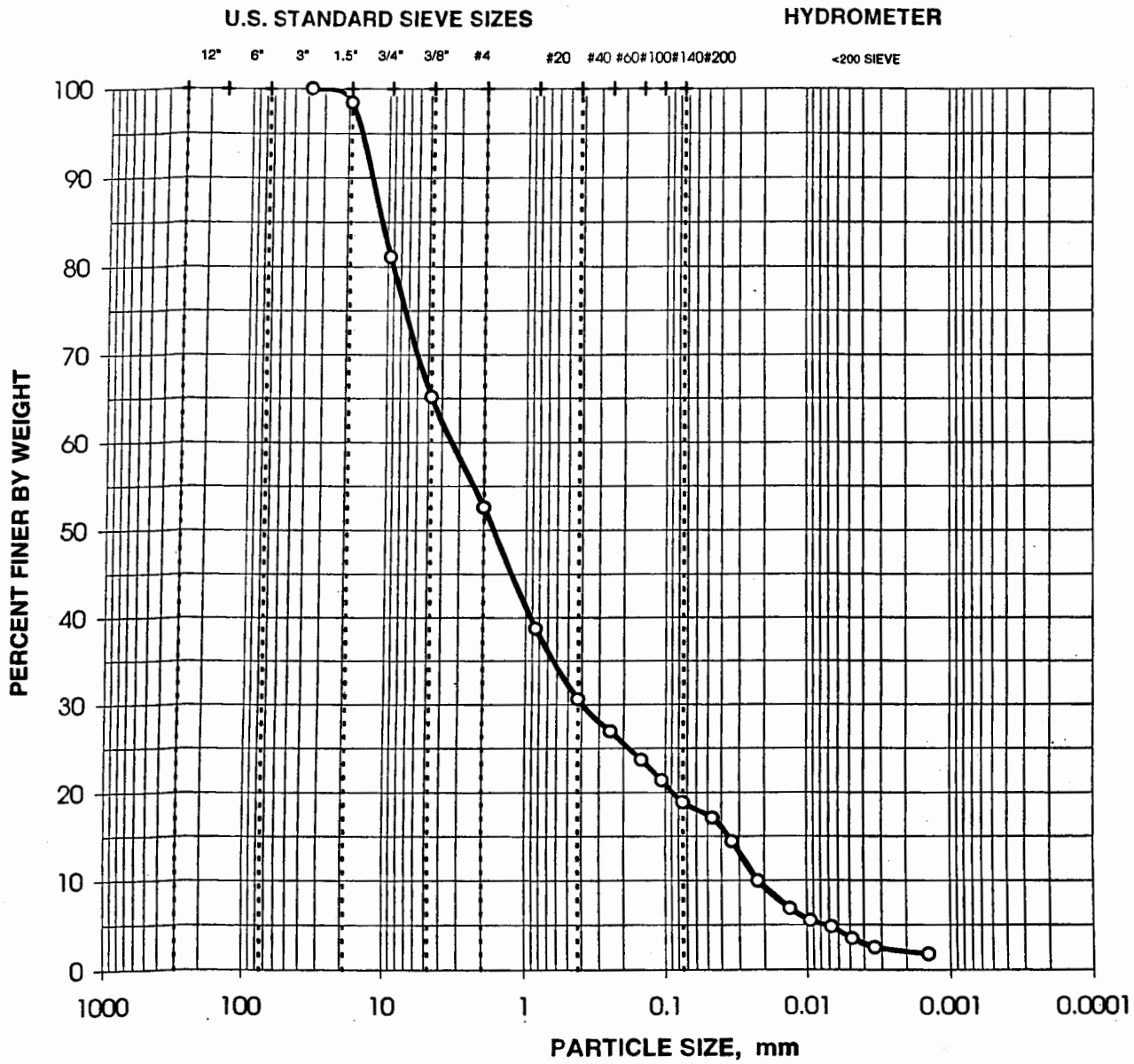
HYDROMETER	Diameter mm	Percent Finer
	0.04625	17.1%
	0.03371	14.4%
	0.02224	9.9%
	0.01321	6.9%
	0.00944	5.5%
	0.00672	4.8%
	0.00480	3.4%
	0.00336	2.4%
	0.00141	1.7%

34.9% Gravel 46.3% Sand 18.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

LANL



CLIENT SAMPLE NO.: Tuff #6

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Appendix C

Nonconformance / Variance Reports

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: LANL	Date: 1/3/02	Page 1 of 1
	Project No.: 817 831775		Report No.: ETDC-115-02-N

Nonconformance/Variance Description (include requirement violated

SAMPLE SHIPMENTS OF RAW SOIL AND TUFF RECEIVED WITHOUT CHAIN-OF-CUSTODY DOCUMENTS.

SHIPMENTS RECEIVED 12-17-01, 12-20,01
TEN SAMPLES TOTAL: MD21-01-0545, MD21-01-054401, MD21-01-0546, MD21-01-054901, MD21-01-054701, TUFF 595, TUFF 583, TUFF 564, MD21-01-0548, 564 SOIL

Identified by [signature]

Root Cause

N/A

Corrective Action (include expected completion date)

NOTIFY CLIENT

To be completed by _____ Expected Completion Date _____

Action taken to preclude recurrence

N/A

To be performed by _____ Expected Completion Date _____

Client notified (include client name, how notified, and response)

PAUL LOAR NOTIFIED VERBALLY

Notified by [signature] Date 1/3/02

Corrective action completed by _____ Date _____

Corrective action approved by

Laboratory Supervisor _____ Date _____

Project Manager [signature] Date 1/3/02

QA Comments

QAO Approval _____ Date _____

Use back of page for additional space. Attach additional pages if necessary.

Appendix B – Performance Testing Reports

Appendix B – Performance Testing Reports

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville TN 37923

March 22, 2002

This is the Certificate of Analysis for the following samples:

Project ID:	**LANL**
Project Number:	**831775**
Date Received by Lab:	December 17 and 20, 2001
Number of Samples:	Ten (10)
Sample Type:	Soil

I. Introduction/Case Narrative

Five soil samples were received by the IT Geotechnical Laboratory beginning on December 17, 2001. Five additional soil samples were received on December 20, 2001. Chain-of-custody documents were not included with the samples. Raw sample material was used in stabilization mixtures and cylindrical test specimens were molded. Replicate specimens were designated for various testing programs, including: unconfined compressive strength, permeability (hydraulic conductivity), and freeze/thaw resistance.

A previous certificate reported the results of sample characterization tests: particle-size distribution, Atterberg limits, moisture content, and bulk density screening.

Please see Appendix A, Sample Number Cross-Reference List; Appendix B, Analysis Results; and Appendix C, Variance/Nonconformance Reports.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

II. Analytical Results/Methodology

REFERENCES: United States Army Corps of Engineers (USACE), Engineer Manual 1110-2-1906, *Laboratory Soils Testing*, appendix II, 1970; United States Environmental Protection Agency, SW846, *Test Methods for Examining Solid Waste, Physical/Chemical Methods*, 3rd ed., Nov 1986 (EPA SW-846). Annual Book of ASTM Standards, Section 4, Construction, Volume 04.08, *Soil and Rock (I)*, and Volume 04.09, *Soil and Rock (II)*, 2000.

Unconfined Compressive Strength of Soils	**ASTM D 2166**
Laboratory Determination of Water (Moisture) Content of Soil and Rock	**ASTM D 2216**
Freeze/Thaw of Solid Wastes	**ASTM D 4842**
Hydraulic Conductivity of Porous Materials	**ASTM D 5084**

III. Quality Control

Quality control checks such as duplicates and spikes (QC samples), are not normally applicable to geotechnical testing. This is due largely to the inability of obtaining samples with known characteristics, the heterogenous nature of the samples, and quality control procedures built-in to the analytical method.

QC measures to ensure accuracy and precision of test results include the following:

- 100% verification of all numerical results - raw data entries, transcriptions and calculations entered by lab technicians are checked, recalculated and verified. Most data calculations are performed by computer programs.

- Data validation through test reasonableness - summaries of all test results for individual reports are reviewed to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers.

- Quality control procedures are built into most standardized geotechnical procedures. For example, liquid limit and plastic limit analyses call for re-analyses and specify acceptance criteria.

- Routine instrument calibration - instruments, gauges and equipment used in testing are calibrated on a routine basis. All instrument calibration follows ASTM or

manufacturer guidelines.

- Maintenance of all past calibration records - calibration records and certification documents of all instruments, gauges and equipment are updated routinely and maintained in the Quality Control Coordinators Quality/Operations files.

- Certified and trained personnel - all technicians are certified by the National Institute for Certification of Engineering Technicians (NICET) in geotechnical soil testing, and are trained in the application of standard laboratory procedures for geotechnical analyses as well as the quality assurance measures implemented by IT.

IV. Data Qualification

Freeze/thaw testing was not complete for the tuff/sediment mix at the time of this report. The results for this series are complete through ten cycles (except specimen eight, which failed at seven cycles). Complete results for the tuff/sediment mix freeze/thaw test will be reported when available.

Freeze/thaw specimens underwent twelve test cycles. Some samples deteriorated prior to the end of twelve cycles, and the tests for these samples was terminated early.

Certain freeze/thaw results are calculated as negative values. This occurs when the control specimen has greater material loss than the corresponding test specimen.

The moisture content of hydraulic conductivity and freeze/thaw samples was assumed to be equal to the moisture content of unconfined compressive strength samples of the same series.

Appendix A
Sample Cross-Reference List

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
1108-06	Sediment mix 1	Solid
1108-07	Sediment mix 2	Solid
1108-08	Sediment mix 3	Solid
1108-09	Sediment mix 4	Solid
1108-10	Sediment mix 5	Solid
1108-11	Sediment mix 6	Solid
1108-12	Sediment mix 7	Solid
1108-13	Sediment mix 8	Solid
1108-14	Tuff mix 1	Solid
1108-15	Tuff mix 2	Solid
1108-16	Tuff mix 3	Solid
1108-17	Tuff mix 4	Solid
1108-18	Tuff mix 5	Solid
1108-19	Tuff mix 6	Solid
1108-20	Tuff mix 7	Solid
1108-21	Tuff mix 8	Solid
1108-23	Soil mix 1	Solid
1108-24	Soil mix 2	Solid
1108-25	Soil mix 3	Solid
1108-26	Soil mix 4	Solid
1108-27	Soil mix 5	Solid
1108-28	Soil mix 6	Solid
1108-29	Soil mix 7	Solid
1108-30	Soil mix 8	Solid
1108-32	Tuff/Sediment mix 1	Solid
1108-33	Tuff/Sediment mix 2	Solid
1108-34	Tuff/Sediment mix 3	Solid
1108-35	Tuff/Sediment mix 4	Solid
1108-36	Tuff/Sediment mix 5	Solid
1108-37	Tuff/Sediment mix 6	Solid
1108-38	Tuff/Sediment mix 7	Solid
1108-39	Tuff/Sediment mix 8	Solid

Appendix B
Sample Test Results

14-Day UCS Tests

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

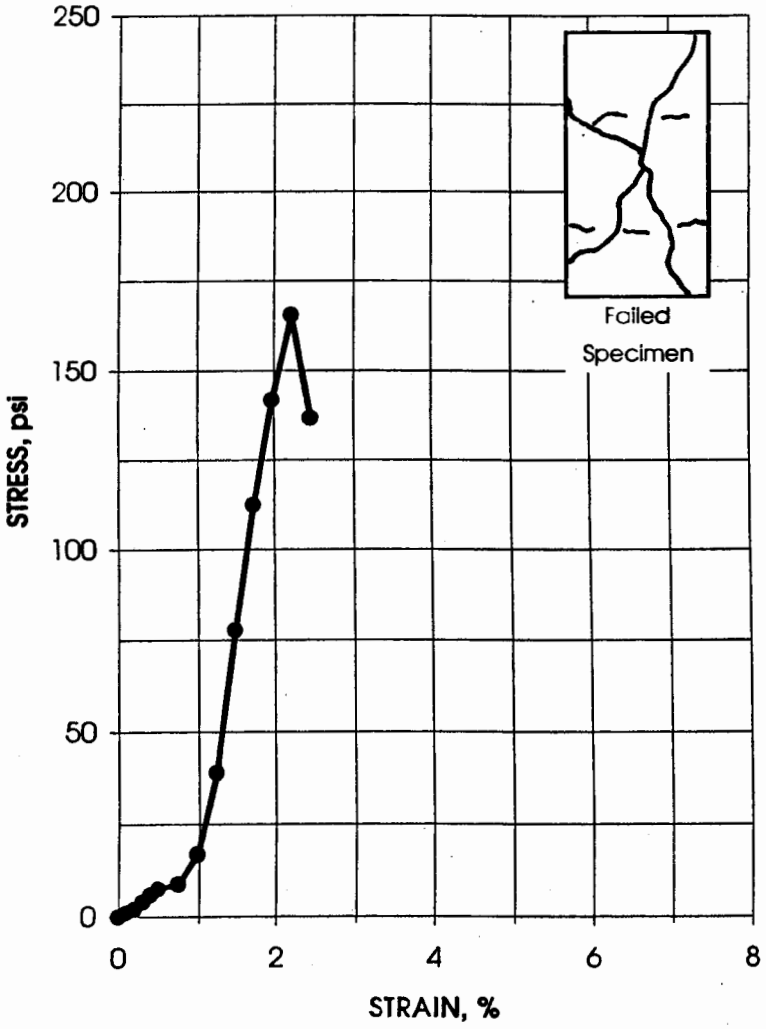
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-06-01
IT Lab No. Sediment mix 1

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**165**
STRAIN AT FAILURE, %	**2.2**

Specimen Height, in.	4.0547
Specimen Diameter, in.	2.0108
Specimen Weight, g.	390.95
Moisture Content, %	20.4
Wet Unit Weight, pcf.	115.7
Dry Unit Weight, pcf.	96.1
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	2
0.30	4
0.39	6
0.49	8
0.74	9
0.99	17
1.23	39
1.48	78
1.73	112
1.97	142
2.22	165
2.47	137



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

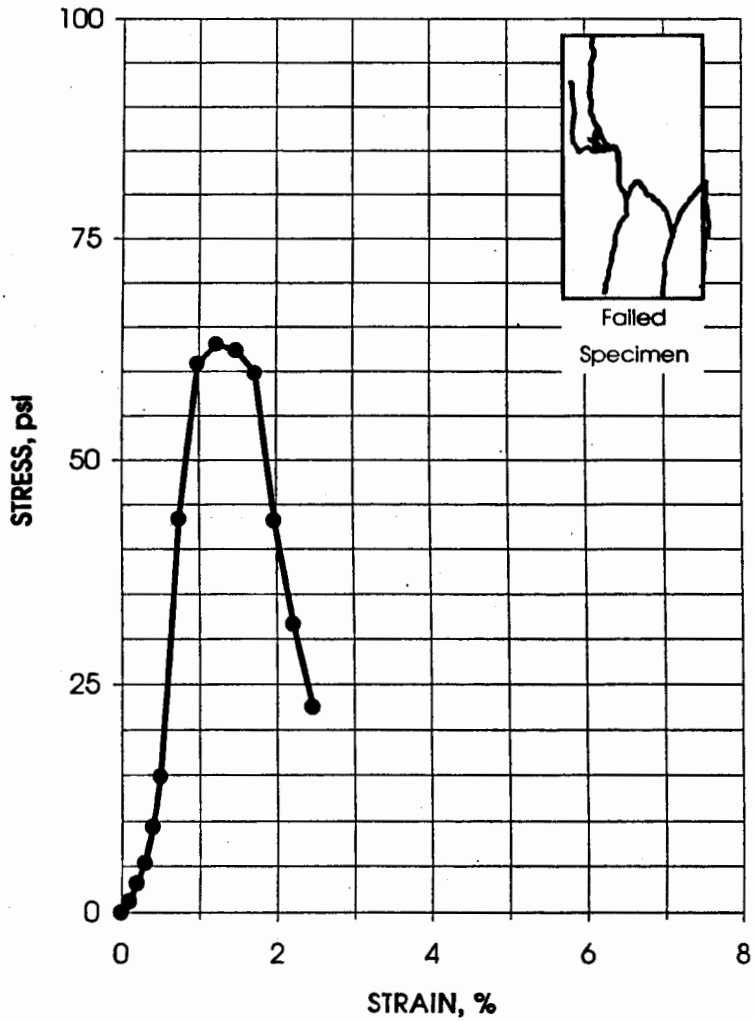
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-07-01
IT Lab No. Sediment mix 2

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**63**
STRAIN AT FAILURE, %	**1.2**

Specimen Height, in.	4.0585
Specimen Diameter, in.	2.0095
Specimen Weight, g.	353.46
Moisture Content, %	15.1
Wet Unit Weight, pcf.	104.6
Dry Unit Weight, pcf.	90.9
Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1.1
0.20	3.1
0.30	5.3
0.39	9.4
0.49	14.8
0.74	43.3
0.99	60.8
1.23	63.0
1.48	62.4
1.72	59.8
1.97	43.2
2.22	31.6
2.46	22.5



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

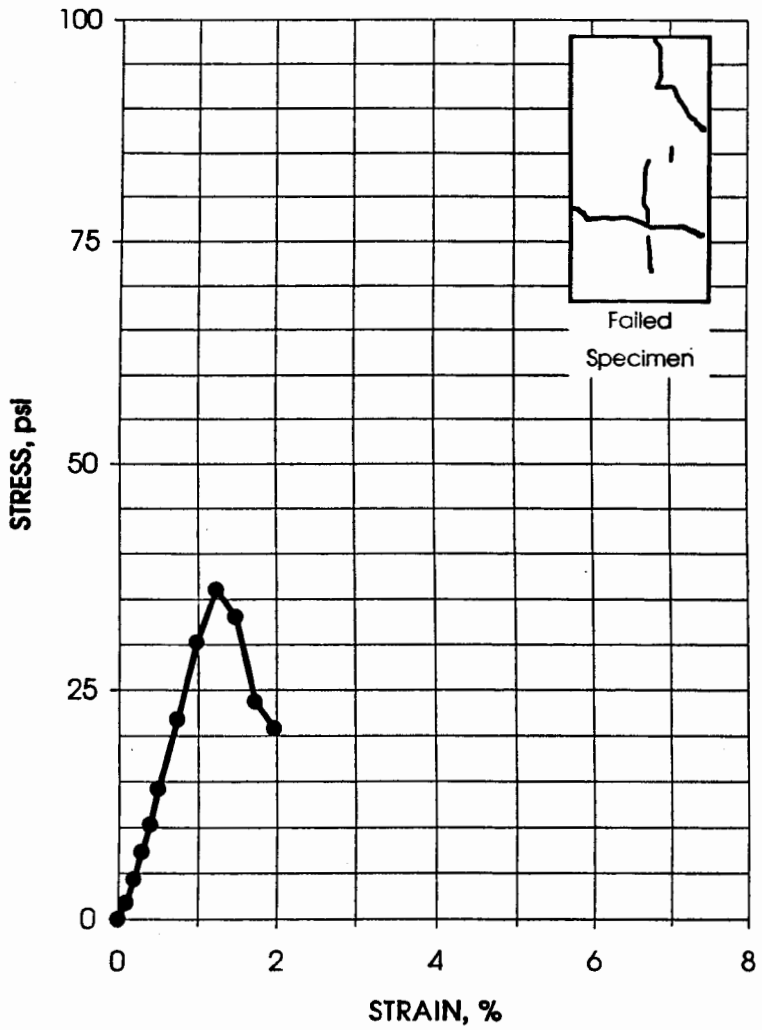
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-08-01
IT Lab No. Sediment mix 3

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**36**
STRAIN AT FAILURE, %	**1.2**

Specimen Height, in.	4.0615
Specimen Diameter, in.	2.0070
Specimen Weight, g.	338.14
Moisture Content, %	17.3
Wet Unit Weight, pcf.	100.3
Dry Unit Weight, pcf.	85.5
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1.7
0.20	4.3
0.30	7.3
0.39	10.3
0.49	14.2
0.74	21.8
0.98	30.2
1.23	36.0
1.48	33.1
1.72	23.8
1.97	20.8



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

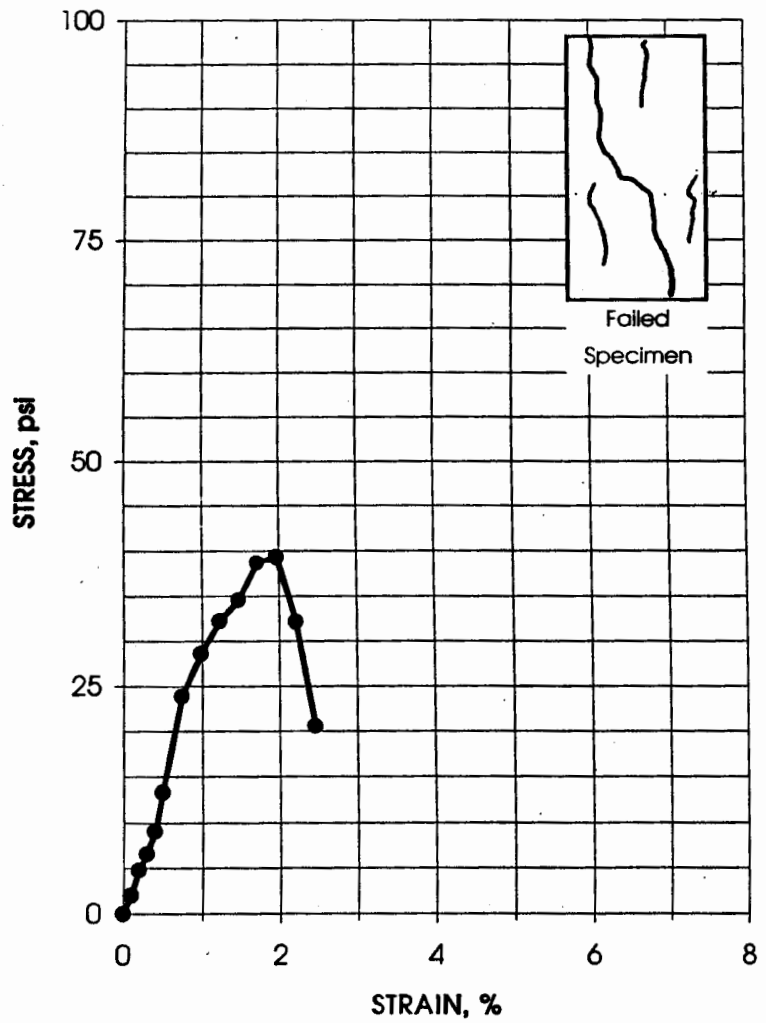
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-09-01
IT Lab No. Sediment mix 4

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**39**
STRAIN AT FAILURE, %	**2.0**

Specimen Height, in.	4.0582
Specimen Diameter, in.	2.0050
Specimen Weight, g.	355.96
Moisture Content, %	18.1
Wet Unit Weight, pcf.	105.9
Dry Unit Weight, pcf.	89.6
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0.0
0.10	2.0
0.20	4.8
0.30	6.5
0.39	9.1
0.49	13.3
0.74	23.9
0.99	28.6
1.23	32.2
1.48	34.6
1.72	38.7
1.97	39.3
2.22	32.1
2.46	20.6



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

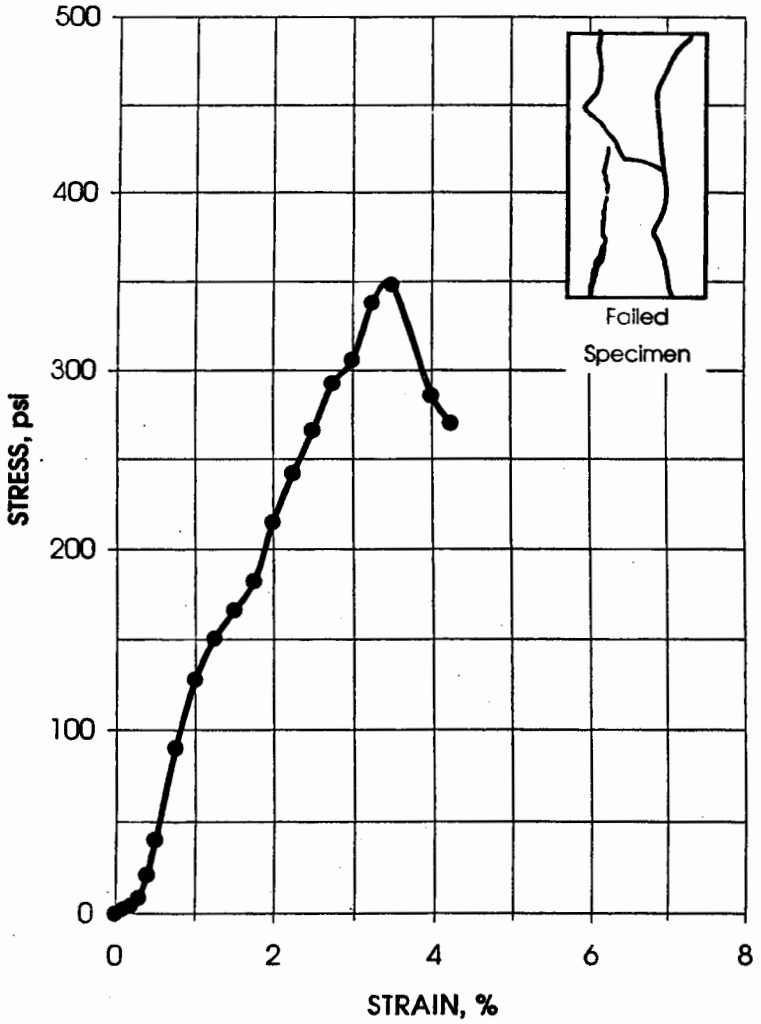
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-10-01
IT Lab No. Sediment mix 5

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**348**
STRAIN AT FAILURE, %	**3.5**

Specimen Height, in.	4.0037
Specimen Diameter, in.	2.0102
Specimen Weight, g.	373.53
Moisture Content, %	27.8
Wet Unit Weight, pcf.	112.0
Dry Unit Weight, pcf.	87.6
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	4
0.30	8
0.40	21
0.50	40
0.75	90
1.00	128
1.25	150
1.50	166
1.75	182
2.00	215
2.25	242
2.50	266
2.75	293
3.00	306
3.25	338
3.50	348
4.00	286
4.25	270



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

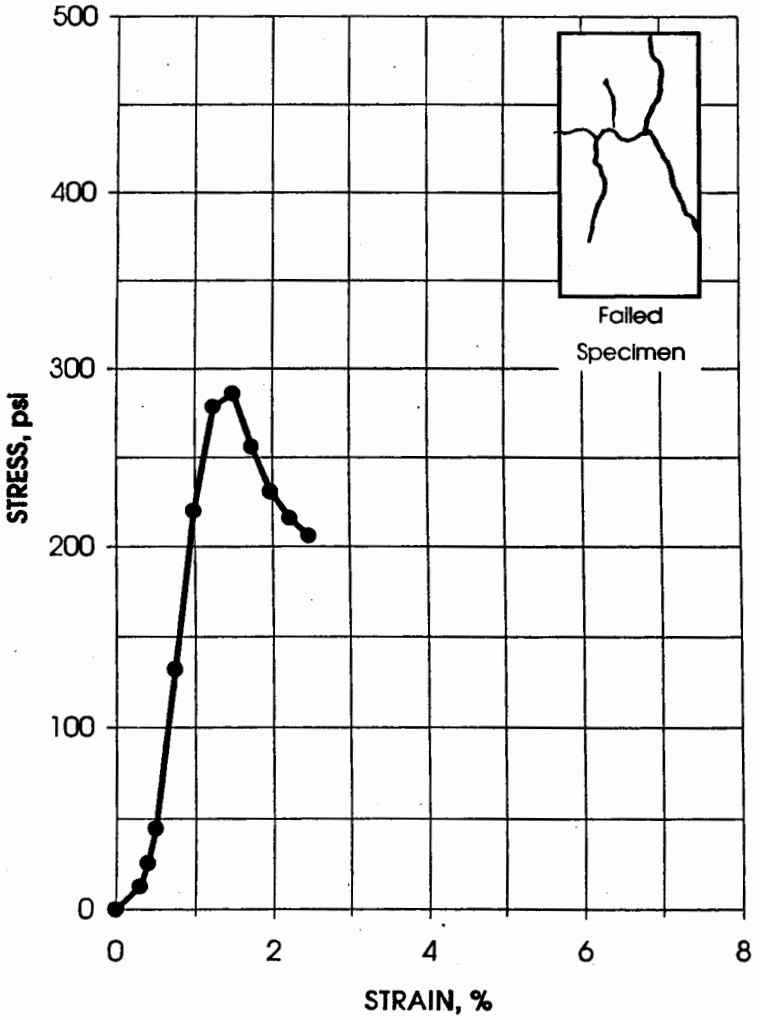
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-11-01
IT Lab No. Sediment mix 6

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**286**
STRAIN AT FAILURE, %	**1.5**

Specimen Height, in.	4.0420
Specimen Diameter, in.	2.0087
Specimen Weight, g.	384.95
Moisture Content, %	21.8
Wet Unit Weight, pcf.	114.5
Dry Unit Weight, pcf.	94.0
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.30	13
0.40	25
0.49	45
0.74	132
0.99	220
1.24	279
1.48	286
1.73	256
1.98	231
2.23	216
2.47	206



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

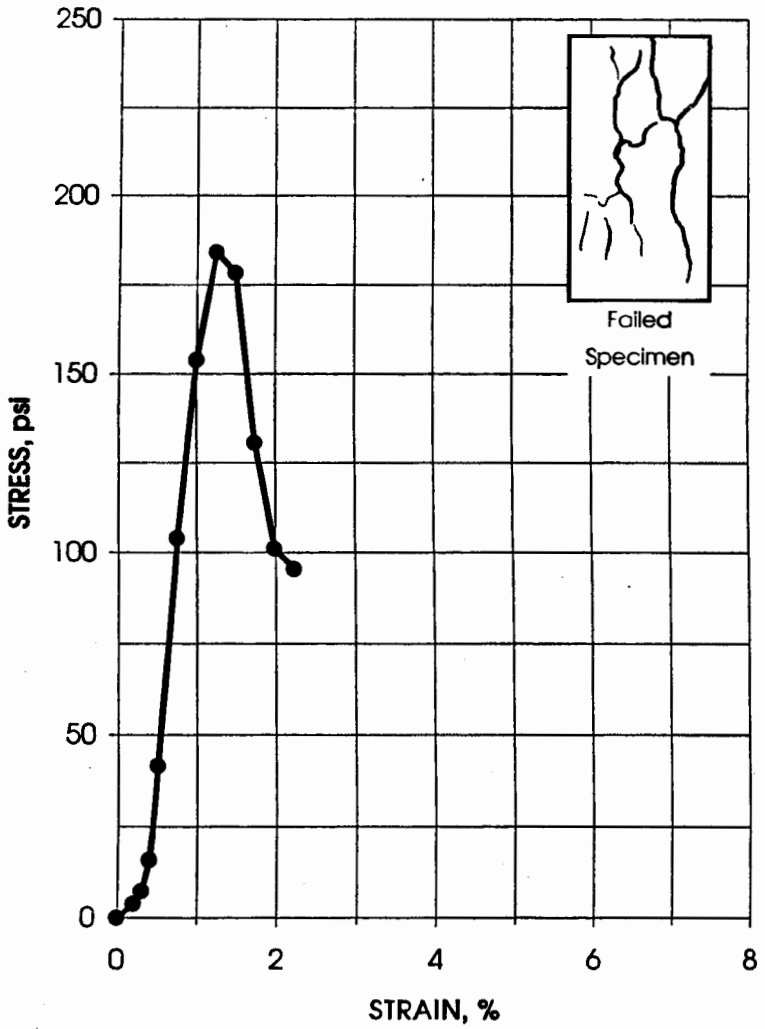
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-12-01
Project No.	831775.00000000	IT Lab No.	Sediment mix 7

Specimen Mold Date	12/19/01	Specimen Height, in.	4.0232
Specimen Test Date	1/2/02	Specimen Diameter, in.	2.0043
		Specimen Weight, g.	365.18
STRESS AT FAILURE, psi	**184**	Moisture Content, %	23.8
STRAIN AT FAILURE, %	**1.2**	Wet Unit Weight, pcf.	109.6
		Dry Unit Weight, pcf.	88.5
		Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.20	4
0.30	7
0.40	16
0.50	42
0.75	104
0.99	154
1.24	184
1.49	178
1.74	130
1.99	101
2.24	95



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

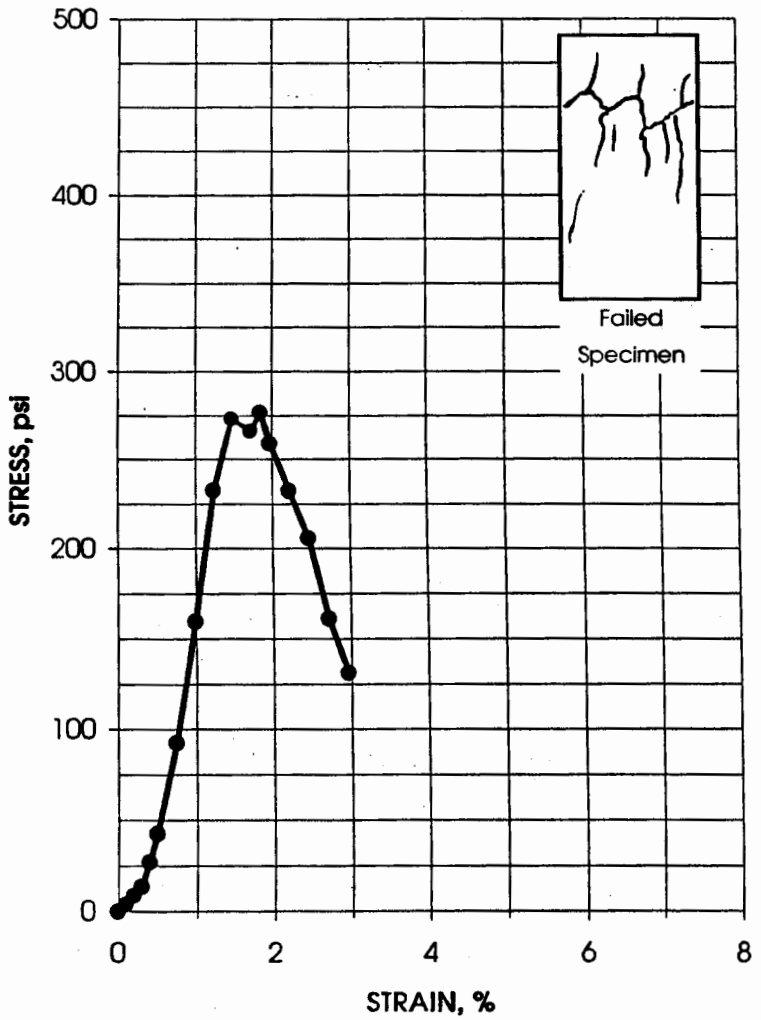
Project No. LANL
Project No. 831775.00000000

Client Sample No. 1108-13-01
IT Lab No. Sediment mix 8

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**277**
STRAIN AT FAILURE, %	**1.9**

Specimen Height, in.	4.0487
Specimen Diameter, in.	2.0110
Specimen Weight, g.	371.68
Moisture Content, %	26.1
Wet Unit Weight, pcf.	110.1
Dry Unit Weight, pcf.	87.3
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	8
0.30	13
0.40	27
0.49	43
0.74	93
0.99	160
1.23	233
1.48	273
1.73	266
1.85	277
1.98	259
2.22	232
2.47	206
2.72	161
2.96	131



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

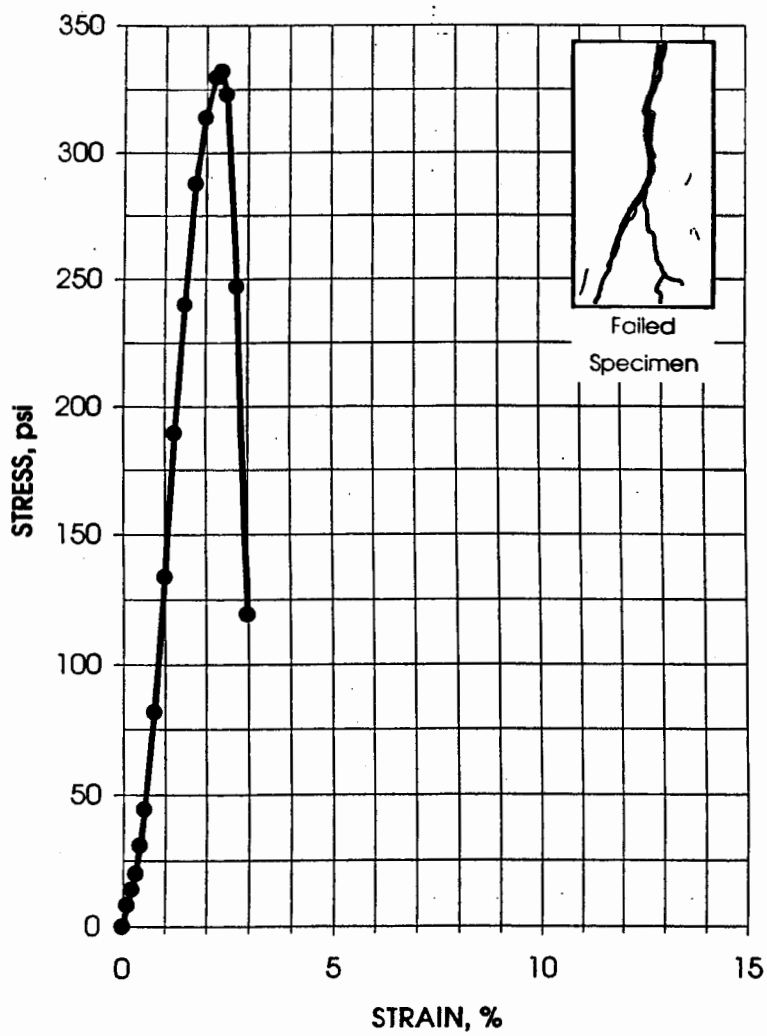
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-14-01
IT Lab Specimen No. Tuff mix 1

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**332**
STRAIN AT FAILURE, %	**2.4**

Specimen Height, in.	4.0277
Specimen Diameter, in.	2.0102
Specimen Weight, g.	390.07
Moisture Content, %	21.1
Wet Unit Weight, pcf.	116.3
Dry Unit Weight, pcf.	96.0
Rate of Strain, in./min.	0.0650

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	8
0.20	14
0.30	20
0.40	31
0.50	45
0.74	82
0.99	134
1.24	190
1.49	240
1.74	288
1.99	314
2.23	330
2.36	332
2.48	323
2.73	247
2.98	119



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

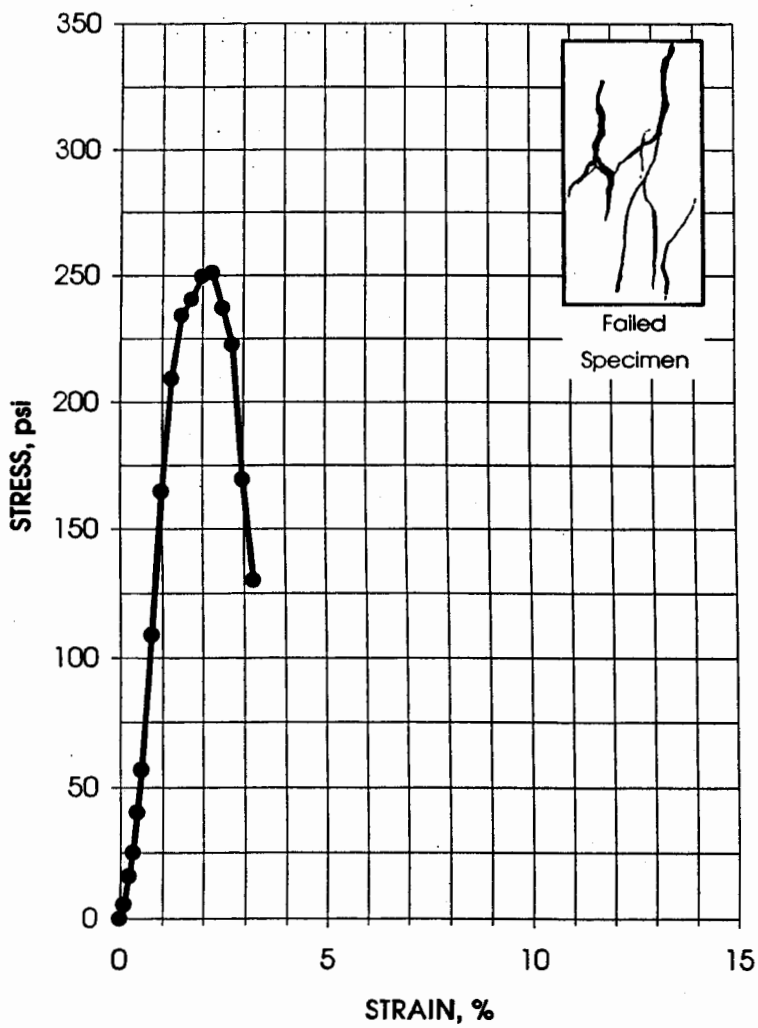
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-15-01
IT Lab Specimen N Tuff mix 2

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**251**
STRAIN AT FAILURE, %	**2.2**

Specimen Height, in.	4.0340
Specimen Diameter, in.	2.0042
Specimen Weight, g.	386.18
Moisture Content, %	20.7
Wet Unit Weight, pcf.	115.6
Dry Unit Weight, pcf.	95.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	5
0.20	16
0.30	25
0.40	40
0.50	57
0.74	109
0.99	165
1.24	209
1.49	234
1.74	240
1.98	249
2.23	251
2.48	237
2.73	223
2.97	169
3.22	130



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

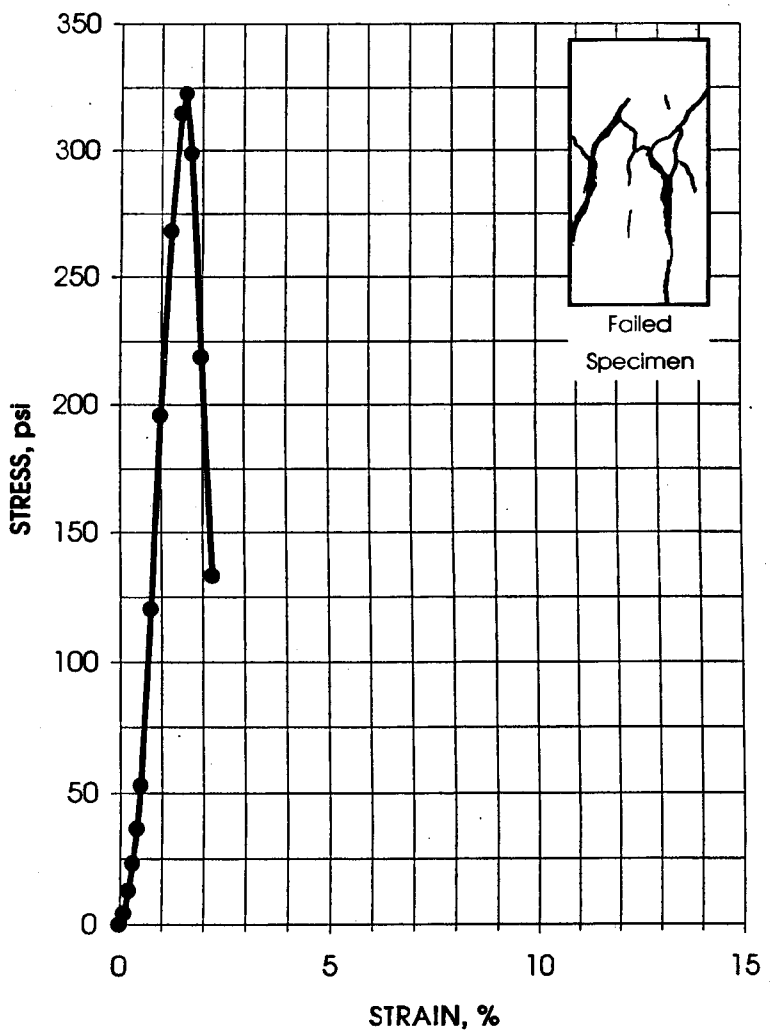
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-16-01
IT Lab Specimen No. Tuff mix 3

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**323**
STRAIN AT FAILURE, %	**1.6**

Specimen Height, in.	4.0378
Specimen Diameter, in.	2.0115
Specimen Weight, g.	388.78
Moisture Content, %	22.4
Wet Unit Weight, pcf.	115.4
Dry Unit Weight, pcf.	94.3
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	4
0.20	13
0.30	23
0.40	36
0.50	53
0.74	120
0.99	196
1.24	268
1.49	315
1.61	323
1.73	299
1.98	219
2.23	133



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

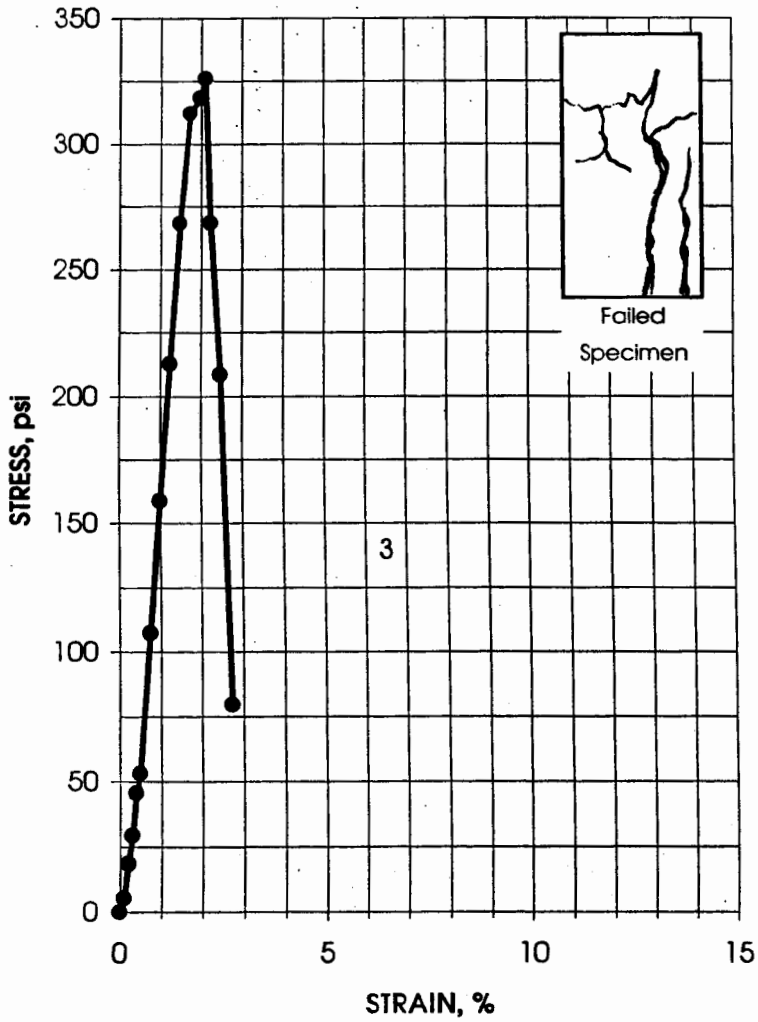
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-17-01
IT Lab Specimen N Tuff mix 4

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**326**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0400
Specimen Diameter, in.	2.0123
Specimen Weight, g.	379.93
Moisture Content, %	23.1
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	91.6
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	5
0.20	19
0.30	29
0.40	46
0.50	53
0.74	107
0.99	159
1.24	213
1.49	268
1.73	312
1.98	318
2.10	326
2.23	268
2.48	209
2.72	80



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

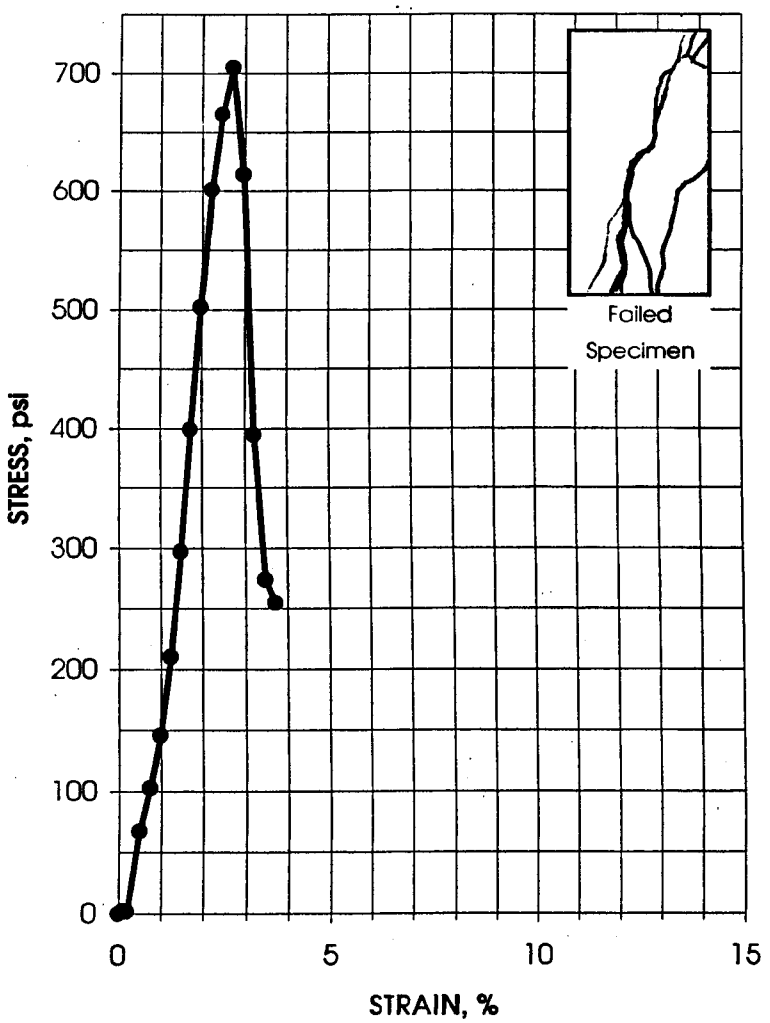
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-18-01
IT Lab Specimen N Tuff mix 5

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**705**
STRAIN AT FAILURE, %	**2.7**

Specimen Height, in.	4.0437
Specimen Diameter, in.	2.0103
Specimen Weight, g.	389.11
Moisture Content, %	23.1
Wet Unit Weight, pcf.	115.5
Dry Unit Weight, pcf.	93.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	3
0.20	2
0.49	67
0.74	103
0.99	146
1.24	210
1.48	297
1.73	399
1.98	502
2.23	601
2.47	665
2.72	705
2.97	614
3.21	395
3.46	274
3.71	255



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

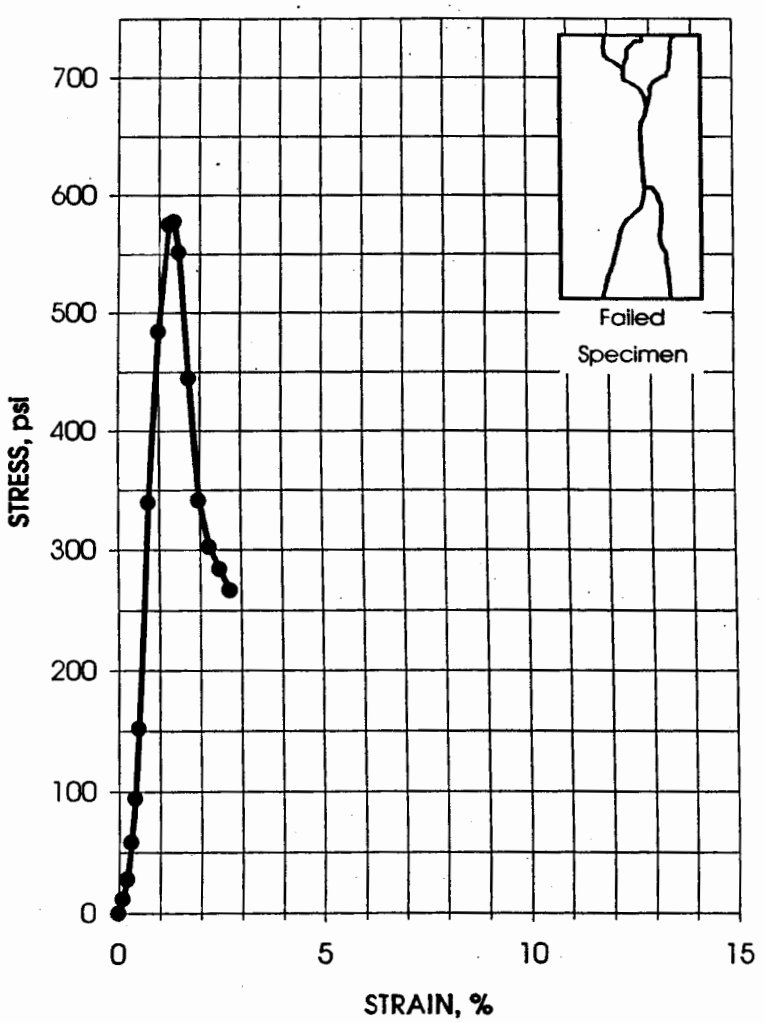
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-19-01
IT Lab Specimen N Tuff mix 6

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**578**
STRAIN AT FAILURE, %	**1.4**

Specimen Height, in.	4.0433
Specimen Diameter, in.	2.0045
Specimen Weight, g.	384.51
Moisture Content, %	21.1
Wet Unit Weight, pcf.	114.8
Dry Unit Weight, pcf.	94.8
Rate of Strain, in./min.	0.6500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	12
0.20	28
0.30	58
0.40	94
0.49	152
0.74	339
0.99	484
1.24	575
1.36	578
1.48	552
1.73	445
1.98	341
2.23	302
2.47	284
2.72	267



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

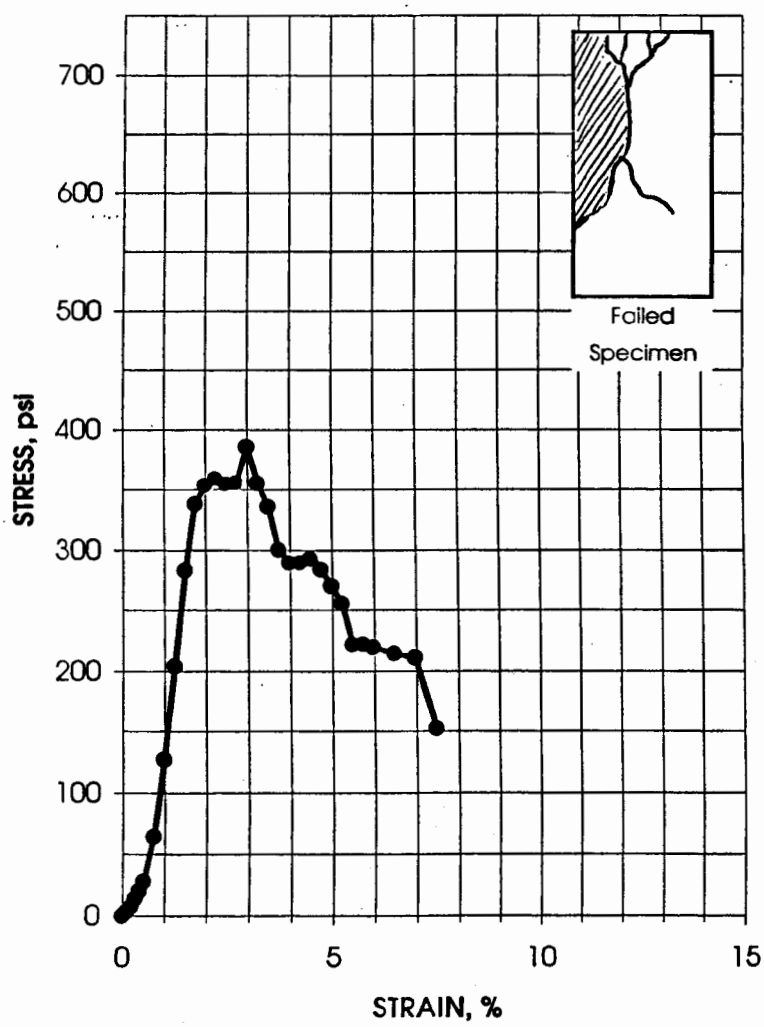
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-20-01
IT Lab Specimen N Tuff mix 7

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**386**
STRAIN AT FAILURE, %	**3.0**

Specimen Height, in.	4.0177
Specimen Diameter, in.	2.0063
Specimen Weight, g.	378.91
Moisture Content, %	24.9
Wet Unit Weight, pcf.	113.7
Dry Unit Weight, pcf.	91.0
Rate of Strain, in./min.	0.0650

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.1	3
0.2	7
0.3	14
0.4	20
0.5	28
0.75	64
1.0	127
1.5	284
2.0	353
2.5	355
3.0	386
3.5	336
4.0	290
4.5	293
5.0	271
5.5	221
6.0	219
6.5	214
7.0	211
7.5	152



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

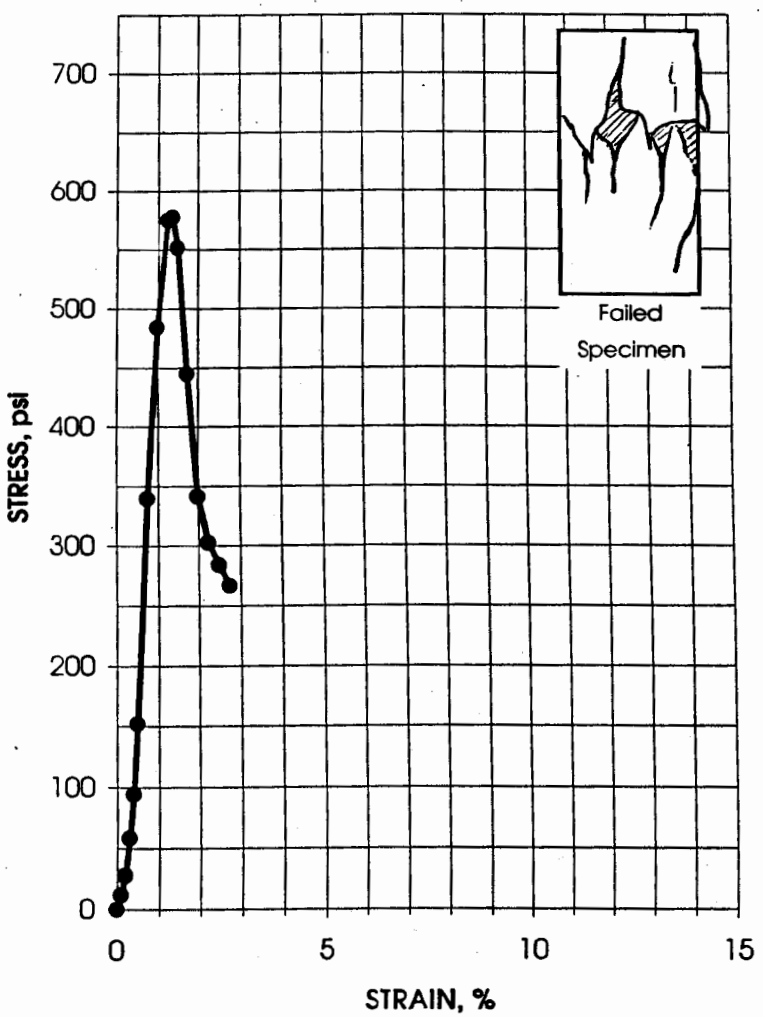
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-21-01
IT Lab Specimen N Tuff mix 8

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**578**
STRAIN AT FAILURE, %	**1.4**

Specimen Height, in.	4.0433
Specimen Diameter, in.	2.0045
Specimen Weight, g.	384.51
Moisture Content, %	25.4
Wet Unit Weight, pcf.	114.8
Dry Unit Weight, pcf.	91.5
Rate of Strain, in./min.	0.6500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	12
0.20	28
0.30	58
0.40	94
0.49	152
0.74	339
0.99	484
1.24	575
1.36	578
1.48	552
1.73	445
1.98	341
2.23	302
2.47	284
2.72	267



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

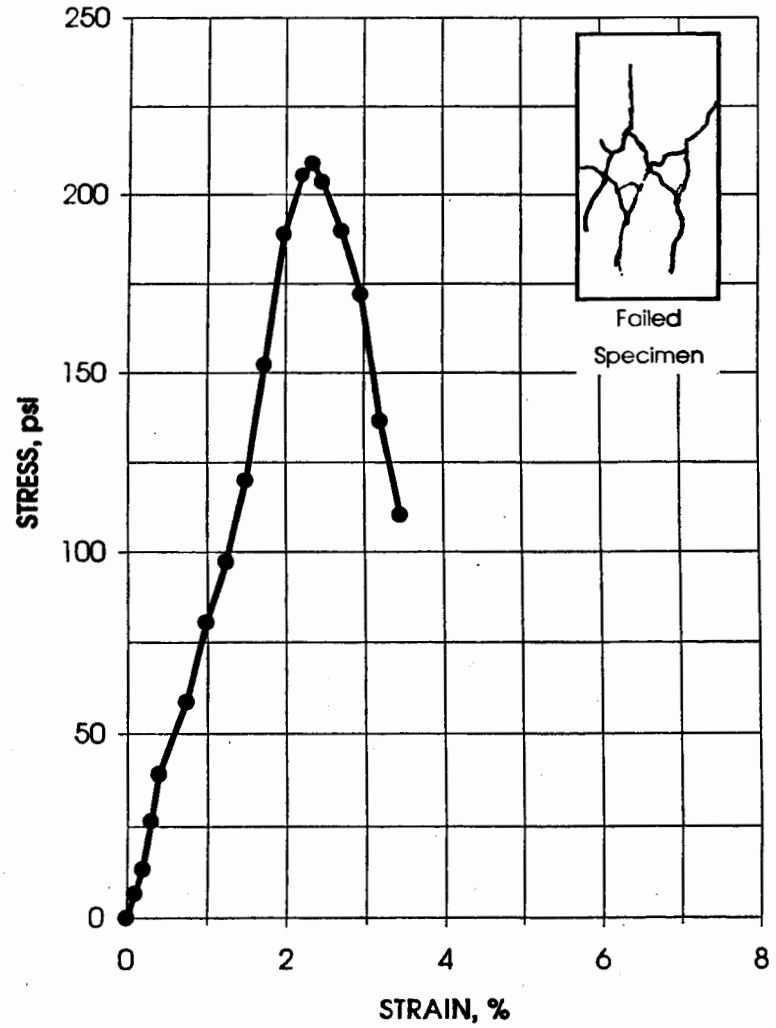
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-23-05
IT Lab No. Soil mix 1

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**209**
STRAIN AT FAILURE, %	**2.3**

Specimen Height, in.	4.0503
Specimen Diameter, in.	2.0110
Specimen Weight, g.	373.06
Moisture Content, %	23.4
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	89.6
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	7
0.20	13
0.30	26
0.40	39
0.74	59
0.99	80
1.23	97
1.48	120
1.73	152
1.98	189
2.22	205
2.35	209
2.47	204
2.72	190
2.96	172
3.21	137
3.46	110



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

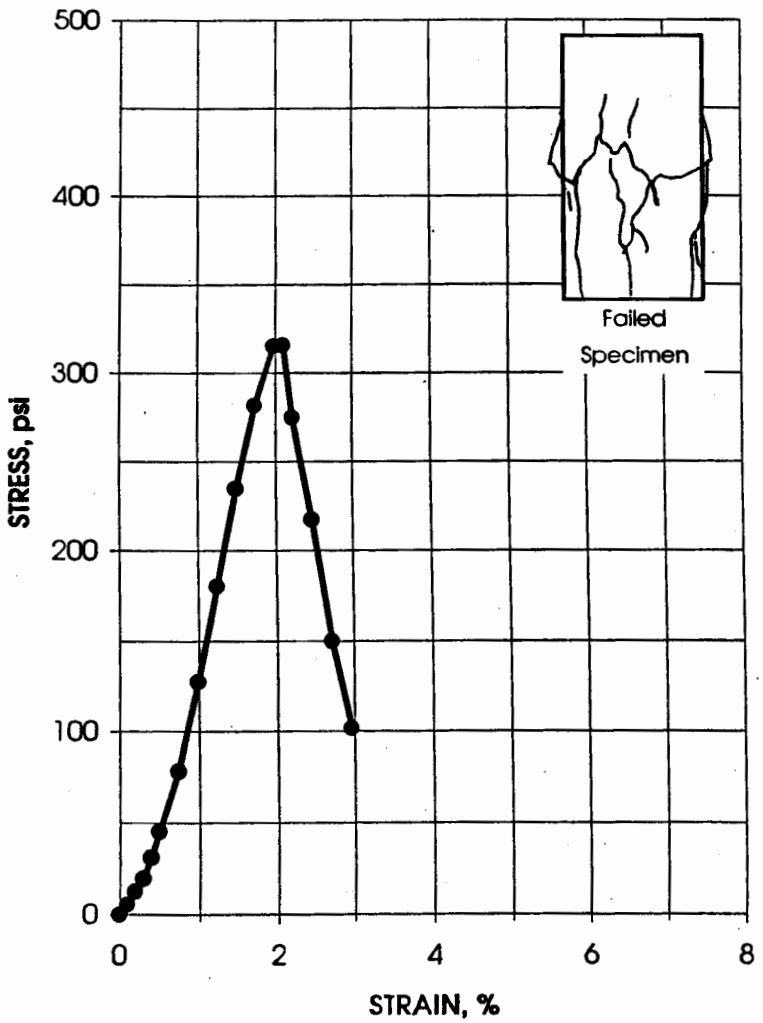
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-24-01
IT Lab No. Soil mix 2

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**316**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0493
Specimen Diameter, in.	2.0100
Specimen Weight, g.	380.64
Moisture Content, %	21.4
Wet Unit Weight, pcf.	112.9
Dry Unit Weight, pcf.	93.0
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	13
0.30	19
0.40	31
0.49	45
0.74	78
0.99	128
1.23	180
1.48	235
1.73	282
1.98	315
2.10	316
2.22	275
2.47	217
2.72	150
2.96	102



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

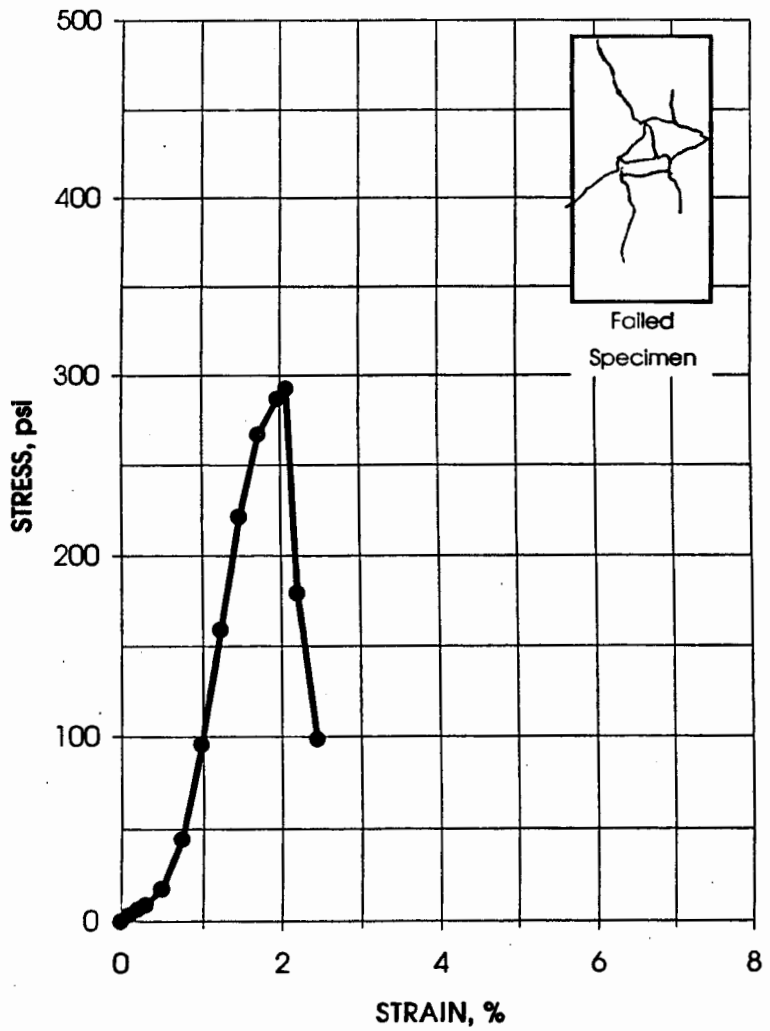
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-25-02
IT Lab Specimen N Soil mix 3

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**293**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0708
Specimen Diameter, in.	2.0047
Specimen Weight, g.	372.69
Moisture Content, %	22.5
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	90.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.29	9
0.49	17
0.74	44
0.98	96
1.23	159
1.47	221
1.72	267
1.97	287
2.09	293
2.21	179
2.46	99



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

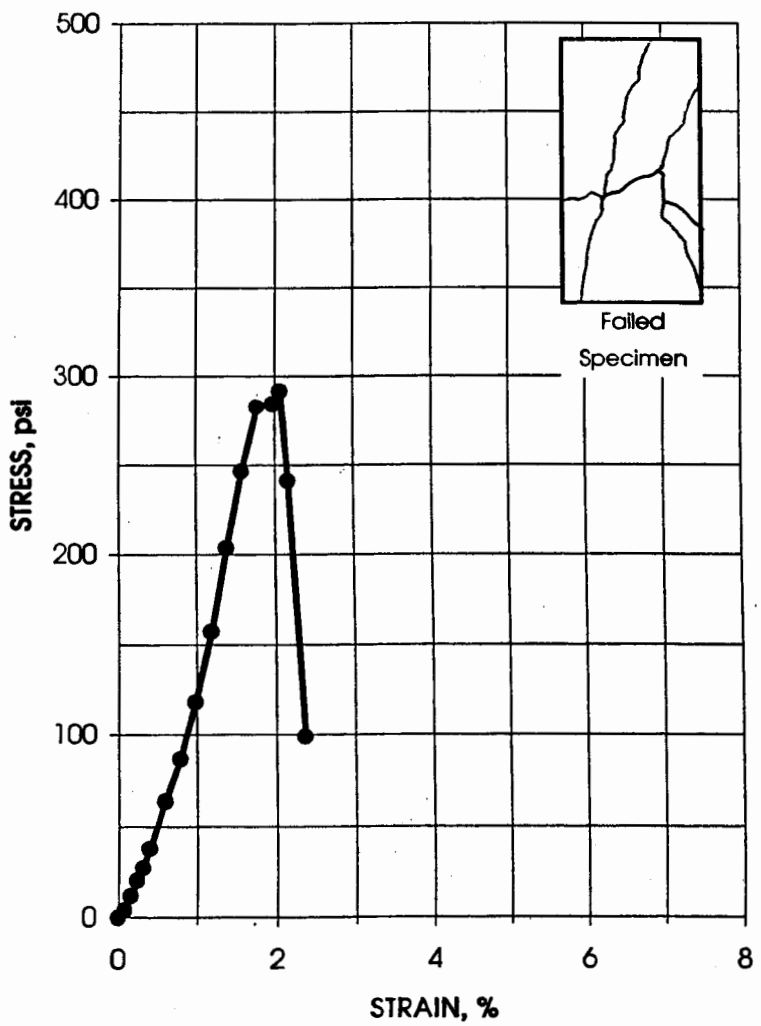
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-26-01
IT Lab No. Soil mix 4

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**291**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	5.0730
Specimen Diameter, in.	2.0032
Specimen Weight, g.	371.08
Moisture Content, %	24.9
Wet Unit Weight, pcf.	88.4
Dry Unit Weight, pcf.	70.8
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.08	4
0.16	11
0.24	20
0.32	27
0.39	38
0.59	63
0.79	86
0.99	118
1.18	157
1.38	203
1.58	246
1.77	283
1.97	284
2.07	291
2.17	241
2.37	99



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

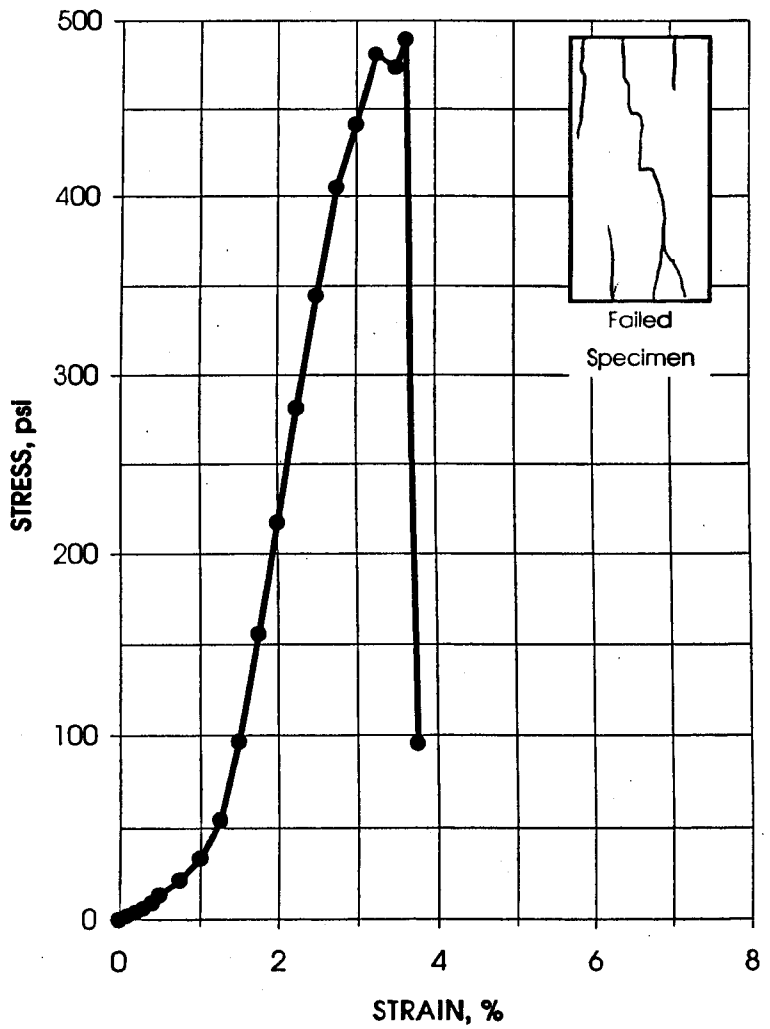
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-27-05
IT Lab No. Soil mix 5

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**489**
STRAIN AT FAILURE, %	**3.6**

Specimen Height, in.	3.9983
Specimen Diameter, in.	2.0110
Specimen Weight, g.	367.02
Moisture Content, %	28.8
Wet Unit Weight, pcf.	110.1
Dry Unit Weight, pcf.	85.5
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	4
0.30	6
0.40	9
0.50	13
0.75	21
1.00	33
1.25	54
1.50	96
1.75	156
2.00	217
2.25	281
2.50	344
2.75	405
3.00	441
3.25	481
3.50	473
3.63	489
3.75	95



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

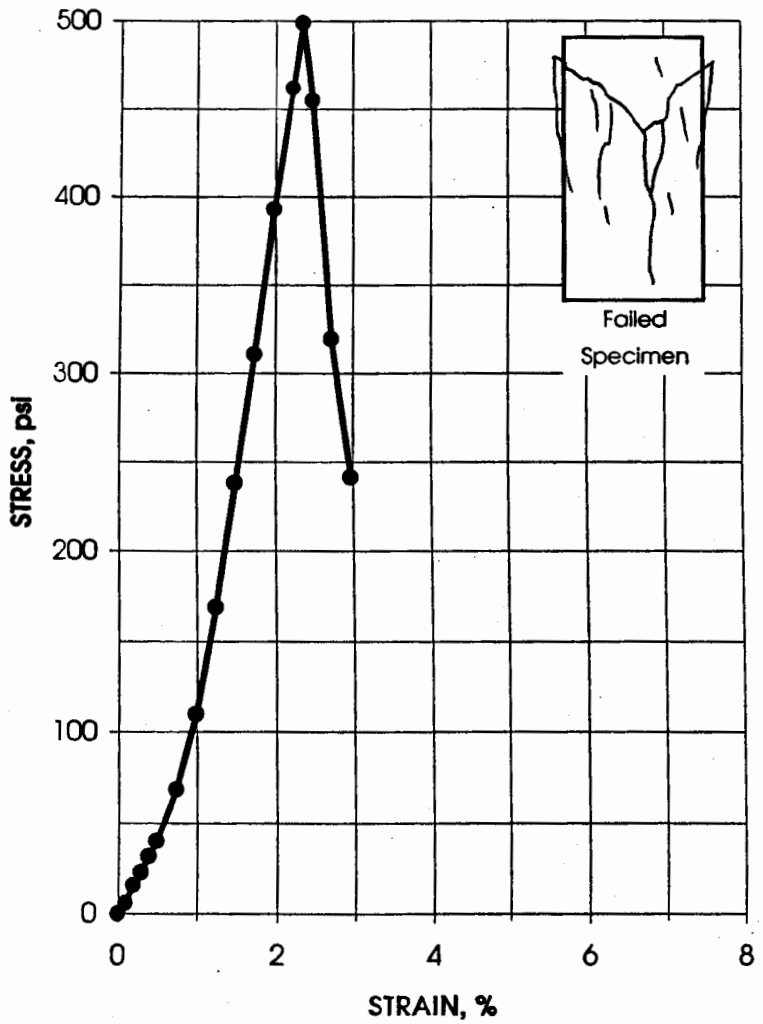
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-28-04
IT Lab No. Soil mix 6

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**499**
STRAIN AT FAILURE, %	**2.4**

Specimen Height, in.	4.0327
Specimen Diameter, in.	2.0123
Specimen Weight, g.	377.08
Moisture Content, %	21.2
Wet Unit Weight, pcf.	112.0
Dry Unit Weight, pcf.	92.4
Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	16
0.30	23
0.40	32
0.50	40
0.74	68
0.99	110
1.24	169
1.49	238
1.74	311
1.98	393
2.23	462
2.36	499
2.48	455
2.73	319
2.98	241



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

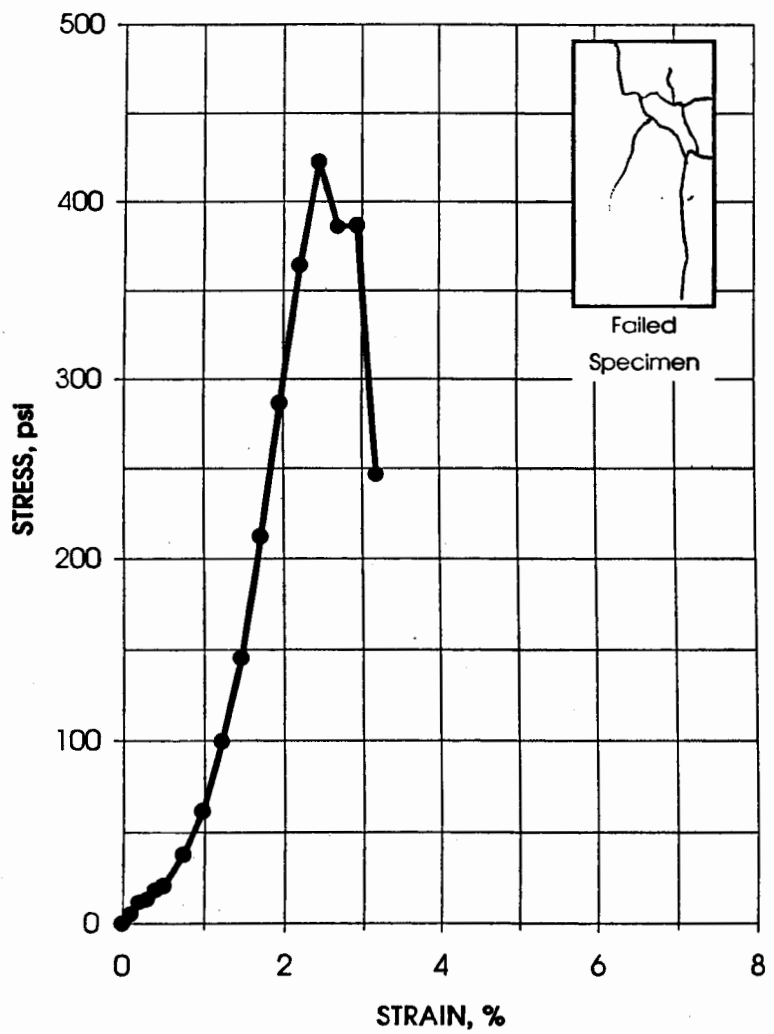
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-29-03
IT Lab No. Soil mix 7

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**422**
STRAIN AT FAILURE, %	**2.4**

Specimen Height, in.	4.0823
Specimen Diameter, in.	2.0123
Specimen Weight, g.	371.09
Moisture Content, %	24.2
Wet Unit Weight, pcf.	108.9
Dry Unit Weight, pcf.	87.7
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	12
0.29	13
0.39	18
0.49	21
0.73	38
0.98	61
1.22	99
1.47	145
1.71	212
1.96	286
2.20	364
2.45	422
2.69	386
2.94	387
3.18	246



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

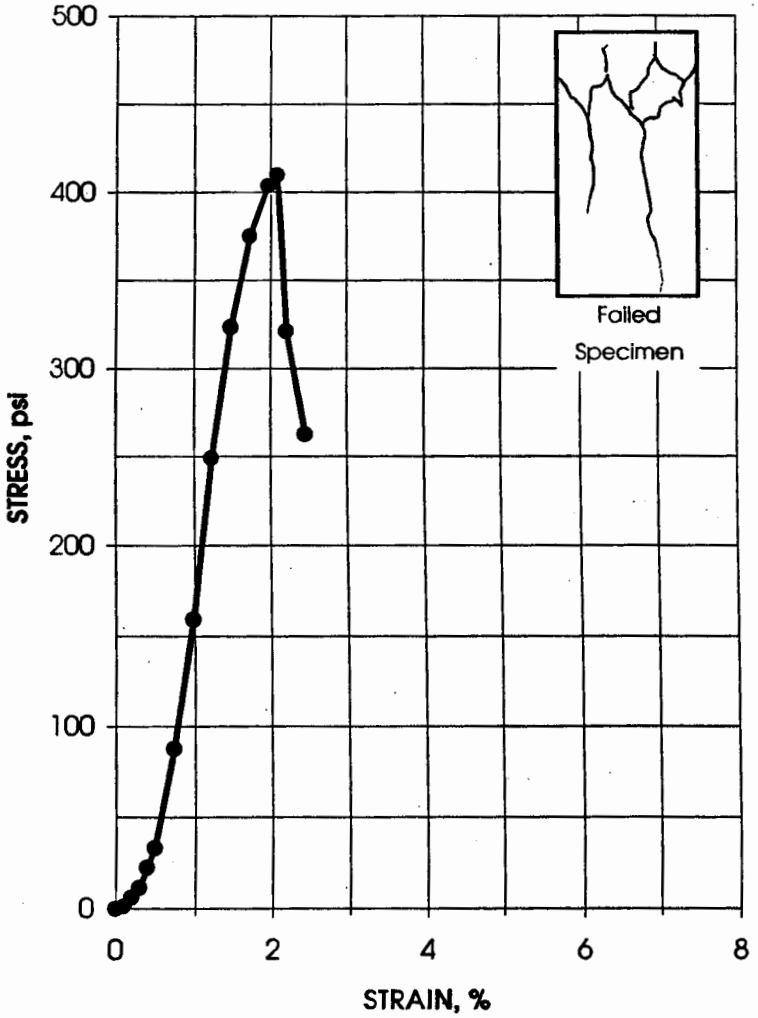
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-30-01
IT Lab No. Soil mix 8

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**410**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0663
Specimen Diameter, in.	2.0160
Specimen Weight, g.	373.85
Moisture Content, %	25.2
Wet Unit Weight, pcf.	109.7
Dry Unit Weight, pcf.	87.7
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	6
0.30	11
0.39	22
0.49	33
0.74	88
0.98	159
1.23	249
1.48	323
1.72	375
1.97	404
2.09	410
2.21	321
2.46	262



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

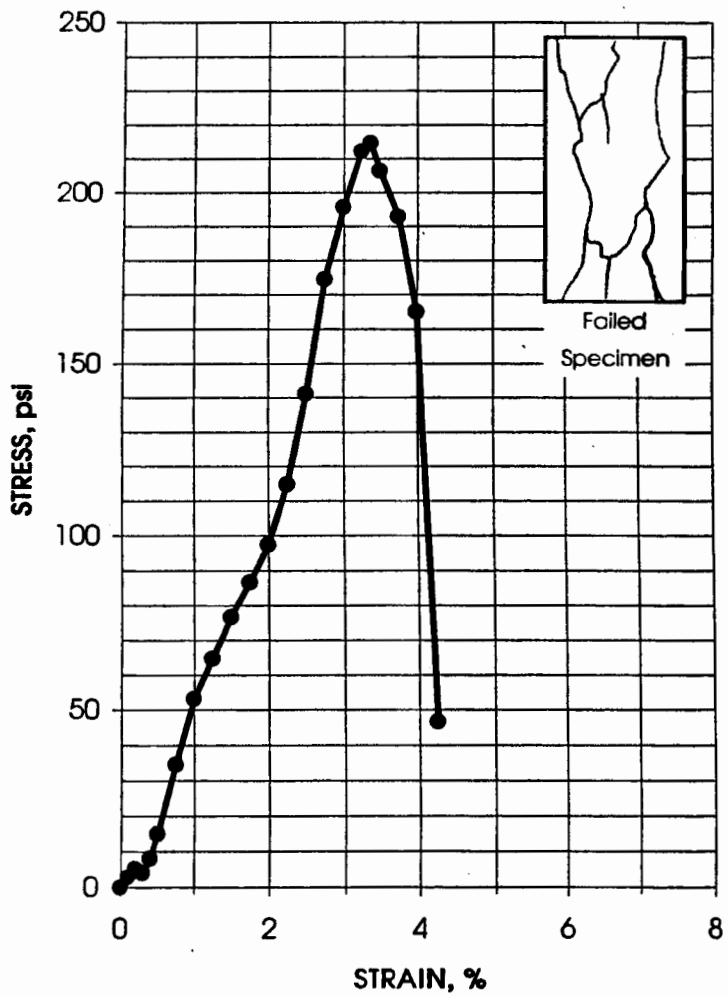
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-32-10
IT Lab No. Tuff/Sed Mix 1

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**215**
STRAIN AT FAILURE, %	**3.4**

Specimen Height, in.	4.0087
Specimen Diameter, in.	2.0147
Specimen Weight, g.	386.96
Moisture Content, %	20.6
Wet Unit Weight, pcf.	115.4
Dry Unit Weight, pcf.	95.7
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	5
0.30	4
0.40	8
0.50	15
0.75	35
1.00	53
1.25	65
1.50	77
1.75	87
2.00	97
2.25	115
2.49	141
2.74	175
2.99	196
3.24	212
3.37	215
3.49	206
3.74	193
3.99	165
4.24	47



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

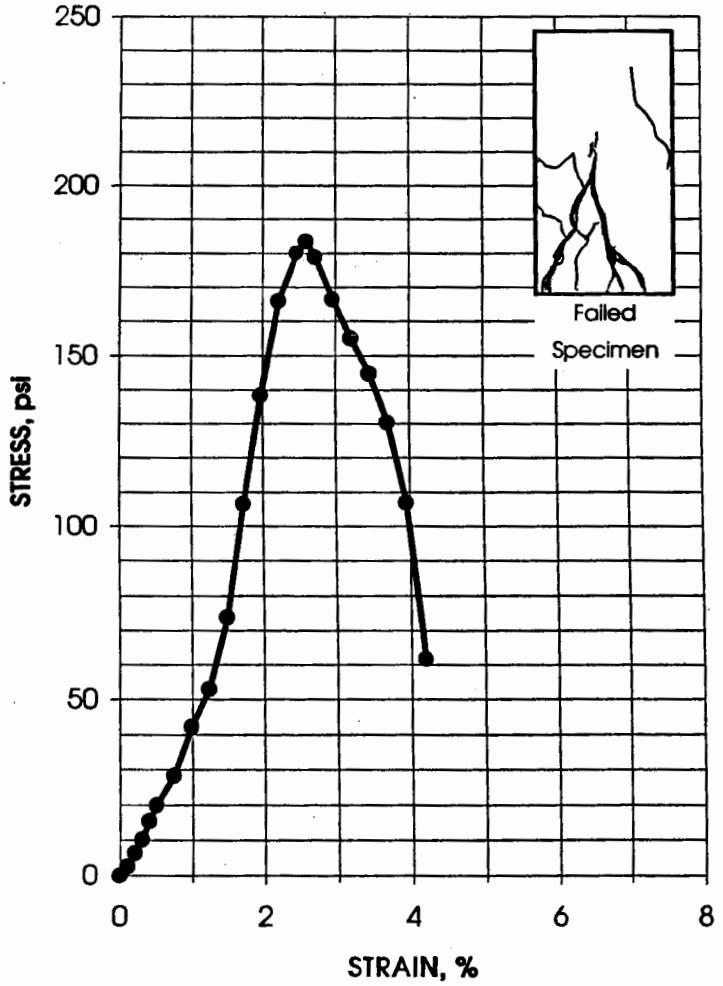
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-33-03
IT Lab No. Tuff/Sed Mix 2

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**183**
STRAIN AT FAILURE, %	**2.6**

Specimen Height, in.	4.0487
Specimen Diameter, in.	2.0038
Specimen Weight, g.	381.90
Moisture Content, %	24.2
Wet Unit Weight, pcf.	114.0
Dry Unit Weight, pcf.	91.8
Rate of Strain, in./min.	0.0691

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	10
0.40	15
0.49	20
0.74	28
0.99	42
1.23	53
1.48	74
1.73	107
1.98	138
2.22	166
2.47	180
2.59	183
2.72	179
2.96	166
3.21	155
3.46	145
3.70	130
3.95	107
4.20	62
4.45	50
4.69	39



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

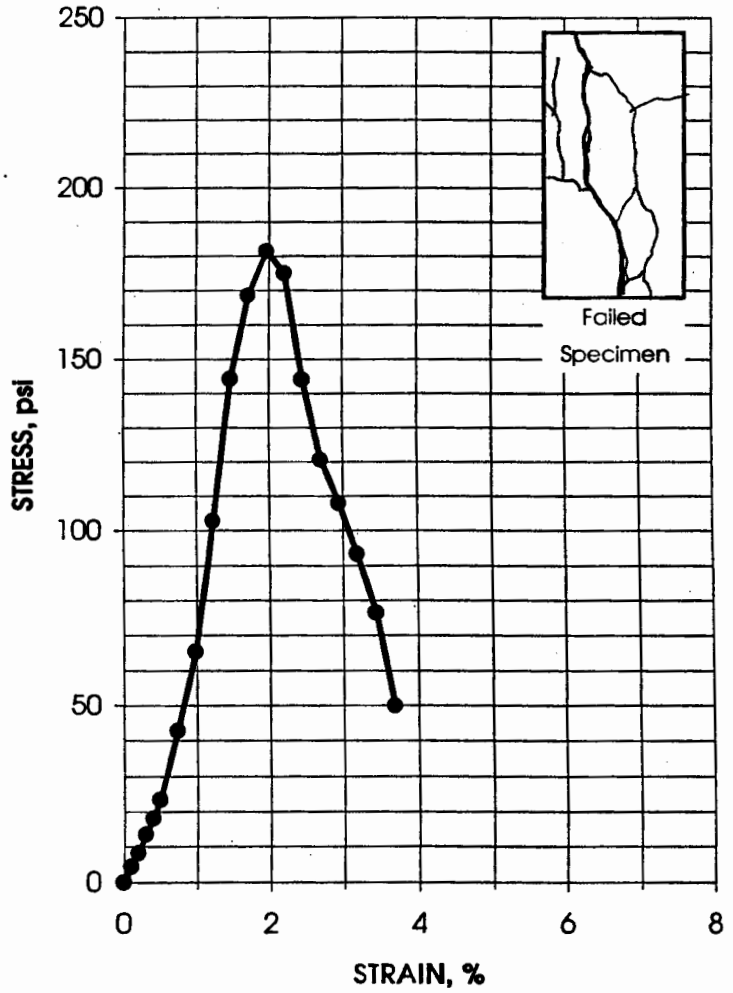
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-34-08
IT Lab No. Tuff/Sed Mix 3

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**181**
STRAIN AT FAILURE, %	**2.0**

Specimen Height, in.	4.0723
Specimen Diameter, in.	2.0133
Specimen Weight, g.	383.58
Moisture Content, %	25.0
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	90.2
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	8
0.29	13
0.39	18
0.49	23
0.74	43
0.98	65
1.23	103
1.47	144
1.72	169
1.96	181
2.21	175
2.46	144
2.70	121
2.95	108
3.19	93
3.44	76
3.68	50



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

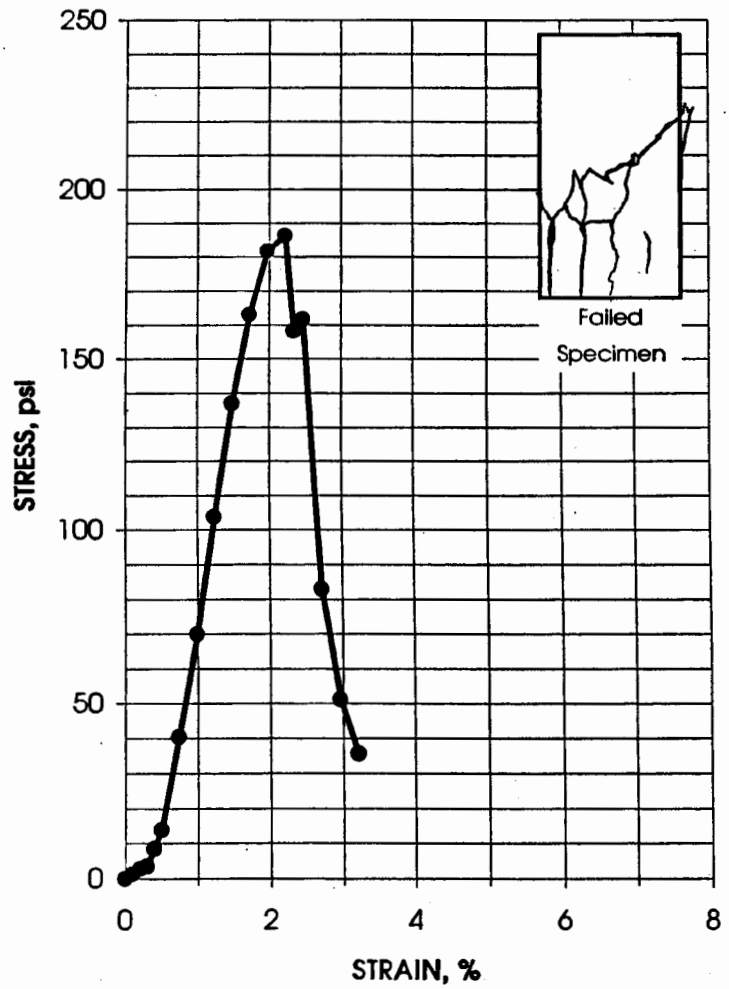
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-35-09
IT Lab No. Tuff/Sed Mix 4

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**186**
STRAIN AT FAILURE, %	**2.2**

Specimen Height, in.	4.0480
Specimen Diameter, in.	2.0092
Specimen Weight, g.	372.69
Moisture Content, %	26.0
Wet Unit Weight, pcf.	110.6
Dry Unit Weight, pcf.	87.8
Rate of Strain, in./min.	0.0550

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	3
0.40	8
0.49	14
0.74	40
0.99	70
1.24	104
1.48	137
1.73	163
1.98	182
2.22	186
2.35	158
2.47	162
2.72	83
2.96	51
3.21	36



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

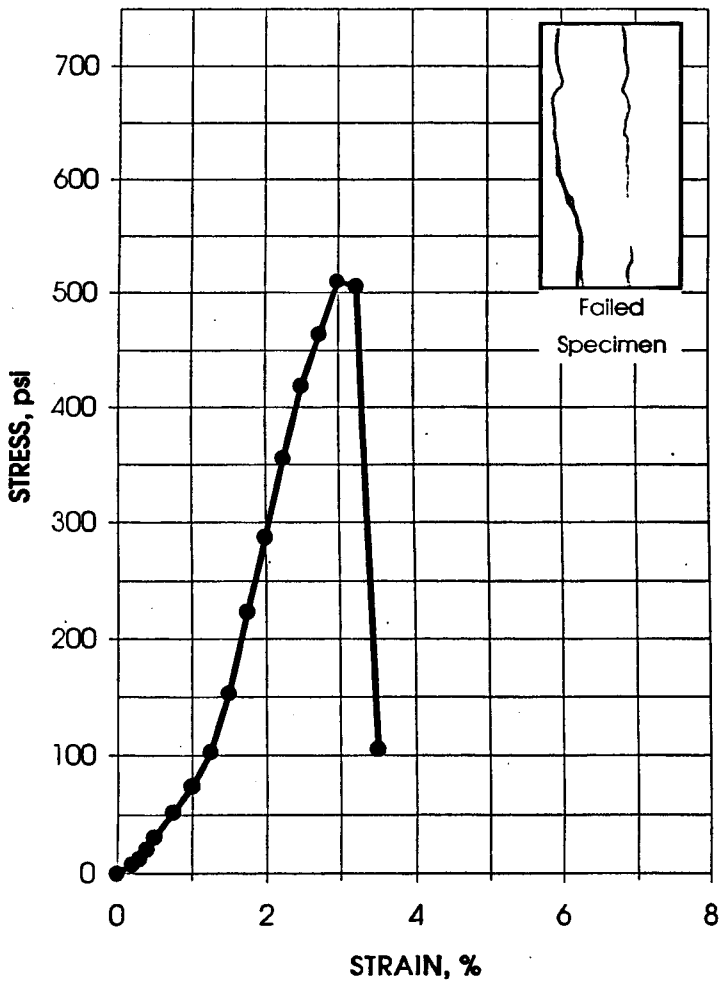
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-36-04
IT Lab No. Tuff/Sed Mix 5

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**509**
STRAIN AT FAILURE, %	**3.0**

Specimen Height, in.	4.0063
Specimen Diameter, in.	2.0133
Specimen Weight, g.	379.08
Moisture Content, %	21.4
Wet Unit Weight, pcf.	113.2
Dry Unit Weight, pcf.	93.3
Rate of Strain, in./min.	0.0596

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.20	7
0.30	12
0.40	20
0.50	30
0.75	52
1.00	74
1.25	103
1.50	153
1.75	223
2.00	287
2.25	355
2.50	418
2.75	464
3.00	509
3.24	506
3.49	105



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

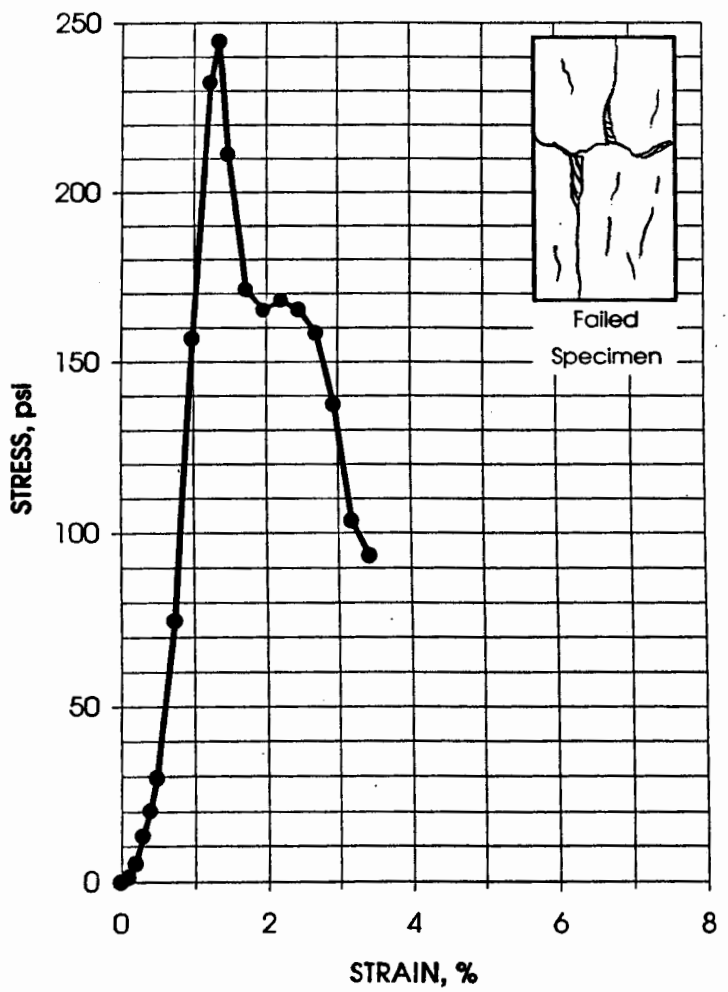
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-37-07
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 6

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0758
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0068
		Specimen Weight, g.	367.34
STRESS AT FAILURE, psi	**245**	Moisture Content, %	22.4
STRAIN AT FAILURE, %	**1.3**	Wet Unit Weight, pcf.	108.6
		Dry Unit Weight, pcf.	88.7
		Rate of Strain, in./min.	0.0447

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	5
0.29	13
0.39	20
0.49	30
0.74	75
0.98	157
1.23	232
1.35	245
1.47	211
1.72	171
1.96	165
2.21	168
2.45	165
2.70	158
2.94	137
3.19	103
3.43	93



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

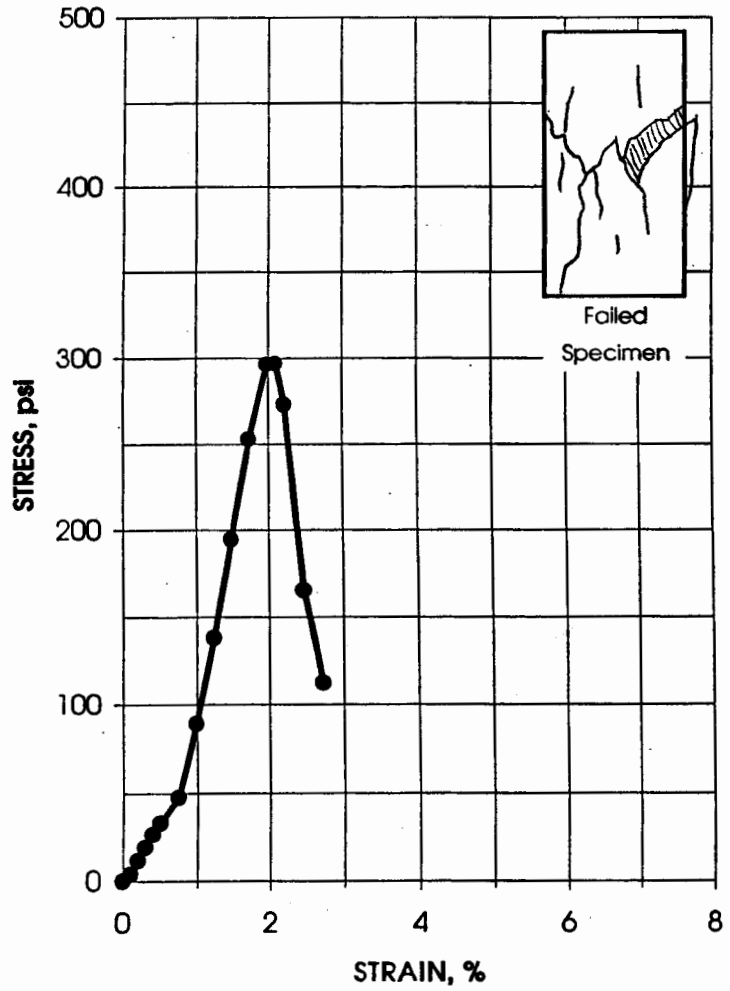
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-38-01
IT Lab No. Tuff/Sed Mix 7

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**297**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0457
Specimen Diameter, in.	2.0112
Specimen Weight, g.	367.36
Moisture Content, %	22.8
Wet Unit Weight, pcf.	108.9
Dry Unit Weight, pcf.	88.7
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	11
0.30	19
0.40	26
0.49	33
0.74	47
0.99	89
1.24	138
1.48	195
1.73	253
1.98	296
2.10	297
2.22	273
2.47	165
2.72	112



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

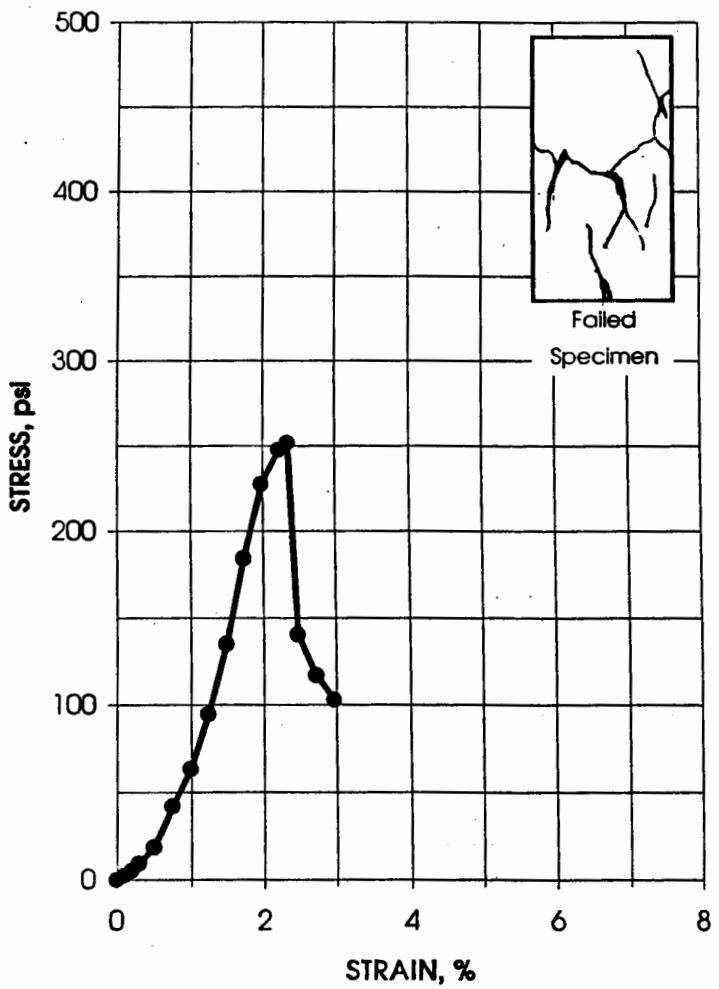
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-39-08
IT Lab No. Tuff/Sed Mix 8

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**252**
STRAIN AT FAILURE, %	**2.3**

Specimen Height, in.	4.0436
Specimen Diameter, in.	2.0096
Specimen Weight, g.	377.26
Moisture Content, %	27.8
Wet Unit Weight, pcf.	112.1
Dry Unit Weight, pcf.	87.7
Rate of Strain, in./min.	0.0720

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	5
0.30	9
0.49	19
0.74	42
0.99	63
1.24	95
1.48	135
1.73	184
1.98	227
2.23	248
2.35	252
2.47	140
2.72	117
2.97	103



28-Day UCS Tests

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

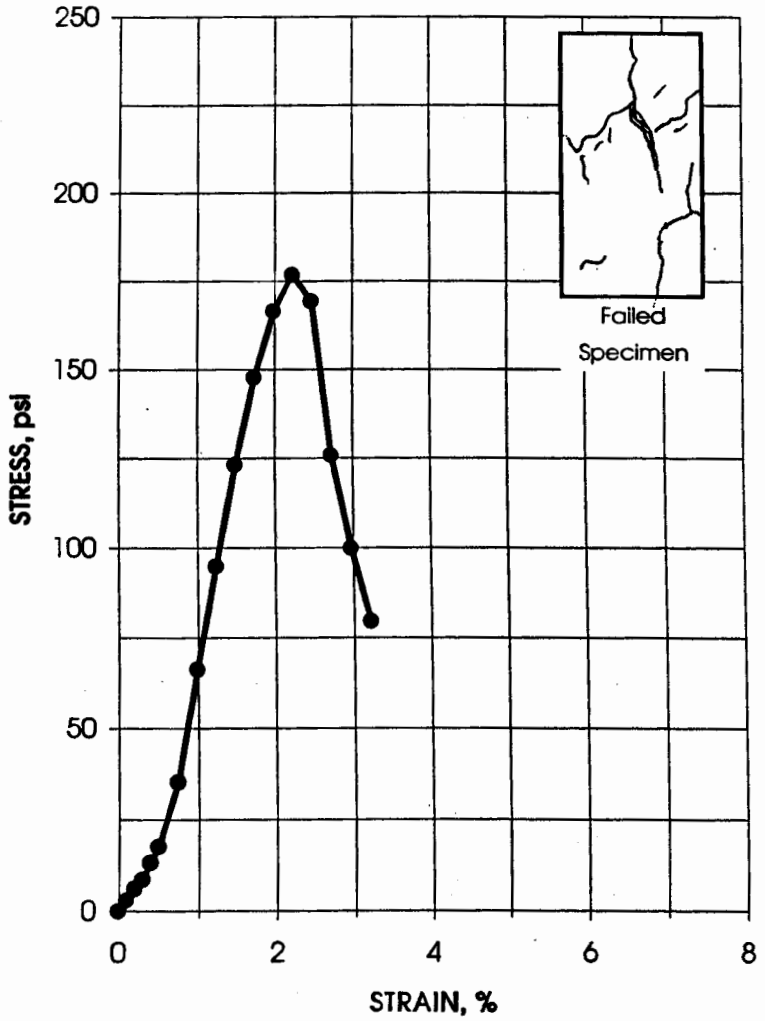
Client Sample No. 1108-06-02
IT Lab No. Sediment mix 1

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **177**
STRAIN AT FAILURE, % **2.2**

Specimen Height, in.	4.0363
Specimen Diameter, in.	2.0142
Specimen Weight, g.	387.60
Moisture Content, %	20.2
Wet Unit Weight, pcf.	114.8
Dry Unit Weight, pcf.	95.6
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	8
0.40	13
0.50	17
0.74	35
0.99	66
1.24	95
1.49	123
1.73	148
1.98	166
2.23	177
2.48	169
2.73	126
2.97	100
3.22	80



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

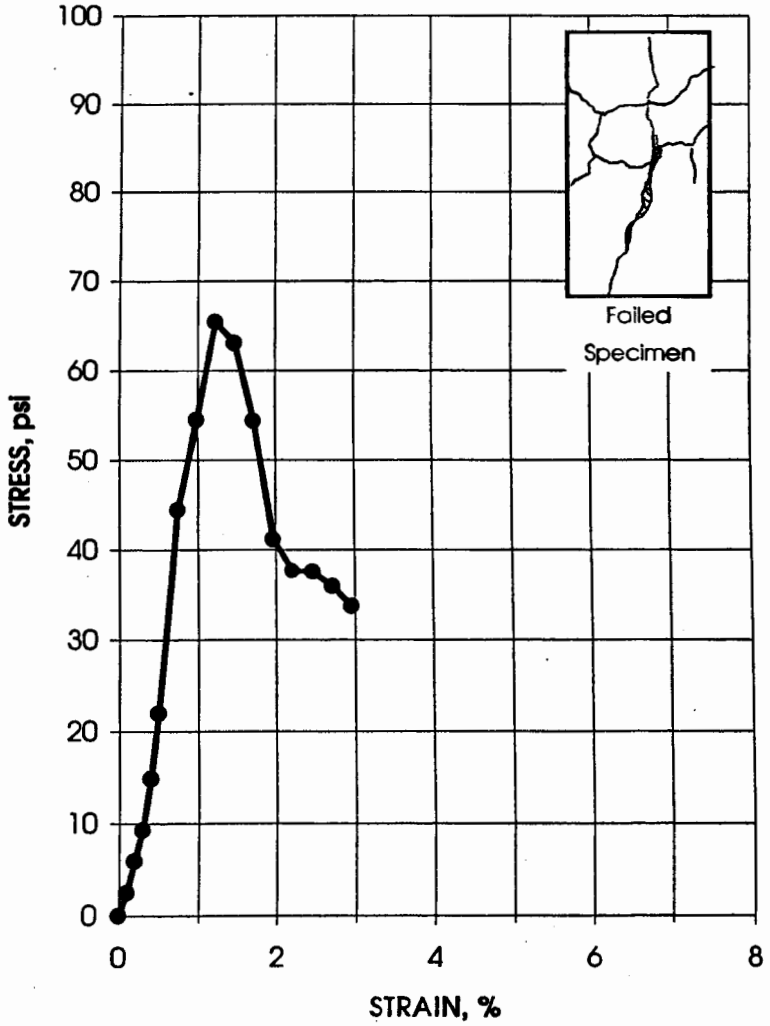
Client Sample No. 1108-07-02
IT Lab No. Sediment mix 2

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **65**
STRAIN AT FAILURE, % **1.2**

Specimen Height, in.	4.0577
Specimen Diameter, in.	2.0245
Specimen Weight, g.	359.67
Moisture Content, %	14.6
Wet Unit Weight, pcf.	104.9
Dry Unit Weight, pcf.	91.6
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	6
0.30	9
0.39	15
0.49	22
0.74	44
0.99	54
1.23	65
1.48	63
1.73	54
1.97	41
2.22	38
2.46	38
2.71	36
2.96	34



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

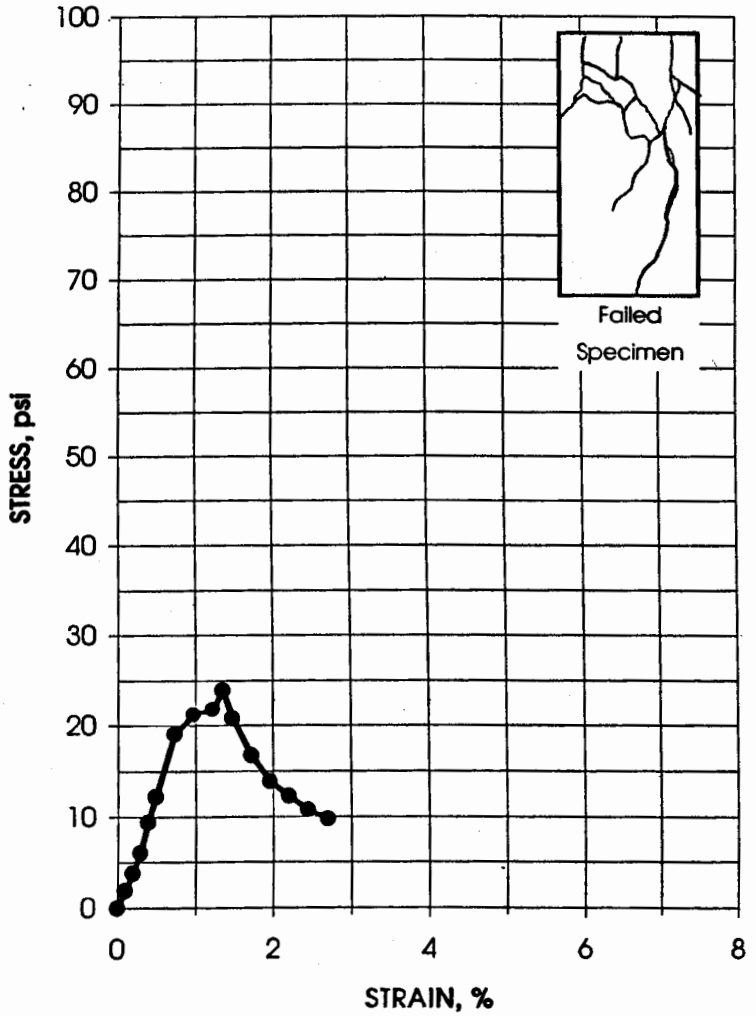
Client Sample No. 1108-08-02
IT Lab No. Sediment mix 3 (a)

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **24**
STRAIN AT FAILURE, % **1.4**

Specimen Height, in.	4.0700
Specimen Diameter, in.	2.0115
Specimen Weight, g.	333.57
Moisture Content, %	16.9
Wet Unit Weight, pcf.	98.3
Dry Unit Weight, pcf.	84.1
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	4
0.29	6
0.39	9
0.49	12
0.74	19
0.98	21
1.23	22
1.35	24
1.47	21
1.72	17
1.97	14
2.21	12
2.46	11
2.70	10



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

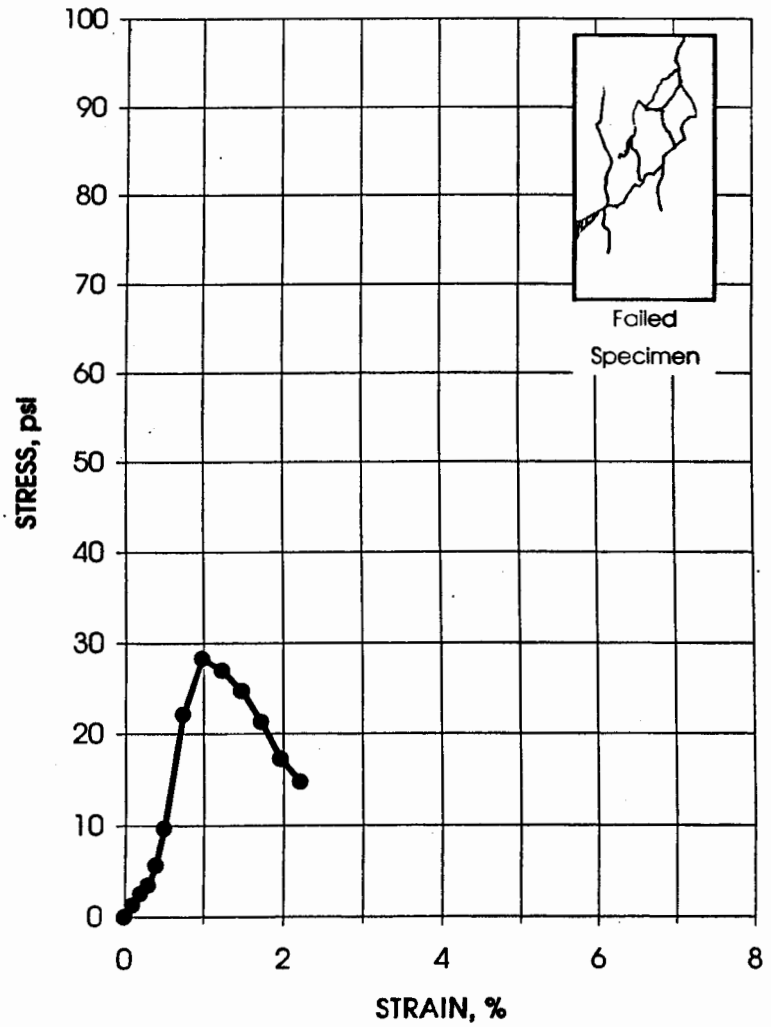
Client Sample No. 1108-08-10
IT Lab No. Sediment mix 3 (b)

Specimen Mold Date
Specimen Test Date 1/17/02

STRESS AT FAILURE, psi **28**
STRAIN AT FAILURE, % **1.0**

Specimen Height, in.	4.0613
Specimen Diameter, in.	2.0142
Specimen Weight, g.	337.01
Moisture Content, %	17.2
Wet Unit Weight, pcf.	99.2
Dry Unit Weight, pcf.	84.7
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	3
0.39	6
0.49	10
0.74	22
0.98	28
1.23	27
1.48	25
1.72	21
1.97	17
2.22	15



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

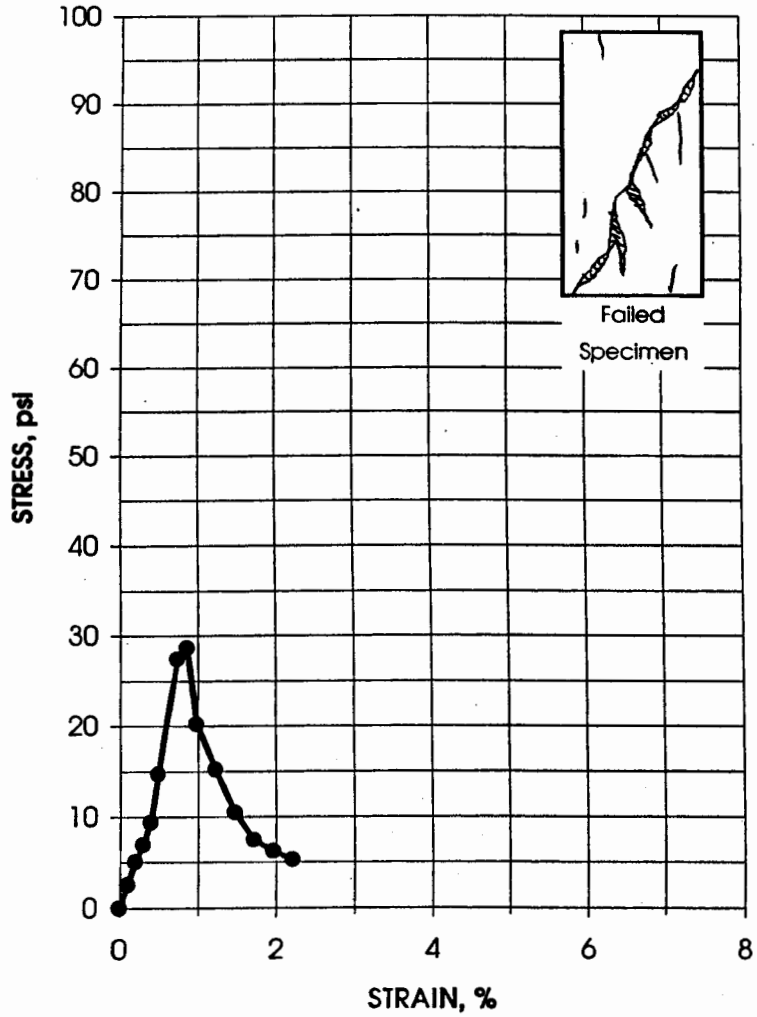
Client Sample No. 1108-09-02
IT Lab No. Sediment mix 4 (a)

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **29**
STRAIN AT FAILURE, % **0.9**

Specimen Height, in.	4.0673
Specimen Diameter, in.	2.0137
Specimen Weight, g.	347.71
Moisture Content, %	17.7
Wet Unit Weight, pcf.	102.3
Dry Unit Weight, pcf.	86.9
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	5
0.30	7
0.39	9
0.49	15
0.74	27
0.86	29
0.98	20
1.23	15
1.48	11
1.72	7
1.97	6
2.21	5



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

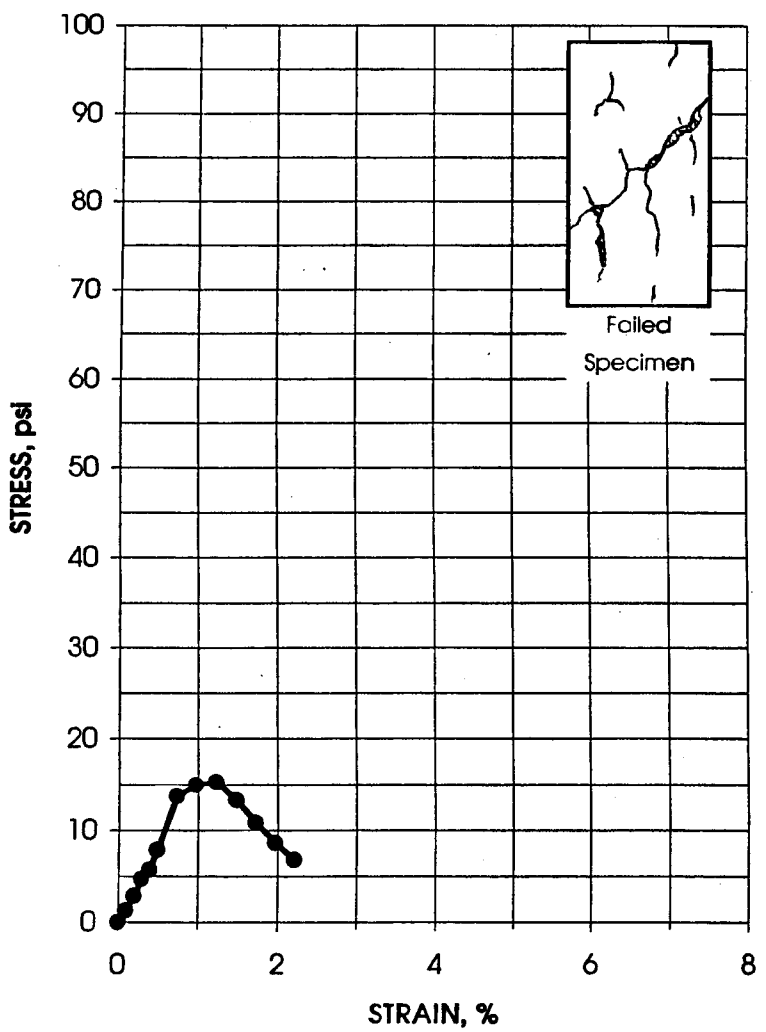
Client Sample No. 1108-09-11
IT Lab No. Sediment mix 4 (b)

Specimen Mold Date
Specimen Test Date 1/17/02

STRESS AT FAILURE, psi **15**
STRAIN AT FAILURE, % **1.2**

Specimen Height, in.	4.0588
Specimen Diameter, in.	2.0097
Specimen Weight, g.	328.47
Moisture Content, %	16.9
Wet Unit Weight, pcf.	97.2
Dry Unit Weight, pcf.	83.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	5
0.39	6
0.49	8
0.74	14
0.99	15
1.23	15
1.48	13
1.72	11
1.97	9
2.22	7



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

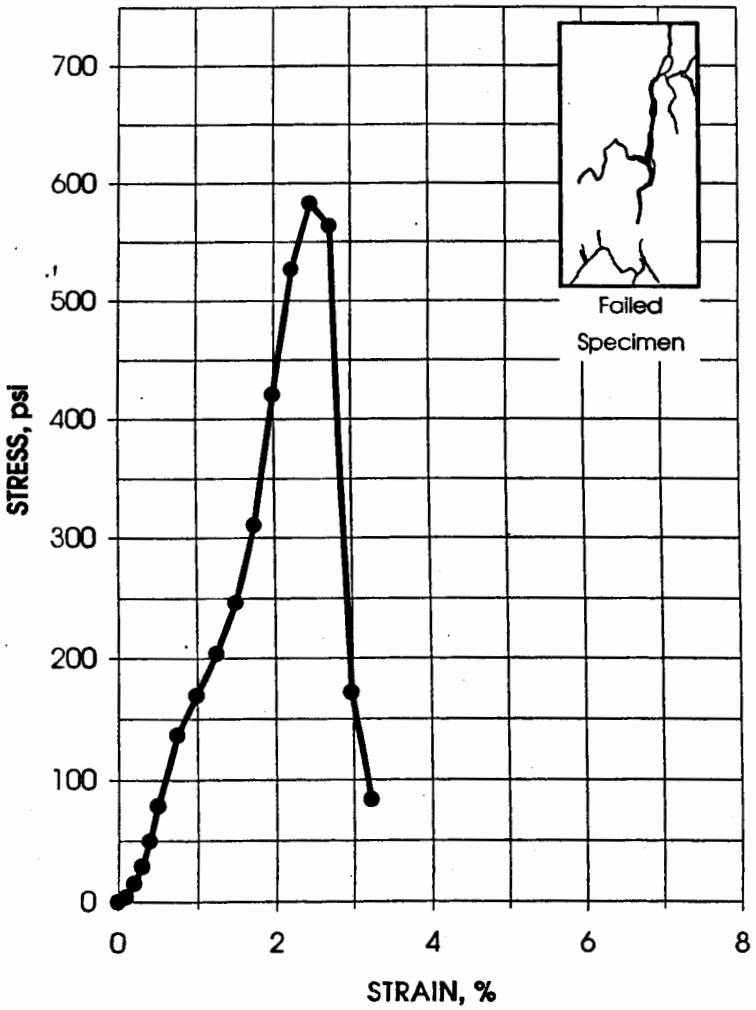
Client Sample No. 1108-10-02
IT Labn No. Sediment mix 5

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **583**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0272
Specimen Diameter, in.	2.0152
Specimen Weight, g.	383.08
Moisture Content, %	25.9
Wet Unit Weight, pcf.	113.6
Dry Unit Weight, pcf.	90.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	15
0.30	29
0.40	50
0.50	79
0.74	137
0.99	169
1.24	203
1.49	246
1.74	310
1.99	421
2.23	527
2.48	583
2.73	564
2.98	172
3.23	84



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

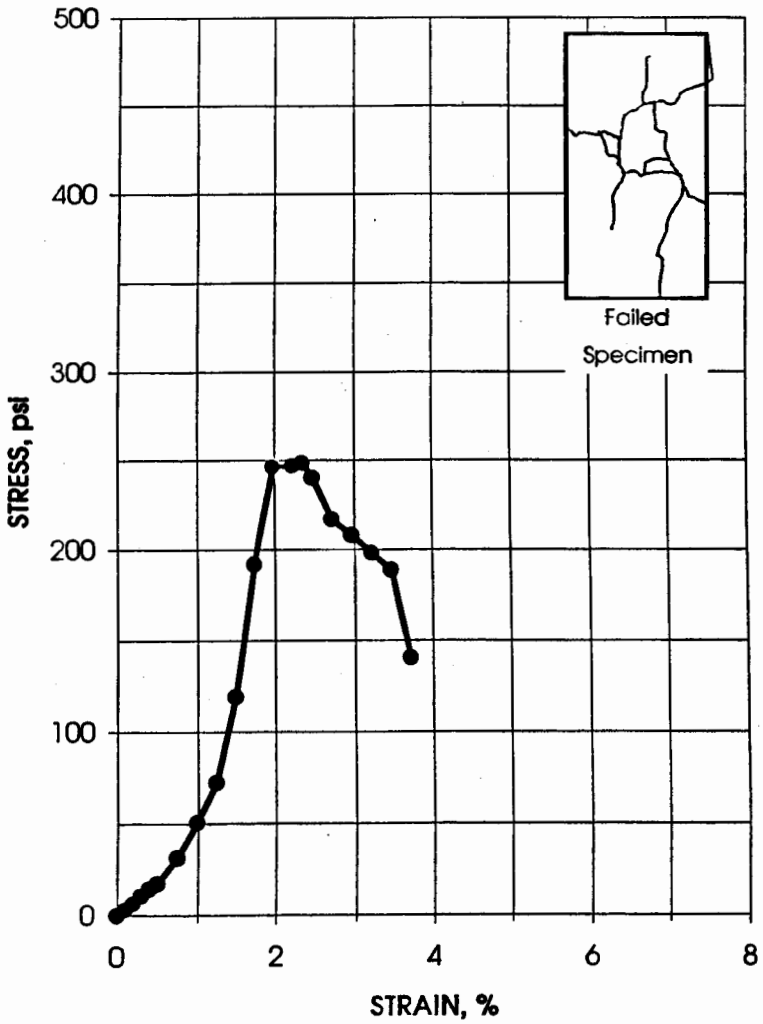
Client Sample No. 1108-11-02
IT Lab No. Sediment 6 (a)

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **248**
STRAIN AT FAILURE, % **2.3**

Specimen Height, in.	4.0435
Specimen Diameter, in.	2.0145
Specimen Weight, g.	375.18
Moisture Content, %	20.9
Wet Unit Weight, pcf.	110.9
Dry Unit Weight, pcf.	91.8
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	11
0.40	14
0.49	17
0.74	31
0.99	50
1.24	73
1.48	119
1.73	192
1.98	246
2.23	247
2.35	248
2.47	240
2.72	217
2.97	208
3.22	198
3.46	189
3.71	140



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

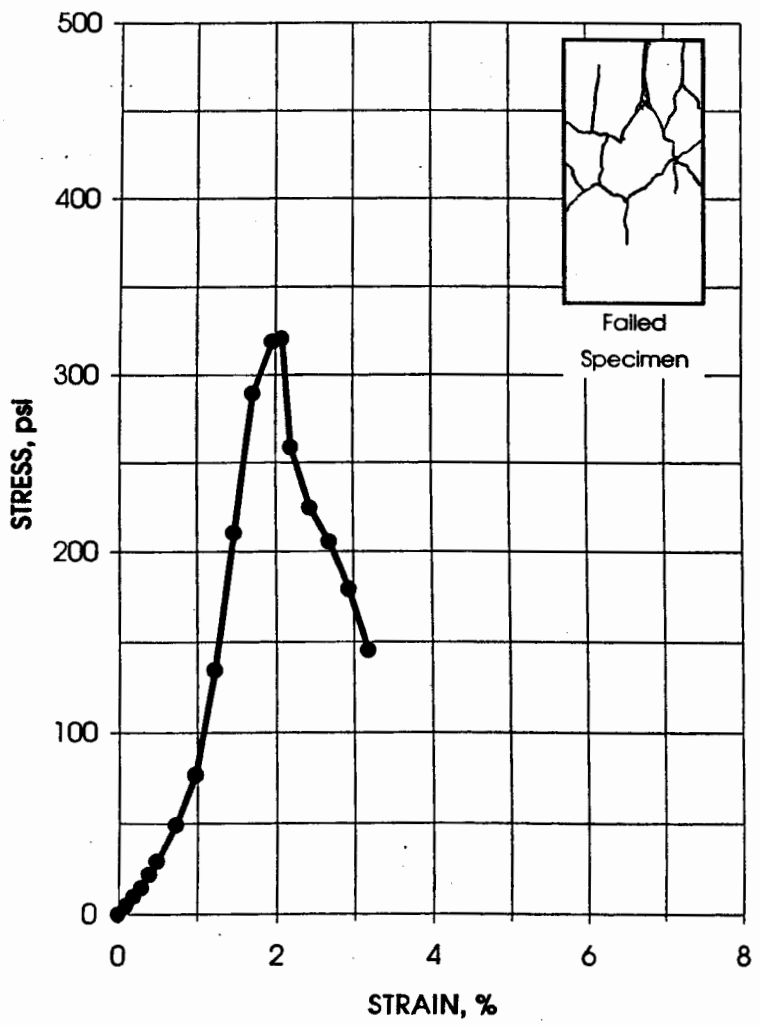
Client Sample No. 1108-11-11
IT Lab No. Sediment 6 (b)

Specimen Mold Date
Specimen Test Date 1/17/02

STRESS AT FAILURE, psi **320**
STRAIN AT FAILURE, % **2.1**

Specimen Height, in.	4.0792
Specimen Diameter, in.	2.0117
Specimen Weight, g.	384.70
Moisture Content, %	20.9
Wet Unit Weight, pcf.	113.1
Dry Unit Weight, pcf.	93.5
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.29	14
0.39	22
0.49	29
0.74	49
0.98	76
1.23	134
1.47	210
1.72	289
1.96	319
2.08	320
2.21	259
2.45	225
2.70	205
2.94	179
3.19	145



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

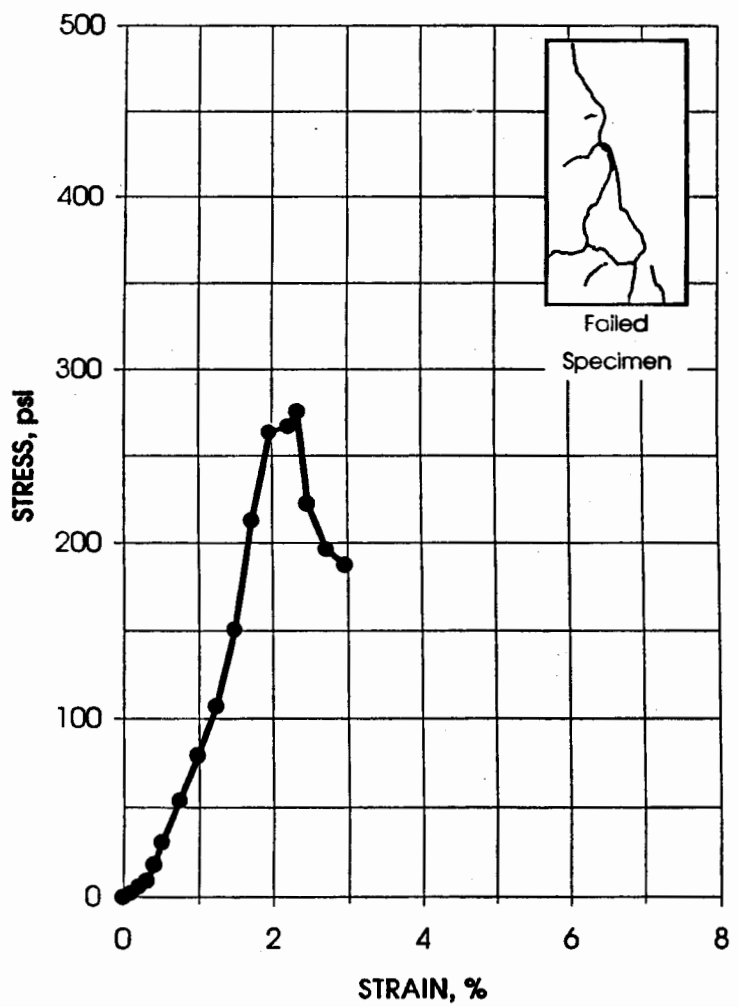
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-12-02
IT Lab No. Sediment mix 7

Specimen Mold Date	
Specimen Test Date	1/16/02
STRESS AT FAILURE, psi	**275**
STRAIN AT FAILURE, %	**2.3**

Specimen Height, in.	4.0507
Specimen Diameter, in.	2.0103
Specimen Weight, g.	374.49
Moisture Content, %	22.5
Wet Unit Weight, pcf.	111.0
Dry Unit Weight, pcf.	90.6
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	6
0.30	9
0.39	18
0.49	30
0.74	54
0.99	79
1.23	107
1.48	151
1.73	213
1.97	263
2.22	267
2.35	275
2.47	222
2.72	196
2.96	187



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

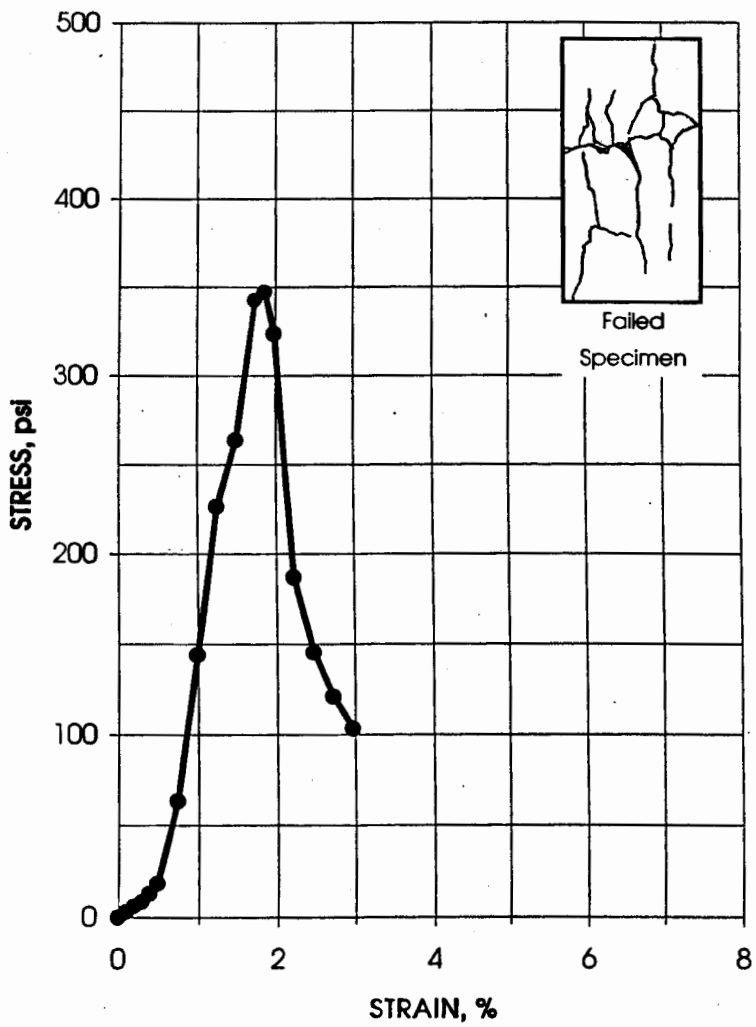
Client Sample No. 1108-13-02
IT Lab No.

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **347**
STRAIN AT FAILURE, % **1.9**

Specimen Height, in.	4.0353
Specimen Diameter, in.	2.0088
Specimen Weight, g.	373.52
Moisture Content, %	25.1
Wet Unit Weight, pcf.	111.3
Dry Unit Weight, pcf.	88.9
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	8
0.40	13
0.50	19
0.74	63
0.99	144
1.24	226
1.49	264
1.73	343
1.86	347
1.98	323
2.23	187
2.48	145
2.73	121
2.97	103



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

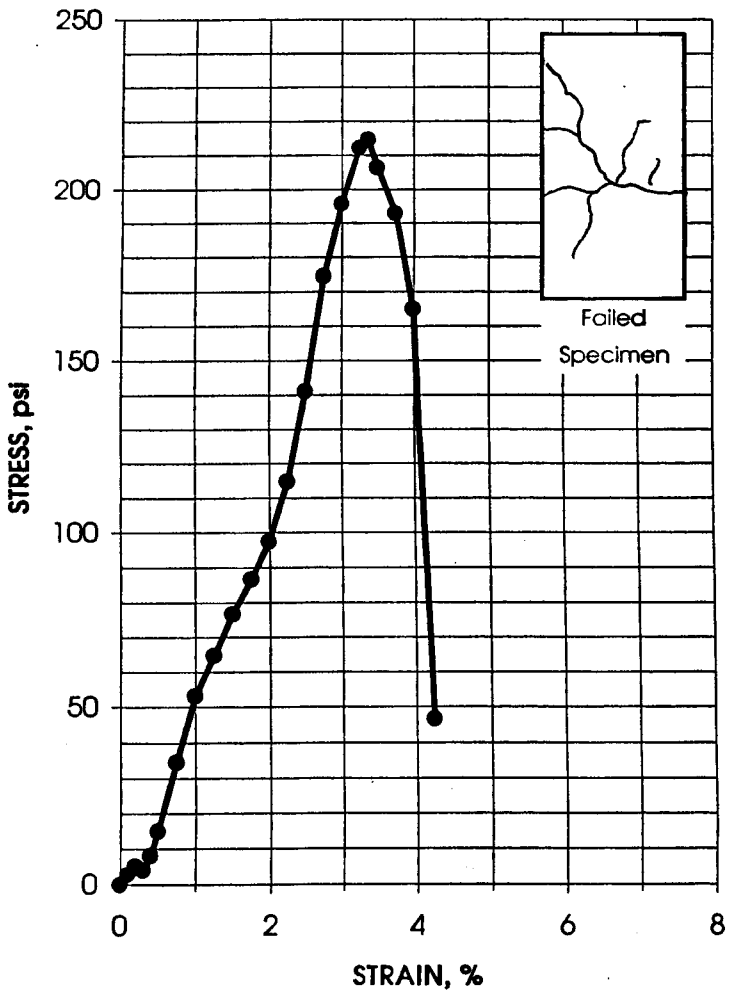
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-32-10
IT Lab No. Tuff/Sed Mix 1

Specimen Mold Date	1/24/02
Specimen Test Date	2/8/02
STRESS AT FAILURE, psi	**215**
STRAIN AT FAILURE, %	**3.4**

Specimen Height, in.	4.0087
Specimen Diameter, in.	2.0147
Specimen Weight, g.	386.96
Moisture Content, %	20.6
Wet Unit Weight, pcf.	115.4
Dry Unit Weight, pcf.	95.7
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	5
0.30	4
0.40	8
0.50	15
0.75	35
1.00	53
1.25	65
1.50	77
1.75	87
2.00	97
2.25	115
2.49	141
2.74	175
2.99	196
3.24	212
3.37	215
3.49	206
3.74	193
3.99	165
4.24	47



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

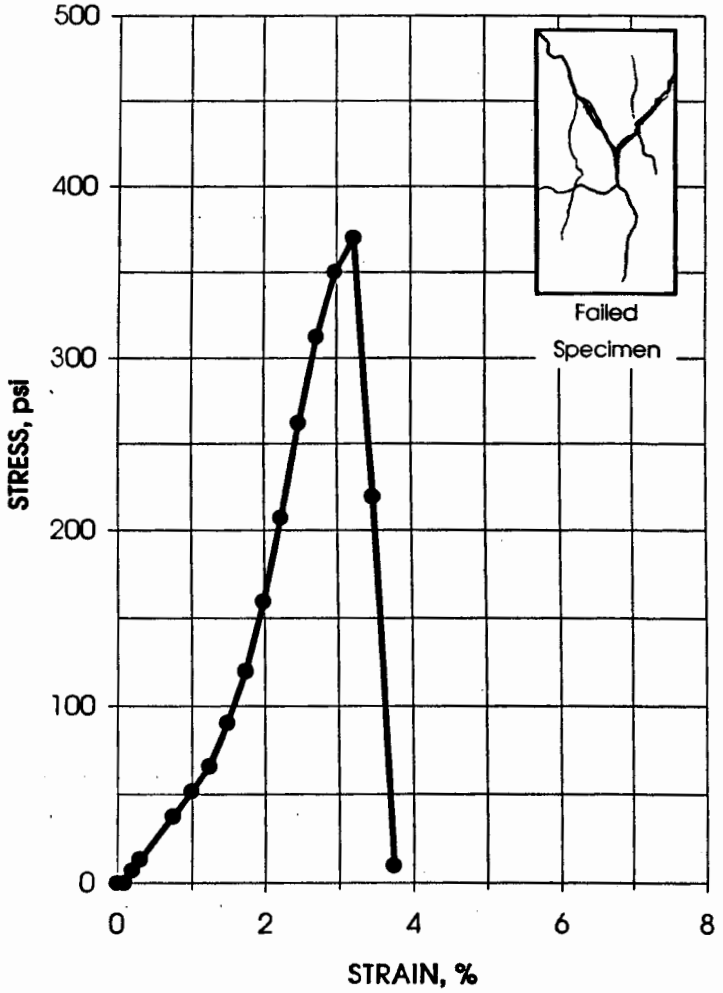
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-14-11
Project No.	831775.00000000	IT Lab No.	Tuff Mix 1

Specimen Mold Date		Specimen Height, in.	4.0245
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0110
		Specimen Weight, g.	390.15
STRESS AT FAILURE, psi	**370**	Moisture Content, %	21.0
STRAIN AT FAILURE, %	**3.2**	Wet Unit Weight, pcf.	116.3
		Dry Unit Weight, pcf.	96.1
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	0
0.20	7
0.30	13
0.75	37
0.99	51
1.24	66
1.49	90
1.74	120
1.99	160
2.24	207
2.48	262
2.73	312
2.98	350
3.23	370
3.48	219
3.73	10



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

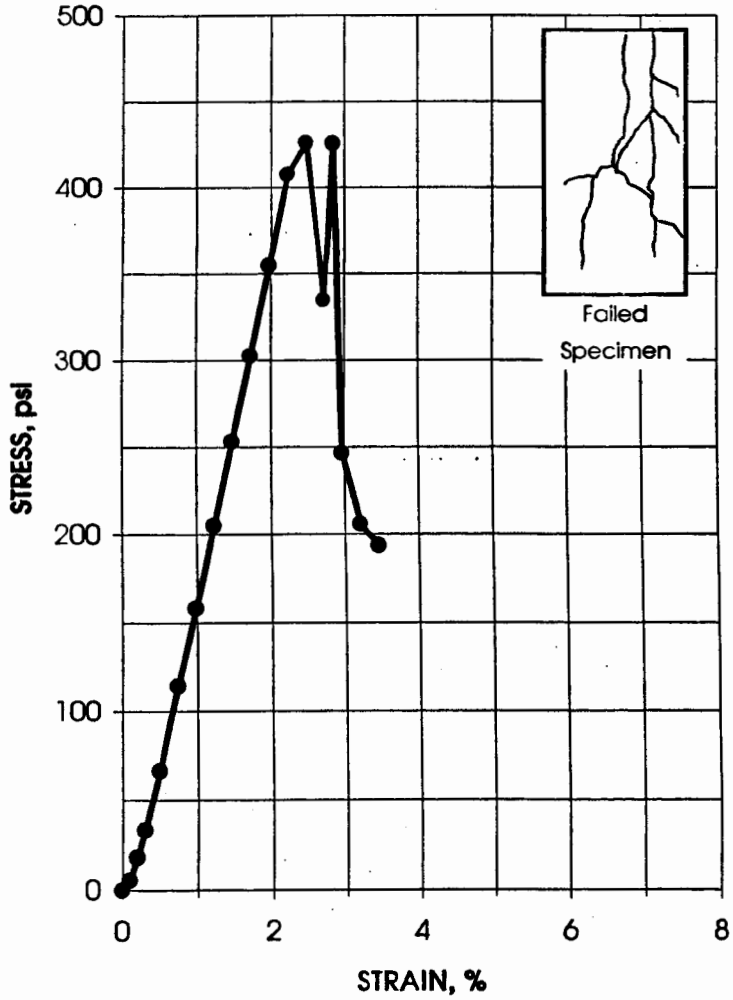
Client Sample No. 1108-15-11
IT Lab No. Tuff Mix 2

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **426**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0433
Specimen Diameter, in.	2.0037
Specimen Weight, g.	388.67
Moisture Content, %	20.0
Wet Unit Weight, pcf.	116.2
Dry Unit Weight, pcf.	96.8
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	18
0.30	33
0.49	67
0.74	114
0.99	158
1.24	205
1.48	253
1.73	303
1.98	355
2.23	408
2.47	426
2.72	335
2.84	426
2.97	246
3.22	206
3.46	194



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

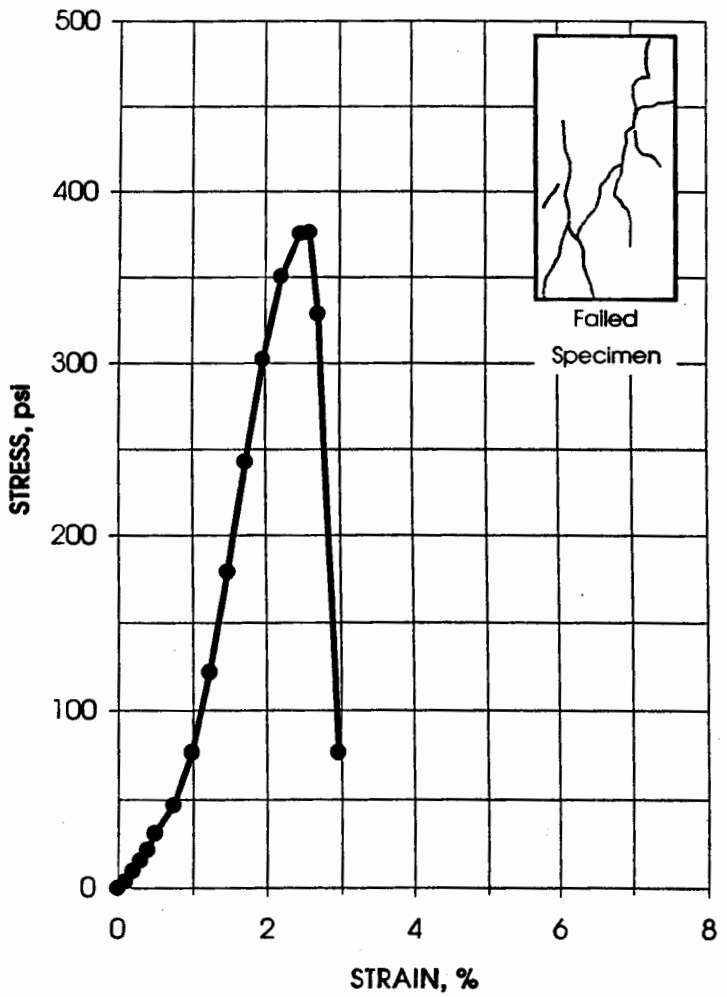
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-16-11
Project No.	831775.00000000	IT Lab No.	Tuff-Mix 3

Specimen Mold Date		Specimen Height, in.	4.0577
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0107
		Specimen Weight, g.	383.82
STRESS AT FAILURE, psi	**376**	Moisture Content, %	21.8
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	113.5
		Dry Unit Weight, pcf.	93.2
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.30	15
0.39	21
0.49	31
0.74	47
0.99	76
1.23	122
1.48	179
1.73	243
1.97	302
2.22	350
2.46	375
2.59	376
2.71	329
2.96	76



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

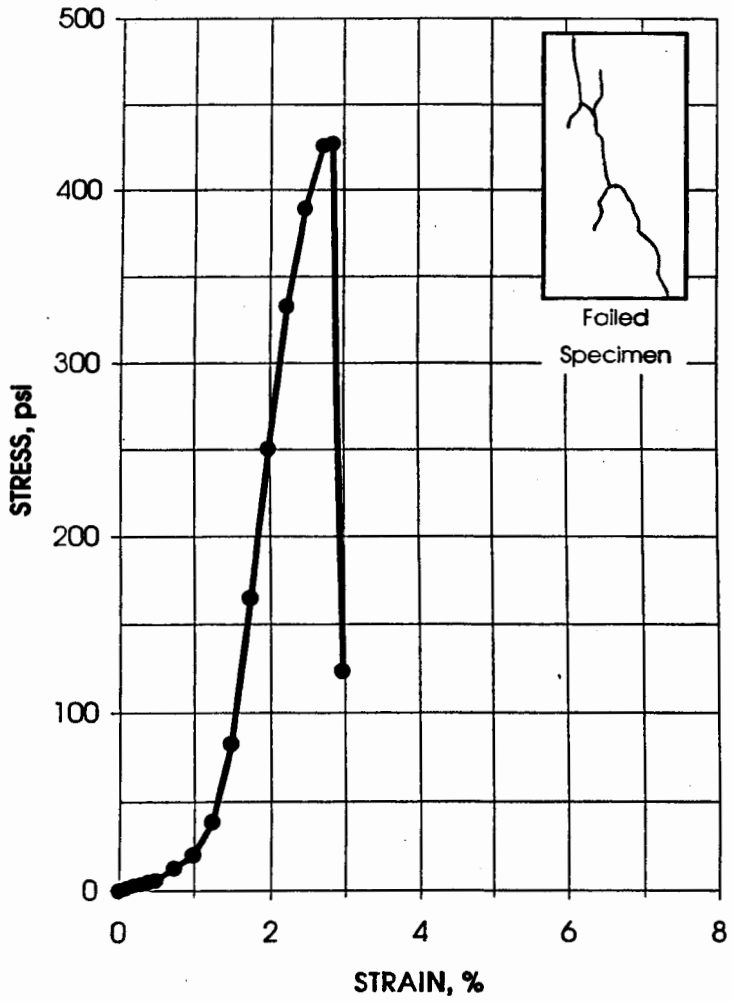
Client Sample No. 1108-17-11
IT Lab No. Tuff Mix 4

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **427**
STRAIN AT FAILURE, % **2.8**

Specimen Height, in.	4.0380
Specimen Diameter, in.	2.0108
Specimen Weight, g.	379.13
Moisture Content, %	22.5
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	92.0
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	3
0.40	5
0.50	6
0.74	13
0.99	20
1.24	39
1.49	82
1.73	165
1.98	250
2.23	333
2.48	389
2.72	426
2.85	427
2.97	123



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

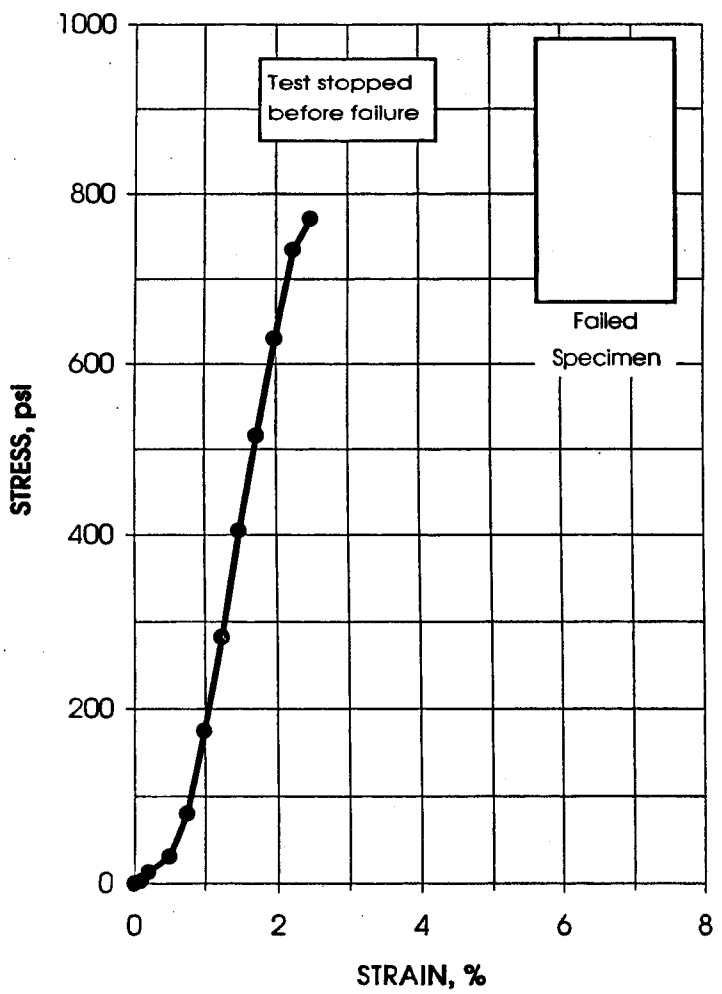
Client Sample No. 1108-18-11
IT Lab No. Tuff Mix 5

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **771**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0307
Specimen Diameter, in.	2.0092
Specimen Weight, g.	388.66
Moisture Content, %	22.3
Wet Unit Weight, pcf.	115.9
Dry Unit Weight, pcf.	94.8
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	13
0.50	30
0.74	80
0.99	174
1.24	282
1.49	405
1.74	515
1.98	629
2.23	734
2.48	771



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

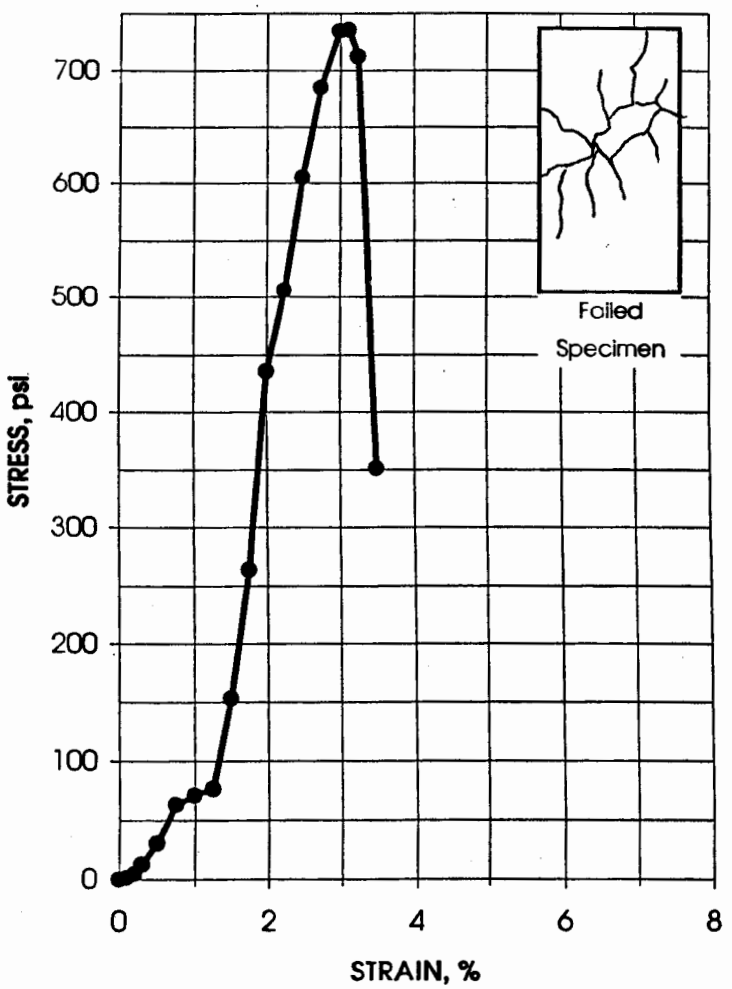
Client Sample No. 1108-19-11
IT Lab No. Tuff Mix 6

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **736**
STRAIN AT FAILURE, % **3.1**

Specimen Height, in.	4.0115
Specimen Diameter, in.	2.0033
Specimen Weight, g.	382.59
Moisture Content, %	20.3
Wet Unit Weight, pcf.	115.3
Dry Unit Weight, pcf.	95.9
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	4
0.30	13
0.50	31
0.75	63
1.00	71
1.25	76
1.50	153
1.74	264
1.99	436
2.24	506
2.49	605
2.74	685
2.99	735
3.12	736
3.24	712
3.49	351



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

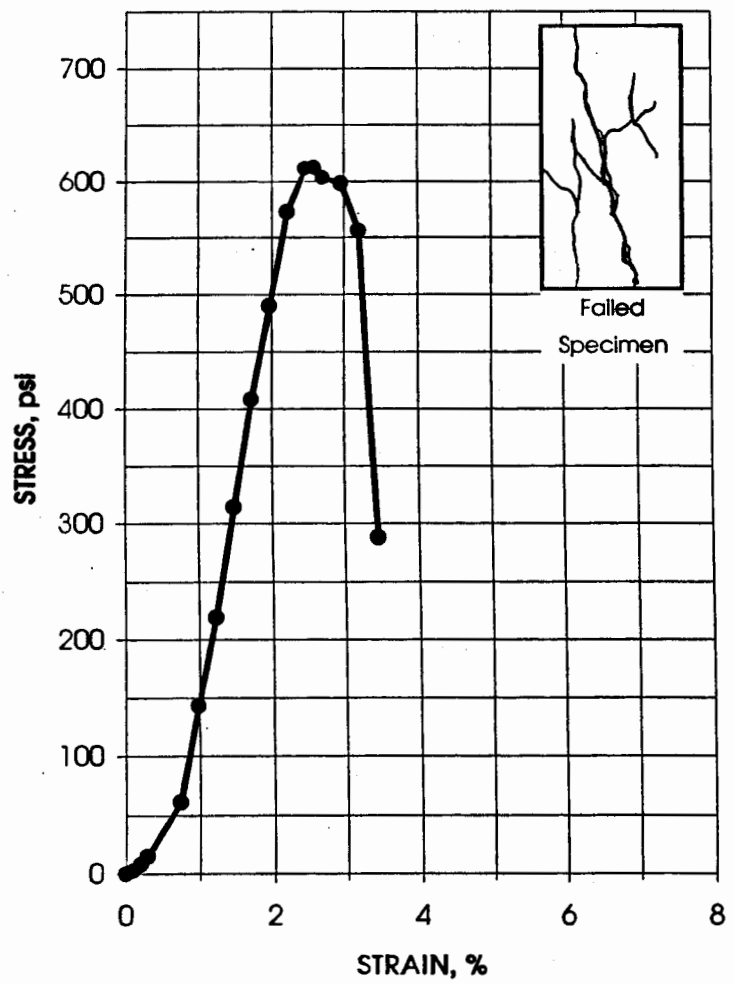
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-20-11
Project No.	831775.00000000	IT Labn No.	Tuff Mix 7

Specimen Mold Date		Specimen Height, in.	4.0533
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0135
		Specimen Weight, g.	376.86
STRESS AT FAILURE, psi	**612**	Moisture Content, %	23.0
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	111.3
		Dry Unit Weight, pcf.	90.4
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	8
0.30	15
0.74	61
0.99	143
1.23	219
1.48	314
1.73	408
1.97	490
2.22	573
2.47	611
2.59	612
2.71	603
2.96	598
3.21	556
3.45	288



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

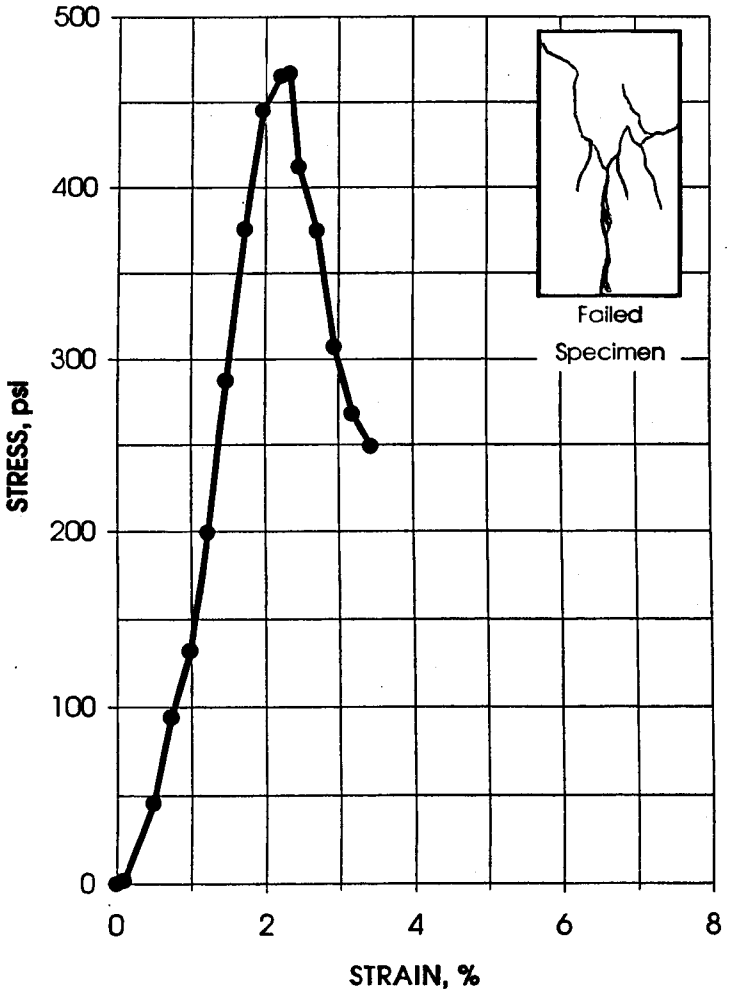
Client Sample No. 1108-21-11
IT Lab No. Tuff Mix 8

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **467**
STRAIN AT FAILURE, % **2.3**

Specimen Height, in.	4.0700
Specimen Diameter, in.	2.0117
Specimen Weight, g.	374.40
Moisture Content, %	25.0
Wet Unit Weight, pcf.	110.3
Dry Unit Weight, pcf.	88.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.49	46
0.74	94
0.98	132
1.23	199
1.47	288
1.72	375
1.97	445
2.21	465
2.33	467
2.46	412
2.70	375
2.95	307
3.19	268
3.44	249



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

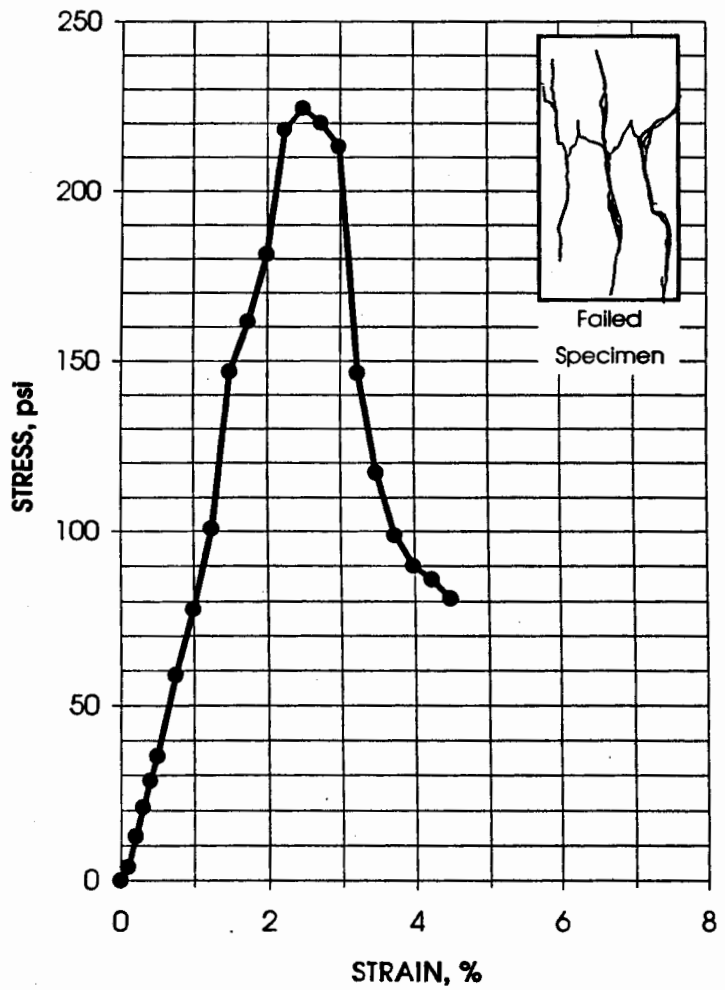
Client Sample No. 1108-23-08
IT Lab No. Soil Mix 1

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **224**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0168
Specimen Diameter, in.	2.0015
Specimen Weight, g.	372.56
Moisture Content, %	24.4
Wet Unit Weight, pcf.	112.3
Dry Unit Weight, pcf.	90.3
Rate of Strain, in./min.	0.0643

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	13
0.30	21
0.40	28
0.50	35
0.75	59
1.00	78
1.24	101
1.49	147
1.74	161
1.99	181
2.24	218
2.49	224
2.74	220
2.99	213
3.24	146
3.49	117
3.73	99
3.98	90
4.23	86
4.48	81



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

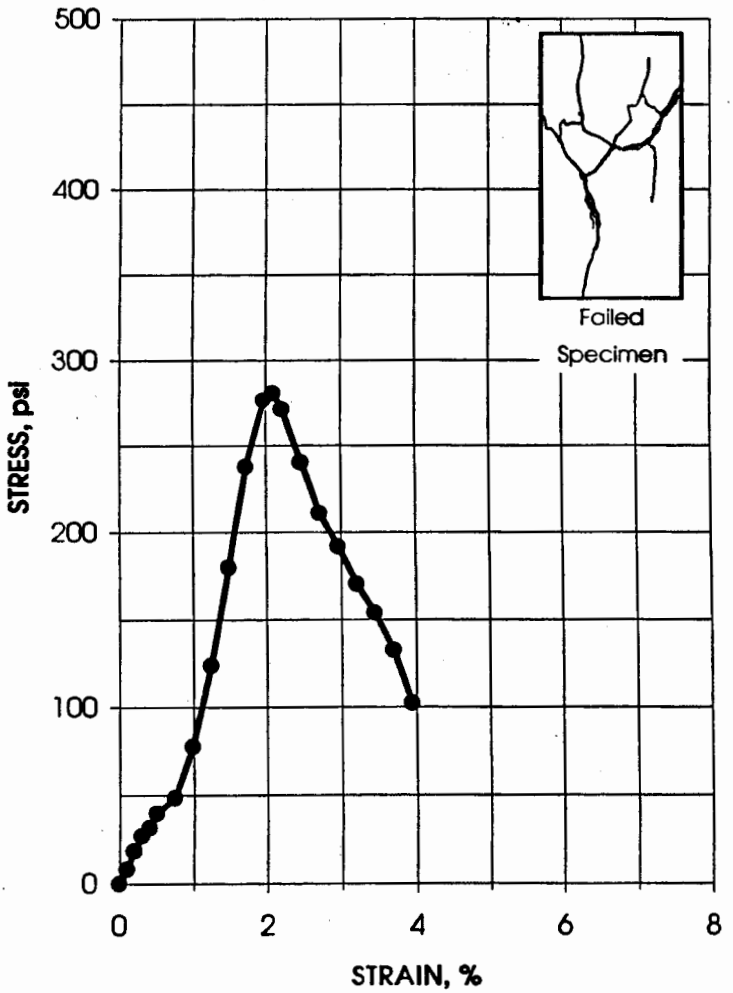
Client Sample No. 1108-24-02
IT Lab No. Soil Mix 2

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **281**
STRAIN AT FAILURE, % **2.1**

Specimen Height, in.	4.0573
Specimen Diameter, in.	2.0075
Specimen Weight, g.	380.45
Moisture Content, %	22.3
Wet Unit Weight, pcf.	112.9
Dry Unit Weight, pcf.	92.3
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	8
0.20	19
0.30	27
0.39	32
0.49	40
0.74	49
0.99	78
1.23	124
1.48	180
1.73	238
1.97	277
2.09	281
2.22	271
2.46	240
2.71	211
2.96	192
3.20	171
3.45	154
3.70	133
3.94	102



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

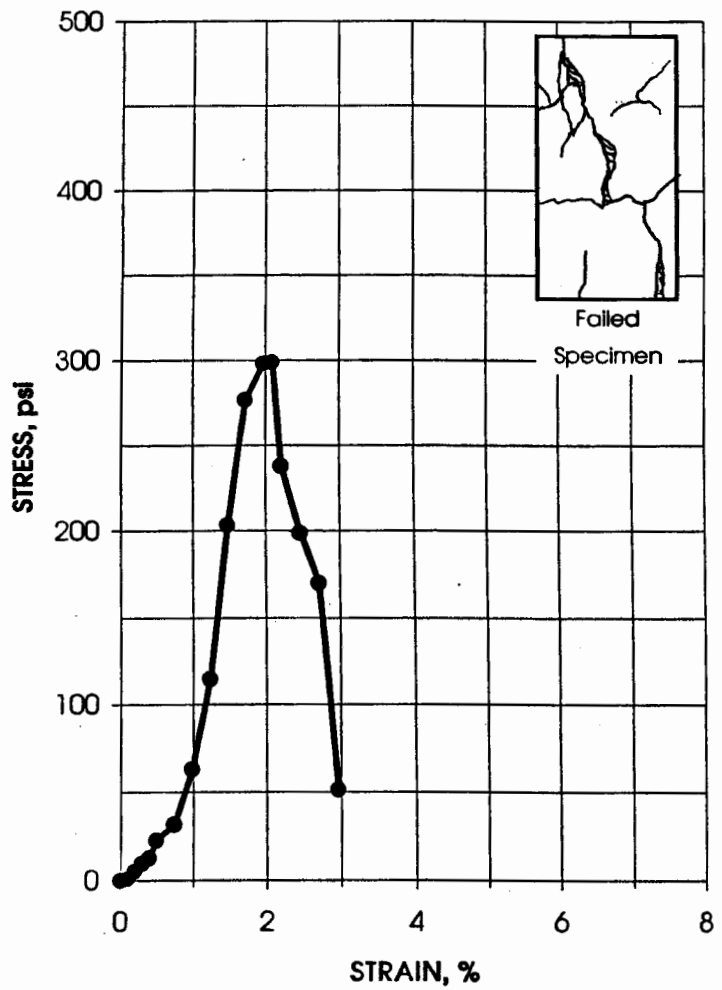
Client Sample No. 1108-25-03
IT Lab No. Soil Mix 3

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **299**
STRAIN AT FAILURE, % **2.1**

Specimen Height, in.	4.0545
Specimen Diameter, in.	2.0093
Specimen Weight, g.	372.23
Moisture Content, %	23.2
Wet Unit Weight, pcf.	110.3
Dry Unit Weight, pcf.	89.5
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	5
0.30	9
0.39	13
0.49	23
0.74	32
0.99	63
1.23	114
1.48	203
1.73	277
1.97	298
2.10	299
2.22	238
2.47	199
2.71	170
2.96	51



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

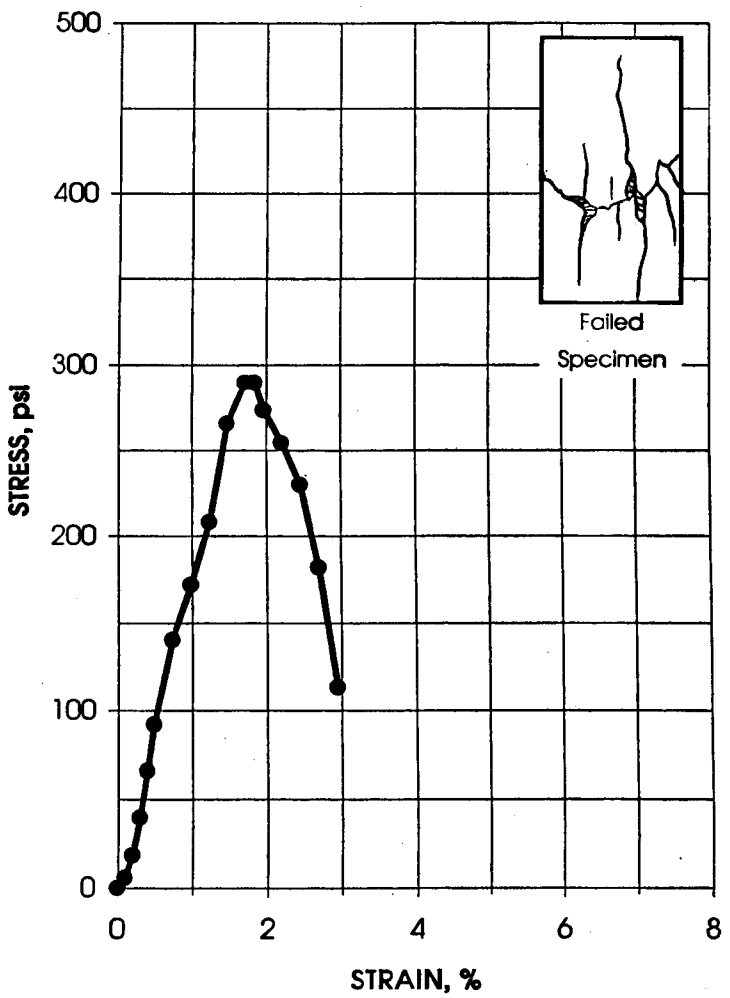
Client Sample No. 1108-26-06
IT Lab No. Soil Mix 4

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **290**
STRAIN AT FAILURE, % **1.7**

Specimen Height, in.	4.0728
Specimen Diameter, in.	2.0020
Specimen Weight, g.	371.98
Moisture Content, %	25.9
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	87.8
Rate of Strain, in./min.	0.0626

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	18
0.29	40
0.39	66
0.49	92
0.74	141
0.98	172
1.23	208
1.47	266
1.72	290
1.84	290
1.96	274
2.21	254
2.46	230
2.70	182
2.95	113



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

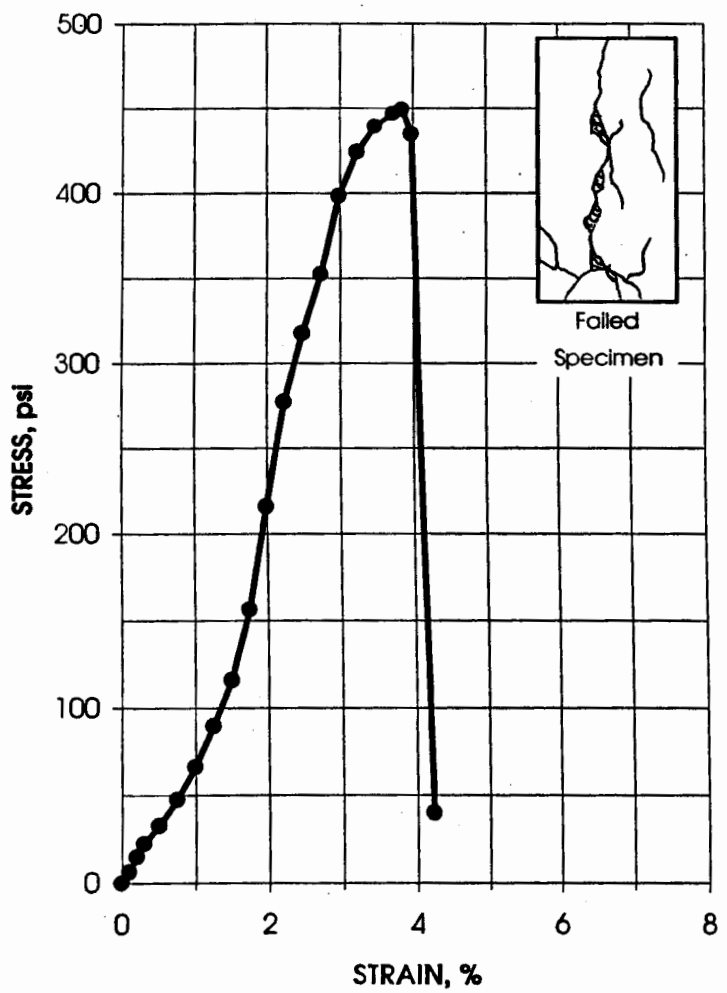
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-27-02
Project No.	831775.00000000	IT Lab No.	Soil Mix 5

Specimen Mold Date		Specimen Height, in.	4.0217
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0103
		Specimen Weight, g.	367.22
STRESS AT FAILURE, psi	**449**	Moisture Content, %	30.2
STRAIN AT FAILURE, %	**3.9**	Wet Unit Weight, pcf.	109.6
		Dry Unit Weight, pcf.	84.2
		Rate of Strain, in./min.	0.0580

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	15
0.30	23
0.50	33
0.75	48
0.99	66
1.24	90
1.49	116
1.74	156
1.99	216
2.24	277
2.49	317
2.74	352
2.98	398
3.23	424
3.48	439
3.73	447
3.85	449
3.98	435
4.23	40



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

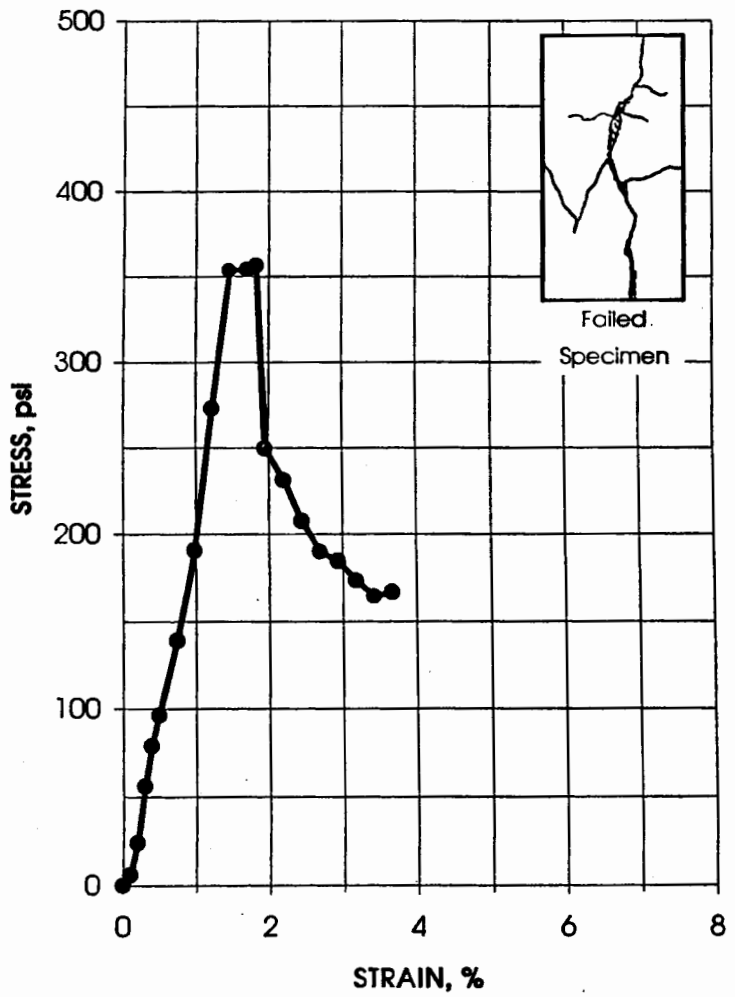
Client Sample No. 1108-28-01
IT Lab No. Soil Mix 6

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **356**
STRAIN AT FAILURE, % **1.8**

Specimen Height, in.	4.0867
Specimen Diameter, in.	2.0058
Specimen Weight, g.	374.18
Moisture Content, %	22.2
Wet Unit Weight, pcf.	110.4
Dry Unit Weight, pcf.	90.3
Rate of Strain, in./min.	0.0469

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	24
0.29	56
0.39	79
0.49	96
0.73	139
0.98	191
1.22	273
1.47	354
1.71	354
1.84	356
1.96	250
2.20	231
2.45	207
2.69	190
2.94	185
3.18	174
3.43	165
3.67	167



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

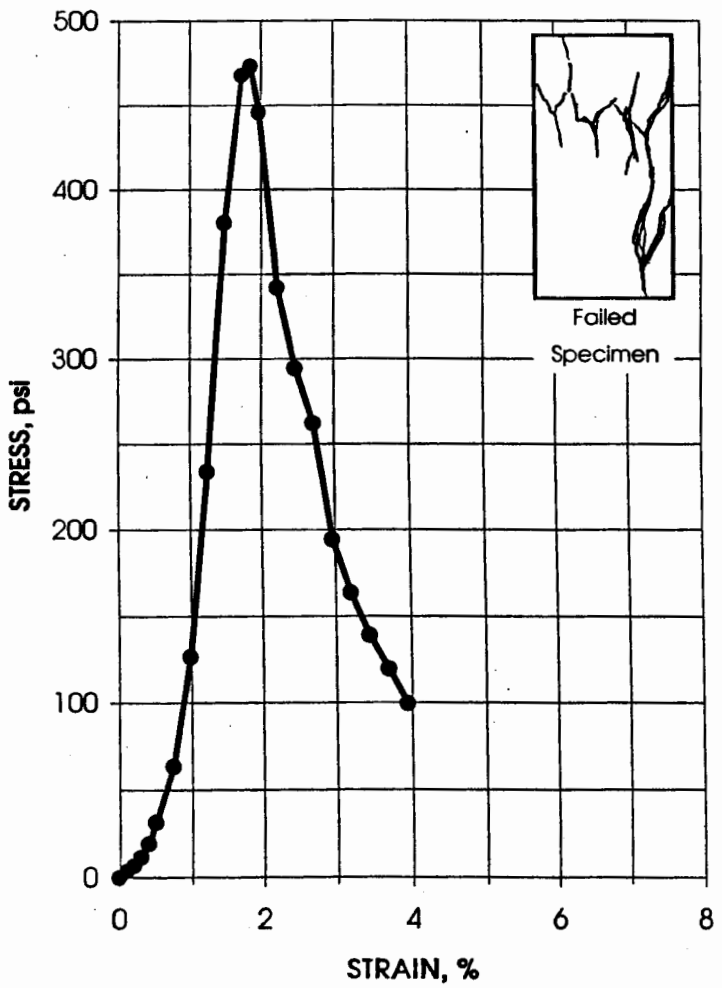
Client Sample No. 1108-29-01
IT Lab No. Soil Mix 7

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **473**
STRAIN AT FAILURE, % **1.9**

Specimen Height, in.	4.0533
Specimen Diameter, in.	2.0133
Specimen Weight, g.	365.98
Moisture Content, %	25.6
Wet Unit Weight, pcf.	108.1
Dry Unit Weight, pcf.	86.0
Rate of Strain, in./min.	0.0469

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	12
0.39	19
0.49	32
0.74	63
0.99	126
1.23	234
1.48	380
1.73	468
1.85	473
1.97	446
2.22	342
2.47	294
2.71	262
2.96	194
3.21	164
3.45	139
3.70	119
3.95	100



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

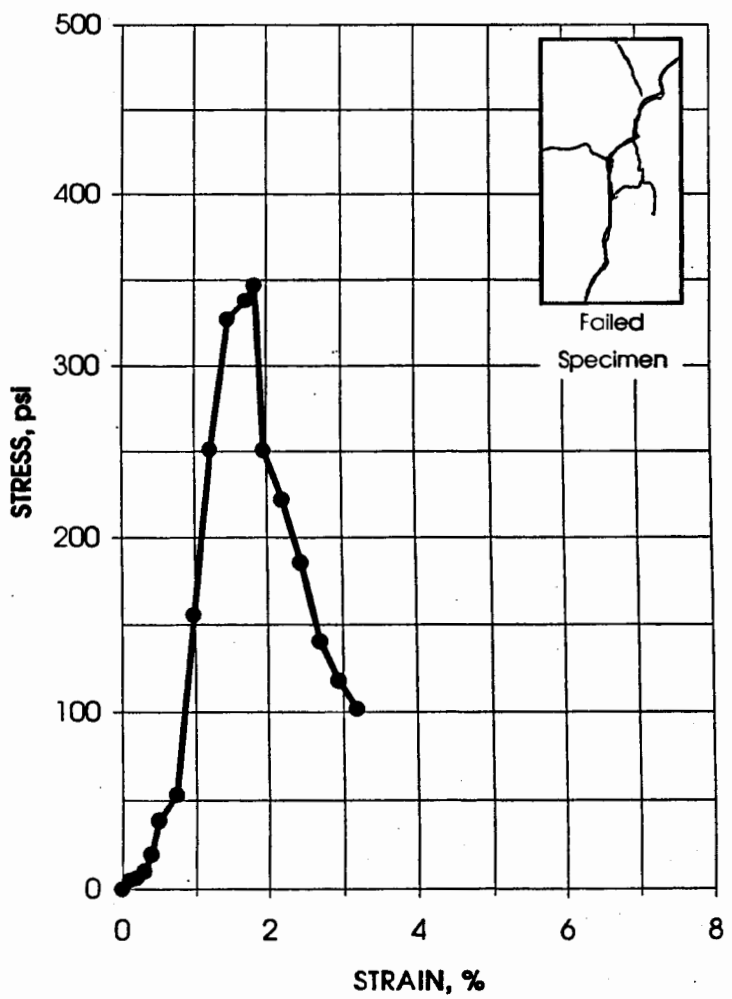
Client Sample No. 1108-30-02
IT Lab No. Soil Mix 8

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **347**
STRAIN AT FAILURE, % **1.8**

Specimen Height, in.	4.0807
Specimen Diameter, in.	2.0145
Specimen Weight, g.	373.80
Moisture Content, %	26.1
Wet Unit Weight, pcf.	109.5
Dry Unit Weight, pcf.	86.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	6
0.29	10
0.39	20
0.49	39
0.74	53
0.98	156
1.23	251
1.47	327
1.72	338
1.84	347
1.96	251
2.21	222
2.45	186
2.70	140
2.94	118
3.19	102



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

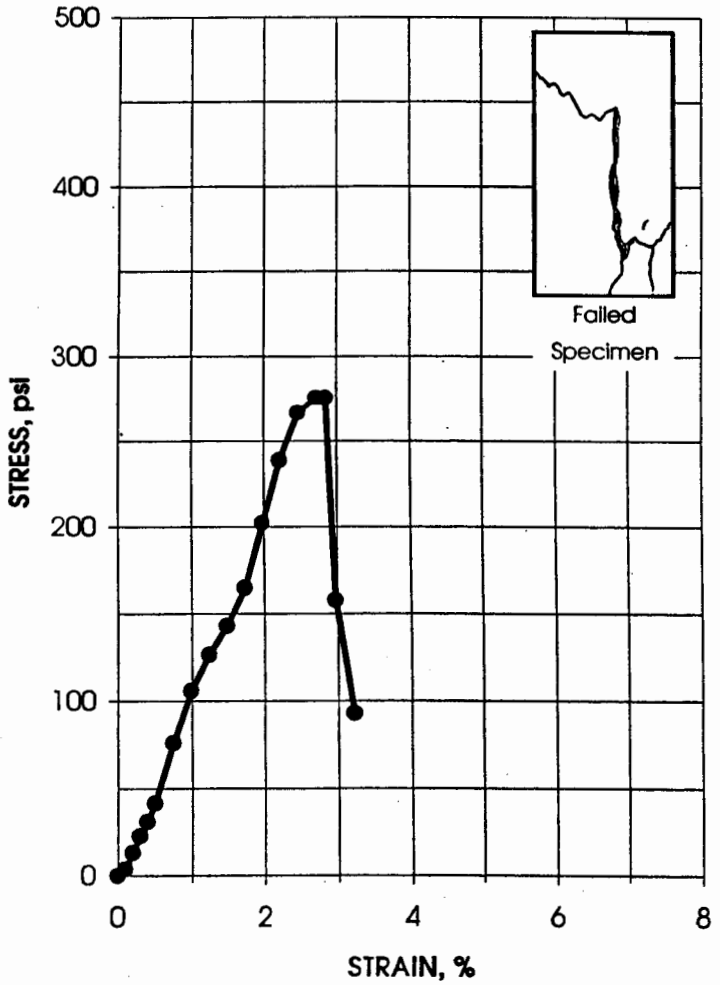
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-32-02
IT Lab No. Tuff/Sed Mix 1

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**276**
STRAIN AT FAILURE, %	**2.7**

Specimen Height, in.	4.0383
Specimen Diameter, in.	2.0112
Specimen Weight, g.	391.97
Moisture Content, %	23.0
Wet Unit Weight, pcf.	116.4
Dry Unit Weight, pcf.	94.7
Rate of Strain, in./min.	0.0796

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	13
0.30	23
0.40	31
0.50	42
0.74	76
0.99	106
1.24	126
1.49	143
1.73	165
1.98	202
2.23	239
2.48	267
2.72	276
2.85	276
2.97	158
3.22	93



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

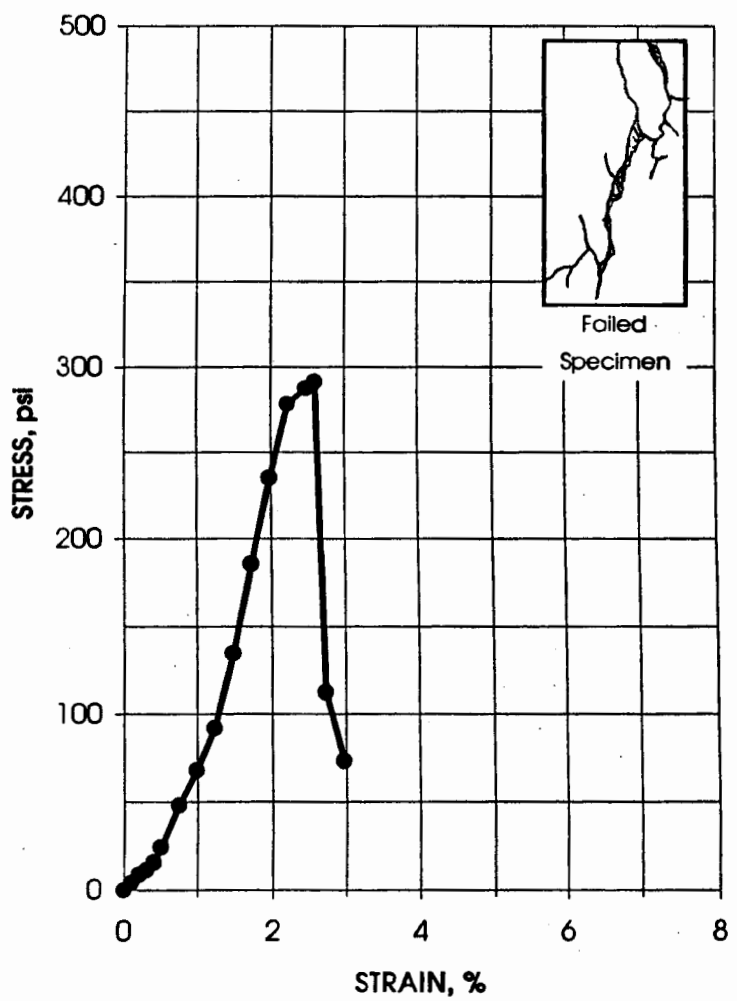
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-33-02
IT Lab No. Tuff/Sed Mix 2

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**291**
STRAIN AT FAILURE, %	**2.6**

Specimen Height, in.	4.0353
Specimen Diameter, in.	2.0087
Specimen Weight, g.	380.96
Moisture Content, %	24.7
Wet Unit Weight, pcf.	113.5
Dry Unit Weight, pcf.	91.0
Rate of Strain, in./min.	0.0735

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.30	11
0.40	15
0.50	24
0.74	48
0.99	68
1.24	92
1.49	135
1.73	186
1.98	235
2.23	278
2.48	287
2.60	291
2.73	112
2.97	73



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

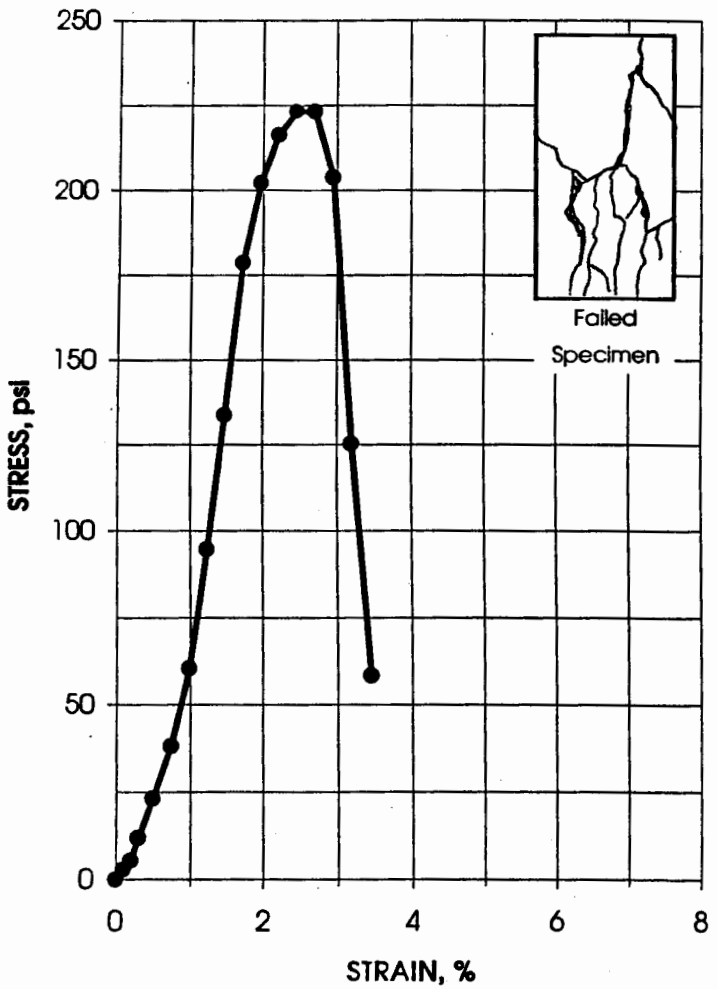
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-34-02
IT Lab No. Tuff/Sed Mix 3

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**223**
STRAIN AT FAILURE, %	**2.7**

Specimen Height, in.	4.0658
Specimen Diameter, in.	2.0127
Specimen Weight, g.	381.48
Moisture Content, %	25.2
Wet Unit Weight, pcf.	112.4
Dry Unit Weight, pcf.	89.8
Rate of Strain, in./min.	0.0735

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	5
0.30	12
0.49	23
0.74	38
0.98	60
1.23	95
1.48	134
1.72	179
1.97	202
2.21	216
2.46	223
2.71	223
2.95	204
3.20	125
3.44	58



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

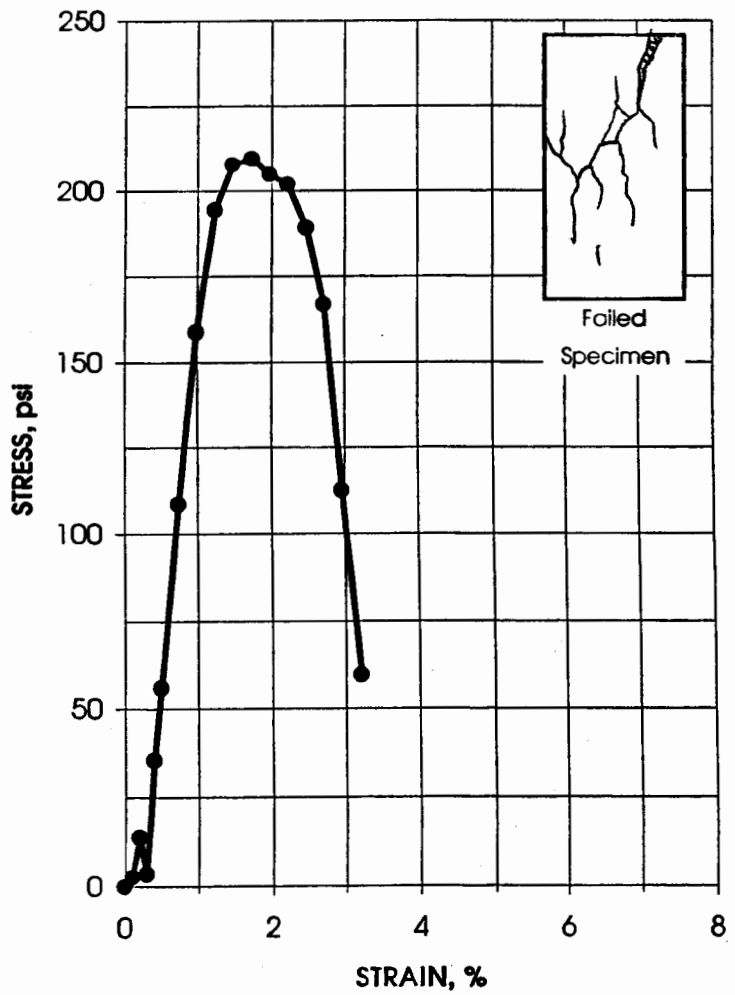
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-35-02
IT Lab No. Tuff/Sed Mix 4

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**209**
STRAIN AT FAILURE, %	**1.7**

Specimen Height, in.	4.0535
Specimen Diameter, in.	2.0095
Specimen Weight, g.	375.39
Moisture Content, %	27.8
Wet Unit Weight, pcf.	111.3
Dry Unit Weight, pcf.	87.1
Rate of Strain, in./min.	0.0867

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	14
0.30	3
0.39	35
0.49	56
0.74	109
0.99	159
1.23	194
1.48	208
1.73	209
1.97	205
2.22	202
2.47	189
2.71	167
2.96	113
3.21	60



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

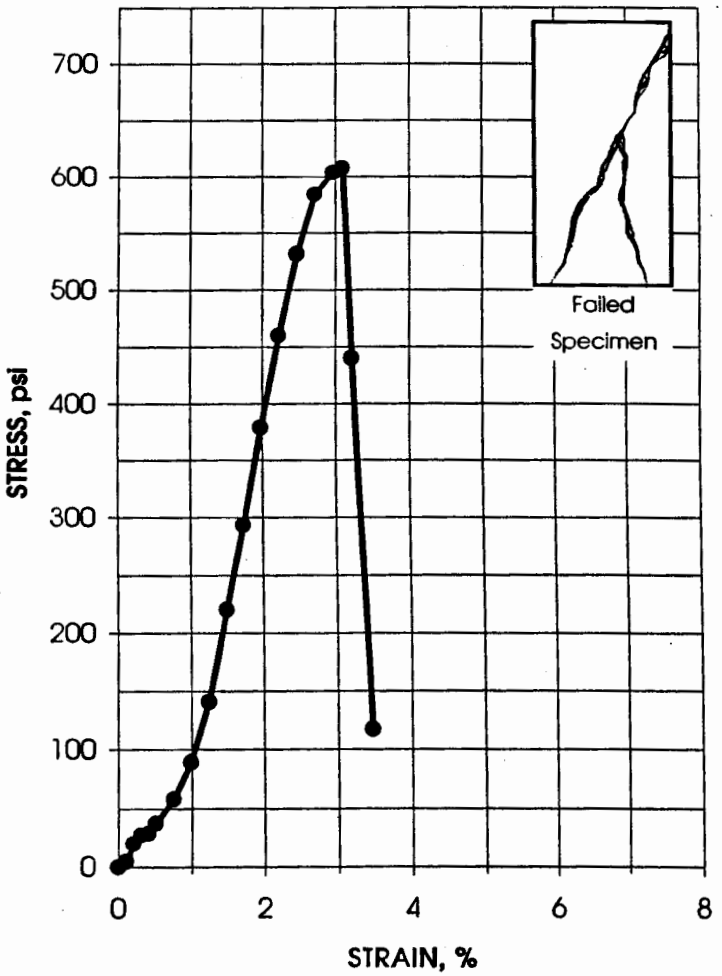
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-36-02
IT Lab No. Tuff/Sed Mix 5

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**607**
STRAIN AT FAILURE, %	**3.1**

Specimen Height, in.	4.0347
Specimen Diameter, in.	2.0142
Specimen Weight, g.	
Moisture Content, %	25.0
Wet Unit Weight, pcf.	
Dry Unit Weight, pcf.	0.0
Rate of Strain, in./min.	0.0730

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	20
0.30	27
0.40	29
0.50	37
0.74	58
0.99	89
1.24	141
1.49	220
1.73	293
1.98	379
2.23	460
2.48	532
2.73	584
2.97	604
3.10	607
3.22	440
3.47	118



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

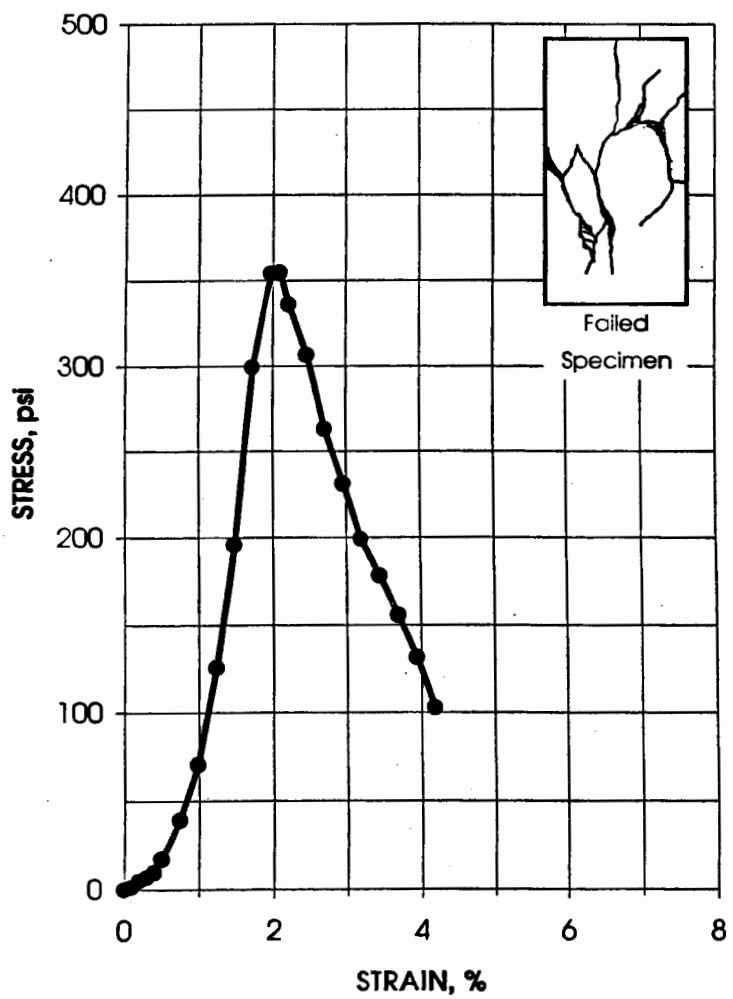
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-37-02
IT Lab No. Tuff/Sed Mix 6

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**355**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0575
Specimen Diameter, in.	2.0045
Specimen Weight, g.	371.45
Moisture Content, %	25.2
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	88.3
Rate of Strain, in./min.	0.0729

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	5
0.30	7
0.39	9
0.49	17
0.74	39
0.99	71
1.23	126
1.48	196
1.73	299
1.97	354
2.09	355
2.22	336
2.46	306
2.71	263
2.96	231
3.20	199
3.45	178
3.70	156
3.94	131
4.19	103



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

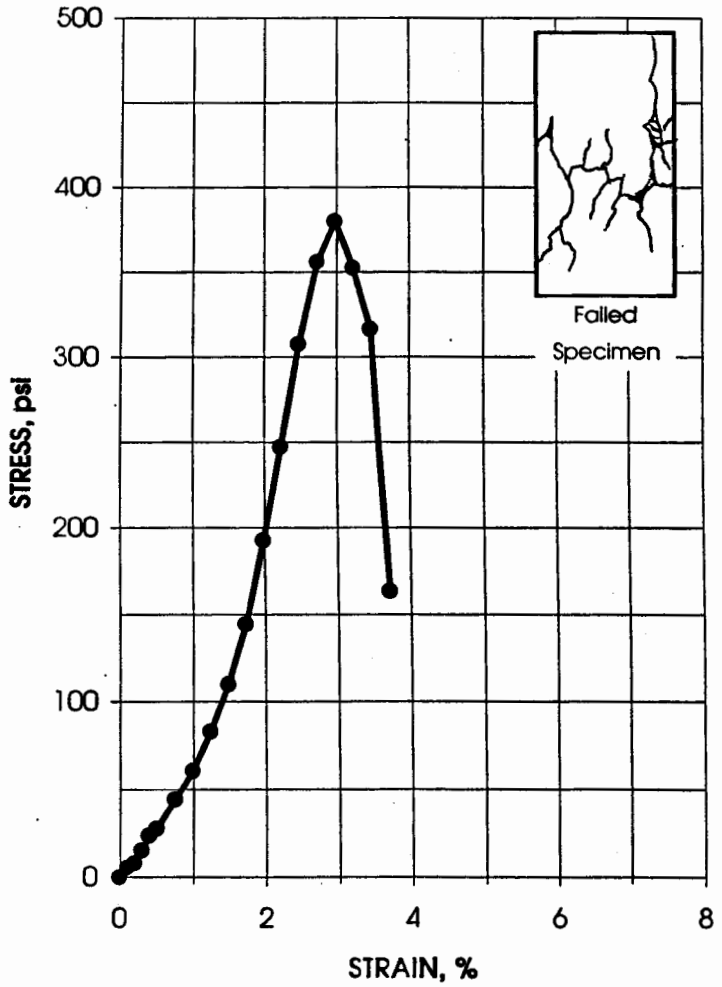
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-38-02
IT Lab No. Tuff/Sed Mix 7

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**380**
STRAIN AT FAILURE, %	**3.0**

Specimen Height, in.	4.0348
Specimen Diameter, in.	2.0150
Specimen Weight, g.	368.21
Moisture Content, %	26.0
Wet Unit Weight, pcf.	109.0
Dry Unit Weight, pcf.	86.5
Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	8
0.30	15
0.40	24
0.50	28
0.74	44
0.99	60
1.24	83
1.49	110
1.73	145
1.98	193
2.23	247
2.48	307
2.73	356
2.97	380
3.22	352
3.47	316
3.72	164



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

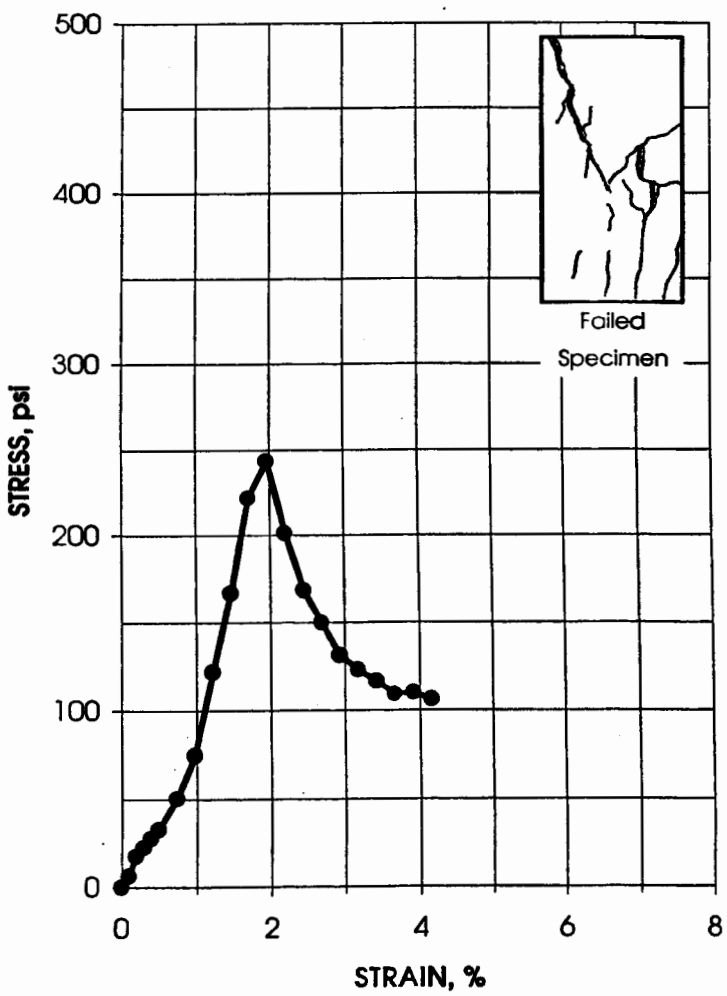
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-39-02
IT Lab No. Tuff/Sed Mix 8

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**244**
STRAIN AT FAILURE, %	**2.0**

Specimen Height, in.	4.0860
Specimen Diameter, in.	2.0225
Specimen Weight, g.	362.49
Moisture Content, %	29.0
Wet Unit Weight, pcf.	105.2
Dry Unit Weight, pcf.	81.5
Rate of Strain, in./min.	0.0944

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	17
0.29	22
0.39	28
0.49	33
0.73	50
0.98	75
1.22	122
1.47	167
1.71	221
1.96	244
2.20	201
2.45	169
2.69	150
2.94	131
3.18	123
3.43	117
3.67	109
3.92	110
4.16	106



Hydraulic Conductivity Tests

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

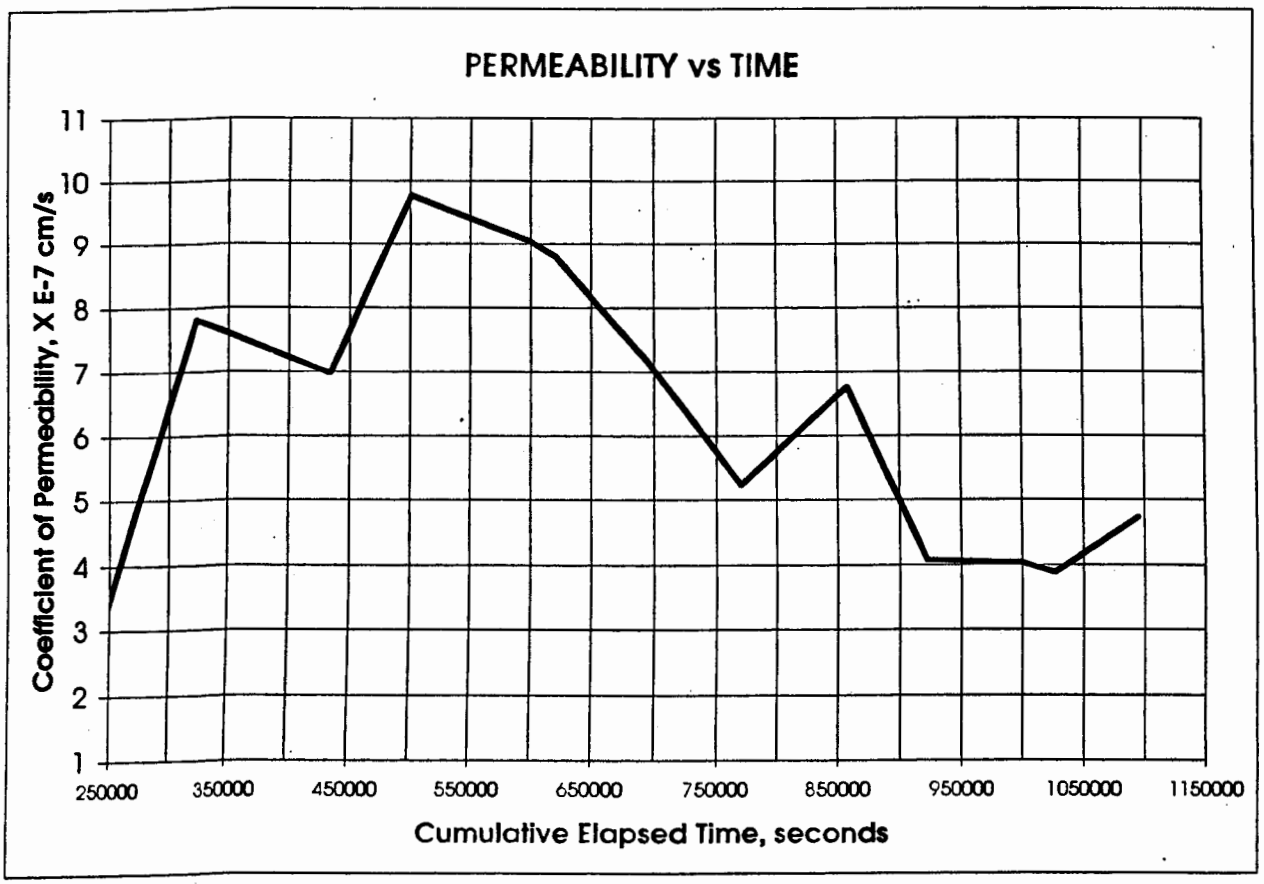
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-06-03
IT LAB SAMPLE NO. Sediment Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.15	
Specimen length, cm	10.17	
Wet weight of specimen, g.	384.15	395.1
Specimen cross-sect. area, cm	20.8706	
Water content, %	21.6	25.0
Wet unit weight, pcf	113.0	
Dry unit weight, pcf	92.9	
Estimated degree of saturatior	73.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 4.2E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

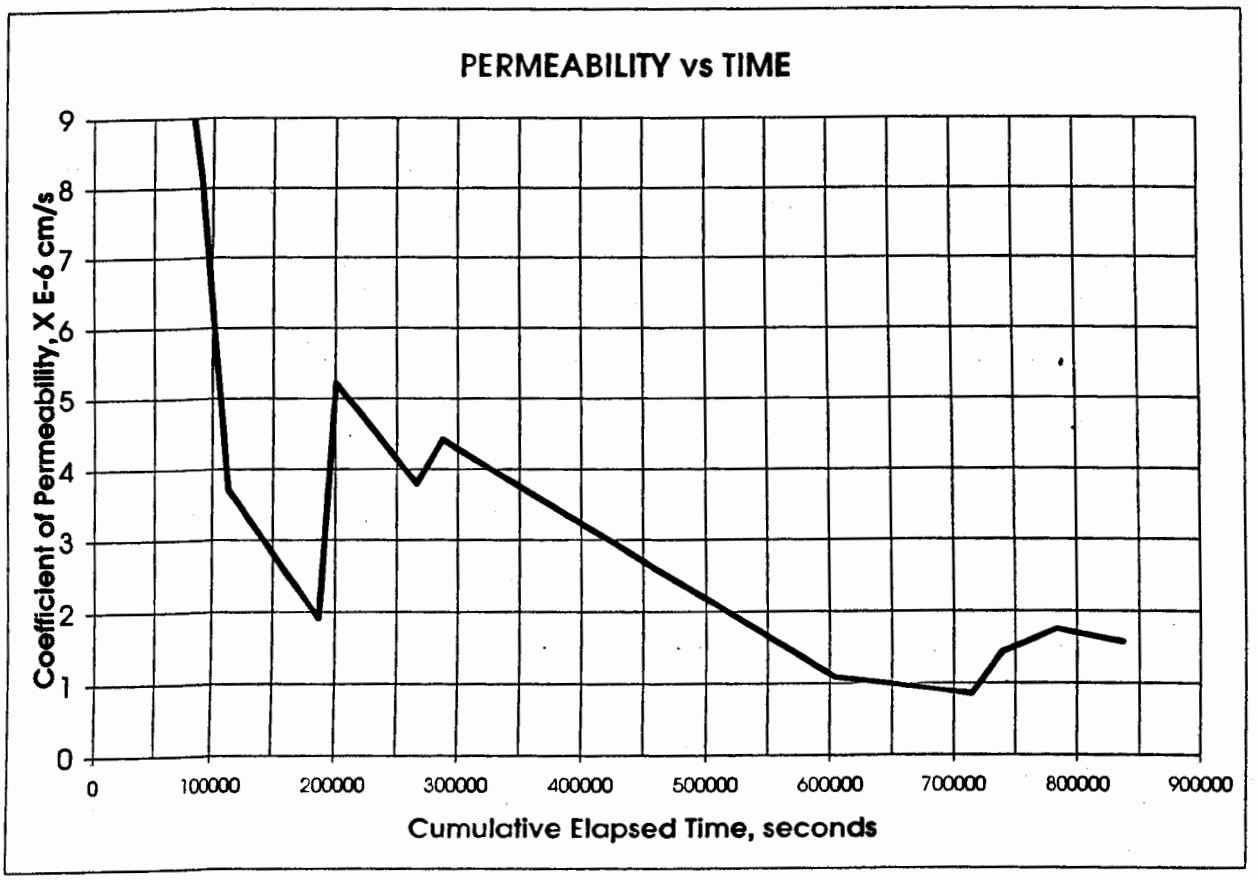
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-07-03
IT LAB SAMPLE NO. Sediment Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.28	
Wet weight of specimen, g.	343.28	382.1
Specimen cross-sect. area, cm	20.5089	
Water content, %	16.3	29.4
Wet unit weight, pcf	101.7	
Dry unit weight, pcf	87.4	
Estimated degree of saturatior	48.4	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	1.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.4E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

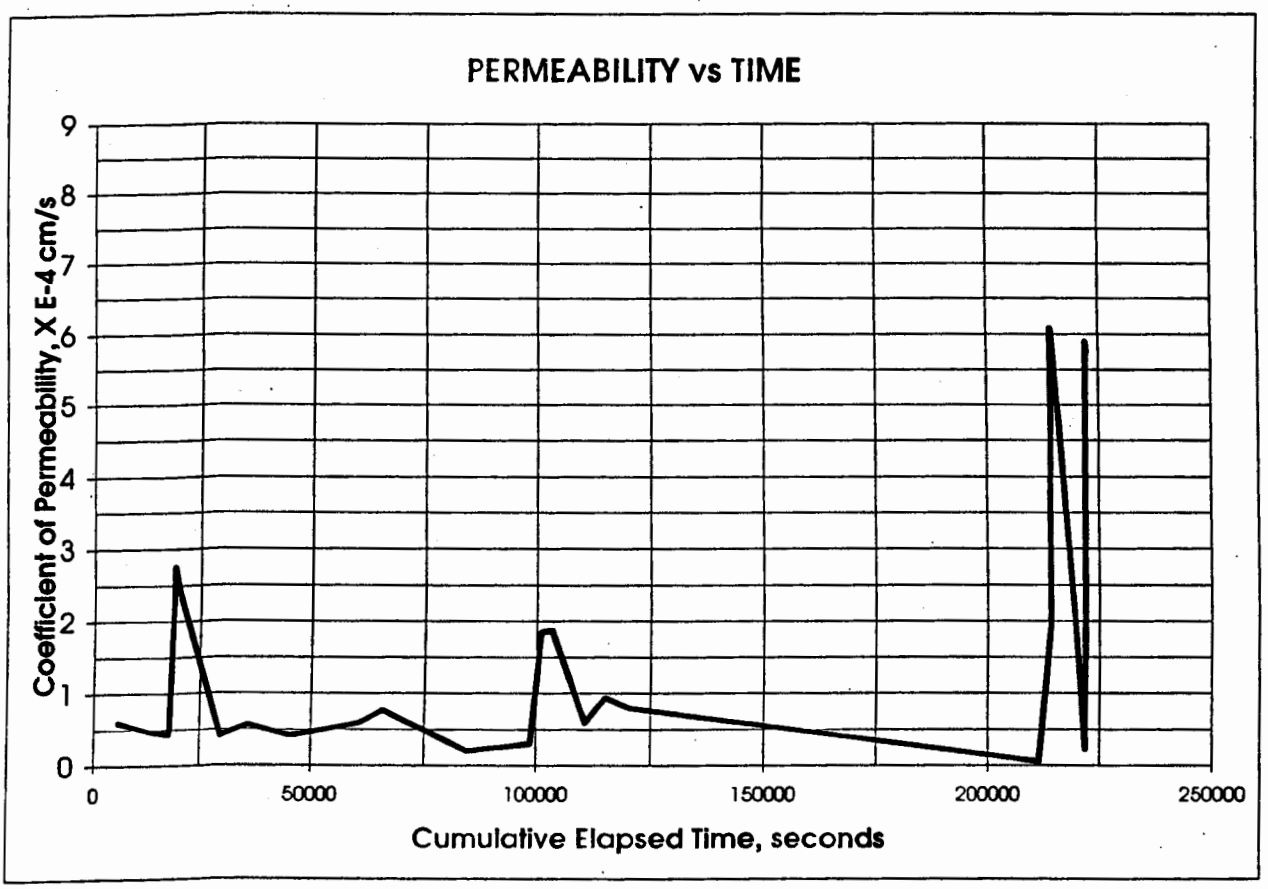
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-08-08
IT LAB SAMPLE NO. Sediment Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	6.07	
Wet weight of specimen, g.	197.7	221.78
Specimen cross-sect. area, cm	20.5224	
Water content, %	19.5	34.1
Wet unit weight, pcf	99.0	
Dry unit weight, pcf	82.8	
Estimated degree of saturatior	51.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	2.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.2
Total backpressure, psi	6.8
Permeant Fluid	Dearied DI Water

Coefficient of Permeability, cm/s 4.5E-04



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

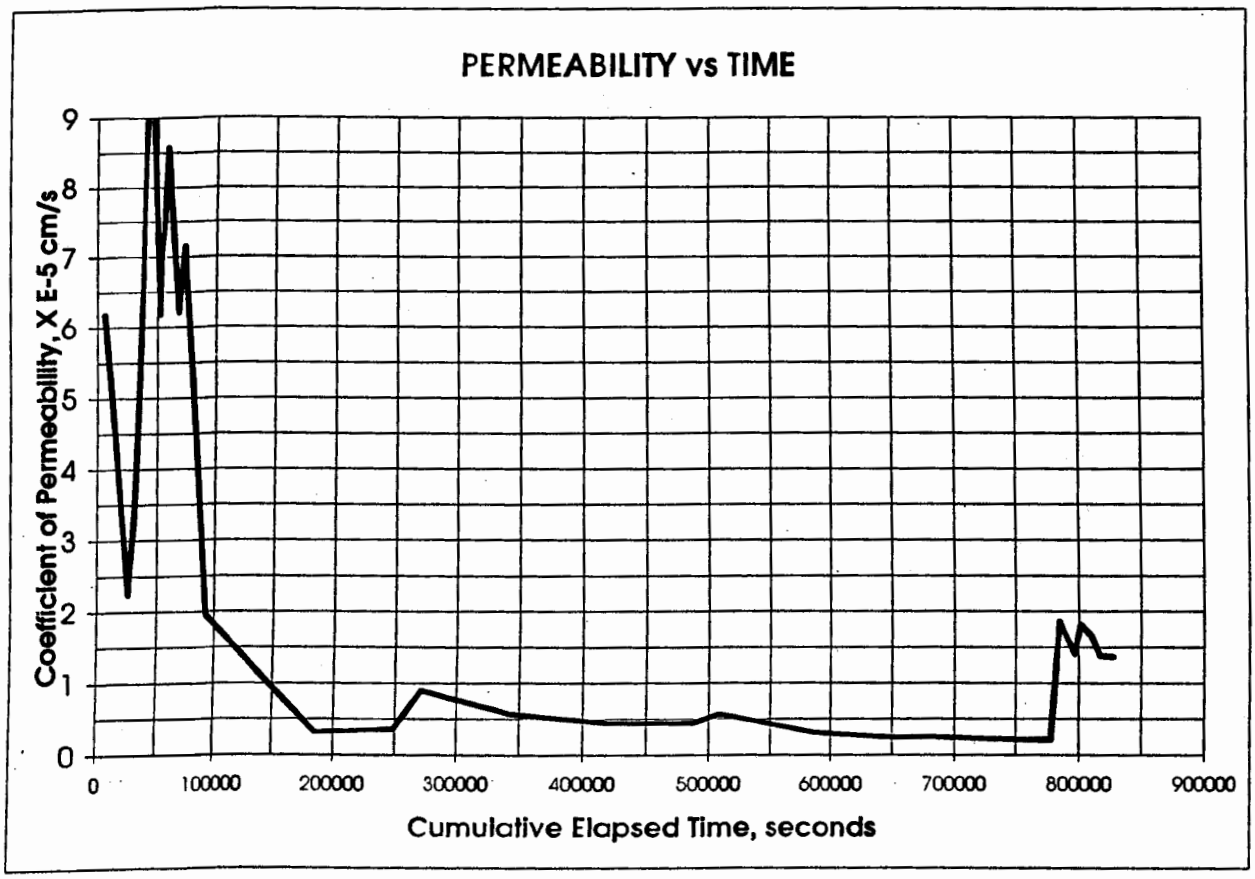
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-09-03
IT LAB SAMPLE NO. Sed Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	331	374.23
Specimen cross-sect. area, cm	20.4953	
Water content, %	19.0	34.6
Wet unit weight, pcf	98.0	
Dry unit weight, pcf	82.3	
Estimated degree of saturatior	49.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	2.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.6E-05



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

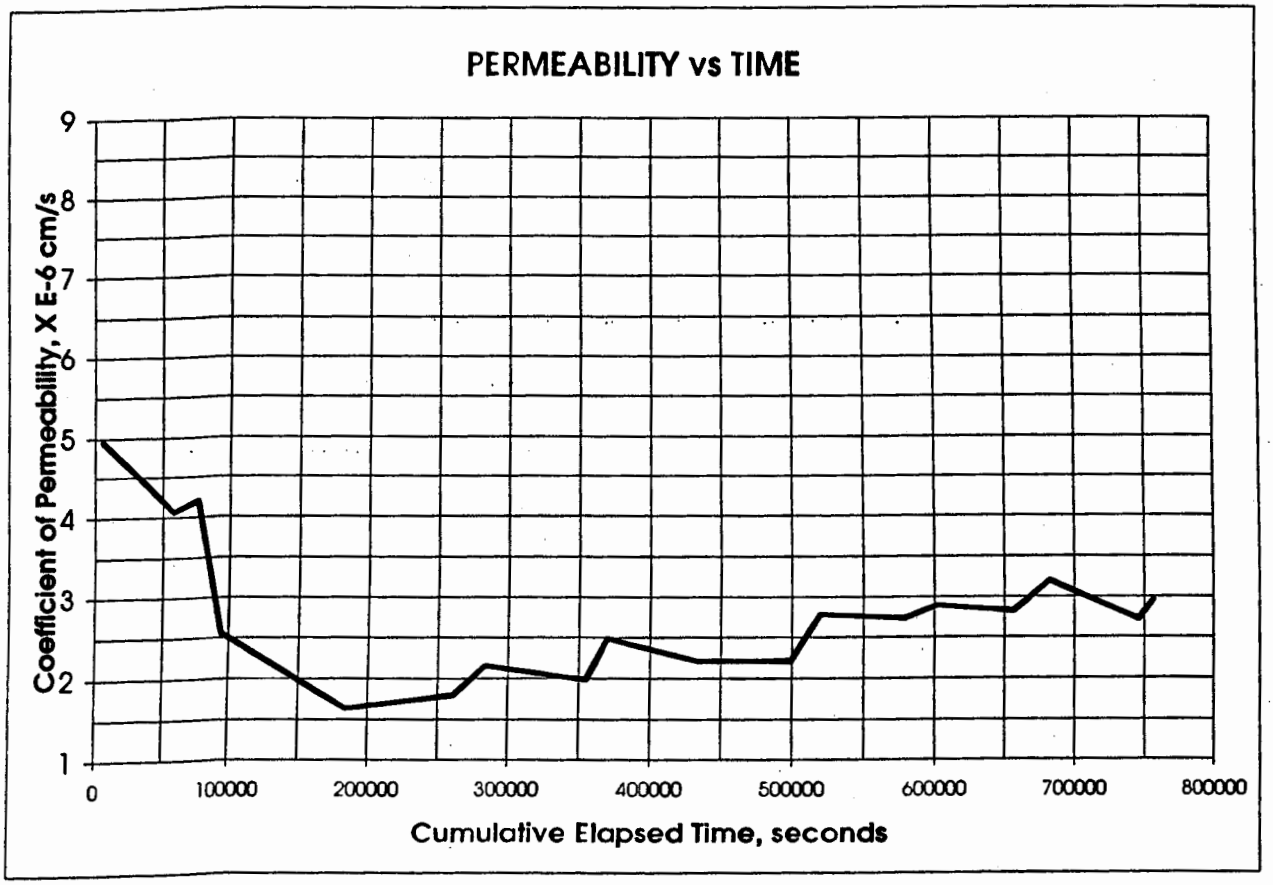
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-10-03
IT LAB SAMPLE NO. Sediment Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.20	
Wet weight of specimen, g.	376.11	384.13
Specimen cross-sect. area, cm	20.5021	
Water content, %	28.3	31.1
Wet unit weight, pcf	112.3	
Dry unit weight, pcf	87.5	
Estimated degree of saturatior	84.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.9E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

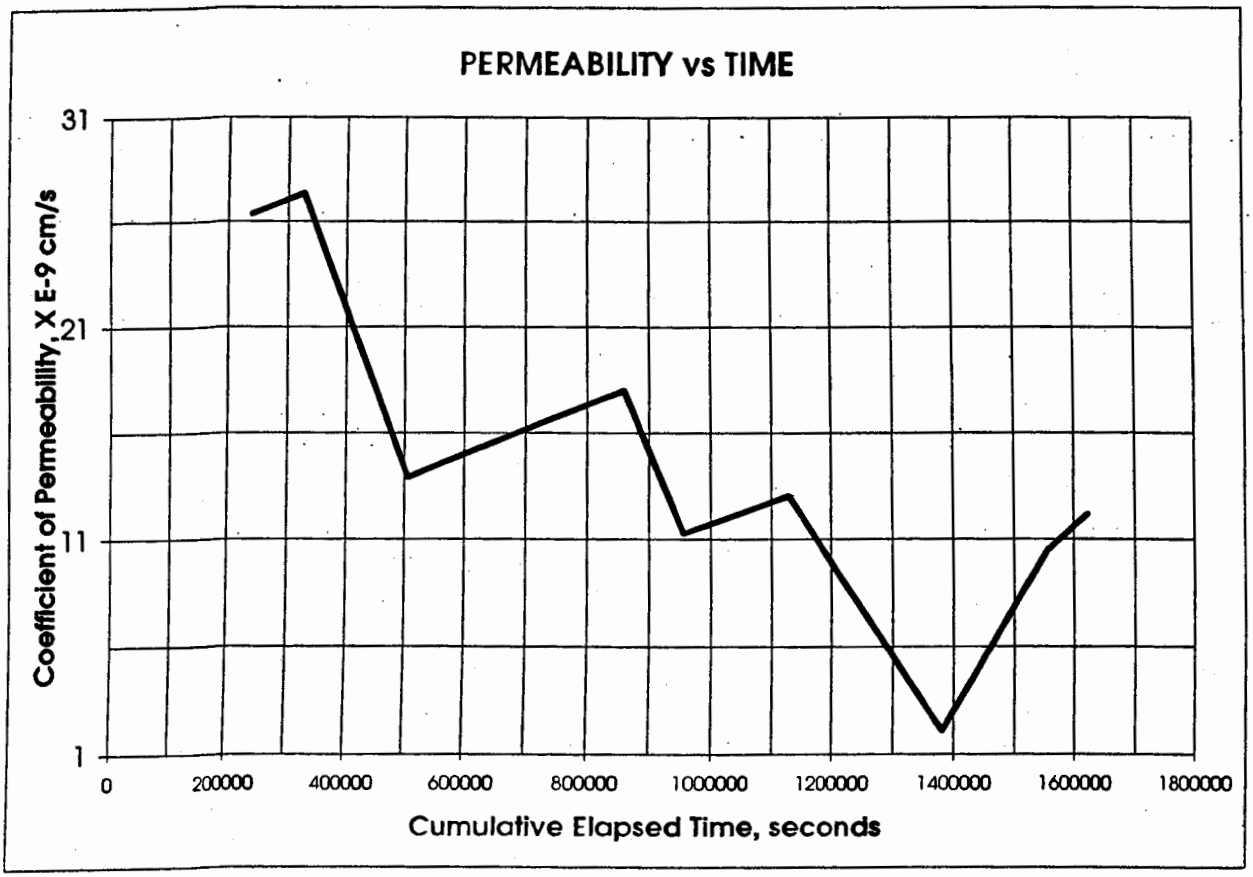
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-11-03
IT LAB SAMPLE NO. Sediment Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.28	
Wet weight of specimen, g.	389.59	397.84
Specimen cross-sect. area, cm	20.5394	
Water content, %	22.8	25.4
Wet unit weight, pcf	115.2	
Dry unit weight, pcf	93.8	
Estimated degree of saturatior	79.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	13.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 9.4E-09



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

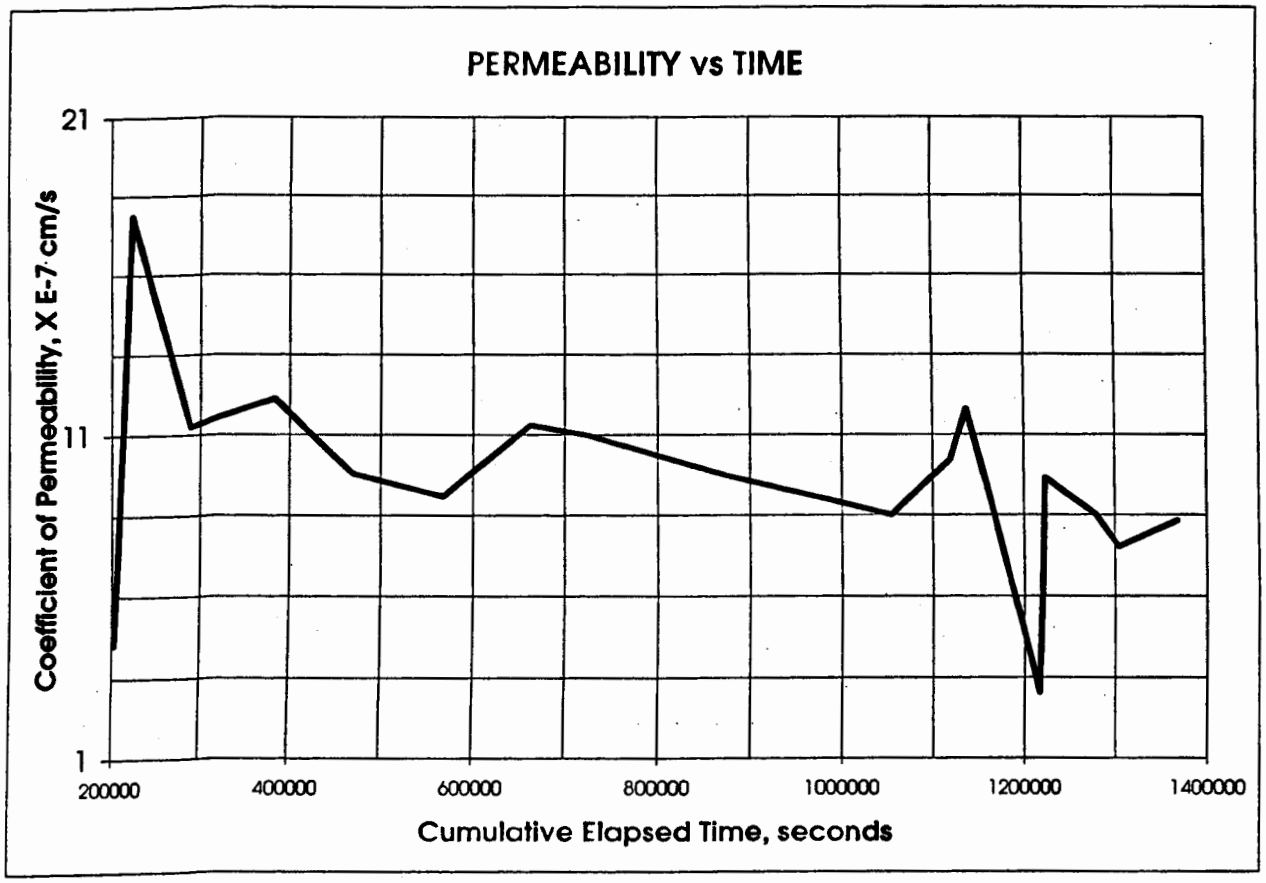
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-12-03
IT LAB SAMPLE NO. Sediment Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.24	
Wet weight of specimen, g.	366.72	378.52
Specimen cross-sect. area, cm	20.4987	
Water content, %	25.8	29.8
Wet unit weight, pcf	109.0	
Dry unit weight, pcf	86.7	
Estimated degree of saturatior	75.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 8.5E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

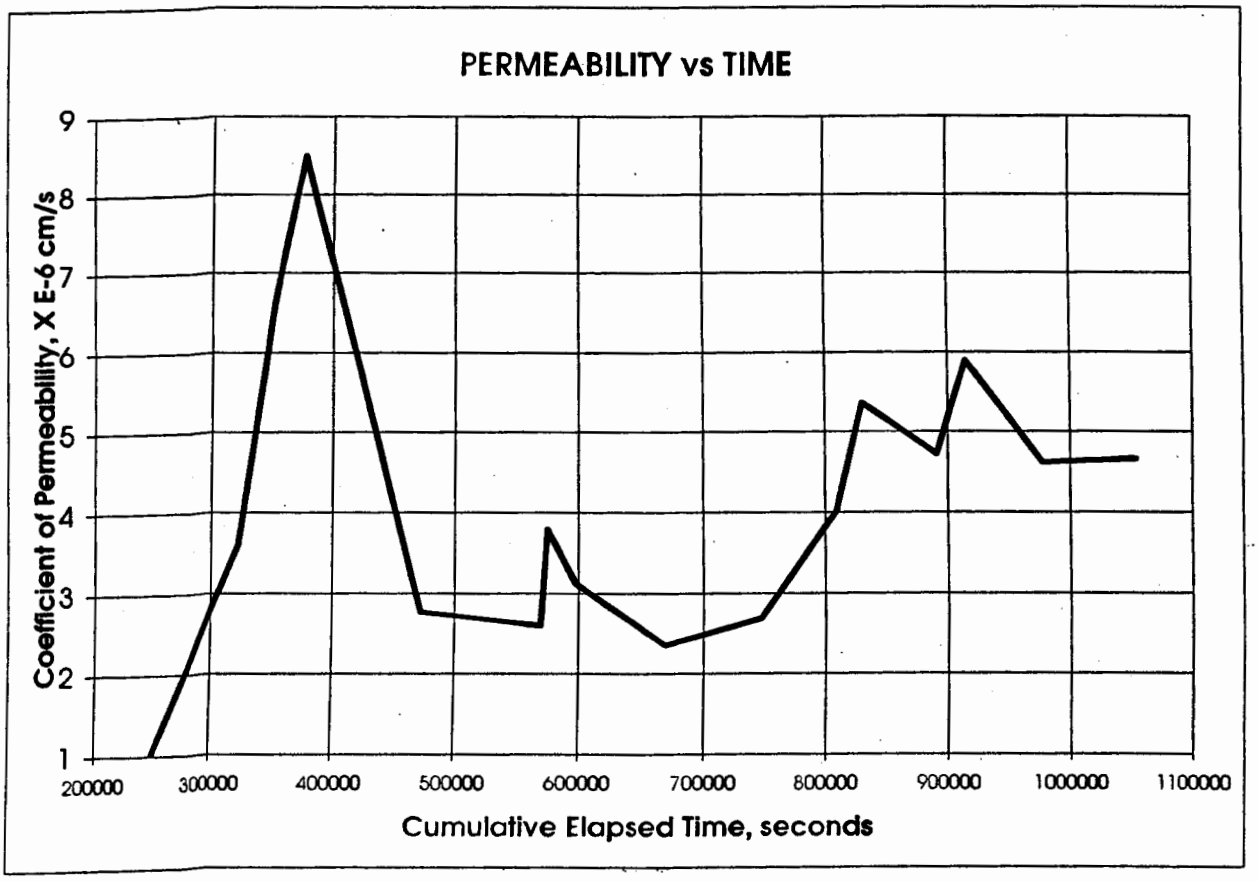
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-13-03
IT LAB SAMPLE NO. Sediment Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.12	
Specimen length, cm	10.33	
Wet weight of specimen, g.	377.76	383.5
Specimen cross-sect. area, cm	20.6041	
Water content, %	28.9	30.8
Wet unit weight, pcf	110.8	
Dry unit weight, pcf	85.9	
Estimated degree of saturatior	82.7	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.0E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

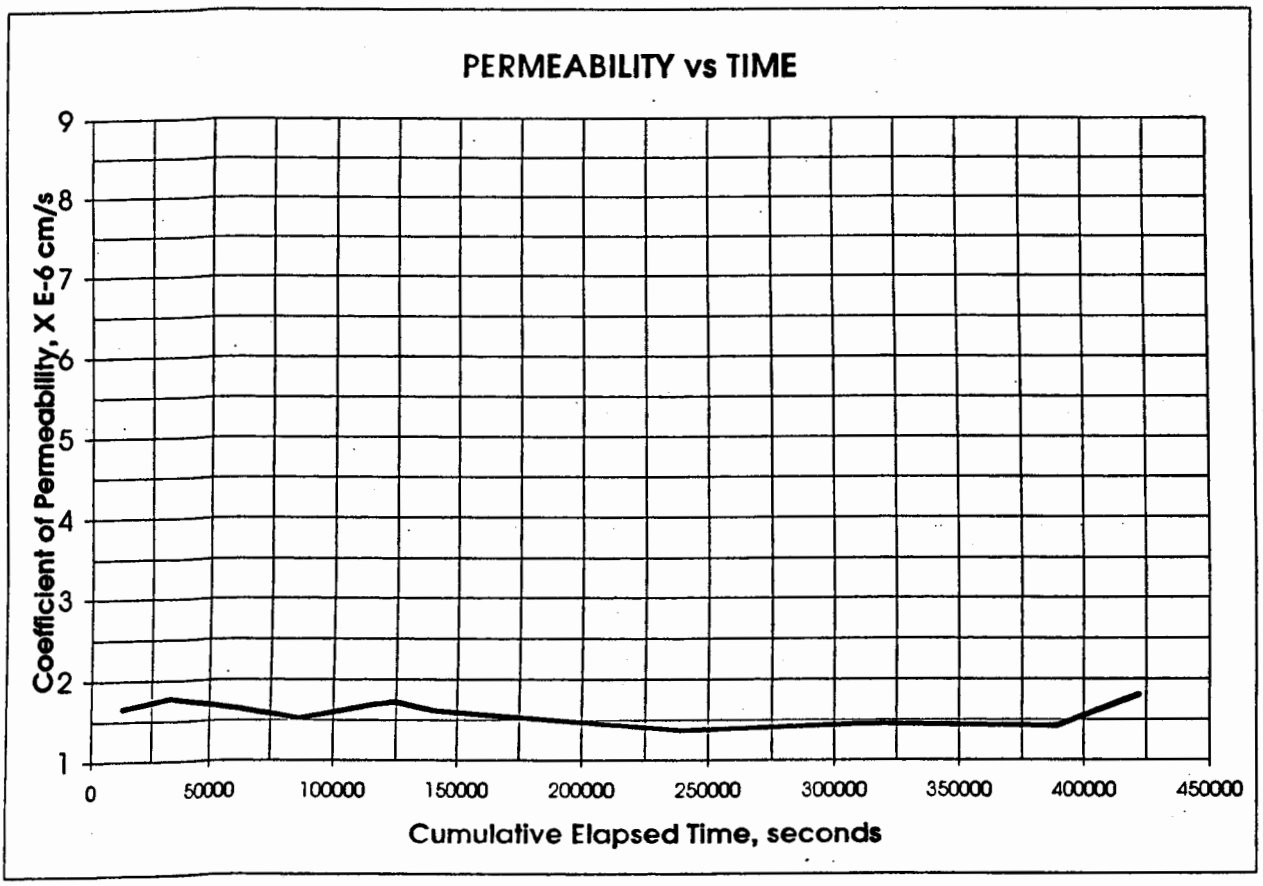
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-23-02
IT LAB SAMPLE NO. Soil Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.18	
Wet weight of specimen, g.	369.42	383.11
Specimen cross-sect. area, cm	20.4172	
Water content, %	20.9	25.4
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	91.8	
Estimated degree of saturatior	69.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.5E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

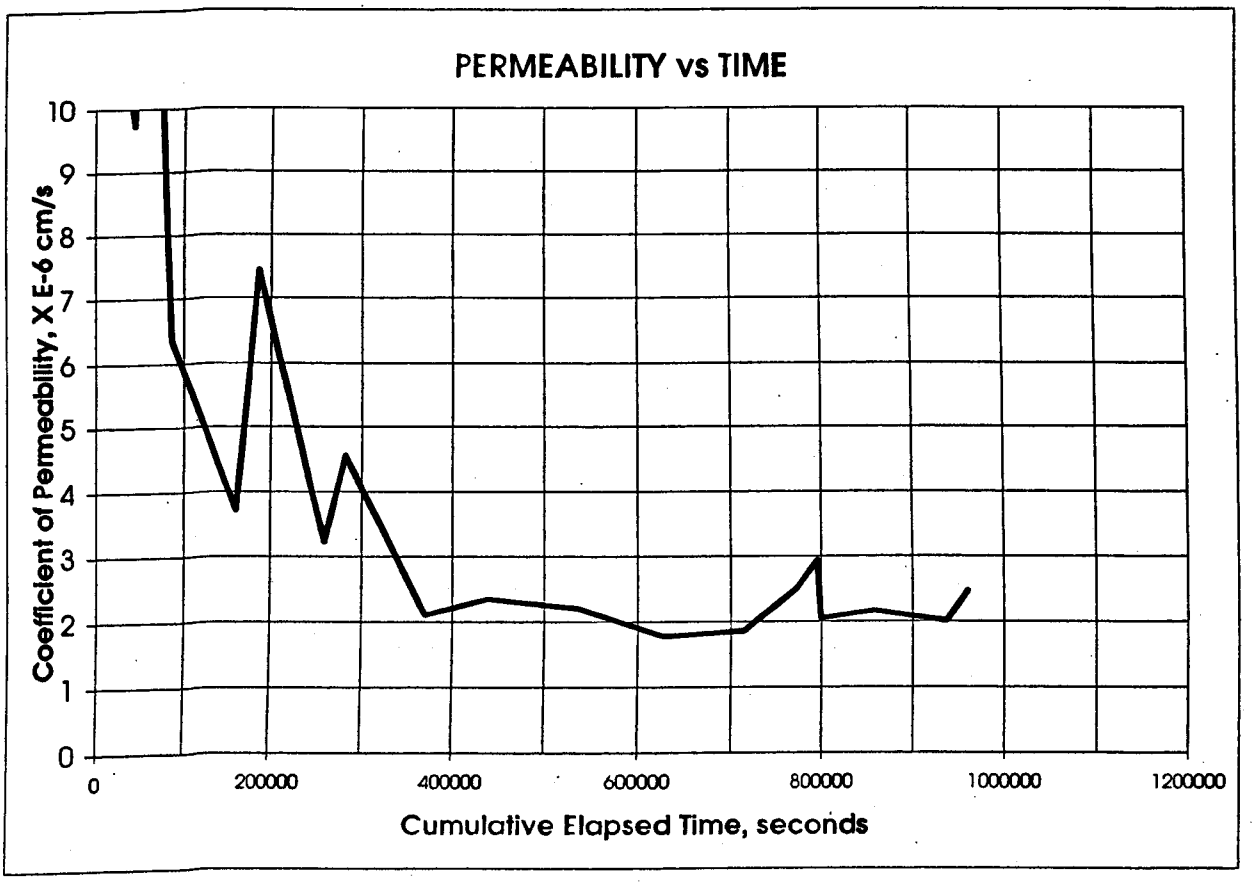
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-24-03
IT LAB SAMPLE NO. Soil Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.12	
Specimen length, cm	10.22	
Wet weight of specimen, g.	374.41	379.58
Specimen cross-sect. area, cm	20.6007	
Water content, %	26.4	28.2
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	87.8	
Estimated degree of saturatior	79.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.2E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

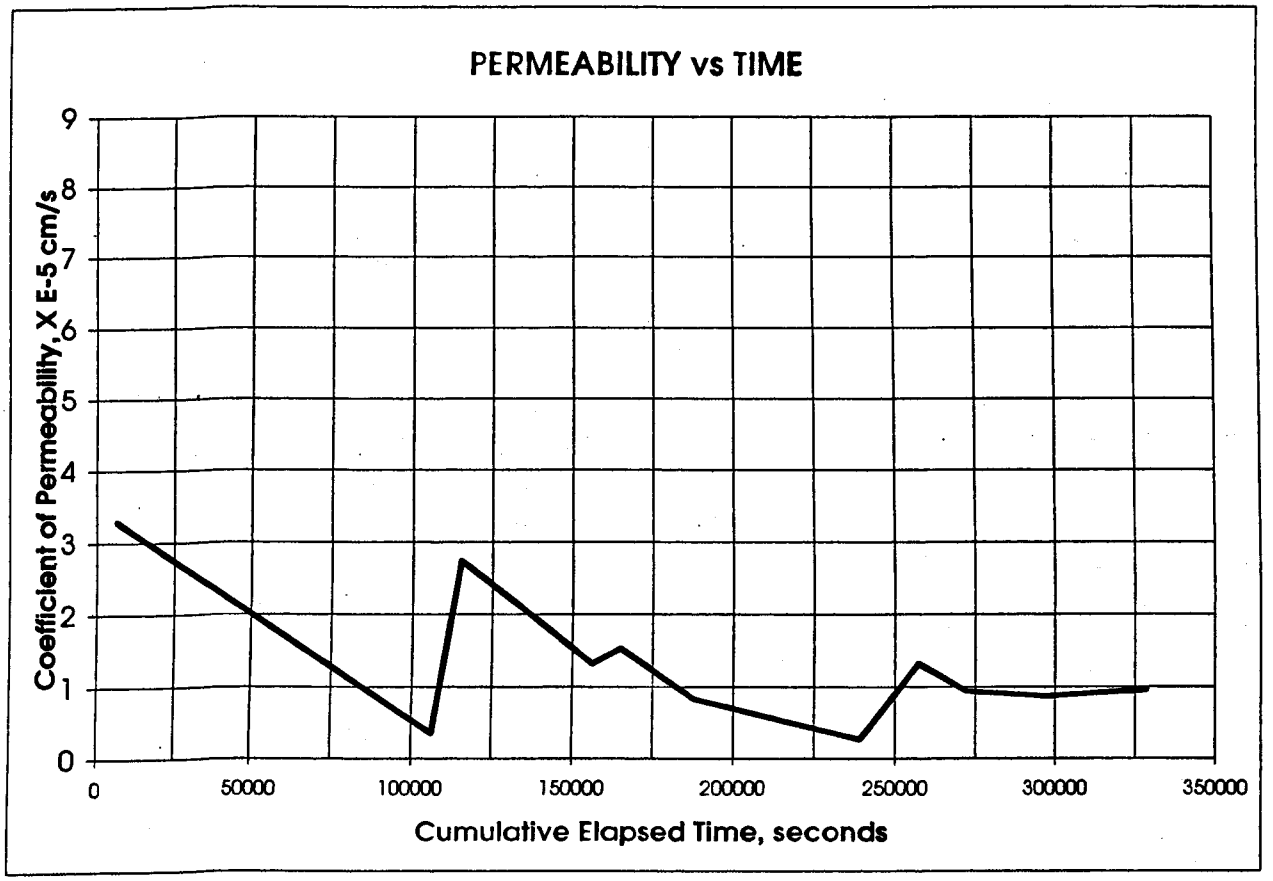
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-25-01
IT LAB SAMPLE NO. Soil Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	378.73	387.83
Specimen cross-sect. area, cm	20.4783	
Water content, %	23.5	26.5
Wet unit weight, pcf	112.3	
Dry unit weight, pcf	90.9	
Estimated degree of saturatior	76.0	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	5.5
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 1.0E-05



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

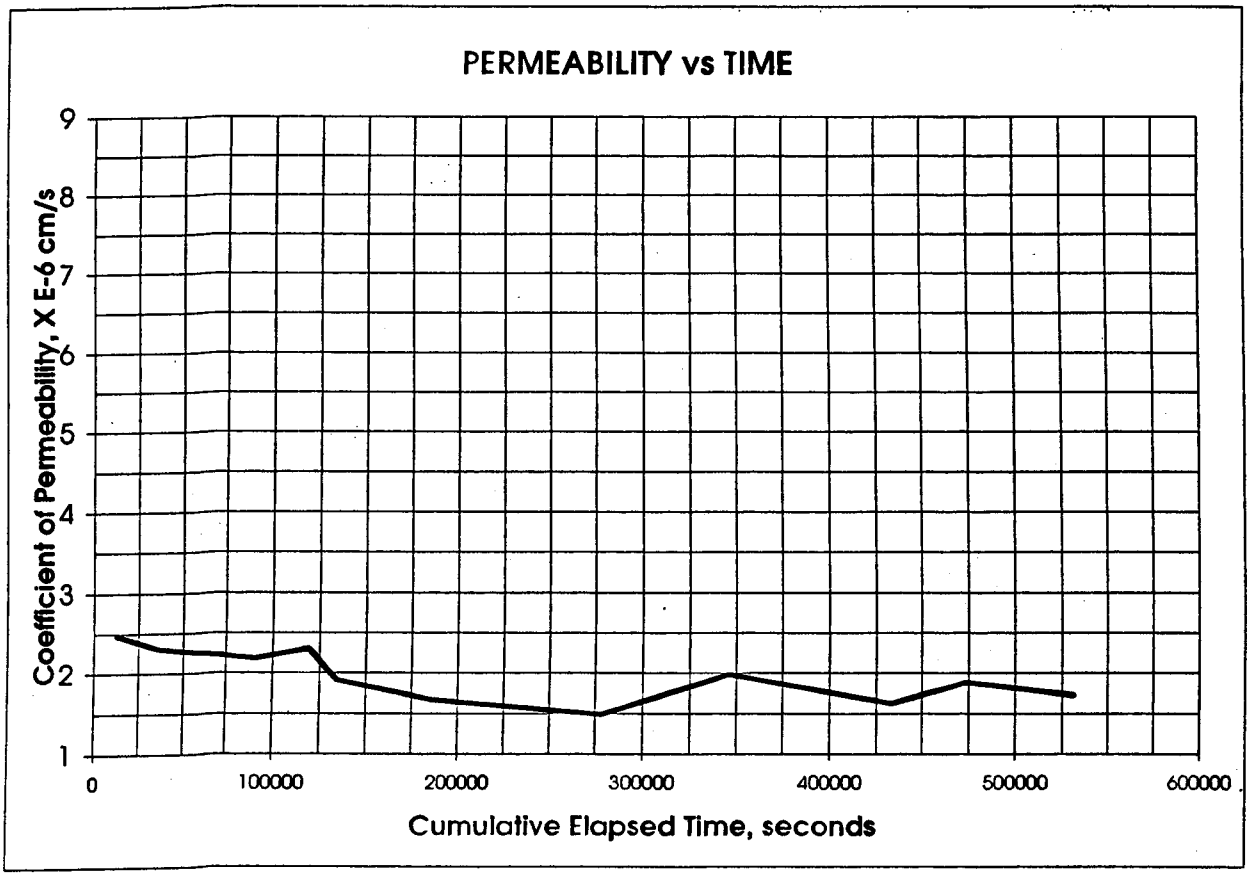
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-26-05
IT LAB SAMPLE NO. Soil Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.31	
Wet weight of specimen, g.	370.32	379.38
Specimen cross-sect. area, cm	20.5190	
Water content, %	26.0	29.0
Wet unit weight, pcf	109.3	
Dry unit weight, pcf	86.8	
Estimated degree of saturatior	75.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.8E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

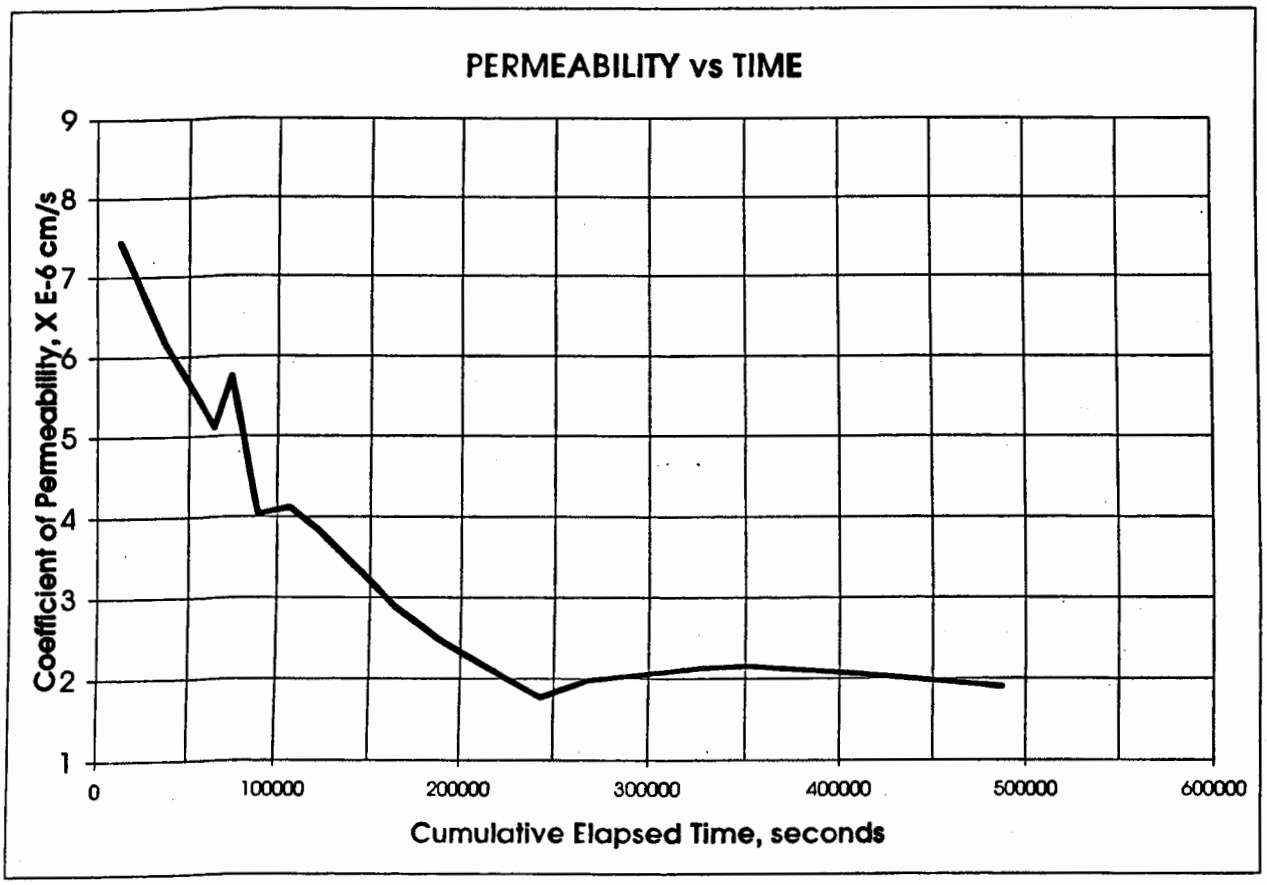
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-27-06
IT LAB SAMPLE NO. Soil Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	365.82	375.17
Specimen cross-sect. area, cm	20.4003	
Water content, %	29.8	33.1
Wet unit weight, pcf	109.7	
Dry unit weight, pcf	84.5	
Estimated degree of saturatior	82.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 2.1E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

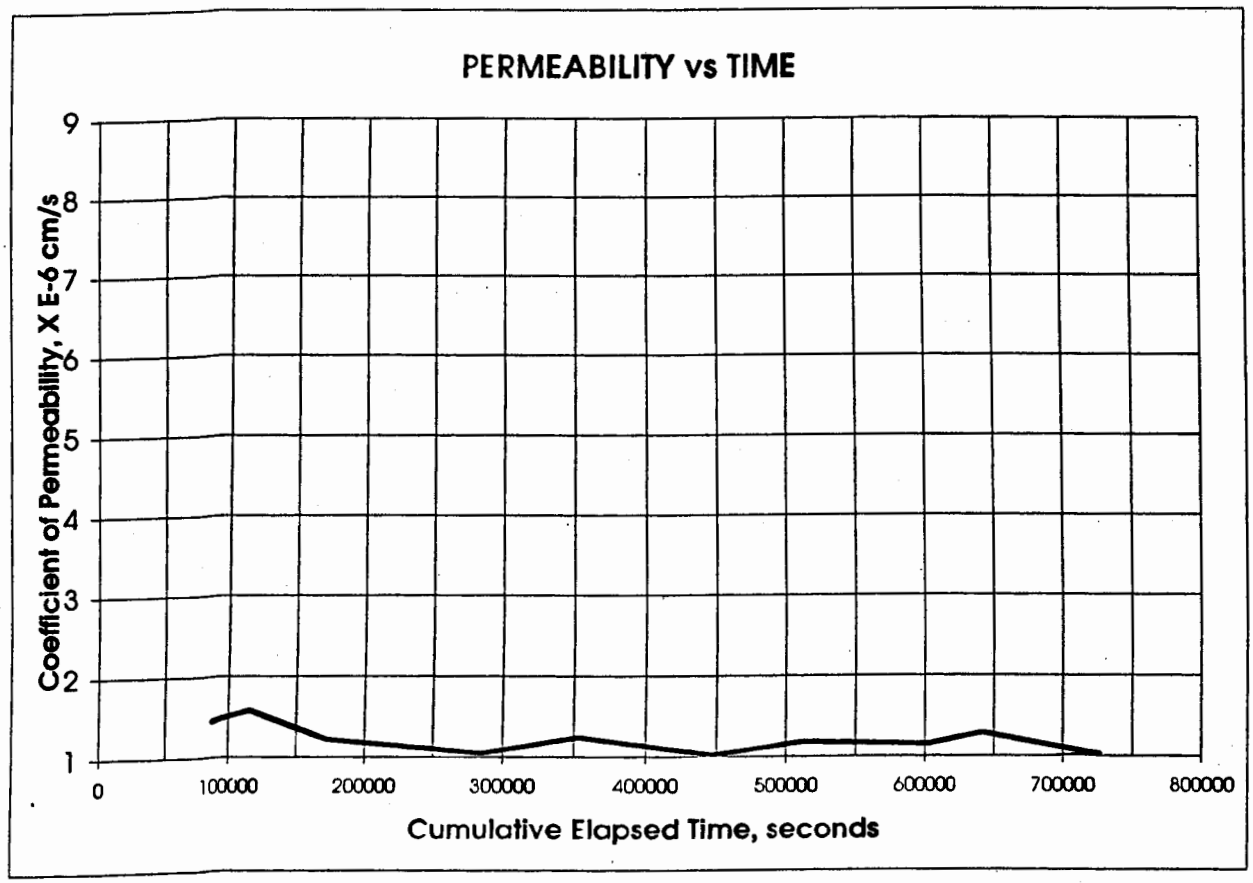
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-28-02
IT LAB SAMPLE NO. Soil Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.13	
Specimen length, cm	10.31	
Wet weight of specimen, g.	378.33	388.8
Specimen cross-sect. area, cm	20.6484	
Water content, %	22.6	25.9
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	90.5	
Estimated degree of saturatior	72.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.2E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

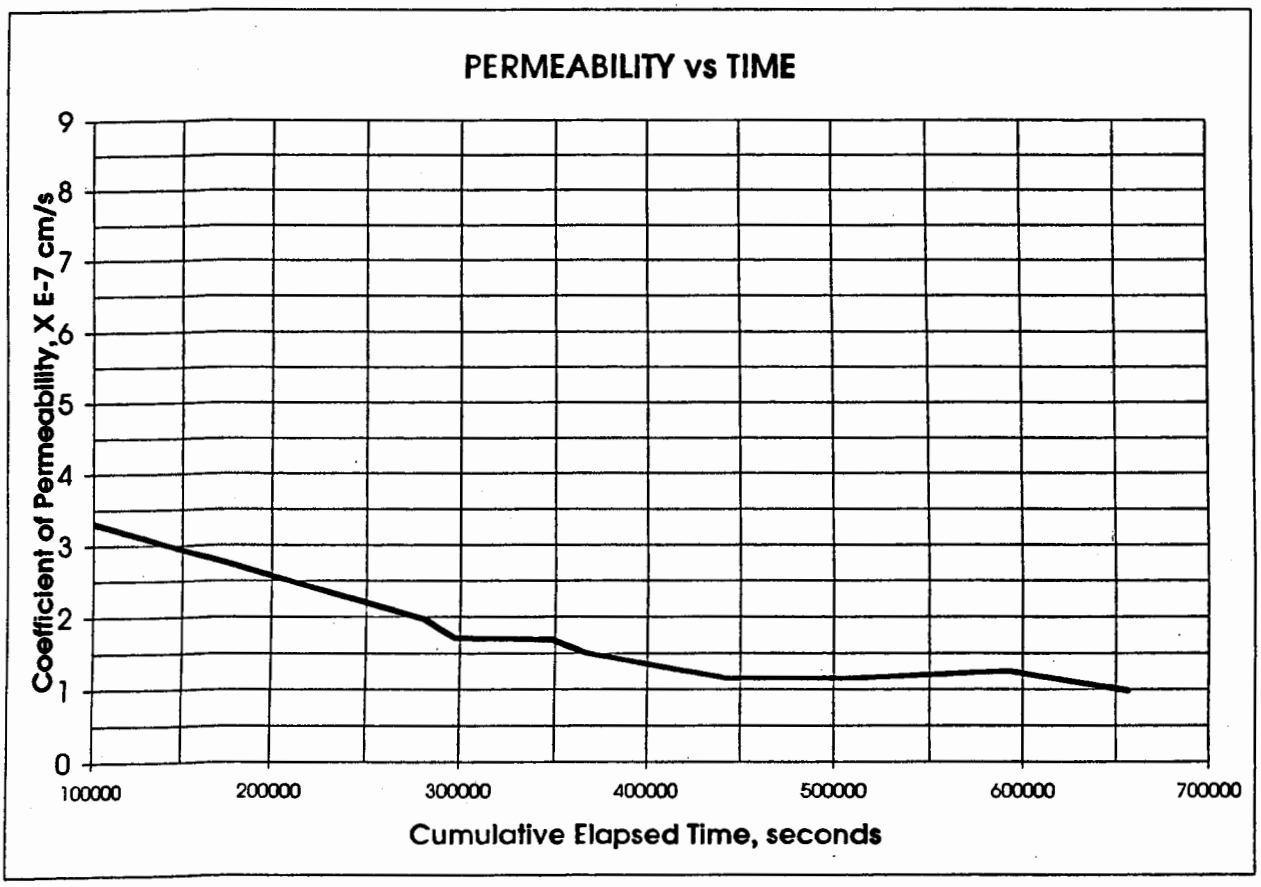
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-29-02
IT LAB SAMPLE NO. Soil Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.27	
Wet weight of specimen, g.	371.6	368.84
Specimen cross-sect. area, cm	20.4919	
Water content, %	25.2	24.3
Wet unit weight, pcf	110.3	
Dry unit weight, pcf	88.0	
Estimated degree of saturatior	76.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.1E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

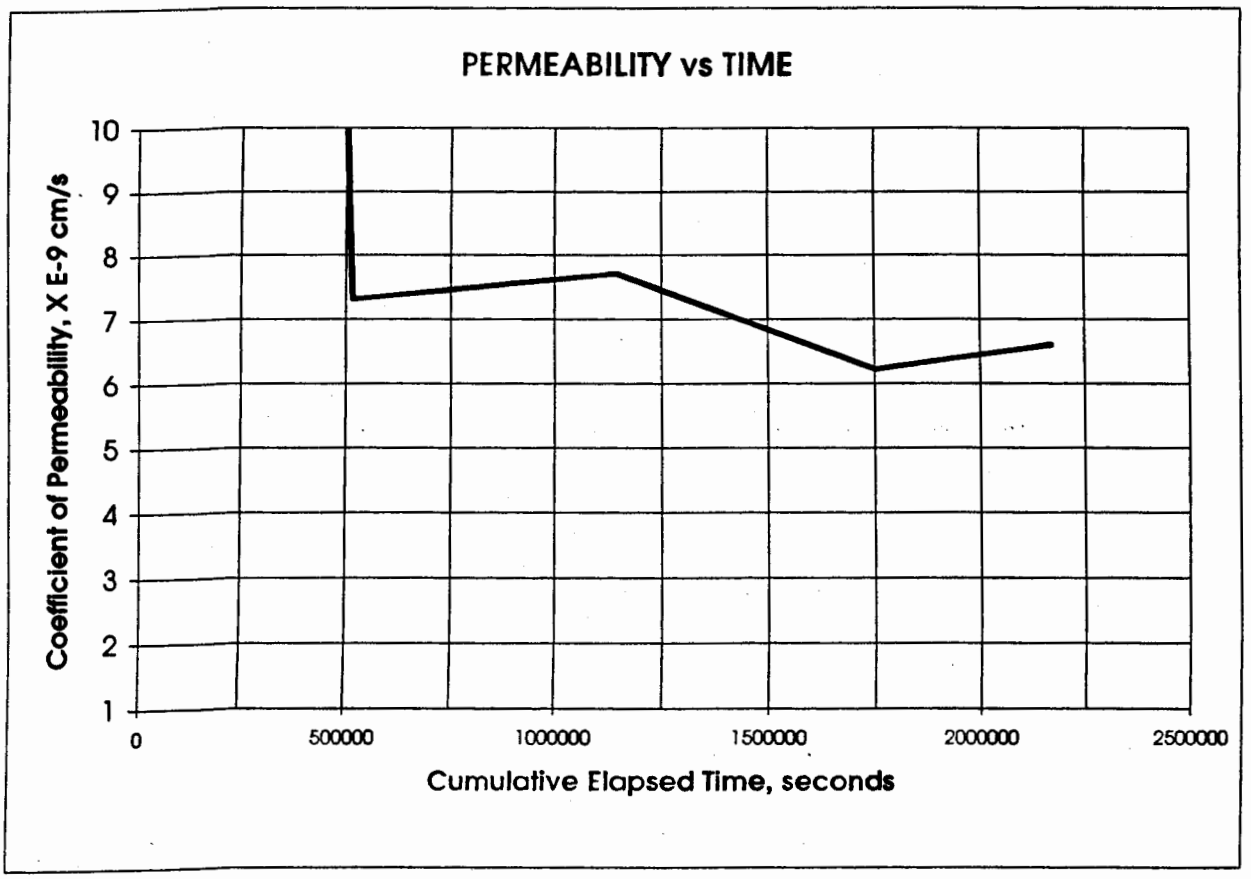
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-30-06
IT LAB SAMPLE NO. Soil Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.35	
Wet weight of specimen, g.	369.23	379.74
Specimen cross-sect. area, cm	20.4715	
Water content, %	25.5	29.1
Wet unit weight, pcf	108.8	
Dry unit weight, pcf	86.7	
Estimated degree of saturatior	74.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	13.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 7.0E-09



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

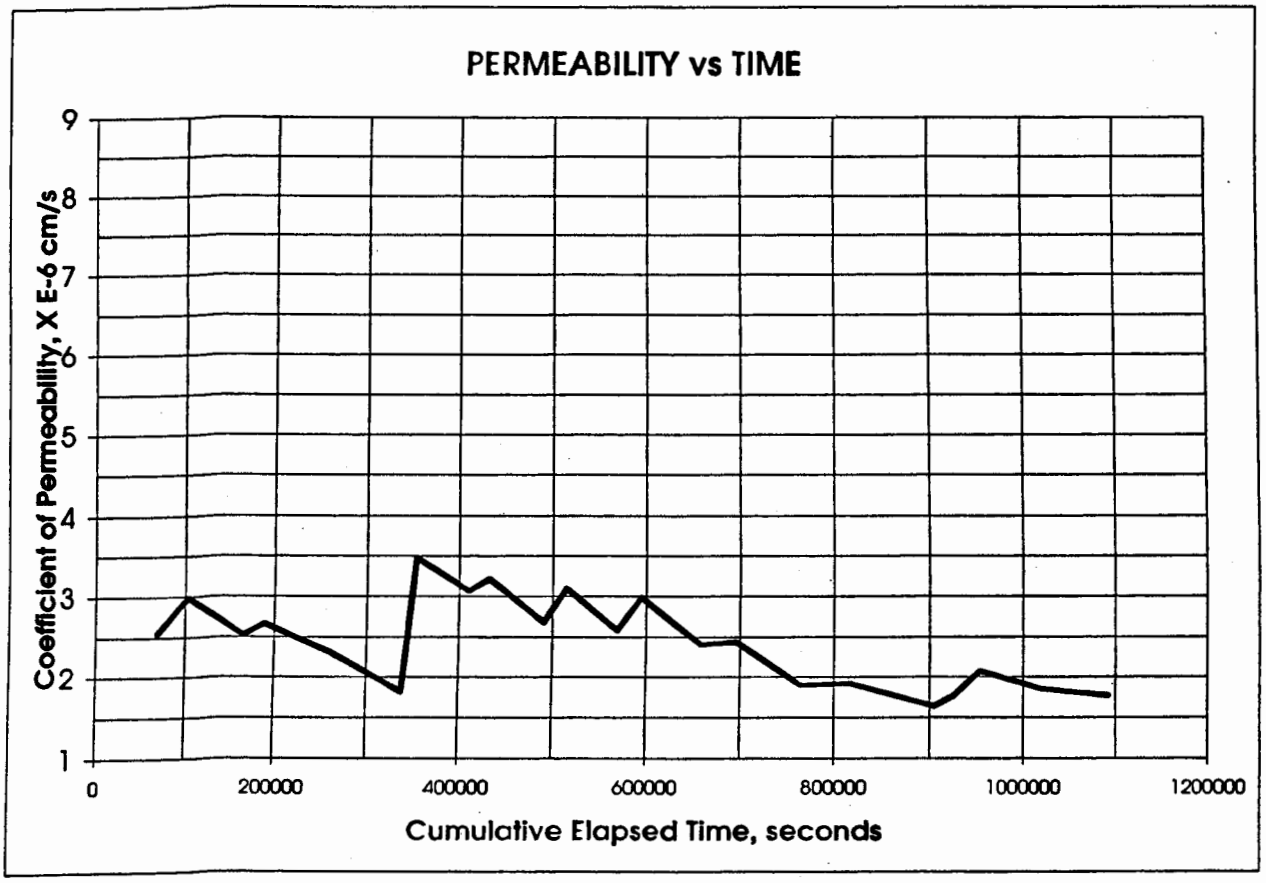
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-14-08
IT LAB SAMPLE NO. Tuff Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.16	
Wet weight of specimen, g.	384.78	394.17
Specimen cross-sect. area, cm	20.4647	
Water content, %	22.0	25.0
Wet unit weight, pcf	115.5	
Dry unit weight, pcf	94.7	
Estimated degree of saturatior	78.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.9E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

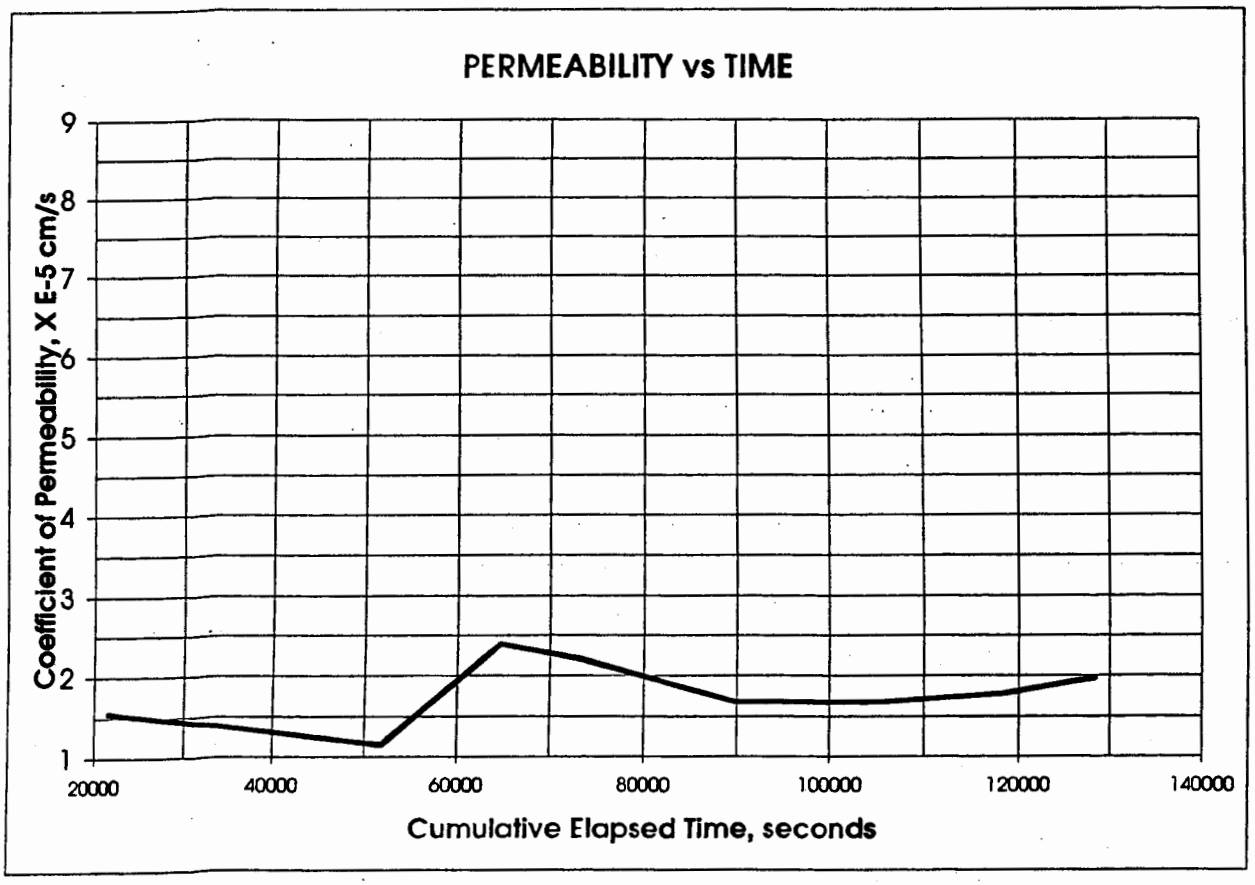
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-15-08
IT LAB SAMPLE NO. Tuff Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.18	
Wet weight of specimen, g.	378.92	389.61
Specimen cross-sect. area, cm	20.3495	
Water content, %	21.3	24.7
Wet unit weight, pcf	114.2	
Dry unit weight, pcf	94.2	
Estimated degree of saturatior	74.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.8E-05



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

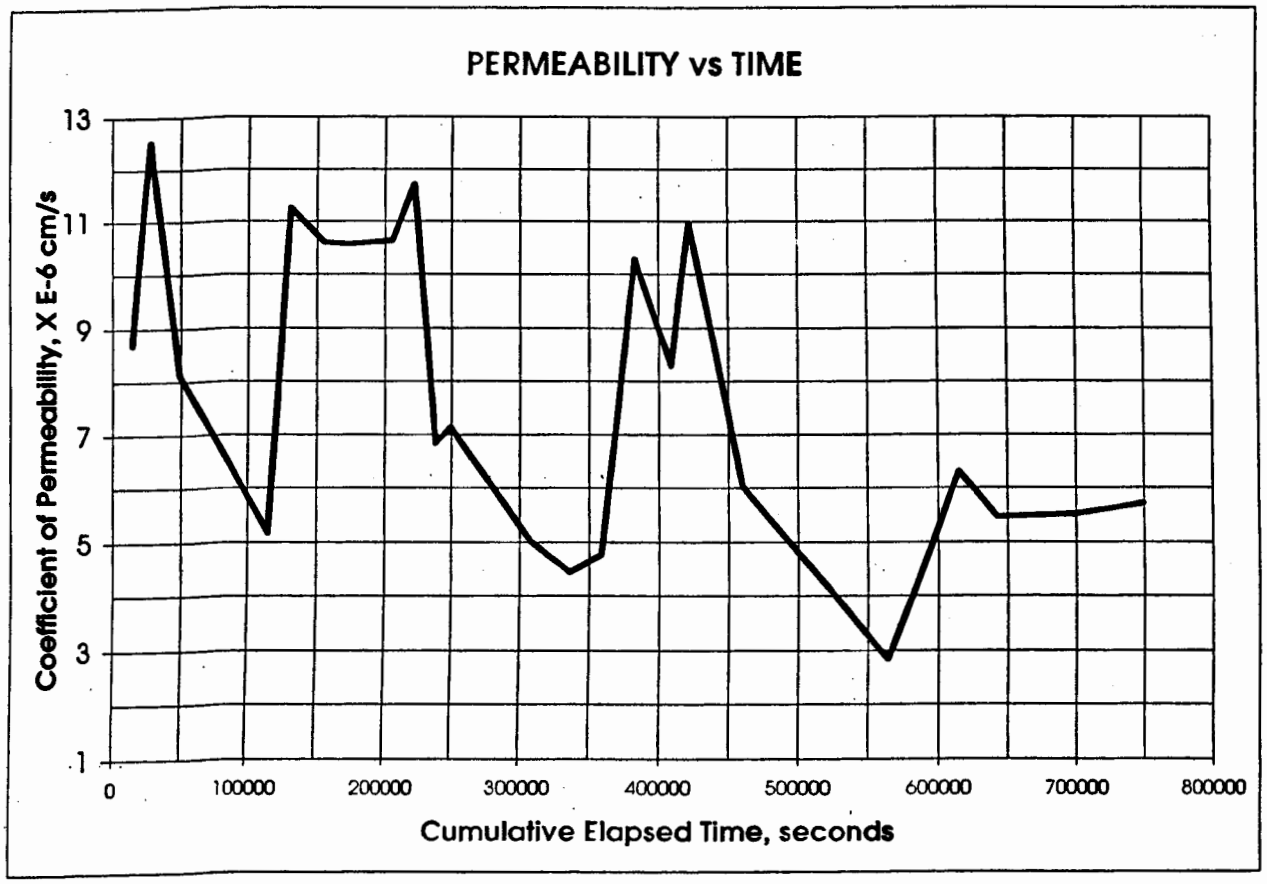
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-16-08
IT LAB SAMPLE NO. Tuff Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	381	392.38
Specimen cross-sect. area, cm	20.4003	
Water content, %	22.6	26.3
Wet unit weight, pcf	114.3	
Dry unit weight, pcf	93.3	
Estimated degree of saturatior	77.4	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.8E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

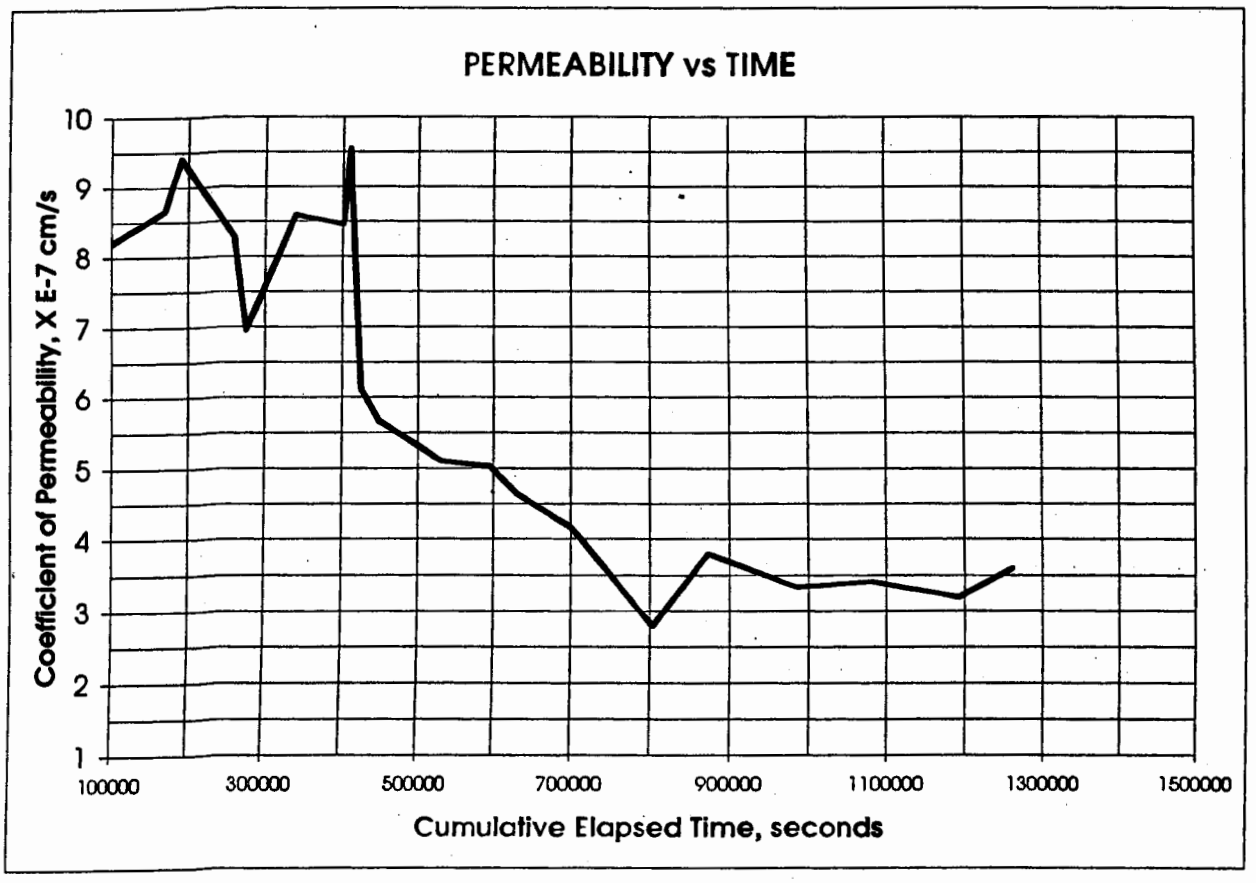
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-17-08
IT LAB SAMPLE NO. Tuff Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	375.86	385.88
Specimen cross-sect. area, cm	20.4342	
Water content, %	23.8	27.1
Wet unit weight, pcf	112.6	
Dry unit weight, pcf	90.9	
Estimated degree of saturatior	76.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 3.4E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

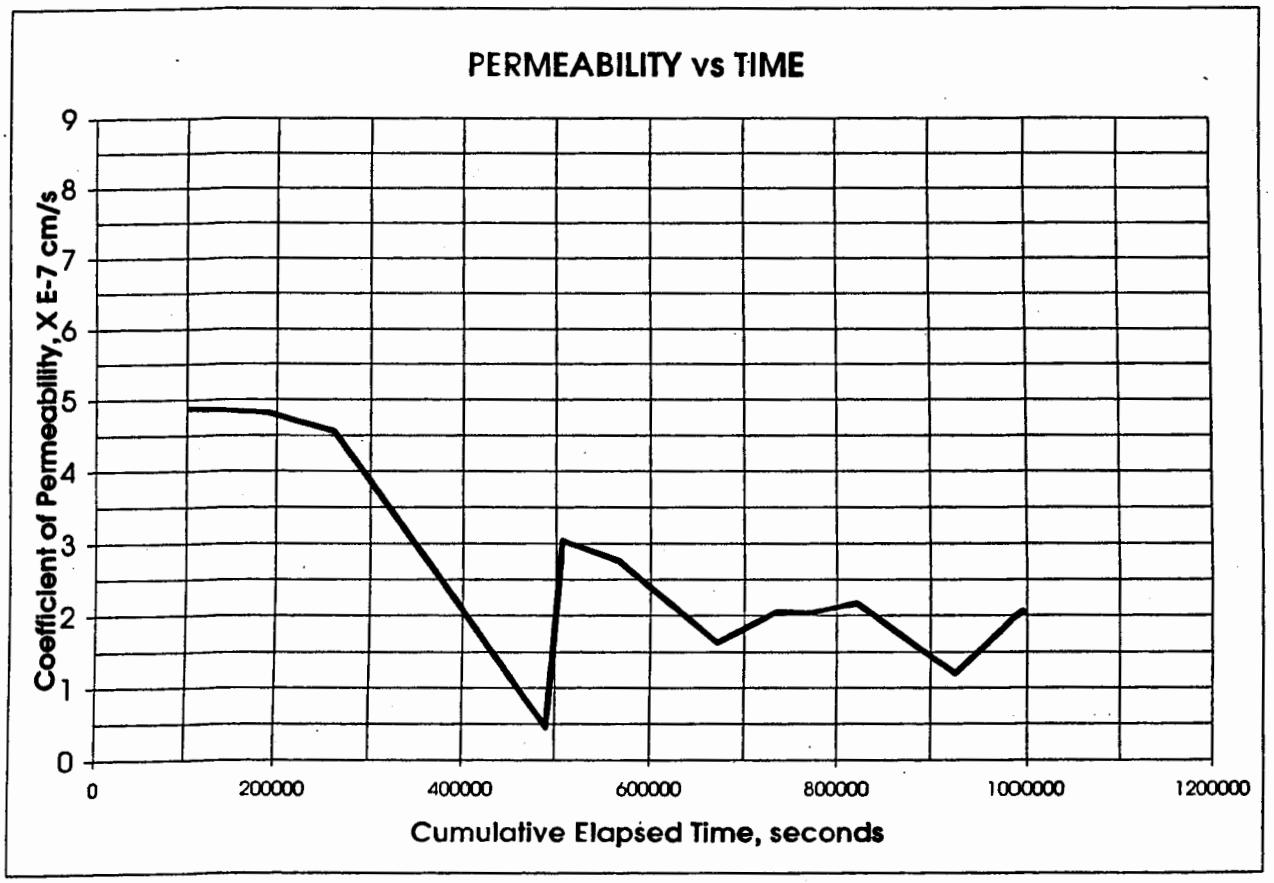
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-18-08
IT LAB SAMPLE NO. Tuff Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.23	
Wet weight of specimen, g.	387.77	396.9
Specimen cross-sect. area, cm	20.5326	
Water content, %	23.0	25.9
Wet unit weight, pcf	115.3	
Dry unit weight, pcf	93.7	
Estimated degree of saturatior	79.7	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	6.0
Permeant Fluid	Dearied DI Water

Coefficient of Permeability, cm/s 1.9E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

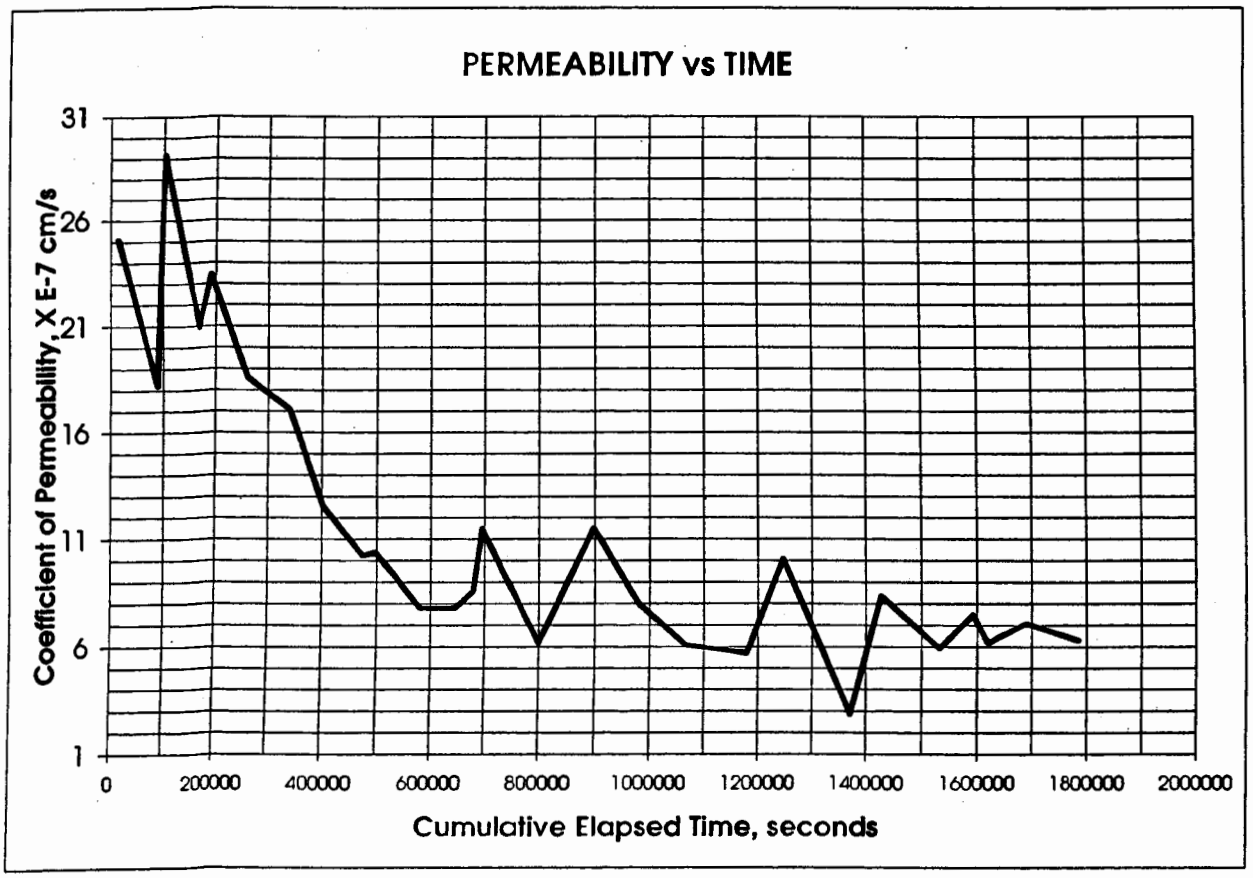
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-19-10
IT LAB SAMPLE NO. Tuff Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.25	
Wet weight of specimen, g.	381.75	392.34
Specimen cross-sect. area, cm	20.3698	
Water content, %	21.5	24.9
Wet unit weight, pcf	114.1	
Dry unit weight, pcf	93.9	
Estimated degree of saturatior	74.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 6.8E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

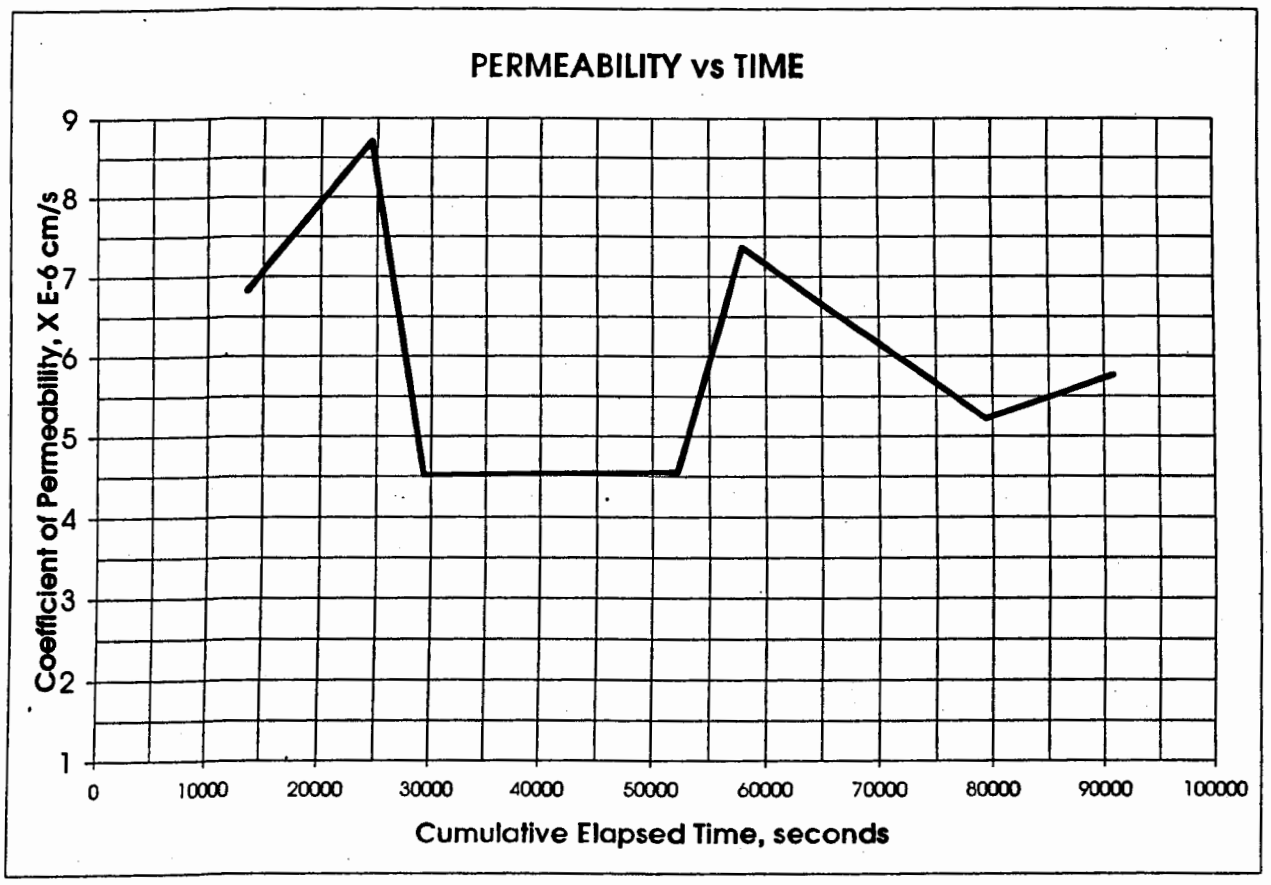
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-20-10
IT LAB SAMPLE NO. Tuff Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.31	
Wet weight of specimen, g.	386.55	386.55
Specimen cross-sect. area, cm	20.5258	
Water content, %		28.7
Wet unit weight, pcf	114.0	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.7E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

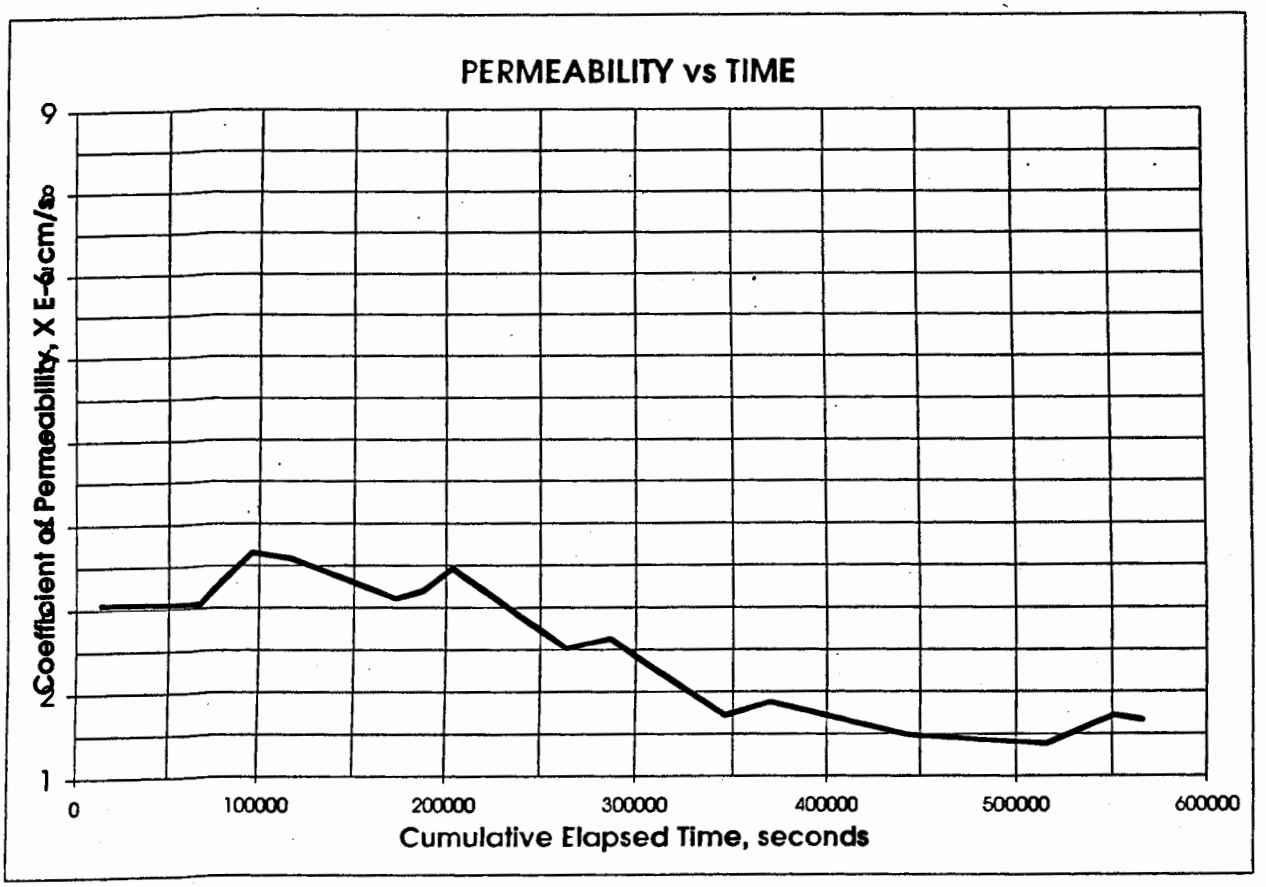
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-21-10
IT LAB SAMPLE NO. Tuff Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.23	
Wet weight of specimen, g.	367.83	379.1
Specimen cross-sect. area, cm	20.3901	
Water content, %	25.9	29.7
Wet unit weight, pcf	110.1	
Dry unit weight, pcf	87.4	
Estimated degree of saturatior	76.8	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	6.0
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 1.6E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

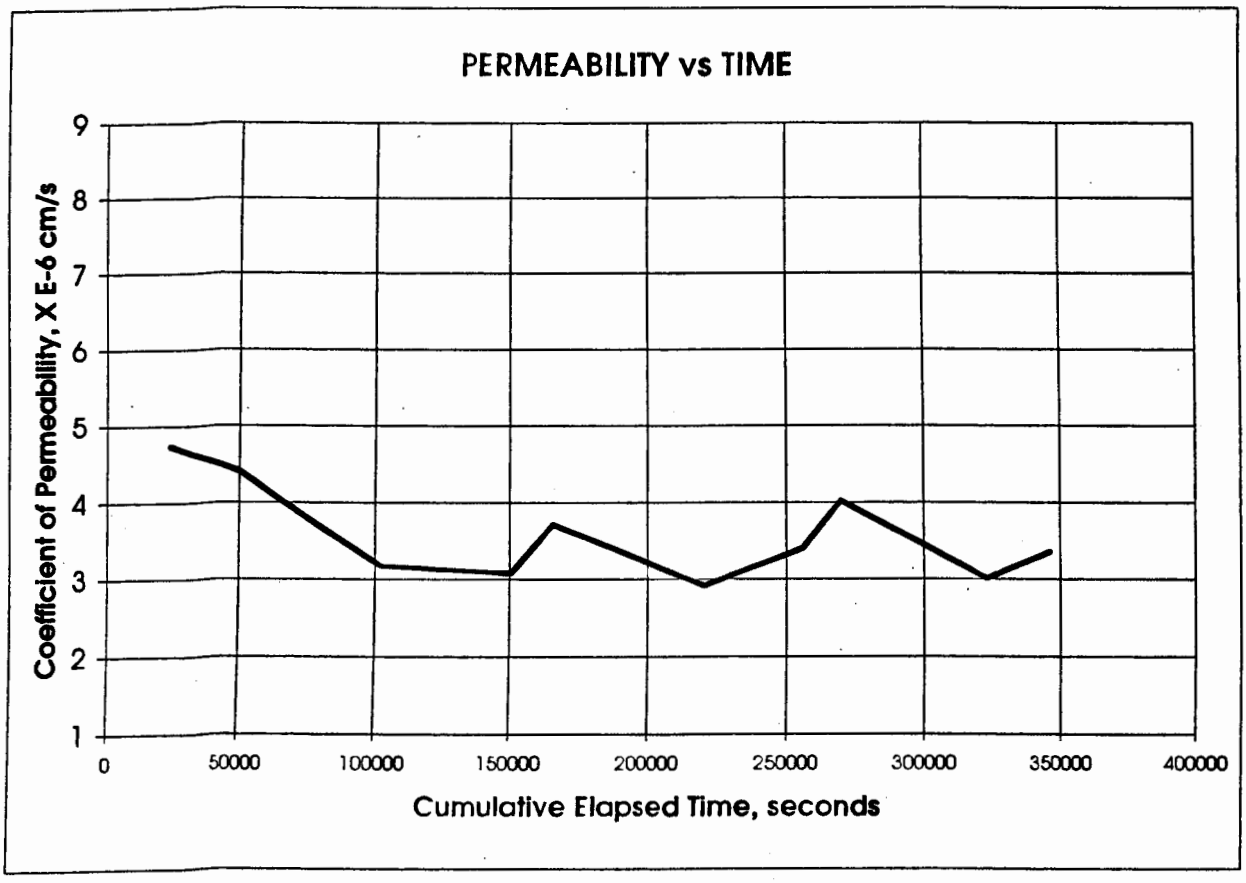
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-32-03
IT LAB SAMPLE NO. Tuff/Soil Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.16	
Wet weight of specimen, g.	391.97	394.35
Specimen cross-sect. area, cm	20.2683	
Water content, %	25.1	25.8
Wet unit weight, pcf	118.8	
Dry unit weight, pcf	95.0	
Estimated degree of saturatior	89.6	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 3.4E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

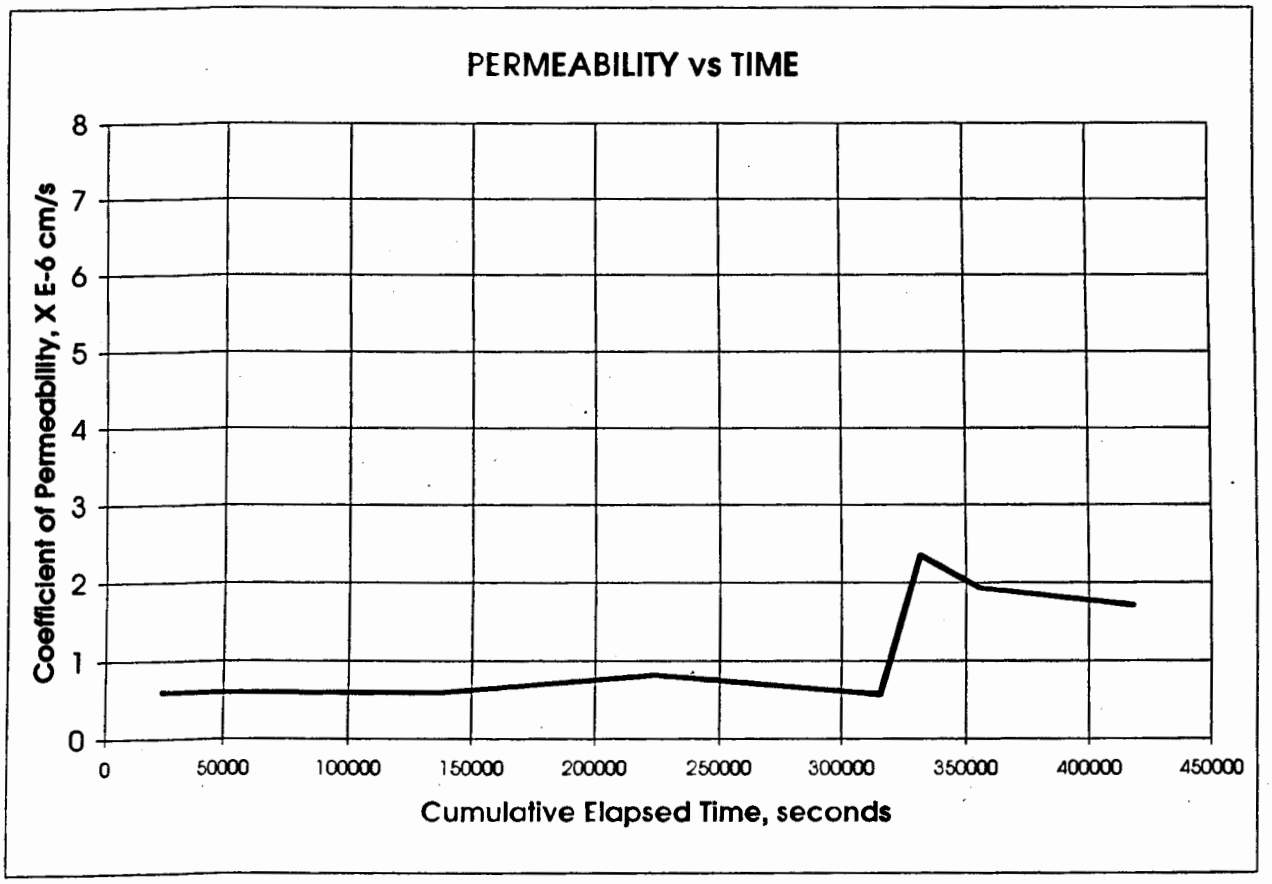
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-33-01
IT LAB SAMPLE NO. Tuff/Soil Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.21	
Wet weight of specimen, g.	382.5	
Specimen cross-sect. area, cm	20.5224	
Water content, %		
Wet unit weight, pcf	114.0	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	10.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.0E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

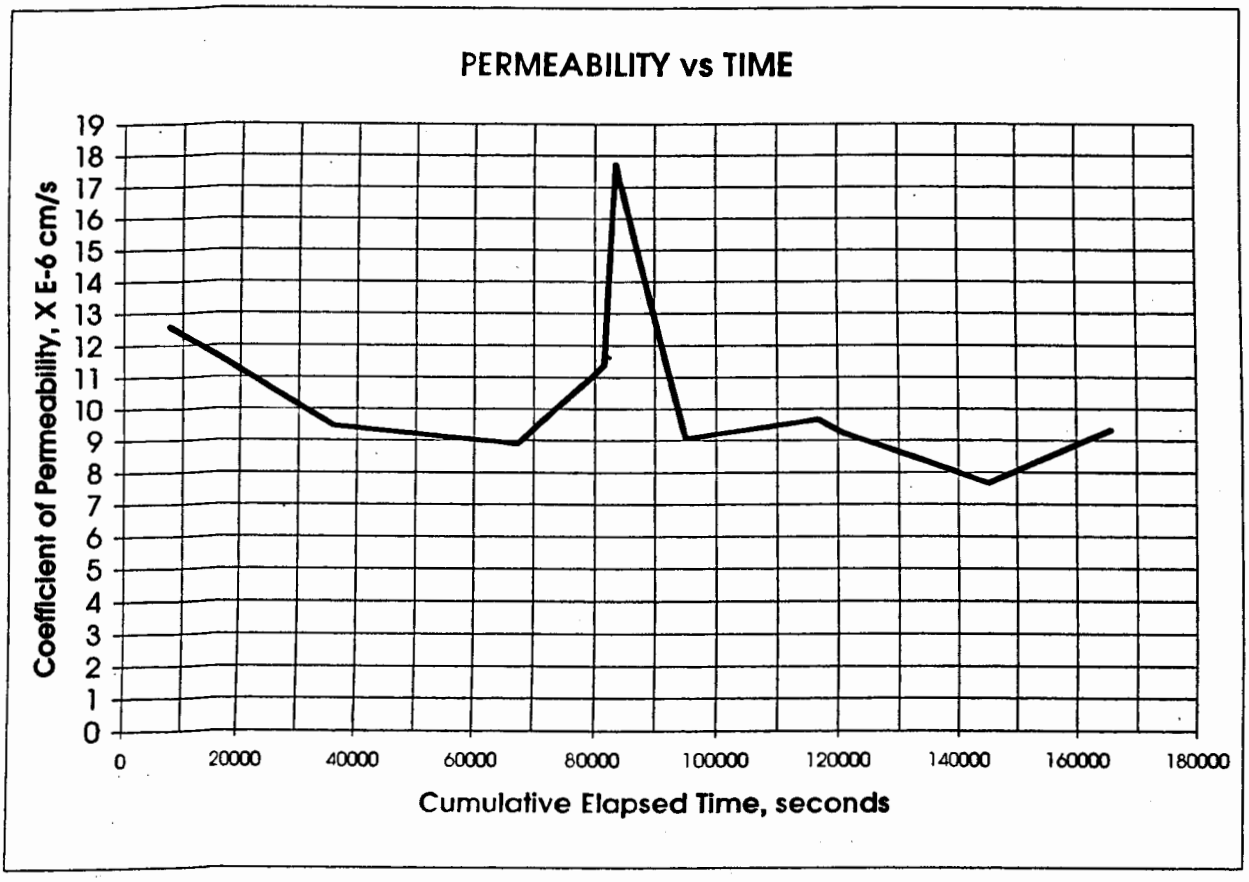
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-34-01
IT LAB SAMPLE NO. Tuff/Soil Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.24	
Wet weight of specimen, g.	393.43	388.18
Specimen cross-sect. area, cm	20.3732	
Water content, %	30.1	28.3
Wet unit weight, pcf	117.8	
Dry unit weight, pcf	90.6	
Estimated degree of saturatior	96.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 9.0E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

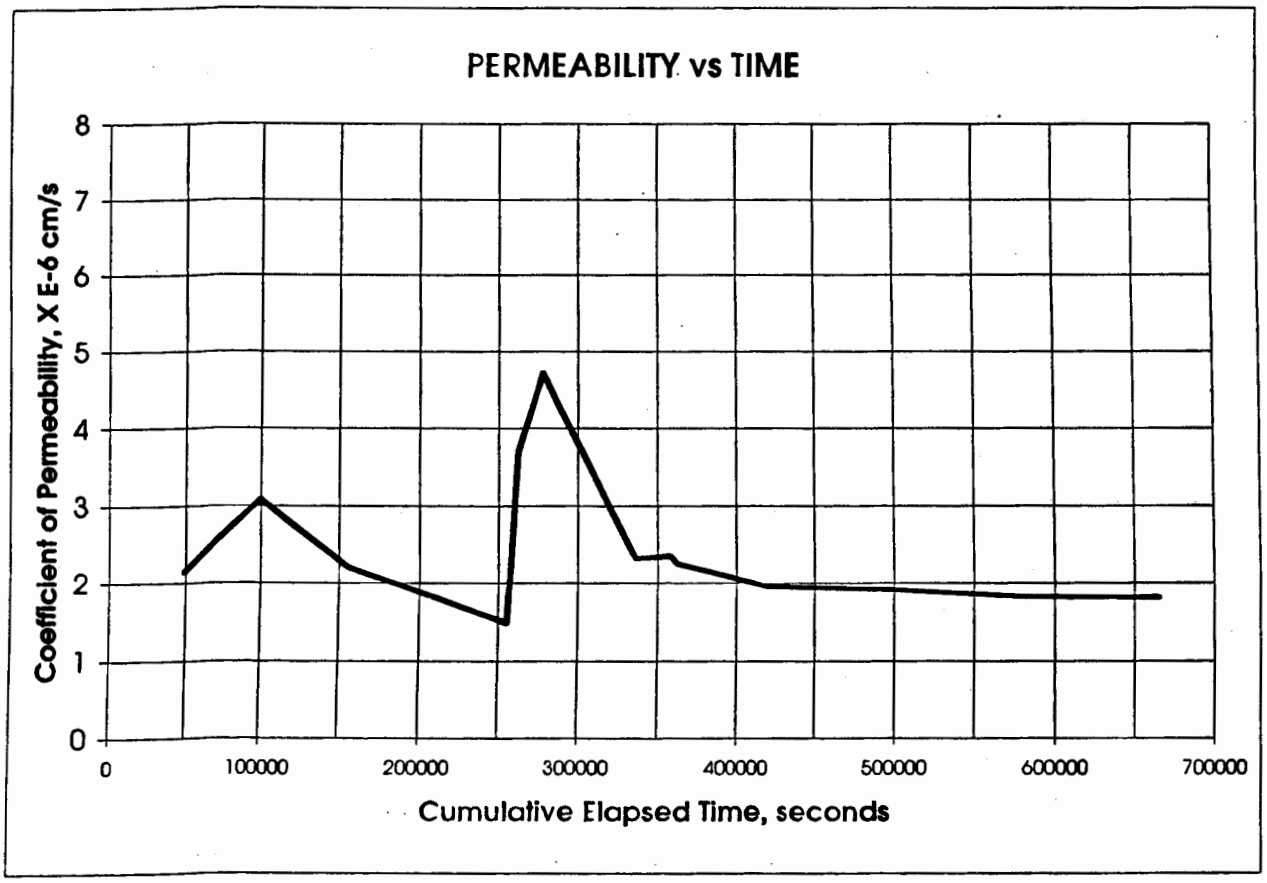
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-35-01
IT LAB SAMPLE NO. Tuff/Soil Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.22	
Wet weight of specimen, g.	370.06	378.35
Specimen cross-sect. area, cm	20.4613	
Water content, %	28.1	31.0
Wet unit weight, pcf	110.5	
Dry unit weight, pcf	86.3	
Estimated degree of saturatior	81.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 1.9E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

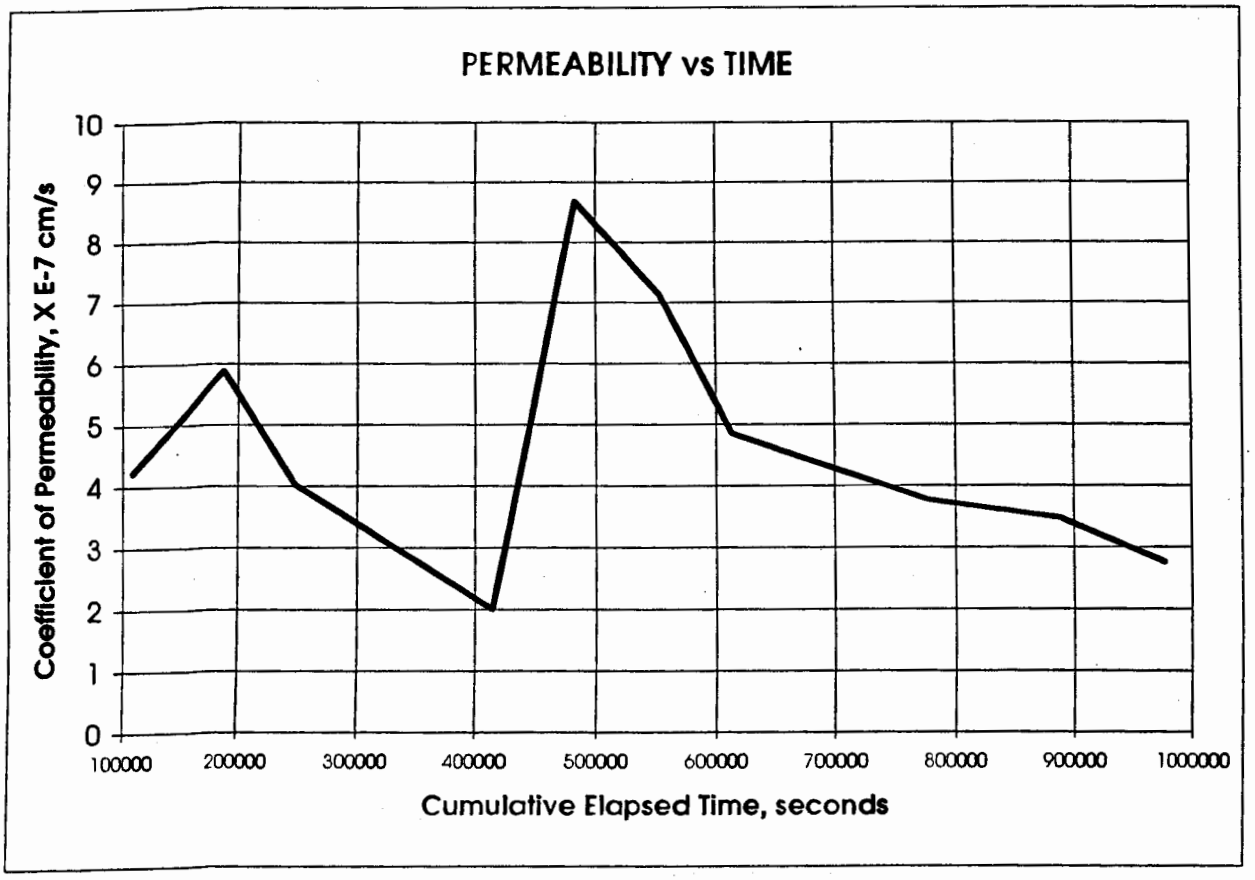
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-36-01
IT LAB SAMPLE NO. Tuff/Soil Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	380.22	388.72
Specimen cross-sect. area, cm	20.4579	
Water content, %	25.2	28.0
Wet unit weight, pcf	113.8	
Dry unit weight, pcf	90.9	
Estimated degree of saturatior	81.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	10.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	3.5
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 4.7E-07



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

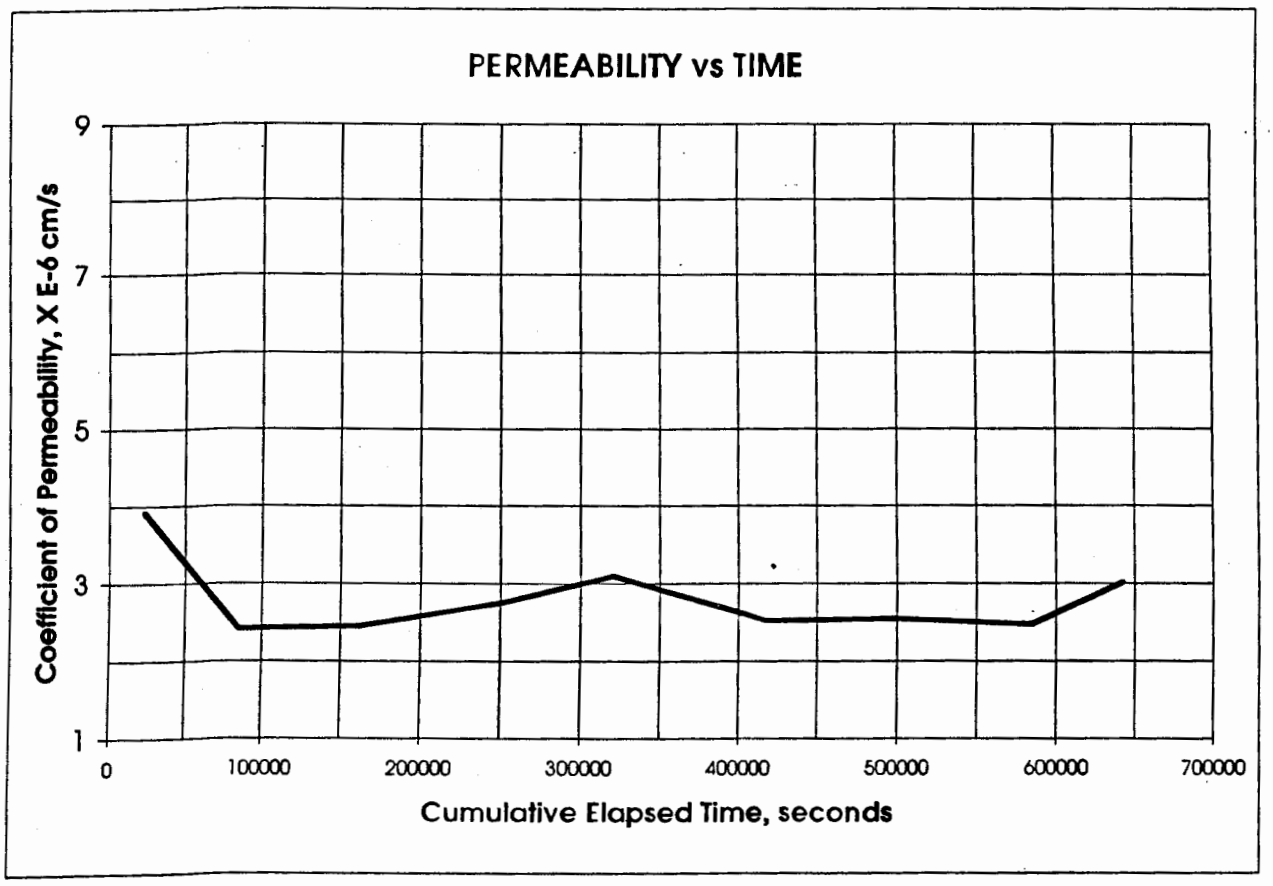
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-37-01
IT LAB SAMPLE NO. Tuff/Soil Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.30	
Wet weight of specimen, g.	372.51	383.46
Specimen cross-sect. area, cm	20.4681	
Water content, %	25.7	29.4
Wet unit weight, pcf	110.3	
Dry unit weight, pcf	87.8	
Estimated degree of saturatior	76.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.6E-06



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

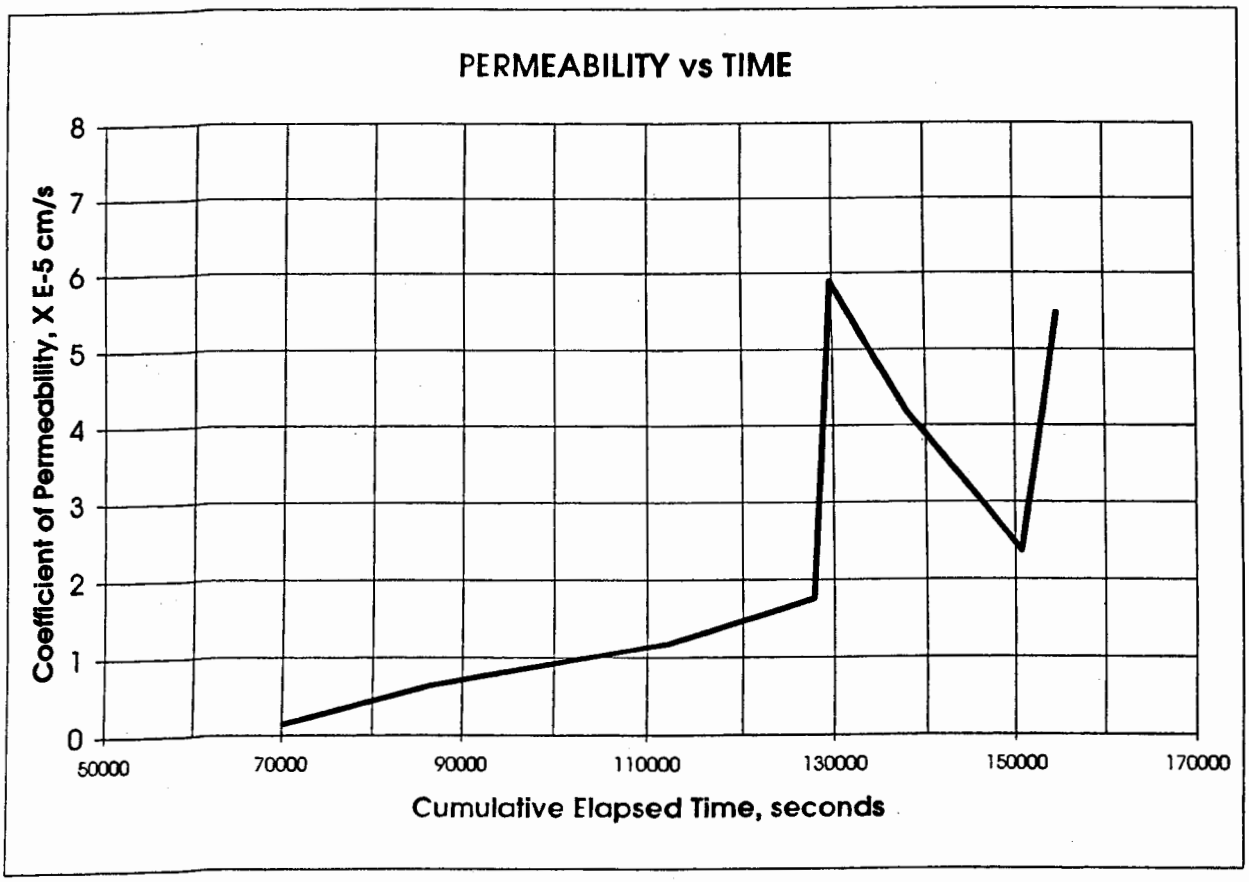
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-38-01
IT LAB SAMPLE NO. Tuff/Soil Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	366.99	
Specimen cross-sect. area, cm	20.5483	
Water content, %		
Wet unit weight, pcf	108.4	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	10.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	7.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 4.5E-05



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

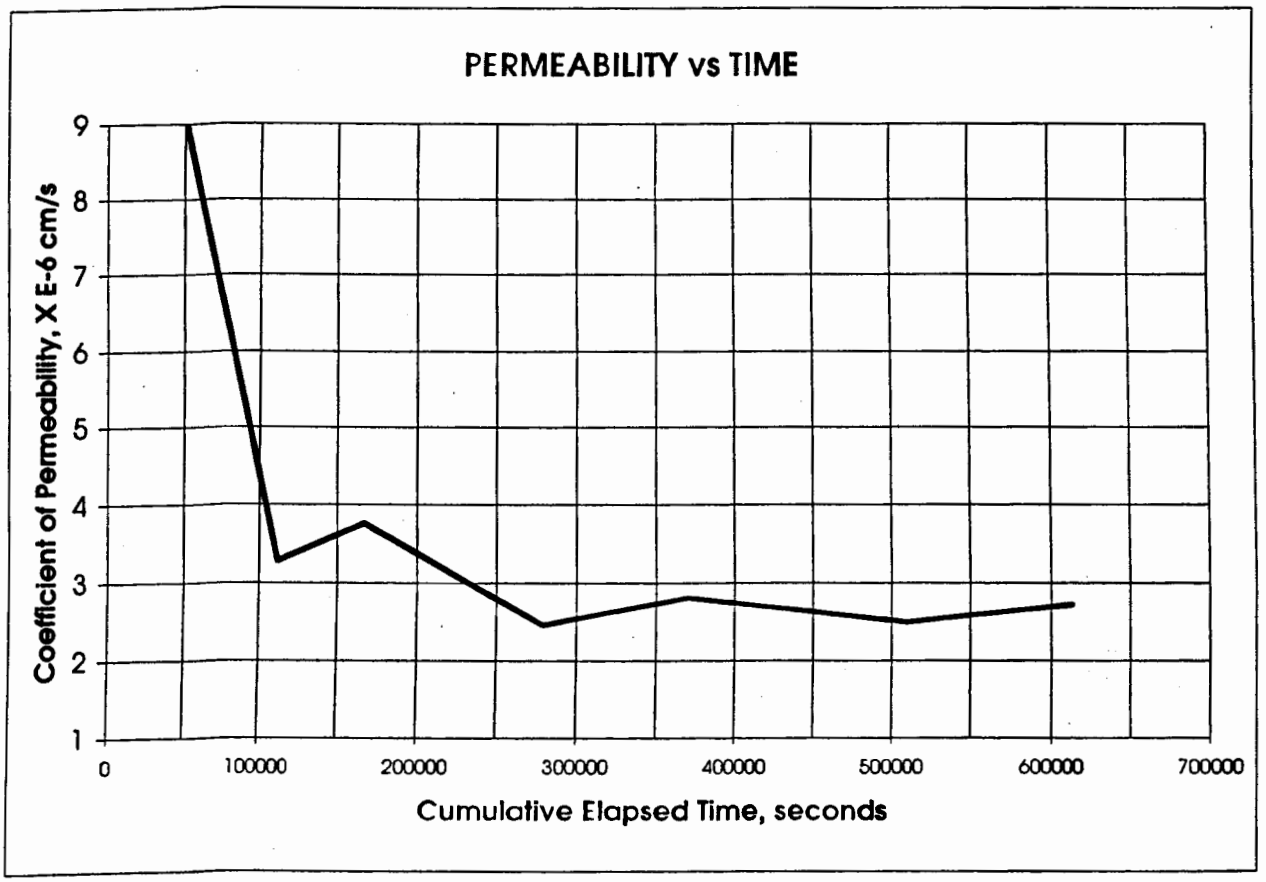
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-39-01
IT LAB SAMPLE NO. Tuff/Soil Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.30	
Wet weight of specimen, g.	354.67	366.21
Specimen cross-sect. area, cm	20.4715	
Water content, %	29.3	33.6
Wet unit weight, pcf	105.0	
Dry unit weight, pcf	81.2	
Estimated degree of saturatior	75.0	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.6E-06



Freeze / Thaw Tests

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 1

CLIENT SAMPLE NUMBER:
1108-06-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.1339	0.1244	0.0095	0.01
2	0.1905	0.1623	0.0282	0.04
3	2.6555	0.0465	2.6090	2.65
4	5.3277	0.0790	5.2487	7.90
5	1.6407	0.0216	1.6190	9.51
6	3.9030	0.0173	3.8857	13.40
7	1.7299	0.0032	1.7267	15.13
8	1.4276	0.0000	1.4276	16.55
9	1.0762	0.0022	1.0740	17.63
10	1.2407	0.0217	1.2190	18.85
11	1.3492	0.0260	1.3231	20.17
12	5.4480	0.0022	5.4458	25.62

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 2

CLIENT SAMPLE NUMBER:
1108-07-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.4329	0.2873	0.1456	0.15
2	0.9370	0.2309	0.7062	0.85
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 3

CLIENT SAMPLE NUMBER:
1108-08-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	3.2139	0.3964	2.8175	2.82
2	3.1103	0.2981	2.8122	5.63
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 4

CLIENT SAMPLE NUMBER:
1108-09-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	34.5829	0.7782	33.8047	33.80
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 5

CLIENT SAMPLE NUMBER:
1108-10-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.1854	0.1985	-0.0131	-0.01
2	0.2465	0.2012	0.0453	0.03
3	0.5038	0.0642	0.4396	0.47
4	3.1194	0.2097	2.9098	3.38
5	0.7857	0.0340	0.7517	4.13
6	0.7386	0.0219	0.7167	4.85
7	1.4271	0.0071	1.4200	6.27
8	0.8631	0.0000	0.8631	7.13
9	0.3737	0.0000	0.3737	7.51
10	0.3675	0.0099	0.3576	7.86
11	1.2101	0.0000	1.2101	9.07
12	0.5534	0.0000	0.5534	9.63

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 6

CLIENT SAMPLE NUMBER:
1108-11-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.2530	0.2891	-0.0361	-0.04
2	0.2497	0.2979	-0.0482	-0.08
3	0.1538	0.0197	0.1340	0.05
4	1.0006	0.1291	0.8715	0.92
5	0.5254	0.0329	0.4925	1.41
6	1.0816	0.0513	1.0302	2.44
7	0.4837	0.0088	0.4749	2.92
8	0.7336	0.0871	0.6465	3.57
9	0.5409	0.0360	0.5049	4.07
10	0.3602	0.0448	0.3153	4.39
11	11.4288	0.0033	11.4255	15.81
12	10.9319	0.0022	10.9297	26.74

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 7

CLIENT SAMPLE NUMBER:
1108-12-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.2413	0.2424	-0.0011	0.00
2	0.2470	0.2447	0.0023	0.00
3	2.5497	0.0476	2.5021	2.50
4	3.2206	0.1392	3.0814	5.58
5	1.6332	0.0238	1.6094	7.19
6	8.4844	0.0238	8.4606	15.65
7	0.7831	0.0000	0.7831	16.44
8	0.5489	0.0000	0.5489	16.99
9	0.3393	0.0079	0.3314	17.32
10	0.3136	0.0340	0.2796	17.60
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 8

CLIENT SAMPLE NUMBER:
1108-13-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.3049	0.3911	-0.0861	-0.09
2	0.3141	0.3397	-0.0257	-0.11
3	1.0957	0.0267	1.0690	0.96
4	2.3071	0.1373	2.1698	3.13
5	5.6122	0.0109	5.6014	8.73
6	21.7062	0.0827	21.6235	30.35
7	1.2916	0.0037	1.2879	31.64
8	0.6493	0.0024	0.6468	32.29
9				
10				
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 1

CLIENT SAMPLE NUMBER:
1108-14-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.238	0.164	0.074	0.07
2	0.088	0.119	-0.032	0.04
3	0.024	0.010	0.014	0.06
4	0.619	0.036	0.583	0.64
5	3.233	0.014	3.219	3.86
6	1.717	0.046	1.671	5.53
7	0.215	0.023	0.192	5.72
8	0.462	0.000	0.462	6.18
9	0.206	1.294	-1.088	5.09
10	0.429	0.126	0.303	5.40
11	0.176	0.117	0.059	5.46
12	0.132	0.079	0.053	5.51

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 2

CLIENT SAMPLE NUMBER:
1108-15-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.330	0.278	0.052	0.05
2	0.090	0.410	-0.320	-0.27
3	0.050	0.002	0.048	-0.22
4	0.984	0.041	0.943	0.72
5	2.534	0.000	2.534	3.26
6	1.994	0.098	1.896	5.15
7	0.376	0.000	0.376	5.53
8	0.238	0.001	0.237	5.77
9	0.321	0.091	0.230	6.00
10	0.225	0.026	0.199	6.20
11	0.345	0.053	0.293	6.49
12	0.334	0.011	0.323	6.81

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 3

CLIENT SAMPLE NUMBER:
1108-16-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.288	0.257	0.031	0.03
2	0.067	0.130	-0.063	-0.03
3	2.133	0.000	2.133	2.10
4	2.246	0.035	2.210	4.31
5	1.064	0.000	1.064	5.38
6	1.209	0.051	1.159	6.53
7	0.676	0.000	0.676	7.21
8	0.572	0.000	0.572	7.78
9	0.169	0.184	-0.016	7.77
10	0.212	0.130	0.082	7.85
11	0.204	0.085	0.119	7.97
12	0.083	0.084	-0.001	7.97

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 4

CLIENT SAMPLE NUMBER:
1108-17-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.188	0.168	0.019	0.02
2	0.077	0.081	-0.004	0.02
3	0.393	0.000	0.393	0.41
4	0.796	0.015	0.781	1.19
5	0.975	0.000	0.976	2.17
6	1.473	0.036	1.437	3.60
7	0.798	0.000	0.798	4.40
8	0.579	0.000	0.579	4.98
9	0.905	0.105	0.800	5.78
10	0.412	0.016	0.396	6.17
11	0.941	0.028	0.914	7.09
12	0.494	0.051	0.443	7.53

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 5

CLIENT SAMPLE NUMBER:
1108-18-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.243	0.224	0.019	0.02
2	0.092	0.130	-0.038	-0.02
3	0.231	0.000	0.231	0.21
4	1.055	0.062	0.993	1.20
5	0.795	0.034	0.761	1.96
6	0.515	0.093	0.423	2.39
7	0.321	0.028	0.294	2.68
8	0.152	0.003	0.149	2.83
9	1.528	0.060	1.469	4.30
10	0.138	0.023	0.115	4.41
11	0.249	0.189	0.060	4.47
12	0.129	0.001	0.128	4.60

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 6

CLIENT SAMPLE NUMBER:
1108-19-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.533	0.355	0.177	0.18
2	0.092	0.153	-0.061	0.12
3	0.000	0.000	0.000	0.12
4	0.836	0.061	0.775	0.89
5	1.418	0.002	1.416	2.31
6	1.199	0.075	1.124	3.43
7	0.348	0.003	0.345	3.78
8	0.609	0.009	0.600	4.38
9	0.848	0.027	0.821	5.20
10	0.244	0.023	0.220	5.42
11	0.202	0.190	0.012	5.43
12	0.271	0.014	0.256	5.69

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 7

CLIENT SAMPLE NUMBER:
1108-20-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.412	0.341	0.072	0.07
2	0.119	0.163	-0.044	0.03
3	1.246	0.000	1.246	1.27
4	1.771	0.061	1.710	2.98
5	1.572	0.000	1.572	4.56
6	0.976	0.055	0.921	5.48
7	0.467	0.000	0.467	5.94
8	0.656	0.000	0.656	6.60
9	0.566	0.273	0.292	6.89
10	0.751	0.055	0.696	7.59
11	0.433	0.116	0.317	7.91
12	0.147	0.034	0.112	8.02

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 8

CLIENT SAMPLE NUMBER:
1108-21-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.528	0.339	0.189	0.19
2	0.171	0.192	-0.022	0.17
3	1.203	0.041	1.162	1.33
4	0.812	0.055	0.757	2.09
5	1.354	0.000	1.354	3.44
6	2.856	0.238	2.618	6.06
7	0.725	0.124	0.601	6.66
8	1.649	0.000	1.649	8.31
9	2.338	0.059	2.279	10.59
10	1.615	0.012	1.604	12.19
11	0.495	0.225	0.270	12.46
12	0.647	0.004	0.644	13.11

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 1

CLIENT SAMPLE NUMBER:
1108-23-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.135	0.094	0.041	0.04
2	0.076	0.192	-0.116	-0.07
3	0.480	0.038	0.442	0.37
4	1.524	0.030	1.494	1.86
5	1.260	0.017	1.243	3.10
6	0.648	0.022	0.626	3.73
7	0.596	0.015	0.580	4.31
8	0.351	0.000	0.351	4.66
9	0.194	0.000	0.194	4.86
10	0.674	0.000	0.674	5.53
11	0.351	0.000	0.351	5.88
12	0.443	0.000	0.443	6.32

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 4

CLIENT SAMPLE NUMBER:
1108-26-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.217	0.125	0.092	0.09
2	0.137	0.101	0.036	0.13
3	0.756	0.036	0.721	0.85
4	1.425	0.027	1.398	2.25
5	3.318	0.010	3.308	5.55
6	2.609	0.039	2.570	8.12
7	2.264	0.029	2.235	10.36
8	1.719	0.001	1.717	12.08
9	1.096	0.000	1.096	13.17
10	1.718	0.013	1.705	14.88
11	2.099	0.059	2.039	16.92
12	2.787	0.002	2.785	19.70

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 5

CLIENT SAMPLE NUMBER:
1108-27-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.198	0.128	0.070	0.07
2	0.128	0.114	0.014	0.08
3	0.143	0.064	0.079	0.16
4	1.415	0.047	1.367	1.53
5	1.079	0.027	1.052	2.58
6	0.819	0.039	0.781	3.36
7	0.707	0.021	0.687	4.05
8	0.663	0.000	0.663	4.71
9	0.847	0.000	0.847	5.56
10	0.701	0.000	0.701	6.26
11	1.426	0.026	1.401	7.66
12	0.294	0.000	0.294	7.96

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 8

CLIENT SAMPLE NUMBER:
1108-30-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.248	0.182	0.066	0.07
2	0.194	0.144	0.050	0.12
3	0.116	0.045	0.072	0.19
4	0.237	0.049	0.189	0.38
5	0.528	0.007	0.520	0.90
6	2.065	0.046	2.019	2.92
7	1.374	0.056	1.318	4.23
8	1.117	0.046	1.071	5.31
9	0.663	0.000	0.663	5.97
10	22.109	0.018	22.091	28.06
11	0.511	0.012	0.499	28.56
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 1

CLIENT SAMPLE NUMBER:
1108-14-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.238	0.164	0.074	0.07
2	0.088	0.119	-0.032	0.04
3	0.024	0.010	0.014	0.06
4	0.619	0.036	0.583	0.64
5	3.233	0.014	3.219	3.86
6	1.717	0.046	1.671	5.53
7	0.215	0.023	0.192	5.72
8	0.462	0.000	0.462	6.18
9	0.206	1.294	-1.088	5.09
10	0.429	0.126	0.303	5.40
11	0.176	0.117	0.059	5.46
12	0.132	0.079	0.053	5.51

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 1

CLIENT SAMPLE NUMBER:
1108-32-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.199	0.162	0.037	0.04
2	0.092	0.068	0.024	0.06
3	0.958	0.011	0.946	1.01
4	5.374	0.068	5.306	6.31
5	1.381	0.039	1.342	7.66
6	0.246	0.036	0.210	7.87
7	0.975	0.003	0.972	8.84
8	0.377	0.019	0.358	9.19
9	0.196	0.002	0.193	9.39
10	0.106	-0.003	0.110	9.50
11				
12				

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 2

CLIENT SAMPLE NUMBER:
11108-33.03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.331	0.364	-0.033	-0.03
2	0.137	0.110	0.028	-0.01
3	4.216	0.000	4.216	4.21
4	4.501	0.054	4.447	8.66
5	0.669	0.000	0.669	9.33
6	0.720	0.023	0.697	10.02
7	0.550	0.000	0.550	10.57
8	0.721	0.032	0.689	11.26
9	0.407	0.000	0.407	11.67
10	0.264	0.000	0.264	11.93
11				
12				

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 3

CLIENT SAMPLE NUMBER:
1108-34-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.292	0.291	0.000	0.00
2	0.122	0.094	0.028	0.03
3	3.705	0.000	3.705	3.73
4	4.454	0.041	4.413	8.15
5	0.912	0.000	0.912	9.06
6	0.571	0.022	0.549	9.61
7	0.835	0.000	0.835	10.44
8	0.516	0.006	0.510	10.95
9	0.574	0.000	0.574	11.53
10	0.452	0.005	0.448	11.97
11				
12				

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 4

CLIENT SAMPLE NUMBER:
1108-35-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.410	0.241	0.168	0.17
2	0.158	0.095	0.063	0.23
3	2.588	0.068	2.520	2.75
4	6.593	0.039	6.555	9.31
5	1.626	0.000	1.626	10.93
6	1.888	0.020	1.869	12.80
7	2.064	0.000	2.064	14.86
8	1.195	0.021	1.174	16.04
9	1.007	0.006	1.001	17.04
10	0.975	0.012	0.963	18.00
11				
12				

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 5

CLIENT SAMPLE NUMBER:
1108-36-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.239	0.225	0.014	0.01
2	0.101	0.126	-0.025	-0.01
3	1.279	0.024	1.255	1.24
4	5.053	0.069	4.983	6.23
5	0.540	0.064	0.477	6.70
6	0.118	0.065	0.053	6.76
7	0.190	0.016	0.173	6.93
8	0.194	0.046	0.148	7.08
9	0.175	0.034	0.140	7.22
10	0.124	0.006	0.118	7.34
11				
12				

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 6

CLIENT SAMPLE NUMBER:
1108-37-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.542	0.565	-0.023	-0.02
2	0.169	0.163	0.007	-0.02
3	0.000	0.000	0.000	-0.02
4	4.008	0.080	3.928	3.91
5	2.623	0.000	2.623	6.54
6	1.154	0.029	1.125	7.66
7	3.468	0.000	3.468	11.13
8	1.107	0.037	1.070	12.20
9	1.202	0.000	1.202	13.40
10	1.524	0.030	1.494	14.89
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 7

CLIENT SAMPLE NUMBER:
1108-38-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.497	0.391	0.106	0.11
2	0.146	0.140	0.005	0.11
3	2.310	0.000	2.310	2.42
4	3.431	0.079	3.353	5.77
5	1.293	0.000	1.293	7.07
6	0.757	0.035	0.722	7.79
7	1.778	0.000	1.778	9.57
8	0.316	0.027	0.289	9.86
9	0.175	0.000	0.175	10.03
10	0.393	0.007	0.386	10.42
11				
12				

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 8

CLIENT SAMPLE NUMBER:
1108-39-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.456	0.511	-0.055	-0.06
2	0.152	0.179	-0.026	-0.08
3	1.016	0.126	0.889	0.81
4	4.260	0.086	4.174	4.98
5	3.156	0.052	3.104	8.09
6	16.500	0.043	16.457	24.54
7	2.808	0.000	2.808	27.35
8				
9				
10				
11				
12				

Appendix C
Nonconformance / Variance Reports

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: LANL	Date: 1/3/02	Page 1 of 1
	Project No. 817 831775		Report No. ETDC-115-02-N

Nonconformance/Variance Description (include requirement violated

SAMPLE SHIPMENTS OF RAW SOIL AND TUFF RECEIVED WITHOUT CHAIN-OF-CUSTODY DOCUMENTS.

SHIPMENTS RECEIVED 12-17-01, 12-20,01
TEN SAMPLES TOTAL: MD21-01-0545, MD21-01-054401, MD21-01-0546, MD21-01-054901, MD21-01-054701, TUFF 595, TUFF 583, TUFF 564, MD21-01-0548, 564 SOIL

Identified by

Root Cause

N/A

Corrective Action (include expected completion date)

NOTIFY CLIENT

To be completed by — Expected Completion Date

Action taken to preclude recurrence

N/A

To be performed by — Expected Completion Date

Client notified (include client name, how notified, and response)

PAUL LOAR NOTIFIED VERBALLY

Notified by — Date 1/3/02

Corrective action completed by — Date

Corrective action approved by

Laboratory Supervisor — Date

Project Manager — Date 1/3/02

QA Comments

QAO Approval — Date

See back of page for additional space. Attach additional pages if necessary.

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110806

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g):	36.7	Sample Weight (g):	387.23
Initial Contaminant Level (pCi):	14211.341		
Monolith Height (cm):	10	Monolith Diameter (cm):	5
Monolith Surface Area (cm^2):	176.72	Leachate Volume (mL):	1800
Monolith Volume (cm^3):	196.35		

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.1	3.78	2.660E-04	9.528E-12	11.02
7	18000	14835	1.8	3.24	2.280E-04	9.231E-12	11.03
24	61200	51231	1.4	2.52	1.773E-04	1.668E-12	11.78
48	86400	125894	1.7	3.06	2.153E-04	3.033E-12	11.52
72	86400	213818	1.5	2.70	1.900E-04	4.010E-12	11.40
96	86400	300849	1.4	2.52	1.773E-04	4.915E-12	11.31
120	86400	387596	1.3	2.34	1.647E-04	5.460E-12	11.26
					Average Leach Index:		11.33

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110806

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 80.8 Sample Weight (g): 387.23

Initial Contaminant Level (pCi): 31288.184

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.7	4.86	1.553E-04	3.249E-12	11.49
7	18000	14835	2.9	5.22	1.668E-04	4.943E-12	11.31
24	61200	51231	15.2	27.36	8.745E-04	4.057E-11	10.39
48	86400	125894	22	39.60	1.266E-03	1.048E-10	9.98
72	86400	213818	19.2	34.56	1.105E-03	1.355E-10	9.87
96	86400	300849	11.7	21.06	6.731E-04	7.082E-11	10.15
120	86400	387596	7.6	13.68	4.372E-04	3.850E-11	10.41

Average Leach Index: 10.51

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110807

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 35.8

Sample Weight (g): 345.48

Initial Contaminant Level (pCi): 12368.184

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	2.183E-04	6.418E-12	11.19
7	18000	14835	1.8	3.24	2.620E-04	1.219E-11	10.91
24	61200	51231	1.4	2.52	2.037E-04	2.202E-12	11.66
48	86400	125894	1.6	2.88	2.329E-04	3.547E-12	11.45
72	86400	213818	1.5	2.70	2.183E-04	5.294E-12	11.28
96	86400	300849	1.1	1.98	1.601E-04	4.006E-12	11.40
120	86400	387596	1.5	2.70	2.183E-04	9.597E-12	11.02

Average Leach Index: 11.27

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110807

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 88.7 Sample Weight (g): 345.48

Initial Contaminant Level (pCi): 30644.076

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.7	4.86	1.586E-04	3.387E-12	11.47
7	18000	14835	2.9	5.22	1.703E-04	5.153E-12	11.29
24	61200	51231	6.3	11.34	3.701E-04	7.265E-12	11.14
48	86400	125894	12.3	22.14	7.225E-04	3.414E-11	10.47
72	86400	213818	18	32.40	1.057E-03	1.242E-10	9.91
96	86400	300849	2	3.60	1.175E-04	2.157E-12	11.67
120	86400	387596	23.5	42.30	1.380E-03	3.837E-10	9.42

Average Leach Index: 10.76

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110808

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 34.9

Sample Weight (g): 354.24

Initial Contaminant Level (pCi): 12362.976

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	2.184E-04	6.423E-12	11.19
7	18000	14835	1.8	3.24	2.621E-04	1.220E-11	10.91
24	61200	51231	1.4	2.52	2.038E-04	2.204E-12	11.66
48	86400	125894	1.6	2.88	2.330E-04	3.550E-12	11.45
72	86400	213818	1.5	2.70	2.184E-04	5.299E-12	11.28
96	86400	300849	1.8	3.24	2.621E-04	1.074E-11	10.97
120	86400	387596	1.4	2.52	2.038E-04	8.367E-12	11.08

Average Leach Index: 11.22

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110808

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 79.5 Sample Weight (g): 354.24

Initial Contaminant Level (pCi): 28162.08

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.7	4.86	1.726E-04	4.011E-12	11.40
7	18000	14835	2.9	5.22	1.854E-04	6.101E-12	11.21
24	61200	51231	7	12.60	4.474E-04	1.062E-11	10.97
48	86400	125894	8.5	15.30	5.433E-04	1.931E-11	10.71
72	86400	213818	10.4	18.72	6.647E-04	4.909E-11	10.31
96	86400	300849	7.3	13.14	4.666E-04	3.403E-11	10.47
120	86400	387596	5.1	9.18	3.260E-04	2.140E-11	10.67
					Average Leach Index:		10.82

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110809

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 32.4 Sample Weight (g): 332.14

Initial Contaminant Level (pCi): 10761.336

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	4	7.20	6.691E-04	6.028E-11	10.22
7	18000	14835	1.8	3.24	3.011E-04	1.610E-11	10.79
24	61200	51231	1.4	2.52	2.342E-04	2.909E-12	11.54
48	86400	125894	1.7	3.06	2.844E-04	5.289E-12	11.28
72	86400	213818	1.5	2.70	2.509E-04	6.993E-12	11.16
96	86400	300849	1.3	2.34	2.174E-04	7.391E-12	11.13
120	86400	387596	1.4	2.52	2.342E-04	1.104E-11	10.96

Average Leach Index: 11.01

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110809

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 77.4 Sample Weight (g): 332.14

Initial Contaminant Level (pCi): 25707.636

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.7	4.86	1.890E-04	4.813E-12	11.32
7	18000	14835	2.9	5.22	2.031E-04	7.322E-12	11.14
24	61200	51231	15.4	27.72	1.078E-03	6.168E-11	10.21
48	86400	125894	13.5	24.30	9.452E-04	5.844E-11	10.23
72	86400	213818	16.2	29.16	1.134E-03	1.429E-10	9.84
96	86400	300849	22.9	41.22	1.603E-03	4.019E-10	9.40
120	86400	387596	9.7	17.46	6.792E-04	9.289E-11	10.03

Average Leach Index: 10.31

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110810

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 33.8 Sample Weight (g): 367.23

Initial Contaminant Level (pCi): 12412.374

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.3	4.14	3.335E-04	1.498E-11	10.82
7	18000	14835	1.8	3.24	2.610E-04	1.210E-11	10.92
24	61200	51231	1.6	2.88	2.320E-04	2.856E-12	11.54
48	86400	125894	1.7	3.06	2.465E-04	3.975E-12	11.40
72	86400	213818	1.6	2.88	2.320E-04	5.981E-12	11.22
96	86400	300849	5.3	9.54	7.686E-04	9.234E-11	10.03
120	86400	387596	1.4	2.52	2.030E-04	8.301E-12	11.08

Average Leach Index: 11.00

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110810

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 87.6 Sample Weight (g): 367.23

Initial Contaminant Level (pCi): 32169.348

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	13.2	23.76	7.386E-04	7.347E-11	10.13
7	18000	14835	2.9	5.22	1.623E-04	4.676E-12	11.33
24	61200	51231	28.3	50.94	1.583E-03	1.330E-10	9.88
48	86400	125894	9.5	17.10	5.316E-04	1.848E-11	10.73
72	86400	213818	12.2	21.96	6.826E-04	5.177E-11	10.29
96	86400	300849	15	27.00	8.393E-04	1.101E-10	9.96
120	86400	387596	19.6	35.28	1.097E-03	2.422E-10	9.62

Average Leach Index: 10.28

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110811

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 27.1 Sample Weight (g): 380.63

Initial Contaminant Level (pCi): 10315.073

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	2.618E-04	9.227E-12	11.03
7	18000	14835	2	3.60	3.490E-04	2.163E-11	10.66
24	61200	51231	2	3.60	3.490E-04	6.462E-12	11.19
48	86400	125894	1.7	3.06	2.967E-04	5.756E-12	11.24
72	86400	213818	1.6	2.88	2.792E-04	8.660E-12	11.06
96	86400	300849	1.2	2.16	2.094E-04	6.854E-12	11.16
120	86400	387596	1.4	2.52	2.443E-04	1.202E-11	10.92

Average Leach Index: 11.04

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110811

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 73.9 Sample Weight (g): 380.63

Initial Contaminant Level (pCi): 28128.557

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	10.8	19.44	6.911E-04	6.432E-11	10.19
7	18000	14835	3	5.40	1.920E-04	6.545E-12	11.18
24	61200	51231	18	32.40	1.152E-03	7.039E-11	10.15
48	86400	125894	10.8	19.44	6.911E-04	3.124E-11	10.51
72	86400	213818	15.9	28.62	1.017E-03	1.150E-10	9.94
96	86400	300849	14.7	26.46	9.407E-04	1.383E-10	9.86
120	86400	387596	14.8	26.64	9.471E-04	1.806E-10	9.74

Average Leach Index: 10.23

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110812

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 24.6 Sample Weight (g): 370.13

Initial Contaminant Level (pCi): 9105.198

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	2.965E-04	1.184E-11	10.93
7	18000	14835	1.8	3.24	3.558E-04	2.249E-11	10.65
24	61200	51231	1.5	2.70	2.965E-04	4.665E-12	11.33
48	86400	125894	1.7	3.06	3.361E-04	7.388E-12	11.13
72	86400	213818	1.5	2.70	2.965E-04	9.769E-12	11.01
96	86400	300849	2.1	3.78	4.151E-04	2.694E-11	10.57
120	86400	387596	1.3	2.34	2.570E-04	1.330E-11	10.88

Average Leach Index: 10.93

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110812

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 63.5 Sample Weight (g): 370.13

Initial Contaminant Level (pCi): 23503.255

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.7	4.86	2.068E-04	5.758E-12	11.24
7	18000	14835	10.4	18.72	7.965E-04	1.127E-10	9.95
24	61200	51231	28.2	50.76	2.160E-03	2.474E-10	9.61
48	86400	125894	9	16.20	6.893E-04	3.108E-11	10.51
72	86400	213818	12.9	23.22	9.879E-04	1.084E-10	9.96
96	86400	300849	7.5	13.50	5.744E-04	5.157E-11	10.29
120	86400	387596	7.8	14.04	5.974E-04	7.186E-11	10.14

Average Leach Index: 10.24

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110813

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 21.2 Sample Weight (g): 368.17

Initial Contaminant Level (pCi): 7805.204

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	9.8	17.64	2.260E-03	6.879E-10	9.16
7	18000	14835	2	3.60	4.612E-04	3.778E-11	10.42
24	61200	51231	1.4	2.52	3.229E-04	5.530E-12	11.26
48	86400	125894	1.6	2.88	3.690E-04	8.906E-12	11.05
72	86400	213818	7.2	12.96	1.660E-03	3.063E-10	9.51
96	86400	300849	1.7	3.06	3.920E-04	2.402E-11	10.62
120	86400	387596	1.3	2.34	2.998E-04	1.810E-11	10.74

Average Leach Index: 10.40

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110813

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 62.5 Sample Weight (g): 368.17

Initial Contaminant Level (pCi): 23010.625

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	9.2	16.56	7.197E-04	6.975E-11	10.16
7	18000	14835	10.4	18.72	8.135E-04	1.175E-10	9.93
24	61200	51231	19.9	35.82	1.557E-03	1.286E-10	9.89
48	86400	125894	5.5	9.90	4.302E-04	1.211E-11	10.92
72	86400	213818	49.2	88.56	3.849E-03	1.646E-09	8.78
96	86400	300849	9	16.20	7.040E-04	7.747E-11	10.11
120	86400	387596	2.2	3.96	1.721E-04	5.964E-12	11.22

Average Leach Index: 10.14

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110814

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 21.6

Sample Weight (g): 390.62

Initial Contaminant Level (pCi): 8437.392

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.3	2.34	2.773E-04	1.036E-11	10.98
7	18000	14835	1.7	3.06	3.627E-04	2.336E-11	10.63
24	61200	51231	1.9	3.42	4.053E-04	8.716E-12	11.06
48	86400	125894	2.1	3.78	4.480E-04	1.313E-11	10.88
72	86400	213818	1.4	2.52	2.987E-04	9.910E-12	11.00
96	86400	300849	1.6	2.88	3.413E-04	1.821E-11	10.74
120	86400	387596	1.5	2.70	3.200E-04	2.062E-11	10.69

Average Leach Index: 10.86

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110814

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 184

Sample Weight (g): 390.62

Initial Contaminant Level (pCi): 71874.08

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	4.5	8.10	1.127E-04	1.710E-12	11.77
7	18000	14835	15.6	28.08	3.907E-04	2.711E-11	10.57
24	61200	51231	51.7	93.06	1.295E-03	8.894E-11	10.05
48	86400	125894	90.9	163.62	2.276E-03	3.390E-10	9.47
72	86400	213818	36.9	66.42	9.241E-04	9.487E-11	10.02
96	86400	300849	32.5	58.50	8.139E-04	1.036E-10	9.98
120	86400	387596	28.8	51.84	7.213E-04	1.048E-10	9.98

Average Leach Index: 10.26

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110829

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 95.2 Sample Weight (g): 368.37

Initial Contaminant Level (pCi): 35068.824

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.9	3.42	9.752E-05	1.281E-12	11.89
7	18000	14835	2.6	4.68	1.335E-04	3.163E-12	11.50
24	61200	51231	4.3	7.74	2.207E-04	2.584E-12	11.59
48	86400	125894	4.4	7.92	2.258E-04	3.336E-12	11.48
72	86400	213818	9.6	17.28	4.927E-04	2.697E-11	10.57
96	86400	300849	42.7	76.86	2.192E-03	7.508E-10	9.12
120	86400	387596	4	7.20	2.053E-04	8.489E-12	11.07

Average Leach Index: 11.03

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110829

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 663 Sample Weight (g): 368.37

Initial Contaminant Level (pCi): 244229.31

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	16.4	29.52	1.209E-04	1.967E-12	11.71
7	18000	14835	44.4	79.92	3.272E-04	1.902E-11	10.72
24	61200	51231	103.4	186.12	7.621E-04	3.081E-11	10.51
48	86400	125894	148.2	266.76	1.092E-03	7.803E-11	10.11
72	86400	213818	289.9	521.82	2.137E-03	5.071E-10	9.29
96	86400	300849	1037.3	1867.14	7.645E-03	9.136E-09	8.04
120	86400	387596	750	1350.00	5.528E-03	6.153E-09	8.21

Average Leach Index: 9.80

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110830

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 87.7 Sample Weight (g): 371.81

Initial Contaminant Level (pCi): 32607.737

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	7.728E-05	8.043E-13	12.09
7	18000	14835	3.2	5.76	1.766E-04	5.541E-12	11.26
24	61200	51231	4	7.20	2.208E-04	2.587E-12	11.59
48	86400	125894	3.3	5.94	1.822E-04	2.171E-12	11.66
72	86400	213818	11.6	20.88	6.403E-04	4.555E-11	10.34
96	86400	300849	24.4	43.92	1.347E-03	2.836E-10	9.55
120	86400	387596	5.3	9.54	2.926E-04	1.724E-11	10.76

Average Leach Index: 11.04

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110830

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 773.6 Sample Weight (g): 371.81

Initial Contaminant Level (pCi): 287632.22

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	16.9	30.42	1.058E-04	1.506E-12	11.82
7	18000	14835	44.2	79.56	2.766E-04	1.359E-11	10.87
24	61200	51231	123	221.40	7.697E-04	3.143E-11	10.50
48	86400	125894	118.9	214.02	7.441E-04	3.621E-11	10.44
72	86400	213818	376.3	677.34	2.355E-03	6.161E-10	9.21
96	86400	300849	750	1350.00	4.693E-03	3.443E-09	8.46
120	86400	387596	125.8	226.44	7.873E-04	1.248E-10	9.90

Average Leach Index: 10.17

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110832

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 41 Sample Weight (g): 388.12

Initial Contaminant Level (pCi): 15912.92

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	1.697E-04	3.877E-12	11.41
7	18000	14835	2.1	3.78	2.375E-04	1.002E-11	11.00
24	61200	51231	1.5	2.70	1.697E-04	1.527E-12	11.82
48	86400	125894	1.4	2.52	1.584E-04	1.640E-12	11.79
72	86400	213818	1.5	2.70	1.697E-04	3.198E-12	11.50
96	86400	300849	1.7	3.06	1.923E-04	5.780E-12	11.24
120	86400	387596	1.5	2.70	1.697E-04	5.798E-12	11.24

Average Leach Index: 11.43

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110832

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g):	20	Sample Weight (g):	388.12
Initial Contaminant Level (pCi):	7762.4		
Monolith Height (cm):	10	Monolith Diameter (cm):	5
Monolith Surface Area (cm^2):	176.72	Leachate Volume (mL):	1800
Monolith Volume (cm^3):	196.35		

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.623E-04	3.548E-12	11.45
7	18000	14835	2.4	4.32	5.565E-04	5.500E-11	10.26
24	61200	51231	22	39.60	5.102E-03	1.381E-09	8.86
48	86400	125894	30	54.00	6.957E-03	3.165E-09	8.50
72	86400	213818	13.4	24.12	3.107E-03	1.073E-09	8.97
96	86400	300849	29.7	53.46	6.887E-03	7.414E-09	8.13
120	86400	387596	17.9	32.22	4.151E-03	3.470E-09	8.46
					Average Leach Index:		9.23

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110833

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g):	38.5	Sample Weight (g):	383.12
Initial Contaminant Level (pCi):	14750.12		
Monolith Height (cm):	10	Monolith Diameter (cm):	5
Monolith Surface Area (cm^2):	176.72	Leachate Volume (mL):	1800
Monolith Volume (cm^3):	196.35		

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	1.830E-04	4.512E-12	11.35
7	18000	14835	1.5	2.70	1.830E-04	5.950E-12	11.23
24	61200	51231	1.6	2.88	1.953E-04	2.022E-12	11.69
48	86400	125894	1.4	2.52	1.708E-04	1.909E-12	11.72
72	86400	213818	1.5	2.70	1.830E-04	3.722E-12	11.43
96	86400	300849	1.7	3.06	2.075E-04	6.727E-12	11.17
120	86400	387596	1.4	2.52	1.708E-04	5.878E-12	11.23
						Average Leach Index:	11.40

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110833

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 19.5 Sample Weight (g): 383.12

Initial Contaminant Level (pCi): 7470.84

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.687E-04	3.831E-12	11.42
7	18000	14835	5.0	9.00	1.205E-03	2.577E-10	9.59
24	61200	51231	38.6	69.48	9.300E-03	4.589E-09	8.34
48	86400	125894	19.7	35.46	4.746E-03	1.474E-09	8.83
72	86400	213818	13.6	24.48	3.277E-03	1.193E-09	8.92
96	86400	300849	21.1	37.98	5.084E-03	4.040E-09	8.39
120	86400	387596	18.3	32.94	4.409E-03	3.915E-09	8.41
						Average Leach Index:	9.13

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110834

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 21.4 Sample Weight (g): 379.99

Initial Contaminant Level (pCi): 8131.786

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	3.320E-04	1.485E-11	10.83
7	18000	14835	1.5	2.70	3.320E-04	1.958E-11	10.71
24	61200	51231	1.5	2.70	3.320E-04	5.849E-12	11.23
48	86400	125894	1.8	3.24	3.984E-04	1.038E-11	10.98
72	86400	213818	1.5	2.70	3.320E-04	1.225E-11	10.91
96	86400	300849	2.1	3.78	4.648E-04	3.378E-11	10.47
120	86400	387596	5.5	9.90	1.217E-03	2.985E-10	9.53

Average Leach Index: 10.67

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110834

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 19.6 Sample Weight (g): 379.99

Initial Contaminant Level (pCi): 7447.804

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.692E-04	3.854E-12	11.41
7	18000	14835	4.2	7.56	1.015E-03	1.830E-10	9.74
24	61200	51231	19.2	34.56	4.640E-03	1.142E-09	8.94
48	86400	125894	38.2	68.76	9.232E-03	5.575E-09	8.25
72	86400	213818	21.4	38.52	5.172E-03	2.972E-09	8.53
96	86400	300849	22.2	39.96	5.365E-03	4.500E-09	8.35
120	86400	387596	24.3	43.74	5.873E-03	6.946E-09	8.16
						Average Leach Index:	9.05

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110835

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 17.8 Sample Weight (g): 373.21

Initial Contaminant Level (pCi): 6643.138

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	4.064E-04	2.225E-11	10.65
7	18000	14835	1.5	2.70	4.064E-04	2.934E-11	10.53
24	61200	51231	2.0	3.60	5.419E-04	1.558E-11	10.81
48	86400	125894	1.4	2.52	3.793E-04	9.412E-12	11.03
72	86400	213818	1.5	2.70	4.064E-04	1.835E-11	10.74
96	86400	300849	1.7	3.06	4.606E-04	3.317E-11	10.48
120	86400	387596	2.9	5.22	7.858E-04	1.243E-10	9.91

Average Leach Index: 10.59

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110835

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 18 Sample Weight (g): 373.21

Initial Contaminant Level (pCi): 6717.78

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.876E-04	4.738E-12	11.32
7	18000	14835	3.0	5.40	8.038E-04	1.147E-10	9.94
24	61200	51231	33.6	60.48	9.003E-03	4.300E-09	8.37
48	86400	125894	18.4	33.12	4.930E-03	1.590E-09	8.80
72	86400	213818	9.2	16.56	2.465E-03	6.751E-10	9.17
96	86400	300849	17.6	31.68	4.716E-03	3.476E-09	8.46
120	86400	387596	13	23.40	3.483E-03	2.443E-09	8.61

Average Leach Index: 9.24

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110836

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 16.5 Sample Weight (g): 374.99

Initial Contaminant Level (pCi): 6187.335

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	4.364E-04	2.564E-11	10.59
7	18000	14835	1.5	2.70	4.364E-04	3.382E-11	10.47
24	61200	51231	2.0	3.60	5.818E-04	1.796E-11	10.75
48	86400	125894	2.5	4.50	7.273E-04	3.460E-11	10.46
72	86400	213818	2.1	3.78	6.109E-04	4.146E-11	10.38
96	86400	300849	2	3.60	5.818E-04	5.292E-11	10.28
120	86400	387596	2.8	5.04	8.146E-04	1.336E-10	9.87

Average Leach Index: 10.40

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110836

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 18.4 Sample Weight (g): 374.99

Initial Contaminant Level (pCi): 6899.816

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.826E-04	4.491E-12	11.35
7	18000	14835	3.7	6.66	9.652E-04	1.655E-10	9.78
24	61200	51231	32.2	57.96	8.400E-03	3.743E-09	8.43
48	86400	125894	33	59.40	8.609E-03	4.848E-09	8.31
72	86400	213818	26.4	47.52	6.887E-03	5.269E-09	8.28
96	86400	300849	11.6	20.88	3.026E-03	1.431E-09	8.84
120	86400	387596	42.8	77.04	1.117E-02	2.511E-08	7.60

Average Leach Index: 8.94

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110837

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 16.2 Sample Weight (g): 370.98

Initial Contaminant Level (pCi): 6009.876

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	4.493E-04	2.718E-11	10.57
7	18000	14835	1.5	2.70	4.493E-04	3.584E-11	10.45
24	61200	51231	1.6	2.88	4.792E-04	1.218E-11	10.91
48	86400	125894	1.5	2.70	4.493E-04	1.320E-11	10.88
72	86400	213818	2.3	4.14	6.889E-04	5.272E-11	10.28
96	86400	300849	1.9	3.42	5.691E-04	5.062E-11	10.30
120	86400	387596	2.4	4.32	7.188E-04	1.041E-10	9.98

Average Leach Index: 10.48

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110837

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 16.6 Sample Weight (g): 370.98

Initial Contaminant Level (pCi): 6158.268

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	2.046E-04	5.638E-12	11.25
7	18000	14835	2.4	4.32	7.015E-04	8.739E-11	10.06
24	61200	51231	23.6	42.48	6.898E-03	2.524E-09	8.60
48	86400	125894	25.6	46.08	7.483E-03	3.662E-09	8.44
72	86400	213818	28	50.40	8.184E-03	7.441E-09	8.13
96	86400	300849	22.5	40.50	6.577E-03	6.761E-09	8.17
120	86400	387596	14.1	25.38	4.121E-03	3.420E-09	8.47
					Average Leach Index:		9.02

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110838

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 14.5 Sample Weight (g): 367.35

Initial Contaminant Level (pCi): 5326.575

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	5.069E-04	3.460E-11	10.46
7	18000	14835	1.5	2.70	5.069E-04	4.563E-11	10.34
24	61200	51231	1.6	2.88	5.407E-04	1.551E-11	10.81
48	86400	125894	1.5	2.70	5.069E-04	1.681E-11	10.77
72	86400	213818	1.5	2.70	5.069E-04	2.854E-11	10.54
96	86400	300849	1.8	3.24	6.083E-04	5.783E-11	10.24
120	86400	387596	2.9	5.22	9.800E-04	1.934E-10	9.71

Average Leach Index: 10.41

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110838

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 18.9 Sample Weight (g): 367.35

Initial Contaminant Level (pCi): 6942.915

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	0.7	1.26	1.815E-04	4.435E-12	11.35
7	18000	14835	6.7	12.06	1.737E-03	5.358E-10	9.27
24	61200	51231	23.6	42.48	6.118E-03	1.986E-09	8.70
48	86400	125894	31.8	57.24	8.244E-03	4.446E-09	8.35
72	86400	213818	8.4	15.12	2.178E-03	5.269E-10	9.28
96	86400	300849	20	36.00	5.185E-03	4.203E-09	8.38
120	86400	387596	19	34.20	4.926E-03	4.886E-09	8.31

Average Leach Index: 9.09

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110839

Analyst: Date: 3/4/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 11.7 Sample Weight (g): 365.67

Initial Contaminant Level (pCi): 4278.339

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.4	4.32	1.010E-03	1.373E-10	9.86
7	18000	14835	1.5	2.70	6.311E-04	7.073E-11	10.15
24	61200	51231	1.8	3.24	7.573E-04	3.043E-11	10.52
48	86400	125894	1.5	2.70	6.311E-04	2.605E-11	10.58
72	86400	213818	1.6	2.88	6.732E-04	5.034E-11	10.30
96	86400	300849	1.7	3.06	7.152E-04	7.996E-11	10.10
120	86400	387596	1.5	2.70	6.311E-04	8.020E-11	10.10

Average Leach Index: 10.23

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110839

Analyst: Date: 3/4/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 18.2 Sample Weight (g): 365.67

Initial Contaminant Level (pCi): 6655.194

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.2	2.16	3.246E-04	1.419E-11	10.85
7	18000	14835	5.6	10.08	1.515E-03	4.074E-10	9.39
24	61200	51231	18.6	33.48	5.031E-03	1.343E-09	8.87
48	86400	125894	23.2	41.76	6.275E-03	2.575E-09	8.59
72	86400	213818	12.2	21.96	3.300E-03	1.210E-09	8.92
96	86400	300849	13.8	24.84	3.732E-03	2.178E-09	8.66
120	86400	387596	19.9	35.82	5.382E-03	5.834E-09	8.23

Average Leach Index: 9.07

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110815

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 29.5

Sample Weight (g): 388.54

Initial Contaminant Level (pCi): 11461.93

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.3	2.34	2.042E-04	5.613E-12	11.25
7	18000	14835	1.7	3.06	2.670E-04	1.266E-11	10.90
24	61200	51231	1.8	3.24	2.827E-04	4.239E-12	11.37
48	86400	125894	1.8	3.24	2.827E-04	5.227E-12	11.28
72	86400	213818	1.4	2.52	2.199E-04	5.370E-12	11.27
96	86400	300849	1.5	2.70	2.356E-04	8.674E-12	11.06
120	86400	387596	1.5	2.70	2.356E-04	1.117E-11	10.95

Average Leach Index: 11.16

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110815

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 165 Sample Weight (g): 388.54

Initial Contaminant Level (pCi): 64109.1

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.9	5.22	8.142E-05	8.928E-13	12.05
7	18000	14835	16.7	30.06	4.689E-04	3.904E-11	10.41
24	61200	51231	27.7	49.86	7.777E-04	3.209E-11	10.49
48	86400	125894	38.1	68.58	1.070E-03	7.485E-11	10.13
72	86400	213818	35.2	63.36	9.883E-04	1.085E-10	9.96
96	86400	300849	13.9	25.02	3.903E-04	2.381E-11	10.62
120	86400	387596	15.6	28.08	4.380E-04	3.863E-11	10.41

Average Leach Index: 10.58

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110816

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 15.4

Sample Weight (g): 387.56

Initial Contaminant Level (pCi): 5968.424

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.3	2.34	3.921E-04	2.070E-11	10.68
7	18000	14835	1.6	2.88	4.825E-04	4.135E-11	10.38
24	61200	51231	2.0	3.60	6.032E-04	1.930E-11	10.71
48	86400	125894	3.4	6.12	1.025E-03	6.877E-11	10.16
72	86400	213818	1.3	2.34	3.921E-04	1.708E-11	10.77
96	86400	300849	1.5	2.70	4.524E-04	3.199E-11	10.50
120	86400	387596	1.7	3.06	5.127E-04	5.293E-11	10.28

Average Leach Index: 10.50

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110816

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 186

Sample Weight (g): 387.56

Initial Contaminant Level (pCi): 72086.16

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	6.9	12.42	1.723E-04	3.998E-12	11.40
7	18000	14835	2.7	4.86	6.742E-05	8.072E-13	12.09
24	61200	51231	72.7	130.86	1.815E-03	1.748E-10	9.76
48	86400	125894	53.6	96.48	1.338E-03	1.172E-10	9.93
72	86400	213818	17.5	31.50	4.370E-04	2.121E-11	10.67
96	86400	300849	15.4	27.72	3.845E-04	2.311E-11	10.64
120	86400	387596	50.3	90.54	1.256E-03	3.177E-10	9.50

Average Leach Index: 10.57

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110817

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 12.1 Sample Weight (g): 378.85

Initial Contaminant Level (pCi): 4584.085

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.3	2.34	5.105E-04	3.509E-11	10.45
7	18000	14835	1.6	2.88	6.283E-04	7.010E-11	10.15
24	61200	51231	1.8	3.24	7.068E-04	2.650E-11	10.58
48	86400	125894	1.8	3.24	7.068E-04	3.268E-11	10.49
72	86400	213818	8.3	14.94	3.259E-03	1.180E-09	8.93
96	86400	300849	1.5	2.70	5.890E-04	5.423E-11	10.27
120	86400	387596	1.5	2.70	5.890E-04	6.986E-11	10.16

Average Leach Index: 10.15

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110817

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 150 Sample Weight (g): 378.85

Initial Contaminant Level (pCi): 56827.5

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.2	3.96	6.968E-05	6.540E-13	12.18
7	18000	14835	2.4	4.32	7.602E-05	1.026E-12	11.99
24	61200	51231	28.5	51.30	9.027E-04	4.323E-11	10.36
48	86400	125894	48.7	87.66	1.543E-03	1.556E-10	9.81
72	86400	213818	43.9	79.02	1.391E-03	2.148E-10	9.67
96	86400	300849	15.2	27.36	4.815E-04	3.623E-11	10.44
120	86400	387596	16.6	29.88	5.258E-04	5.568E-11	10.25

Average Leach Index: 10.67

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110818

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 10.6 Sample Weight (g): 390.65

Initial Contaminant Level (pCi): 4140.89

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.3	2.34	5.651E-04	4.300E-11	10.37
7	18000	14835	1.7	3.06	7.390E-04	9.698E-11	10.01
24	61200	51231	2.0	3.60	8.694E-04	4.010E-11	10.40
48	86400	125894	1.5	2.70	6.520E-04	2.781E-11	10.56
72	86400	213818	1.9	3.42	8.259E-04	7.578E-11	10.12
96	86400	300849	1.6	2.88	6.955E-04	7.561E-11	10.12
120	86400	387596	1.5	2.70	6.520E-04	8.562E-11	10.07

Average Leach Index: 10.23

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110818

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 133 Sample Weight (g): 390.65

Initial Contaminant Level (pCi): 51956.45

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	8.2	14.76	2.841E-04	1.087E-11	10.96
7	18000	14835	12.9	23.22	4.469E-04	3.547E-11	10.45
24	61200	51231	37.7	67.86	1.306E-03	9.050E-11	10.04
48	86400	125894	38.1	68.58	1.320E-03	1.140E-10	9.94
72	86400	213818	21.6	38.88	7.483E-04	6.221E-11	10.21
96	86400	300849	12	21.60	4.157E-04	2.702E-11	10.57
120	86400	387596	8.8	15.84	3.049E-04	1.872E-11	10.73

Average Leach Index: 10.41

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110819

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 26.8 Sample Weight (g): 378.51

Initial Contaminant Level (pCi): 10144.068

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.5	2.70	2.662E-04	9.541E-12	11.02
7	18000	14835	1.7	3.06	3.017E-04	1.616E-11	10.79
24	61200	51231	1.8	3.24	3.194E-04	5.412E-12	11.27
48	86400	125894	1.7	3.06	3.017E-04	5.952E-12	11.23
72	86400	213818	1.3	2.34	2.307E-04	5.911E-12	11.23
96	86400	300849	1.6	2.88	2.839E-04	1.260E-11	10.90
120	86400	387596	1.5	2.70	2.662E-04	1.427E-11	10.85

Average Leach Index: 11.04

American Nu[illegible]er Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110819

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 133 Sample Weight (g): 378.51

Initial Contaminant Level (pCi): 50341.83

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.2	3.96	7.866E-05	8.333E-13	12.08
7	18000	14835	2.4	4.32	8.581E-05	1.308E-12	11.88
24	61200	51231	13.3	23.94	4.755E-04	1.200E-11	10.92
48	86400	125894	29.2	52.56	1.044E-03	7.130E-11	10.15
72	86400	213818	15.1	27.18	5.399E-04	3.238E-11	10.49
96	86400	300849	16.5	29.70	5.900E-04	5.441E-11	10.26
120	86400	387596	11.2	20.16	4.005E-04	3.230E-11	10.49

Average Leach Index: 10.90

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110820

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 17.1 Sample Weight (g): 382.27

Initial Contaminant Level (pCi): 6536.817

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	2.1	3.78	5.783E-04	4.503E-11	10.35
7	18000	14835	1.6	2.88	4.406E-04	3.447E-11	10.46
24	61200	51231	1.8	3.24	4.957E-04	1.303E-11	10.88
48	86400	125894	1.5	2.70	4.130E-04	1.116E-11	10.95
72	86400	213818	1.3	2.34	3.580E-04	1.424E-11	10.85
96	86400	300849	1.6	2.88	4.406E-04	3.034E-11	10.52
120	86400	387596	1.5	2.70	4.130E-04	3.436E-11	10.46

Average Leach Index: 10.64

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110820

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 129 Sample Weight (g): 382.27

Initial Contaminant Level (pCi): 49312.83

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	4.9	8.82	1.789E-04	4.308E-12	11.37
7	18000	14835	2.4	4.32	8.760E-05	1.363E-12	11.87
24	61200	51231	20.7	37.26	7.556E-04	3.029E-11	10.52
48	86400	125894	30.5	54.90	1.113E-03	8.107E-11	10.09
72	86400	213818	15.9	28.62	5.804E-04	3.742E-11	10.43
96	86400	300849	20.6	37.08	7.519E-04	8.838E-11	10.05
120	86400	387596	10.4	18.72	3.796E-04	2.902E-11	10.54

Average Leach Index: 10.69

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110821

Analyst: Date: 2/13/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 35 Sample Weight (g): 373.88

Initial Contaminant Level (pCi): 13085.8

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.9	3.42	2.614E-04	9.199E-12	11.04
7	18000	14835	1.7	3.06	2.338E-04	9.711E-12	11.01
24	61200	51231	1.8	3.24	2.476E-04	3.252E-12	11.49
48	86400	125894	1.5	2.70	2.063E-04	2.785E-12	11.56
72	86400	213818	3.1	5.58	4.264E-04	2.020E-11	10.69
96	86400	300849	1.6	2.88	2.201E-04	7.571E-12	11.12
120	86400	387596	1.6	2.88	2.201E-04	9.754E-12	11.01

Average Leach Index: 11.13

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110821

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 130 Sample Weight (g): 373.88

Initial Contaminant Level (pCi): 48604.4

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	5.3	9.54	1.963E-04	5.188E-12	11.28
7	18000	14835	5.7	10.26	2.111E-04	7.913E-12	11.10
24	61200	51231	18.2	32.76	6.740E-04	2.410E-11	10.62
48	86400	125894	23.6	42.48	8.740E-04	4.996E-11	10.30
72	86400	213818	16.1	28.98	5.962E-04	3.949E-11	10.40
96	86400	300849	9.6	17.28	3.555E-04	1.976E-11	10.70
120	86400	387596	11.2	20.16	4.148E-04	3.465E-11	10.46

Average Leach Index: 10.70

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110823

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 127.6 Sample Weight (g): 373.53

Initial Contaminant Level (pCi): 47662.428

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	5.287E-05	3.765E-13	12.42
7	18000	14835	3.7	6.66	1.397E-04	3.467E-12	11.46
24	61200	51231	5.3	9.54	2.002E-04	2.125E-12	11.67
48	86400	125894	8.2	14.76	3.097E-04	6.273E-12	11.20
72	86400	213818	7.2	12.96	2.719E-04	8.214E-12	11.09
96	86400	300849	93.8	168.84	3.542E-03	1.961E-09	8.71
120	86400	387596	9.3	16.74	3.512E-04	2.484E-11	10.60

Average Leach Index: 11.02

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110823

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 968.1

Sample Weight (g): 373.53

Initial Contaminant Level (pCi): 361614.393

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	32.6	58.68	1.623E-04	3.546E-12	11.45
7	18000	14835	50.4	90.72	2.509E-04	1.118E-11	10.95
24	61200	51231	181.7	327.06	9.044E-04	4.340E-11	10.36
48	86400	125894	237.3	427.14	1.181E-03	9.126E-11	10.04
72	86400	213818	300.2	540.36	1.494E-03	2.481E-10	9.61
96	86400	300849	1849.9	3329.82	9.208E-03	1.325E-08	7.88
120	86400	387596	213.6	384.48	1.063E-03	2.277E-10	9.64

Average Leach Index: 9.99

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110824

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 80.3 Sample Weight (g): 377.66

Initial Contaminant Level (pCi): 30326.098

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	8.310E-05	9.299E-13	12.03
7	18000	14835	3.3	5.94	1.959E-04	6.813E-12	11.17
24	61200	51231	3	5.40	1.781E-04	1.682E-12	11.77
48	86400	125894	2.8	5.04	1.662E-04	1.807E-12	11.74
72	86400	213818	8.3	14.94	4.926E-04	2.696E-11	10.57
96	86400	300849	45.6	82.08	2.707E-03	1.145E-09	8.94
120	86400	387596	5.9	10.62	3.502E-04	2.470E-11	10.61

Average Leach Index: 10.98

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110824

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 875.7

Sample Weight (g): 377.66

Initial Contaminant Level (pCi): 330716.862

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	19.5	35.10	1.061E-04	1.517E-12	11.82
7	18000	14835	29.1	52.38	1.584E-04	4.455E-12	11.35
24	61200	51231	128.9	232.02	7.016E-04	2.611E-11	10.58
48	86400	125894	96.8	174.24	5.269E-04	1.816E-11	10.74
72	86400	213818	331	595.80	1.802E-03	3.606E-10	9.44
96	86400	300849	1046.8	1884.24	5.697E-03	5.074E-09	8.29
120	86400	387596	139	250.20	7.565E-04	1.153E-10	9.94

Average Leach Index: 10.31

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110825

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 79.4 Sample Weight (g): 365.76

Initial Contaminant Level (pCi): 29041.344

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	8.677E-05	1.014E-12	11.99
7	18000	14835	2.3	4.14	1.426E-04	3.609E-12	11.44
24	61200	51231	4.5	8.10	2.789E-04	4.127E-12	11.38
48	86400	125894	5	9.00	3.099E-04	6.282E-12	11.20
72	86400	213818	11.9	21.42	7.376E-04	6.043E-11	10.22
96	86400	300849	48	86.40	2.975E-03	1.384E-09	8.86
120	86400	387596	6.3	11.34	3.905E-04	3.071E-11	10.51

Average Leach Index: 10.80

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110825

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 831.4 Sample Weight (g): 365.76

Initial Contaminant Level (pCi): 304092.864

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	25.5	45.90	1.509E-04	3.068E-12	11.51
7	18000	14835	59.5	107.10	3.522E-04	2.203E-11	10.66
24	61200	51231	142.3	256.14	8.423E-04	3.764E-11	10.42
48	86400	125894	132.6	238.68	7.849E-04	4.030E-11	10.39
72	86400	213818	365.5	657.90	2.163E-03	5.200E-10	9.28
96	86400	300849	1191.1	2143.98	7.050E-03	7.770E-09	8.11
120	86400	387596	136.2	245.16	8.062E-04	1.309E-10	9.88

Average Leach Index: 10.04

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110826

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 87.3 Sample Weight (g): 369.57

Initial Contaminant Level (pCi): 32263.461

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	7.811E-05	8.216E-13	12.09
7	18000	14835	2.4	4.32	1.339E-04	3.184E-12	11.50
24	61200	51231	2.2	3.96	1.227E-04	7.992E-13	12.10
48	86400	125894	4.7	8.46	2.622E-04	4.497E-12	11.35
72	86400	213818	8.5	15.30	4.742E-04	2.498E-11	10.60
96	86400	300849	39.3	70.74	2.193E-03	7.514E-10	9.12
120	86400	387596	2.7	4.86	1.506E-04	4.569E-12	11.34

Average Leach Index: 11.16

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110826

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 821.4

Sample Weight (g): 369.57

Initial Contaminant Level (pCi): 303564.798

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	14.5	26.10	8.598E-05	9.955E-13	12.00
7	18000	14835	34	61.20	2.016E-04	7.218E-12	11.14
24	61200	51231	70.2	126.36	4.163E-04	9.192E-12	11.04
48	86400	125894	198.3	356.94	1.176E-03	9.043E-11	10.04
72	86400	213818	268.9	484.02	1.594E-03	2.824E-10	9.55
96	86400	300849	1006.2	1811.16	5.966E-03	5.564E-09	8.25
120	86400	387596	77.8	140.04	4.613E-04	4.286E-11	10.37

Average Leach Index: 10.34

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110827

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 92.6 Sample Weight (g): 366.39

Initial Contaminant Level (pCi): 33927.714

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	7.428E-05	7.430E-13	12.13
7	18000	14835	3	5.40	1.592E-04	4.499E-12	11.35
24	61200	51231	4.6	8.28	2.440E-04	3.160E-12	11.50
48	86400	125894	6.2	11.16	3.289E-04	7.077E-12	11.15
72	86400	213818	14.5	26.10	7.693E-04	6.574E-11	10.18
96	86400	300849	45.4	81.72	2.409E-03	9.068E-10	9.04
120	86400	387596	2.9	5.22	1.539E-04	4.767E-12	11.32

Average Leach Index: 10.95

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110827

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 682.9 Sample Weight (g): 366.39

Initial Contaminant Level (pCi): 250207.73

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	27	48.60	1.942E-04	5.081E-12	11.29
7	18000	14835	53.7	96.66	3.863E-04	2.650E-11	10.58
24	61200	51231	133.7	240.66	9.618E-04	4.908E-11	10.31
48	86400	125894	209	376.20	1.504E-03	1.479E-10	9.83
72	86400	213818	355.4	639.72	2.557E-03	7.262E-10	9.14
96	86400	300849	1276.4	2297.52	9.182E-03	1.318E-08	7.88
120	86400	387596	82.6	148.68	5.942E-04	7.111E-11	10.15

Average Leach Index: 9.88

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110828

Analyst: Date: 2/22/02

Contaminant: Gross Alpha

Inital Contaminant Conc. (pCi/g): 78.7 Sample Weight (g): 377.88

Initial Contaminant Level (pCi): 29739.156

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	1.4	2.52	8.474E-05	9.670E-13	12.01
7	18000	14835	2.3	4.14	1.392E-04	3.442E-12	11.46
24	61200	51231	5.3	9.54	3.208E-04	5.459E-12	11.26
48	86400	125894	4.4	7.92	2.663E-04	4.639E-12	11.33
72	86400	213818	9.6	17.28	5.811E-04	3.751E-11	10.43
96	86400	300849	29.8	53.64	1.804E-03	5.085E-10	9.29
120	86400	387596	5.6	10.08	3.389E-04	2.314E-11	10.64

Average Leach Index: 10.92

American Nuclear Society - 16.1 Static Leach Test

Project:

Sample Formulation: 110828

Analyst: Date: 2/13/02

Contaminant: Gross Beta

Inital Contaminant Conc. (pCi/g): 635 Sample Weight (g): 377.88

Initial Contaminant Level (pCi): 239953.8

Monolith Height (cm): 10 Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72 Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	16	28.80	1.200E-04	1.940E-12	11.71
7	18000	14835	53.1	95.58	3.983E-04	2.818E-11	10.55
24	61200	51231	155.7	280.26	1.168E-03	7.237E-11	10.14
48	86400	125894	153	275.40	1.148E-03	8.616E-11	10.06
72	86400	213818	209.1	376.38	1.569E-03	2.733E-10	9.56
96	86400	300849	981.6	1766.88	7.363E-03	8.475E-09	8.07
120	86400	387596	115.6	208.08	8.672E-04	1.514E-10	9.82

Average Leach Index: 9.99

Appendix C – SEP Testing Reports

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

SEP FRACTION CONCENTRATIONS AS EXTRACTED

		SED	TUFF	SED/TUFF	110812	110820	110836	110838
Air Dried Sample Wt. (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Percent Solids (fraction)		1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sample Dry Solids Weight (g):		45.040	45.010	45.000	44.990	45.010	45.000	44.990
Sample Water Weight (g):		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tare Wt (g)		36.54	38.71	38.14	38.43	38.18	38.13	38.62
Volume Extractant (mLs):		225	225	225	225	225	225	225
Ion Exchangeable	1	225 mLs 1M $MgCl_2$						
Density Extractant (g/mL):		1.0712						
Vol Extract Recovered (mL)		206.0	215.0	210.0	220.0	215.0	215.0	210.0
Gross wt Tare+residue (g)		97.24	105.91	201.85	97.33	97.58	96.80	98.84
Residue wt (g)		60.70	67.20	163.71	58.90	55.40	58.67	60.22
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23
Density of Residual Liquid (g/mL):		1.071	1.071	1.071	1.071	1.071	1.071	1.071
Strontium -90	pCi/L	546.200	5006.900	2156.800	423.400	542.800	732.600	623.800
Cesium -137	pCi/L	0.074	76.146	16.382	0.011	174.750	36.025	35.079
Strontium -90	pCi/L	546.200	5006.900	2156.800	423.400	542.800	732.600	623.800
Cesium -137	pCi/L	0.074	76.146	16.382	0.011	174.750	36.025	35.079
Carbonate Fraction	2	225 mLs 1M NaOAC/25%HOAC pH 5.0						
Density Extractant (g/mL):		1.047						
Vol Extract Recovered (mL)		215.0	210.0	210.0	225.0	220.0	215.0	220.0
Gross wt Tare+residue (g)		96.51	110.77	103.80	94.88	97.78	95.32	95.06
Residue wt (g)		55.97	72.06	65.66	56.45	55.60	57.19	56.46
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		14.93	27.05	20.66	11.46	14.59	12.19	11.47
Density of Residual Liquid (g/mL):		1.048	1.049	1.055	1.048	1.048	1.048	1.048
Strontium -90	pCi/L	76.600	717.100	312.200	233.400	703.400	335.900	458.600
Cesium -137	pCi/L	0.0	237.4	67.9	43.7	406.70	62.07	54.88
Corrected for liquid contribution								
Strontium -90	pCi/L	20.873	254.992	-677.737	210.298	650.282	300.579	405.638
Cesium -137	pCi/L	0.0	231.0	62.4	43.7	396.85	60.03	52.80

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23
Oxyhydroxide Fraction 3		225 mLs 0.1M Hydroxylamine Hydrochloride pH 2						
Density Extractant (g/mL):		0.9881						
Vol Extract Recovered (mL)		215.0	220.0	215.0	220.0	220.0	215.0	220.0
Gross wt Tare+residue (g)		96.66	104.01	102.38	94.32	92.95	94.10	91.86
Residue wt (g)		60.12	66.30	64.24	55.89	54.77	56.97	53.24
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		15.06	20.29	19.24	10.90	9.76	10.97	8.25
Density of Residual Liquid (g/mL):		0.992	0.994	0.993	0.991	0.992	0.991	0.991
Strontium-90	pCi/L	26.400	367.800	106.400	152.000	404.500	168.700	205.900
Cesium-137	pCi/L	25.78	162.26	23.09	25.69	126.990	22.31	40.03
corrected for liquid contribution								
Strontium-90	pCi/L	21.722	234.069	61.403	141.186	363.527	151.997	166.636
Cesium-137	pCi/L	25.775	137.847	.000	.000	102.300	16.275	35.627
Organic Fraction	4		50 mLs 5% NaOCL (pH 8.5)					
Density Extractant (g/mL):		1.0798						
Vol Extract Recovered (mL)		220.00	215.00	220.00	230.00	220.00	230.00	220.00
Gross wt Tare+residue (g)								
Residue wt (g)		-36.54	-38.71	-38.14	-38.43	-38.18	-38.13	-36.62
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		-81.58	-83.72	-83.14	-83.42	-83.19	-83.13	-83.61
Density of Residual Liquid (g/mL):		1.074	1.073	1.073	1.076	1.076	1.076	1.077
Strontium-90	pCi/L	21.900	60.800	43.000	44.200	124.200	51.900	56.600
Cesium-137	pCi/L	84.	549.	146.	68.8.	542.77	167.5	157.5
corrected for liquid contribution								
Strontium-90	pCi/L	20.229	35.207	34.568	37.116	107.247	43.990	51.110
Cesium-137	pCi/L	82.135	535.846	143.990	67.605	537.449	166.444	156.072

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23			
Sulfide Fraction	5	50 mLs 4M HNO_3									
Density Extractant (g/mL):		1.111									
Vol Extract Recovered (mL)		220.0	220.0	215.0	220.0	225.0	225.0	225.0			
Gross wt Tare+residue (g)		57.65	107.47	103.17	51.33	91.65	92.24	93.16			
Residue wt (g)		61.11	68.76	65.03	52.90	53.47	54.11	54.54			
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		16.07	23.75	20.03	7.91	6.46	9.11	9.55			
Density of Residual Liquid (g/mL):		1.130	1.131	1.131	1.130	1.129	1.130	1.129			
Strontium-90	pCi/L	23.600	64.000	45.500	46.700	125.800	105.500	61.700			
Cesium-137	pCi/L	2.321	8077.	3523.	1869.	54.1	2619.	2999.			
corrected for liquid contribution											
Strontium-90	pCi/L	34.758	96.291	66.087	65.948	164.610	136.654	82.586			
Cesium-137	pCi/L	2363.708	8368.552	3555.997	1904.988	336.230	2906.930	3062.014			
Residual Fraction	6	Total HNO3/HF/HCL 3052									
Density Extractant (g/mL):		NA									
Fr 6 - Residue wt (g)		61.11	68.76	65.03	52.90	53.47	54.11	54.54			
Fr 6 - Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Fr 6 - Wt. Residual Liquid (g):		16.07	23.75	20.03	7.91	6.46	9.11	9.55			
Fr 6 - Density of Res. Liq. (g/mL):		1.130	1.131	1.131	1.130	1.129	1.130	1.129			
Fr 6 - Fr Air Dry Solids in Residue:		0.737	0.655	0.692	0.850	0.842	0.832	0.826			
Fr 6 - Analysis aliquot (g)		2.85	2.92	2.87	3.33	3.36	3.43	3.52			
Strontium-90	pCi/kg	2480.213	4362.676	4756.634	4202.788	7727.508	3152.248	3604.379			
Cesium-137	pCi/kg	7.374	24.401	6.735	3.676	13.642	6.409	8.890			
corrected for liquid contribution/aliquot/solids content											
Strontium-90	mg/kg	3357.685	6665.391	6656.247	4535.616	5156.352	3616.876	4236.651			
Cesium-137	mg/kg	5272.059	23508.528	11236.649	4021.331	16196.721	7200.848	6576.191			

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23			
SEP TOTAL SUMMED CORRECTED FOR SOLIDS CONTENT											
Strontium-90	mg/Kg	8458.27	36066.21	31852.12	9378.16	20354.56	10561.45	11957.58			
Cesium-137	mg/Kg	21895	81642	30674	14156	22573	23339	23732			

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID SED

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4726.798	55.4%	111.04	1.3%	115.379	1.4%	107.9	1.3%	115.03	1.3%	3357.68	39.3%	8533.8
Cesium-137	0.370	0.0%	0	0.0%	158.2	0.9%	438	2.5%	7823	44.2%	9272	52.4%	17691

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID TUFF

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	25028.938	71.3%	1610.396	4.6%	1304.177	3.7%	192.0	0.5%	314.38	0.9%	6665.391	19.0%	35115.2
Cesium-137	380.645	0.6%	1261	1.9%	768.05	1.2%	2922	4.4%	27323	41.3%	33509	50.6%	66163

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **SED/TUFF**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	13484.000	63.6%	0.00	0.0%	442.440	2.1%	187.7	0.9%	223.20	1.1%	6856.25	32.4%	21193.6
Cesium-137	81.9	0.3%	466	1.9%	0.0	0.0%	782	3.2%	11801	48.4%	11237	46.1%	24368

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID 110812

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	2117.471	22.7%	1112.42	11.9%	740.390	7.9%	194.7	2.1%	229.24	2.5%	4935.6	52.9%	9329.8
Cesium-137	0.05	0.0%	231	2.1%	0.0	0.0%	355	3.3%	6243	57.5%	4031	37.1%	10860

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID 110820

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4712.953	23.1%	3444.77	16.8%	1929.632	9.4%	559.6	2.7%	639.24	3.1%	9158	44.8%	20444.5
Cesium-137	873.56	3.7%	2102	8.9%	548.3	2.3%	2804	11.9%	1110	4.7%	16197	68.5%	23635

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID 110836

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	3663.000	34.7%	1588.136	15.1%	799.261	7.6%	230.770	2.2%	448.576	4.3%	3818.875	36.2%	10548.6
Cesium-137	190.125	1.0%	423	2.3%	96.10	0.5%	873	4.8%	9542	52.1%	7201	39.3%	18325

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID 110838

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4119.916	34.1%	2178.099	18.0%	989.258	8.2%	265.1	2.2%	303.22	2.5%	4236.65	35.0%	12092.2
Cesium-137	175.434	1.0%	493	2.7%	186.836	1.0%	809	4.4%	10093	55.1%	6576	35.9%	18335

Attachment 5

90% Design Package – Plans and Specifications for the Engineered Cover

SPEC SECTION TITLE	CURRENT REVISION
1300 SUBMITTALS	REV B
2005 SURVEYING SERVICES	REV B
2205 STRIPPING CLEARING AND GRUBBING	REV C
2300 EARTHWORK	REV C
2307 RIPRAP, GRAVEL & SAND	REV B
2322 CONTAMINATED SOIL AND TUFF	REV C
2401 CONTAMINATED SOIL AND TUFF TREATMENT	REV B
2600 STORMWATER AND EROSION CONTROL	REV C
2936 SEEDING	REV A

DRAWINGS

05-010	Site Layout	REV C
05-030	Restoration Cover & Details	REV C
05-031	Excavation & Final Grading Plan	REV C

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
5/30/02	K. Ohsiek	JB	K. Ohsiek	JB for RER	Issue "A" "30% Issue for Review"
6/12/02	RRgr	JB	RER for KLO	RRgr	Issue "B" "60% Issue for Review"

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 01300	SUBMITTALS

SECTION 01300

SUBMITTALS

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SCOPE 1
1.2 REFERENCES 1
1.3 DEFINITIONS 1
1.4 SUBMITTAL DRAWINGS 2
1.5 AS-BUILT DRAWINGS 2
1.6 MANUFACTURER'S CERTIFICATES 3
1.7 IDENTIFICATION OF SUBMITTALS 3
1.8 COORDINATION OF SUBMITTALS 3
1.9 SCHEDULES 4
1.10 SUBMITTAL REQUIREMENTS 5

PART 2 PRODUCTS 6
NOT USED 6

PART 3 EXECUTION 6
NOT USED 6

SECTION 01300

SUBMITTALS

LOS ALAMOS NATIONAL LABORATORY VCM FOR PRS 21-011(k)

PART 1 GENERAL

1.1 SCOPE

A. This Specification Section describes the requirement and procedures for submittals as identified and listed in the Technical Specifications. To ensure that the specified products are furnished and installed in accordance with technical requirements, procedures have been established for advanced submittal of design data and for its review and acceptance or rejection.

B. Work scope covered by this specification includes access road improvements, treated soil placement area excavation, cover and site restoration fill, and contaminated treated soil and preparation and placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

1.2 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

1.3 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.
3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

1.4 SUBMITTAL DRAWINGS

A. Scale Required: All submittal drawings shall be of such scale as to clearly show all pertinent features of the item and its method of connection to the work.

B. Certification of Submittal Drawings: When submittal drawings are required to be prepared either by or under the direct supervision of a registered professional engineer, these submittal drawings shall bear the seal of that registered professional engineer appropriate for the discipline intended.

C. Status of Submittal Drawings: Submittal drawings are not Construction Drawings. The purpose of the submittal drawing review is to establish a reporting procedure and is intended as a convenience in organizing the Work and to permit Owner to monitor Contractor progress and compliance with Construction Drawings and Specifications. If deviations, discrepancies, or conflicts between submittal drawings and the Construction Drawings and Specifications are discovered, the Construction Drawings and Specifications will govern.

1.5 AS-BUILT DRAWINGS

A. Maintain and submit marked-up prints of as-built drawings for all Work performed. The prints shall be marked up by redlining. The submittal of as-built drawings, with surveyor's seal on them, shall be completed prior to final acceptance of the Work. Maintain and submit as-built drawings of the work as completed for different areas, phases, and disciplines. The as-built drawings shall be prepared in accordance with the following requirements:

1. The Construction Drawings shall be utilized as the drawing base for as-built drawings.
2. The as-built drawings shall be to scale, of good quality, and legible.
3. The as-built drawings shall include all approved field modifications made during construction.
4. The as-built drawings shall include consolidated information provided by vendor data and drawings, Contractor and Owner sketches and drawings.
5. The as-built drawings shall reflect final as-built field conditions.

B. Mark up one set of controlled prints to show the as-built conditions as work progresses including the accurate location of all Contractor-installed underground utilities. These as-built marked prints shall be kept current and available on the jobsite at all times. All changes which are made in the work or additional information which might be uncovered in the course of construction, shall be accurately and neatly recorded as they occur by means of details and notes. As work progresses, submit as-built marked prints for each drawing superseded by revision on a monthly basis or as otherwise required.

C. The as-built marked prints will be jointly reviewed for accuracy and completeness by the Owner's representative and a responsible representative of the Contractor on a monthly basis. Correct any inaccuracies and complete mark-up of any omissions noted in this review. Completed as-built drawings shall be subject to approval by the Owner.

D. As-built drawings shall conform to Section 02005.

1.6 MANUFACTURER'S CERTIFICATES

A. Submit certificates according to the requirements of each Specification Section.

1.7 IDENTIFICATION OF SUBMITTALS

A. Completely identify each submittal and resubmittal by showing at least the following information.

1. Name and address of submitter, plus name and telephone number of the individual who may be contacted for further information.
2. Name of Project as it appears on the Construction Documents.
3. Drawing number or Specifications Section number to which the submittal applies.
4. Submittal number, numerically serialized and sequential beginning with the number one.
5. Resubmittals shall be designated with numeric suffixes to the original submittal number (e.g., Submittal No. 32R-1).

B. Each submittal shall be submitted using the Owner's "Construction Submittal Transmittal and Disposition Form," Figure 1.

1.8 COORDINATION OF SUBMITTALS

A. General: Prior to submittal for Owner's review, use all means necessary to fully coordinate all material, including the following requirements:

1. Determine and verify all field dimensions and conditions, materials, catalog numbers, availability with respect to Project Schedule, and similar data.
2. Coordinate as required with all trades.

B. Groupings of Submittals: Make all submittals in groups containing all associated items. Owner may reject partial submittals as not complying with the Construction Documents.

1.9 SCHEDULES

A. Initial Submittal:

1. The scheduling and progress reporting of construction is the responsibility of the Contractor.
2. The complete construction schedule shall be submitted for review and approval before start of work. The construction schedule shall consist of the following:
   a. Barchart Schedule: The selection and number of activities will be left to the discretion of the Contractor but subject to the Owner's approval. Unless otherwise approved by the Owner, the construction schedule shall consist of the following items and shall be represented on the same diagram. Upon approval by the Owner, this schedule will be classified as the Baseline Schedule and will be the schedule against which all progress will be measured. The barchart schedule shall include the following:
      1) Identification number for each activity (activity code), coded in such a manner to reflect the major project work areas.
      2) Description of each activity.
      3) Baseline start and finish dates for each activity (early/late start and finish dates if CPM logic diagram required).
      4) Duration for each activity.
      5) Manpower assigned to each activity.
      6) Arrange in order of forecast start dates.
      7) Activities grouped by major work area.
   b. Logic Diagram: Submit a critical path method (CPM) logic diagram, precedence or arrow. The CPM diagram shall be structured following the same criteria detailed in Items (1) – (4) of Article A.2.a above.

B. Monthly Transmittals: The construction schedule, as described above, shall show monthly status and shall be transmitted on or about the 15th of every month. This monthly transmittal shall consist of the following reports:

1. Barchart Diagram: Show progress, (actual or forecast start/finish dates) for each activity laid against the original Baseline Schedule. Include all items as described in Article A.2.a. in addition to the following:
2. Arrange in order of actual/forecast start dates
3. Show new, approved field modification activities and their respective scheduled dates
4. Percent complete for each activity
5. Total float for each activity (only if CPM required)
6. Schedule Reports: List all activities in tabular format with the same information included on the updated Barchart Diagram and sorted as follows:
   a. In the same order as the updated barchart diagram

b. In order of activity code

7. Narrative Report: Discuss accomplishments, goals/milestones met, current or anticipated problem areas, delaying factors and potential impacts. Also describe current or proposed corrective action or recovery plans that would be required to ensure meeting the completion date. Address individual activities as required.

1.10 SUBMITTAL REQUIREMENTS

A. Submittals such as catalog cuts, material certifications, shop drawings, Contractor drawings, operating/maintenance manuals, samples, special procedures, and/or other types of data as may be specified or listed in these documents shall be submitted to the Owner as specified herein.

B. Submit all data identified in these specifications to the Owner with such promptness as to cause no delay in the Work or that of any other subcontractor. Unless otherwise specified, submittals for all material and equipment requiring approval shall be submitted, reviewed, and approved prior to receipt, inspection, installation, and/or incorporation of the item into the Work.

C. Furnish copies of such data requiring approval sufficiently in advance of the date that the material/equipment is required to meet the approved schedule so that, if the item is disapproved, no delay will be occasioned to the schedule.

D. The Owner will review and generally return submittals within ten days of receipt, but in no case will this process take longer than 30 days.

E. Following a review, the Owner will indicate, by stamping upon each submittal, the appropriate approval category:

1. Categories:

a. Approved

b. Approved as Noted, Work May Proceed, Revise and Resubmit

c. Not Approved, Work May Not Proceed, Revise and Resubmit

d. Rejected

e. Receipt Acknowledged, Approval Not Required

F. The applicable blocks of the Construction Submittal Transmittal and Disposition Form will be completed by the Owner showing the disposition action for each item listed on the form. When submittals are returned marked with either "Revise and Resubmit," or "Rejected," the Contractor shall make such revisions and corrections as required and resubmit the submittal with the same submittal number followed by a sequential revision number as specified in Article 1.5.A.5.

G. One copy of the stamped Submittal will be returned to the Contractor. If further action is required, the Contractor shall perform such actions as directed. The required submittal and resubmittal sequence shall be repeated until no further action is required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION 01300

SUBMITTAL DISPOSITION

VCM for PRS 21-011(k)	From:_____	Date:_____	New Submittal:___
			Resubmittal:___
		Submittal No.	
		Previous Submittal No. (if any)	

Disposition Legends:

(A) Approved

(B) Approved as noted work may proceed revise and resubmit

(C) Not approved, work may not proceed

(D) Rejected

(E) Receipt Acknowledged Approval Not Required

Item No.		No. of Copies	Spec/Dwg. Reference	Submittal			Description	Disp. Status
				Mand. Apvl	QA ENG Apvl	Info		

Remarks:

Contractor's Signature:

Reviewers Comments:

Disposition By:

Additional Comment Sheets attached? Y _ N_

Review Distribution				Final Distribution:			

Figure 1 Submittal Disposition Form

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
05/30/02	K. Ohsiek	JB	K. Ohsiek	JB for RER	Issue "A" "30% Issue for Review"
06/12/02	R. Ryr	JB	RER for KLO	RRr	Issue "B" "90% Issue for Review"

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 02005	SURVEYING SERVICES

SECTION 02005

SURVEYING SERVICES

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SCOPE 1
1.2 RELATED SECTIONS 2
1.3 REFERENCES 2
1.4 DEFINITIONS 2
1.5 APPLICABLE PUBLICATIONS 2
1.6 SUBMITTALS 3
1.7 SUBMITTAL SCHEDULE 3

PART 2 PRODUCTS 3
NOT USED 3

PART 3 EXECUTION 4
3.1 GENERAL REQUIREMENTS 4
3.2 SPECIFIC FIELD REQUIREMENTS 5
3.3 AS-BUILT DRAWINGS 7
3.4 DELIVERABLE DATA 7

SECTION 02005

SURVEYING SERVICES

LOS ALAMOS NATIONAL LABORATORY VCM FOR PRS 21-011(k)

PART 1 GENERAL

1.1 SCOPE

A. This Specification Section describes the requirements for surveying services.

1. A Land Surveyor licensed in the State of New Mexico shall supervise or perform all necessary surveying and staking for the successful execution of the work. Staking shall be in accordance with accepted surveying practices, provisions herein, and subject to Owner approval.
2. Control surveys and construction staking shall consist of, but are not limited to:
   a. Establishing temporary control points from NAD 83 New Mexico State Plane Coordinate System monuments.
   b. Verifying existing topographic features and existing above ground utility locations prior to work.
   c. Establishing a horizontal and vertical project control system based on the three established monuments and other approved existing reference monuments.
   d. Setting clearing limits for all proposed improvements.
   e. Establishing preliminary and final surveys for quantity determinations.
   f. Setting limits and boundaries of construction activities for clearing, grubbing, stripping and earthwork operations.
   g. Setting alignments and/or baselines and grading stakes as required for the waste placement area, stockpiles, work areas, temporary access roads, ditches, channels, and all other work described in the Construction Drawings and Specifications.
   h. Setting work limits and grade stakes for riprap and other erosion control features.
   i. Conducting topographic surveys as required to periodically determine amount of work performed and prior to completion of work. Survey methods shall be approved by the Owner.
   j. Preparing and furnishing as-built drawings.
3. All surveying work shall be under the direct supervision of a person who has at least five years of experience in construction staking. Any work performed in referencing or re-establishment of land or United States survey monuments

shall be performed by or under the direct supervision of a New Mexico-registered land surveyor.

4. Redline drawings containing all items as constructed in the field shall be required. Redline drawings shall be kept up to date and as a minimum reflect all permanent features. Upon request, redline drawings shall be made available to the Owner for inspection.

B. Work scope covered by this specification includes access road improvements, treated soil placement area excavation, cover and site restoration fill, and contaminated treated soil and preparation and placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

1.4 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.
3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designation only:

1. New Mexico Administrative Code Title 16, Chapter 39.6

1.6 SUBMITTALS

A. In accordance with the schedule given in this Section, submit the following to the Owner for approval in accordance with Section 01300:

1. Verification of existing topographic features and existing aboveground utility locations (see 02005 1.1.A.2.b)
2. Calibration of equipment
3. New Mexico surveyor's license (see 02005 1.1.A.3)
4. As-built drawings requirements (see 02005 3.3)
5. Deliverable data (see 02005 3.4.A)
   a. Reduced and checked field notes
   b. All drawings and sketches
   c. Electronic data

B. The stake marking format and the fieldbook notation format shall be compatible.

1.7 SUBMITTAL SCHEDULE

A. The information, Construction Drawings, and data required shall be submitted in accordance with the following schedule:

Specification Reference	Requirements	Period
02005 (1.3.A.1)	Verification of topographic features and utilities	15 days prior to work
02005 (1.3.A.2)	Calibration of Equipment	15 days prior to work
02005 (1.3.A.3)	New Mexico Surveyors License	15 days prior to work
02005 (1.3.A.4)	As-built Drawings	Upon completion of contract
02005 (1.3.A.5)	Deliverable Data	Prior to completion of work

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Maintain accurate and complete notes of field surveys.

1. Handwritten field survey notes and information shall be entered in "write in rain" notebooks. A copy of the numbered, dated, and signed field book pages shall be submitted weekly.
2. Electronically collected field survey information shall be collected in Owner-approved total station data collector equipment. Backup equipment shall be available in the event of equipment malfunction.
   a. The electronic format for printed output of data collector field survey notes shall be compatible with the approved fieldbook notation format.
   b. The electronic format for printed output of data collector field work shall be compatible with the Owner's computer equipment and software for verifying and checking the work as required in Article 3.4.A.5. A copy of the data disk shall be submitted weekly.
   c. The format shall be consistently applied to all project survey work.

B. License: Survey work of record shall be conducted under the direction of a Land Surveyor registered in the State of New Mexico.

C. Preserve Owner-furnished baseline controls, references, and location benchmarks. Provide all additional baseline stakes necessary for the successful execution of the work including, but not limited to:

1. Additional lines, connections, ramps, and loops.
2. Slope stakes.
3. Fine-grade stakes.
4. Construction benchmarks and reference stakes locating structures.

D. Perform construction layout surveys at least 2 full working days in advance of scheduled construction operations. At completion of a survey, notify the Owner and provide a copy of the field notes, Construction Drawings, and sketches so that the Owner may perform checks or review the work. Allow at least 2 full working days for inspection before the scheduled start of associated construction operations.

E. Provide a copy of all surveying field notes and computations at least 2 working days prior to commencing applicable construction operations.

F. Upon completion of the work, Provide all original surveying field notes, layouts, computations, and electronic files in standard bound survey notebooks, binders containing electronic file information and two copies each of electronic files compatible with the Owner's computer equipment and software.

3.2 SPECIFIC FIELD REQUIREMENTS

A. Establish temporary control points, as necessary, in accordance with Article 1.1.

B. Survey Monuments, Accuracy, and Documentation:

1. The following information shall be recorded in survey notebooks for each control point established and for all other surveying:
   a. Designation of control point, as shown on the Construction Drawings.
   b. State plane coordinates in NAD 83.
   c. Elevation.
   d. Date of establishment.
   e. Description of the nature and location of the control point.
   f. A sketch of the control point location.
   g. Control points shall be referenced to a minimum of three permanent features that can be seen from the monument.
2. The location of survey monuments for horizontal and vertical control work shall be established by traverse to conform with second-order Class II based on established monuments shown on the Construction Drawings. Location of other points shall conform to third-order Class II accuracy.
3. The following information shall be recorded and documented for existing Owner-approved control points used or recovered for this work:
   a. General condition of monument.
   b. Exact letters and numbers stamped on the monument.
   c. A sketch of monument location.
   d. Date of use.
   e. Coordinates and elevation and the new calculated coordinates and elevations including error of closure and survey level of accuracy.
4. Survey work shall be documented in the field notebook or electronic notebooks using the format and procedures described below:
   a. Title and consecutive number on the front cover.
   b. Consecutively numbered pages.
   c. Table of contents, indexed by survey task, on the first numbered page.
   d. Legend indicating symbols used in survey notes.
   e. Names of survey team for each task.
   f. Notes on weather, equipment, etc.
   g. Date and time on each page to indicate when work was completed.
   h. Notes in a uniform character such that they can be interpreted and used by anyone with survey knowledge.
   i. Description and sketches of the existing survey control used.
   j. Signature and stamp of licensed land surveyor supervising the work (on the first numbered page of all survey notebooks).

C. Temporary control points shall be placed so that they remain undisturbed throughout the construction period with at least two points being visible from any portion of the construction area.

D. Surveys:

1. Clearing Limit Staking: Clearing limits shall be staked according to the minimum clearing limits identified on the Construction Drawings. Clearing limits stakes shall be 4-foot lathe marked "clearing limits." Lathe shall be tied with brightly colored flagging. Flagging color shall be subject to approval by the Owner.
2. Alignment and Existing Ground Staking: Following clearing operations and before stripping operations begin, preliminary locations of alignments and/or baselines of project features shall be established. Cross-sections shall be taken to describe original ground features before stripping or excavation begins. The distance between grid points shall not exceed 50 feet, and all breaks shall be noted. In addition, cross sections shall be taken at all grade breaks along the baseline. A minimum of three points shall be recorded on each side of the baseline or alignment for each cross section. Additional points shall be taken at all grade breaks along the cross section.
3. Earthwork Staking: Staking for cut and fill limits shall establish the exterior limits of excavations and embankments. The maximum staking interval shall be 50 feet. Stakes shall be prominently noted with description of point, vertical distance to design elevation, and offset distance as applicable. A brightly flagged 4-foot lathe shall be provided with each stake.
4. Ditches and Channels: Ditches, channels and culverts shall be staked along an offset control line sufficiently removed from the centerline so that they remain undisturbed during construction. Both horizontal and vertical position shall be referenced from the offset line or lines with stakes clearly marked indicating the applicable horizontal and vertical reference distance.
5. Erosion Protection Features: Corners of riprap, erosion control materials, and other protected zones shall be staked and horizontally and vertically controlled to ensure that surfaces are uniformly installed to the design lines and grades. For shallow ditches and channels, the termination of protected zones shall be staked according to the Construction Drawings.
6. Final Surveys: The Contractor shall perform topographic surveys required to establish the actual quantities of work completed. The Owner may verify the surveys or supervise Contractor during performance of final surveys.
7. When required, construction cross sections shall be established in accordance with the following:
   a. Original contours on the Construction Drawings shall not be used to compute quantities.
   b. pProvide a topographic survey for verification at least 48 hours before disturbing any natural ground.
   c. The Contractor shall record cross-section notes.

E. Construction Tolerances: The following table provides required tolerances (plus or minus) for items shown in the Construction Drawings:

Construction Item	Horizontal Control	Vertical Control	Cumulative Tolerance
Drainage*	0. 1 foot	0. 1 foot	N/A
Riprap, sand and gravel layers	.2 foot	0.1 foot	0.1 foot
Temporary earthwork features including excavations, fills, ramps, etc.	0.2 foot	0.2 foot	N/A
Access Road, Pugmill Area and Work Area Surfaceing**	0.2 foot	0.1 foot	N/A
Final Site Grading***	0.1 foot	0.2 foot	N/A

* Ditch slope graded to drain regardless of tolerance.
** 0.2 percent for cross-slope
*** Increase tolerances to 0.6 foot for horizontal control and .0 foot for vertical control on slopes over 20%.

3.3 AS-BUILT DRAWINGS

A. Submit as-built horizontal and vertical control information including coordinates and elevations of all proposed facilities, including but not limited to, the following:
   1. Waste placement area.
   2. Permanent erosion control features.
   3. Final site grading.

3.4 DELIVERABLE DATA

A. Before completion of the work, furnish one copy each of the following data:
   1. Reduced and checked field notes.
   2. All Construction Drawings and sketches.
   3. All electronic data. All survey data submitted in electronic form shall have the following format:
      a. 3D.dgn files compatible with Intergraph MicroStation or AutoCAD. All lines and point elevations (i.e., spot elevations, contour lines, etc.) on the file shall also be labeled with the appropriate elevation above MSL. All break lines shall be labeled.
      b. All contour elevations, break lines, and spot elevations shall be placed on separate levels.
      c. Additionally, all data shall be submitted in ASCII files. The file shall consist of rows, each with five (5) columns, representing one location with its elevation. Each column shall be delimited by commas, shall be of fixed width, and in the following order:
         1) ID Number, Easting (NAD83), Northing (NAD83), Elevation (MSL), Word Description.

4. Additionally, all rows with spot elevations shall be sandwiched between one row at the top with the number 1, and one row at the bottom with the text "end." All rows with points representing the vertices of a single contour line shall be sandwiched between one row at the top with the number 3, and one row at the bottom with the text "end."

   a. All files shall be delivered either on a 3.5-inch floppy disk or a CD disk. Data on disks may be formatted under a DOS or Windows file format.

5. All records shall conform to LANL document control requirements. At the end of the construction, survey records shall be turned over to the Owner.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
3/21/02	R. Rager	K. Ohsiek	K. Ohsiek	R. Rager	Issue "A" "Issue for Review"
5/29/02	JB for RER	K. Ohsiek	K. Ohsiek	JB for RER	Issue "B" "90% Issue for Review
6/12/02	RRr	[illegible]	RER for KLO	RRr	Issue "C" "90%" Reissue for Review

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 02205	STRIPPING, CLEARING AND GRUBBING

SECTION 02205

STRIPPING, CLEARING AND GRUBBING

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SECTION INCLUDES 1
1.2 RELATED SECTIONS 1
1.3 REFERENCES 1
1.4 DEFINITIONS 1

PART 2 PRODUCTS 2
NOT USED 2

PART 3 EXECUTION 2
3.1 GENERAL 2
3.2 STRIPPING 3
3.3 CLEARING 3
3.4 GRUBBING 3
3.5 DISPOSAL OF MATERIALS 4
3.6 QUALITY CONTROL 4

SECTION 02205

STRIPPING, CLEARING AND GRUBBING

LOS ALAMOS NATIONAL LABORATORY VCM for PRS 21-011(k)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section covers the requirements for stripping, clearing and grubbing for the project site.

B. Work scope covered by this specification includes access road improvements, treated soil placement area excavation, cover and site restoration fill, and contaminated treated soil and preparation and placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

B. Section 02300 – Earthwork – General

C. Section 02322 – Contaminated Soil and Tuff

D. Section 02600 – Stormwater Control

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

1.4 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.

3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

C. Stripping: Stripping shall consist of removing the surface organic layer including grass, shallow bushes and topsoil; and stockpiling for disposal or reuse.

D. Clearing: Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

E. Grubbing: Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

F. Limbing: Limbing shall consist of the removal of all tree limbs from tree trunks over 6 inches in diameter.

G. RCA: Radiological Control Area as shown on the Drawings.

H. RCT: A LANL Radiological Control Technician.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. All areas requiring fill, subgrade preparation, excavation, or as otherwise indicated shall be stripped or cleared and grubbed. Protect other areas within the site boundary from disturbance at all times during remediation and restoration activities.

B. All work covered by this specification shall follow the Health and Safety requirements of the SSHASP.

3.2 STRIPPING

A. Within areas to be disturbed by remediation or restoration activities, and outside contaminated soil removal areas, remove stripped material prior to other earthmoving operations.

B. A separate stripping operation is not required within the areas of contaminated soil or tuff removal. During stripping operations within the RCA, the RCT will determine if topsoil is contaminated.

   1. Stripping outside the RCA is considered clean work.

3.3 CLEARING

A. Cut off material to be cleared within 6-inches above the original ground surface. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

B. All trees over 6 inches in diameter shall be limbed, and cut into 10 to 15-foot nominal lengths.

C. Prevent cleared material from being contaminated by contact with contaminated soil.

   1. Clearing outside the RCA is considered clean work.

3.4 GRUBBING

A. Grub roots and stumps to a depth of not less than 18 inches below the original surface level of the ground in areas to receive fill including work pad areas.

B. Grub roots and stumps as deep as necessary to remove root balls from contaminated soils and clean fill soil obtained from site excavations.

C. During grubbing operations within the RCA, the RCT will determine if the material is clean or contaminated.

   1. Maintain separation of contaminated and uncontaminated grubbed material.
   2. Grubbing material outside the RCA is considered clean work.
   3. Knock soil and tuff from grubbed root masses with grubbing equipment.
   4. Scan and decontaminate grubbing equipment before using for grubbing or other operations in clean areas.

D. Where necessary, depressions made by grubbing shall be backfilled with restoration material.

3.5 DISPOSAL OF MATERIALS

A. Dispose of uncontaminated stripped, cleared and grubbed materials in the following manner:

1. Store stripped topsoil in on-site designated stockpile area for use in restoration activities.
2. Logs under 6 inches in diameter, stumps, roots, brush, and rotten wood from the clearing and grubbing material shall be loaded into Owner haul trucks for disposal off-site.
3. Store logs over 6 inches in diameter outside the RCA near the access control trailer.
4. Dispose of uncontaminated refuse in a public landfill off-site.

B. Storage of cleared or grubbed materials on-site prior to off-site disposal for a period of more than 7 days is prohibited.

C. Uncontaminated material shall remain on site until release approval is obtained from the RCT.

D. Dispose of contaminated stripped, cleared and grubbed materials in the following manner:

1. Load into Owner haul trucks for off-site disposal.
2. Contaminated refuse shall be disposed of according to Owner Procedures.

3.6 QUALITY CONTROL

Not Used.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
3/21/02	R. Rager	K. Ohsiek	K. Ohsiek	R. Rager	Issue "A" "Issue for Review"
5/29/02	JB for RER	K. Ohsiek	K. Ohsiek	JB for RER	Issue "B" "90% Issue for Review"
6/12/02	RRr	JB	RER FOR KLO	RRr	Issue "C" "90% Reissue for Review"

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 02300	EARTHWORK – GENERAL

SECTION 02300

EARTHWORK – GENERAL

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SECTION INCLUDES 1
1.2 RELATED SECTIONS 2
1.3 REFERENCES 2
1.4 GENERAL PROCEDURES 3
1.5 DEFINITIONS 4
1.6 SUBMITTALS 5
1.7 SUBMITTAL SCHEDULE 5
1.8 WEATHER CONDITIONS 5
1.9 SURVEYING 5

PART 2 PRODUCTS 6
2.1 RESTORATION MATERIALS 6

PART 3 EXECUTION 7
3.1 PREPARATION 7
3.2 ACCESS ROADS AND WORK PADS 7
3.3 SUPPORT OF EXCAVATED AREAS 8
3.4 DEWATERING 8
3.5 EXCAVATION 8
3.6 STOCKPILING OF MATERIALS 10
3.7 LOADING AND HAULING 10
3.8 UTILIZATION OF EXCAVATED MATERIALS 10
3.9 SELECTION OF OFF-SITE BORROW MATERIAL 11
3.10 FOUNDATION PREPARATION 11
3.11 GENERAL PROCEDURES FOR FILL CONSTRUCTION 11
3.12 ACCESS ROAD, PUGMILL AREA, AND WORK AREA SURFACING 12
3.13 DITCHES 12
3.14 MOISTURE CONDITIONING AND COMPACTION 13
3.15 WORK LINES, FINISHING AND TOLERANCES 14
3.16 FIELD QUALITY CONTROL 14

SECTION 02300

EARTHWORK - GENERAL

LOS ALAMOS NATIONAL LABORATORY VCM for PRS 21-011-(k)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Specification Section covers the general requirements for uncontaminated earthwork construction.

B. Work includes access road improvements, treated material placement area excavation, cover and site restoration fill, and contaminated treated soil and tuff preparation, and treated material placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

C. Earthwork related to the outfall pipe is excluded.

D. The work includes furnishing of all plant, equipment, labor, materials, and supplies to complete the required excavations, fills, and backfills to the lines and grades shown on the Drawings.

E. Required items of work addressed in this Specification Section include, but are not limited to, the following:

1. Constructing and maintaining access and haul roads.
2. Subgrade preparation.
3. Clean soil and tuff excavation.
4. Selecting and hauling of materials from borrow areas to produce the specified finished materials.
5. Restoration fill construction.
6. Structural excavation and backfill.
7. Riprap and granular soil placement and compaction requirements.
8. Final site grading requirements.
9. Ground support required for protection of existing features and safety.
10. Incidental items.

F. Earthwork, fill and excavation include all soil and rock materials excavated, placed and/or removed regardless of material classification, moisture content or degree of compaction.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

B. Section 02005 – Surveying Services

C. Section 02205 – Stripping, Clearing, and Grubbing

D. Section 02307 – Riprap, Gravel and Sand

E. Section 02322 – Contaminated Soil and Tuff

F. Section 02600 – Stormwater Control

G. Section 02680 – Seeding and Vegetation

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

D. Comply with the requirements of the reference standards noted in this Specification, except where more stringent requirements are listed or otherwise required by Contract Documents.

E. ASTM – American Society for Testing and Materials

ASTM C33 – Concrete Aggregates

ASTM C117 – Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C131 – Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates

ASTM D422 – Particle-Size Analysis of Soils

ASTM D1140 – Amount of Material in Soils Finer than the No. 200 (75 μm) Sieve

ASTM D1556 – Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)

ASTM D2216 –Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System

ASTM D2922 – Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D3017 – Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4643 – Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

F. OSHA – Occupational Safety and Health Administration

OSHA 29 CFR 1926 –Safety and Health Regulations for Construction

OSHA 29 CFR 1910 – Occupational Safety and Health Standards

1.4 GENERAL PROCEDURES

A. Geotechnical Investigations: Limited geotechnical data is available for on-site soils and tuff. Contractor shall be responsible to become familiar with on-site soil conditions whether represented in the data or not, and make an independent interpretation of site investigations performed to date. Owner is not responsible for interpretations of the data made by Contractor for his own purposes. Availability of the information or Contractor's interpretation of data does not relieve Contractor of responsibility to satisfactorily complete any and all portions of work covered by this Specification.

B. In the event Contractor encounters material outside the RCA reasonably believed to be a toxic or hazardous material, or a toxic or hazardous waste, including, but not limited to, asbestos, polychlorinated biphenyl (PCB), or containers of unknown materials, Contractor shall immediately stop work in the affected area and immediately notify the RCT of the condition. Pending receipt of written instructions from RCT, Contractor shall not resume work in the affected area.

C. Contractor shall lay out temporary facilities and access/haul roads so as to prevent any unnecessary impact to wetlands, waters of the United States and other physical features and sites under the jurisdiction of the National Environmental Policy Act (NEPA).

1.5 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.
3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

C. Satisfactory Material: Subgrade, and borrow source materials meeting specified requirements, free of excess moisture, organic matter, debris and other deleterious materials.

D. Unsatisfactory Materials: Fill materials which do not meet the specified requirements, or any materials that are frozen, or contain excess moisture, organic matter (such as strippings, roots, etc.), trash, or debris. Fill and backfill placed during previous construction are unsatisfactory unless testing demonstrates materials meet specified requirements for adjacent fill.

E. Degree of Compaction: Degree of compaction is the ratio, expressed as a percentage, of the dry density of the fill material as measured in the field, to the maximum dry density of the same material measured in the laboratory by the test procedure specified.

F. Required Moisture Content: Moisture content required is expressed as a range of moisture contents (+/-) about the optimum laboratory moisture content for the specified material obtained by the test procedure specified.

G. RCA: Radiological Control Area.

H. RCT: Radiation Control Technician.

I. QCT: Quality Control Technician.

1.6 SUBMITTALS

A. Submit the following for review in accordance with the requirements of Sections 01300.

1. Proposed layout of work activities including stockpile locations, a detailed schedule, and sequencing/coordination with treated material operations.
2. Equipment: Show type of equipment to be used and schedule of mobilization of equipment at site.
3. Special excavation methods, shoring and bracing plan (if any).
4. Borrow source material investigations.
5. Field records including:
   a) Field survey records.
   b) Red line drawings.

1.7 SUBMITTAL SCHEDULE

Specification Reference	Requirements	Period
02300(1.6.A.1)	Layout of work activities	30 days prior to start of work
02300(1.6.A.2) & 02300(3.14.B &C)	Equipment type and Schedule	30 days prior to equipment mobilization
02300(1.6.A.4)	Shoring and Bracing Plan	30 days prior to installation
02300(1.6.A.7)	Field surveys/record drawings	Within 30 days of completion of work activity.
02300(3.9)	Source borrow material investigation	30 days prior to import

1.8 WEATHER CONDITIONS

A. Fill materials may not be placed, spread or compacted during adverse weather conditions. Schedule work activities to minimize potential weather interruptions such that excavated areas have minimum exposure to adverse weather conditions. In the event interruptions occur, no additional compensation will be provided for delay or material drying-out time. When the work is interrupted by adverse weather, do not resume fill operations until field tests indicate the moisture content and density of the fill are as specified or are in a condition suitable for resuming the work.

1.9 SURVEYING

A. Perform all surveying required to establish location and elevation of structures, based on the existing site grid. General survey requirements are in Section 02005. Tolerances specific to earthwork are contained in the following sections.

PART 2 PRODUCTS

2.1 RESTORATION MATERIALS

A. Fill and Backfill Materials: Required material types are defined below and shall conform to the gradations and physical properties specified. Gradations shown are for fill materials in place.

B. Restoration Fill: Uncontaminated materials obtained from project excavations or off-site borrow sources processed to:

1. Consist of soil or crushed tuff.
2. Exclude topsoil, roots, organic muck, salt, fill, debris and other deleterious materials.
3. Exclude any rock, concrete, or tuff fragments over 10 inches in diameter.
4. Be thoroughly mixed to a uniform gradation.
5. Restoration fill may contain random large pieces of rock that are placed and surrounded completely by compacted restoration soil.
6. Have a soil classification of GM, GC, SW, SP, SM, or SC as tested in accordance with ASTM D2487.

C. Structural Fill: Uncontaminated SP or SM material obtained from project excavations or off-site borrow sources processed to:

1. Consist of soil only.
2. Exclude topsoil, roots, organic muck, salt, fill, debris and other deleterious materials.
3. Have no more than 15 percent greater than the No. 4 sieve.
4. Be thoroughly mixed to a uniform gradation.

D. Tuff Boulders: Obtain tuff boulders used to retain restoration soil on slopes steeper than 2:1 from clean on-site excavation of the disposal area. Tuff boulders are greater than 6 inches in diameter and sound as determined by a moderate blow with a 2-pound sledgehammer. Smaller particles may be present as long as boulders have contact with each other.

E. Gravel Surfacing or Road Base: Obtain gravel for roads and work pads from off-site borrow pits or commercial source. Gravel surfacing shall meet the requirements of Section 2307.

F. Bedding Material: Bedding material shall be non-cohesive granular soil meeting the requirements of Section 2307.

G. Riprap: Granular erosion protection shall meet the requirements of Section 02307.

H. Unsatisfactory Material: Unsatisfactory material will be rejected. All rejected materials shall be reworked as required to become satisfactory material or will be disposed of off- by the Owner.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide, erect, maintain, and remove temporary safeguards such as barricades, flagging, guardrails, bridges, signs, lights, and flares for protection of personnel, the public, equipment and materials, as required by Owner, state, and local codes and ordinances.

3.2 ACCESS ROADS AND WORK PADS

A. As a part of temporary facilities, construct, maintain, and provide ice and snow removal for all temporary access roads and work pads as may be necessary to complete the works and as shown on the Drawings. Provide adequate drainage ditches, berm and culverts and runoff shall be directed to natural drainage channels and not allowed to pond.

B. Maintain work pads and roads in good condition at all times and signs, barriers, lighting and other similar devices shall be provided to assure safe operation of vehicles.

C. Permit travel on construction roads by Owner and Engineer, and their employees.

D. Maintain access and provide traffic control on TA-21 (public) access road at all times.

E. Assume maintenance responsibility for all existing and new roads used in the prosecution of the works. Such maintenance includes all necessary grading and surfacing repairs and clearance of drainage courses, during and at completion of the works.

F. Plan to use existing roads and minimize haul road construction on the site. Any new haul roads must not adversely affect the appearance and stability of the existing site. Repair any damages required on the site caused by Contractor's construction and use. Unless otherwise directed by the Engineer or incorporated into the restoration fill, at the completion of the work, obliterate haul roads and work pads by removing granular material and grading the subgrade materials to blend smoothly into the surrounding land contours. Restoration of haul roads and work pads shall meet the requirements contained in this Section. Seeding and vegetation shall meet the requirements of Section 02680.

G. When hauling materials from off-site, cover the beds of trucks with tarps to minimize dust generation.

3.3 SUPPORT OF EXCAVATED AREAS

A. Stabilize excavations or support surfaces of open cuts as required for the safety of operations. Provide sheeting, shoring, bracing, and other OSHA-approved methods to retain excavations and prevent cave-ins. Sheeting and shoring shall be designed by a registered civil engineer, licensed in the State of New Mexico. Remove shoring, sheeting, and bracing as backfilling proceeds. Perform any other operations required to render safe the condition of all excavations and open cuts.

B. Provide OSHA-approved barriers to protect vehicles and personnel on raised embankments or grades.

3.4 DEWATERING

A. Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of surface, subsurface, and storm water during all excavation and backfilling. Provide necessary diversion ditches or dewatering systems. Dispose of water in accordance with Section 02600 so construction and storage areas, roads, and other surfaces are not flooded.

B. Maintain separation between runon and contaminated runoff.

C. Keep excavations dewatered until backfilled to above the level where surface water will not adversely influence construction.

D. Furnish, install, maintain, and operate all necessary pumping and other equipment and construct all necessary cofferdams, channels, flumes, drains, sumps and other facilities for removal of water from the various parts of the work and for maintaining excavations and other parts of the work free from water.

3.5 EXCAVATION

A. Contaminated material excavation requirements are contained in Section 02322.

B. Maximize the separation of clean material from contaminated material during excavation.

C. Excavate clean material upon scanning and approval of the RCT.

D. Perform excavation of every type of uncontaminated material encountered within the limits of Project, to the lines, grades, and elevations indicated and as specified.

Excavation shall conform with the notes, typical sections and the tolerances specified on the Drawings and this Specification.

E. Prior to excavation, perform stripping, clearing and grubbing as required in Section 02205.

F. In no case shall material be deposited less than 4 feet from the edge of an excavation. Maintain all excavations free of leaves, brush, sticks, trash, and other debris.

G. Excavate ditches, cutting accurately to the cross-sections, grades, and elevations shown on the Drawings. Care shall be taken not to excavate ditches below grades shown. Backfill ditch over-excavation with Structural Fill material. Place backfill in horizontal layers and compact as specified in Table 3-1.

TABLE 3-1

Required Fills	*Fill Types Used*	*% Relative Compaction and, Moisture Content*	*ASTM Test****	*Frequency of Testing*
1. Structural Fill and Structural Backfill	Structural Fill	90% Compaction & ±3% of Optimum Moisture***	D1556, D422 or D2922 & D2216 or D3017	1 test each 200 cubic yards, but not less than 1 test per lift
2. Access roads	Gravel surfacing	4 passes of a 10-ton smooth drum roller at plus or minus 2% of Optimum Moisture	D3017	1 moisture test every 2 hours of compaction operations.
3. Restoration Fill/ Backfill	Restoration Fill**/****	90% Compaction*/** & ±3% of Optimum Moisture***	D1556 or D2922 & D2216 or D3017	1 test each 200 cubic yards, but not less than 1 test per lift for areas >100 square yards. 1 test per placement area for areas <100 square yards. ****
4. Ditch bedding Material	Bedding Material	±3% of Optimum Moisture 3 passes of vibrating plate compactor***	D1556 or D2922 & D2216 or D3017	1 test each 200 cubic yards

* Performance testing is acceptable following test correlation.
**Upper 12-inches of restoration fill will be placed parallel with the slope and compacted by dozer tracking – 2 passes.
***Testing of compaction and moisture content shall be performed based on the maximum dry density and optimum moisture content for the material being placed, as tested by ASTM D1557, Method D.
****Testing is not required on the first 12 inches compacted over treated contaminated material.

Note:
1) Subgrades consisting of soil or crushed tuff shall be compacted to the same density as the fill immediately above the subgrade.
2) Subgrade consisting of treated waste shall be protected from damage by restoration fill equipment and operations.

H. For excavation, grading tolerance shall be from plus 0.3 feet to minus 0.2 feet for horizontal and sloped planes of excavation, unless otherwise shown.

I. If the bottom of the excavation is found to consist of soft or unstable material, remove material as directed by the Geotechnical Engineer, to a depth required to provide a non-yielding working surface.

J. If the bottom of the excavation is disturbed by construction activities or by water, remove disturbed material to a depth required to provide a non-yielding surface and refill with Structural fill.

K. Restore over-excavated horizontal areas to the designated grade with compacted Structural fill.

L. Maintain and protect survey benchmarks and monuments by barriers or flagged markers.

3.6 STOCKPILING OF MATERIALS

A. General: Temporarily stockpile excavated materials and/or processed materials for the convenience of operations provided that stockpiles meet the following requirements. Because space is limited, minimize the stockpile of material on-site.

B. Stockpile Location and Size Limitations:

1. Locate stockpiles within the designated areas.
2. Maintain stockpiles as compactly as possible to conserve area. At the end of each work period, vertical work faces shall be knocked down and the slopes graded to ensure no sudden collapses or slope failure occur. Maintain stockpile and stockpile areas such that they are clean and orderly.
3. Maintain separation of stockpiles by material type.

C. Control run-off from entering other work areas and upon leaving the site to prevent erosion and sedimentation.

3.7 LOADING AND HAULING

A. Load excavated material into haul vehicles, haul, and place in a manner to avoid segregation and loss of material, and to control dust emissions. Dump gravel and riprap material from as small a height as practicable.

3.8 UTILIZATION OF EXCAVATED MATERIALS

A. Use all clean material removed from excavations in construction of site restoration fills within the limit of work.

B. Crush tuff using spreading, hauling and compaction equipment to the maximum extent practical to reduce particle size. Large boulders of tuff may be used intact if placed as landscaping or in a manner that avoids nesting and formation of large voids. Blend crushed tuff and other site soils as necessary to provide uniform fill material.

3.9 SELECTION OF OFF-SITE BORROW MATERIAL

A. Select off-site borrow material to meet the specified requirements and conditions of the particular fill for which it is to be used. Obtain approval of off-site borrow sources from the Geotechnical Engineer.

3.10 FOUNDATION PREPARATION

A. Verify foundation areas are clean to the level of contaminated soil removal prior to placement of fill.

B. Verify that foundation preparation meets the requirements specified in Table 3-1. Place materials on the final prepared subgrade/foundation only after it is visually inspected and approved.

C. Repair any damage to an approved foundation surface to meet specifications prior to placement of fill or treated soil material.

   1. If damaged foundation is tuff, replace damaged material with structural fill.

D. Prevent damage of foundation consisting of treated soil or crushed tuff. If damaged, additional treatment may be required. Geotechnical Engineer will provide the method of correcting treated soil subgrade damage.

E. Grade foundation surfaces to provide relatively smooth lines and grades.

   1. Correct irregularities to allow for the placement of relatively smooth layers of fill.
   2. Minor and occasional protrusions of tuff above foundation grade are acceptable.

F. Protect subgrades from freezing or saturation.

3.11 GENERAL PROCEDURES FOR FILL CONSTRUCTION

A. Construct fills from satisfactory materials and in accordance with the moisture conditioning, placement and compaction requirements specified in Table 3-1. Blending and crushing of tuff for fill material may be performed at the fill location.

B. Do not place fill material when the material is frozen, or contains any snow, ice or frozen earth. Suspend fill construction when the ambient air temperature is below 32°F, except as approved by the Geotechnical Engineer.

C. Unless otherwise specified or specifically authorized by the Geotechnical Engineer, construct fill in continuous and approximately horizontal lifts for the full width.

D. Place the first lift of restoration fill over the treated waste on the 5:1 slope and achieve a nominal 12-inch thick compacted lift.

E. Excavate and remove haul road fills over finished slopes, except the access road, prior to completion of the Works. Grade and compact rutted areas of the finished surface.

F. Where location limits use of the specified compaction equipment, compact materials with hand-held compactors in 4-inch lifts to a density equal to the density achieved by the specified compaction equipment and methods. Compact each layer in a systematic, orderly and continuous manner.

G. Minimize and randomly route traffic of haul equipment over fill materials to minimize rutting.

3.12 ACCESS ROAD, PUGMILL AREA, AND WORK AREA SURFACING

A. Construct or resurface road surfaces to alignment, grade and cross-section shown on the Drawings. Final surface tolerances are provided in Section 02005.

B. Place a minimum of 2 inches of loose gravel over the access road, pugmill area and work area surfaces.

3.13 DITCHES

A. Bedding and Riprap material requirements are in Section 02307.

B. Install ditches at the locations and grade and in accordance with the cross-sections as shown on the Drawings. Grading tolerances are provided in Section 02005.

C. Install bedding at the locations and to the horizontal dimensions and depths shown on the Drawings. The horizontal dimensions and depths are minimums except where greater dimensions or depths might interfere with other features. Place and compact in accordance with the moisture conditioning, placement and compaction requirements specified in Table 3-1.

D. Install riprap at the locations and to the horizontal dimensions and depths shown on the Drawings. The horizontal dimensions and depths are minimums except where greater dimensions or depths might interfere with other features. Place riprap loose. After placing loose, Contractor shall use mechanical equipment or hand labor to distribute riprap to uniform gradation and firm interlocking surfaces. Otherwise, place riprap by hand.

3.14 MOISTURE CONDITIONING AND COMPACTION

A. Compact each layer of fill by the compaction equipment types specified in Article 3.14.E, dry density of the compacted fill shall be maintained within the control limits specified in Table 3-1, and water content shall be maintained at ±3% of optimum, as identified by ASTM D1557.

B. Performance standards are an acceptable replacement for the compaction requirements, providing the initial fill lifts are correlated to the density test for each material type, equipment weight, equipment type, number of passes, material moisture content and lift thickness.

1. Maintenance of moisture content is required.
2. Counting of passes begins following moisture conditioning and testing.
3. Changes of material type as determined by ASTM D1557 or ASTM D2487 will require re-verification of compaction procedures.
4. Lift thickness may vary depending on the compaction equipment. Do not exceed 12 inches lift thickness.

C. Rework materials not meeting the specified water content and dry density requirements to conform to this specification. If freezing of previously compacted and accepted fill has resulted in a decrease in compacted density of the fill, rework the fill until required densities are obtained. Reworking may include removal, rehandling, reconditioning, re-compacting, or combinations of these procedures.

D. Moisture condition fill materials by uniformly adding water as necessary to achieve compaction and preclude bulking of the material. Add moisture on the fill sufficiently in advance of compaction to permit the added water to penetrate the entire layer or process the material to provide a uniform moisture content throughout this lift. If the material becomes too wet to achieve the required compaction, the material shall be scarified or removed and allowed to dry to reduce the water content, and compacted to achieve satisfactory results.

E. Compaction Equipment: All compaction equipment shall be in good condition. Use the following compaction equipment types:

1. Access Road, Pugmill Area and Work Area Surfacing: Smooth drum compactor.
2. Structural Fill and Restoration Fill: Adjacent to boulders, use hand-operated heavy duty vibrating plate compactors, vibrating trench rollers or vibrating smooth-bottom tampers approved by the Geotechnical Engineer. Outside the above limits, use vibratory pad-foot roller.
3. Bedding Material: Smooth drum or vibrating plate compactor.

3.15 WORK LINES, FINISHING AND TOLERANCES

A. Preserve the material outside the work lines in the soundest possible condition.

B. Finish the surface of all excavations, fills and subgrades to a uniform and compact surface in accordance with the lines, grades, and cross sections or elevations shown on the Drawings. Unless otherwise noted, finish all graded areas as indicated in Section 02005.

C. Finish to drain readily and take measures to prevent erosion of freshly graded areas by appropriate means until permanent drainage and erosion control facilities are installed. Repair and reestablish areas of settlement or erosion to required elevations and slopes prior to acceptance of the work.

3.16 FIELD QUALITY CONTROL

A. Field quality control is the responsibility of QCT in accordance with the test methods and frequencies set forth in this Section. Acceptance of work is based on the record of field quality control. Corrective action required due to failing tests shall be at Contractor's expense.

B. The material gradations specified are for the materials after placement and compaction in the fill. Field in-place density will be determined in accordance with ASTM D1556 or ASTM D2922. Field in-place moisture content will be determined in accordance with ASTM D2216, ASTM 4643, or ASTM D3017. Table 3-1 indicates test frequency. Locations are selected by QCT. Test results will be delivered to Contractor. Nuclear densimeters shall not be used under freezing conditions or where radiation from waste or the surrounding site may interfere with the results.

C. Tests will be performed on the subject lift prior to placement of the next lift.

D. Geotechnical Engineer may elect to have additional testing performed or may direct that inspection trenches or test pits be cut into the fills to determine that the specifications have been met. Such trenches or pits will be of limited depth and size, and shall be backfilled with the material excavated and compacted. When test results indicate the work is not as specified, the work will be corrected using a method approved by Geotechnical Engineer. If additional testing indicates that work meets the specified requirements, Contractor will be compensated for the trenching and backfilling. Backfill shall be compacted to a density at least equal to that of the contiguous fill.

E. Contractor shall give QCT 48 hours advance notice, when requesting a test for acceptance of work in progress or a final acceptance test.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
5/29/02	JB for RER	K. Ohsiek	K. Ohsiek	JB for RER	Issue "A" "90% Issue for Review"
6/12/02	R. Ryr	JB	RER FOR KLO	R. Ryr	Issue "B" "90%" Reissue for Review

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 02307	RIPRAP, GRAVEL AND SAND

SECTION 02307

RIPRAP, GRAVEL, AND SAND

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SCOPE 1
1.2 RELATED WORK 1
1.3 DEFINITIONS 1
1.4 REFERENCES 2
1.5 PROTECTION 3
1.6 PERMITS 3
1.7 SUBMITTALS 3
1.8 SUBMITTAL SCHEDULE 3
1.9 WITNESS POINTS 3

PART 2 PRODUCTS 3
2.1 RIPRAP 3
2.2 GRADATION 4
2.3 RIPRAP SOURCE QUALITY CONTROL 4
2.4 SOURCE QUALITY REQUIREMENTS FOR BEDDING AND ACCESS ROAD SURFACE MATERIAL 5

PART 3 EXECUTION 5
3.1 MATERIAL PLACEMENT 5
3.2 FIELD QUALITY CONTROL 5

SECTION 02307

RIPRAP, GRAVEL, AND SAND

LOS ALAMOS NATIONAL LABORATORY VCM FOR PRS 21-011(k)

PART 1 GENERAL

1.1 SCOPE

A. The Section includes requirements for furnishing:
   1. Riprap in lined ditches.
   2. Bedding gravel for riprap, as shown on the Construction Drawings.
   3. Aggregate base and aggregate surface for the access road, plant area and work area.

B. Work scope includes access road improvements, treated material placement area excavation, cover and site restoration fill, and contaminated treated soil and tuff preparation, and treated material placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

1.2 RELATED WORK

A. Section 01300 - Submittals

B. Section 02300 - Earthwork

1.3 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:
   1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
   2. Contractor: The entity performing the work defined in these Specifications and Drawings.
   3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

C. Quality Assurance Technician (QAT) – The Owner's quality representative.

1.4 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site-Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

D. Comply with the requirements of the reference standards noted in this Specification, except where more stringent requirements are list or otherwise required by contract Documents:

E. American Society for Testing and Materials (ASTM):

ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates*

ASTM D75 – Sampling Aggregates

ASTM D422 – Particle-Size Analysis of Soils

ASTM D3740 – Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D4992 – Evaluation of Rock to be Used for Erosion Control

ASTM E29 – Using Significant Digits in Test Data to Determine Conformance with Specifications

ASTM E329 – Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

F. Occupational Safety and Health Administration (OSHA):

Code of Federal Regulations 29 CFR, Part 1926, Subpart P as applicable

G. New Mexico State Highway and Transportation Department (NMSHTD):

Standard Specifications for Highway and Bridge Construction (2000)

---

*Rulers or templates may be substituted for sieves for particles larger than 3 inches.

H. American Association of State Highway and Transportation Officials (AASHTO):

Standard Specifications for Materials

1.5 PROTECTION

A. Protect existing roadways and other site features from damage during site delivery.

1.6 PERMITS

A. Provide all required permits for borrow sources of materials used. Perform the work in accordance with the requirements of all applicable permits.

1.7 SUBMITTALS

A. In accordance with the schedule given in this Section and guidelines given in Section 01300, submit the following for approval:

1. For all material proposed for use as bedding and aggregate surface, submit certificates of conformance verifying that the materials meet the requirements of Article 2.4 below.

1.8 SUBMITTAL SCHEDULE

Specification Reference	Requirements	Period
02306 (1.7.A.1)	Certificates of Conformance	Four weeks prior to hauling on site

1.9 WITNESS POINTS

A. Witness points are:

1. Initial monitoring of processed material at the borrow source to ensure acceptable materials are being processed.
2. Inspection, including sampling and testing, of processed materials at borrow source to ensure acceptability of materials prior to transportation to site.

PART 2 PRODUCTS

2.1 RIPRAP

A. Materials Sources: Obtain materials for use as riprap only from pre-approved borrow sources.

B. Obtain riprap only from a stockpile approved by the QCT.

C. Riprap shall be obtained from the Espanola Transit Mix borrow source from a stockpile approved by the QCT and Geotechnical Engineer.

2.2 GRADATION

A. Riprap gradation is Coarse Aggregate Standard Size 1 per AASHTO M43:

U.S. Standard Sieve Size (Square Openings)	Percent Passing (by Weight)
4-inch	95 to 100
3-inch	50 to 100
2-inch	10 to 65
1-inch	0 to 15
1/2-inch	0 to 5

1. The shape of at least 75 percent of the material by weight shall be such that the minimum dimension is not less than 1/3 of the maximum dimension.
2. Deliver material free of organic matter, deleterious material, clay balls, friable particles, etc.

B. Use Type I aggregate material for access road surfacing and budding conforming to the NMSHTD Standard Specifications for Highways and Bridges Section 304, Base Course, obtained from an NMSHTD-approved borrow source.

2.3 RIPRAP SOURCE QUALITY CONTROL

A. Monitor materials acquisition and production at each source using a qualified engineering geologist to ensure acceptable materials under this Section. The Geotechnical engineer and QCT will confirm acceptability. Allow inspection of riprap production by the Geotechnical Engineer and QAT:

1. Ensure stripping and material selection procedures are adequate to prevent inclusion of topsoil material.
2. Exercise care in loading to prevent degradation of material gradation through the inclusion of stockpile subgrade material.

B. QCT will perform one source conformance gradation test for the initial 10,000 cubic yards of riprap produced. If more than 10,000 cubic yards are required, perform gradation tests on equal quantities of riprap produced, but not less than one test per each 10,000 cubic yards.

2.4 SOURCE QUALITY REQUIREMENTS FOR BEDDING AND ACCESS ROAD SURFACE MATERIAL

A. Supply certificates of Conformance and other documentation that Type I and Type II aggregates meet the requirements of NMSHTD Standard Specification for Highway and Bridge Construction Section 303, Base Course (QC/QA).

PART 3 EXECUTION

3.1 MATERIAL PLACEMENT

A. See Specification 02300 for riprap, bedding and road aggregate placement and compaction requirements.

3.2 FIELD QUALITY CONTROL

A. See Specification 02300 for riprap, bedding and road aggregate placement and compaction requirements.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
3/21/02	R. Rager	K. Ohsiek	K. Ohsiek	R. Rager	Issue "A" "Issue for Review"
5/29/02	JB for RER	K. Ohsiek	K. Ohsiek	JB for RER	Issue "B" "90% Issue for Review"
6/12/02	RRr	JB	RER for KLO	RRr	Issue "C" "90%" Reissue for Review

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448	CONTAMINATED SOIL AND TUFF
	Specification Section 02322	

SECTION 02322

CONTAMINATED SOIL AND TUFF

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SECTION INCLUDES 1
1.2 RELATED SECTIONS 1
1.3 REFERENCES 2
1.4 GENERAL PROCEDURES 3
1.5 DEFINITIONS 3
1.6 SUBMITTALS 4
1.7 SUBMITTAL SCHEDULE 4
1.8 WEATHER CONDITIONS 4
1.9 SURVEYING 5

PART 2 PRODUCTS 5
NOT USED 5

PART 3 EXECUTION 5
3.1 GENERAL 5
3.2 PREPARATION 5
3.3 SUPPORT OF EXCAVATED AREAS 5
3.4 DEWATERING 6
3.5 EXCAVATION 7
3.6 STOCKPILING OF MATERIALS 7
3.7 LOADING AND HAULING 8
3.8 GENERAL PROCEDURES FOR TREATED SOIL AND CRUSHED TUFF FILL CONSTRUCTION 8
3.9 MOISTURE CONDITIONING AND COMPACTION OF TREATED SOIL AND CRUSHED TUFF 9
3.10 WORK LINES, FINISHING AND TOLERANCES 9
3.11 FIELD QUALITY CONTROL 10

SECTION 02322

CONTAMINATED SOIL AND TUFF

LOS ALAMOS NATIONAL LABORATORY VCM for PRS 21-011(k)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Specification Section covers the general requirements for excavation of contaminated soil and tuff hot spots, as well as placement and compaction of the treated soil and crushed tuff product.

B. The work includes furnishing of all plant, equipment, labor, materials, and supplies to complete the required excavations, and fill to the lines and grades shown on the Drawings.

C. Required items of work addressed in this Specification Section include, but are not limited to, the following:

1. Constructing and maintaining access and haul roads.
2. Contaminated soil and tuff excavation.
3. Contaminated soil and tuff stockpile requirements.
4. Treated soil and crushed tuff placement and compaction requirements.
5. Incidental items.

D. Treatment of the excavated tuff includes the requirements for crushing to the required correct size. Contaminated soil and tuff treatment requirements are contained in Section 02401.

E. Work scope includes access road improvements, treated soil placement area excavation, cover and site restoration fill, and contaminated treated soil and preparation and placement. See the Voluntary Corrective Measure Plan for the entire remediation effort.

F. Excavation and other work scope of the outfall pipe are excluded from this specification.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

B. Section 02005 – Surveying Services

C. Section 02205 – Stripping, Clearing, and Grubbing

D. Section 02300 – Earthwork - General

E. Section 02401 – Contaminated Soil and Tuff Treatment

F. Section 02600 – Stormwater Control

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

D. Comply with the requirements of the reference standards noted in this Specification, except where more stringent requirements are listed or otherwise required by Contract Documents

E. ASTM – American Society for Testing and Materials

ASTM C33 – Concrete Aggregates

ASTM C117 – Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates

ASTM D422 – Particle-Size Analysis of Soils

ASTM D1140 – Amount of Material in Soils Finer than the No. 200 (75 μm) Sieve

ASTM D2216 –Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System

ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils

F. OSHA – Occupational Safety and Health Administration

OSHA 29 CFR 1926 –Safety and Health Regulations for Construction

OSHA 29 CFR 1910 – Occupational Safety and Health Standards

1.4 GENERAL PROCEDURES

A. Geotechnical Investigations: Limited geotechnical data is available for on-site soils and tuff. Contractor shall be responsible to become familiar with on-site soil conditions whether represented in the data or not, and make an independent interpretation of site investigations performed to date. Owner is not responsible for interpretations of the data made by Contractor for his own purposes. Availability of the information or Contractor's interpretation of data does not relieve Contractor of responsibility to satisfactorily complete any and all portions of work covered by this Specification.

B. Contaminated soil and tuff contains minor amounts of radioactive material. In the event Contractor encounters material reasonably believed to be other toxic or hazardous material, or a toxic or hazardous waste, including, but not limited to, asbestos, polychlorinated biphenyl (PCB), or containers of unknown materials, Contractor shall immediately stop work in the affected area and immediately notify the RCT of the condition. Pending receipt of written instructions from RCT, Contractor shall not resume work in the affected area.

C. Lay out temporary facilities and access/haul roads so as to prevent any unnecessary impact to wetlands, waters of the United States and other physical features and sites under the jurisdiction of the National Environmental Policy Act (NEPA).

1.5 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:
   1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
   2. Contractor: The entity performing the work defined in these Specifications and Drawings.
   3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

C. Contaminated Soil: Native radiologically-contaminated soils or sediment having a classification of SM, SC, SP and SW as tested in accordance with ASTM D2487.

D. Contaminated tuff: Native radiologically-contaminated bedrock consisting of highly to moderately weathered welded volcanic ash excavatable with excavating

equipment, including tractor with ripping shank, or excavators with hoe-ram attachments.

E. Treated material: Soil-like material composed of contaminated soil and crushed tuff, and stabilized using cement, bentonite and silicate additives in a pugmill.

F. Required Moisture Content: Moisture content at which the treated material is delivered from the end of the pugmill.

G. RCT: Radiation Control Technician.

H. RCA: Radiation Control Area.

I. QCT: Quality Control Technician.

1.6 SUBMITTALS

A. Submit the following for review in accordance with the requirements of Sections 01300 and 01340.

1. Proposed layout of work activities including stockpile locations and a detailed schedule and sequence for coordination of excavation for treated material placement.
2. Equipment: Show type of equipment to be used and schedule of mobilization of equipment at site.
3. Special excavation methods, shoring and bracing plan (if any).
4. Field records including:
   a) Field survey records.
   b) Red line drawings of construction.

1.7 SUBMITTAL SCHEDULE

Specification Reference	Requirements	Period
02322(1.6.A.1)	Layout of work activities/sequencing of work	30 days prior to start of work
02322(1.6.A.2)	Equipment type and Schedule	30 days prior to equipment mobilization
02322(1.6.A.3)	Shoring & Bracing Plan	30 days prior to installation
02322(1.6.A.4)	Survey and data and red line drawings	As collected and no less than 30 days following completion of activity

1.8 WEATHER CONDITIONS

A. Fill materials may not be placed, spread or compacted during adverse weather conditions. Schedule work activities to minimize potential weather interruptions such that excavated areas will have minimum exposure to adverse weather

conditions. In the event interruptions occur, no additional compensation will be provided for delay or material drying-out time. When the work is interrupted by adverse weather, resume fill operations when field tests indicate the moisture content and density of the fill are as specified or are in a condition suitable for resuming the work.

1.9 SURVEYING

A. Perform all surveying required to establish location and elevation of structures, based on the existing site grid. General survey requirements are in Section 02005. Tolerances specific to earthwork are contained in Section 02005.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Radiological controls will be implemented on all personnel, equipment and materials within the RCA. Minimize the contamination and cross contamination of clean equipment through planning and execution of the excavation and treated material placement process.

3.2 PREPARATION

A. Provide, erect, maintain, and remove temporary safeguards such as barricades, flagging, guardrails, bridges, signs, lights, and flares for protection of personnel, the public, equipment and materials, as required by Owner, state, and local codes and ordinances.

3.3 SUPPORT OF EXCAVATED AREAS

A. Unbraced excavation depths on sloping ground of DP Canyon are limited for safety.

1. Contaminated soil and tuff depths are measured perpendicular to the ground surface. OSHA limits the depth of unbraced soil excavations based on the depth of excavation measured vertically from the highest point of the intersection of the ground surface with the excavation sideslope. Table 3-1 provides guidance for depth of contaminated soil excavation in sloping ground.

Table 3-1

PRACTICAL EXCAVATION DEPTHS IN SOIL ON SLOPING GROUND AS LIMITED BY OSHA (29 CFR 1926.652)		
Ground Slope (H to V)	**Depth of Excavation (feet)[1,5]**	
	Excavation Slope (H to V)[3] 0.5 to 1	Excavation Slope (H to V) 1.5 to 1
10 to 1[2]	4.7	16.9
5 to 1	4.4	13.7
3 to 1	4	9.5
2 to 1	3.3	4.5
1.5 to 1	2.7	
1 to 1		**(See Note 4)**

Notes:
1. Interpolation for other slope conditions and depths between those shown in the table is permitted.
2. Follow OSHA guidance for excavation of flat ground for ground slopes flatter than 10 H to 1V.
3. Use near vertical slope (0.5:1) wherever possible to minimize uphill disturbance of the ground surface.
4. Shoring and bracing is required for all excavations in soil.
5. Depth measured perpendicular to the ground surface.

2. Excavations in tuff shall follow the guidance for "stable rock" as defined by OSHA 29 CFR 1926.652.

B. Provide OSHA-approved barriers to protect vehicles and personnel on raised embankments or grades.

3.4 DEWATERING

A. Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of subsurface, surface, and storm water during all excavation and backfilling. Provide necessary pumps and haul trucks to capture contaminated storm water within the excavation area for treatment.

B. Prevent stormwater runon and contaminated runoff.

C. Keep excavations dewatered until backfilled to above the level where surface water will not adversely influence construction.

D. Furnish, install, maintain, and operate all necessary pumping and other equipment and construct all necessary cofferdams, channels, flumes, drains, sumps and other facilities for removal of water from the various parts of the work and for maintaining excavations and other parts of the work free from water.

3.5 EXCAVATION

A. Clean soil and tuff excavation requirements are contained in Section 02300.

B. Maximize the separation of clean material from contaminated material during excavation.

C. The extent and depth of contamination shown on the Drawings are for bidding purposes. Actual depth and extent may change as excavation proceeds. Excavate contaminated soil and tuff to the lines and grades directed by the RCT.

D. Excavate all hot spots within the limits of the Work, to the lines, grades, and elevations indicated and as specified. Excavation shall conform with the notes, typical sections and the tolerances specified on the Drawings and this Specification.

E. Excavate contaminated areas shown on the Drawings with excavation equipment located outside the contaminated area in order to minimize contamination of the running gear, wheels, tracks, etc.

F. Prior to excavation, perform stripping, clearing and grubbing as required in Section 02205.

G. In no case shall material be deposited less than 4 feet from the edge of an excavation. Maintain all excavations free of leaves, brush, sticks, trash, and other debris.

H. For excavation, grading tolerance shall be in accordance with Section 02005.

I. Maintain and protect survey benchmarks and monuments by barriers or flagged markers.

3.6 STOCKPILING OF MATERIALS

A. General: Temporarily stockpile excavated contaminated materials for the convenience of operations provided that stockpiles meet the following requirements. Because space is limited, minimize the stockpile of material on-site.

B. Stockpile Location and Size Limitations:

1. Locate stockpiles within the designated area.

2. Maintain stockpiles as compactly as possible to conserve area. At the end of each work period, vertical work faces shall be knocked down and the slopes graded to ensure no sudden collapses or slope failure occur. Maintain stockpile and stockpile areas such that they are clean and orderly.
3. Separate stockpiles by material type.

C. Contain run-off using ditches, berms, dikes and ponds that prevent the release of contaminated surface water following the requirements of Section 02600.

3.7 LOADING AND HAULING

A. Load excavated material into haul vehicles, haul, and place in a manner to avoid material loss and to control dust emissions.
   1. Line haul trucks of treated soil and crushed tuff with plastic disposable liners prior to each use.
   2. Dump material from as small a height as practicable.
   3. Avoid contamination of haul truck wheels by dumping from a clean area into the contaminated placement area.

3.8 GENERAL PROCEDURES FOR TREATED SOIL AND CRUSHED TUFF FILL CONSTRUCTION

A. Avoid spreading of contamination by using dedicated equipment within the placement area.

B. Minimize the exposure of treated soil and crushed tuff following placement by planning and executing staged treated material placement.

C. Place treated material in nearly horizontal lifts to form 8-inch compacted lifts.

D. Place treated material in a lift of uniform thickness and a single area for each day's production.
   1. Minimize the formation of cold joints in the treated material by maintaining continual production for each day treated material is produced.
   2. Stagger cold joints caused by interruption of production such that they do not coincide with those in the underlying lift.
   3. Complete placement and compaction of an entire lift of treated material over the bottom of the placement area prior to placing the next lift.

E. Place all treated material produced immediately. Stockpiling is prohibited.

F. Work on treated material is limited to 6 hours following mixing to complete compaction activities of placed material. Prevent damage or operation of equipment near the completed lift for 16 hours following completion.

G. Do not place fill material when the material is frozen, or contains any snow, ice or frozen earth. Suspend fill construction when the ambient temperature air is below 32°F, except as approved by the Geotechnical Engineer.

H. Cure the completed treated material placement area for approximately 72 hours prior to covering with restoration cover.

1. Place a minimum of 1 foot of restoration cover over the treated material placement area as soon as possible.
2. Prohibit equipment operation adjacent to curing treated material for 16 hours following placement.

I. Do not place treated material on the access ramp. Place clean soil lifts such that during placement operations, adjacent to the treatted material mass, the surface of the ramp is maintained equal to that of the treated material.

3.9 MOISTURE CONDITIONING AND COMPACTION OF TREATED SOIL AND CRUSHED TUFF

A. No moisture conditioning will be allowed on treated contaminated soil and crushed tuff.

B. Should rain interrupt placement activities, immediately cover the exposed area with a tarp.

C. Compact each layer of treated soil and crushed tuff using a vibratory smooth drum roller:

1. Minimum 10,000-pound weight on the roller drum as approved by the Geotechnical Engineer.
2. Compact with vibration turned on.

D. Compact each lift with a minimum of four passes. A pass consists of the travel of the roller across the surface of the treated material once.

3.10 WORK LINES, FINISHING AND TOLERANCES

A. Preserve the material outside the work lines in the soundest possible condition.

B. Finish the surface of all excavation, and fills to a uniform and compact surface in accordance with the lines, grades, and cross sections or elevations shown on the Drawings.

C. Finish to drain readily and take measures to prevent erosion of freshly graded areas by appropriate means until permanent drainage and erosion control facilities are installed. Repair and reestablish areas of settlement or erosion to required elevations and slopes prior to acceptance of the work.

3.11 FIELD QUALITY CONTROL

A. Field quality control is the responsibility of QCT in accordance with the test methods and frequencies set forth in this Section. Acceptance of work is based on the record of field quality control. Corrective action required due to failing tests shall be at Contractor's expense.

B. The QCT will perform full time observation of the number of passes by the compactor during compaction of the treated soil and crushed tuff.

C. Tests will be performed on the subject lift prior to placement of the next lift.

D. Contractor shall give QCT 48 hours advance notice, when requesting a test for acceptance of work in progress or a final acceptance test.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
5/30/02	K. Ohsiek	JB	K. Ohsiek	JB for RER	Issue "A" "30% Issue for Review"
6/12/02	R. Raggw	JB	RER FOR KLO	R. Ryr	Issue "B" "90% Issue for Review

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448 *Specification Section* 02401	CONTAMINATED SOIL AND TUFF TREATMENT

SECTION 02401

CONTAMINATED SOIL AND TUFF TREATMENT

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SCOPE 1
1.2 RELATED SPECIFICATIONS 1
1.3 REFERENCES 1
1.4 DEFINITIONS 2
1.5 SUBMITTALS 3
1.6 SUBMITTAL SCHEDULE 3
1.7 SUBMITTAL SCHEDULE 4

PART 2 PRODUCTS 4
2.1 MOBILE PLANT 4
2.2 PORTLAND CEMENT 4
2.3 SODIUM BENTONITE 4
2.4 WATER 4

PART 3 EXECUTION 4
3.1 GENERAL 4
3.2 PILOT TESTING 5
3.3 CONTAMINATED SOIL AND TUFF PROCESSING 5
3.4 TREATED MATERIAL 5
3.5 TREATMENT PROCESSING 6
3.6 FIELD QUALITY CONTROL 6

SECTION 02401

CONTAMINATED SOIL AND TUFF TREATMENT

LOS ALAMOS NATIONAL LABORATORY VCM for PRS 21-011(k)

PART 1 GENERAL

1.1 SCOPE

A. This Specification Section describes the treatment and processing of excavated soil tuff, including requirements for crushing to the required sizes. Excavation and placement of treated material are cover in Section 02322.

B. Work scope includes access road improvements, treated material placement area excavation, cover and site restoration fill, contaminated treated soil and tuff preparation, and treated material placement. See the Voluntary Corrective Measures Plan for the entire remediation effort.

1.2 RELATED SPECIFICATIONS

A. Section 01300 – Submittals

B. Section 02005 – Surveying Services

C. Section 02205 – Stripping, Clearing, and Grubbing

D. Section 02300 – Earthwork – General

E. Section 02322 – Contaminated Soil and Tuff

F. Section 02600 – Stormwater Control

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

D. Comply with the requirements of the reference standards noted in this Specification, except where more stringent requirements are listed or otherwise required by Contract Documents

E. ASTM – American Society for Testing and Materials

ASTM C150 – Portland Cement

ASTM D422 – Particle-Size Analysis of Soils

ASTM D558 – Moisture-Density Relations of Soil-Cement Mixtures

ASTM D559 – Wetting & Drying Compacted Soil-Cement Mixtures

ASTM D1632 – Making and Curing Soil-Cement and Flexure Test Specimens in the Laboratory

ASTM D1633 – Compressive Strength of Molded Soil-Cement Cylinders

ASTM D2216 – Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2901 – Cement Content of Freshly Mixed Soil-Cement

ASTM D4643 – Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

F. EPA – U.S. Environmental Protection Agency

Test Method 9050A – Paint Filter Liquids Test

G. OSHA – Occupational Safety and Health Administration

OSHA 29 CFR 1926 –Safety and Health Regulations for Construction

OSHA 29 CFR 1910 – Occupational Safety and Health Standards

1.4 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.

3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

C. Contaminated Soil: Native radiologically-contaminated soils or sediment having a classification of SM, SC, SP and SW as tested in accordance with ASTM D2487.

D. Contaminated tuff: Native radiologically-contaminated bedrock consisting of highly to moderately weathered welded volcanic ash excavatable with excavating equipment, including tractor with ripping shank, or excavators with hoe-ram attachments.

E. Soil: As used in this specification, soil is defined as contaminated soil and crushed tuff prepared for mixing in the mobile mixer.

F. Batch: A batch of treated material, as defined in this Section, is no more than 10 cubic yards.

G. Treated Material: Soil-like material composed of contaminated soil and crushed tuff having properties defined in this Specification Section.

H. RCA: Radiological Control Area.

I. QCT: Quality Control Technician

1.5 SUBMITTALS

A. In accordance with the schedule given in this Section, submit the following to the Owner for approval in accordance with Section 01300.

1.6 SUBMITTAL SCHEDULE

A. Submit the following for review in accordance with the requirements of Section 01300:

1. Proposed layout of work activities including stockpile locations and a detailed schedule and sequence for construction from excavation to treated material placement.
2. Equipment: Show type of equipment to be used and schedule of mobilization of equipment to site.

3. Materials: Provide vendor data sheets for all materials used in preparing the treated material.

1.7 SUBMITTAL SCHEDULE

Specification Reference	Requirements	Period
02401(15.A.1)	Layout of work activities/sequencing of work	30 days prior to start of work
02401(1.5.A.2)	Equipment type and Schedule	30 days prior to equipment mobilization
02401(1.5.A.3)	Vendor Data Sheets	30 days prior to start of work

PART 2 PRODUCTS

2.1 MOBILE PLANT

A. The mobile plant shall be a Rapid Mix 400 model continuous mixer system manufactured by Rapid International, Ltd., or Owner-approved equivalent. The mobile plant will be furnished by the Owner.

2.2 PORTLAND CEMENT

A. Portland cement used in the treated material shall be Type IA, IIA, or IA/IIA in accordance with ASTM C150.

2.3 SODIUM BENTONITE

A. Sodium bentonite used in the treated material shall be powdered, high-quality sodium bentonite free of contaminants.

2.4 WATER

A. Water used in treated material shall be potable.

PART 3 EXECUTION

3.1 GENERAL

A. Radiological controls will be implemented on all personnel, equipment and materials within the RCA. Minimize the contamination and cross-contamination of clean equipment through proper planning and execution of the excavation, treatment, and treated material placement processes.

B. An initial set of test batches prepared on uncontaminated soil and crushed tuff prepared as required in this Section, shall be prepared to prove the bench scale design mix presented in this specification. Based on the results of these initial batches the processing and mix ratios for the treated contaminated soil and crushed tuff may be modified as directed by the Engineer.

3.2 PILOT TESTING

A. In order to assure the results of the processing and mix design of the treated material, a series of batches shall be prepared in accordance with this Section, using uncontaminated soil and crushed tuff processed as required for contaminated soil and crushed tuff.

B. Record all weights, and measures of the batch tests.

C. Once processed the workability of the batches will be evaluated by the Engineer and if necessary, adjustment to the batch ratios will be made.

D. The processed batch material will be placed in the treated material placement area and compacted according to Section 02322 for treated material.

E. Following completion of the pilot batch testing, additional adjustment to the batch ratios shall be made only to adjust for initial moisture content of the soil and only in accordance with this Section.

3.3 CONTAMINATED SOIL AND TUFF PROCESSING

A. Contaminated soil and tuff shall be obtained from the temporary stockpiles for size reduction and processing.

B. Contaminated soil and tuff shall be crushed, pulverized, and otherwise processed to achieve 100 percent passing the 3-inch sieve. The processed contaminated soil and tuff shall have no more than 1 percent organics content by weight.

C. The processed contaminated soil and tuff shall be stockpiled and thoroughly blended and mixed to produce a uniform material prior to treating in the mobile mixing plant.

3.4 TREATED MATERIAL

A. Treated material shall be comprised of portland cement, sodium bentonite, and water, and shall be prepared in batch mode at the following ratios. The ratios are based on batch weight of contaminated soil and tuff (i.e., soil) to be treated:

Soil/portland cement:	10:1
Soil/sodium bentonite:	32:1
Soil/water:	4.23:1

B. All ratios are based on the dry weight of the processed contaminated soil and tuff (soil). Adjust the mixture accordingly based on on the actual moisture content of the soil.

C. Treated material constituents shall not vary from their design ratios by more than 1 percent by weight. The soil/water ratio may be adjusted after obtaining Engineer-approval to accommodate capabilities of the grout pumping and handling equipment.

D. Mix treated soil in batch mode. Weights of grout constituents shall be recorded prior to mixing.

E. Set retarder shall not be used.

3.5 TREATMENT PROCESSING

A. Processed contaminated soil and tuff batch weight shall be recorded.

B. Thoroughly mix the processed contaminated soil and tuff batch with the required additives in the mobile plant to produce treated material.

3.6 FIELD QUALITY CONTROL

A. Field quality control is the responsibility of QCT in accordance with the test methods and frequencies set forth in this Section. Acceptance of work is based on the record of field quality control.

B. Pilot Testing: One cement content test in accordance with ASTM D2901 to verify calibration of the pugmill metering system.

C. Processed contaminated soil and tuff:

1. One particle-size analysis in accordance with ASTM D422 and visual observation for organics will be performed on each batch of processed contaminated soil and tuff prior to mixing with the prepared contaminated soil and crushed tuff.
2. One moisture content analysis in accordance with ASTM D2487 or D4643 will be performed on each batch of processed contaminated soil and tuff prior to mixing with the prepared contaminated soil and crushed tuff.
3. Record any adjustment of the mix ratios made prior to and during batch mixing.
4. Four cylinders of treated grout will be sampled and prepared by the QCT for each day of operation in accordance with ASTM D632 or D1633.

5. A paint filter test will be performed in accordance with EPA Test Method 9050A by the QCT when cylinders are taken.

END OF SECTION

Washington

SPECIFICATION TITLE SHEET

This sheet is a record of each issue or revision to the subject specification.

The exact sheets changed and the nature of the change should be noted under "Remarks." These remarks are not a part of the specification. The revised sheets become part of the original document and shall be complied with in their entirety.

Issue Date	*Originated or Revised By*	*Checked By*	*APPROVAL*		*REMARKS*
			Department	*Project*	
3/29/02	J. Bessaw	K. Ohsiek	K. Ohsiek	L. Gleason-QA	Issue "A" "Issue for Review"
05/29/02	JB	K. Ohsiek	K. Ohsiek	--	Issue "B" "90% Issue for Review"
06/12/02	R. Rr	[illegible]	RLR for KLO	RRr	Issue "C" "90% Reissue for Review"

Client, Project, Location	*Work Order Number*	Washington Group International, Inc. *Specification Title/Description*
Los Alamos National Laboratory Los Alamos, New Mexico	23448	STORM WATER AND EROSION CONTROL
	Specification Section 02600	

SECTION 02600

STORM WATER AND EROSION CONTROL

TABLE OF CONTENTS

PART 1 GENERAL 1
1.1 SECTION INCLUDES 1
1.2 RELATED SECTIONS 1
1.3 REFERENCES 1
1.4 DEFINITIONS 2
1.5 GENERAL REQUIREMENTS 2
1.6 SUBMITTAL 3
1.7 SUBMITTAL SCHEDULE 3

PART 2 PRODUCTS 3
2.1 MATERIALS 3

PART 3 EXECUTION 4
3.1 SEQUENCE OF OPERATION 4
3.2 EROSION AND SEDIMENT CONTROL 4
3.3 WATER CONTROL 5
3.4 POLLUTION PREVENTION 5
3.5 INSPECTION AND MAINTENANCE 5

SECTION 02600

STORM WATER AND EROSION CONTROL

LOS ALAMOS NATIONAL LABORATORY VCM FOR PRS 21-011(k)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Specification Section covers requirements for storm water and erosion control, including segregation of runoff from contaminated and uncontaminated areas and sediment control for the project site.

B. The work includes furnishing all of the plant, equipment, labor, materials, and supplies to implement required storm water and erosion control measures.

C. Measures shall include berms, dikes, dams, sediment basins, fiber mats, netting, gravel/riprap, mulches, grasses, slope drains, straw bales, silt fences, geocell, and other erosion control devices or methods.

D. Work scope includes access road improvements, treated material placement area excavation, cover and site restoration fill, contaminated treated soil and tuff preparation, and placement of treated material. See the Voluntary Corrective Measures Plan for a description of the entire remediation effort.

1.2 RELATED SECTIONS

A. Section 01300 - Submittal Procedures

B. Section 02205 – Stripping, Clearing and Grubbing

C. Section 02300 – Earthwork - General

D. Section 02322 – Contaminated Soil and Tuff

1.3 REFERENCES

A. Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21, LANL

B. Construction Quality Control Plan for VCM Activities at PRS 21-011(k), WGII

C. Site Specific Health and Safety Plan (SSHASP) for PRS 21-011(k)

D. Comply with the requirements of the reference standards noted in this specification, except where more stringent requirements are listed or otherwise required by the Contract Documents.

E. 40 CFR 122, EPA Administered Permit Programs: The National Pollutant Discharge Elimination System (NPDES)

F. U.S. Environmental Protection Agency (EPA)

EPA 832-R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices

Guidelines for Erosion and Sediment Control, Planning and Implementation

G. LANL ESH-18 Storm Water BMP Guidance

H. OSHA 29 CFR 1910 – Occupational Safety and Health Standards

I. OSHA 29 CFR 1926 – Safety and Health Regulations for Construction

1.4 DEFINITIONS

A. The following are used to define responsibilities in these Specifications:

1. Owner: Los Alamos National Laboratory (LANL) or LANL's Representative
2. Contractor: The entity performing the work defined in these Specifications and Drawings.
3. Engineer or Geotechnical Engineer: The Engineer of record for the work covered by these Specifications and Drawings. A Registered Civil Engineer in the State of New Mexico. The Geotechnical Engineer shall be specialized in the geotechnical or soil mechanics discipline. The Engineer represents the Owner in technical decisions related to the work.

B. Work: All construction and pre- and post-construction activities related to the portion of the Volunteer Corrective Action as defined by the Specifications and Drawings.

1.5 GENERAL REQUIREMENTS

A. Implement storm water controls that meet National Pollutant Discharge Elimination System (NPDES) requirements and Guidelines for Erosion and Sediment Control, Planning and Implementation (USEPA).

B. Implement erosion controls to prevent soil loss from disturbed areas, excavations, haul roads, borrow areas, and any other areas where erosion develops as a result of construction activities.

C. The project-specific Storm Water Control Plan shall conform to the LANL ESH-18 Storm Water BMP Guidance.

1.6 SUBMITTAL

A. Submit a project-specific Storm Water Control Plan for approval in accordance with the requirements of Sections 01300. The plan shall describe the following:

1. Proposed sequence of operations for storm water control.
2. Location of run-on control berms.
3. Means and methods to confine all potentially contaminated water resulting from within the project remediation limits shown on the Drawings.
4. Pollution prevention of clean areas within the project remediation limits throughout all phases of the Work.
5. Scheduling of revegetation activities to follow excavation or contaminated soil removal.

B. Submit manufacturer's documentation on silt fence indicating conformance to these Specification requirements.

1.7 SUBMITTAL SCHEDULE

Specification Reference	Requirements	Period
02600 (1.5.A)	Storm Water Control Plan	30 days prior to start of work and monthly thereafter
02600 (1.5.B)	Manufacturer's material documentation	1 week prior to ordering for use

PART 2 PRODUCTS

2.1 MATERIALS

A. Erosion control ground cover may be hay, straw, fiber mats, or other approved material, and shall be reasonably clean and free of noxious weeds and deleterious material.

B. Slope drains may be constructed of pipe, fiber mats, plastic sheeting or other approved materials.

C. Straw Bales

1. Provide hay or straw bales free of noxious seeds, weeds, mold and rot.
2. Provide nominal 18-inch by 18-inch by 36-inch bales weighing between 65 and 80 pounds.

D. Silt Fence:

1. Filter Fabric: Conforming to the following:

Fabric Properties	Test Method	Minimum Value
Grab Tensile, Warp/Fill	ASTM D-4632	120/100 lbs.
Grab Elongation	ASTM D-4632	15%
Trapezoid Tear	ASTM D-4633	50 lbs.
Mullen Burst	ASTM D-3786	280 psi
Puncture Strength	ASTM D-4833	60 lbs.
Permitivity	ASTM D-4491	0.27 sec^{-1}
AOS (sieve size)	ASTM D-4751	20
UV Stability (500 hrs., xenon arc)	ASTM D-4355	90% strength retained
Vertical Water Flow Rate	ASTM D-4491	18.5 gpm/sf

(American Excelsior GTF 180 or approved equal)

2. Post:

a. Provide lumber conforming to PS 20, graded in accordance with established grading rules of the National Forest Products Association, with maximum moisture content of 19 percent, No.2 grade.

b. Provide steel posts of standard T or U sections weighing not less than 1.0 pound per linear foot.

PART 3 EXECUTION

3.1 SEQUENCE OF OPERATION

A. Where possible, make temporary erosion and sediment control measures compatible with permanent control measures.

B. In portions of the site where construction activity has temporarily ceased, initiate temporary control measures as soon as practicable.

3.2 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction, earthwork, and Best Management Practices (BMP's) in accordance with the Storm Water Control Plan to prevent erosion and sedimentation.

B. Limit the surface area of erodible material exposed by earthwork activities, and install permanent or temporary sediment control measures to prevent the transport of sediment as needed, or directed by the Geotechnical Engineer.

3.3 WATER CONTROL

A. Provide methods to control surface water to prevent damage to the Project, the site, and adjoining areas as required in the Storm Water Control Plan.

1. Control fill, grading, and ditching to direct surface drainage away from excavations, pits, tunnels, slopes, contaminated areas, and other construction areas. Direct drainage to flow lines shown in the Storm Water Control Plan.
2. Provide, operate and maintain temporary channels and/or hydraulic equipment of adequate capacity to control surface water as specified in the Storm Water Control Plan.

B. Dispose of surface water in accordance with the Storm Water Control Plan.

3.4 POLLUTION PREVENTION

A. Prevent contamination of soil and water in accordance with the Storm Water Control Plan.

B. Restrict fuel, lubrication, chemical storage, and equipment maintenance to a designated area on-site as specified in the Storm Water Control Plan.

3.5 INSPECTION AND MAINTENANCE

A. Inspect the storm water control measures of the construction site at least once every 7 days (June through September) or within 24 hours of the end of a storm that is 0.5 inch or greater. During the drier months (October through May) the routine frequency of inspection may be reduced to every 30 days.

B. Complete a monthly inspection report and incorporate it into the Storm Water Control Plan as a Revision. Submit copies for approval.

C. Damaged structures shall be promptly repaired as directed by the Geotechnical Engineer.

END OF SECTION

SECTION 02936

SEEDING

****

LANL MASTER CONSTRUCTION SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the LEM Civil POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

Specification developed for ML-3 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

****

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preparation of seedbed.

B. Seeding.

C. Mulching and erosion control blankets.

D. Watering and maintenance.

1.2 RELATED SECTIONS

A. Section 02270, Slope Protection and Erosion/Sediment Control

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:

1. Catalog data, including sources of supply for amendments, mulch, tackifier, fertilizer and erosion control blankets.

2. Certification substantiating that material complies with specified requirements. Submit certified seed bag tags and copies of seed invoices identified by project name.

3. Installation instructions, including proposed seeding schedule. Coordinate with specified maintenance periods to provide maintenance from date of final acceptance. Once schedule is accepted, revise dates only with LANL approval after documentation of delays.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Perform work by a single firm experienced with the type and scale of work required and having equipment and personnel adequate to perform the work satisfactorily.

B. Material Quality Control:

1. Provide seed mixture in containers showing species percentages in seed mix; test information including, purity, germination and noxious/restricted weeds; net weight; date of packaging; and location of packaging.

2. Furnish seed labeled in accordance with the requirements of federal and New Mexico statutes and regulations governing seed labeling. Such resulting requirements include but are not necessarily limited to: Federal Seed Act and Amendments, rules and regulations established by the United States Department of Agriculture; the New Mexico Seed Law; and all resulting regulations or restrictions established by New Mexico State University or other authorized entity.

3. In addition, ensure seed mix and its application complies with the requirements of all other federal and New Mexico statutes and regulations governing seeds, plants, and weeds. These requirements include but are not necessarily limited to: the Noxious Weed Control Act and all rules, regulations, or control measures by a noxious weed control district embracing Los Alamos County, New Mexico; and the Harmful Plant Act.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials in sealed containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site. Opened or wet seed shall be rejected and returned to the responsible party.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Comply with 01630, Product Options and Substitutions.

2.2 SEED

A. Obtain native grass seed from sources whose origin would ensure site adaptability at LANL. Plant sources from New Mexico or surrounding states are preferred.

B. Obtain shrub and wildflower seed from sources whose origin would ensure site adaptability at LANL. Plant sources from New Mexico or surrounding states are preferred.

C. Cover crops (e.g., annual barley, oats, winter rye, etc.) may be used only as a temporary stabilization measure and shall not be used in conjunction with a perennial seed mix.

D. Furnish certification, showing origin of seed and pure live seed (PLS) content as determined by a certified authority. Provide bags of seed that are tagged and sealed in accordance with the State Department of Agriculture or other local certification authority within the state of origin. The tag or label shall indicate analysis of seed and date of analysis, which shall not be more than 9 months prior to delivery date. Seed may be premixed by the seed dealer and appropriate data indicated on the bag label for each variety.

E. Seed mixture shall be:

****

Develop seed mixture from the following guidelines. Choose a minimum of 5 grass species from the list. Should wildflowers be included in the mix, use a ratio of 80 – 90 percent grasses and 10-20 percent wildflowers. Choose 3 –5 species from the forb and wildflowers list.

****

NATIVE PERENNIAL MIX

Common Name	Scientific Name	% of Mix
Grasses		
Blue grama*	*Bouteloua gracilis*	5 – 10%
Galleta grass*	*Hilaria jamesii*	5- 10%
Mutton grass	*Poa fendleriana*	10-15%
Sideoats grama*	*Bouteloua curtipendula*	10-15%
Arizona fescue†	*Festuca arizonica*	10 – 15%
Prairie junegrass†	*Koeleria macrantha*	5 – 10%
Bottlebrush squirreltail*	*Elymus elymoides*	15 – 20%
Little bluestem†	*Schizachyrium scoparium*	10 – 15%
Indian ricegrass*	*Oryzopsis hymenoides*	10 – 15%
Mountain brome†	*Bormus marginatus*	10 – 15%
Sand dropseed*	*Sporobolus cryptandrus*	1 - 8%
Thickspike wheatgrass	*Agropyron dasystachyum*	20 – 25%
Needle and Thread grass*	*Stipa comata*	5 – 10%
New Mexico needlegrass*	*Stipa neomexicana*	10 - 15%
Sheep fescue	*Festuca ovina*	10 – 15%
Forbs/ Wildflowers		
Firewheel	*Gaillardia pulchella*	2%
Evening primrose	*Oenothera caespitosa*	1%
Gooseberry leaf Globemallow	*Sphaeralcea grossulariafolia*	1.5%

2.7 AMENDMENTS / SOIL ADDITIONS

A. Fertilizer: Apply slow-release organic fertilizers such as Biosol Mix, Biosol, Osmocote, Granular Humate, composted manure or approved equal to minimize deficiencies of the topsoil. If composted manure is to be applied, test the nutrient content and interpret before it is used.

B. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth.

C. Sand: Clean, washed, and free of toxic materials.

D. Wood chips: Wood chips shall have a relatively large surface area to volume ratio to be more easily broken down in the soil. Incorporate wood chips at low rates (0.5 ton/ acre) in order to assure the Carbon to Nitrogen ratio in soil is at favorable conditions for plant germination and growth. If higher rates are used, add nitrogen fertilizer to assure nutrient availability to plants.

PART 3 EXECUTION

3.1 PREPARATION

A. Preparation of the Seedbed:

1. Prepare seedbed to a maximum depth of 4 inches by tilling with a disc harrow or chiseling tool. Uproot all competitive vegetation during seedbed preparation and work soil uniformly, leaving surface rough to reduce surface erosion. Remove large clods and stones, or other foreign material that would interfere with seeding equipment.

2. Do not till on ground that is already loose to a depth of 2 inches or more that has undergone regrading and fill. Till newly cut slopes.

3. Perform tillage across slope when practical and perform in 2 directions whenever one pass is insufficient to adequately break up soil. Do not till up and down slopes, as this will create excessive surface erosion problems.

4. Do not do work when moisture content of soil is unfavorable or ground is otherwise in a non-tillable condition. To minimize dust problems for adjoining areas, do not till when wind speeds are over 10 mph.

5. The extent of seedbed preparation shall not exceed the area on which the entire seeding operation can be accomplished within a 24-hour period.

B. Soil Amendments/Additions: Uniformly apply slow release organic fertilizer to prepared seedbed in accordance with manufacturer recommended rates.

C. Prepare seedbed again if prior to seeding LANL Construction Inspector determines that rain or some other factor has affected prepared surfaces and that it may prevent seeding to proper depth.

D. On excessively steep slopes (steeper than 2:1), hydraulic/broadcast seeding may be appropriate. If seeding in this fashion, multiply application rate of seed by a factor of 2.

E. If cover crop has been established in area to be seeded, mow cover crop early in growing season before cover crop is ready to drop seeds.

3.2 APPLICATION OF SEED

A. General:

1. Avoid seeding between August 1 and September 30. Do not seed during windy weather, or when topsoil is dry, saturated or frozen.

2. Equip seed boxes used for drill and broadcast seeding with an agitator.

3. To prevent stratification of seed mix, do not run seed box agitators while seeding is not being performed.

4. If seed mix is transported to site in a seed box or other equipment that subjects mix to shaking or similar movement that has the potential to cause stratification, remix seed prior to application.

5. Calibrate seeding equipment in presence of LANL Construction Inspector to determine that equipment setting is appropriate to distribute seed at the specified rates.

6. Unless otherwise shown on Drawings, seed areas disturbed by or denuded by construction operations or erosion.

7. Use markers to ensure that no gaps will exist between passes of seeding equipment.

8. If cover crop has been established, mow the crop and drill seed perennial seed mix into the crop stubble.

B. Drill Seeding:

When drill seeding, plant seed mix at a rate of 20 - 25 PLS lbs/acre. Uniformly apply prescribed mix over area to be seeded as follows:

1. Accomplish seeding operations, where practical, by drilling in a direction across slope.

2. Plant seeds approximately 1/4 inch deep.

3. Do not exceed 4 inches distance between drilled furrows. If furrow openers on drill exceed 4 inches, drill area twice to obtain a 4-inch distance between furrows.

4. Seed with grass wheels, rate control attachments, seed boxes with agitators, and separate boxes for small seed.

C. Broadcast Seeding:

When broadcast seeding, plant seed mix at a rate of 32 - 37 PLS lbs/acre.

1. Where it is not practical to accomplish seeding by drilling, mechanically broadcast seed by use of a hydraulic mulch slurry blower, rotary spreader, or a seeder box with a gear feed mechanism. If seeding is done with a slurry blower, use highest pressure and smallest nozzle opening, which will accommodate the seed.

2. Immediately following seeding operation, lightly rake seedbed or loosen with a chain harrow to provide approximately 1/4 inch of soil cover over most of the seed.

3. If hydraulically applying mulch as part of the broadcast seeding process, use a 2 step process. Apply seed with a tracer (200 – 300 lbs/ acre) amount of mulch across entire seeded area. Once seed is applied, apply full complement of mulch (to equal 2000 lbs/ acre). This shall allow seed to be in good contact with soil surface and not suspended in mulch matrix.

4. Prohibit vehicles and other equipment from traveling over the seeded areas.

3.3 STRAW MULCH: Slopes Flatter than 2:1, Non-Irrigated Projects

A. For locations that have not been hydraulically mulched, immediately following raking/chaining operation, add straw mulch to seeded areas.

1. Apply straw mulch at a minimum rate of 1.5 tons per acre of air-dry material. Spread straw mulch uniformly over area either by hand or with a mechanical mulch spreader to achieve 80 percent ground cover. When spread by hand, tear bales of straw apart and fluff before spreading. Depth of applied straw mulch shall not exceed 3 inches. Do not mulch when wind velocity exceeds 10 mph.

2. Wherever use of crimping equipment is practical, place mulch in manner noted above and anchor it into the soil to a minimum depth of 2 inches. Use a crimper or heavy disc such as a mulch tiller, with flat serrated discs at least 1/4 inch in thickness, having dull edges, and spaced no more than 9 inches apart. Provide discs of sufficient diameter to prevent frame of equipment from dragging the mulch. Where practical, perform crimping in 2 (opposite) directions. Do not use Sheep's Foot Rollers, heavy equipment tracks, and standard disc cultivators for crimping.

3. If straw mulched areas cannot be anchored by crimping, use hydraulic mulch wood fibers with tackifier. Mix slurry in a tank with an agitation system and spray under pressure uniformly over the soil surface. Keep all materials in uniform suspension throughout the mixing and suspension cycle when using hydraulic mulching equipment. Mix 100 lb. of wood fiber with 150 lbs. of tackifier to anchor straw mulch. Apply mixture at a rate of 250 lbs/acre.

4. Use both horizontal and vertical movements in the applicator to achieve an even application of the slurry material.

3.4 HYDRAULIC MULCHING/TACKIFIER: Slopes Flatter than 2:1, Irrigated Projects

A. Immediately following raking/chaining operation, apply hydraulic mulch fibers with tackifier to seeded areas. Mix slurry in a tank with an agitation system and spray, under pressure, uniformly over soil surface. Apply mulch evenly across landscape at a rate of 2000 lbs/ acre.

B. Use both horizontal and vertical movements in applicator to achieve an even application of slurry material. Keep all materials in uniform suspension throughout mixing and suspension cycle when using hydraulic mulching equipment.

C. When using plantago based tackifier as mulch, apply tackifier at a rate of 100 lbs/acre. When applied alone for dust control, apply tackifier at a rate of 150 lbs/acre.

D. Prohibit foot/vehicle traffic from hydraulically mulched areas.

3.5 EROSION CONTROL BLANKET: Slopes 3:1 and Steeper, Irrigated and Non-Irrigated Projects

A. Place blankets over native grass seeding immediately following the raking/chaining operation.

B. When using single netted products for 3:1 or flatter slopes, place blanket with netting on top and the wood/ straw fibers in contact with soil over entire seeded area.

C. For slope installations, the following guidelines shall be used:

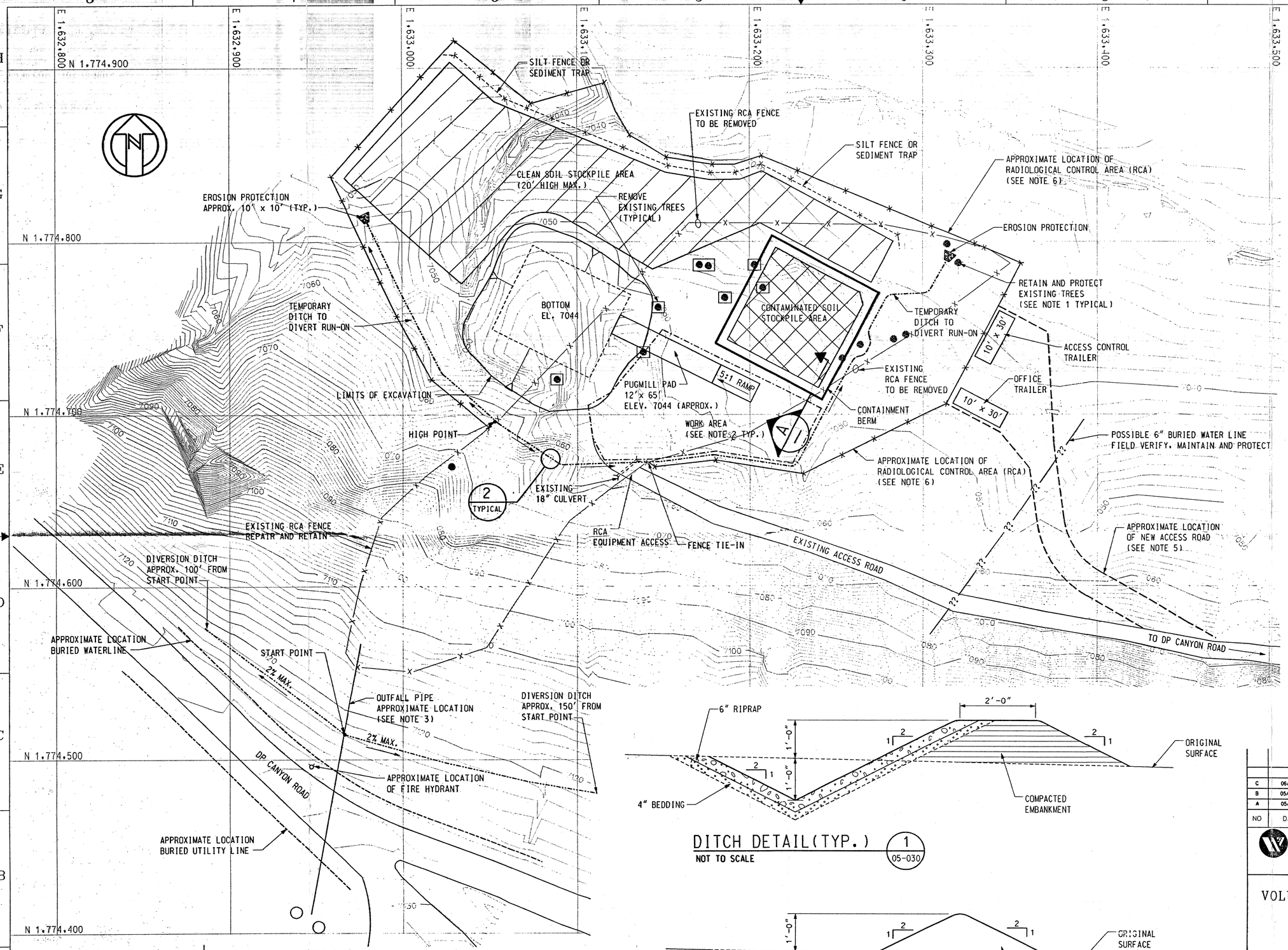
1. Begin at top of slope and anchor its blanket in a 6 inch deep by 6-inch wide trench. Backfill trench and tamp earth firmly.

2. Unroll blanket downslope in direction of water flow.

3. Overlap edges of adjacent parallel rolls 2 to 3 inches and staple every 3 feet.

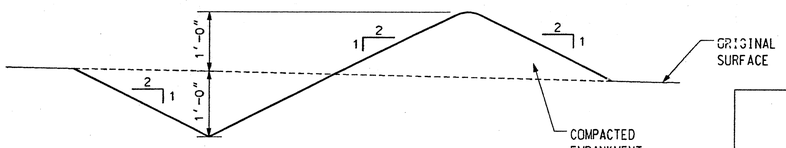
4. When blankets are spliced, place blankets end over end (shingle style) with 6-inch overlap. Staple through overlapped area, approximately 12 inches apart.

5. Lay blankets loosely and maintain direct contact with soil – do not stretch.



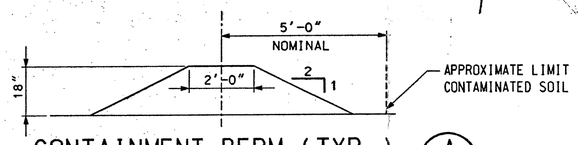
DITCH DETAIL (TYP.) 1 / 05-030

NOT TO SCALE



TEMPORARY DITCH DETAIL (TYP.) 2

NOT TO SCALE



CONTAINMENT BERM (TYP.) A

NOT TO SCALE

NOTES

1. RETAIN AND PROTECT ALL TREES EXCEPT AS NOTED.
2. LEVEL WORK AREA AS NEEDED.
3. OUTFALL LOCATION, EXCAVATION AND RESTORATION IS NOT PART OF THIS DESIGN.
4. OUTFALL REMEDIATION IS ADDRESSED IN THE VOLUNTARY CORRECTIVE MEASURES PLAN.
5. SEE SHEET 05-011 AND 05-012 FOR ACCESS ROAD PLAN AND DETAILS.
6. RADIOLOGICAL CONTROL AREA (RCA) SHALL BE FENCED WITH TEMPORARY ORANGE CONSTRUCTION FENCING, RETAINED EXISTING RCA FENCE, AND/OR OTHER MATERIAL APPROVED BY GEOTECHNICAL ENGINEER.
7. STOCKPILE AREA LOCATIONS ARE APPROXIMATE. CONTRACTOR MAY MAKE MINOR CHANGES IN THE LOCATION WITH THE APPROVAL OF THE GEOTECHNICAL ENGINEER.
8. OTHER TREES ARE PRESENT WITHIN THE RCA THAT REQUIRE CLEARING TO ACCOMODATE STOCKPILE AREAS.

REFERENCE:
VOLUNTARY CORRECTIVE MEASURES PLAN FOR SOLID WASTE MANAGEMENT UNIT 21-011(K) AT TECHNICAL AREA 21.

LEGEND:

- CLEAN SOIL STOCKPILE AREA
- CONTAMINATED SOIL STOCKPILE AREA (COVERED STOCKPILE)
- PUGMILL AREA
- CONTAINMENT BERM
- STORMWATER DITCH
- SILT FENCE OR SEDIMENT TRAP

0ft 10 30 60 90 120ft
SCALE IN FEET

NO	DATE	CLASS REV	DESCRIPTION	DWN	VER	CHKD	SUB	APP
C	06/17/02		REISSUE FOR 90% REVIEW	RPP				
B	05/29/02		90% REVIEW	RPP	JB	KLO		
A	05/15/02		30% REVIEW	RPP	RER	JB		

Washington
ENERGY and ENVIRONMENT
720 PARK BLVD. BOISE, IDAHO 83712

PRS 21-011(1)
VOLUNTARY CORRECTIVE MEASURE

SITE LAYOUT

DRAWN	RPP
DESIGN	RER
CHECKED	JB
DATE	05/06/02

CATEGORY: DCE

SUBMITTED: WGII PROJECT MANAGER; WGII QA MANAGER
LANL PROJECT TEAM LEADER; LANL QA PROJECT TEAM LEADER

environmental restoration project
A Department of Energy Environmental Cleanup

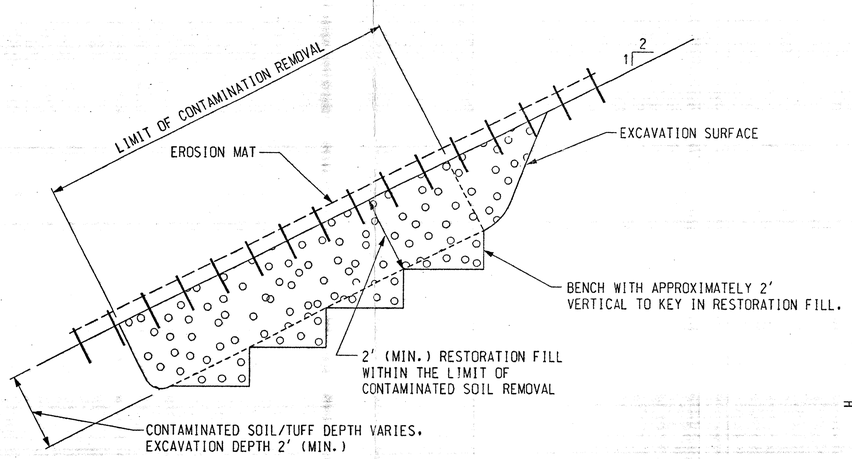
10646-A

SHEET
OF

CLASSIFICATION
REVIEWER
DATE

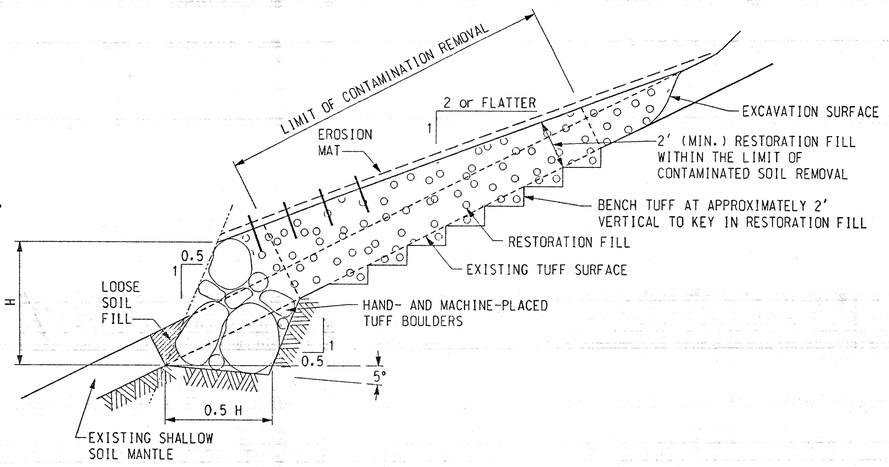
CODE 23448-0019-06
DRAWING NO 05-010
REV C

MICROSTATION DWG NO. W023448/TASK0019/05-010.DGN PLOTDATE: 06/17/02



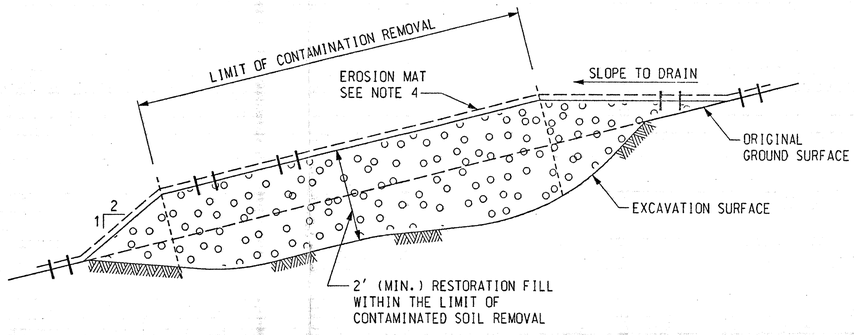
TYPICAL RESTORATION COVER DETAIL FOR SOIL OR TUFF EXCAVATION ON 2:1 SLOPE

NOT TO SCALE



TYPICAL RESTORATION COVER DETAIL FOR THIN SOIL OR EXPOSED TUFF ON SLOPES STEEPER THAN 2:1

NOT TO SCALE



TYPICAL RESTORATION COVER DETAIL FOR SOIL OR TUFF EXCAVATION ON SLOPES FLATTER THAN 2:1

NOT TO SCALE

GENERAL NOTES

1. SEE SPECIFICATION 02322 FOR SHORING AND BRACING REQUIREMENTS OF EXCAVATIONS. EXCAVATIONS AS SHOWN ON THIS DRAWING WILL GENERALLY PRECLUDE MANNED ENTRY INTO EXCAVATION WITHOUT PROPER SHORING (NONE SHOWN).
2. EROSION MAT SHALL BE JUTE MATTING OR EQUAL PER SPECIFICATION 02600.
3. EXTEND EROSION MAT 2' (MIN.) BEYOND LIMIT OF DISTURBED AREA.
4. PLACE AND PIN EROSION MAT TO GROUND SURFACE WITH METAL SPIKES PER MFG. RECOMMENDATIONS.
5. OUTFALL LOCATION, EXCAVATION AND RESTORATION IS NOT PART OF THIS DESIGN.
6. OUTFALL REMEDIATION IS ADDRESSED IN THE VOLUNTARY CORRECTIVE MEASURES PLAN.

REFERENCE:
VOLUNTARY CORRECTIVE MEASURES PLAN FOR SOLID WASTE MANAGEMENT UNIT 21-011(K) AT TECHNICAL AREA 21.

NO	DATE	CLASS REV	DESCRIPTION	DWN	VER	CHKD	SUB	APP
C	06/12/02		REISSUE FOR 90% REVIEW	RPP	RER	JB		
B	05/29/02		90% REVIEW	RPP	JB	KLO		
A	05/15/02		30% REVIEW	RPP	RER	JB		

Washington
ENERGY and ENVIRONMENT
720 PARK BLVD. BOISE, IDAHO 83712

PRS 21-011(k)
VOLUNTARY CORRECTIVE MEASURE

RESTORATION COVER
SECTIONS AND DETAILS

CATEGORY: DCE

DRAWN	RPP
DESIGN	RER
CHECKED	JB
DATE	05/06/02

SUBMITTED: WGII PROJECT MANAGER; WGII QA MANAGER; LANL PROJECT TEAM LEADER; LANL QA PROJECT TEAM LEADER

DOE Environmental Restoration project
A Department of Energy Environmental Cleanup

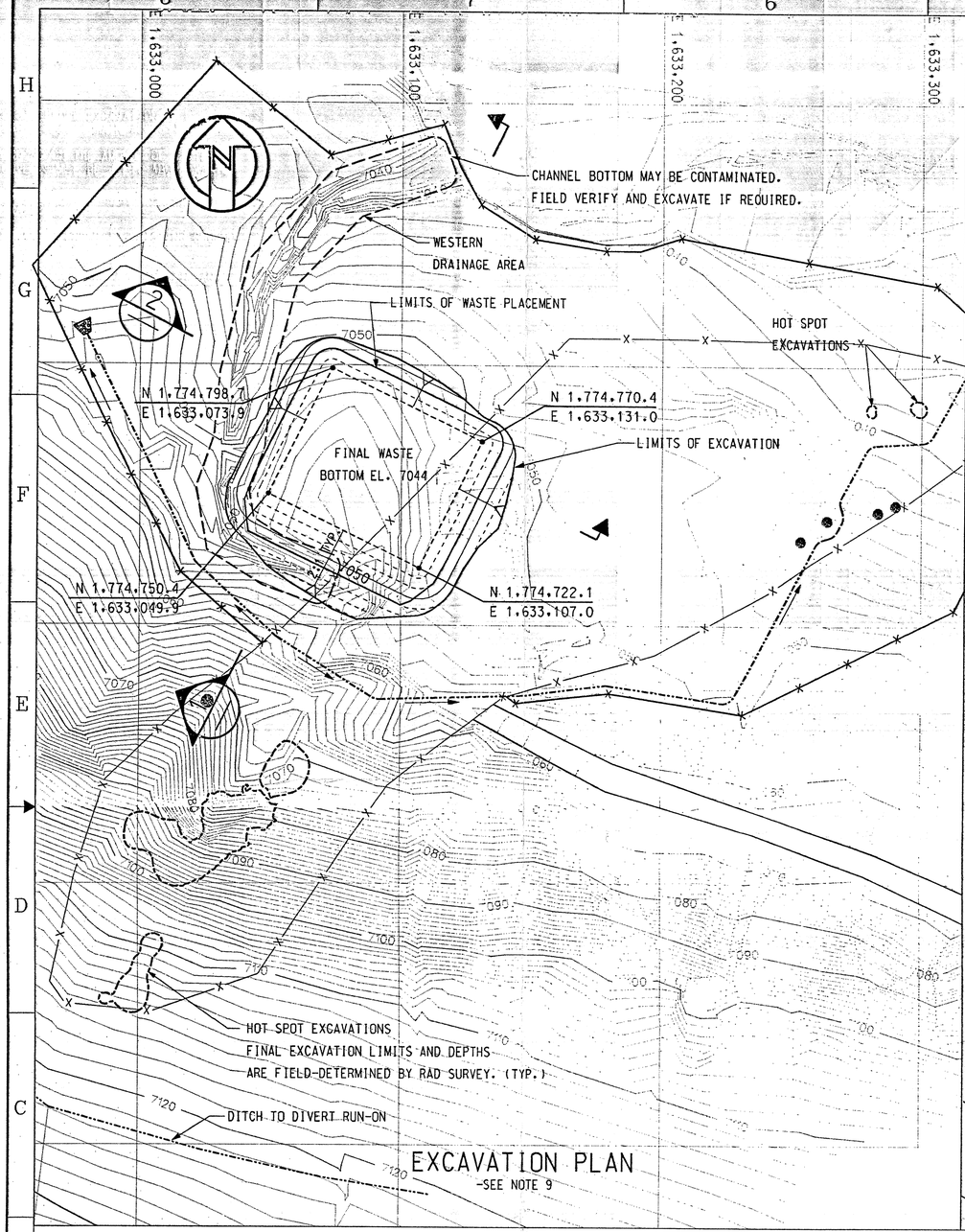
10646-B

SHEET
OF

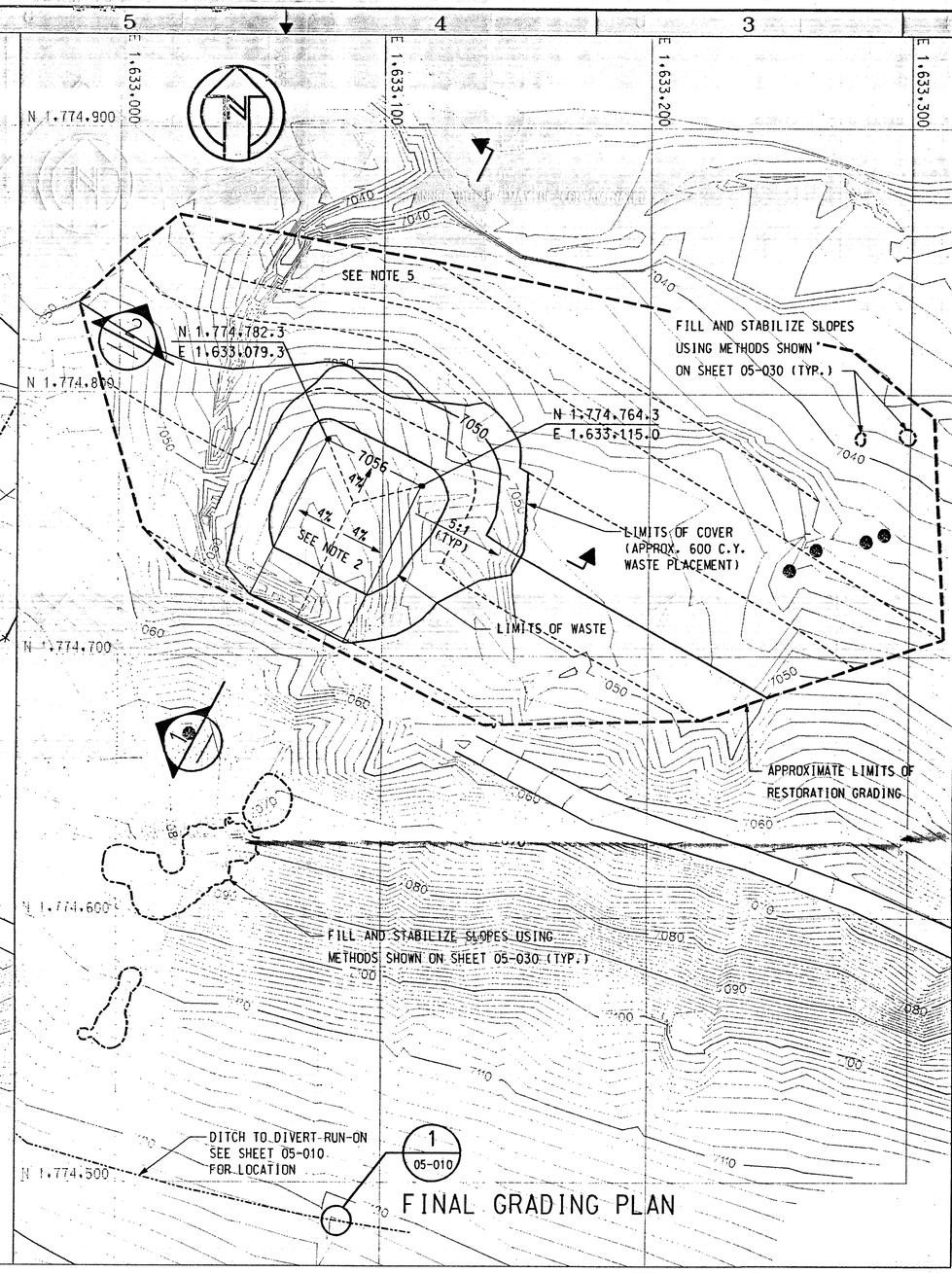
CLASSIFICATION | REVIEWER | DATE

CODE 23448-0019-06 | DRAWING NO 05-030 | REV C

MICROSTATION DWG NO. W023448/TASK0019/05-030.DGN PLOTDATE: 06/12/02



EXCAVATION PLAN
-SEE NOTE 9



FINAL GRADING PLAN

NOTES

1. RESTORE ACCESS RAMPS AND ROADS TO SIDESLOPE EXCAVATIONS USING METHODS SHOWN ON SHEET 05-030. (EXCEPT MAIN ACCESS)
2. ELEVATION OF COVER WILL VARY DEPENDING ON THE AMOUNT OF WASTE PLACEMENT. MINIMUM THICKNESS OF COVER SHALL BE 4 FT. ABOVE WASTE.
3. ALL SHARP CORNERS OR INTERSECTIONS ON CONTOURS SHALL BE SMOOTHED WITH CURVES TO AVOID FLOW CONCENTRATION.
4. DESIGN CONTOUR LINES SHALL BE TIED AND BLENDED TO EXISTING GROUND CONTOUR LINES ALONG DISTURBED AREA BOUNDARIES.
5. OUTER LIMITS OF FINAL SITE GRADING CONTOURS ARE APPROXIMATE AND SHOULD MATCH EXISTING GRADE AS APPROVED BY THE ENGINEER.
6. RESTORE HOT SPOT EXCAVATION AREAS WITH APPROPRIATE TECHNIQUE DEPICTED ON DRAWING 05-030.
7. OUTFALL LOCATION, EXCAVATION AND RESTORATION IS NOT PART OF THIS DESIGN.
8. OUTFALL REMEDIATION IS ADDRESSED IN THE VOLUNTARY CORRECTIVE MEASURES PLAN.
9. EXCAVATION FOR PUGMILL PAD IS NOT SHOWN.

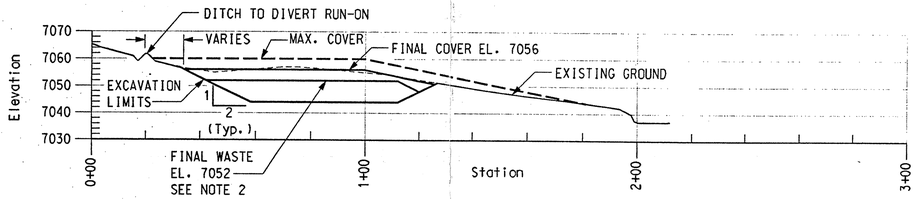
REFERENCE:
VOLUNTARY CORRECTIVE MEASURES PLAN FOR SOLID WASTE MANAGEMENT UNIT 21-011(K) AT TECHNICAL AREA 21.

LEGEND

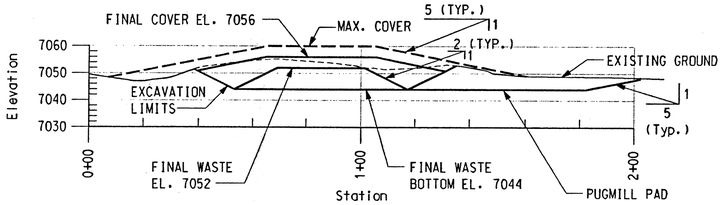
EXCAVATION LIMITS BASED ON FIELD SCANS - LOCATION SHOWN IS APPROXIMATE.

RESTORATION GRADING LIMITS

0ft 10 30 60 90 120ft
SCALE IN FEET



SECTION 1
AS SHOWN



SECTION 2
AS SHOWN

NO	DATE	CLASS REV	DESCRIPTION	DWN	DES	CHKD	SUB	APP
C	06/17/02		REISSUE FOR 90% REVIEW					
B	05/29/02		90% REVIEW	RPP				
A	05/15/02		30% REVIEW	RPP				

Washington
ENERGY and ENVIRONMENT
720 PARK BLVD. BOISE, IDAHO 83712

PRS 21-011(k)
VOLUNTARY CORRECTIVE MEASURE
EXCAVATION & FINAL GRADING PLAN
AND
CROSS SECTIONS

DRAWN	RPP
DESIGN	JB
CHECKED	JB
DATE	05/06/02

CATEGORY: DCE

SUBMITTED: WGII PROJECT MANAGER; WGII QA MANAGER; LANL PROJECT TEAM LEADER; LANL QA PROJECT TEAM LEADER

DOE Environmental Restoration Project
A Department of Energy Environmental Cleanup

10646-C

SHEET
OF

CLASSIFICATION | REVIEWER | DATE

CODE 23448-0019-06 | DRAWING NO 05-031 | REV C

MICROSTATION DWG NO. W023448/TASK0019/05-031.DGN PLOTDATE: 06/17/02

6. Staple blankets sufficiently to anchor blanket and maintain contact with soil. Place staples down the center and staggered with the staples placed along the edges. Steep slopes (1:1 – 2:1) require 2 staples per square yard. Moderate slopes (2:1 – 3:1) require 1 to 2 staples per square yard. Gentle slopes require 1 staple per square yard. Use a common row of staples on adjoining blankets.

D. Use wood stakes on tuff slopes, in place of wire staples. Use same installation rate as for staples. Drive stakes in perpendicular to slope and leave 2 inches exposed above soil grade.

3.6 BONDED FIBER MATRIX (BFM): Slopes 2:1 and Steeper, Irrigated and Non-Irrigated Projects

A. Hydraulically apply BFM over seeded area (or apply seed with a tracer amount, 200-300 lbs/ acre) immediately following raking/chaining operations and in accordance with manufacturer's specified procedures. Hydraulically apply BFM as a viscous mixture. Upon drying, it shall form a continuous, porous and erosion resistant mat. Upon drying, matrix shall not inhibit germination and growth of plants in and beneath the layer. Matrix shall retain its form despite re-wetting.

B. Apply matrix uniformly across area and apply in multiple directions to ensure a 100 percent soil surface coverage.

C. Apply at a rate of approximately 3,500-lbs/ acre in a manner that achieves uniform coverage of all exposed soils.

D. Prohibit vehicle traffic on hydraulic BFM applications.

3.7 WATERING

A. Where temporary watering is required for seeded areas, provide temporary water system which may be a sprinkler system, or a water truck with a spray boom or any other method satisfactory to distribute a uniform coverage of clean water (free or oil, acid, salt or other substances harmful to plants) to previously seeded and mulched areas.

B. If a temporary sprinkler system is used, keep all pipe connections tight to avoid leakage and loss of water, and to prevent washing or erosion of growing areas. Maintain sprinklers in proper working order during watering.

C. Do not drive trucks with spray systems on seeded areas and ensure water force does not cause movement of mulch or seed on the ground.

D. Water revegetated areas only if areas were planted between April 15 and July 31.

E. Apply water at a maximum of 1/2 inch/hour for 2 hours. Additional applications of water may be made as designated by LANL Construction Inspector. Water source will be approved by LANL, prior to use.

3.8 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain seeded areas for not less than 60 days after final acceptance of work and longer as required to achieve final stabilization as described in Section 3.10 ACCEPTANCE.

C. Reseed void areas greater than 6 square feet or repetitive voids greater than 2 square feet amounting to more than 10 percent of any area that appears the growing season following installation.

D. Keep revegetated areas free of noxious weeds until acceptance by LANL. Contact LANL Construction Inspector prior to application of any control measure.

3.9 CLEANUP AND PROTECTION

A. After completion of work, clear site of excess soil, waste material, debris and objects that may hinder maintenance and detract from neat appearance of site.

B. Protect work and materials from damage due to seeding operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged work as directed.

3.10 ACCEPTANCE

A. Seeded areas will be reviewed for acceptance by LANL when final stabilization has been achieved. Final stabilization is defined as "All soil disturbing activities at the site have been completed and a uniform (e.g., evenly distributed, without large bare areas) perennial vegetative cover with a density of 70 percent of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed."

B. In the event that all other work required by the Contract is completed before final stabilization is achieved or because seasonal limitations prevent seeding, partial acceptance of the work shall be made with final acceptance delayed until satisfactory vegetative growth has been established.

END OF SECTION

Attachment 6

Notice of Intent
Application for Pug Mill

Los Alamos
NATIONAL LABORATORY

Risk Reduction & Environmental Stewardship Division
Meteorology & Air Quality Group
PO Box 1663, MS J978
Los Alamos, New Mexico 87545
(505) 665-8855/Fax: (505) 665-8858

Date: June 19, 2002
Refer to: RRES-MAQ:02-216

Mr. Ted Schooley
New Mexico Environment Department
Air Quality Bureau, Enforcement Section
2048 Galisteo Street
Santa Fe, New Mexico 87505

Mr. Vince Vigil
New Mexico Environment Department
Air Quality Bureau, Enforcement Section
2048 Galisteo Street
Santa Fe, New Mexico 87505

Mr. Lester Drapela
New Mexico Environment Department
Air Quality Bureau, New Source Review Section
2048 Galisteo Street
Santa Fe, New Mexico 87505

Gentlemen:

We would like to inform NMED of an Environmental Restoration project that will take place at Technical Area 21 at Los Alamos National Laboratory (LANL) this year. The project plan is to solidify and stabilize contaminated soil. The project goal is to achieve source reduction and control, radionuclide dose reduction, and prevention of subsequent contaminant migration from contaminated soil. Equipment will be used to excavate contaminated soil; screen for size of soil particles; perform size reduction of soil particles; measure and deliver cement, bentonite, and water; mix aggregate; and transfer materials. The equipment is scheduled to be on site for 30 days and to be in use for up to 65 hours. To allow operational flexibility and schedule contingencies, we have assumed that the equipment could be on site for up to 11 weeks. Air emissions will be minimized with the implementation of mitigation measures including the use of water spray on the contaminated soil.

Approximately 500 yd^3 of contaminated soil will be excavated for processing. The soil will be transferred to a screening and crushing mechanism. Then the soil will be transferred to a mixing unit (pug mill) that also receives water, cement and bentonite. After proper mixing, the mixture will be placed and left to solidify in a designated on-site pit. This pit, upon completion of the stabilization and solidification process, will be backfilled and revegetated. Process equipment will be powered with a 238.5 kw diesel generator. The generator will have a small fuel tank.

The pug mill will be operated at 10 yd^3 per hour feed rate of contaminated soil. If the project goes as planned, the stabilization and solidification should be completed in 4 weeks with a work schedule of 8 hours per day and 5 days per week. The pug mill is being leased for 1 month from Rapid International LTD. It is anticipated that the project could start as early as July 22nd. Worst case emissions, assuming 11 weeks of operations, have been estimated to

be 4.7 lb/hr (1.9 ton/yr) of particulate matter, 4.3 lb/hr (1.7 ton/yr) of nitrogen oxides, and less than 1 lb/hr (0.4 ton/yr) of all other regulated air pollutants.

The Environmental Restoration activities are part of a voluntary corrective action for Potential Release Site (PRS) 21-011(k). The soil, tuff, and sediment at the PRS 21-011(k) site were exposed to treated liquid radioactive waste effluent as the outfall for the industrial wastewater from one of the old wastewater treatment plants. Radionuclides measured in the soil, at levels above background values, include Cs-137, Am-241, U-234, and Pu-238/239. In addition, the area is contaminated with metals, some of which are listed as Toxic Air Pollutants (TAPs) under 20 NMAC 2.72.501. However, hourly emission estimates of all TAPs are below the TAP thresholds.

LANL will comply with the requirements of 40 CFR 61, Subpart H – National Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. Based on the CAP88 modeling results of estimate emissions, the potential effective dose equivalent from the source at the nearest off-site receptor is 0.014 mrem/yr. The estimated project dose is below the monitoring threshold of 0.1 mrem/yr. Therefore, radionuclide air emissions monitoring is not required. However, the project will be reported in LANL's annual report for *Radionuclide Air Emissions* to EPA as new construction.

Based on phone conversations between Mr. Drapela and Jackie Hurtle (LANL Meteorology and Air Quality Group), we understand that no construction permit is required for short term temporary use of these pieces of equipment for environmental restoration. However, this notice of intent application is being submitted so that NMED will have the relevant information.

If you have any questions or comments regarding this submittal or would like to discuss this in greater detail please feel free to contact me (505-665-8862) or Jackie Hurtle (505-665-4380).

Sincerely,

Scott Miller
Meteorology and Air Quality Group
Deputy Group Leader

Cy:
S. Fong, DOE-LAAO, A316
Beverly Ramsey, RRES-DO, J591
Doug Stavert, RRES-DO, J591
J. Hurtle, RRES-MAQ, J978
H. Kopp, RRES-SWRC, M992
J. Hopkins, RRES-R, M992
D. Woitte, LC/GL, A187
D. McInroy, RRES-R, M992
RRES-MAQ Project File
ESH-ID File 02-0005
RRES-MAQ File

Mail Application To:		**Application No.** _____
New Mexico Environment Department Air Quality Bureau New Source Review Unit 2048 Galisteo Santa Fe, NM 87505 Phone (505) 827-1494 http://www.nmenv.state.nm.us		**AIRS No.** _____ - _____ - _____ ***For NMED use only***

Air Quality Permit Application And Notice Of Intent
For Hot Mix Asphalt Facilities

Acknowledgement: I acknowledge that a pre-application meeting is available to me upon request

Filing Fee: Permit filing fee enclosed, Check No.: _____N/A_____

Part I – General Information

I-A: Company Information

1	Company name: University of California for the U. S. Department of Energy		Date application notarized: June 19, 2002
2	Facility name: Los Alamos National Laboratory		SIC code (4 digits): 9711
3	Company mailing address: Meteorology and Air Quality Group, PO Box 1663, MS J978, Los Alamos, New Mexico, 87545		
4	Contact person: Scott Miller		Title: Deputy Group Leader
5	Phone No: (505) 665-8862	Fax No: (505) 665-8858	e-mail: s_miller@lanl.gov

I-B: Current Facility Status

1	Application is for: New Facility or Revision Under 20 NMAC 2.72, Sec. 219 (cite paragraph): New Facility = Pug mill	
2	Has this facility already been constructed? Y e s XNo	If yes, is it currently operating in New Mexico? Y e s N o
3	Is the facility currently shut down? Y e s XNo	If yes, give month and year of shut down (MM/YY):
4	Was this facility constructed before 1972 and operated since 1972? Ye s XNo	
5	Does this facility have an operating permit under 20 NMAC 2.70? Ye s XNo	If yes, the permit No. is: P
6	Has this facility received a No Permit Required (NPR) letter? Ye s XNo	If yes, date of NPR letter is:
7	Has this facility been issued a Notice of Intent (NOI)? Y e s XNo	If yes, the NOI Number is:
8	Does this facility have a construction permit (20 NMAC 2.72, Section 200.A or 200.B) Yes XNo	
•	If yes, the permit No. is:	
9	Has this facility been issued a general permit (GCP-1, GCP-2,...)? Ye s XNo	If yes, the registration No. is:
10	Is this a "major source" under the PSD rules? Y e s XNo Un s ure.	Is this a "major source" under Title V (20 NMAC
•	2.70)? Yes XNo Unsure.	Is this a major modification under the PSD rules (20 NMAC 2.74)? Ye s XNo Un s ure.
11	If *Yes* or *Unsure* to any of the questions in question No. 10, contact the AQB to see if a pre-application meeting is required.	

Table I-B: Current Facility Status (continued)

12	What is the facility's maximum input capacity, specify units (reference here and list capacities in Attachment L if more room is required)			
•	Current	Hourly: 300 Tons	Daily: 2400 Tons	Annually: 600,000* Tons
•	Proposed	Hourly: 10 Tons	Daily: 80 Tons	Annually: 4240** Tons
13	What is the facility's maximum production rate, specify units (reference here and list capacities in Attachment L if more room is required)			
•	Current	Hourly: 400 Tons	Daily: 3,200 Tons	Annually: 800,000* Tons
•	Proposed	Hourly: 15 Tons	Daily: 120 Tons	Annually: 6,360** Tons

*Assumes 50 weeks per year and 5 days per week, ** Assumes 53 work days

Table I-C: Facility Location Information

1	Section: 14	Range: 6E	Township: 19N	County: Los Alamos	Elevation (ft): 7200
2	UTM Zone: 12 or 13	UTMH (record to one tenth of a km):		UTMV (record to one tenth of a km):	
OR	Latitude (deg., min., sec.): 35 52' 38''N			Longitude (deg., min., sec.): 106 16' 28''W	
3	Name and zip code of nearest New Mexico town or tribal community: 87544				
4	Distance and direction from nearest New Mexico town or tribal community with detailed driving instructions (attach a road map if necessary): From the intersection of Trinity Drive and DP Road, the site is 1 mile down DP Road within Technical Area 21 of Los Alamos National Laboratory.				
5	Status of land at facility (check one): P rivate I ndian/Pueblo XGovernment				
6	Name of nearest Class I area to the facility (see Figure 1.0): Bandelier Wilderness				
7	Shortest distance from facility boundary to the boundary of the nearest Class I area (record to the nearest km): 8 km				

Table I-D: Proposed Operating Schedule (Note: the operating schedule (D1, D2) shall become a condition of the permit)

1	Facility **maximum** operating ($\frac{hours}{day}$): =12	($\frac{days}{week}$): =6	($\frac{weeks}{year}$): =11	($\frac{hours}{year}$):792	
2	Facility's maximum daily operating schedule (if less than 24 $\frac{hours}{day}$)? Start: 6:00 AM	X AM PM	End: 7:00 PM	☐AM XPM	
3	Month and year of anticipated start of construction: July, 2002				
4	Month and year of anticipated construction completion: September, 2002				
5	Month and year of anticipated startup of new or modified facility: July 2002				
6	Will this facility operate at this site for more than one year? Ye s XNo				

Table I-E: Other

1	Is this application in response to a Notice of Violation (NOV)? Ye s XNo	
•	If yes, NOV date:	NOV Tracking No:
2	Is air quality dispersion modeling being submitted with this application? XYes No	
3	Does this facility require an "Air Toxics" permit under 20 NMAC 2.72, Part IV, Tables A and/or B in Part V? Yes XNo	
4	Will this facility be a major source of federal Hazardous Air Pollutants? Ye s XNo	
•	If yes, list applicable subparts in 40 CFR 61 and/or 63:	

Part II – Required Attachments

The following Attachments are required, please label each accordingly. A complete application shall include:

Attachment A√ A process flow sheet and/or block diagram indicating the individual equipment, all emission points and types of control applied to those points. Numbering system should cross reference with Attachment B.

Attachment B√ A plot plan drawn to scale, showing emissions points, structures, tanks, and fences of property owned, leased, or under direct control of the applicant.

Attachment C√ All calculations used to determine both the hourly and annual controlled and uncontrolled emission rates. Reference where emission factors were obtained. If identical units are being permitted and will be subject to the same operating conditions, submit calculations for only one unit and a note specifying what other units the calculations represent.

Attachment D√ Information Used to Determine Emissions

- If manufacturer data are used, include specifications for emissions units and control equipment.
- If test data are used, include a copy of the complete test report. If the test data are for an emissions unit other than the one being permitted, the emission units must be identical. Test data may not be used if any difference in operating conditions of the unit being permitted and the unit represented in the test report significantly affect emission rates.
- If the most current copy of AP-42 is used, reference the section and date located at the bottom of the page. Include a copy of the page containing the emissions factors, and clearly mark the factors used in the calculations.
- If an older version of AP-42 is used, include a complete copy of the section.
- If an EPA document or other material is referenced, include a complete copy.
- Fuel specifications sheet.
- If computer models are used to estimate emissions, include an input summary and a detailed report, and a disk containing the input file(s) used to run the model.

Generator Data

Attachment E√ A map such as a USGS 7.5 minute topographic quadrangle showing the exact location of the facility. The map shall also include the following:

The UTM or Longitudinal coordinate system on both axes	An indicator showing which direction is north
A minimum radius around the facility of 5 km (3.1 miles)	The nearest occupied structure within 5 km
Topographic features of the area	Access and haul roads
The name of the map	Facility property boundaries
A scale	The area which will be restricted to public access

Attachment F Proof of public notice; Include a copy of the certified letter receipts, a list of the places where the public notice has been posted, and: (see guidance document)

a sample of the letters sent to land owners	a sample and verification of the local postings
a sample of the letters sent to municipalities	a copy of the display ad and its affidavit of publication
a copy of the announcement sent to a local radio station	a copy of the classified ad and its affidavit of publication

Not Applicable

Attachment G√ A written description of the routine operations of the facility. Include a description of how each piece of equipment will be operated, how controls will be used, and the fate of both the products and waste generated. For modifications and/or revisions, explain how the changes will affect the existing process.

Attachment H√ A PSD applicability determination for the facility. For PSD facilities applying for a significant permit revision, use the procedures for determining the net emissions change at a facility as specified by Table A-5 (Page A.45) of the EPA New Source Review Workshop Manual to determine if the revision is subject to PSD review.

Attachment I√ A discussion demonstrating compliance with each applicable state & federal regulation. If there is a state or federal regulation for your facility's source category that does not apply to your facility, explain why. For example 40 CFR 60 Subpart OOO (crushers), 40 CFR 63 Subpart HHH (HAPs), or 20 NMAC 2.74 (PSD major sources).

Attachment J A preliminary operational plan defining the measures to be taken to mitigate facility emissions during malfunction, startup, or shutdown.
Not Applicable

Attachment K√ An air quality dispersion modeling demonstration (if applicable) as outlined in the Air Quality Bureau's *Dispersion Modeling Guidelines*. Model asphalt fumes if the estimated emissions exceed 0.333 pounds per hour according to 20 NMAC 2.72.403.A; see instructions.

Attachment L√ Other relevant information. Use this attachment to clarify any part in the application that you think needs explaining. Reference the section, table, column, and/or field.
Allu Bucket and Pug Mill Information

Submit the original signed and notarized copy of the application package and;

1) One working copy for department use, and
2) One copy if air dispersion modeling is included (include one (1) set of disks with input and output files), and
3) One copy if public notice was required, and
4) If subject to PSD review under 20 NMAC 2.74 (PSD) one copy for US EPA, one copy for each federal land manager affected (NPS, USFS, USFWS), and one copy for each affected regulatory agency other than the Air Quality Bureau.

Part III – Specific Facility Information

Table III-A: Plant Information

Plant capacity (product produced)	400	tons/hr	Area of disturbed earth	3	acres
Material moisture content (default 2%)[1]	2	%	Area of storage pile & operations	1.5	acres
Area with restricted public access	3	Acres	Electrical power required	238.5	kW
Hydrated lime, maximum (% by weight)	N/A	%	Direct drive power required	320	HP
Facility Type: ☐ Drum, X Batch			Dryer Fuel (specify): N/A		
Dryer Control(s): ☐ Baghouse, ☐ Wet Scrubber, ☐ Cyclone N/A					
Was the disposal of particulate matter collected from control equipment accounted for in Attachment G? Yes XNo					

[1] If a moisture content greater than the default is used, an independent lab analysis using appropriate ASTM testing methods shall be included in Attachment C.

Table III-B: Equipment Summary List

Equipment	Number of Units	Equipment	Number of Units
Power Generators/Engines	1	Conveyors, Transfers, Elevators	1
Silos	1	Pug mills	1
Screens	Size Reduction/Screening Performed w/ Loader & Attachment	Burner/Dryer	0

Table III-C: Process Equipment Information (use additional sheets if necessary)

Unit No.	Process Control Component Description	Serial Number / Mfg. Model No.	Date of Manufacture (MM/DD/YY)	Nameplate / Site Rating	Stack Exit Conditions (for engine, dryers, ...) Height (ft)	Inside Diameter or L × W (ft)	Velocity (ft/sec)	Temp (°F)
1	Rapid Mix 400 Pug Mill	RMX4010256 / Rapid Mix 400	06/25/01	Production rate / 400 tons/hr	N/A	N/A	N/A	N/A
2	Generator	WR462N1302551 / Perkins GCD230A	06/19/01	238.5 kw / 320 HP	13.4	0.2	1380	975
3	Reverse Jet Dust Collector	N/A / N/A	06/25/01	N/A / N/A	44.3	0.2	N/A	Amb.
4	Cement Silo	N/A / N/A	06/25/01	Capacity / 40 tons	44.3	N/A	N/A	Amb.

Table III-D: Storage Tank Information (Note: This data will be used to determine 40 CFR 60 Subpart Kb applicability) (Use additional sheets if necessary)

Tank No.	Materials Stored	Date Installed (MM/DD/YY)	Capacity (bbl)	Capacity (M^3)	Diameter (M)	Height (M)	True Vapor Pressure (kPa)	*Project* Through-puts (gal)	*Project* Turnovers
	Diesel	7/15/02	3.2	0.38	0.73	0.9	0.13 @ 20 C	700	7

Part IV – Emissions Calculations

Table IV-A: TSP Road Emissions [AP-42, Fifth Edition, Volume I, CHAPTER 13, Miscellaneous Sources, 13.2.2 Unpaved Roads (Supplement E)]

Variable →	T	L	VMT	W		E*	PER	EF	PTE
Road Segment	Average Number of Round Trips per Hour	One way road length (miles)	Vehicle Mile Traveled Per Hour (miles/hr)	Average (Full + Empty)/2 Vehicle Weight (tons)	Average Load Weight (tons)	TSP Emission Rate (lb/VMT)	TSP Emission Rate (lb/hr)	Haul Road Control Efficiency (Table 4-B)	Hourly TSP PTE (lb/hr)
TSP Loader			0.24			10.98	2.67		1.05
	6	0.02	2 × T × L = VMT	15.7	2.7	$2.77 \times W^{0.5} = E^*$	VMT × E = PER	0.40	PER × EF = PTE
TSP Truck			0.08			13.40	1.07		0.43
	2	0.02	2 × T × L = VMT	23.4	10	$2.77 \times W^{0.5} = E^*$	VMT × E = PER	0.40	PER × EF = PTE
TSP									
			2 × T × L = VMT			$2.77 \times W^{0.5} = E^*$	VMT × E = PER		PER × EF = PTE
							3.74	← Sum →	1.48

PM10 Road Emissions [AP-42, Fifth Edition, Volume I, CHAPTER 13, Miscellaneous Sources, 13.2.2 Unpaved Roads (Supplement E)]

Variable →	T	L	VMT	W		E*	PER	EF	PTE
Road Segment	Average Number of Round Trips per Hour	One way road length (miles)	Vehicle Mile Traveled Per Hour (miles/hr)	Average (Full + Empty)/2 Vehicle Weight (tons)	Average Load Weight (tons)	PM10 Emission Rate (lb/VMT)	PM10 Emission Rate (lb/hr)	Haul Road Control Efficiency (Table 4-B)	Hourly PM10 PTE (lb/hr)
PM10 Loader			0.24			2.42	0.58		0.23
	6	0.02	2 × T × L = VMT	15.7	2.7	$0.805 \times W^{0.4} = E^*$	VMT × E = PER	0.40	PER × EF = PTE
PM10 Truck			0.08			2.84	0.23		0.09
	2	0.02	2 × T × L = VMT	23.4	10	$0.805 \times W^{0.4} = E^*$	VMT × E = PER	0.40	PER × EF = PTE
PM10									
			2 × T × L = VMT			$0.805 \times W^{0.4} = E^*$	VMT × E = PER		PER × EF = PTE
							0.81	← Sum →	0.32

*E = k x (s/12)^a x (W/3)^b / (Mdry/0.2)^c = lbs/VMT, where Mdry = 0.2%, , AP-42, Section 13.2.2 (9/98) Equations 1 & 2

Table IV-B: Haul Road Control Methods and Control Factors

Control Method	Efficiency	Efficiency Factor (EF)	Control Method	Efficiency	Efficiency Factor (EF)
Base Course or Watering	60%	0.40	Base Course and Surfactants	90%	0.10
Base Course and Watering	80%	0.20	Paved and Swept	95%	0.05

Table IV-C: Emissions to Atmosphere (Before Control Measures) (Use additional sheets of necessary)

☐ **By checking the box, I acknowledge that 20 NMAC 2.72 is applicable to this facility and choose not to fill out this page.**

Unit No.	Process or Operation	TSP (lbs/hr) (ton/yr)	PM10 (lbs/hr) (ton/yr)	NO_X (lbs/hr) (ton/yr)	CO (lbs/hr) (ton/yr)	VOC (lbs/hr) (ton/yr)	SO_2 (lbs/hr) (ton/yr)	Asphalt Fumes (lbs/hr) (ton/yr)	Estimation Method
Dryer									Manufacture AP-42 ____ Test
Gen/Eng No. 1	Perkins generator[E]	0.16	0.16	4.3	0.68	0.21	0.66	N/A	XManufacture X AP-42 Sec. 3.3 for SOx
		0.063	0.063	1.7	0.27	0.082	0.26	N/A	
Gen/Eng No. 2									Manufacture AP-42 ____ Test
Screens: Fill in the sum of the screen processing rates and the annual operating hours, then solve		1.6	TSP(lb/hr) = 0.16(lb/ton) × 10 (sum of screen process rates) (ton/hr)						AP42 - 8.19 9/1985
		0.63	TSP(ton/yr) = 0.0005(ton/lb) × 1.6 (TSP(lb/hr)) (lb/hr) × 792[A] (hours per year) (hr/yr)						
Conveyors (Transfer): Fill in the sum of the transfer conveyor processing rates and the annual operating hours, then solve		0.43	TSP(lb/hr) = 0.029(lb/ton) × 15 (sum of conveyor process rates) (ton/hr)						AP42 - 8.19 9/1985
		0.17	TSP(ton/yr) = 0.0005(ton/lb) × 0.435 (TSP(lb/hr)) (lb/hr) × 792[B] (hours per year) (hr/yr)						
Road Emissions: Fill in sum of PER (lb/hr) (from table IV-A), annual operating hours, and then solve.		3.74	TSP(lb/hr) = 3.74 (sum of PER, from Table 4-A) (lb/hr)						AP42 - 13.2.2 9/1998
		1.2	[2]TSP(ton/yr) = 0.0005(ton/lb) × 3.74 (TSP(lb/hr)) (lb/hr) × 792[C] (hours per year) (hr/yr) × 0.81						
Aggregate Handling: fill in the plant capacity (ton/hr), annual operating hours, and then solve. **(Bentonite)**		0.01	[1]TSP(lb/hr) = 0.01 (lb/ton) × 1.50 (process rate) (ton/hr)						AP42 - 13.2.4 1/1995
		0.006	TSP(ton/yr) = 0.0005(ton/lb) × 0.015 (TSP(lb/hr)) (lb/hr) × 792[D] (hours per year) (hr/yr)						

[1] TSP (lb/hr) = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 x (plant capacity), AP-42, 1/95 Section 13.2.4 where U = 15 mph and M = 2%
[2] The annual haul road emission was multiplied by 0.81 to account for 70 rain days per year.

[A] Estimate of actual hours of operation to achieve project plan of 650 tons of contaminated soil is 65 hours
[B] Estimate of actual hours of operation to convey 975 tons of mixed material is 65 hours
[C] Estimate of actual hours of operation for transfer of contaminated soil and mixed materials (40-50 hours) and clean soil (128 hours) is less than 200 hours
[D] Estimate of actual hours of operation for loading bentonite is 43 hours
[E] Estimate of actual hours of operation is 65 hours

Table IV-D: Emissions to atmosphere (After Control Measures) (Use additional sheets of necessary)

Unit No.	Control Equipment Type	Control Equipment Manufacture and Model No.	TSP (lbs/hr) (ton/yr)	PM10 (lbs/hr) (ton/yr)	NO_X (lbs/hr) (ton/yr)	CO (lbs/hr) (ton/yr)	VOC (lbs/hr) (ton/yr)	SO_2 (lbs/hr) (ton/yr)	Asphalt Fumes (lbs/hr) (ton/yr)	Estimation Method
Dryer	N/A									Manufacture AP-42 ____ Test
Gen/Eng No. 1	N/A									Manufacture AP-42 ____ Test
Gen/Eng No. 2	N/A									Manufacture AP-42 ____ Test

Cement Silo: Fill in total number of lime silos and the annual operating hours then solve.	0.50	TSP(lb/hr) = 0.50 (lb/hr) × 1 (total number of silos) .	20% Opacity Based
	0.20	TSP(ton/yr) = 0.0005(ton/lb) × 0.50 (TSP(lb/hr)) (lb/hr) × 792[E] (hours per year) (hr/yr) .	
Pug Mills: Fill in total number of pug mills and the annual operating hours, then solve.	0.50	TSP(lb/hr) = 0.50 (lb/hr) × 1 (total number of pug mills) .	20% Opacity Based
	0.20	TSP(ton/yr) = 0.0005(ton/lb) × 0.50 (TSP(lb/hr)) (lb/hr) × 792[F] (hours per year) (hr/yr) .	
Screens: Fill in total number of screens and the annual operating hours, then solve.	N/A	TSP(lb/hr) = 0.50 (lb/hr) × ____ (total number of screens) .	20% Opacity Based
	N/A	TSP(ton/yr) = 0.0005(ton/lb) × ____ (TSP(lb/hr)) (lb/hr) × ____ (hours per year) (hr/yr) .	
Conveyors (Transfer): Fill in total number of transfer conveyors and the annual operating hours, then solve.	N/A	TSP(lb/hr) = 0.50 (lb/hr) × ____ (total number of transfers) .	20% Opacity Based
	N/A	TSP(ton/yr) = 0.0005(ton/lb) × ____ (TSP(lb/hr)) (lb/hr) × ____ (hours per year) (hr/yr) .	
Road Emissions: Fill in sum of PTE (lb/hr) (from table IV-A), annual operating hours, and then solve.	1.48	TSP(lb/hr) = 1.48 (sum of PTE from, Table 4-A) (lb/hr) .	AP42 - 13.2.2 9/1998
	0.59	[2]TSP(ton/yr) = 0.0005(ton/lb) × 1.48 (TSP(lb/hr)) (lb/hr) × 792[G] (hours per year) (hr/yr) × 0.81 .	
Aggregate Handling: Fill in the plant capacity (ton/hr), annual operating hours, and then solve.	N/A	[1]TSP(lb/hr) = 0.01 (lb/ton) × ____ (process rate) (ton/hr) .	AP42 - 13.2.4 1/1995
	N/A	TSP(ton/yr) = 0.0005(ton/lb) × ____ (TSP(lb/hr)) (lb/hr) × ____ (hours per year) (hr/yr) .	

[1]TSP (lb/hr) = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 x (plant capacity), AP-42, 1/95, Section 13.2.4 where U = 15 mph and M = 2%

[2] The annual haul road emission was multiplied by 0.81 to account for 70 rain days per year.
[E] Estimated silo will be filled for 6.5 hours at a rate of 20 tons per hour
[F] Estimate of actual hours of operation is 65 hours
[G] Estimate of actual hours of operation for transfer of contaminated soil and mixed materials (40-50 hours) and clean soil (128 hours) is less than 200 hours

Table IV-E: Emissions to atmosphere (After Control Measures) (Use additional sheets of necessary)

Type N/A	PM10 (lbs/hr) (ton/yr)		Estimation Method
Lime Silo: Fill in total number of lime silos and the annual operating hours then solve.	lb/hr	PM10 (lb/hr) = 0.50 (lb/hr) × _____. (total number of silos) .	20% Opacity Based
	ton/yr	PM10 (ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) (PM10(lb/hr)) (hours per year) .	
Pug Mills: Fill in total number of pug mills and the annual operating hours, then solve.	lb/hr	PM10 (lb/hr) = 0.50 (lb/hr) × _____. (total number of Pug Mills) .	20% Opacity Based
	ton/yr	PM10 (ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) (PM10 (lb/hr)) (hours per year) .	
Screens: Fill in total number of screens and the annual operating hours, then solve.	lb/hr	PM10 (lb/hr) = 0.24 (lb/hr) × _____. (total number of screens) .	20% Opacity Based
	ton/yr	PM10 (ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) (PM10 (lb/hr)) (hours per year) .	
Conveyors (Transfer): Fill in total number of transfer conveyors and the annual operating hours, then solve.	lb/hr	PM10 (lb/hr) = 0.24 (lb/hr) × _____. (total number of transfers) .	20% Opacity Based
	ton/yr	PM10 (ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) (PM10 (lb/hr)) (hours per year) .	
Road Emissions: Fill in sum of PTE (lb/hr) (from table IV-A), annual operating hours, and then solve.	lb/hr	PM10(lb/hr) = _____ (lb/hr) (PTE from, Table 4-A) .	AP42 - 13.2.2 9/1998
	ton/yr	[2]PM10(ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) ×0.81 (PM10 (lb/hr)) (hours per year) .	
Aggregate Handling: fill in the plant capacity (ton/hr), annual operating hours, and then solve.	lb/hr	[1]PM10 (lb/hr) = 0.005 (lb/ton) × _____ (ton/hr) (process rate) .	AP42 - 13.2.4 1/1995
	ton/yr	PM10 (ton/yr) = 0.0005(ton/lb) × _____ (lb/hr) × _____ (hr/yr) (PM10 (lb/hr)) (hours per year) .	

[1]PM10 (lb/hr) = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 x (plant capacity), AP-42, 1/95, Section 13.2.4 where U = 15 mph and M = 2%

[2]The annual haul road emission was multiplied by 0.81 to account for 70 rain days per year.

Part 5 – Certification

Company Name: University of California for the U. S. Department of Energy

I, _Scott Miller and David McInroy, hereby certify that the information and data submitted in this application are true and as accurate as possible, to the best of my knowledge and professional expertise and experience.

Signed this 19th_ day of June, 2002, upon my oath or affirmation, before a notary of the State of New Mexico.

Scott Miller — Date: 6/19/02
Deputy Group Leader of the Meteorology and Air Quality Group

David McInroy — Date: 6/19/02
Acting Program Manager of the Environmental Restoration Project

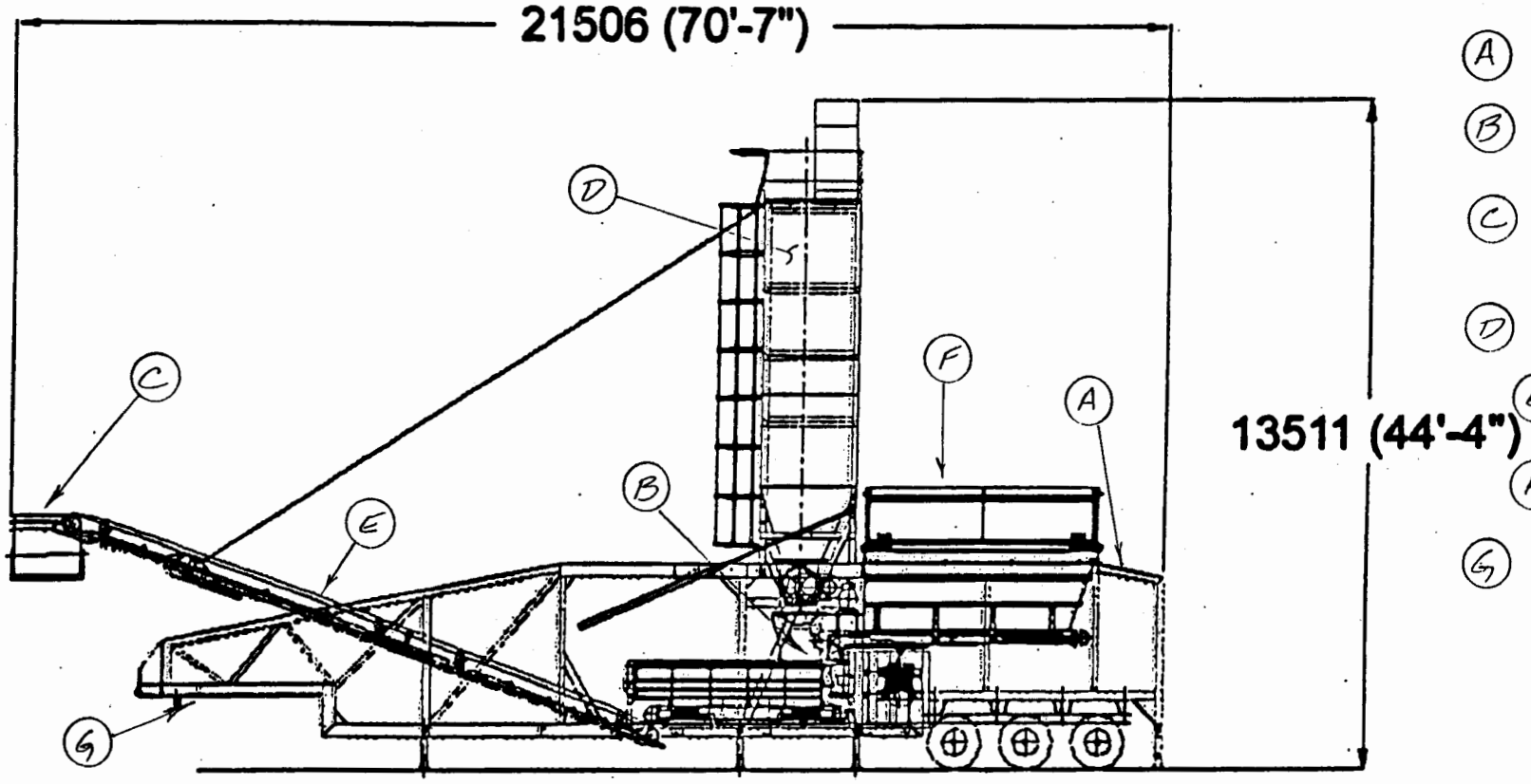
Scribed and sworn before me on this 19 day of June, 2002

My authorization as a notary of the State of New Mexico expires on the 13 day of November, 2003.

Notary's Signature — Date: 6/19/02

I. Ruth Dupre
Notary's Printed Name

Attachment A



(A) GENERATOR

(B) PUG MILL INPUT

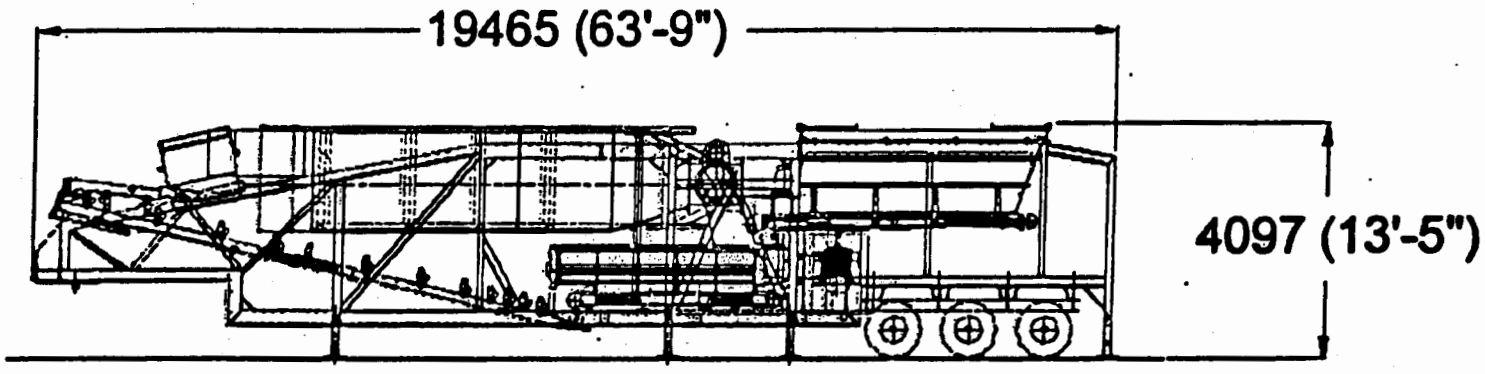
(C) CONVEYOR DISCHARGE

(D) CEMENT SILO

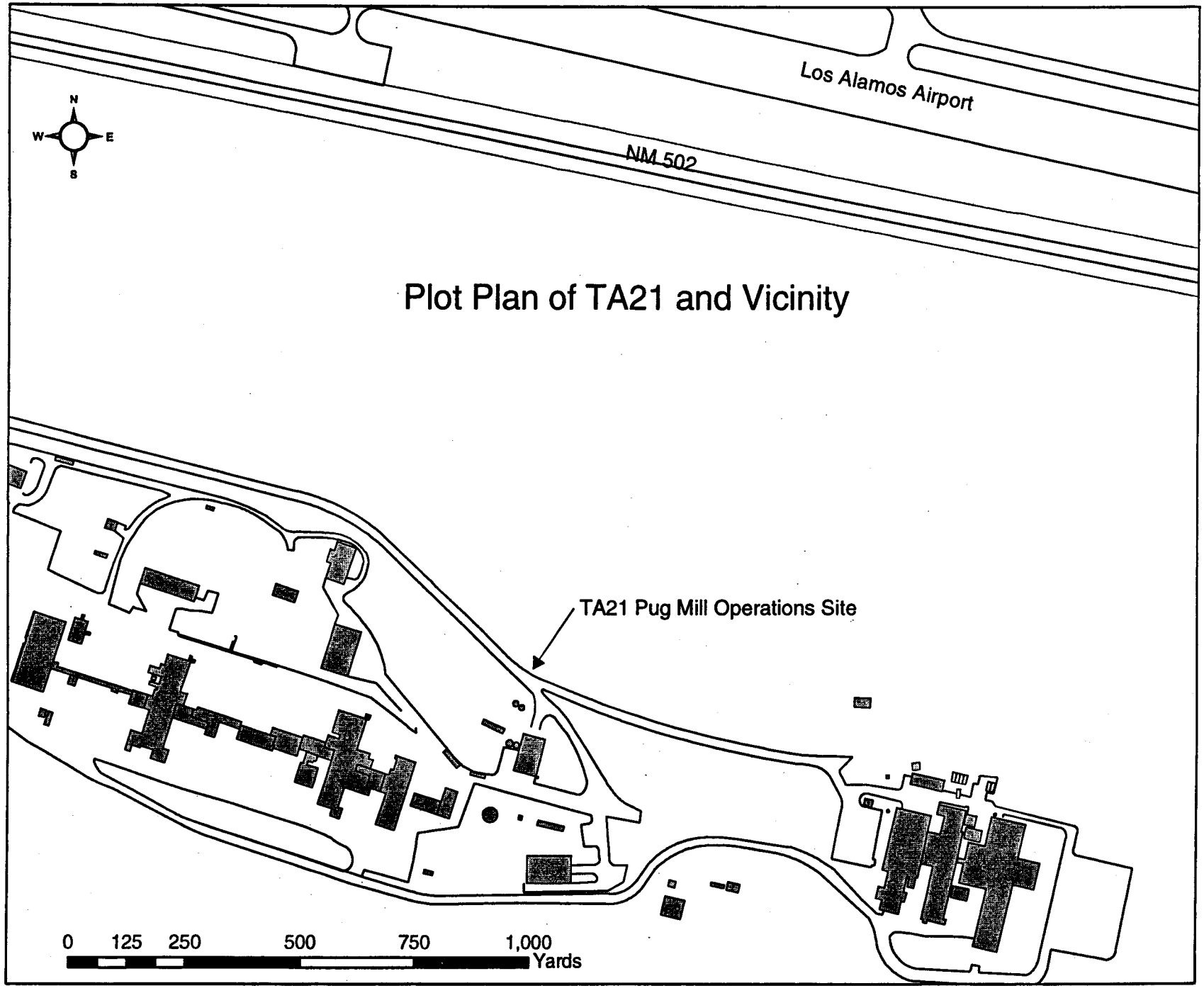
(E) CONVEYOR

(F) FEED HOPPER

(G) WATER STORAGE TANK



Attachment B


Los Alamos Airport
NM 502
N
W
E
S
Plot Plan of TA21 and Vicinity
TA21 Pug Mill Operations Site
0
125
250
500
750
1,000
Yards

Attachment C

Criteria Pollutant Emissions Estimates

Particulate Emissions		
Process	lb/hr	ton/yr
Road Emissions (controlled)	1.48	0.59
Screen	1.6	0.63
Conveyors	0.43	0.17
Aggregate Handling	0.01	0.006
Cement Silo	0.5	0.2
Pug Mill	0.5	0.2
Generator	0.16	0.063
Total	**4.7**	**1.9**

Emissions Summary			
Pollutant	lb/hr	ton/yr	grams/sec
Particulate	4.7	1.9	0.590
NOx	4.3	1.7	0.542
CO	0.68	0.27	0.086
VOC	0.21	0.082	0.026
SOx	0.66	0.26	0.083

Emission Estimates from Contaminated Soil

Soil Emissions from Tables IV-C and IV-D			
Process	Emissions (lb/hr)	Operation (hours)	Total Emissions (lb)
Pug mill	0.5	65	33
Screens	1.6	65	104
Road emissions	3.74	178	666
Conveyors*	0.29	65	19
Total	6.13		821

* 2/3 of the mixed material is contaminated soil

Inorganic Contaminant Emissions				
Contaminant	Max Concentration (mg/kg)	Max Concentration (lb/lb)	Contaminant Emissions (lb/hr)	TAP threshold (lb/hr)
Aluminum	56000	5.62E-02	0.34	0.667
Barium	308	3.09E-04	0.0019	0.0333
Cadmium	2	2.01E-06	0.000012	0.00333
Chromium (total)	48.1	4.83E-05	0.00030	0.0333
Lead	36.3	3.64E-05	0.000223	
Nickel	19.4	1.95E-05	0.000119	0.0667
Silver	2.6	2.61E-06	0.000016	0.00667

Radionuclide Emissions						
Analyte	Avg Concentration (pCi/g)	Avg Concentration (pCi/lb)	Air Emissions (pCi)	Air Emissions (Ci)	Dose Factors (mrem/Ci)	Dose (mrem)
Americium-241	12.57	5.69E+03	4.67E+06	4.67E-06	1.65E+03	7.71E-03
Cesium-134	0.01	4.53E+00	3.72E+03	3.72E-09	1.66E+00	6.17E-09
Cesium-137	163.881	7.42E+04	6.09E+07	6.09E-05	1.16E+01	7.07E-04
Cobalt-60	0.026	1.18E+01	9.67E+03	9.67E-09	3.04E+00	2.94E-08
Europium-152	0.041	1.86E+01	1.52E+04	1.52E-08	1.89E+00	2.88E-08
Plutonium-238	3.94	1.78E+03	1.47E+06	1.47E-06	9.67E+02	1.42E-03
Plutonium-239	9.5	4.30E+03	3.53E+06	3.53E-06	1.04E+03	3.67E-03
Ruthenium-106	0.062	2.81E+01	2.31E+04	2.31E-08	1.80E+00	4.15E-08
Sodium-22	0.041	1.86E+01	1.52E+04	1.52E-08	2.08E+00	3.17E-08
Strontium-90	30.1	1.36E+04	1.12E+07	1.12E-05	7.44E-01	8.33E-06
Tritium	0.21415	9.70E+01	7.96E+04	7.96E-08	4.60E-04	3.66E-11
Uranium-234	3.8035	1.72E+03	1.41E+06	1.41E-06	4.02E+02	5.69E-04
Uranium-235	0.27	1.22E+02	1.00E+05	1.00E-07	3.72E+02	3.73E-05
					Total	**0.014**

Attachment D

- Electrical Power Generation
- Industrial Engines
- Truck Engines
- Switchgear & Control Systems
- UPS Systems
- Product Support
- Generator Rentals

RUST

POWER DIVISION

- Pump Packages
- Petroleum Pumps
- Fire Pumps
- Mud Pumps
- Blower Packages
- Mechanical Drives
- Compressor Rentals
- Pump Rentals

TO: Dana Wilson	FROM: Paul Keener	
COMPANY: Washington Group	DATE: June 6, 2002	
TEL: 505-662-1328	TEL: 1-505-343-2727	
FAX: 505-662-7800	FAX: 1-505-344-0397	
REF: Emissions data on Caterpillar Model 3306TA Gen Set	Total # of Pages	3

Dana

I have attached the information you requested.\

Regards,

Paul

Paul Keener
Vice President
Rust Power Division

CAT

VISIT OUR WEB SITE: www.[illegible]

STREET: 4600 OSUNA ROAD N.E. ALBUQUERQUE, NM 87109 U.S.A.

MAILING: P.O. BOX 25007 ALBUQUERQUE, NM 87125 U.S.A.

Phone: 1-505-345-5411
Mid Wests: 1-800-433-8413
Fax: 1-505-344-2582
Fax: 1-505-344-0397

Stores Located in ALBUQUERQUE, FARMINGTON, HOBBS, New Mexico - EL PASO, Texas

EMISSIONS REQUEST 01 - 69

3306B DITAJWAC GS PRIME

Rating: 238.5 kw (320 hp) @ 1800 rpm
Test Spec:2T-8487 BEA:132-5400

Nominal Values @ Rated

HC g/Hr	CO g/Hr	NOx g/Hr	Part g/Hr
49	165	1599	38

Not To Exceed Values @ Rated

HC g/Hr	CO g/Hr	NOx g/Hr	Part g/Hr
93	309	1935	73

Caterpillar Inc recommends that you use the "not to exceed values" to account for instrument and engine variability. If you require exact measurements, an emissions test will be needed on your engine.

Sample Calculation:

$$1935\frac{g}{hr} * \frac{1\ lb}{453.593\ g} = 4.3\frac{lb}{hr}$$

Prepared by Caterpillar Inc.,
6/6/02

3.3 Gasoline And Diesel Industrial Engines

3.3.1 General

The engine category addressed by this section covers a wide variety of industrial applications of both gasoline and diesel internal combustion (IC) engines such as aerial lifts, fork lifts, mobile refrigeration units, generators, pumps, industrial sweepers/scrubbers, material handling equipment (such as conveyors), and portable well-drilling equipment. The three primary fuels for reciprocating IC engines are gasoline, diesel fuel oil (No.2), and natural gas. Gasoline is used primarily for mobile and portable engines. Diesel fuel oil is the most versatile fuel and is used in IC engines of all sizes. The rated power of these engines covers a rather substantial range, up to 250 horsepower (hp) for gasoline engines and up to 600 hp for diesel engines. (Diesel engines greater than 600 hp are covered in Section 3.4, "Large Stationary Diesel And All Stationary Dual-fuel Engines".) Understandably, substantial differences in engine duty cycles exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate some of the emission factors.

3.3.2 Process Description

All reciprocating IC engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 methods used for stationary reciprocating IC engines: compression ignition (CI) and spark ignition (SI). This section deals with both types of reciprocating IC engines. All diesel-fueled engines are compression ignited, and all gasoline-fueled engines are spark ignited.

In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.3.3 Emissions

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank and carburetor because of evaporation. Nearly all of the TOCs from diesel CI engines enter the

atmosphere from the exhaust. Evaporative losses are insignificant in diesel engines due to the low volatility of diesel fuels.

The primary pollutants from internal combustion engines are oxides of nitrogen (NO_x), total organic compounds (TOC), carbon monoxide (CO), and particulates, which include both visible (smoke) and nonvisible emissions. Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, if any, of the fuel. The other pollutants, HC, CO, and smoke, are primarily the result of incomplete combustion. Ash and metallic additives in the fuel also contribute to the particulate content of the exhaust. Sulfur oxides (SO_x) also appear in the exhaust from IC engines. The sulfur compounds, mainly sulfur dioxide (SO_2), are directly related to the sulfur content of the fuel.[2]

3.3.3.1 Nitrogen Oxides -

Nitrogen oxide formation occurs by two fundamentally different mechanisms. The predominant mechanism with internal combustion engines is thermal NO_x which arises from the thermal dissociation and subsequent reaction of nitrogen (N_2) and oxygen (O_2) molecules in the combustion air. Most thermal NO_x is formed in the high-temperature region of the flame from dissociated molecular nitrogen in the combustion air. Some NO_x, called prompt NO_x, is formed in the early part of the flame from reaction of nitrogen intermediary species, and HC radicals in the flame. The second mechanism, fuel NO_x, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Gasoline, and most distillate oils have no chemically-bound fuel N_2 and essentially all NO_x formed is thermal NO_x.

3.3.3.2 Total Organic Compounds -

The pollutants commonly classified as hydrocarbons are composed of a wide variety of organic compounds and are discharged into the atmosphere when some of the fuel remains unburned or is only partially burned during the combustion process. Most unburned hydrocarbon emissions result from fuel droplets that were transported or injected into the quench layer during combustion. This is the region immediately adjacent to the combustion chamber surfaces, where heat transfer outward through the cylinder walls causes the mixture temperatures to be too low to support combustion.

Partially burned hydrocarbons can occur because of poor air and fuel homogeneity due to incomplete mixing, before or during combustion; incorrect air/fuel ratios in the cylinder during combustion due to maladjustment of the engine fuel system; excessively large fuel droplets (diesel engines); and low cylinder temperature due to excessive cooling (quenching) through the walls or early cooling of the gases by expansion of the combustion volume caused by piston motion before combustion is completed.[2]

3.3.3.3 Carbon Monoxide -

Carbon monoxide is a colorless, odorless, relatively inert gas formed as an intermediate combustion product that appears in the exhaust when the reaction of CO to CO_2 cannot proceed to completion. This situation occurs if there is a lack of available oxygen near the hydrocarbon (fuel) molecule during combustion, if the gas temperature is too low, or if the residence time in the cylinder is too short. The oxidation rate of CO is limited by reaction kinetics and, as a consequence, can be accelerated only to a certain extent by improvements in air and fuel mixing during the combustion process.[2-3]

3.3.3.4 Smoke and Particulate Matter -

White, blue, and black smoke may be emitted from IC engines. Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. These are formed in the quench layer adjacent to the cylinder walls, where the temperature is not high enough to ignite the fuel. Blue smoke is emitted when lubricating oil leaks, often past worn piston rings, into the combustion chamber and is partially burned. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of IC engines. The primary constituent of black smoke is agglomerated carbon particles (soot) formed in regions of the combustion mixtures that are oxygen deficient.[2]

3.3.3.5 Sulfur Oxides -

Sulfur oxides emissions are a function of only the sulfur content in the fuel rather than any combustion variables. In fact, during the combustion process, essentially all the sulfur in the fuel is oxidized to SO_2. The oxidation of SO_2 gives sulfur trioxide (SO_3), which reacts with water to give sulfuric acid (H_2SO_4), a contributor to acid precipitation. Sulfuric acid reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction. Sulfur oxide emissions also contribute to corrosion of the engine parts.[2-3]

3.3.4 Control Technologies

Control measures to date are primarily directed at limiting NO_x and CO emissions since they are the primary pollutants from these engines. From a NO_x control viewpoint, the most important distinction between different engine models and types of reciprocating engines is whether they are rich-burn or lean-burn. Rich-burn engines have an air-to-fuel ratio operating range that is near stoichiometric or fuel-rich of stoichiometric and as a result the exhaust gas has little or no excess oxygen. A lean-burn engine has an air-to-fuel operating range that is fuel-lean of stoichiometric; therefore, the exhaust from these engines is characterized by medium to high levels of O_2. The most common NO_x control technique for diesel and dual-fuel engines focuses on modifying the combustion process. However, selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR) which are post-combustion techniques are becoming available. Controls for CO have been partly adapted from mobile sources.[4]

Combustion modifications include injection timing retard (ITR), preignition chamber combustion (PCC), air-to-fuel ratio adjustments, and derating. Injection of fuel into the cylinder of a CI engine initiates the combustion process. Retarding the timing of the diesel fuel injection causes the combustion process to occur later in the power stroke when the piston is in the downward motion and combustion chamber volume is increasing. By increasing the volume, the combustion temperature and pressure are lowered, thereby lowering NO_x formation. ITR reduces NO_x from all diesel engines; however, the effectiveness is specific to each engine model. The amount of NO_x reduction with ITR diminishes with increasing levels of retard.[4]

Improved swirl patterns promote thorough air and fuel mixing and may include a precombustion chamber (PCC). A PCC is an antechamber that ignites a fuel-rich mixture that propagates to the main combustion chamber. The high exit velocity from the PCC results in improved mixing and complete combustion of the lean air/fuel mixture which lowers combustion temperature, thereby reducing NO_x emissions.[4]

The air-to-fuel ratio for each cylinder can be adjusted by controlling the amount of fuel that enters each cylinder. At air-to-fuel ratios less than stoichiometric (fuel-rich), combustion occurs under conditions of insufficient oxygen which causes NO_x to decrease because of lower oxygen and lower temperatures. Derating involves restricting the engine operation to lower than normal levels of power production for the given application. Derating reduces cylinder pressures and temperatures, thereby lowering NO_x formation rates.[4]

SCR is an add-on NO_x control placed in the exhaust stream following the engine and involves injecting ammonia (NH_3) into the flue gas. The NH_3 reacts with NO_x in the presence of a catalyst to form water and nitrogen. The effectiveness of SCR depends on fuel quality and engine duty cycle (load fluctuations). Contaminants in the fuel may poison or mask the catalyst surface causing a reduction or termination in catalyst activity. Load fluctuations can cause variations in exhaust temperature and NO_x concentration which can create problems with the effectiveness of the SCR system.[4]

NSCR is often referred to as a three-way conversion catalyst system because the catalyst reactor simultaneously reduces NO_x, CO, and HC and involves placing a catalyst in the exhaust stream of the engine. The reaction requires that the O_2 levels be kept low and that the engine be operated at fuel-rich air-to-fuel ratios.[4]

The most accurate method for calculating such emissions is on the basis of "brake-specific" emission factors (pounds per horsepower-hour [lb/hp-hr]). Emissions are the product of the brake-specific emission factor, the usage in hours, the rated power available, and the load factor (the power actually used divided by the power available). However, for emission inventory purposes, it is often easier to assess this activity on the basis of fuel used.

Once reasonable usage and duty cycles for this category were ascertained, emission values were aggregated to arrive at the factors for criteria and organic pollutants presented. Factors in Table 3.3-1 are in pounds per million British thermal unit (lb/MMBtu). Emission data for a specific design type were weighted according to estimated material share for industrial engines. The emission factors in these tables, because of their aggregate nature, are most appropriately applied to a population of industrial engines rather than to an individual power plant. Table 3.3-2 shows unweighted speciated organic compound and air toxic emission factors based upon only 2 engines. Their inclusion in this section is intended for rough order-of-magnitude estimates only.

Table 3.3-3 summarizes whether the various diesel emission reduction technologies (some of which may be applicable to gasoline engines) will generally increase or decrease the selected parameter. These technologies are categorized into fuel modifications, engine modifications, and exhaust after-treatments. Current data are insufficient to quantify the results of the modifications. Table 3.3-3 provides general information on the trends of changes on selected parameters.

3.3.5 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the memoranda describing each supplement or the background report for this section.

Supplement A, February 1996

No changes.

Supplement B, October 1996

- Text was revised concerning emissions and controls.
- The CO_2 emission factor was adjusted to reflect 98.5 percent conversion efficiency.

Table 3.3-1. EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant	Gasoline Fuel (SCC 2-02-003-01, 2-03-003-01)		Diesel Fuel (SCC 2-02-001-02, 2-03-001-01)		EMISSION FACTOR RATING
	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	
NO_x	0.011	1.63	0.031	4.41	D
CO	0.439	62.7	6.68 E-03	0.95	D
SO_x	5.91 E-04	0.084	2.05 E-03	0.29	D
PM-10[b]	7.21 E-04	0.10	2.20 E-03	0.31	D
CO_2[c]	1.08	154	1.15	164	B
Aldehydes	4.85 E-04	0.07	4.63 E-04	0.07	D
TOC					
Exhaust	0.015	2.10	2.47 E-03	0.35	D
Evaporative	6.61 E-04	0.09	0.00	0.00	E
Crankcase	4.85 E-03	0.69	4.41 E-05	0.01	E
Refueling	1.08 E-03	0.15	0.00	0.00	E

[a] References 2,5-6,9-14. When necessary, an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr was used to convert from lb/MMBtu to lb/hp-hr. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code. TOC = total organic compounds.

[b] PM-10 = particulate matter less than or equal to 10 μm aerodynamic diameter. All particulate is assumed to be ≤ 1 μm in size.

[c] Assumes 99% conversion of carbon in fuel to CO_2 with 87 weight % carbon in diesel, 86 weight % carbon in gasoline, average BSFC of 7,000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and gasoline heating value of 20,300 Btu/lb.

Sample Calculation

$$2.05E^{-3}\ \frac{lb}{hp\text{-}hr} * 320hp = 0.66\ \frac{lb}{hr}$$

Table 3.3-2. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR UNCONTROLLED DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (Fuel Input) (lb/MMBtu)
Benzene[b]	9.33 E-04
Toluene[b]	4.09 E-04
Xylenes[b]	2.85 E-04
Propylene[b]	2.58 E-03
1,3-Butadiene[b,c]	<3.91 E-05
Formaldehyde[b]	1.18 E-03
Acetaldehyde[b]	7.67 E-04
Acrolein[b]	<9.25 E-05
Polycyclic aromatic hydrocarbons (PAH)	
Naphthalene[b]	8.48 E-05
Acenaphthylene	<5.06 E-06
Acenaphthene	<1.42 E-06
Fluorene	2.92 E-05
Phenanthrene	2.94 E-05
Anthracene	1.87 E-06
Fluoranthene	7.61 E-06
Pyrene	4.78 E-06
Benzo(a)anthracene	1.68 E-06
Chrysene	3.53 E-07
Benzo(b)fluoranthene	<9.91 E-08
Benzo(k)fluoranthene	<1.55 E-07
Benzo(a)pyrene	<1.88 E-07
Indeno(1,2,3-cd)pyrene	<3.75 E-07
Dibenz(a,h)anthracene	<5.83 E-07
Benzo(g,h,l)perylene	<4.89 E-07
TOTAL PAH	1.68 E-04

[a] Based on the uncontrolled levels of 2 diesel engines from References 6-7. Source Classification Codes 2-02-001-02, 2-03-001-01. To convert from lb/MMBtu to ng/J, multiply by 430.
[b] Hazardous air pollutant listed in the *Clean Air Act.*
[c] Based on data from 1 engine.

Table 3.3-3. EFFECT OF VARIOUS EMISSION CONTROL TECHNOLOGIES ON DIESEL ENGINES[a]

Technology	Affected Parameter	
	Increase	Decrease
Fuel modifications		
Sulfur content increase	PM, wear	
Aromatic content increase	PM, NO_x	
Cetane number		PM, NO_x
10% and 90% boiling point		PM
Fuel additives		PM, NO_x
Water/Fuel emulsions		NO_x
Engine modifications		
Injection timing retard	PM, BSFC	NO_x, power
Fuel injection pressure	PM, NO_x	
Injection rate control		NO_x, PM
Rapid spill nozzles		PM
Electronic timing & metering		NO_x, PM
Injector nozzle geometry		PM
Combustion chamber modifications		NO_x, PM
Turbocharging	PM, power	NO_x
Charge cooling		NO_x
Exhaust gas recirculation	PM, power, wear	NO_x
Oil consumption control		PM, wear
Exhaust after-treatment		
Particulate traps		PM
Selective catalytic reduction		NO_x
Oxidation catalysts		TOC, CO, PM

[a] Reference 8. PM = particulate matter. BSFC = brake-specific fuel consumption.

References For Section 3.3

1. H. I. Lips, *et al., Environmental Assessment Of Combustion Modification Controls For Stationary Internal Combustion Engines*, EPA-600/7-81-127, U. S. Environmental Protection Agency, Cincinnati, OH, July 1981.

2. *Standards Support And Environmental Impact Statement, Volume 1: Stationary Internal Combustion Engines*, EPA-450/2-78-125a, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1979.

3. M. Hoggan, *et al., Air Quality Trends In California's South Coast And Southeast Desert Air Basins, 1976-1990, Air Quality Management Plan, Appendix II-B,* South Coast Air Quality Management District, July 1991.

4. R. B. Snyder, *Alternative Control Techniques Document .. NO_x Emissions From Stationary Reciprocating Internal Combustion Engines*, EPA-453/R-93-032, U. S. Environmental Protection Agency, Research Triangle Park, July 1993.

5. C. T. Hare and K. J. Springer, *Exhaust Emissions From Uncontrolled Vehicles And Related Equipment Using Internal Combustion Engines, Part 5: Farm, Construction, And Industrial Engines*, APTD-1494, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1973.

6. *Pooled Source Emission Test Report: Oil And Gas Production Combustion Sources, Fresno And Ventura Counties, California*, ENSR 7230-007-700, Western States Petroleum Association, Bakersfield, CA, December 1990.

7. W. E. Osborn and M. D. McDannel, *Emissions Of Air Toxic Species: Test Conducted Under AB2588 For The Western States Petroleum Association*, CR 72600-2061, Western States Petroleum Association, Glendale, CA, May 1990.

8. *Technical Feasibility Of Reducing NO_x And Particulate Emissions From Heavy-duty Engines*, CARB Contract A132-085, California Air Resources Board, Sacramento, CA, March 1992.

9. G. Marland and R. M. Rotty, *Carbon Dioxide Emissions From Fossil Fuels: A Procedure For Estimation And Results For 1951-1981*, DOE/NBB-0036 TR-003, Carbon Dioxide Research Division, Office of Energy Research, U. S. Department of Energy, Oak Ridge, TN, 1983.

10. A. Rosland, *Greenhouse Gas Emissions in Norway: Inventories and Estimation Methods*, Oslo: Ministry of Environment, 1993.

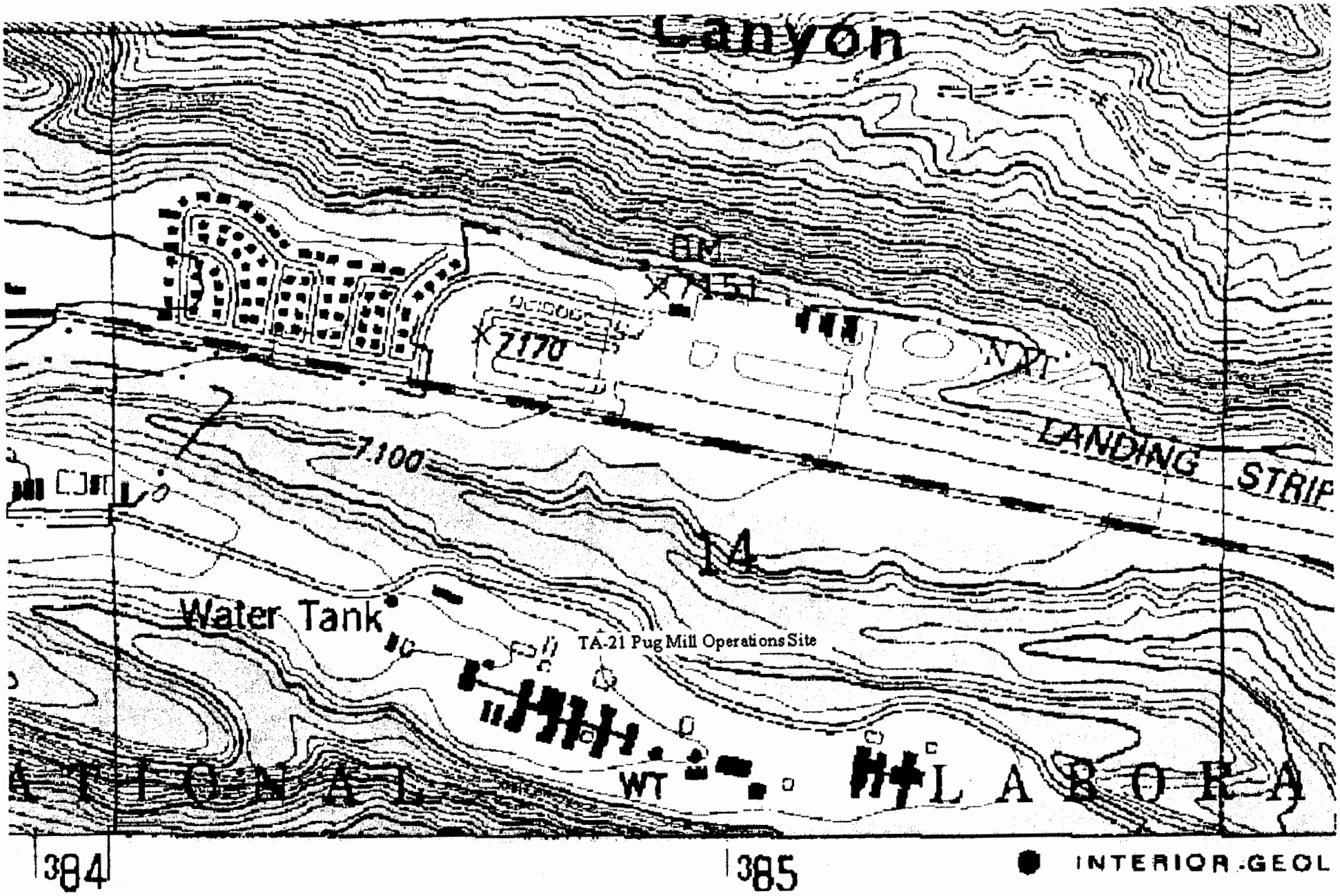
11. *Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992* (1994) DOE/PO-0028, Volume 2 of 3, U.S. Department of Energy.

12. G. Marland and R. M. Rotty, *Carbon Dioxide Emissions From Fossil Fuels: A Procedure For Estimation And Results For 1950-1982*, Tellus 36B:232-261, 1984.

13. *Inventory Of U. S. Greenhouse Gas Emissions And Sinks: 1990-1991*, EPA-230-R-96-006, U. S. Environmental Protection Agency, Washington, DC, November 1995.

14. *IPCC Guidelines For National Greenhouse Gas Inventories Workbook*, Intergovernmental Panel on Climate Change/Organization for Economic Cooperation and Development, Paris, France, 1995.

Attachment E



Topographic Map of TA-21 and Vicinity

Attachment G

VCM Activities at PRS 21-011(k)
Field Work Description

This scope of work pertains to a Resource, Conservation, and Recovery Act (RCRA) Voluntary Correction Measure (VCM) at Technical Area (TA) 21. These activities are part of the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Project. The activities in this description address construction requirements necessary for VCM implementation. The project is proposed to start on July 8, and to be completed by September 30, 2002. The Pug Mill operations are proposed to begin July 22, 2002 and are to be completed within two weeks. The schedule provides a two week period for decontamination operations.

The estimated total work area for this project consists of approximately 3 acres of disturbed area. After all site controls are established, excavation will begin with the excavation of radionuclide contaminated and clean soils with the use of an excavator. All soil will be stockpiled in separate areas approximately 200 feet apart, both being 100 feet from the proposed Pug Mill. Both stockpiles will be processed to a 1 inch minus gradation using a Cat IT-38 Loader equipped with an Allu material processing bucket. The Loader will scoop the material from the stockpiles into the Allu bucket with a series of hammers and crushing bars that crush the material and pass the material through the bottom of the bucket. All material will be processed with the use of the Loader and the Allu Bucket.

The contaminated soil (500 yd^3 or approximately 650 tons) will be processed with the Pug Mill for the stabilization of the contaminants. Once mixed, the solidified material will be placed in the disposal cell. Then the solidified material will be capped with the previously stockpiled clean material for a cover thickness of approximately 10 feet. Approximately 2,000 yd^3 of clean soil will be used for the cover.

The Pug Mill, a self-contained trailer unit, will be set-up between the two generated stockpiles. The process equipment includes a 238.5 Kw generator mounted in the rear of the unit, a two compartment feed hopper, a cement silo equipped with a reverse jet dust collector; Pug Mill mixer; water storage tank; discharge conveyor; and a drop shoot for loading of a haul truck. One compartment of the feed hopper will be loaded with the processed soil and the other side will be loaded with bentonite material. The Pug Mill is operated by computer that is capable of controlling and reporting all materials. It is able to provide a print out of process materials and the final product composition. The proposed mix design consists of all contaminated soil, with the addition of 20% cement, 10% bentonite and 20% water.

In preparation for plant operation, a transport truck carrying cement will blow off the load through a 4" hose into the cement silo. The silo is capable of holding two loads of cement or approximately 40 tons of cement. The cement silo has a reverse jet dust collector equipped with filters. The filters are self-cleaning and can be changed at any time. The operation of the silo is performed under negative pressure and when the cement is added to the process it is sheared rather than blown. The silo provides accurate dispensing and is virtually a dust free operation.

One side of the feed hopper will be loaded with the bentonite material. This transfer will be performed using the loader to dump supersacks in the hopper. The loader will also be used to place the contaminated soil in the other side of the hopper.

An existing fire hydrant will be utilized for the water source needed. A temporary water line will be installed to the Pug Mill from the fire hydrant. After the installation of the water line, the plant will be ready for operations.

Once all materials are loaded, they are then introduced at the same time in their designated quantities into the front of the Pug Mill. The Pug Mill is an enclosed tub which mixes the materials and feeds the material onto the conveyor into the discharge gob hopper and then into a waiting

dump truck. The loaded truck then shall proceed to the disposal cell where the solidified material is dumped. A dozer will place the material in the desired lift thickness. Each lift will then be compacted with a smooth drum roller for final disposition. This entire operation of the Pug Mill will be performed in a batch sequence.

The heavy equipment consists of a loader feeding the plant and a dump truck hauling material away from the plant. Both of these pieces of equipment will require their haul patterns to be moisture conditioned, applied with the use of fire hoses, to prevent dust emissions. The other portion of this operation consists of the placement of the solidified material into the disposal cell. This process will involve the use of a dozer spreading the material in the required lift thickness. The material will be in a moist state coming from the Pug Mill; therefore, fugitive dust emissions will be mitigated.

A total of 500 cubic yards of contaminated material is estimated to be solidified in this process. After all solidified material is placed in the disposal cell the material will then be capped with the previously stockpiled clean material, for a cover thickness of approximately 10 feet.

The pug mill equipment is being leased from Rapid International LTD. for a period of 30 days. It is intended that processing can be accomplished over a two-week period (approximately 65 hours of processing). The remaining two weeks will be used to decontaminate and clean the equipment. Broader periods of time were presented in Tables I-B and I-D to allow for operational flexibility and contingency scheduling.

Attachment H

PSD Applicability Review

Based on the potential emission rates from the pug mill operations, this project does not meet the definition of major modification under 20 NMAC 2.74. This project does not result in a significant net increase in emissions. In addition, based on the modeling presented in Attachment K, this project does not cause the concentration of any regulated air pollutant to exceed 1 $\mu g/m^3$ at the nearest border of the Class I Bandelier Wilderness.

Attachment I

Applicable Regulation Summary

20 NMAC 2.3 –Ambient Air Quality Standards – Pug mill activities will not exceed any national or New Mexico ambient air quality standards. Dispersion modeling was conducted and is included in Attachment K.

20 NMAC 2.7 – Excess Emissions During Malfunction, Startup, Shutdown or Scheduled Maintenance – In the event of any malfunction of the generator that results in excess emissions, LANL will comply with the notification requirements specified in 20 NMAC 2.7, Section 110.

20 NMAC 2.61 – Smoke and Visible Emissions – Visible emissions may not exceed an opacity of 20 percent for the generator. Based on experience, opacity violations do not occur during normal operations.

20 NMAC 2.70 – Operating Permits – The LANL facility, as a whole, is subject to the Title V Operating permit requirements. LANL submitted an Operating Permit application in December 1995 and received a completeness determination from NMED. LANL will submit a revised application in December of 2002. These activities will be completed prior to a permit being issued. Furthermore, the pug mill is not a major source of air emissions.

20 NMAC 2.72 – Construction Permits – This NOI application is being submitted for review by NMED. NMED has previously commented that the pug mill does not require a construction permit. Emissions from soil contaminants are below the Toxic Air Pollutant thresholds.

20 NMAC 2.73 – Notice of Intent and Emission Inventory Requirements – This NOI fulfills the requirements of 20 NMAC 2.73. LANL will report estimated emissions for pug mill operations at NMED's request.

20 NMAC 2.77 – New Source Performance Standards (NSPS) – No NSPS apply to the pug mill.

<u>40 CFR 60 Subpart F –</u> The pug mill is not capable of manufacturing Portland cement.

<u>40 CFR 60 Subpart I –</u> The pug mill is not capable of manufacturing hot mix asphalt.

<u>40 CFR 60 Subpart K</u> – Storage tanks greater than 40,000 gallons are not being used for this operation.

<u>40 CFR 60 Subpart Ka</u> – Storage tanks greater than 40,000 gallons are not being used for this operation.

<u>40 CFR 60 Subpart Kb</u> – Storage tanks greater than 40 cubic meters are not being used for this operation.

40 CFR Subpart OOO- Soil, the only material being screened or crushed, does not meet the definition of nonmetallic minerals. Screening and crushing will be performed with an Allu bucket. The pug mill itself does not screen or crush any materials. Therefore, the equipment planned for these activities is not an affected facility. In other words, the designated equipment is not considered a portable nonmetalic mineral processing plant.

20 NMAC 2.78 –Emission Standards for Hazardous Air Pollutants – The Rad NESHAP, 40 CFR 61 Subpart H, applies to the radionuclide emissions from the contaminated soil. Based on emission estimates using the Appendix D release factors and CAP88 modeling for the dose, this operation is not subject to the pre-construction approval process or the emissions monitoring requirements. Estimated dose is less than 0.1 mrem.

20 NMAC 2.82 – Maximum Achievable Control Technology Standards – None of the MACT standards that have been promulgated apply to the pug mill.

Attachment K

Attachment K – Air Dispersion Modeling

Modeling Summary

The Los Alamos Meteorological and Air Quality Group (MAQ) performed air dispersion analysis to determine air quality impacts; we used the maximum emission rates provided from Attachment C. We used the "Dispersion Modeling Guidelines" (DMG) published by the New Mexico Air Quality Bureau (AQB) as the primary aid and guide for this analysis.[1] The ISCST3 model was used for this analysis. A detailed description of the methodology is included in this Attachment.

Based on the results of the air quality analysis, emissions from the TA-21 Pug Mill operations will not result in any off-site exceedances of the National Ambient Air Quality standards (NAAQS) or New Mexico Ambient Air Quality Standards (NMAAQS), for any of the criteria pollutants. Table K-1 presents a summary of the dispersion modeling results. The gaseous emission standards have been converted from ppm to ug/m^3 using the equation provided on page 25 of the DMG.

Table K-1. Summary of Dispersion Modeling Results

Pollutant	Averaging Period	Ambient Standard[a] ($\mu g/m^3$)	Highest Modeled Offsite Concentration ($\mu g/m^3$)	% of the Standard
NOx	Annual	76	8.5	11.2
	24 hr	115	47.7	31.5
SOx	Annual	42	1.3	3.1
	24 hr	211	7.3	3.5
	3 hr	1053	23.6	2.2
CO	8-hr	8008	14.4	0.2
	1-hr	12058	34.1	0.3
TSP / PM_{10}[b]	Annual	50	9.2	15.4
	30 day	90	15.1	16.8
	24 hr	150	51.9	34.6
VOC[c]	Annual	NA	0.4	NA
	24 hr	NA	2.3	NA
	1 hr	NA	10.3	NA

(a) Gaseous air quality standards adjusted for site elevation.
(b) Total Suspended Particulate matter and PM_{10} were assumed equal for this analysis.
(c) Volatile Organic Carbons are reported in regards to the O_3 standard.

[1] "New Mexico Air Quality Bureau Dispersion Modeling Guidelines" New Mexico Air Quality Bureau, June 1998.

We also determined that we do not exceed the Potential Significant Deterioration (PSD) standards at the Bandelier Class I Wilderness Area, the closest point of which is about as 7.8 km from the release site. A detailed description of the modeling analysis is provided on the following pages using the numbered checklist following the AQB's Dispersion Modeling Guidelines.

Dispersion Modeling Analysis for LANL's TA-21 Pug Mill Operations

1) A Checklist for the dispersion modeling analysis and Narrative Summary of the Project.

This environmental restoration project is to remove soils and sediments potentially contaminated with radionuclides from past Laboratory operations. Any contaminated media will be mixed with Portland cement and solidified in a designated on-site pit. The work will take place near the middle section of DP Canyon at TA-21, which is just south of the Los Alamos Airport and NM 502. The dispersion modeling included emissions from a variety of activities, as discussed in Section 3 below.

2) A list of file names of the model input, output, and other files used.

A list of the input and output file names used in the dispersion modeling analysis is given in Table K-2. Other files used in the analysis are also listed in the table.

Table K-2. Names and Descriptions of Files Used for Modeling Analysis

Filename	File Type	Size (kB)	Description
TA21_TSP.inp	*ISCST-3 Input file*	*8*	*Input file for TSP analysis*
TA21_TSP.out	*ISCST-3 Output file*	*107*	*Output file for TSP air quality analysis*
TA21_SOx.inp	*ISCST-3 Input file*	*8*	*Input file for SOx analysis*
TA21_SOx.out	*ISCST-3 Output file*	*107*	*Output file for SOx air quality analysis*
TA21_NOx.inp	*ISCST-3 Input file*	*8*	*Input file for NOx analysis*
TA21_NOx.inp	*ISCST-3 Output file*	*86*	*Output file for NOx air quality analysis*
TA21_CO.inp	*ISCST-3 Input file*	*8*	*Input file for CO analysis*
TA21_CO.inp	*ISCST-3 Output file*	*92*	*Output file for CO air quality analysis*
TSP_psd.inp	*ISCST-3 Input file*	*27*	*Input file for pug mill and PSD analysis*
TSP_psd.out	*ISCST-3 Output file*	*194*	*Air concentrations for pug mill and PSD analysis*

SOx_psd.inp	*ISCST-3 Input file*	*27*	*Input file for pug mill and SOx analysis*
SOx_psd.out	*ISCST-3 Output file*	*194*	*Air concentrations for pug mill and SOx analysis*
NOx_psd.inp	*ISCST-3 Input file*	*27*	*Input file for pug mill and NOx analysis*
NOx_psd.out	*ISCST-3 Output file*	*194*	*Air concentrations for pug mill and NOx analysis*
CO_psd.inp	*ISCST-3 Input file*	*27*	*Input file for pug mill and CO analysis*
CO_psd.out	*ISCST-3 Output file*	*194*	*Air concentrations for pug mill and CO analysis*
ls99ta53.met	*ISCST-3 Met-data file*	*541*	*Input meteorological data file*
GuajeMtn.dem	*USGS DEM file*	*1,139*	*7.5 arc-minute digitized terrain data*
Frijoles.dem	*USGS DEM file*	*1,141*	*7.5 arc-minute digitized terrain data*

3) Discussion of modeling approach, model options, and types of analysis. (Models used and the justification, regulated pollutants emitted by source, selection of terrain options.)

In addition to requirements outlined in the modeling guidelines, the AQB recommends following the procedures given in the EPA's Guideline on Air Quality Models.[2] The model chosen for the analysis was ISCST3. This is a steady-state Gaussian plume model that can operate in both long-term and short-term modes.

The LANL Meteorology and Air Quality Group used the graphics user interface program "ISC View" from Lakes Environmental to perform the analysis. ISCST3 has the capability of processing averages when calm winds occur. This is important since Los Alamos has light surface winds as discussed in "Los Alamos Climatology".[3] Also, hourly variations in mixing height are allowed in the meteorological data input.

In addition, the model has considerable flexibility in the specification of receptor locations. Output files can include summaries of high values and overall maximum values for each averaging period. In addition, the output files generated allow for easy plotting and visualization of results. We performed preliminary modeling using a number of receptors located over the area of interest. This was followed with a second model run using a denser array of receptors in areas showing potential for high concentrations, as indicated by results of our preliminary model run.

[2] "Guideline on Air Quality Models (Revised)" U.S. Environmental Protection Agency, EPA-450/2-79-027R, July 1986.
[3] "Los Alamos Climatology", Brent M. Bowen, Los Alamos National Laboratory Report LA-11735-MS, May 1990

The elevated terrain modeling option was chosen for this analysis. We used digitized elevation data obtained from the U.S Geological Survey, the specific quads used were "Frijoles" and "White Rock" New Mexico. "Often the highest concentrations are predicted to occur under very stable conditions, when the plume is near, or impinges on the terrain".[4]

For the air-dispersion modeling, we selected the elevated terrain heights (ELEV) option, along with the "complex only" option (NOSMPL). We specified that the RURAL dispersion parameters would be used. We used the missing data processing routine MSGPRO along with an on-site meteorological data file. To simplify the analysis, we combined all particulate emissions into one source for the modeling. We developed a set of source parameters for this combined source and used these for other pollutants as well (Table K-3).

Table K-3. Source Input Parameters

Source	Source ID	Temperature (K)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)
TA-21 Pug Mill	COMBINED	293	1.0	2.0	0.1

Criteria pollutant emissions based on proposed allowable operating limits for the Pug Mill were modeled and compared to the National Ambient Air Quality Standards (NAAQS) and the New Mexico Ambient Air Quality Standards (NMAAQS).

Emissions calculations for the TA-21 Pug Mill are included in Attachment C. All emission rates were converted from units of pounds per hour to grams per second for input to the ISCST3 model. For total particulate matter emissions, we summed the emissions from the Pug Mill, aggregate handling, conveyors, screen, cement silo, generator, and road emissions. Table K-4 lists the estimated emission rates based on the proposed allowable operating conditions.

[4] "Appendix W" of 40 Code of Federal Regulations Pt. 51, U.S. Environmental Protection Agency

Table K-4. Maximum Estimated Emissions from TA-21 Pug Mill

Pollutant	Source	Emission Rate (lb/hr)	Emission Rate (g/sec)
NOx	TA-21 Pug Mill	4.3	0.542
SOx	TA-21 Pug Mill	0.66	0.083
CO	TA-21 Pug Mill	0.68	0.086
TSP / PM_{10}[(a)]	TA-21 Pug Mill and soil disturbance	4.7	0.590
VOC	TA-21 Pug Mill	0.21	0.026

[(a)] Total Particulate Matter and PM_{10} were assumed equal for this analysis.

4) A discussion of the met-data including identification of the source.

The Meteorology and Air Quality Group used meteorological data collected by LANL's on-site monitoring program. In particular, data from the LANL met-tower located at TA-53 was used in the analysis. The year 1999 was chosen for the analysis since this data set has a high completeness rate (99.76 %) with only 21 hours of missing data. This met-tower is located about 2 km from the work site. Mixing heights used in this data-set were based on a sodar study conducted in 1995 and 1996.[5]

5) A copy of an USGS map showing the location of the facility, etc.

A map showing the location of the TA-21 Pug Mill operations is included as Attachment B of this application. In addition, a topographical map showing TA-21 of LANL is included as Attachment E of this application.

6) A description of the site, building dimensions and a plot plan and a discussion of building down-wash.

The work site is an open area north Building 257 at TA-21, and consists of trees, shrubs and grasses. There are no surrounding large buildings, thus building down-wash was not incorporated into the analysis (see Attachment B).

7) A description of the receptor grids, including the fence line coordinates, and any receptors on the property boundary.

[5] "Mixing Depth Estimation at Los Alamos—a Preliminary Study", Jeffrey A. Baars, Los Alamos National Laboratory Report LA-UR-97-366, 1997

For the final modeling analysis, a uniform Cartesian receptor grid was used. The source was centered in a 2 km x 2 km grid that had a mesh size of 100 m. Concentration plots were created for each modeling run to ensure the highest concentration was captured in the modeling. An example concentration plot is included as an attachment to this section. For the final analysis, the area of highest concentrations for all modeling scenarios was found to be adjacent to the release point, on DOE property. We placed receptors to the north along the DOE boundary of the work-site, where the highest off-site concentrations occurred.

Table K-5. Source and Receptor Locations in Universal Transmercator (UTM) Coordinates (NAD '27)

Location	Easting (m)	Northing (m)
TA-21 work site	384955	3970875
Offsite Fence-line Receptor	385150	3971250
Offsite Fence-line Receptor	385075	3971175
Offsite Fence-line Receptor	384955	3971185
Offsite Fence-line Receptor	385050	3971170
Offsite Fence-line Receptor	385150	3971145

8) A copy of the surrounding sources of emissions and those used in the modeling/Any adjacent sources modeled.

No surrounding or adjacent sources were included with this source model.

9) A cross-reference between the sources listed in the permit and their names used in the modeling.

For the TA-21 Pug Mill, the release rate given in table K-4 was used for each averaging time. The source ID of "COMBINED" specified in the input files corresponds to the emissions from the work site.

10) If standards are exceeded because of surrounding sources, a culpability analysis for the source is needed.

No standards are exceeded.

11) Discuss how the radius of impact was determined / the radius and significance of impact.

Using the information given in the NMED Dispersion Modeling Guidelines, the largest radius of impact (ROI) was determined. For the 24-hr averaging period, the ROI for TSP was the largest, at 5 km.

12) A cross-reference to the output files in which report table values (of ambient impacts) were taken from.

The first highest concentration values were obtained from the output files listed in Table K-2. Pollutant averaging times used were 1 hour, 3 hour, 8 hour, 24 hour, 30 day, and annual. The modeling analysis showed that none of the air quality standards would be exceeded under the operating conditions listed in this air permit application.

13) Tables of standards corrected for the site elevation.

The air quality standards for TSP/PM_{10} were not adjusted for site elevation as described in the procedure given on page 25 of the AQB's Dispersion Modeling Guidelines. The gaseous conversion standard formula is applicable to the gases NO_2, SO_2, and CO since the NMAAQS for these gases are presented in ppm concentrations (see Table K-1). The elevation for the work site is about 2179 m.

14) A summary of the modeling results including the maximum concentrations and where they occurred as compared to the standards.

There were no NAAQS or NMAAQS exceedances noted for any of the criteria pollutant emissions from this project. In addition, none of the short term or annual standards were exceeded at any offsite public locations. Table K-1 provides a summary of the modeling results.

15) If modeled stack parameters differ from those listed in the report, explain why.

The modeling used a point source type. To simplify the analysis, we combined all particulate emissions into one point source for the modeling.

16) A summary of flare calculations (if used).

The project did not involve flare calculations.

17) Hardcopy output to be bound in a three-ring binder, plus electronic copies of the files used.

Hardcopy output of the modeling results is being maintained in the MAQ records file. Electronic copies of the files are included with this permit application.

Class I Increment Impact and PSD Applicability.

Due to the proximity to Bandelier National Monument, which is a Class I Wilderness Area, ambient modeling was performed to determine if the source emissions would have impacts above the PSD applicability levels. The Bandelier Class I Wilderness Area is adjacent to LANL's southern boundary and is located about 7.8 km from the proposed work-site.

Dispersion modeling was conducted to determine maximum concentrations at the Class I Wilderness Area and results were compared to the PSD applicability level. The modeling was performed in a similar manner as discussed previously, with a larger modeling domain. Concentration plots on a uniform Cartesian grid were generated to identify where the highest concentrations occurred with respect to the Wilderness Area. As expected, the highest concentration occurred along the Wilderness Area boundary location nearest to LANL. Discrete receptor locations along the boundary were added to the model to find the maximum concentration level. Table K-6 provides a summary of the PSD dispersion modeling at the discrete receptor location on the Wilderness Area boundary (with the highest air concentration).

Table K-6. Summary of Modeling Results for PSD Analysis

Pollutant	Averaging Period	Highest Modeled Concentration ($\mu g/m^3$)	UTM Easting (m)	UTM Northing (m)
NOx	24 hr	0.49	380225	3964735
SOx	24 hr	0.08	380225	3964735
CO	24 hr	0.08	380225	3964735
TSP/PM_{10}[a]	24 hr	0.54	380225	3964735

[a] Total Particulate Matter and PM_{10} were assumed equal for this analysis.

The highest air-concentration at the boundary of the Wilderness Area was determined to be at a distance of 7.8 km from the source, to the SW. Because the dispersion modeling analysis showed the air concentrations to be below the significance threshold, no further analysis is required for PSD applicability.

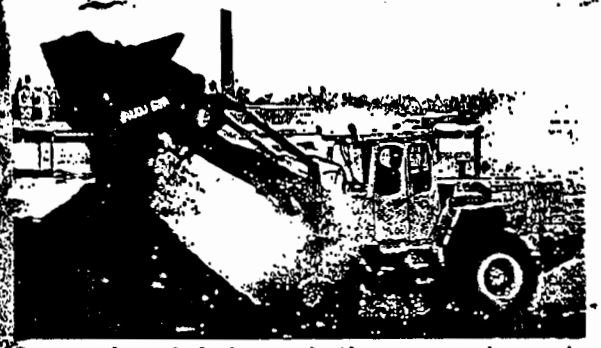
Attachment L

ALLU SM
ALLU

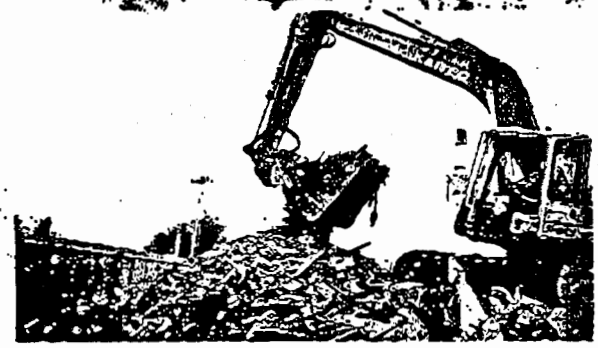
Numerous ALLU applications worldwide

The wide ALLU-product range can be easily installed on almost any base machine, creating an effective screening/crushing unit, which can replace expensive specialized machinery. Here you will find some applications.

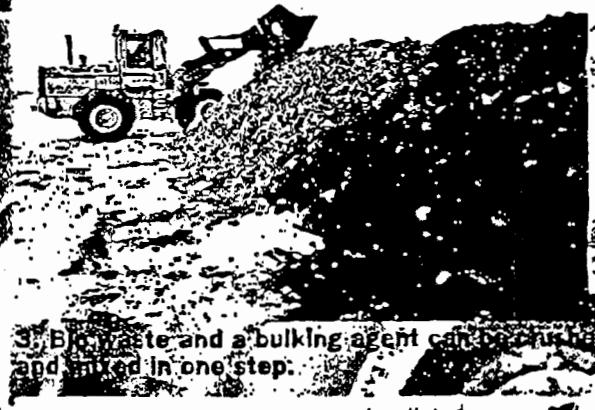
1. Screening of peat e.g. separation of stumps from fuel peat.



2. Aeration of sludge and other compost speeds up the composting process.



5. Construction waste can be screened and crushed.



3. Bio waste and a bulking agent can be crushed and mixed in one step.

6. Screening of aggregate back into the pipe ditch speeds up the filling process.

4. Pre-screening, aerating and loading directly into the truck in one step.

7. ALLU separates the fine from oversized materials.

How Do

The ALLU at
operated
backhoe/w
ALLU is atta
or quick co

The ALLU is
place of a b
in place of
discs with
material. A

8. Screenin

9. Pulveriz
mining/fer

lt Work

nent is designed for hydraulically
hines, such as skidsteer
loaders and excavators. The
to the host machine by a bracket

ttachment, which is installed in
on either a loader or excavator
bottom, the ALLU has rotating
mers that pulverize and siz
oading the bucket. The operator

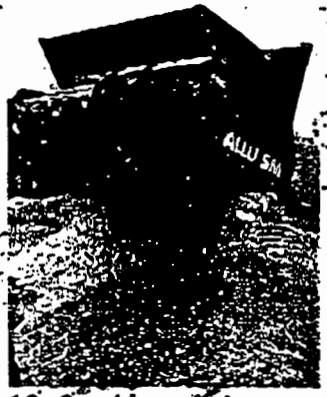
activates the auxiliary hydraulic controls, which rotate the drums breaking up soft materials and screening fines out by gravity. Once all fines have come out, the operator dumps the oversized to another location. The cycle is fast, reliable and extremely cost-effective. Variable speed and direction, forward or reverse, are controlled by the hydraulic oil pressure provided by the host machine carrier and operated by a joystick (3rd valve) in the cab of the machine.

pulverizing of any soil

frozen soil or materials in the
industry e.g. ore concentrate

10. Stabilization of clay and contaminated soil

11. Easy way to make different soil mixtures.



12. Crushing of glass.

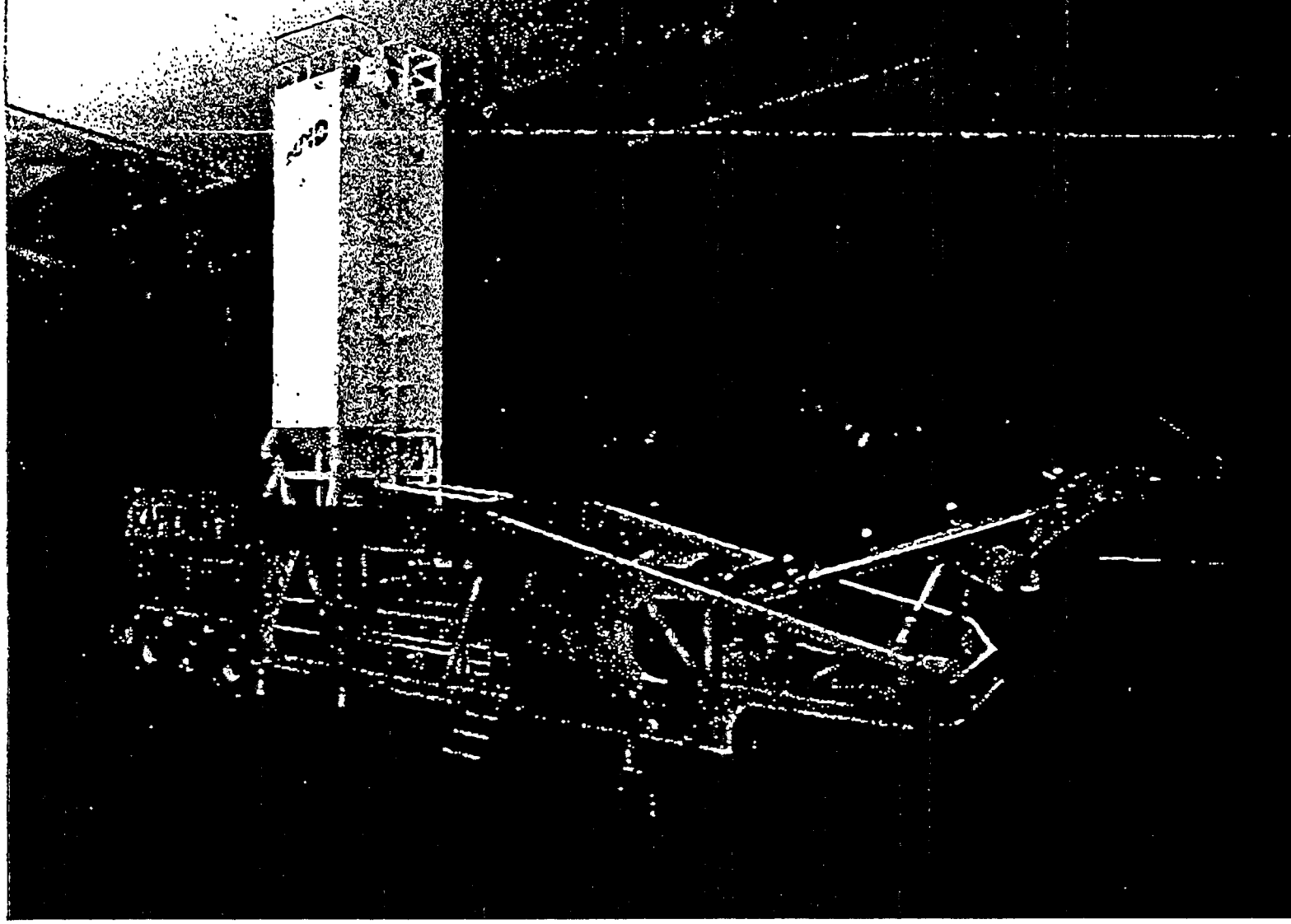
13. Crushing of lightweight concrete.

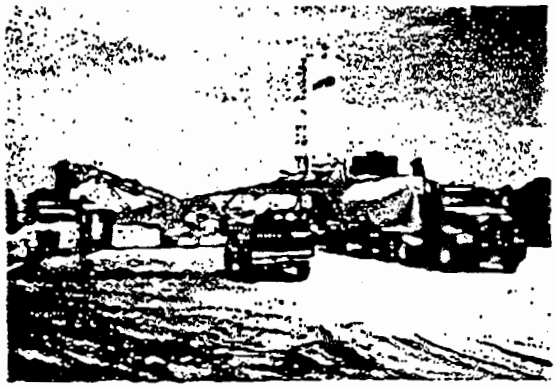
14. Crushing of bark.

RAPID

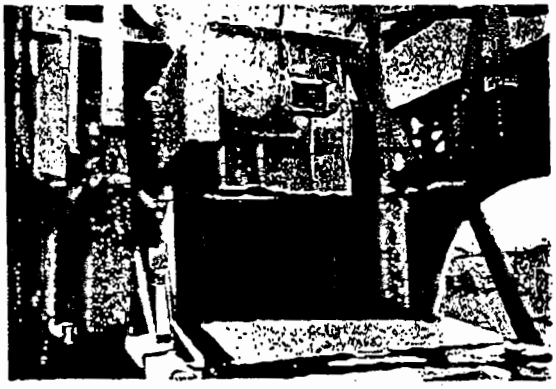
INTERNATIONAL LTD.

For the Consistent and Accurate Mixing
of a Wide Range of Materials





A dust free clean environment is typical of this Rapidmix 400 working in Florida.

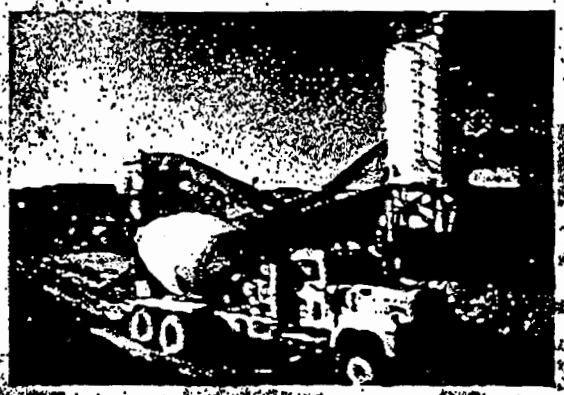


The rotary valve and aggregate conveyor feed into the mixer at the same point.

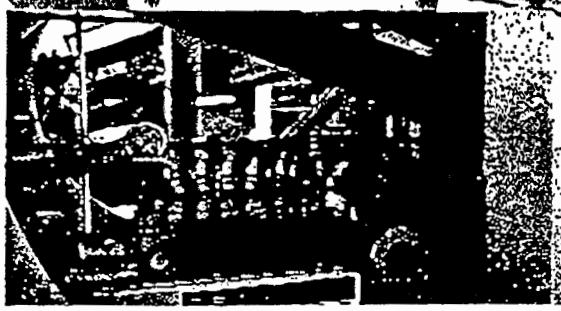
A busy Rapidmix 4(Meade Nevada.

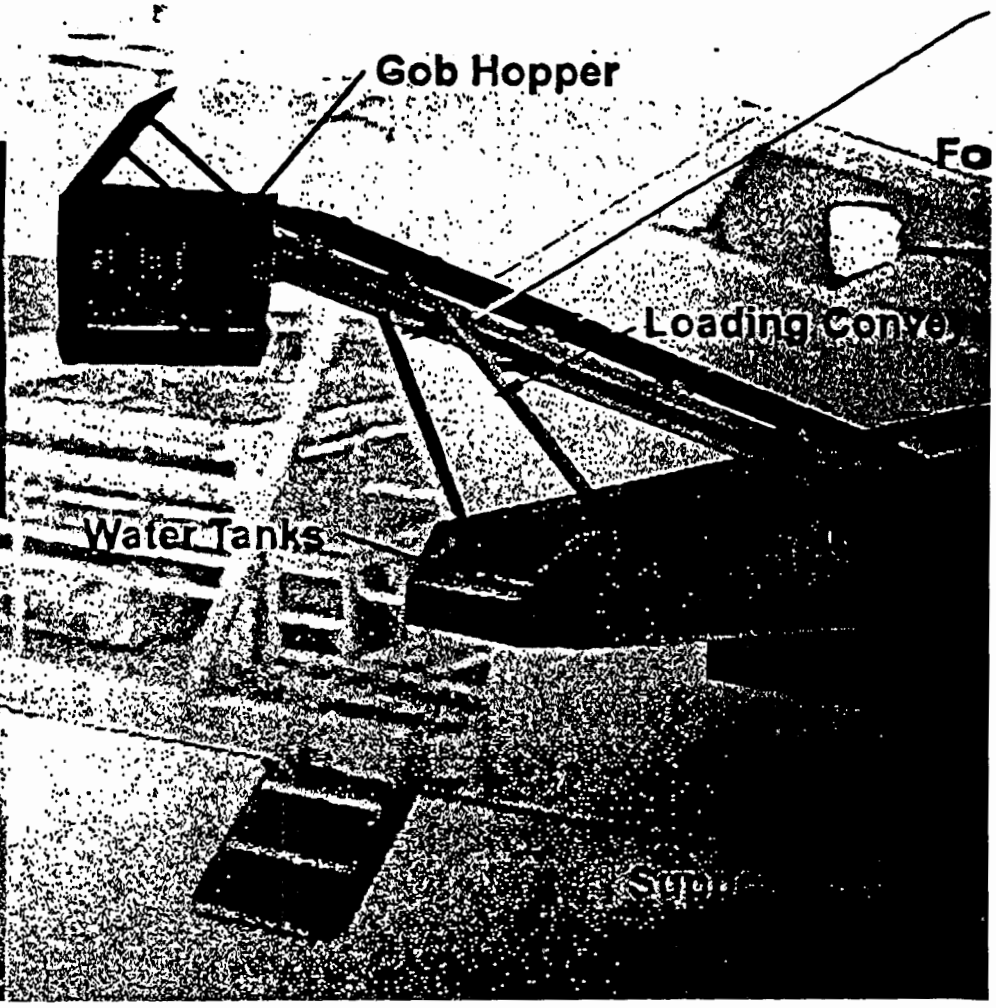
The Rapidmix 400 is electrically powered by a FG Wilson 160 KVA generator set.

Self Er

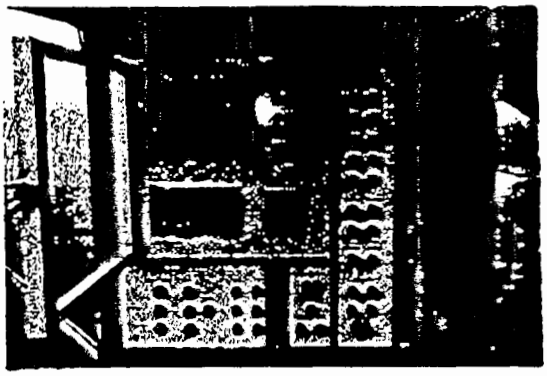


This machine can be easily adapted to fill ready mix trucks.

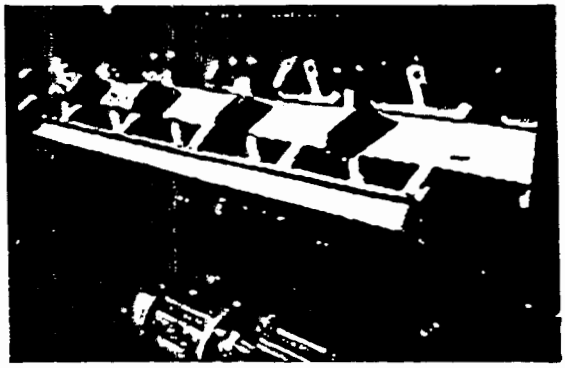




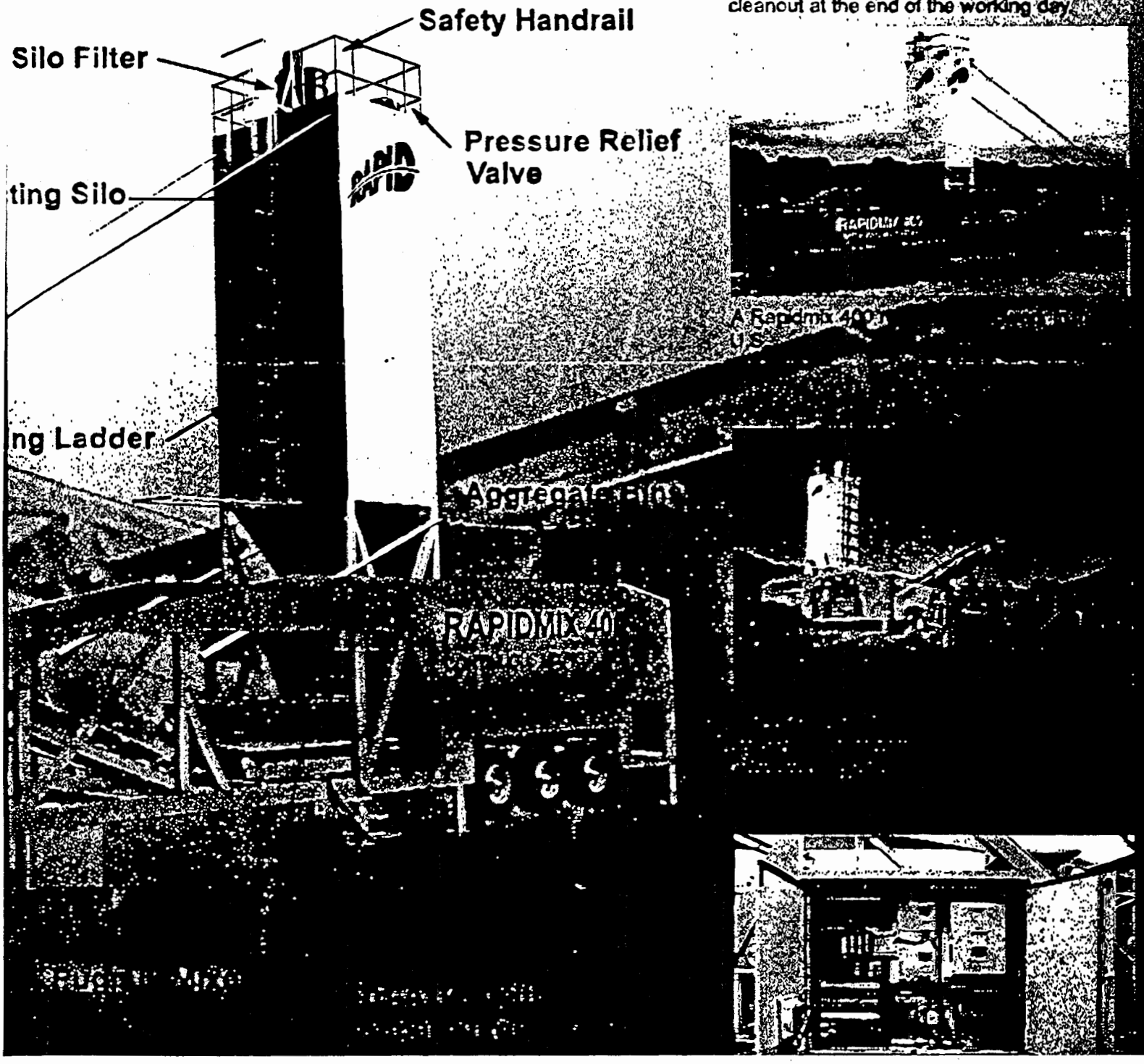
: work at Lake

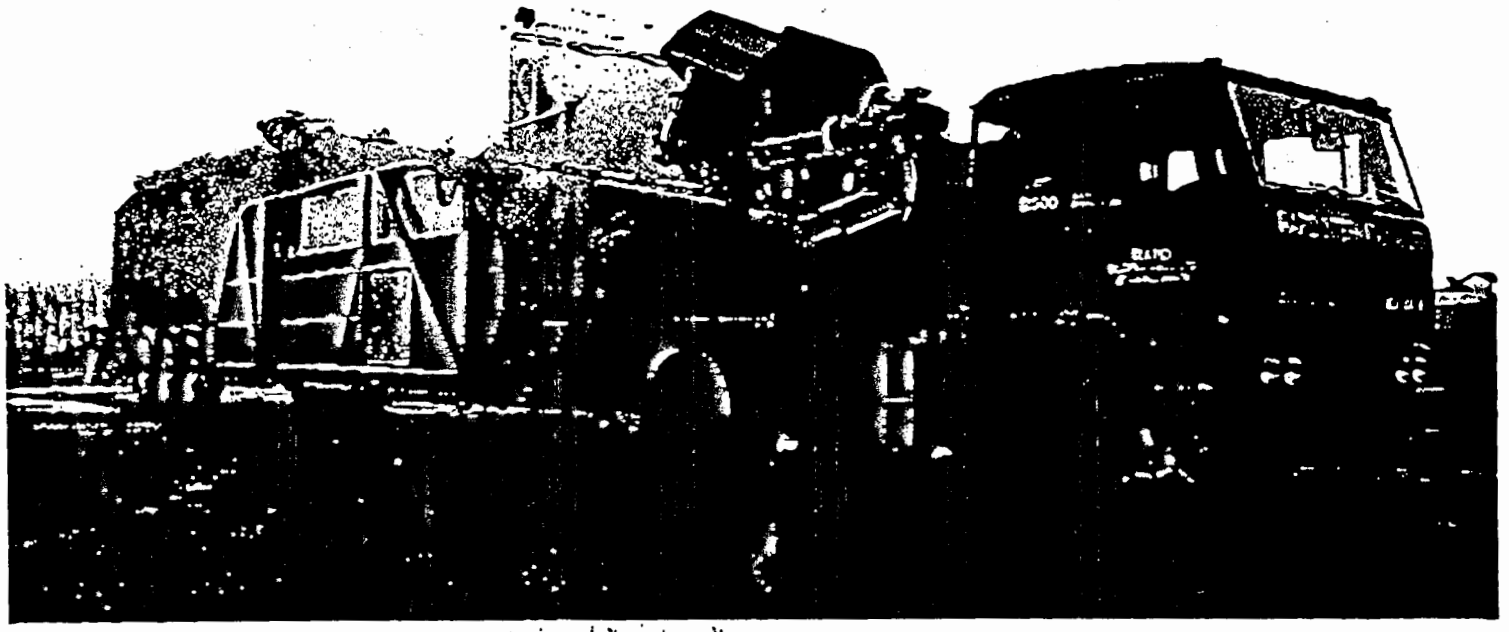


All the Rapidmix 400's functions are controlled at one place.

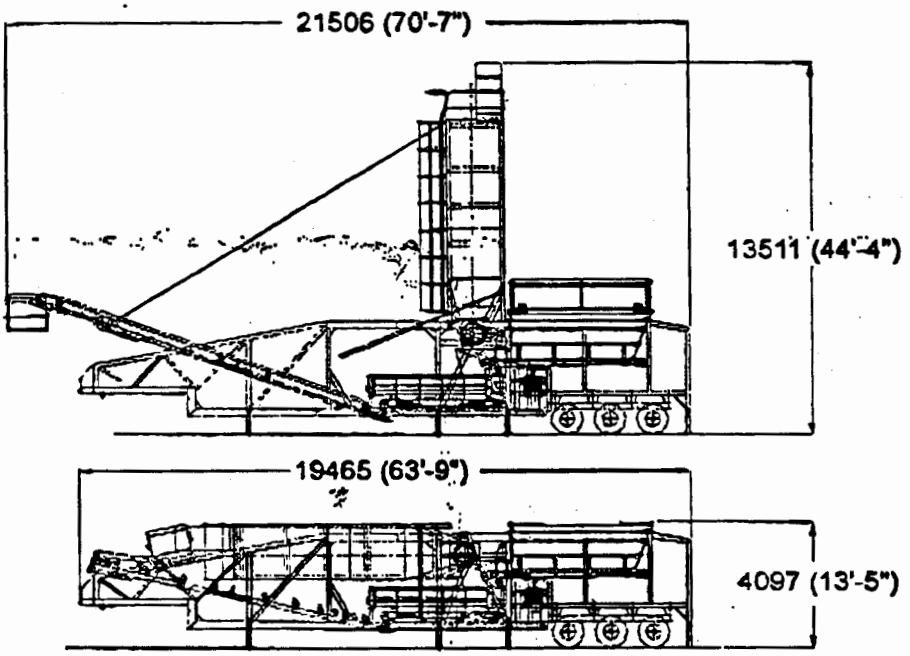


The twin shaft pugmill mixer is capable of mixing 400 TPH and the hydraulically operated side doors are lined with rubber. The floor of the mixer is a conveyor to ease cleanout at the end of the working day.





Rapidmix 400 in transport mode



Your Local Rapid Dealer

Rapid International USA, Inc.
7081 Brighton Boulevard
Commerce City, CO 80022
(303) 853-0068 Phone
(303) 286-1416 Fax

Head Office and Works
96 Mullavilly Road, Tandragee,
Craigavon, N.Ireland BT62 2LX
Tel: (028) 3884 0671
Fax: (028) 3884 0880

International
Tel: 44 28 3884 0671
Fax: 44 28 3884 0880

E-Mail: sales@rapidinternational.com

Attachment 7

CONSTRUCTION QUALITY CONTROL PLAN FOR VCM ACTIVITIES AT SWMU 21-011(k)

ABSTRACT

This Construction Quality Control Plan (CQCP) identifies the means by which the remediation of the Solid Waste Management Unit (SWMU) 21-011 (k) activities are controlled, verified and documented. This plan is developed within the scope of and is subordinate to the Washington Group International, Inc./Los Alamos National Laboratory Project (WGII/LANL) Contractor's Quality Management Program and complies with the applicable portions of DOE Order 414.1

The procedures covering source inspection, nonconformance item control, certification of inspection and test personnel, quality receipt inspection, measuring and test equipment, and quality control inspection and acceptance testing are in accordance with the following site quality procedures (QAP): QAP 7.1 *Procurement and Control of Purchased Items and Services,* QAP 3.1 *Managing Nonconformances, Deficiencies and Corrective Actions*, QAP 2.2 *Qualification Requirements for Inspection Personnel*, QAP 8.3 *Receipt Inspection*, QAP 8.2 *Calibration and Control of M&TE*, QAP 8.1 *Conduct and Control of Inspections and Surveillance.*

This CQCP and the WGII/LANL CQMP describes the means by which WGII will ensure that the TA-21 Operable Unit Remedial Field Investigation (RFI) Work Plan for Environmental Restoration, Department of Energy (DOE) Environmental Protection Agency (EPA) and the State of New Mexico requirements are satisfied.

This plan shall apply to all permanent installations and work. Temporary facilities, installations, and work are to be tested and inspected to the applicable item specific requirements or good construction practices, as required.

SUMMARY OF CHANGES

Revision 0, initial issue dated 07/01/02.

TABLE OF CONTENTS

ABSTRACT **2**
1.0 INTRODUCTION **5**
1.1 Purpose 5
1.2 Scope 5
1.3 Authorizing Document 5
2.0 STRIPPING, CLEARING AND GRUBBING **5**
3.0 GENERAL EARTHWORK **5**
3.1 Restoration Fill 5
3.1 Structural Fill 6
4.0 RIPRAP, GRAVEL AND SAND **7**
4.1 Contractor Hold Points 7
4.2 Contractor Witness Points 7
5.0 CONTAMINATED SOIL AND TUFF TREATMENT AND MIXING **8**
5.1 Contractor Hold Points 8
5.2 Treated Contaminated Soil And Tuff Placement 10
6.0 FINAL SITE RESTORATION: **10**
6.1 Restoration Material 10
6.2 Moisture Conditioning 10
7.0 DOCUMENTATION REQUIREMENTS: **10**
7.1 Surveillance/Inspections 10
7.2 Compressive Strength Cylinders 11
7.3 Gradation Testing 11
7.4 Density Testing 11
8.0 SUBCONTRACTOR RESPONSIBILITIES: **11**
9.0 REFERENCES **11**
10.0 ATTACHMENTS: **13**

1.0 INTRODUCTION

1.1 Purpose

This CQCP describes the methods by which the construction activities will be inspected and tested to verify compliance with specification requirements.

1.2 Scope

This plan covers the inspection and testing of materials for remedial action activities for the in situ stabilization/solidification (S/S) of contaminant hot spots at SWMU 21-011(k). The Department of Energy (DOE) and New Mexico Environment Department (NMED) has agreed that this action is a viable alternative and agreed to work with the LANL ER Project to implement this approach (ER Project Communication Record, August 14, 2001).

1.3 Authorizing Document

The authorizing document for this plan is the *WGII Construction Quality Management Program* (Ref. 1)

2.0 STRIPPING, CLEARING AND GRUBBING

Stripping, Clearing and Grubbing removal activities are monitored and controlled by the Geotechnical Engineer for acceptance, and are not part of this CQCP. Monitoring for contaminated material removal is performed by the Radiation Control Technician (RCT) and is not part of this CQCP.

3.0 GENERAL EARTHWORK

- This section is limited to uncontaminated earthwork construction.
- Restoration and Structural Fill materials are uncontaminated materials obtained from project excavations or offsite borrow sources.

3.1 Restoration Fill

3.1.1 Contractor Hold Points

- Material shall be classified as GM, GC, SW, SP, SM, or SC as tested in accordance with American Standard Testing Method (ASTM) D2487.
- Material shall be compacted to 90 percent modified proctor at +/- three percent of optimum moisture based on ASTM D1557 method D, as per ASTM D1556 or D2922 and D2216 or D3017. With one test for each 200 cubic yards, but not less than 1 test per lift for areas less than 100 square yards. One test per placement area for areas greater then 100 square yards.
- Moisture will be tested for plus or minus 3 percent of optimum.
- Material shall be free of excess moisture, organic material, debris and other deleterious material.
- Material shall be soil or crushed tuff no larger than 10 inches in diameter, thoroughly mixed to a uniform gradation. Fill may contain random large pieces or rock that are placed and surrounded completely by compacted restoration fill.

Contractor Witness Points

- Materials when placed shall be free of topsoil, roots, organic muck, salt, fill, debris and other deleterious materials and not frozen, as determined by visual determination by the QCT. Materials will not be placed, spread or compacted during adverse weather.
- Excavations and grading shall maintain a tolerance from plus 0.3 to minus 0.2 feet for horizontal and slope planes unless otherwise indicted per Spec. 02300 Earthwork. Once excavation is complete, it will be examined by the Geotechnical Engineer for unstable material.
- Placement:
  - Restoration material placed over treated waste shall be in 12-inch thick nominal compacted lifts.
  - Material shall be compacted to 90% Modified Proctor (one moisture density test shall be performed for each 500 cubic yards per material type, and for each change in material as determined by the QCT) at +/- 3% of optimum moisture, per ASTM D 1556 or D 2922 & D 2216 or D 3017. Material density/moisture testing frequency shall be one test for each 200 cubic yards placed, but not less than 1 test per lift for areas greater than 100 square yards. Performance testing (roller pass verification) may be performed in lieu of density testing if a correlation can be established for number of roller passes required to meet the required minimum density requirement. A minimum of three passing density tests is required per material type. Where areas are limited 4-inch lifts will be placed with hand-held compactors to achieve specified compaction. Verification of roller pass comparison and compaction to density test results will be documented by the QCT.

3.1 Structural Fill

3.2.1 Contractor Hold Points

- Material shall be classified as SP or SM as tested in accordance with ASTM D2487. Soil shall be free of topsoil, roots, organic muck, debris or other deleterious materials.
- Gradation:
  - No more than 15% may be retained on a No. 4 sieve. One test each 200 cubic yards, but not less than one test per lift.
- Material shall consist of soil only, and be free of topsoil, roots, organic muck, salt, fill, debris and other deleterious materials, as determined by visual determination by the QCT.
- Material shall be compacted to 90% Modified Proctor at +/- 3% of optimum moisture (based on ASTM D1557 Method D) per ASTM D 1556, or D 2922 & D 2216 or D 3017. In-place material density/moisture-testing frequency shall be one test for each 200 cubic yards placed, but not less than 1 test per lift. Performance testing (roller pass verification) may be performed in lieu of density testing if a correlation can be established for number of roller passes required to meet the required minimum density requirement. A minimum of three passing density tests is required per material type. Verification of roller pass comparison to density test results will be documented by the QCT.

4.0 RIPRAP, GRAVEL AND SAND

4.1 Contractor Hold Points

Contractor hold points that are needed for the contractor to conduct the necessary inspections; sampling and tests are listed below:

- Particle-size test results-Four weeks prior to hauling on site
- Certificate of Conformance-Four weeks prior to hauling on site.
- Road Base and Surfaces-1 Inplace Moisture test every two hours per 1,600 square yards of surface area, but not less than 1 test per construction area or patched area. Moisture will be maintained +/- 2 percent of optimum and compaction will be performed with a 10 ton smooth drum roller with 4 passes.
- Ditch Bedding Material-1 Inplace Moisture test for 200 cubic yards placed per construction area. Moisture will be maintained +/- 3% of optimum. Based on ASTM D1557 method D. Compaction will have 3 passes of a vibrating plate compactor.
- Riprap gradation is course Aggregate standard size 1 per AASHTO M43

U.S. Standard Sieve Size (Square Openings)	Percent Passing (by Weight)
4-inch	95 to 100
3-inch	50 to 100
2-inch	10 to 65
1-inch	0 to 15
½-inch	0 to 5

The shape will be at least 75 percent of the material by weight shall be such that the minimum dimension is not less than 1/3 of the maximum material. It will be free of organics, deleterious material, clay balls and friable particles.

Road surfacing and bedding in NMSHTD standard for Highways and Bridges Section 304, type 1.

U.S. Standard Sieve Size (Square Openings)	Percent Passing (by Weight)
1-inch	100
¾-inch	80 to 100
3/8-inch	-
#4	30 to 60
#10	20 to 45
#200	3 to 10

2 ff. a minimum of two fractured faces on more than 50% of the material on #4.

4.2 Contractor Witness Points

Contractor witness points are as follows:

- Initial monitoring of processed material at the borrow source to ensure acceptable materials are being processed.
- Riprap, bedding and sand shall be tested by a commercial testing laboratory prior to delivery, in accordance with the following (the appropriate ASTM method shall be used based on the particle size of the sample materials:

Testing	Designation
Petrographic Examination	ASTM D4992 (94)
	C295 (90)
Specific Gravity (Saturated Surface Dry Basis)	ASTM C127-88 (1993)
	C128 (93)
Absorption	ASTM C127 (93)
	C128-93
Soundness (5 cycles)	ASTM C88-90
	D5240
Abrasion (100 Rev.) Modified	ASTM C131-89
	C136-96
	D422-63 (1990)

- An RQS score of no less than 65 is required.
- Inspection, including sampling and testing of processed materials at borrow source shall be monitored during acquisition and production to ensure acceptability of materials prior to transportation to the site.
- A minimum set of one gradation test for the initial 10,000 cubic yards of material produced. If over 10,000 cubic yards are required, perform on equal quantities of material produced but not less than one test per each 10,000 cubic yards.

5.0 CONTAMINATED SOIL AND TUFF TREATMENT AND MIXING

5.1 Contractor Hold Points

Material being mixed shall be classified as SM, SC, SP and SW as tested in accordance with ASTM D2487 and/or welded volcanic ash.

Additives will consist of Portland cement type IA, IIA or I/ IIA and Sodium bentonite that will be a high quality powder and free of contaminants.

Ratios for treated soil and tuff are based on dry weight of processed material and will be adjusted based on soil moisture. Ratios will not vary more than 1 percent by weight.

Soil/tuff composite 60:40

Soil and tuff composite/portland 10:1

Soil and tuff composite/sodium bentonite 32:1

Premix soil/water 4.23:1

Material will be composed of contaminated soil and crushed tuff. This material will be processed through a mobile Rapid Mix 400 Plant and batched no more than intervals of 10 cubic yards.

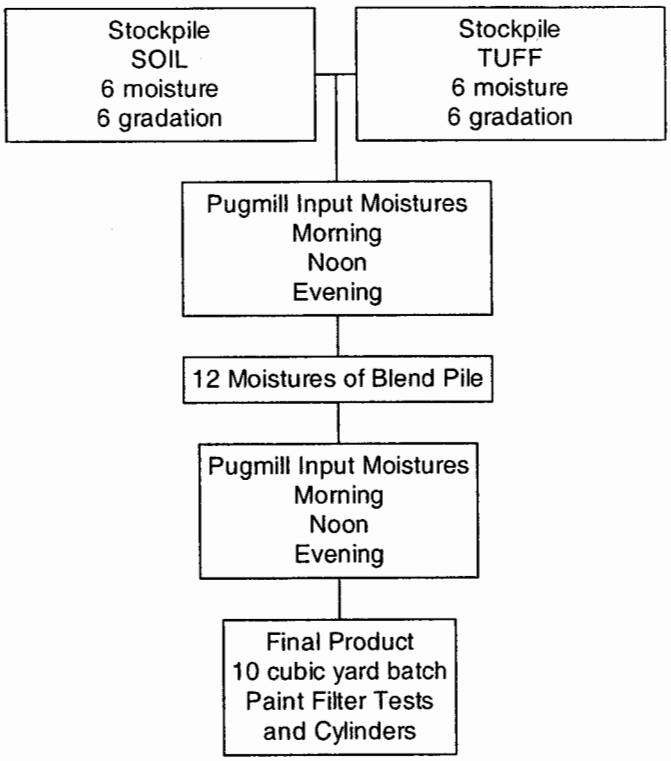
During processing contaminated soil and tuff shall be crushed, pulverized and reduced to 100 percent passing the 3-in. sieve, uncontaminated over-sized tuff boulders greater than 6 inches in diameter will be utilized for soil restoration on slopes steeper than 2:1. Durability of the tuff boulder will be determined by a moderate blow using a 2 pound sledgehammer.

The contaminated soil material will be excavated and stockpiled. During excavation, the material will be examined for no more than 1% organic material by weight. Six moistures and six gradations will be performed on the stockpile materials based on ASTM D4643 and ASTM D422.

The contaminated tuff material will be excavated and stockpiled. During excavation, the material will be examined for no more than 1% organic material by weight. Six moistures and six gradations will be performed on the stockpile materials based on ASTM D4643 and ASTM D422.

Materials from the two stockpiles will be mixed at a 60:40 soil/tuff ratio along with the sodium bentonite using the Rapid Mix 400 to produce a uniform material and re-stockpiled. During that process, moisture tests will be performed in accordance with ASTM D4643 once in the morning, once in the afternoon, and once prior to shutdown.

After all contaminated materials have been metered and blended with the bentonite, the secondary stockpile will then be thoroughly blended and mixed with portland cement through the Rapid Mix 400 to produce a uniform material. Moistures will be performed three times throughout the day in accordance with ASTM D4643.



No moisture conditioning is allowed and should it rain cover the exposed area immediately with a tarp.

During initial start-up, one cement test will be performed in accordance with ASTM D2901 to verify the Rapid Mix 400 Plant.

Minimum testing required per day of operation consists of the following:

- One particle-size analysis in accordance with ASTM D422 and visual observation for organic contamination per each batch mix.
- One moisture content in accordance with ASTM D2487 or D4643 on each batch prior to mixing of additives and soil.
- One set of four cylinders of treated grout mix will be prepared for each day of operation in accordance with ASTM D632 or D1633 and 1 paint filter test performed in accordance with EPA 9050A when cylinders are produced.

5.2 Treated Contaminated Soil And Tuff Placement

Material shall be spread to form 8-in. compacted lifts.

Compaction shall be performed with a minimum 10,000-lb. vibratory smooth drum roller with the vibrator on.

Place treated material in a lift of uniform thickness within a single area for each day's production.

Minimize the formation of cold joints in the treated material by maintaining continual production for each day treated material is produced. Stagger cold joints caused by interruption of production so they do not coincide with underlying lifts.

Complete placement and compaction of an entire lift of treated material over the bottom of the placement area prior to placing the next lift.

Working of treated material is limited to six hours following mixing to complete compaction activities. To prevent damage, do not allow equipment near completed lift for 16 hours.

Each lift shall be compacted with a minimum of four passes; a pass is defined as the travel of the roller up and down the lift once.

6.0 FINAL SITE RESTORATION:

6.1 Restoration Material

Restoration material will be Hackory loam (silty sand) soil and crushed tuff along with in situ clean excavated.

6.2 Moisture Conditioning

Prior to compaction, the material shall be moisture conditioned to optimum, +/-3 % (Based on ASTM D1557, Method D). Material shall be placed in 12-in. loose lifts and compacted with 6 passes of a minimum 8,000-lb. lug footed vibratory roller.

7.0 DOCUMENTATION REQUIREMENTS:

7.1 Surveillance/Inspections

Daily Surveillance/Inspections shall be performed by the WGII Quality Representative to verify that quality-related activities have been performed in accordance with the requirements of the design specifications, this plan, and the Contractor's Quality Management Program (Ref.1) and documented on Surveillance Checklists.

7.2 Compressive Strength Cylinders

Compressive strength cylinders of processed S/S material will be cast, and documented by the WGII Quality Representative on the Surveillance Checklist, noting the lift represented and location (quadrant), date and number of cylinders cast.

7.3 Gradation Testing

Gradation testing of materials to be used as clean cover will be performed by the geotechnical subcontractor and documented on material gradation reports.

7.4 Density Testing

In-place density testing of compacted clean materials will be performed by the geotechnical testing subcontractor and documented on density report forms.

8.0 SUBCONTRACTOR RESPONSIBILITIES:

Subcontracted Quality Control testing shall be performed by a qualified laboratory meeting the requirements of ASTM D3740-95 and ASTM E329-956. The subcontractors Quality Assurance Program shall be evaluated and approved by WGII prior to start of testing. Subcontract QC personnel shall work to their approved program and this CQCP. Subcontractor's test report forms shall be used except where WGII supplied test report forms are provided.

Original reports for tests performed off site shall be reviewed by the subcontractor and submitted to WGII for review and approval within 5 days of completing the tests. Results of tests performed on site shall be provided to the QGII QAT the same day the test is completed.

9.0 REFERENCES

A. *WGII Contractors Quality Management Program*

B. **ASTM:** American Society for Testing and Materials

ASTM C33 *Specification for Concrete Aggregates*

ASTM C88-90 *Standard Test Method for Test for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine*

ASTM C117 *Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing*

ASTM C127-88 (1993) *Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate*

ASTM C128-93 *Standard Test Method for Specific Gravity and Absorption of Fine Aggregate*

ASTM C131-89 *Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine*

ASTM C136-96 *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates (Rulers or Templates may be substituted for sieves for particles larger than 3 inches)*

ASTM C295-90 *Standard Guide for Petrographic Examination of Aggregates for Concrete*

ASTM D75-87 (1992) *Standard Practice for Sampling Aggregates*

ASTM D420-93 *Standard Guide to Site Characterization for Engineering Design and Construction Purposes*

ASTM D422-63 (1990) *Standard Test Method for Particle-Size Analysis of Soils*

ASTM D558-82 *(1990) Standard Test Methods for Moisture-Density Relations of Soil-Cement Mixtures*

ASTM D559-89 *Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures*

ASTM D1140 *Standard Test Method for Amount of soils finer than the No. 200 Sieve*

ASTM D1556 *Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method*

ASTM D1557 *Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort*

ASTM D1632-87 *Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory*

ASTM D1633-84 *Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders*

ASTM D2216 *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*

ASTM D2487 *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

ASTM D2901-93 *Standard Test Method for Cement Content of Freshly Mixed Soil-Cement*

ASTM D2922 *Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)*

ASTM D3017 *Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)*

ASTM D3740-95 *Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*

ASTM D4318 *Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*

ASTM D4643 *Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method*

ASTM D4992-94 *Standard Practice for Evaluation of Rock to be Used for Erosion Control*

ASTM D5240-92 *Standard Test Method for Testing Rock Slabs to Evaluate Soundness of Riprap by Use of Sodium Sulfate or Magnesium Sulfate*

ASTM E29-93a *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

ASTM E329-95b *Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction*

C. OSHA: Occupational Safety and Health Administration

OSHA 29 CFR 1926 *Safety and Health Regulations for Construction*

OSHA 29 CFR 1910 *Occupational Safety and Health Standards*

D. DOE ORDERS:

414.1 *Quality Assurance*

E. Environmental Protection Agency (EPA)

EPA Test Method 9050A, Paint Filter Liquids Test

F. New Mexico State Highway and Transportation Department (NMSHTD)

Standard Specifications for Highway and Bridge Construction (2000)

PROCEDURES (Check titles when revised procedures are issued)

QAP 2.1 *Indoctrination and Training*

QAP 2.2 *Qualification Requirements for Inspection Personnel*

QAP 3.1 *Identification and Control of Deviations*

QAP 3.2 *Trend Analysis*

QAP 3.3 *Lessons Learned*

QAP 4.1 *Site Document Control*

QAP 6.1 *Design Control*

QAP 7.1 *Procurement and Control of Purchased Items and Services*

QAP 7.3 *Supplier and Subcontractor Assessment*

QAP 8.1 *Conduct and Control of Inspections and Surveillance*

QAP 8.2 *Calibration and Control of M&TE*

QAP 8.3 *Receipt Inspection*

10.0 ATTACHMENTS:

ATTACHMENT A *Daily Surveillance/Inspection Form*

ATTACHMENT B *Gradation Test Report Form (to be provided by vendor)*

ATTACHMENT C *Inplace Nuclear Density/Moisture Content Test Report Form (to be provided by vendor)*

ATTACHMENT D *Microwave/Conventional Oven Moisture Correlation Form (to be provided by vendor)*

ATTACHMENT E *Microwave Oven Moisture Content Form (to be provided by vendor)*

ATTACHMENT A

Example of Surveillance/Inspection Report Form

Washington

WGII/LANL PROJECT SURVEILLANCE/INSPECTION REPORT

_____ Surveillance Task order:

_____ In-Process Work Contractor:

_____ Other Location/Area:

_____ Inspection

Activities/Item(s) Monitored:

M&TE Used:

Surveillance/Inspection Item:

Surveillance Results:

__ Satisfactory ___ Corrective Action Required _____

Quality Control Engineer/Specialist

Date

NCR No. or DR (if required)_____

Follow-up (if required):

14

PQM Remarks:

PQM Review:__16

Signature and Date

QAP 8.3.1 R1