Soil Stabilization/Solidification Grout Mix Design Study for the C-, K-, L-, and P-Reactor Seepage Basins Closure Final Report

by

P. Nakagawa

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

DOE Contract No. **DE-AC09-96SR18500**

This paper was prepared in connection with work done under the above contract number with the U. S. Department of Energy. By acceptance of this paper, the publisher and/or recipient acknowledges the U. S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper, along with the right to reproduce and to authorize others to reproduce all or part of the copyrighted paper.

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-96SR18500 with the U. S. Department of Energy.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents 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 United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced directly from the best available copy.

Available for sale to the public, in paper, from: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161,
phone: (800) 553-6847,
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/help/index.asp

Available electronically at http://www.osti.gov/bridge
Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from: U.S. Department of Energy, Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831-0062,
phone: (865)576-8401,
fax: (865)576-5728
email: reports@adonis.osti.gov

United States Department of Energy

Savannah River Site

SOIL STABILIZATION/SOLIDIFICATION GROUT MIX DESIGN STUDY FOR THE C-, K-, L-, AND P-REACTOR SEEPAGE BASINS CLOSURE FINAL REPORT (U)

CLASSIFICATION CANCELLED

WSRC-RP-99-4075

Revision 1

August 1999

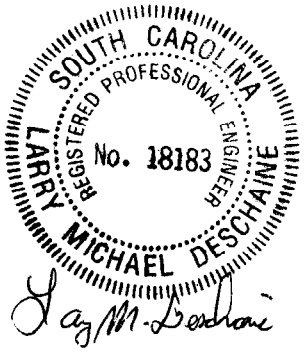
Westinghouse Savannah River Company
Savannah River Site
Aiken, S.C. 29808

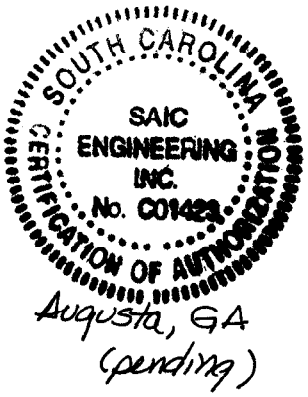
SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

Prepared for U.S. Department of Energy Under
Contract DE-AC09-96SR18500

This report documents the laboratory bench-scale soil stabilization/solidification design study performed for Westinghouse Savannah River Company under Contract C001311N by Science Applications International Corporation (SAIC) Engineering, Inc. Factors out of SAIC's direct control affect the scalability from bench scale testing to full field applications, including, but not limited to; basin variability, mixing type and application, and experience of the S/S contractor. SAIC does not warrant, guarantee, or assume any responsibility for full-scale field application of the recommended mixes.

Larry M. Deschaine, PE
SC PE# 18183





Augusta, GA
(pending)

EXECUTIVE SUMMARY

At the Savannah River Site (SRS), reactor seepage basins received low-level radioactive purge water from the disassembly basins between 1957 and 1991. Almost all of the radioactivity was due to tritium which migrated quickly from the basins via leaching. Most of the remaining radioactivity is associated with cesium-137 (Cs-137), strontium-90 (Sr-90), and plutonium-239/240 (Pu-239/240). These constituents are present in soils immediately beneath each basin.

Although the natural properties of the local soils tend to immobilize these constituents within a few feet of the bottom of the basin, in-situ stabilization/solidification (S/S) treatment has been selected to supplement the natural retention properties of the local soils. This treatment process combines the soil with a grout mixture to form a reduced permeability material which further reduces contaminant mobility. Following stabilization of contaminated soils, each basin is then provided with drainage control, such as a geotextile membrane or other acceptable means, backfilled, and the surrounding area contoured to reduce the infiltration of rain water above the stabilized monolith.

This Revision 1 report documents the results of a bench-scale study conducted by SAIC under Contract No. C001311N to develop a grout mix capable of stabilizing the constituents of concern via the S/S treatment of the soils for reactor seepage basins at four SRS locations: C-Area (CRSB), K-Area (KRSB), L-Area (LRSB), and P-Area (PRSB). It recommends a specific grout mix for each reactor seepage basin and provides recommendations, limitations, and constraints for the full-scale field implementation.

Based on a review of literature and previous stabilization studies conducted at SRS, four grout mixes were selected for study. Portland cement, the basic ingredient, was combined with bentonite alone, silicate alone (four percent by weight), bentonite with silicate (four percent by weight), and silicate alone (two percent by weight).

The general geologic settings of the four seepage basins are very similar. However, a significant degree of variability was observed within each basin, with soils ranging from sands to clays. Therefore, the possible variability in lithology within a reactor seepage basin was a primary consideration in developing the technical approach for the study.

Soils from CRSB and PRSB were divided or segregated to represent the range of lithology within the sample material: coarse (sandy), primarily fine (clayey), and the overall bulk

combination of coarse and fine soil material (bulk fractions). Soils from KRSB and LRSB were segregated into only coarse and fine fractions. The grout mixes were evaluated on each soil fraction from each reactor seepage basin.

The tests performed under this study fall into three general categories: (1) geotechnical tests, (2) chemical characterization, and (3) S/S performance testing.

With respect to geotechnical testing, the particle size of the soils showed variation in the amounts of silt and clay, as shown in Table ES-1. Although soils at each basin exhibit a range in type, CRSB soils were found to have the higher percentage of sands while PRSB and LRSB have higher clay contents. The smaller sized particles (silts and clays) are important, since particle size distribution appears to be important to the grout set process and may effect the hydraulic conductivity of the treated material.

The chemical and radiological characterization of the soils performed during this study showed that:

- Chlorides, nitrates, nitrites, sulfates, and sulfites are not present at levels which would have an inhibitory effect on the cementitious reactions during the curing of Portland cement.
- Cs-137 and Sr-90 were present at moderate levels in C-, K- and PRSB (174 - 2040 pCi/g of Cs-137 and 5 – 26 pCi/g of Sr-90)
- Pu-239/240 was present at low levels (0.2 – 4.1 pCi/g)
- LRSB soils had low levels of radioactivity: <2 pCi/g of Cs-137, <0.4 pCi/g of Sr-90, and <0.06 pCi/g of Pu 239/240

Soils from each of the basins were mixed with each of the four grout mixes under evaluation. The treated material was tested to evaluate how effectively each formulation met the performance objectives. Tables ES-2 through ES-5 list the performance objectives and present the results of this testing for each basin by soil fraction. Tables ES-6 through ES-9 list the performance objectives and present the results by grout formulation for each soil fraction. Tables ES-10 and ES-11 show the average hydraulic conductivity values by grout formulation for each reactor seepage basin. Key findings of the performance testing are:

- Unconfined compressive strength (UCS) requirements were met by all mix formulations for all soil fractions.

- The leach indices for all formulations met requirements and were at least 2 orders of magnitude above the performance requirement. This indicates the COCs are immobilized within the grout mix for all formulations for all soil fractions.

- Shrink/swell, volume increase, pH, temperature rise, false set, and bleed fluid criteria were met by all formulations for all soil fractions at all reactor seepage basins.

- Set time met or exceeded the criterion for all formulations and all soil fractions, except for the LRSB formulations.

- For CRSB (16 soil/mix formulations), the hydraulic conductivity after 28 days of curing ranged from $6x10^{-7}$ to $9x10^{-9}$ centimeters/second (cm/sec).

- For KRSB (eight soil/mix formulations), the hydraulic conductivity after 28 days of curing ranged from $2x10^{-6}$ to $2x10^{-9}$ cm/sec.

- For LRSB (eight soil/mix formulations), the hydraulic conductivity after 28 days of curing ranged from $3x10^{-8}$ to $5x10^{-10}$ cm/sec.

- For PRSB (16 soil/mix formulations), the hydraulic conductivity after 28 days of curing ranged from $6x10^{-8}$ to $4x10^{-10}$ cm/sec.

- Following water immersion for 90-days, the formulations for experienced a one to two order-of-magnitude increase in hydraulic conductivity:

  CRSB ranged from $2x10^{-5}$ to $5x10^{-8}$ cm/sec

  KRSB ranged from $1x10^{-5}$ to $9x10^{-7}$ cm/sec

  LRSB ranged from $2x10^{-6}$ to $9x10^{-9}$ cm/sec

  PRSB ranged from $3x10^{-6}$ to $4x10^{-7}$ cm/sec

As highlighted in Tables ES-2 through ES-9, with the exception of the hydraulic conductivity results and the set time for the LRSB, all performance criteria were met by each formulation for each soil fraction for all four reactor seepage basins. While at least one formulation for CRSB and KRSBs met the performance criterion for the 28-day hydraulic conductivity, the observed 28-day values did not consistently achieve a hydraulic conductivity of $1x10^{-8}$ cm/sec.

The hydraulic conductivity performance criterion was met by three of the formulations in every soil fraction for LRSB and PRSB. As shown in Table ES-10, the average hydraulic conductivity of at least one formulation met the performance criterion in KRSB, LRSB, and PRSB. For CRSB, the average hydraulic conductivity for all formulations was an order of magnitude higher than the performance criterion.

The 28-day hydraulic conductivity test results showed a large variability, with no clear pattern related to grout mix or soil fraction. The variability observed in the 28-day tests is attributed to the resolution and repeatability of the technique using these soil types. No additional testing of these grout mixes is recommended for CRSB, since the formulations meet all of the other desired criteria and there is no clear increase or decrease in hydraulic conductivity with any of the mix formulations.

Table ES-11 illustrates that none of the formulations for any soil fraction was able to achieve a hydraulic conductivity of $1x10^{-8}$ cm/sec after immersion in water for 90 days. The increase in hydraulic conductivity occurred in all soil types and all formulations.

Importantly, the 90-day immersion test is not representative of post treatment conditions at any of the reactor seepage basins. The true water table at each basin is well below the contaminated soils, and the perched zones that are now present at some of the basins will not be present after the soils are stabilized and the basins have been backfilled and sloped for proper drainage. Consequently, while the measured 90-day immersion hydraulic conductivity values do not meet the performance objectives, this test does not represent expected field conditions and should not form the basis for modification of formulations that fulfill the requirements of more representative field conditions.

The set time for all formulations for the LRSB soil fractions did not meet the performance criterion. A set retarder may be necessary during full-scale implementation at LRSB, and this should be determined during a pilot test prior to full-scale implementation.

With these qualified exceptions, the performance tests showed that all four mixes met all performance criteria. For those criteria that were not met, no clear correlation was found to suggest that these could be obtained without an adverse impact on other criteria. Therefore, reagent cost was used as the primary basis to select the recommended formulation. Based on the results of the bench scale tests a formation with 15% Portland cement and 5% bentonite by weight in the final treated material is recommended for the full-scale treatment of the CRSB, KRSB, LRSB, and PRSB soils.

While the final detailed methodology will be determined by the successful contractor for the full scale work, the following discussion may provide useful insight into successful S/S practices. To be effective, the grout mix must be thoroughly mixed with the contaminated soil. The clay content of the soils will require high speed, high shear mixing. A dual auger mixer would produce the high energy, high shear mixing required to adequate mix the grout and soils. Excavators or rake-like attachments on excavators would not produce the high energy, high shear mixing required. Jet-grouting has been effective in sandy soils, but has had inadequate mixing results in soils with higher clay contents. Therefore, the latter two delivery systems are not recommended. To ensure a complete grout monolith, the construction process should follow specific procedures:

- Multiple auger passes at each column should be made to completely mix the grout throughout the column. Two thirds of the grout volume should be injected during the initial downward pass and the remainder injected during the initial upward pass.

- An overlap between the columns is necessary to ensure the all of the contaminated soil is treated. The overlap volume should be between five and ten percent. Mapping of the column placement on the surface profile of each reactor seepage basin will verify that the overlap volume will be between five and ten percent.

- The auger position for each column should be precisely located by survey equipment and recorded to verify a consistent overlap of columns.

- A batch plant capable of providing an individual grout batch for each column or sets of columns should be used.

- The weights of Portland cement and bentonite and the volume of water should be recorded for each grout batch and controlled to within plus or minus one percent of the desired value as evaluated in the final bench scale study.

- The amount of water can be modified to adjust the viscosity of the grout to match the S/S vendor's batching, grout pumping and mixing equipment.

- Each grout batch should be used within a maximum of 2 hours of batching. The results of the bench scale testing suggest that a retarder will not be needed at CRSB, KRSB, or PRSB, but a retarder may be needed at LRSB. If a set retarder is used at any of the reactor seepage

basins, the effect of the set retarder on the performance of the treated material should be determined during pilot testing.

- Temperature and soil moisture are both known to affect grout mixes as they set. The following guidance is provided for dealing with changing ambient conditions during full-scale implementation.

  Modification of the S/S treatment will not be required as long as the moisture content of the soil is greater than 10% (dwb). If the soil requires the addition of water to prevent drying and cracking of the grout-treated soil, water can be added directly to the soil or by adjusting the volume of water added to the grout. (Variability of soil moisture content within a 11 to 20% range had little to no effect on the S/S testing results.)

  The core and surface temperatures of the treated material should be monitored to determine temperature rise during full-scale treatment and compared with predictions. The S/S temperature, temperature gradients, and rate of temperature change should remain within final grout design parameters to prevent cracking of the grouted soil. Common industrial practice is to control the rate of temperature change and keep the surface temperature within final grout design parameters to minimize cracking of the grouted soil. If higher temperatures are encountered, additional water may be added to the grout mix to serve as a heat sink and other temperature control means or methods may be used.

  Field operations should cease when temperatures fall below 32°F.

  Ambient temperatures above 100°F may accelerate the reaction rates and ruin the final product and may affect the viscosity and pumpability of the grout. Additional water or a set retarder may be added to the grout mix to decrease the viscosity and increase the pumpability of the grout.

- To meet unique vendor requirements, limited field refinement of the grout mix may be done to adapt the grout mix to the batching, grout pumping, and mixing equipment. This should be limited only to the addition of water or the use of a set retarder.

- Additional water can be added only to account for low soil moisture content, to lower the temperature rise of grouted soil, or to decrease the grout viscosity.

- A set retarder may be used to prolong the time between batching and injection of the grout mix or to decrease the viscosity of the grout. If a set retarder is used, field pilot testing

should be conducted to determine the effect of the set retarder on the performance of the treated material.

The daily system operation cost for the S/S treatment of a cubic yd of soil is estimated to be approximately $115, based on daily production rates for a single auger system. The estimated unit cost does not include fixed project costs nor ancillary costs associated with the project, such as air permits for the batch plant, administrative and support costs (site preparation, administrative staff, etc.), mobilization and demobilization, analytical costs for treated material and grout mix samples, nor any contingency for project uncertainties. The estimate was compared to unit costs contained in *Environmental Cost Handling Options and Solutions (ECHOS)* by R. S. Means. While direct comparison was not possible; units costs for equipment, labor, and material in ECHOS were comparable to those used to develop the above estimate.

Table ES-1. General Particle Size Distribution

Location	Gravel	Sand	Silt	Clay
CRSB	4 %	75 %	6 %	15 %
KRSB	1 %	70 %	11 %	15 %
LRSB	2 %	67 %	10 %	21 %
PRSB	4 %	68 %	8 %	20 %

ES-2. CRSB Data Summary by Soil Fractions

Parameter	Desired Criteria	Formulation[2] 1				Formulation[2] 2				Formulation[2] 3				Formulation[2] 4			
		Fractions[1]				Fractions[1]				Fractions[1]				Fractions[1]			
		CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2
UCS after 14 days	>100 psi	389.5	251.4	419.9	382.2	224.4	481.8	405.2	335.3	367.4	302	336.4	280.9	451.8	289	345.8	427.9
UCS after 28 days	>100 psi	399.7	237	354.6	379.1	347.7	487	420.3	424.3	388.9	360.8	351.5	378.6	410	410.7	361	504.1
UCS 90 days immersion	>100 psi	440.9	372.4	342.3	289.6	581.9	244.4	481.8	531.7	462.6	355.1	472.4	365.2	478	460.8	590.1	517.2
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$3x10^{-7}$	$6x10^{-7}$	$2x10^{-8}$	$2x10^{-7}$	$3x10^{-7}$	$4x10^{-7}$	$1x10^{-8}$	$2x10^{-7}$	$3x10^{-7}$	$4x10^{-7}$	$9x10^{-9}$	$3x10^{-7}$	$3x10^{-7}$	$1x10^{-8}$	$2x10^{-7}$	$3x10^{-7}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$7x10^{-8}$	$4x10^{-6}$	$2x10^{-5}$	$9x10^{-7}$	$6x10^{-7}$	$1x10^{-6}$	$8x10^{-7}$	$4x10^{-7}$	$5x10^{-8}$	$3x10^{-6}$	$4x10^{-6}$	$9x10^{-7}$	$3x10^{-7}$	$8x10^{-7}$	$1x10^{-7}$	$2x10^{-7}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.24	0.03	3.38	4.29	0.28	0.79	0.44	0.71	1.34	1.35	2.89	0.32	1.36	2.29	1.09	1.01
Leach Index – Gross Alpha	>8.0	11.4	11.5	12.8	11.9	12.1	12.2	12.4	12.7	11.4	11.7	11.8	11.9	12.3	12	12.8	12
Leach Index – Non-volatile Beta	>8.0	9.9	10	11.2	9.8	10.3	10.5	11	10.2	9.8	10	10.5	10.2	10.4	10.4	11.1	10.4
Volume Increase (%)	<50%	39	32	30	28	38	25	26	25	44	41	37	36	47	41	33	36
pH	>10.0	12.3	12.4	12.3	12.3	12.7	12.8	12.8	12.7	12.5	12.6	12.6	12.6	12.8	12.7	12.6	12.7
Temperature Rise (C)	Not Specified	2	1.5	2	2	2	0	2	1	1	1	2	1	1	1	2	1
False Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

[1]Fractions:
CF - Coarse Fraction
FF - Fine Fraction
BF#1 - Bulk Fraction #1
BF#2 - Bulk Fraction #2

[2]Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Meets the performance criterion
Does not meet the performance criterion

ES-3. KRSB Data Summary by Soil Fractions

Parameter	Desired Criteria	Formulation[2] 1		Formulation[2] 2		Formulation[2] 3		Formulation[2] 4	
		Fractions [1]		Fractions [1]		Fractions [1]		Fractions [1]	
		CF	FF	CF	FF	CF	FF	CF	FF
UCS after 14 days	>100 psi	537.8	401.1	512.7	403.4	493.7	274.8	412.2	307
UCS after 28 days	>100 psi	500.7	412.2	619.1	372.4	532.7	318.3	541	462.2
UCS 90 days immersion	>100 psi	539.5	258.1	593.3	410.2	448.4	333.5	477.8	525.3
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$1x10^{-8}$	$2x10^{-8}$	$3x10^{-9}$	$9x10^{-7}$	$8x10^{-7}$	$2x10^{-9}$	$3x10^{-9}$	$2x10^{-6}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$4x10^{-6}$	$3x10^{-6}$	$9x10^{-7}$	$1x10^{-6}$	$1x10^{-6}$	$4x10^{-6}$	$1x10^{-5}$	$3x10^{-6}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.64	0.39	<0.01	0.34	4.11	<0.01	1.06	0.2
Leach Index – Gross Alpha	>8.0	11.7	11.6	12.1	12	12.6	12.3	12.9	12.4
Leach Index – Non-volatile Beta	>8.0	10.9	10.2	11	10.6	11	10.5	11.5	11.1
Volume Increase (%)	<50%	29	24	28	20	36	30	39	30
pH	>10.0	12.6	12.8	12.5	12.6	12.7	12.8	12.4	12.4
Temperature Rise (C)	Not Specified	2	2	1	2	2	2	2	2
False Set	Prohibited	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None

[1]Fractions:
CF - Coarse Fraction
FF - Fine Fraction
BF#1 - Bulk Fraction #1
BF#2 - Bulk Fraction #2
nd - Not determined

[2]Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Meets the performance criterion
Does not meet the performance criterion

ES-4. PRSB Data Summary by Soil Fractions

Parameter	Desired Criteria	Formulation[2] 1				Formulation[2] 2				Formulation[2] 3				Formulation[2] 4			
		Fractions[1]				Fractions[1]				Fractions[1]				Fractions[1]			
		CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2	CF	FF	BF#1	BF#2
UCS after 14 days	>100 psi	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
UCS after 28 days	>100 psi	592.3	411.1	543.4	585.3	537.3	342.4	737.1	594.4	646.8	340.1	495.2	487.7	638.1	492.2	504.8	543.1
UCS 90 days immersion	>100 psi	509.7	314.2	532.9	392.6	571.4	315.8	685.2	663.6	621.5	343.8	359.7	578.8	707.1	453	687.8	780.9
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$5x10^{-9}$	$7x10^{-9}$	$3x10^{-8}$	$3x10^{-9}$	$2x10^{-9}$	$8x10^{-10}$	$7x10^{-10}$	$6x10^{-8}$	$4x10^{-10}$	$9x10^{-10}$	$1x10^{-9}$	$5x10^{-10}$	$4x10^{-8}$	$8x10^{-10}$	$2x10^{-8}$	$2x10^{-8}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$8x10^{-7}$	$8x10^{-7}$	$4x10^{-7}$	$8x10^{-7}$	$3x10^{-6}$	$1x10^{-6}$	$6x10^{-7}$	$2x10^{-6}$	$1x10^{-6}$	$4x10^{-7}$	$9x10^{-7}$	$6x10^{-7}$	$6x10^{-7}$	$3x10^{-6}$	$1x10^{-6}$	$7x10^{-7}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	<0.01	5.54	0.28	5.48	0.99	0.53	1.38	0.73	2.72	5.33	4.52	7.18	0.55	1.14	0.81	0.02
Leach Index – Gross Alpha	>8.0	13.2	13.4	12.9	12.3	13.2	13	13.1	12.8	13.5	13	12.8	12.6	12.7	12.8	12.8	12.8
Leach Index – Non-volatile Beta	>8.0	10.2	10.6	9.8	9.6	10.8	10.9	10.4	10	10.6	10.6	10	9.8	11	11	10.8	10.3
Volume Increase (%)	<50%	37	32	37	34	39	34	42	36	40	33	49	35	42	36	43	40
pH	>10.0	12.4	12.5	12.4	12.4	12.6	12.7	12.6	12.4	12.8	12.8	12.7	12.7	12.7	12.9	12.9	12.8
Temperature Rise (C)	Not Specified	5	3	3	2	3	2	1	2	3	2	1	2	2	2	1	2
False Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

[1]Fractions:
CF - Coarse Fraction
FF - Fine Fraction
BF#1 - Bulk Fraction #1
BF#2 - Bulk Fraction #2

[2]Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Meets the performance criterion
Does not meet the performance criterion

ES-5. LRSB Data Summary by Soil Fractions

Parameter	Desired Criteria	Formulation[2] 1		Formulation[2] 2		Formulation[2] 3		Formulation[2] 4	
		Fractions [1]		Fractions [1]		Fractions [1]		Fractions [1]	
		CF	FF	CF	FF	CF	FF	CF	FF
UCS after 14 days	>100 psi	nd	nd	nd	nd	nd	nd	nd	nd
UCS after 28 days	>100 psi	473.1	490.6	639.6	376.6	607.6	417.5	509.6	546.6
UCS 90 days immersion	>100 psi	613	479.9	982.5	461.6	426.9	499.3	697	459.8
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$9x10^{-9}$	$7x10^{-10}$	$3x10^{-9}$	$7x10^{-9}$	$3x10^{-9}$	$5x10^{-10}$	$3x10^{-8}$	$2x10^{-9}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$1x10^{-6}$	$1x10^{-6}$	$2x10^{-6}$	$2x10^{-7}$	$1x10^{-6}$	$9x10^{-9}$	$2x10^{-6}$	$2x10^{-8}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.22	2.32	0.75	0.1	4.13	1.98	1.12	1.07
Leach Index – Gross Alpha	>8.0	12.6	12.8	13.1	13.1	12.4	13	12.4	13.1
Leach Index – Non-volatile Beta	>8.0	nd	nd	nd	nd	nd	nd	nd	nd
Volume Increase (%)	<50%	33	33	36	34	34	33	40	37
pH	>10.0	12.4	12.5	12.7	12.6	12.7	12.6	12.8	12.9
Temperature Rise (C)	Not Specified	3	3	1	1	1	2	0	2
False Set	Prohibited	No	No	No	No	No	No	No	No
Flash Set	Prohibited	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Set Time (hours)	> 6 hours	4	4	4	4	4	4	4	4
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None

[1]Fractions:
CF - Coarse Fraction
FF - Fine Fraction
BF#1 - Bulk Fraction #1
BF#2 - Bulk Fraction #2

[2]Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Note: Leach Index for nonvolatile beta not determined since beta activities in LRSB soils were below the detection limit

Meets the performance criterion

Does not meet the performance criterion

ES-6. CRSB Data Summary by Formulations

Parameter	Desired Criteria	Coarse Fraction				Fine Fraction				Bulk Fraction #1				Bulk Fraction #2			
		Formulation[1]				Formulation[1]				Formulation[1]				Formulation[1]			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
UCS after 14 days	>100 psi	389.5	224.4	367.4	451.8	251.4	481.8	302	289	419.9	405.2	336.4	345.8	382.2	335.3	280.9	427.9
UCS after 28 days	>100 psi	399.7	347.7	388.9	410	237	487	360.8	410.7	354.6	420.3	351.5	361	379.1	424.3	378.6	504.1
UCS 90 days immersion	>100 psi	440.9	581.9	462.6	478	372.4	244.4	355.1	460.8	342.3	481.8	472.4	590.1	289.6	531.7	365.2	517.2
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$3x10^{-7}$	$3x10^{-7}$	$3x10^{-7}$	$3x10^{-7}$	$6x10^{-7}$	$4x10^{-7}$	$4x10^{-7}$	$1x10^{-8}$	$2x10^{-8}$	$1x10^{-8}$	$9x10^{-9}$	$2x10^{-7}$	$2x10^{-7}$	$2x10^{-7}$	$3x10^{-7}$	$3x10^{-7}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$7x10^{-8}$	$6x10^{-7}$	$5x10^{-8}$	$3x10^{-7}$	$4x10^{-6}$	$1x10^{-6}$	$3x10^{-6}$	$8x10^{-7}$	$2x10^{-5}$	$8x10^{-7}$	$5x10^{-7}$	$1x10^{-7}$	$9x10^{-7}$	$4x10^{-7}$	$9x10^{-7}$	$2x10^{-7}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.24	0.28	1.34	1.36	0.03	0.79	1.35	2.29	3.38	0.44	2.89	1.09	4.29	0.71	0.32	1.01
Leach Index – Gross Alpha	>8.0	11.4	12.1	11.4	12.3	11.5	12.2	11.7	12	12.8	12.4	11.8	12.8	11.9	12.7	11.9	12
Leach Index – Non-volatile Beta	>8.0	9.9	10.3	9.8	10.4	10	10.5	10	10.4	11.2	11	10.5	11.1	9.8	10.2	10.2	10.4
Volume Increase (%)	<50%	39	38	44	47	32	25	41	41	30	26	37	33	28	25	36	36
pH	>10.0	12.3	12.7	12.5	12.8	12.4	12.8	12.6	12.7	12.3	12.8	12.6	12.6	12.3	12.7	12.6	12.7
Temperature Rise (C)	Not Specified	2	2	1	1	1.5	0	1	1	2	2	2	2	2	1	1	1
False Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

[1]Formulation:

1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Meets the performance criterion
Does not meet the performance criterion

ES-7. KRSB Data Summary by Formulations

Parameter	Desired Criteria	Coarse Fraction				Fine Fraction			
		Formulation[1]				Formulation[1]			
		1	2	3	4	1	2	3	4
UCS after 14 days	>100 psi	537.8	512.7	493.7	412.2	401.1	403.4	274.8	307
UCS after 28 days	>100 psi	500.7	619.1	532.7	541	412.2	372.4	318.3	462.2
UCS 90 days immersion	>100 psi	539.5	593.3	448.4	477.8	258.1	410.2	333.5	525.3
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$1x10^{-8}$	$3x10^{-9}$	$8x10^{-7}$	$3x10^{-9}$	$2x10^{-8}$	$9x10^{-7}$	$2x10^{-9}$	$2x10^{-6}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$4x10^{-6}$	$9x10^{-7}$	$1x10^{-6}$	$1x10^{-5}$	$3x10^{-6}$	$1x10^{-6}$	$4x10^{-6}$	$3x10^{-6}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.64	<0.01	4.11	1.06	0.39	0.34	<0.01	0.2
Leach Index – Gross Alpha	>8.0	11.7	12.1	12.6	12.9	11.6	12	12.3	12.4
Leach Index – Non-volatile Beta	>8.0	10.9	11	11	11.5	10.2	10.6	10.5	11.1
Volume Increase (%)	<50%	29	28	36	39	24	20	30	30
pH	>10.0	12.6	12.5	12.7	12.4	12.8	12.6	12.8	12.4
Temperature Rise (C)	Not Specified	2	1	2	2	2	2	2	2
False Set	Prohibited	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None

[1]Formulation:

1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Meets the performance criterion
Does not meet the performance criterion

ES-8. PRSB Data Summary by Formulations

Parameter	Desired Criteria	Coarse Fraction				Fine Fraction				Bulk Fraction #1				Bulk Fraction #2			
		Formulation[1]				Formulation[1]				Formulation[1]				Formulation[1]			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
UCS after 14 days	>100 psi	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
UCS after 28 days	>100 psi	592.3	537.3	646.8	638.1	411.1	342.4	340.1	492.2	543.4	737.1	495.2	504.8	585.3	594.4	487.7	543.1
UCS 90 days immersion	>100 psi	509.7	571.4	621.5	707.1	314.2	315.8	343.8	453	532.9	685.2	359.7	687.8	392.6	663.6	578.8	780.9
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$5x10^{-9}$	$2x10^{-9}$	$4x10^{-10}$	$4x10^{-8}$	$7x10^{-9}$	$8x10^{-10}$	$9x10^{-10}$	$8x10^{-10}$	$3x10^{-8}$	$7x10^{-10}$	$1x10^{-9}$	$2x10^{-8}$	$3x10^{-9}$	$6x10^{-8}$	$5x10^{-10}$	$2x10^{-8}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$8x10^{-7}$	$3x10^{-6}$	$1x10^{-6}$	$6x10^{-7}$	$8x10^{-7}$	$1x10^{-6}$	$4x10^{-7}$	$3x10^{-6}$	$4x10^{-7}$	$6x10^{-7}$	$9x10^{-7}$	$1x10^{-6}$	$8x10^{-7}$	$2x10^{-6}$	$6x10^{-7}$	$7x10^{-7}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	<0.01	0.99	2.72	0.55	5.54	0.53	5.33	1.14	0.28	1.38	4.52	0.81	5.48	0.73	7.18	0.02
Leach Index – Gross Alpha	>8.0	13.2	13.2	13.5	12.7	13.4	13	13	12.8	12.9	13.1	12.8	12.8	12.3	12.8	12.6	12.8
Leach Index – Non-volatile Beta	>8.0	10.2	10.8	10.6	11	10.6	10.9	10.6	11	9.8	10.4	10	10.8	9.6	10	9.8	10.3
Volume Increase (%)	<50%	37	39	40	42	32	34	33	36	37	42	49	43	34	36	35	40
pH	>10.0	12.4	12.6	12.8	12.7	12.5	12.7	12.8	12.9	12.4	12.6	12.7	12.9	12.4	12.4	12.7	12.8
Temperature Rise (C)	Not Specified	5	3	3	2	3	2	2	2	3	1	1	1	2	2	2	2
False Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Flash Set	Prohibited	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Set Time (hours)	> 6 hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

[1]Formulation:

1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Meets the performance criterion
Does not meet the performance criterion

ES-9. LRSB Data Summary by Formulations

Parameter	Desired Criteria	Coarse Fraction				Fine Fraction			
		Formulation[1]				Formulation[1]			
		1	2	3	4	1	2	3	4
UCS after 14 days	>100 psi	nd	nd	nd	nd	nd	nd	nd	nd
UCS after 28 days	>100 psi	473.1	639.6	607.6	509.6	490.6	376.6	417.5	546.6
UCS 90 days immersion	>100 psi	613	982.5	426.9	697	479.9	461.6	499.3	459.8
Hydraulic Conductivity	$<1x10^{-8}$ (cm/sec)	$9x10^{-9}$	$3x10^{-9}$	$3x10^{-9}$	$3x10^{-8}$	$7x10^{-10}$	$7x10^{-9}$	$5x10^{-10}$	$2x10^{-9}$
Hydraulic Conductivity 90 days immersion	$<1x10^{-8}$ (cm/sec)	$1x10^{-6}$	$2x10^{-6}$	$1x10^{-6}$	$2x10^{-6}$	$1x10^{-6}$	$2x10^{-7}$	$9x10^{-9}$	$2x10^{-8}$
Shrink/Swell (% of 28 day failure strain)	<25% of 28-day UCS failure strain	0.22	0.75	4.13	1.12	2.32	0.1	1.98	1.07
Leach Index – Gross Alpha	>8.0	12.6	13.1	12.4	12.4	12.8	13.1	13	13.1
Leach Index – Non-volatile Beta	>8.0	nd	nd	nd	nd	nd	nd	nd	nd
Volume Increase (%)	<50%	33	36	34	40	33	34	33	37
pH	>10.0	12.4	12.7	12.7	12.8	12.5	12.6	12.6	12.9
Temperature Rise (C)	Not Specified	3	1	1	0	3	1	2	2
False Set	Prohibited	No	No	No	No	No	No	No	No
Flash Set	Prohibited	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Set Time (hours)	> 6 hours	4	4	4	4	4	4	4	4
Bleed Fluid	<0.5%	None	None	None	None	None	None	None	None

[1]Formulation:

1 - Portland cement and bentonite

2 - Portland cement and 4% silicate (high)

3 - Portland cement, bentonite, and 2% silicate (low)

4 - Portland cement, bentonite, and 4% silicate (high)

nd - Not determined

Note: Leach Index for nonvolatile beta not determined since beta activities in LRSB soils were below the detection limit

Meets the performance criterion

Does not meet the performance criterion

Table ES-10. Average Hydraulic Conductivity by Formulation
All Soil Fractions – 28-Day Cure

Seepage Basin	Average Hydraulic Conductivity (cm/sec)[1]			
	Formulation[2] 1	Formulation[2] 2	Formulation[2] 3	Formulation[2] 4
CRSB	2E-07	1E-07	1E-07	1E-07
KRSB	1E-08	5E-08	4E-08	8E-08
PRSB	7E-09	3E-09	7E-10	1E-08
LRSB	3E-09	5E-09	1E-09	8E-09

[1] Logarithmic average to the base 10

[2] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

Meets the performance criterion
Does not meet the performance criterion

Table ES-11. Average Hydraulic Conductivity by Formulation
All Soil Fractions – 28-Day Cure, 90-Day Immersion

Seepage Basin	Average Hydraulic Conductivity (cm/sec)[1]			
	Formulation[2] 1	Formulation[2] 2	Formulation[2] 3	Formulation[2] 4
CRSB	1E-06	7E-07	5E-07	3E-07
KRSB	3E-06	9E-07	2E-06	5E-06
PRSB	7E-07	1E-06	7E-07	1E-06
LRSB	1E-06	6E-07	9E-08	2E-07

[1] Logarithmic average to the base 10

[2] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

Does not meet the performance criterion

This page intentionally left blank.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
APPENDICES xxi
FIGURES xxii
TABLES xxii
ACRONYMS xxv

1.0 EXPERIMENTAL PLAN 1-1
1.1 Project Description 1-1
1.1.1 Background 1-1
1.1.2 C-Reactor Seepage Basin 1-2
1.1.3 K-Reactor Seepage Basin 1-2
1.1.4 L-Reactor Seepage Basin 1-3
1.1.5 P-Reactor Seepage Basin 1-3
1.1.6 Related Immobilization Investigation at L-Area Oil and Chemical Basin 1-3
1.2 Technical Approach 1-5
1.3 Equipment, Materials, And Facilities 1-6
1.3.1 Equipment 1-6
1.3.2 Materials 1-7
1.3.3 Facilities 1-7
1.4 Sample Transportation And Tracking 1-7
1.4.1 Sample Transportation 1-7
1.4.2 Sample Chain of Custody 1-8
1.4.3 Sample Labeling 1-8
1.5 Health and Safety 1-8

2.0 STUDY AND TEST OBJECTIVES 2-1
2.1 Objectives 2-1
2.2 Study Performance Standards 2-1

3.0 TEST OBSERVATIONS AND RESULTS 3-1
3.1 Phase I Testing 3-1
3.1.1 Treatability Testing on CRSB Soils 3-1
3.1.2 Treatability Testing on KRSB Soils 3-2
3.2 Phase II Testing 3-2
3.2.1 Treatability Testing on PRSB Soils 3-2
3.2.2 Treatability Testing on LRSB Soils 3-3
3.3 Grout Mix Design 3-3

TABLE OF CONTENTS (Continued)

3.4 Stabilization Formulation Development 3-4
3.5 Testing Results 3-4
3.5.1 Soil Characterization 3-4
3.5.2 Treated Material Performance Testing 3-5

4.0 DATA ANALYSIS AND INTERPRETATION 4-1
4.1 Soil Characterization 4-1
4.1.1 CRSB Soil Fractions 4-1
4.1.2 KRSB Soil Fractions 4-2
4.1.3 PRSB Soil Fractions 4-3
4.1.4 LRSB Soil Fractions 4-4
4.2 Treated Material Performance Testing 4-5
4.2.1 Treated Material Performance Testing 4-5

5.0 CONCLUSIONS AND RECOMMENDATIONS 5-1
5.1 Soil Characterization 5-1
5.1.1 CRSB Soil 5-1
5.1.2 KRSB Soil 5-1
5.1.3 PRSB Soil 5-2
5.1.4 LRSB Soil 5-2
5.2 Stabilization/Solidification Testing 5-2
5.2.1 CRSB Soil 5-3
5.2.2 KRSB Soil 5-3
5.2.3 PRSB Soil 5-4
5.2.4 LRSB Soil 5-4
5.2.5 Data Set Evaluation 5-5
5.3 FULL-SCALE S/S TREATMENT 5-6
5.3.1 S/S Formulation 5-6
5.3.2 Process Mixing Constraints 5-10
5.3.3 Construction Tolerances 5-10
5.4 Estimated Construction Unit Cost 5-13

APPENDICES

Appendix A
- Geotechnical Testing Results for the C-, K-, L-, and PRSB
- Attachment A
- Sample Number Cross-Reference List
- Attachment B
- Analysis Results
- CRSB and KRSB Soil Geotechnical Results
  - Moisture Content
  - Atterberg Limits
  - Specific Gravity
  - Soil Classification
  - Particle Size Analysis
  - 14-Day Unconfined Compressive Strength (UCS)
  - 28-Day UCS
  - 28-Day Cure, 90-Day Immersion UCS
  - 28-Day Expansion/Shrinkage
  - 28-Day Permeability
  - 90-Day Immersion Permeability
  - Leach Index
- LRSB and PRSB Soil Geotechnical Results
  - Moisture Content
  - Specific Gravity
  - Atterberg Limits
  - Soil Classification
  - Particle Size Analysis
  - 28-Day UCS
  - 28-Day Cure, 90-Day Immersion UCS
  - 28-Day Expansion/Shrinkage
  - 28-Day Permeability
  - 90-Day Immersion Permeability
  - Leach Index
- Attachment C
  - Chain-of-Custody & Request-for-Analysis Records
- Attachment D
  - Variance Reports

Appendix B
- Sampling Notes

Appendix C
- CSRB Sampling Map

APPENDICES (Continued)

Appendix D
Test Procedures

Appendix E
Analytical Methods

Appendix F
Laboratory Health and Safety

Appendix G
Stabilization/Solidification Additives

FIGURES

Figure 3-1. Flowchart for the Segregation of the Reactor Seepage Basin Soils 3-6
Figure 3-2. Flowchart for Formulation Testing on Reactor Seepage Basin Soils 3-7

TABLES

Table ES-1. General Particle Size Distribution viii
Table ES-2. CRSB Data Summary by Soil Fractions ix
Table ES-3. KRSB Data Summary by Soil Fractions x
Table ES-4. PRSB Data Summary by Soil Fractions xi
Table ES-5. LRSB Data Summary by Soil Fractions xii
Table ES-6. CRSB Data Summary by Formulations xiii
Table ES-7. KRSB Data Summary by Formulations xiv
Table ES-8. PRSB Data Summary by Formulations xv
Table ES-9. LRSB Data Summary by Formulations xvi
Table ES-10. Average Hydraulic Conductivity by Formulation All Soil Fractions – 28-Day Cure xvii
Table ES-11. Average Hydraulic Conductivity by Formulation All Soil Fractions – 28-Day Cure, 90-Day Immersion xvii
Table 1-1. Grout Design Mixes for the Reactor Seepage Basin Soils 1-9
Table 1-2. Treatability Testing Sample Numbering Scheme 1-10
Table 2-1. Performance Criteria for the S/S Treated Material 2-3
Table 3-1. Samples Generated During Treatability Testing of CRSB Soil Samples 3-8

TABLES (Continued)

Table 3-2. Grout Mix Designs for the CRSB Soil 3-9
Table 3-3. Samples Generated During Treatability Testing of KRSB Soil Samples 3-10
Table 3-4. Grout Mix Designs for the KRSB Soil 3-11
Table 3-5. Samples Generated During Treatability Testing of PRSB Soil Samples 3-12
Table 3-6. Grout Mix Designs for the PRSB Soil 3-13
Table 3-7. Samples Generated During Treatability Testing of LRSB Soil Samples 3-14
Table 3-8. Grout Mix Designs for the LRSB Soil 3-15
Table 3-9. Physical Characterization of the CRSB Soil Fractions 3-15
Table 3-10. Particle Size Distribution of the CRSB Soil Fractions 3-16
Table 3-11. Chemical Characterization of the CRSB Soil Fractions 3-16
Table 3-12. Radionuclide Characterization of the CRSB Soil Fractions 3-17
Table 3-13. Physical Characterization of the KRSB Soil Fractions 3-17
Table 3-14. Particle Size Distribution of the KRSB Soil Fractions 3-18
Table 3-15. Chemical Characterization of the KRSB Soil Fractions 3-18
Table 3-16. Radionuclide Characterization of the KRSB Soil Fractions 3-19
Table 3-17. Physical Characterization of the PRSB Soil Fractions 3-19
Table 3-18. Particle Size Distribution of the PRSB Soil Fractions 3-20
Table 3-19. Chemical Characterization of the PRSB Soil Fractions 3-20
Table 3-20. Radionuclide Characterization of the PRSB Soil Fractions 3-21
Table 3-21. Physical Characterization of the LRSB Soil Fractions 3-21
Table 3-22. Particle Size Distribution of the LRSB Soil Fractions 3-22
Table 3-23. Chemical Characterization of the LRSB Soil Fractions 3-22
Table 3-24. Radionuclide Characterization of the PRSB Soil Fractions 3-23
Table 3-25. Results for Treated Material from Coarse Fraction of CRSB Soils 3-24
Table 3-26. Results for Treated Material from Fine Fraction of CRSB Soils 3-25
Table 3-27. Results for Treated Material from Bulk Fraction #1 of CRSB Soils 3-26
Table 3-28. Results for Treated Material from Bulk Fraction #2 of CRSB Soils 3-27
Table 3-29. Results for Treated Material from Coarse Fraction of KRSB Soils 3-28
Table 3-30. Results for Treated Material from Fine Fraction of KRSB Soils 3-29
Table 3-31. Results for Treated Material from Coarse Fraction of PRSB Soils 3-30
Table 3-32. Results for Treated Material from Fine Fraction of PRSB Soils 3-31
Table 3-33. Results for Treated Material from Bulk Fraction #1 of PRSB Soils 3-32
Table 3-34. Results for Treated Material from Bulk Fraction #2 of PRSB Soils 3-33
Table 3-35. Results for Treated Material from Coarse Fraction of LRSB Soils 3-34
Table 3-36. Results for Treated Material from Fine Fraction of LRSB Soils 3-35

TABLES (Continued)

Table 4-1. Average Hydraulic Conductivity by Formulation All Soil Fractions – 28-Day Cure 4-12
Table 4-2. Average Hydraulic Conductivity by Formulation All Soil Fractions – 28-Day Cure, 90-Day Immersion 4-12
Table 5-1. Estimated Construction Unit Cost 5-15

ACRONYMS

ACI	American Concrete Institute
ANS	American Nuclear Society
ASTM	American Society for Testing and Materials
°C	Degrees Celsius
cm/sec	centimeter/second
Co	Cobalt
COC	Contaminant of Concern
CRSB	C-Reactor Seepage Basin
Cs	Cesium
DOE	Department of Energy
dwb	dry weight basis
ETDC	Environmental Technology Development Center
°F	Degrees Fahrenheit
ft	ft
g	Gram
in	inch
IT	IT Corporation
kg	Kilogram
KRSB	K-Reactor Seepage Basin
LAOCB	L-Area Oil and Chemical Basin
LRSB	L-Reactor Seepage Basin
mg/kg	milligrams per kilograms
mL	milliliter
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
pCi/g	picoCuries per gram
POR	pilot operations room
PRSB	P-Reactor Seepage Basin
psi	pounds per square inch
PTSM	Principal Threat Source Material
Pu	Plutonium
QA/QC	Quality Assurance/Quality Control
RMA	Radiological Material Area
rpm	revolutions per minute
ROD	Record of Decision
SAIC	Science Applications International Company
SCDHEC	South Carolina Department of Health and Environmental Control
Sr	Strontium
SRS	Savannah River Site
S/S	Stabilization/Solidification
TDL	Technology Development Laboratory

ACRONYMS (Continued)

UCS	Unconfined Compressive Strength
US EPA	United States Environmental Protection Agency
WSRC	Westinghouse Savannah River Company

1.0 EXPERIMENTAL PLAN

1.1 Project Description

1.1.1 Background

Between 1957 and 1991, reactor seepage basins received low-level radioactive purge water from the disassembly basins at operating Savannah River Site (SRS) production reactors. This water purge was necessary to keep the tritium concentration in the disassembly basin water within safe levels. Before the use of mixed-bed deionizers and sand filters began in the 1960s, purge water was pumped directly from the disassembly basins to the seepage basins. From 1970 to 1978, the seepage basins for active reactors were bypassed. In 1978, C-Reactor Seepage Basin (CRSB), L-Reactor Seepage Basin (LRSB), and P-Reactor Seepage Basin (PRSB) were reactivated. The K-Reactor Seepage Basin (KRSB) was used only from 1957 to 1960. None of the four basins have been active since 1991.

Although many radionuclides were in the purge water discharged to the basins, almost all of the radioactivity was due to tritium. Tritium is highly mobile and migrated relatively quickly from the basins via leaching. Most of the remaining radioactivity is the result of small amounts of cobalt-60 (Co-60), strontium-90 (Sr-90), cesium-137 (Cs-137), and alpha emitters such as plutonium-239/240 (Pu-239/240). Cobalt-60 has a relatively short half-life; therefore, Cs-137, Sr-90, and Pu-239/240 are of more concern with respect to future leaching to groundwater.

The CRSB, KRSB, LRSB, and PRSBs are scheduled for closure during the next several years. Under the "Plug-In Record of Decision (ROD)" approach, the selected remediation technology for CRSB, KRSB, LRSB and PRSB is the in-situ stabilization/solidification (S/S) treatment of soils beneath the basins. Following stabilization of contaminated soils, each basin is then provided with drainage control, such as a geotextile membrane or other acceptable means, backfilled, and the surrounding area contoured to reduce the infiltration of rain water above the stabilized monolith.

A grout mix utilizing various reagents and additives/admixtures is required for the definitive S/S remediation design. A grout mix design developed during this study conducted by SAIC under Contract No. C001311N will be recommended for the in-situ S/S of the contaminants of concern (COCs) in each of the reactor seepage basins.

A previous study (Section 1.6) evaluated grout mixes utilizing various reagents (e.g., Portland cement, bentonite, and soluble silicates) for the in-situ S/S treatment of soils. The results of that study were used as the basis for selecting formulations evaluated in this study.

A phased approach was used to identify the grout mix to be recommended for each of the four seepage basins. Phase I, the treatability testing on the CRSB and KRSB soils, involved four grout formulations of Portland cement, bentonite, and soluble silicates in various combinations. Each formulation was tested on soil formulated to encompass the expected variation in lithology and geotechnical properties within each reactor seepage basin (Section 1.2). In Phase II, the same four grout formulations were tested on the LRSB and PRSB soils, again using soil material which encompassed the expected variation in lithology and geotechnical properties for each basin.

1.1.2 C-Reactor Seepage Basin

The CRSB is three unlined basins constructed in the late 1950s and operated from 1959 to 1970. Wastewater from the reactor disassembly basin was discharged into the southeastern end of the L-shaped Basin No. 1. A cascade overflow pipe located in the top of the basin wall connects it to Basin No. 2. Basin No. 2 also has a similar cascade overflow into Basin No. 3. Basin No. 3 would have received wastewater if Basins No. 1 and 2 were nearly full.

Radiation surveys and shallow soil sampling indicate that Basin No. 3 was used sparingly. In-situ S/S is not included in the remedial action plan for the soil in Basin No. 3. Therefore, Basin No. 3 will not be discussed further in this document.

The Principal Threat Source Materials (PTSMs) are Cs-137, Sr-90, and Pu-239/240. Basin No. 1 contains the highest concentrations of these radioactive materials, with the highest detected concentrations found in the 4 to 6 ft depth. In Basin No. 2 the highest detected concentrations were found in the 1 to 4 ft depth range.

1.1.3 K-Reactor Seepage Basin

The KRSB was constructed in 1957 as an unlined basin. The K-Reactor disassembly basin discharged low-level radioactive wastewater by gravity to the eastside of the KRSB.

The PTSMs for KRSB are also Cs-137, Sr-90, and Pu-239/240. Approximately 83 percent of the non-volatile beta activity is in the top 1 ft of soil, 90 percent in the top 3 ft of soil, and at least 95 percent of the activity is above a depth of 7 ft.

1.1.4 L-Reactor Seepage Basin

The LRSB is an unlined, L-shaped earthen basin which received low-level radioactive purge water from 1958 until 1968 when L-Reactor was placed on warm standby. In 1978, four soil samples were collected inside the LRSB. These samples contained Co-60 (1052.2 picoCuries per gram [pCi/g]), Cs-137 (258 pCi/g) and Sr-90 (70.6 pCi/g).

1.1.5 P-Reactor Seepage Basin

The PRSB consists of three unlined basins connected in series, located to the west of the P-Reactor perimeter fence. Two 400-ft underground process sewer lines extended from the P-Reactor disassembly basin to Basin 1. The basins have not received wastewater since the P-Reactor was shut down for repairs in 1991.

In 1972, a limited number of soil cores taken to a depth of 1.5 ft were analyzed for radionuclides. Maximum Cs-137 activities of 7,100 pCi/g were noted. In 1976, five surface soil samples (4-in deep) were taken from each basin. The maximum Cs-137 activity was observed to be 4,400 pCi/g and the maximum Sr-89/90 concentration was 600 pCi/g. In 1978, sixteen borings were advanced to a maximum depth of 20 ft. These samples were analyzed for Co-60, Cs-137, and Sr-90. The highest activities were measured in Basins 1 and 2, with elevated activity levels in the top 5 ft.

1.1.6 Related Immobilization Investigation at L-Area Oil and Chemical Basin

The stabilization of soils and waste materials was previously selected as the remedial action for the L-Area Oil and Chemical Basin (LAOCB). A laboratory-scale immobilization study was conducted to evaluate the effectiveness of various grout formulations in immobilizing the radionuclides present in the LAOCB soil. The similarity of the soils and COCs present at the LAOCB and the four reactor seepage basins suggest that the immobilization study for the LAOCB is very relevant to addressing the soil stabilization at the C-, K-, L-, P-Area reactor seepage basins.

The radionuclides of concern in the LAOCB included all the PTSMs identified in the C-, K-, L-, and P-Area reactor seepage basins: Cs-137, Sr-90, and Pu-239/240. The LAOCB also contained additional radionuclides not identified as PTSMs in the reactor seepage basins: Americium-241, Co-60, Uranium-234, -235, and -238.

The LAOCB immobilization study was conducted in three phases: reagent screening, reagent optimization, and extended performance testing. The reagent screening phase evaluated mixing characteristics and performance of six possible mixtures: Portland cement, Portland cement and flyash, Portland cement and bentonite, Portland cement and silicate, Portland cement and hematite, and Portland cement and apatite.

The objective of the second phase was to determine the optimum dosage ratios of three selected mixes. The screening phase showed that mixes having a high ratio of reagents to soil (high mixes) appeared to reduce leachability of COCs more appreciably than mixes with a low ratio. Consequently, three high mixes were retained for further evaluation in extended performance testing: Portland cement, Portland cement and bentonite, and Portland cement and silicate.

The objective of the extended testing was to determine the long-term performance of soils treated with three selected reagent combinations. There were three significant results of this phase of testing:

- The unconfined compressive strength (UCS) of all three mixes exceeded the Nuclear Regulatory Commission (NRC) guidelines for compressive strengths of at least 500 pounds per square inch (psi).
- The compressive strength of all three mixtures were significantly reduced by the 90-day water immersion. The greatest reduction in average compressive strength was seen in the Portland Cement sample which was reduced by 89 percent to 450 psi.
- The three mixtures all effectively reduced the leachability of gross alpha and nonvolatile beta (reduced the leachability to below 20 percent).

The study results suggested that both bentonite and silicate additives significantly increased the effectiveness of Portland cement at reducing the leachability of radionuclides of concern. The LAOCB study recommended additional testing of mixes using a combination of Portland cement, bentonite, and sodium silicate to determine the mixture that would be most effective for the least cost. Dosage ratios of 0.15 Portland cement to 0.05 bentonite to 0.04 sodium silicate (fraction of the total weight), respectively, were recommended for further evaluation in a pilot study. Because of the relatively high cost of the sodium silicate, it was recommended that a lower sodium silicate dosage ratio of 0.02 be evaluated to determine how much benefit is achieved by adding more sodium silicate.

Based on the results of the LAOCB study, four grout mixes were identified for evaluation in this study: Portland cement and bentonite; Portland cement and sodium silicate; Portland cement, bentonite, and sodium silicate (low); and Portland cement, bentonite, and sodium silicate (high). These four grout mixes are defined in Table 1-1.

1.2 Technical Approach

The technical approach to the S/S treatability testing on the soil from the four reactor seepage basins was based on the similarity of the chemical nature of the COCs and the method of contamination for each reactor seepage basin. Therefore, the grout mix for the reactor seepage basins did not have to compensate for variability in the activity of radionuclides, or the concentration of heavy metals, organic, or inorganic constituents. The major variability for which the S/S mix design must compensate is the possible variability in lithology within a reactor seepage basin (e.g., clay lenses).

The samples used for the LAOCB treatability testing consisted of reddish and tan sandy soil, reddish and tan sandy soil (80%) mixed with small amounts of olive green clay (20%), and olive green clay (80%) mixed with reddish sandy soil (20%). Since the reactor seepage basins are located in areas of similar lithology to the LAOCB, it was likely that a similar range in soil material would encountered for the CRSB, KRSB, LRSB, and PRSB soils. The S/S grout mix design must be effective within a similar range of lithologic properties.

The technical approach to the treatability testing was to divide, or segregate, the soils from each reactor seepage basin into fractions which represent the range of lithology represented by the sample material. This was accomplished by physically segregating the soil sample material from each reactor seepage basin into fractions which are primarily coarse (sandy), fractions which are primarily fine (clayey), and fractions which represent the overall bulk combination of coarse and fine soil material (bulk fractions). The bulk fraction samples were considered to represent the typical or expected lithological conditions, while the fine and coarse fraction samples would represent lithologic end members.

Soil from the CRSB was collected specifically for this study. Samples were collected from Basin 1 and Basin 2 (Appendix C). Soil from KRSB, LRSB, and PRSB was the residual from previous characterization activities. The precise location within the basins and sample collection interval is not known for KRSB, LRSB, and PRSB. However, review of the sampling plans for these units suggest that these samples are representative of overall basin conditions.

For the CRSB and LRSB, sufficient soil samples were available to allow for the physical segregation discussed above. For the KRSB and PRSB soils, the quantity of the samples available for performing the tests was limited. Therefore, the KRSB and PRSB soils were segregated into only coarse and fine fraction samples, representing the extremes in lithology for the these reactor seepage basins.

The fractions resulting from the physical segregation of the soil material from each reactor seepage basin were used in the S/S grout mix design testing. During this testing, four grout mixes (Table 1-1) were tested on each fraction of each reactor seepage basin. The S/S treated material from each soil/grout mix combination was subjected to physical and chemical testing to determine if it met the specified performance criteria (Section 2.2).

A copy of the Work Plan, which outlines the test procedures and grout mix designs, is included in Appendix D. Section 3.0 discusses how the technical approach was applied to each of the reactor seepage basin soils.

1.3 Equipment, Materials, And Facilities

1.3.1 Equipment

The equipment used in the laboratory-scale S/S treatability testing included:

- 2 ft by 3 ft plastic trays,
- Stainless steel mixing bowls,
- 5 quart planetary mixer,
- 3 in by 6 in right cylinder plastic molds,
- 2 in by 4 in right cylinder plastic molds,
- Stainless steel spatulas,
- Laboratory balances, and
- Graduated cylinders.

1.3.2 Materials

The reagents used during the laboratory-scale S/S treatability testing included:

- Type I Portland cement,
- Sodium bentonite, and
- Type N soluble silicates.

Information on these reagents is included in Appendix G.

The personal protective equipment used during the treatability study included:

- Nitrile gloves,
- Tyvek coveralls, and
- Tyvek boot covers.

1.3.3 Facilities

The laboratory-scale S/S treatability testing was conducted at the IT Corporation (IT) Technology Development Laboratory (TDL) in Knoxville, TN. Geotechnical testing on the CRSB, LRSB, PRSB, and KRSB soils and the S/S treated materials was conducted at IT's Environmental Technology Development Center (ETDC) in Oak Ridge, TN.

The TDL and ETDC each maintain a Radioactive Materials License from the State of Tennessee and operate under the treatability exemption in 40 CFR 261.4. The treatability study and other activities were performed under these relevant permits, licenses, or exemptions.

1.4 Sample Transportation And Tracking

1.4.1 Sample Transportation

Soil samples from the CRSB, KRSB, LRSB, and PRSB were transported by licensed shipper from the Radiological Material Area (RMA) at Building 772-7B, SRS, to the ETDC. Chain of custody forms accompanied the sample shipment. Upon receipt at the ETDC, the soil samples were each 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.

Upon receipt, the outside of the containers was smeared to measure external radiation contamination, and the dose rate at the surface of the containers was measured. The results were consistent with the initial gross alpha and non-volatile beta radiation data received from WSRC. The containers were then moved to the pilot operations room (POR) at the ETDC. The containers were opened to visibly assess the condition of the contents in the POR.

1.4.2 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.

1.4.3 Sample Labeling

Samples were assigned a unique sample identification which described the reactor seepage basin, the soil fraction or subsample, the formulation, applicable cure period, testing to be conducted on the sample, and any subsample required for the applicable testing. Table 1-2 details the sample numbering categories and their applicable codes.

For example, Sample Number C422F00 was the unconfined compressive strength sample, cured 28 days, from the cement + high silicate formulation from the Fine Fraction of the CRSB soil material. Likewise, Sample L612H02 was the second leachate subsample from the ANS 16.1 leachability test on the treated material, cured 28 days, from the cement + bentonite formulation on the Bulk Fraction #2 of the LRSB soil material.

1.5 Health and Safety

A copy of the Chemical Hygiene Plan for the TDL and ETDC facilities is included in Appendix F.

Table 1-1. Grout Design Mixes for the Reactor Seepage Basin Soils

Formulation	Soil	Portland Cement		Sodium Bentonite		Sodium Silicate	
	(gm)	(gm)	(% by weight)	(gm)	(% by weight)	(gm)	(% by weight)
1	2,500	469	15	156	5	0	0
2	2,500	463	15	0	0	124	4
3	2,500	481	15	160	5	65	2
4	2,500	494	15	165	5	132	4

Table 1-2. Treatability Testing Sample Numbering Scheme

Category	Code	Category	Code
Reactor	C = C Reactor Seepage Basin	Test	A = COCs
	K = K Reactor Seepage Basin		B = gross alpha, nonvolatile beta
	L = L Reactor Seepage Basin		C = Inorganics
	P = P Reactor Seepage Basin		D = Total carbonation activity
Subsample	1 = Grab 1 (Soil before segregation)		E = Oxidation/reduction potential
	2 = Grab 2 (Soil before segregation)		F = Unconfined Compressive Strength
	3 = Coarse Fraction		G = Hydraulic Conductivity
	4 = Fine Fraction		H = ANS 16.1 Leachability
	5 = Bulk Fraction #1		I = Temperature
	6 = Bulk Fraction #2		J = pH
	7 = Remaining Soil #1 (After Segregation)		K = Shrink/Swell
	8 = Remaining Sample #2 (After Segregation)		L = Bleed Volume
Formulation	1= Cement + bentonite		M = Volume Increase
	2 = Cement + high silicate		N = Setting
	3 = Cement + bentonite + low silicate		Q = Geotechnical
	4 = Cement + bentonite + high silicate		
Cure Period	0 = Not Applicable	Test Subsample	01-10, when Test = H
	1 = 14 days		Otherwise = 00
	2 = 28 days		
	3 = 90 days immersed		

2.0 STUDY AND TEST OBJECTIVES

2.1 Objectives

The purpose of this study was to perform bench-scale (laboratory-scale) studies to develop grout mix designs which can stabilize and solidify the radiological contaminants in the CRSB, KRSB, LRSB, and PRSB soils. One objective is to determine if a unique grout mix design is required for the in-situ S/S each seepage basin. It is expected that the depth of S/S will not exceed 20 ft below the existing basin bottoms, and in most cases will probably be less than 10 ft.

The study was implemented in two phases. The first phase of work, designated Phase I, was implemented using the CRSB and KRSB soils. With Phase I substantially complete, Phase II was implemented using the LRSB and PRSB soils.

Initial treatability testing (Phase I) on the CRSB and KRSB soils involved the four formulations defined in Table 1-1. Each formulation was replicated on the soil fractions for each reactor seepage basin. In Phase II, the four formulations were tested on the LRSB and PRSB soils, again on soil fractions from each reactor seepage basin.

The grout mix recommended for each reactor seepage basin will be the one that the test results indicate will produce a stabilized waste monolith (grouted waste) which meets the performance requirements/acceptance criteria (Section 2.2). Information on construction tolerances and mixing process constraints are provided in Section 5.3. Field optimization tests are not expected to be necessary as long as the construction tolerances, PTSMs, and mixing process constraints identified as a result of this study are not exceeded. A pilot test may be necessary to verify the full scale application method provides acceptable mixing or to determine the effect of additives, such as set retarders, if they are found to be needed.

2.2 Study Performance Standards

The primary goal of S/S treatment is to minimize the mobility of the PTSMs. Soil S/S treatment is a performance-based remedial approach since it does not reduce the total mass of the PTSMs and cannot in itself achieve concentration-based remedial objectives. The performance standards for the S/S treated soils are given in Table 2-1.

Additional performance parameters such as total carbonation activity, sulfates, sulfides, sulfite, chloride, nitrate, nitrite, nitric compounds, boric compounds, and oxidation/reduction potential had been considered for the S/S treated material. Total carbonation activity would be required to

demonstrate that the stabilized material contains sufficient carbonation to maintain an alkaline pH. The Portland cement (15 percent of the total treated weight) added as part of the S/S grout mix will produce a sufficient total carbonation activity level to satisfy this criterion. Therefore, the determination of total carbonation activity on the S/S treated material would not supply any useful information.

When high salt content wastes are stabilized, the sulfate, sulfide, sulfite, nitrate, nitrite, and nitric and boric compound levels are of concern, as the presence of these chemical species in high (>50,000 milligram/kilogram (mg/kg)) levels can affect the physical properties of the final S/S treated material. However, there is no indication that the soils beneath the CRSB, KRSB, LRSB or PRSB contain high levels of these chemical species. Furthermore, previous S/S treatability work on the LAOCB soils indicated minimal anion leaching from similar S/S treated soils using similar reagents. Therefore, performance criteria for these chemical species would not influence the physical stability of the S/S treated material.

Certain contaminants, such as arsenic, chromium, and selenium, can easily exist in a number of valance states. The immobilization of these contaminants can be affected by the oxidation/ reduction potential of the S/S treated material. The immobilization of the PTSMs are not affected by their valance state and the oxidation/reduction potential of the S/S treated material will not affect its performance. Therefore, performance criteria for these parameters were not considered further.

Table 2-1. Performance Criteria for the S/S Treated Material

Parameter	Criteria	Standard Test Method
Batching Weight Precision	≤ 5 %	NIST traceable
Batching Mix Ratio Variation	≤ 0.5 gal/lb.	NIST traceable
Unconfined Compressive Strength at 14 days Cure	>100 psi	ASTM D 2166
Unconfined Compressive Strength at 28 days Cure	>100 psi	ASTM D 2166
Unconfined Compressive Strength after Water Immersion for 90 days	>100 psi	ASTM D 2166, immersion per NRC guidelines
Hydraulic Conductivity at 28 days Cure	<1x10E-08 cm/sec	ASTM D 5084
Hydraulic Conductivity after Water Immersion for 90 days	<1x10E-08 cm/sec	ASTM D 5084, immersion per NRC guidelines
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	ANS 16.1
Temperature at Core and Surface	<100 °F	ASTM C 1064
pH	>10.0	ASTM D 4972
Shrink/Swell	<25% of 28-day UCS failure strain	ASTM D 3877
Bleed Fluid	<0.5%	ANS 55.1 or EPA 9095
Volume Increase	<50%	None
Hazardous dust/vapor release	--	Per OSHA Standards
Gas generation due to chemical, biological, organic, thermal, and radiation sources	Lesser of: 0.5 moles/cf/yr or 800 moles/cf total	Per 10 CFR 60 or Per NUREG-CR-2333
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

This page intentionally left blank.

3.0 TEST OBSERVATIONS AND RESULTS

The bench-scale treatability testing demonstrated how the treated material from the selected grout mix designs performed with respect to the performance criteria listed in Table 2-1. The technical approach used for selecting the soil fractions for S/S testing was described in Section 1.2. The analytical methods utilized during the testing are included in Appendix E. Appendix A contains the raw data from the testing.

3.1 Phase I Testing

The first phase of the S/S treatability study involved the soils from the CRSB and KRSB, the basins scheduled for early closure. The flowcharts in Figures 3-1 and 3-2 demonstrate the progression of the treatability testing.

3.1.1 Treatability Testing on CRSB Soils

Step 1. The soil material from the CRSB was placed into two plastic trays, each 2 ft wide by 3 ft long. Two 1-quart grab samples, which appeared representative of the soil material in the tray, were collected for geotechnical and characterization analysis (Table 3-1).

Step 2. Based on visual inspection, the soil material was segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation was to produce samples for testing which bracketed the anticipated range in lithologic properties. This ensured that the performance of the mix designs was evaluated against the potential variability in lithology within the CRSB.

Clayey material was segregated by removing visible "clay balls" from one of the trays. This material was combined to make the Fine Fraction sample. Coarse material remaining in the tray was segregated and combined to make the Coarse Fraction sample. The material in the other tray was homogenized and the two Bulk Fraction samples for mix design testing were prepared. Two 1-quart samples of the remaining material were also collected for geotechnical analysis (Remaining Samples).

Step 3. The four fractions (coarse, fine, and 2 bulk) were used for formulation mix design testing. Four grout mix formulations were made on each fraction (Table 3-2).

3.1.2 Treatability Testing on KRSB Soils

Step 1. The soil material from the KRSB was placed into a plastic tray, 2 ft wide by 3 ft long. Two 1-quart grab samples, which appeared representative of the soil material in the tray, were collected for geotechnical and characterization analysis (Table 3-3).

Step 2. Based on visual inspection, the soil material was segregated by lithological properties into samples for formulation mix design testing. Clayey material was segregated by removing visible "clay balls". This material was combined to make a fine fraction sample for mix design testing. Coarse material remaining in the tray was segregated and combined to make a coarse fraction sample for mix design testing. The objective of this segregation was to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This ensured that the performance of the mix designs was evaluated against the potential variability in lithology within the KRSB. The remaining material was homogenized and two 1-quart samples were also collected for geotechnical analysis.

Step 3. The two fractions (coarse and fine) segregated above were used for formulation mix design testing. Four formulations were made on each fraction (Table 3-4).

3.2 Phase II Testing

The second phase of the S/S treatability study on the reactor seepage basin soils involved the soils from the LRSB and PRSB. This phase began during the latter part of the Phase I testing. The flowcharts in Figures 3-1 and 3-2 demonstrate the progression of the treatability testing.

3.2.1 Treatability Testing on PRSB Soils

Step 1. The soil material from the PRSB was placed into two plastic trays, each 2 ft wide by 3 ft long. Two 1-quart grab samples, which appeared representative of the soil material in the tray, were collected for geotechnical and characterization analysis (Table 3-5).

Step 2. Based on visual inspection, the soil material was segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation was to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This ensured that the performance of the mix designs was evaluated against the potential variability in lithology within the PRSB.

Clayey material was segregated by removing visible "clay balls" from one tray. These were combined to make a Fine Fraction sample. Coarse material remaining in the tray were segregated

and combined to make a Coarse Fraction sample. The remaining material was homogenized and two Bulk Fraction samples were prepared. Two 1-quart samples were also collected for geotechnical analysis (Remaining Samples).

Step 3. The four fractions (coarse, fine, and 2 bulk) were used for formulation mix design testing. Four formulations were made on each fraction (Table 3-6).

3.2.2 Treatability Testing on LRSB Soils

Step 1. The soil material from the LRSB was placed into a plastic tray, 2 ft wide by 3 ft long. Two 1-quart grab samples, which appeared representative of the soil material in the tray, were collected for geotechnical and characterization analysis (Table 3-7).

Step 2. Based on visual inspection, the soil material was segregated by lithological properties into samples with the objective of producing samples which bracketed the anticipated range in lithologic properties. This ensured that the performance of the mix designs was evaluated against the potential variability in lithology within the LRSB.

Clayey material was segregated by removing visible "clay balls". These were combined to make a Fine Fraction sample. Coarse material remaining was segregated and combined to make a Coarse Fraction sample. The remaining material was homogenized, and two 1-quart samples were collected for geotechnical analysis (Remaining Samples).

Step 3. The two fractions (coarse and fine) segregated above were used for formulation mix design testing. Four formulations were made on each fraction (Table 3-8).

3.3 Grout Mix Design

The S/S grout mixes for each basin were prepared using the soil from the appropriate basin, selected additives (admixtures), and other grout mix components. Four mixes were prepared for each reactor seepage basin (see Table 1-1 for specific weights and ratios):

- Portland cement and bentonite
- Portland cement and high silicate
- Portland cement, bentonite, and high silicate
- Portland cement, bentonite, and low silicate.

In developing the mixes, the components (including cementitious and pozzolanic components and their chemical constituents) were of high quality and of known composition, and commercially available. All cementitious and pozzolanic components were chemically stable and were environmentally nonhazardous before and after their S/S applications.

3.4 Stabilization Formulation Development

Each formulation was mixed in a planetary mixer. A 2,500 g aliquot of reactor soil was added to the mixing bowl. The dry reagents were weighed, blended, and mixed with an equal weight of water. Soluble silicate or additional water was added to the reagent slurry. The reagent slurry was then added to the soil in the mixing bowl. The soil and reagent slurry was mixed at 30-40 revolutions per minute (rpm) for 1 to 2 minutes to produce a homogeneous treated material.

The treated material was poured into appropriate molds, 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.

3.5 Testing Results

3.5.1 Soil Characterization

The soil samples from Steps 1 and 2 were subjected to the characterization testing listed in Tables 3-1, 3-3, 3-4, and 3-5. Results are presented in Appendix A, Attachment B.

3.5.1.1 CRSB Soil Fractions

The results for the characterization analyses on the CRSB soil fractions are summarized in Tables 3-9 through 3-12.

3.5.1.2 KRSB Soil Fractions

The results for the characterization analyses on the KRSB soil fraction are summarized in Tables 3-13 through 3-16.

3.5.1.3 PRSB Soil Fractions

The results for the characterization analyses on the PRSB soil fraction are summarized in Tables 3-17 through 3-20.

3.5.1.4 LRSB Soil Fractions

The results for the characterization analyses on the LRSB soil fraction are summarized in Tables 3-21 through 3-24.

3.5.2 Treated Material Performance Testing

The cured treated material was subjected to the performance criteria testing listed in Tables 3-1, 3-3, 3-4 and 3-5 for Step 3. The tests were the same as the performance criteria (Table 2-1) for the final stabilized waste material; with the exception of the criteria for the batching, hazardous dust/vapor release, and the gas generation. The results from the performance testing provide information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material. Test results are in Appendix A, Attachment A.

3.5.2.1 CRSB Treated Material

The results of the performance testing on the treated material produced from the treatment of the CRSB soil fractions are summarized in Tables 3-25 through 3-28.

3.5.2.2 KRSB Treated Material

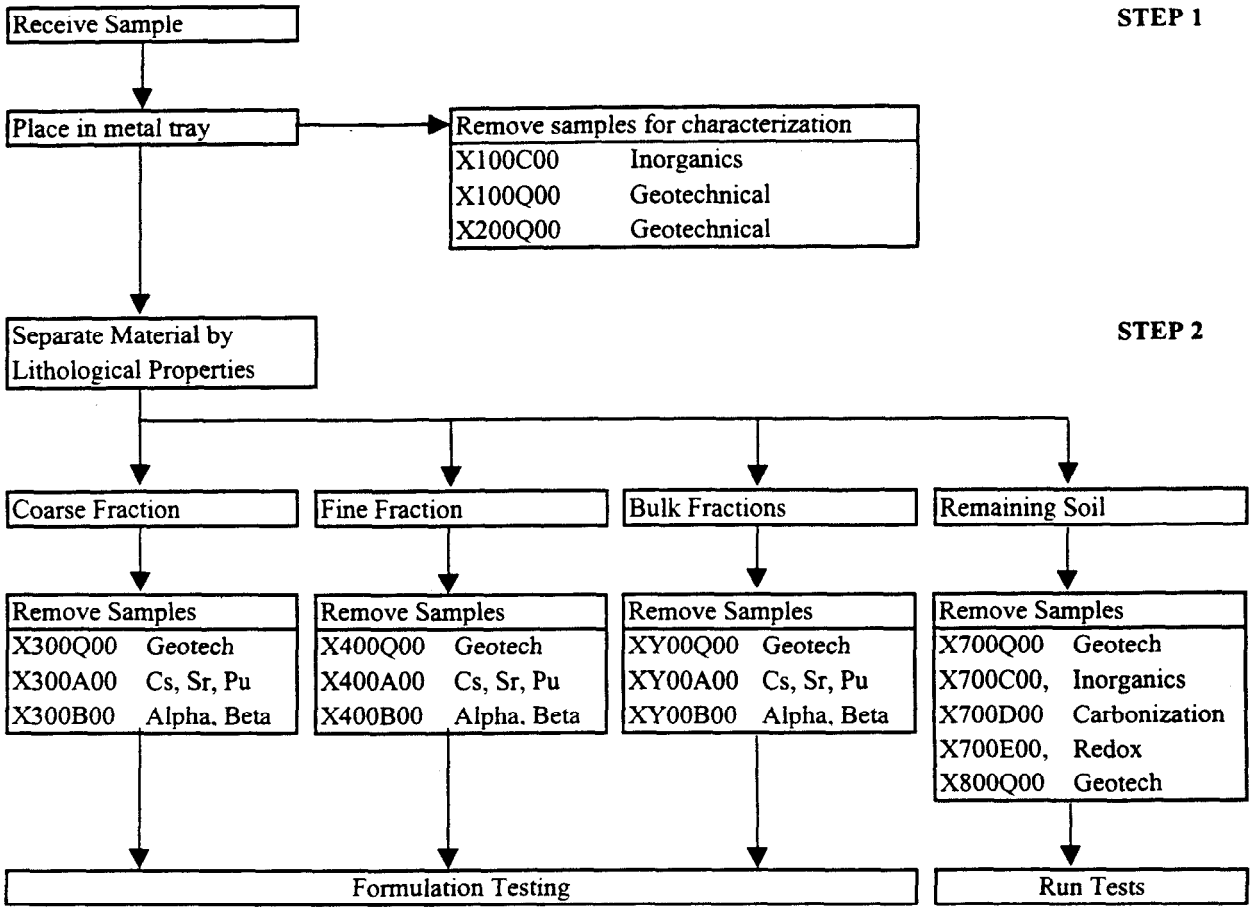
The results of the performance testing on the treated material produced from the treatment of the KRSB soil fractions are summarized in Tables 3-29 and 3-30.

3.5.2.3 PRSB Treated Material

The results of the performance testing on the treated material produced from the treatment of the PRSB soil fractions are summarized in Tables 3-31 through 3-34.

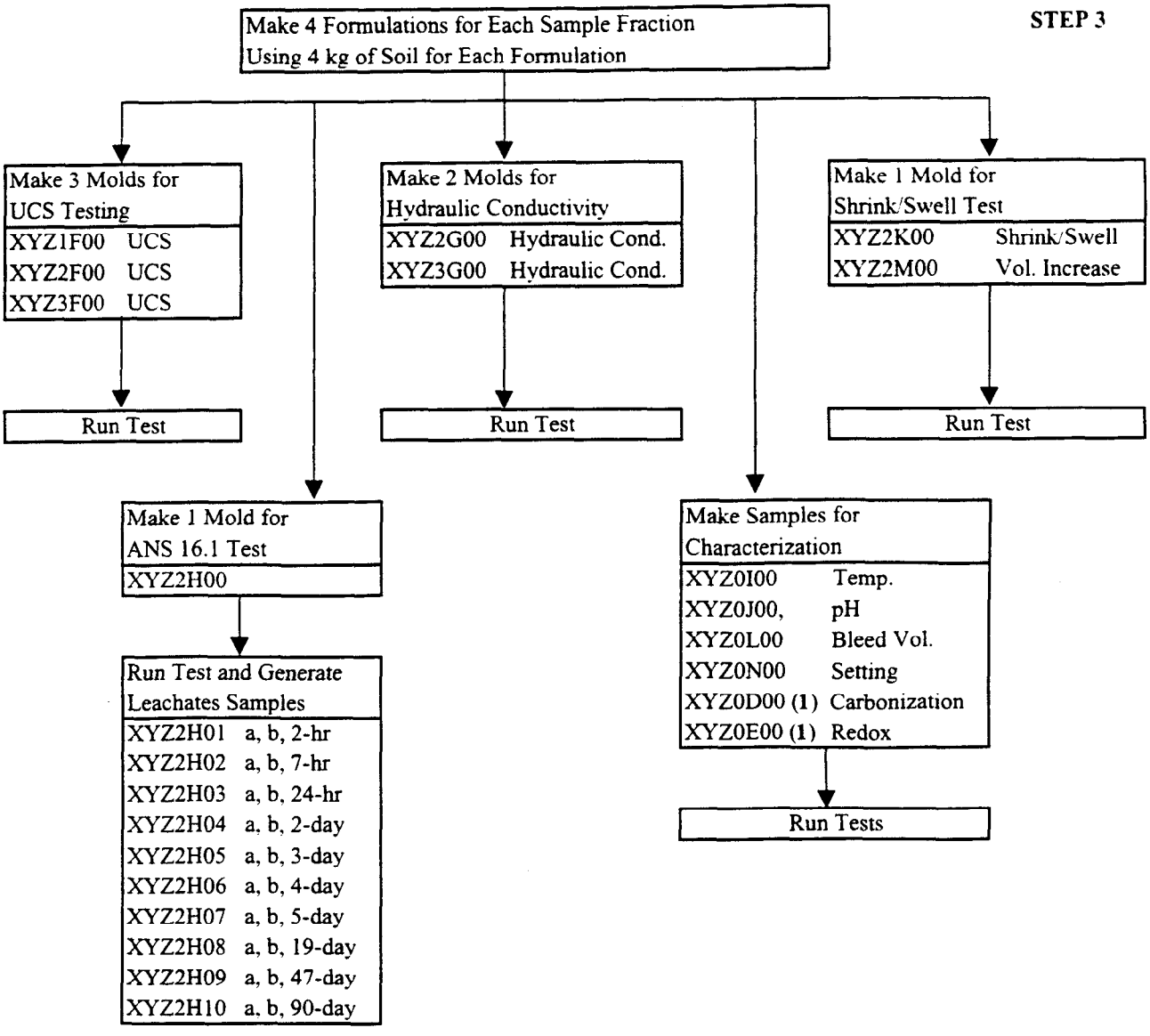
3.5.2.4 LRSB Treated Material

The results of the performance testing on the treated material produced from the treatment of the LRSB soil fractions are summarized in Tables 3-35 and 3-36.



X = C, K, L, or P (Reactor)
Y = 5 or 6 (Subsample)

Figure 3-1. Flowchart for the Segregation of the Reactor Seepage Basin Soils



(1) Only on two randomly selected formulations
X = C, K, L, or P (Reactor)
Y = 3, 4, 5, or 6 (Subsample)
Z = 1, 2, 3, or 4 (Formulation)
UCS = Unconfined Compressive Strength

Figure 3-2. Flowchart for Formulation Testing on Reactor Seepage Basin Soils

Table 3-1. Samples Generated During Treatability Testing of CRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	8	2	6	
Grain Size Distribution	ASTM D422	8	2	6	
Moisture Content	ASTM D2216	8	2	6	
Specific Gravity	ASTM D854	8	2	6	
USCS Soil Classification	ASTM D2487	8	2	6	
Cesium-137	Gas Flow	4		4	
Plutonium-239/240	Gas Flow	4		4	
Strontium-90	Gas Flow	4		4	
Gross Alpha	Gas Flow	164		4	160
Non-volatile Beta	Gas Flow	164		4	160
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	1	1		
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	16			16
UCS @ 28 days cure	ASTM D2166	16			16
USC @ 90 days immersion	ASTM D2166	16			16
Hydraulic Conductivity @ 28 days	ASTM D5084	16			16
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	16			16
Temperature	ASTM C1064	16			16
pH	SW-846 Method 9045C	16			16
Shrinkage/Swell	ASTM D3877	16			16
Bleed Fluid	SW-846 Method 9095	16			16
Set Time	ASTM C191	16			16

Table 3-2. Grout Mix Designs for the CRSB Soil

Formulation [1]	Soil Fraction	Portland Cement	Soluble Bentonite	Sodium Silicate	Water
		Mix Ratio [2]			
1	Coarse	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Fine	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Bulk Fraction # 1	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Bulk Fraction # 2	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

[2] Fraction of total weight

Table 3-3. Samples Generated During Treatability Testing of KRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	6	2	4	
Grain Size Distribution	ASTM D422	6	2	4	
Moisture Content	ASTM D2216	6	2	4	
Specific Gravity	ASTM D854	6	2	4	
USCS Soil Classification	ASTM D2487	6	2	4	
Cesium-137	Gas Flow	2		2	
Plutonium-239/240	Gas Flow	2		2	
Strontium-90	Gas Flow	2		2	
Gross Alpha	Gas Flow	82		2	80
Non-volatile Beta	Gas Flow	82		2	80
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	1	1		
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	8			8
UCS @ 28 days cure	ASTM D2166	8			8
USC @ 90 days immersion	ASTM D2166	8			8
Hydraulic Conductivity @ 28 days	ASTM D5084	8			8
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	8			8
Temperature	ASTM C1064	8			8
pH	SW-846 Method 9045C	8			8
Shrinkage/Swell	ASTM D3877	8			8
Bleed Fluid	SW-846 Method 9095	8			8
Set Time	ASTM C191	8			8

Table 3-4. Grout Mix Designs for the KRSB Soil

Formulation [1]	Soil Fraction	Portland Cement	Soluble Bentonite	Sodium Silicate	Water
		Mix Ratio [2]			
1	Coarse	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Fine	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

[2] Fraction of total weight

Table 3-5. Samples Generated During Treatability Testing of PRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	8	2	6	
Grain Size Distribution	ASTM D422	8	2	6	
Moisture Content	ASTM D2216	8	2	6	
Specific Gravity	ASTM D854	8	2	6	
USCS Soil Classification	ASTM D2487	8	2	6	
Cesium-137	Gas Flow	4		4	
Plutonium-239/240	Gas Flow	4		4	
Strontium-90	Gas Flow	4		4	
Gross Alpha	Gas Flow	164		4	160
Non-volatile Beta	Gas Flow	164		4	160
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	1	1		
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	16			16
UCS @ 28 days cure	ASTM D2166	16			16
USC @ 90 days immersion	ASTM D2166	16			16
Hydraulic Conductivity @ 28 days	ASTM D5084	16			16
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	16			16
Temperature	ASTM C1064	16			16
pH	SW-846 Method 9045C	16			16
Shrinkage/Swell	ASTM D3877	16			16
Bleed Fluid	SW-846 Method 9095	16			16
Set Time	ASTM C191	16			16

Table 3-6. Grout Mix Designs for the PRSB Soil

Formulation [1]	Soil Fraction	Portland Cement	Soluble Bentonite	Sodium Silicate	Water
		Mix Ratio [2]			
1	Coarse	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Fine	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Bulk #1	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Bulk #2	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

[2] Fraction of total weight

Table 3-7. Samples Generated During Treatability Testing of LRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	8	2	6	
Grain Size Distribution	ASTM D422	8	2	6	
Moisture Content	ASTM D2216	8	2	6	
Specific Gravity	ASTM D854	8	2	6	
USCS Soil Classification	ASTM D2487	8	2	6	
Cesium-137	Gas Flow	4		4	
Plutonium-239/240	Gas Flow	4		4	
Strontium-90	Gas Flow	4		4	
Gross Alpha	Gas Flow	164		4	160
Non-volatile Beta	Gas Flow	164		4	160
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	1	1		
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	16			16
UCS @ 28 days cure	ASTM D2166	16			16
USC @ 90 days immersion	ASTM D2166	16			16
Hydraulic Conductivity @ 28 days	ASTM D5084	16			16
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	16			16
Temperature	ASTM C1064	16			16
pH	SW-846 Method 9045C	16			16
Shrinkage/Swell	ASTM D3877	16			16
Bleed Fluid	SW-846 Method 9095	16			16
Set Time	ASTM C191	16			16

Table 3-8. Grout Mix Designs for the LRSB Soil

Formulation [1]	Soil Fraction	Portland Cement	Soluble Bentonite	Sodium Silicate	Water
		Mix Ratio [2]			
1	Coarse	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24
1	Fine	0.15	0.05	--	0.20
2		0.15	--	0.04	0.19
3		0.15	0.05	0.02	0.22
4		0.15	0.05	0.04	0.24

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

[2] Fraction of total weight

Table 3-9. Physical Characterization of the CRSB Soil Fractions

Soil Fraction	Moisture Content (% dwb[1])	Liquid Limit	Plastic Limit	Plasticity Index	USCS Class
		Moisture Content (%)			
Grab Sample #1	14.5	26	16	10	CL
Grab Sample #2	18.5	20	17	3	ML
Coarse Fraction	12.3	21	18	3	ML
Fine Fraction	20.0	25	16	9	CL
Bulk Sample #1	14.5	24	16	8	CL
Bulk Sample #2	14.5	27	15	12	CL
Remaining Sample #1	12.6	23	15	8	CL
Remaining Sample #2	13.1	21	16	5	CL-ML

[1] determined on a dry weight basis

Table 3-10. Particle Size Distribution of the CRSB Soil Fractions

Particle Size Fraction	Percent Solids by Weight			
	Gravel	Sand	Silt	Clay
Grab Sample #1	2.4	71.1	7.5	19.0
Grab Sample #2	4.7	76.9	5.7	12.7
Coarse Fraction	2.3	79.2	5.3	13.2
Fine Fraction	1.9	70.5	8.4	19.2
Bulk Fraction #1	2.0	76.8	6.5	14.7
Bulk Fraction #2	4.5	74.8	5.5	15.2
Remaining Sample #1	9.8	71.2	5.6	13.4
Remaining Sample #2	11.2	70.1	5.1	13.6

Table 3-11. Chemical Characterization of the CRSB Soil Fractions

Sample	Bulk Sample #1	Remaining Soil #1
Parameter	**Result**	
Chloride (mg/kg)	0.629 J	1.2 J
Nitrite (mg/kg)	<0.551	<0.565
Nitrate (mg/kg)	<0.551	4.1 J
Sulfate (mg/kg)	10.1 J	11.1 J
Sulfide (mg/kg)	<8.99	<8.99
Relative Oxidation (mV)	nd	237 J
Reduction Potential (mV)	nd	441 J

J = Estimated

Table 3-12. Radionuclide Characterization of the CRSB Soil Fractions

Sample	Coarse Fraction	Fine Fraction	Bulk Fraction #1	Bulk Fraction #2
Parameter	**Result**			
Cesium-137 (pCi/g)	266	279	683	246
Plutonium-239/240 (pCi/g)	3.47 J	3.18 J	3.83 J	4.12 J
Strontium-90 (pCi/g)	18.1 J	9.5 J	13.6J	11.5 J
Gross Alpha (pCi/g)	13.5	16.1	24.3	23.2
Non-volatile Beta (pCi/g)	170	224	284	182

J = Estimated

Table 3-13. Physical Characterization of the KRSB Soil Fractions

Soil Fraction	Moisture Content (% dwb)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Class
		Moisture Content (%)			
Grab Sample #1	9.7	NP[1]	NP	NP	NP
Grab Sample #2	18.5	30	16	14	CL
Coarse Fraction	11.3	NP	NP	NP	NP
Fine Fraction	22.7	33	18	15	CL
Remaining Sample #1	13.2	23	16	7	CL-ML
Remaining Sample #2	15.1	23	16	7	CL-ML

[1] NP = nonplastic

Table 3-14. Particle Size Distribution of the KRSB Soil Fractions

Particle Size Fraction	Percent Solids by Weight			
	Gravel	Sand	Silt	Clay
Grab Sample #1	0.3	81.6	5.9	12.2
Grab Sample #2	1.1	67.4	11.4	20.1
Coarse Fraction	1.0	80.4	7.5	11.1
Fine Fraction	1.2	62.9	15.4	20.5
Remaining Sample #1	3.6	73.1	8.0	15.3
Remaining Sample #2	0.7	74.6	9.2	15.5

Table 3-15. Chemical Characterization of the KRSB Soil Fractions

Sample	Bulk Sample #1	Remaining Soil
Parameter	**Result**	
Chloride (mg/kg)	<2.78	0.74 J
Nitrite (mg/kg)	<0.556	<0.569
Nitrate (mg/kg)	8.35 J	8.64 J
Sulfate (mg/kg)	9.09 J	6.75 J
Sulfide (mg/kg)	<8.7	<8.99
Relative Oxidation (mV)	nd	292 J
Reduction Potential (mV)	nd	496 J

J =-Estimated

Table 3-16. Radionuclide Characterization of the KRSB Soil Fractions

Sample	Coarse Fraction	Fine Fraction
Parameter	**Result**	
Cesium-137 (pCi/g)	1240	227
Plutonium-239/240 (pCi/g)	3.83 J	1.93 J
Strontium-90 (pCi/g)	13.2J	5.02 J
Gross Alpha (pCi/g)	21.1	12.9
Non-volatile Beta (pCi/g)	704	293

J = Estimated

Table 3-17. Physical Characterization of the PRSB Soil Fractions

Soil Fraction	Moisture Content (% dwb[1])	Liquid Limit	Plastic Limit	Plasticity Index	USCS Class
		Moisture Content (%)			
Coarse Fraction	14.9	33	19	14	CL
Fine Fraction	19.6	38	20	18	CL
Bulk Sample #1	14.9	39	19	20	CL
Bulk Sample #2	13.1	45	21	24	CL
Grab Sample #1	13.1	35	18	17	CL
Grab Sample #2	14.9	44	21	23	CL
Remaining Sample #1	14.9	46	20	26	CL
Remaining Sample #2	15.9	50	23	27	CH

[1] Determined on a dry weight basis

Table 3-18. Particle Size Distribution of the PRSB Soil Fractions

Particle Size Fraction	Percent Solids by Weight			
	Gravel	Sand	Silt	Clay
Coarse Fraction	3.8	67.8	9.4	19.0
Fine Fraction	1.2	68.8	7.7	22.3
Bulk Fraction #1	0.9	68.6	10.9	19.6
Bulk Fraction #2	1.6	63.6	10.7	24.1
Grab Sample #1	1.4	66.9	9.1	22.6
Grab Sample #2	5.1	69.1	7.5	18.3
Remaining Sample #1	3.7	65.7	9.8	20.8
Remaining Sample #2	0.9	67.3	7.8	24.0

Table 3-19. Chemical Characterization of the PRSB Soil Fractions

Sample	Bulk Sample #1	Remaining Soil #1
Parameter	**Result**	
Chloride (mg/kg)	1.46 J	0.875 J
Nitrite (mg/kg)	<0.552	<0.565
Nitrate (mg/kg)	<0.552	0.227 J
Sulfate (mg/kg)	14.1	11.3 J
Sulfide (mg/kg)	<8.99	<9.09
Relative Oxidation (mV)	nd	394 J
Reduction Potential (mV)	nd	598 J

J = Estimated

Table 3-20. Radionuclide Characterization of the PRSB Soil Fractions

Sample	Coarse Fraction	Fine Fraction	Bulk Fraction #1	Bulk Fraction #2
Parameter	**Result**			
Cesium-137 (pCi/g)	273	2040	226	174
Plutonium-239/240 (pCi/g)	0.182	1.62	0.289	0.292
Strontium-90 (pCi/g)	9.33	14.0	19.0	25.8
Gross Alpha (pCi/g)	19.0	32.3	17.9	13.5
Non-volatile Beta (pCi/g)	239	1340	338	183

Table 3-21. Physical Characterization of the LRSB Soil Fractions

Soil Fraction	Moisture Content (% dwb)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Class
		Moisture Content (%)			
Grab Sample #1	14.7	34	17	17	CL
Grab Sample #2	15.1	32	17	15	CL
Coarse Fraction	15.1	36	16	20	CL
Fine Fraction	15.9	36	17	19	CL
Remaining Sample #1	14.6	34	17	17	CL
Remaining Sample #2	14.9	33	17	16	CL

Table 3-22. Particle Size Distribution of the LRSB Soil Fractions

Particle Size Fraction	Percent Solids by Weight			
	Gravel	Sand	Silt	Clay
Coarse Fraction	0.8	65.0	9.9	24.3
Fine Fraction	0.2	67.8	9.7	22.3
Grab Sample #1	0.4	72.2	7.3	20.1
Grab Sample #2	0.4	65.8	9.8	24.0
Remaining Sample #1	0.5	65.5	10.8	23.2
Remaining Sample #2	0.7	64.7	10.8	23.8

Table 3-23. Chemical Characterization of the LRSB Soil Fractions

Sample	Bulk Sample #1	Remaining Soil
Parameter	**Result**	
Chloride (mg/kg)	3.43	3.37
Nitrite (mg/kg)	<0.582	<0.568
Nitrate (mg/kg)	0.396J	0.613
Sulfate (mg/kg)	4.46J	3.44J
Sulfide (mg/kg)	<9.2	<9.09
Relative Oxidation (mV)	nd	368J
Reduction Potential (mV)	nd	572J

J = Estimated

Table 3-24. Radionuclide Characterization of the PRSB Soil Fractions

Sample	Coarse Fraction	Fine Fraction
Parameter	**Result**	
Cesium-137 (pCi/g)	1.77	0.999
Plutonium-239/240 (pCi/g)	<0.06	<0.06
Strontium-90 (pCi/g)	<0.4	<0.4
Gross Alpha (pCi/g)	13.4	17.9
Non-volatile Beta (pCi/g)	<7.33	<7.58

Table 3-25. Results for Treated Material from Coarse Fraction of CRSB Soils

CRSB Soil Fraction	Coarse Fraction			
Formulation [1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	389.5	224.4	367.4	451.8
UCS after 28 days (psi)	399.7	347.7	388.9	410.0
UCS after 28 days cure and 90 days immersion in water (psi)	440.9	581.9	462.6	478.0
Hydraulic Conductivity after 28 days (cm/sec)	3E-07	3E-07	3E-07	3E-07
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	7E-08	6E-07	5E-08	3E-07
Shrink/Swell (% of 28 day failure strain)	0.24	0.28	1.34	1.36
Leach Index – Gross Alpha	11.4	12.1	11.4	12.3
Leach Index – Non-volatile Beta	9.9	10.3	9.8	10.4
Volume Increase (%)	39	38	44	47
pH	12.3	12.7	12.5	12.8
Temperature Rise (°C)	2	2	1	1
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-26. Results for Treated Material from Fine Fraction of CRSB Soils

CRSB Soil Fraction	Fine Fraction			
Formulation [1]	1	2	3	4
Parameter	Result			
UCS after 14 days (psi)	251.4	481.8	302.0	289.0
UCS after 28 days (psi)	237.0	487.0	360.8	410.7
UCS after 28 days cure and 90 days immersion in water (psi)	372.4	244.4	355.1	460.8
Hydraulic Conductivity after 28 days (cm/sec)	6E-07	4E-07	4E-07	1E-08
Hydraulic Conductivity after 28 days cure and 90 days immersion (cm/sec)	4E-06	1E-06	3E-06	8E-07
Shrink/Swell (% of 28 day failure strain)	0.03	0.79	1.35	2.29
Leach Index – Gross Alpha	11.5	12.2	11.7	12.0
Leach Index – Non-volatile Beta	10.0	10.5	10.0	10.4
Volume Increase (%)	32	25	41	41
pH	12.4	12.8	12.6	12.7
Temperature Rise (°C)	1.5	0	1	1
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-27. Results for Treated Material from Bulk Fraction #1 of CRSB Soils

CRSB Soil Fraction	Bulk Fraction #1			
Formulation [1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	419.9	405.2	336.4	345.8
UCS after 28 days (psi)	354.6	420.3	351.5	361.0
UCS after 28 days cure and 90 days immersion in water (psi)	342.3	481.8	472.4	590.1
Hydraulic Conductivity after 28 days (cm/sec)	2E-08	1E-08	9E-09	2E-07
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	2E-05	8E-07	5E-07	1E-07
Shrink/Swell (% of 28 day failure strain)	3.38	0.44	2.89	1.09
Leach Index – Gross Alpha	12.8	12.4	11.8	12.8
Leach Index – Non-volatile Beta	11.2	11.0	10.5	11.1
Volume Increase (%)	30	26	37	33
pH	12.3	12.8	12.6	12.6
Temperature Rise (°C)	2	2	2	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-28. Results for Treated Material from Bulk Fraction #2 of CRSB Soils

CRSB Soil Fraction	Bulk Fraction #2			
Formulation [1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	382.2	335.3	280.9	427.9
UCS after 28 days (psi)	379.1	424.3	378.6	504.1
UCS after 28 days cure and 90 days immersion in water (psi)	289.6	531.7	365.2	517.2
Hydraulic Conductivity after 28 days (cm/sec)	2E-07	2E-07	3E-07	3E-07
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	9E-07	4E-07	9E-07	2E-07
Shrink/Swell	4.29	0.71	0.32	1.01
Leach Index – Gross Alpha	11.9	12.7	11.9	12.0
Leach Index – Non-volatile Beta	9.8	10.2	10.2	10.4
Volume Increase (%)	28	25	36	36
pH	12.3	12.7	12.6	12.7
Temperature Rise (°C)	2	1	1	1
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-29. Results for Treated Material from Coarse Fraction of KRSB Soils

KRSB Soil Fraction	Coarse Fraction			
Formulation [1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 16 days (psi)	537.8	512.7	493.7	412.2
UCS after 28 days (psi)	500.7	619.1	532.7	541.0
UCS after 28 days cure and 90 days immersion in water (psi)	539.5	593.3	448.4	477.8
Hydraulic Conductivity after 28 days (cm/sec)	1E-08	3E-09	8E-07	3E-09
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	4E-06	9E-07	1E-06	1E-05
Shrink/Swell (% of 28 day failure strain)	0.64	<0.01	4.11	1.06
Leach Index – Gross Alpha	11.7	12.1	12.6	12.9
Leach Index – Non-volatile Beta	10.9	11.0	11.0	11.5
Volume Increase (%)	29	28	36	39
pH	12.6	12.5	12.7	12.4
Temperature Rise (°C)	2	1	2	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-30. Results for Treated Material from Fine Fraction of KRSB Soils

KRSB Soil Fraction	Fine Fraction			
Formulation [1]	1	2	3	4
Parameter	Result			
UCS after 16 days (psi)	401.1	403.4	274.8	307.0
UCS after 28 days (psi)	412.2	372.4	318.3	462.2
UCS after 28 days cure and 90 days immersion in water (psi)	258.1	410.2	333.5	525.3
Hydraulic Conductivity after 28 days (cm/sec)	2E-08	9E-07	2E-09	2E-06
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	3E-06	1E-06	4E-06	3E-06
Shrink/Swell (% of 28 day failure strain)	0.39	0.34	<0.01	0.20
Leach Index – Gross Alpha	11.6	12.0	12.3	12.4
Leach Index – Non-volatile Beta	10.2	10.6	10.5	11.1
Volume Increase (%)	24	20	30	30
pH	12.8	12.6	12.8	12.4
Temperature Rise (C)	2	2	2	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

Table 3-31. Results for Treated Material from Coarse Fraction of PRSB Soils

PRSB Soil Fraction	Coarse Fraction			
Formulation [1]	1	2	3	4
Parameter	Result			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	592.3	537.3	646.8	638.1
UCS after 28 days cure and 90 days immersion in water (psi)	509.7	571.4	621.5	707.1
Hydraulic Conductivity after 28 days (cm/sec)	5E-09	2E-09	4E-10	4E-08
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	8E-07	3E-06	1E-06	6E-07
Shrink/Swell (% of 28 day failure strain)	<0.01	0.99	2.72	0.55
Leach Index – Gross Alpha	13.2	13.2	13.5	12.7
Leach Index – Non-volatile Beta	10.2	10.8	10.6	11.0
Volume Increase (%)	37	39	40	42
pH	12.4	12.6	12.8	12.7
Temperature Rise (°C)	5	3	3	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 - Portland cement and bentonite
2 - Portland cement and 4% silicate (high)
3 - Portland cement, bentonite, and 2% silicate (low)
4 - Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

Table 3-32. Results for Treated Material from Fine Fraction of PRSB Soils

PRSB Soil Fraction	Fine Fraction			
Formulation[1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	411.1	342.4	340.1	492.2
UCS after 28 days cure and 90 days immersion in water (psi)	314.2	315.8	343.8	453.0
Hydraulic Conductivity after 28 days (cm/sec)	7E-09	8E-10	9E-10	8E-10
Hydraulic Conductivity after 28 days cure and 90 days immersion (cm/sec)	8E-07	1E-06	4E-07	3E-06
Shrink/Swell (% of 28 day failure strain)	5.54	0.53	5.33	1.14
Leach Index – Gross Alpha	13.4	13.0	13.0	12.8
Leach Index – Non-volatile Beta	10.6	10.9	10.6	11.0
Volume Increase (%)	32	34	33	36
pH	12.5	12.7	12.8	12.9
Temperature Rise (°C)	3	2	2	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

Table 3-33. Results for Treated Material from Bulk Fraction #1 of PRSB Soils

PRSB Soil Fraction	Bulk Fraction #1			
Formulation[1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	543.4	737.1	495.2	504.8
UCS after 28 days cure and 90 days immersion in water (psi)	532.9	685.2	359.7	687.8
Hydraulic Conductivity after 28 days (cm/sec)	3E-08	7E-10	1E-09	2E-08
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	4E-07	6E-07	9E-07	1E-06
Shrink/Swell (% of 28 day failure strain)	0.28	1.38	4.52	0.81
Leach Index – Gross Alpha	12.9	13.1	12.8	12.8
Leach Index – Non-volatile Beta	9.8	10.4	10.0	10.8
Volume Increase (%)	37	42	49	43
pH	12.4	12.6	12.7	12.9
Temperature Rise (°C)	3	1	1	1
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

Table 3-34. Results for Treated Material from Bulk Fraction #2 of PRSB Soils

PRSB Soil Fraction	Bulk Fraction #2			
Formulation[1]	1	2	3	4
Parameter	**Result**			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	585.3	594.4	487.7	543.1
UCS after 28 days cure and 90 days immersion in water (psi)	392.6	663.6	578.8	780.9
Hydraulic Conductivity after 28 days (cm/sec)	3E-09	6E-08	5E-10	2E-08
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	8E-07	2E-06	6E-07	7E-07
Shrink/Swell (% of 28 day failure strain)	5.48	0.73	7.18	0.02
Leach Index – Gross Alpha	12.3	12.8	12.6	12.8
Leach Index – Non-volatile Beta	9.6	10.0	9.8	10.3
Volume Increase (%)	34	36	35	40
PH	12.4	12.4	12.7	12.8
Temperature Rise (°C)	2	2	2	2
False Set	No	No	No	No
Flash Set	No	No	No	No
Set Time (hours)	16	16	16	16
Bleed Fluid	None	None	None	None

[1] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

Table 3-35. Results for Treated Material from Coarse Fraction of LRSB Soils

LRSB Soil Fraction	Coarse Fraction			
Formulation[1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	473.1	639.6	607.6	509.6
UCS after 28 days cure and 90 days immersion in water (psi)	613.0	982.5	426.9	697.0
Hydraulic Conductivity after 28 days (cm/sec)	9E-09	3E-09	3E-09	3E-08
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	1E-06	2E-06	1E-06	2E-06
Shrink/Swell (% of 28 day failure strain)	0.22	0.75	4.13	1.12
Leach Index – Gross Alpha	12.6	13.1	12.4	12.4
Leach Index – Non-volatile Beta[3]	nd	nd	nd	nd
Volume Increase (%)	33	36	34	40
PH	12.4	12.7	12.7	12.8
Temperature Rise (°C)	3	1	1	0
False Set	No	No	No	No
Flash Set	Yes	Yes	Yes	Yes
Set Time (hours)	4	4	4	4
Bleed Fluid	None	None	None	None

[1] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

[3] Total non-volatile beta value less than detection limit

Table 3-36. Results for Treated Material from Fine Fraction of LRSB Soils

LRSB Soil Fraction	Fine Fraction			
Formulation[1]	**1**	**2**	**3**	**4**
Parameter	**Result**			
UCS after 14 days (psi)	np[2]	np[2]	np[2]	np[2]
UCS after 28 days (psi)	490.6	376.6	417.5	546.6
UCS after 28 days cure and 90 days immersion in water (psi)	479.9	461.6	499.3	459.8
Hydraulic Conductivity after 28 days (cm/sec)	7E-10	7E-09	5E-10	2E-09
Hydraulic Conductivity after 28 days cure and 90 days immersion in water (cm/sec)	1E-06	2-E07	9E-09	2E-08
Shrink/Swell (% of 28 day failure strain)	2.32	0.10	1.98	1.07
Leach Index – Gross Alpha	12.8	13.1	13.0	13.1
Leach Index – Non-volatile Beta[3]	nd	nd	nd	nd
Volume Increase (%)	33	34	33	37
pH	12.5	12.6	12.6	12.9
Temperature Rise (C)	3	1	2	2
False Set	No	No	No	No
Flash Set	Yes	Yes	Yes	Yes
Set Time (hours)	4	4	4	4
Bleed Fluid	None	None	None	None

[1] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

[2] np – this test was not performed

[3] Total non-volatile beta value was less than detection limit

This page intentionally left blank.

4.0 DATA ANALYSIS AND INTERPRETATION

4.1 Soil Characterization

4.1.1 CRSB Soil Fractions

Visually the CRSB soil, when initially placed in the plastic pans, appeared to be composed of balls of clay-aggregated material ("clay balls") and loamy sand. A sample of each soil type was obtained for characterization (Grab Samples #1 and #2). The coarse and fine fractions were prepared as outlined in Section 3.1.1. The remaining material was homogenized and separated into two Bulk Fractions. Two samples (Remaining Soil #1 and Remaining Soil #2) were collected from the residual soil for analysis. Samples were also obtained from the bulk fractions (Bulk Fraction #1 and Bulk Fraction #2).

The particle size distribution results (Table 3-9) were as expected. The Coarse Fraction contained more sand-sized particles and less clay-sized particles than the Fine Fraction, and the Bulk Fractions were intermediate. The particle size of the grab samples, one from the clay balls and one from the loamy sand, mirrored those of the coarse and fine fraction. Consistent with the material selected for the samples, Grab Sample #1 had a particle size distribution similar to that of the Fine Fraction, while Grab Sample #2 had a particle size distribution similar to that of the Coarse Fraction. The Remaining Soil samples had particle size distributions similar to those of the Bulk Fraction samples. The Fine Fraction and Grab Sample #1 were classified as sandy loam/sandy clay loam soils. The Coarse Fraction and Grab Sample #2 were classified as loamy sand soils. The Bulk Fraction and Remaining Soil samples were classified as sandy loam soils.

The moisture content and Atterberg limits results (Table 3-10) were in agreement with the particle size distribution results. The Fine Fraction and Grab Sample #1 had higher moisture contents, higher liquid limits, and higher plasticity indices, as would be expected due to their higher clay content. Conversely, the Coarse Fraction and Grab Sample #2 had lower moisture contents, lower liquid limits, and low plasticity indices, as expected due to their higher sand content. Overall, the results for the Bulk Fractions and the Remaining Soil samples were intermediate between these two extremes.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide (Table 3-11). The presence of these compounds at these low levels suggests that they will have little or no inhibitory effect on the cementitious reactions which occur during the curing of

Portland cement. The oxidation/reduction data for the Remaining Soil #1 sample indicated an oxidation/reduction potential well within the typical range for surface soils.

The radionuclide results in Table 3-12 indicate the levels of radionuclides in each sample were similar, although Cs-137 and gross beta levels showed variability.

4.1.2 KRSB Soil Fractions

The KRSB soil visually appeared to be composed of balls of clay-aggregated material ("clay balls") and loamy sand. A sample of each was obtained for characterization (Grab Samples #1 and #2). The Coarse and Fine Fractions were prepared as outlined in section 3.1.2. The soil remaining after extraction of the Course and Fine Fractions was homogenized prior to obtaining the Remaining Soil samples.

The particle size distribution results (Table 3-13) confirm that the Coarse Fraction contained more sand-sized particles and less clay-sized particles than the Fine Fraction. The particle size of the Grab Samples, one from the clay balls and one from the loamy sand, mirrored those of the Coarse and Fine Fraction. Grab Sample #2 had a particle size distribution similar to that of the Fine Fraction, while Grab Sample #1 had a particle size distribution similar to that of the Coarse Fraction. The particle size distributions of the Remaining Soil samples were intermediate of the Coarse and Fine Fractions. The Fine Fraction and Grab Sample #2 were classified as sandy clay loam soils. The coarse fraction and Grab Sample #1 were classified as loamy sand soils. The Remaining Soil samples were classified as sandy loam soils.

The moisture content and Atterberg limits results (Table 3-14) were in agreement with the particle size distribution results. The Fine Fraction and Grab Sample #2 had higher moisture contents, higher liquid limits, and higher plasticity indices, as would be expected due to their higher clay content. Conversely, the Coarse Fraction and Grab Sample #1 had lower moisture contents and were non-plastic, as would be expected with their higher sand content. The results for the Remaining Soil samples were intermediate.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide (Table 3-15). The presence of these compounds at these low levels suggests that these chemical compounds will have little or no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The oxidation/reduction data for the Remaining Soil #1 sample indicated the oxidation/reduction potential of the sample was well within the typical range for surface soils.

The radionuclide results in Table 3-16 indicate levels of radionuclides in the coarse and fine fractions were similar, although the Coarse Fraction contained higher Cs-137 and gross beta levels.

4.1.3 PRSB Soil Fractions

The PRSB soil was composed primarily of balls of clay-aggregated material ("clay balls") with minor amounts of loamy sand. Grab samples were obtained for characterization (Grab Samples #1 and #2). The Coarse and Fine Fractions were obtained as outlined in Section 3.2.1. The remaining material was homogenized and split into two bulk fractions and two samples (Remaining Soil #1 and Remaining Soil #2). Samples were also obtained from the bulk fractions (Bulk Fraction #1 and Bulk Fraction #2).

The particle size distribution results (Table 3-17) indicated that the PRSB Coarse Fraction contained more sand-sized particles and less clay-sized particles than the PRSB Fine Fraction. The particle size distributions of the PRSB Bulk Fractions, the Grab Samples, and the Remaining Soil samples were intermediate to the PRSB Coarse and Fine Fractions. The PRSB Fine Fraction and Remaining Soil #1 were classified as loam soils. The PRSB Coarse Fraction and the other samples were classified as sandy clay loam soils.

The moisture content and Atterberg limits results (Table 3-18) are in agreement with the particle size distribution results. There were very little differences seen for the moisture contents, liquid limits, plastic limits, and plasticity indices between the PRSB samples. This was probably due to their higher clay contents than the CRSB and KRSB soils.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide (Table 3-19). At these low levels, these chemical compounds will have little to no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The oxidation/reduction data for the Remaining Soil #1 sample indicated the oxidation/reduction potential of the sample was well within the typical range for surface soils.

The radionuclide results in Table 3-20 indicate levels of radionuclides in Coarse and Bulk Fractions were similar, though these was some variability, especially with the Cs-137, Sr-90, and gross beta levels. The Fine Fraction contained significantly higher Cs-137, Pu-239/240, and gross beta levels.

4.1.4 LRSB Soil Fractions

The LRSB soil was composed of balls of clay-aggregated material ("clay balls") and loamy sand. A sample of each was obtained for characterization (Grab Samples #1 and #2). The Coarse and Fine Fractions were obtained as outlined in Section 3.2.2. The remaining soil was homogenized prior to obtaining the Remaining Soil samples.

The particle size distribution results (Table 3-21) indicated that the Coarse Fraction contained more sand-sized particles and less clay-sized particles than the Fine Fraction. The particle size of the grab samples, one from the clay balls and one from the loamy sand, mirrored those of the Coarse and Fine Fraction. Grab Sample #1 had a particle size distribution similar to that of the Fine Fraction, while Grab Sample #2 had a particle size distribution similar to that of the Coarse Fraction. The particle size distributions of the Remaining Soil samples were intermediate of the Coarse and Fine Fractions. The Fine Fraction and Grab Sample #2 would be classified as loam soils. The Coarse Fraction and Grab Sample #1 were classified as sandy clay loam soils. The Remaining Soil samples were classified as sandy loam soils.

The moisture content and Atterberg limits results (Table 3-22) were in agreement with the particle size distribution results. As with the PRSB soils, there was very little differences seen for the moisture contents, liquid limits, plastic limits, and plasticity indices between the LRSB samples. This was probably due to their higher clay contents than the CRSB and KRSB soils.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide (Table 3-23). At these low levels, these chemical compounds will have little or no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The oxidation/reduction data for the Remaining Soil #1 sample indicated an oxidation/reduction potential of the sample well within the typical range for surface soils.

The radionuclide results in Table 3-24 indicate levels of radionuclides in the coarse and fine fractions were similar, though the levels of Cs-137, Pu-239/240, Sr-90, and gross beta in the PRSB soil fractions were much lower than soil fractions from the other three reactor seepage basins.

4.2 Treated Material Performance Testing

4.2.1 Treated Material Performance Testing

The cured treated material was subjected to the performance criteria testing listed in Tables 3-1, 3-3, 3-5 and 3-7 for Step 3. The tests were conducted to evaluate the effectiveness of the final stabilized waste material performance criteria (Table 2-1), with the exception of the criteria for the batching, hazardous dust/vapor release and the gas generation which were not performed. The results from the performance testing provide information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material. Test results are in Appendix A, Attachment A.

4.2.1.1 CRSB Treated Material

The results of the performance testing on the treated material produced from the treatment of the CRSB soil fractions are summarized in Tables 3-25 through 3-28.

The UCS results indicated that the treated material from the all soil fractions reached 200 to 400 psi strength within 14 days of curing, exceeding the performance criterion of 100 psi. Overall, little additional strength was gained over the next 14 days (28 days total) of curing. Variation in the UCS was not correlated to the amount of sodium bentonite or sodium silicate in the formulation, indicating that these had little effect on the UCS attained for a given formulation.

The hydraulic conductivity, after 28 days of curing, ranged from $6x10^{-7}$ to $9x10^{-9}$ cm/sec for the treated material from the CRSB soil fractions. The Portland cement and sodium silicate and Portland cement, bentonite, and sodium silicate (low) formulations produced treated material met the performance criterion ($<1x10^{-8}$ cm/sec) for Bulk Fraction #1. The average hydraulic conductivity for each formulation considering all soil fractions were essentially identical, approximately $1x10^{-7}$ cm/sec (Table 4-1).

Immersion in water for 90 days had little to no detrimental effect on the UCS values for the CRSB formulations. Most formulations had an increase in UCS during the 90 day water immersion; only the fine soil, Portland cement and silicate (high) and bulk fraction #2 soil, Portland cement and bentonite had significant reductions in UCS (50% and 24%, respectively).

Immersion in water affected the hydraulic conductivity of the formulations for the CRSB soils. Previous stabilization testing experience has indicated that immersion in water will increase the hydraulic conductivity by 1 to 2 orders of magnitude. Minor increases or decreases within the

expected range were seen for the hydraulic conductivity after immersion for most CRSB formulations. With the exception of the Fine Fraction, nearly all formulations in all soil fractions had hydraulic conductivity values of less than $1x10^{-6}$ cm/sec even after immersion in water for 90 days. The average hydraulic conductivity for each formulation ranged from $1x10^{-6}$ cm/sec to $3x10^{-7}$ cm/sec (Table 4-2).

The gross alpha and gross nonvolatile beta leach indices for a treated materials from the CRSB soil fractions met the performance criterion (>8). Generally, the Portland cement and bentonite and Portland cement, bentonite, and silicate (low) formulations had lower leach indices, suggesting that the high addition level of sodium silicate increases the immobilization of the radionuclides.

The shrink/swell results indicated that the treated material from the CRSB did not exhibit significant deformation during such events. The shrink/swell values were well below the performance criterion of less than 25% of the 28-day UCS failure strain.

The volume increases for the treated CRSB material were similar to those reported for similar grout stabilization projects and met the performance criterion of <50%. The volume increases were slightly higher for the CRSB coarse fraction as compared to the other fractions.

The pH values of the treated material from the CRSB fractions were high (12.2 to 12.8), exceeding the performance criterion (>10). These pH values may drop slightly over time as the treated material is exposed to carbonate in the environment.

The setting characteristics of the treated material from the CRSB soil fractions were favorable. The temperature rises of the treated material, measured in the cure within 1 hour after treatment, were low (0-2 °C), mostly due to the low Portland cement addition level. During full-scale treatment, it is likely that the temperature rise of the treated material would be much larger. The treated material did not false or flash set, and the treated material set overnight. No bleed fluid was noted for the treated material within 24 hours of treatment.

4.2.1.2 KRSB Treated Material

The results of the performance testing on the treated material produced from the KRSB soil fractions are summarized in Tables 3-29 and 3-30.

The UCS results indicated that the treated material from the KRSB soil fractions reached 270 to 540 psi strength within 16 days of curing. These UCS values exceed the performance criterion of

100 psi. The UCS measurements were taken on Day 16 instead of Day 14, as Day 14 was a Saturday. Overall, little additional strength was gained over the next 12 days (28 days total) of curing. Variation in the UCS was not correlated to the amount of sodium bentonite or sodium silicate in the formulation, indicating that this parameter had little effect on the UCS attained for a given formulation.

The hydraulic conductivity after 28 days of curing ranged from $2x10^{-6}$ to $2x10^{-9}$ cm/sec for the treated material from the KRSB soil fractions. For the KRSB Coarse Fraction, the treated material from three of the four formulations met the performance criterion ($<1x10^{-8}$ cm/sec), with only the Portland cement, bentonite, and silicate (low) formulation not meeting it. For the KRSB Fine Fraction, the Portland cement, bentonite, and silicate (low) was the only formulation which met the performance criterion, although the Portland cement and bentonite formulation nearly met it with a hydraulic conductivity of $2x10^{-8}$ cm/sec. The average hydraulic conductivity for the Portland cement and bentonite formulation met the performance criterion, while the other three formulations did not meet the performance criterion (Table 4-1).

Immersion in water for 90 days had little to no detrimental effect on the UCS values for the KRSB formulations. Most formulations had an increase in UCS during the 90 day water immersion; only the coarse soil, Portland cement, bentonite and silicate (low) and fine soil, Portland cement and bentonite had significant reductions in UCS (16% and 37%, respectively).

The immersion in water did significantly affect the hydraulic conductivity of the all formulations for the KRSB soils. Only one formulation in each soil type met a value of $1x10^{-6}$ cm/sec. Previous stabilization testing shows that immersion in water will increase the hydraulic conductivity by 1 to 2 orders of magnitude. Several of the formulations for the KRSB had larger increases in hydraulic conductivity after the 90-day immersion in water, though this may be an artifact of their low initial hydraulic conductivity. None of the formulations met the performance criterion for the average hydraulic conductivity (Table 4-2).

The gross alpha and gross nonvolatile beta leach indices for a treated materials from the KRSB soil fractions met the performance criterion (>8). Generally, the Portland cement and bentonite formulation had the lowest leach indices, suggesting that the addition of sodium silicate increases the immobilization of the radionuclides.

The shrink/swell results indicate that the treated material from the KRSB will not exhibit significant deformation during such events. The shrink/swell values were well below the performance criterion of less than 25% of the 28-day UCS failure strain.

The volume increases for the treated KRSB material was similar to those reported for similar grout stabilization projects. The volume increase performance criterion of less than 50% was met by all KRSB formulations.

The pH values of the treated material from the KRSB fractions were high (11.6 to 12.8), exceeding the performance criterion (>10). These pH values may drop slightly over time as the treated material is exposed to carbonate in the environment.

The setting characteristics of the treated material from the KRSB soil fractions were favorable. The temperature rises of the treated material, measured in the cure within 1 hour after treatment, were low (0-2 °C), mostly due to the low Portland cement addition level. During full-scale treatment, it is likely that the temperature rise of the treated material would be much larger. The treated material did not false or flash set, and the treated material set overnight. No bleed fluid was noted for the treated material within 24 hours of treatment.

4.2.1.3 PRSB Treated Material

The results of the performance testing on the treated material produced from the PRSB soil fractions are summarized in Tables 3-31 through 3-34.

The UCS results indicated that the treated material from the PRSB soil fractions achieve a strength of 340 to 740 psi within 28 days of curing. These UCS values exceed the performance criterion of 100 psi. The 14 day UCS testing was mistakenly omitted during the testing of the PRSB treated material. Variation in the UCS was not correlated to the amount of sodium bentonite or sodium silicate in the formulation, indicating that this parameter had little effect on the UCS attained for a given formulation.

The hydraulic conductivity after 28 days of curing ranged from $6x10^{-8}$ to $4x10^{-10}$ cm/sec for the treated material from the PRSB soil fractions. Overall, the average hydraulic conductivity for the treated materials from all formulations for each of the PRSB soil fractions met or exceeded the performance criterion ($<1x10^{-8}$ cm/sec). The Portland cement, bentonite, and silicate (low) met the hydraulic conductivity performance criterion for all formulations and for all PRSB soil fractions. The Portland cement and bentonite formulation met the performance criteria for all PRSB soil fractions, with the exception of the Bulk Fraction #1 where the hydraulic conductivity was $3x10^{-8}$cm/sec. The Portland cement, bentonite, and silicate (high) formulation met the performance criterion for the Fine Fraction and was between $4x10^{-8}$ and $2x10^{-8}$ cm/sec for the other PRSB soil fractions. The Portland cement and silicate (high) met the performance criterion

in all PRSB soil fractions, except the Bulk Fraction #2. The average hydraulic conductivity for all formulations met the performance criterion (Table 4-1).

Immersion in water for 90 days had little to no detrimental effect on the UCS values for the PRSB formulations. All formations for all soil fractions exceeded the performance criterion of 100 psi. Only two test formulations had reductions in UCS exceeding 25%. Most formulations had slight a change in UCS during the 90 day water immersion.

Immersion in water affected the hydraulic conductivity of the formulations for the PRSB soils. Previous stabilization testing experience has indicated that immersion in water will increase the hydraulic conductivity by one to two orders of magnitude. The least reduction in the hydraulic conductivity following immersion in water was experienced by the Portland cement with bentonite mix, slightly more than two orders of magnitude. All of the other formulations had reductions of more than three orders of magnitude in at least one soil fraction. The Portland cement, bentonite, and 4% silicate (high) formulation had a reduction of less than two orders of magnitude in three of the soil fractions. After immersion in water for 90 days, the treated material from PRSB soil had hydraulic conductivity values on the order of $1x10^{-6}$ cm/sec, regardless of formulation or soil fraction.

The gross alpha and gross nonvolatile beta leach indices for the treated materials from the PRSB soil fractions met the performance criterion (>8). The leach indices for all formulations were consistent and comparable.

The shrink/swell results indicated that the treated material from the PRSB did not exhibit significant deformation during such events. The shrink/swell values were well below the performance criteria of less than 25% of the 28-day UCS failure strain.

The volume increases for the treated PRSB material were similar to those reported for other RSB soils and met the performance criterion of 50% increase.

The pH values of the treated material from the PRSB fractions were high (12.4 to 12.9), exceeding the performance criterion (>10). These pH values may drop slightly over time as the treated material is exposed to carbonate in the environment.

The setting characteristics of the treated material from the PRSB soil fractions were favorable. The temperature rises of the treated material, measured in the cure within one hour after treatment, were low (1-5 °C), mostly attributable to the low percentage of Portland cement added. During full-scale treatment, it is likely that the temperature rise of the treated material

would be much larger. The treated material did not false or flash set, and the treated material set overnight. No bleed fluid was noted for the treated material within 24 hours of treatment.

4.2.1.4 LRSB Treated Material

The results of the performance testing on the treated material produced from the LRSB soil fractions are summarized in Tables 3-35 and 3-36.

The UCS results indicated that the treated material from the LRSB soil fractions reached 370 to 640 psi within 28 days of curing. These UCS values exceed the performance criterion of 100 psi. The 14 day UCS testing was mistakenly omitted during the testing of the LRSB treated material. Variation in the UCS was not correlated to the amount of sodium bentonite or sodium silicate in the formulation, indicating that this parameter had little effect on the UCS attained for a given formulation.

The average hydraulic conductivity after 28 days of curing for all formulations was less than $1x10^{-8}$ cm/sec. The hydraulic conductivity ranged from $3x10^{-8}$ to $5x10^{-10}$ cm/sec for the treated material from the LRSB soil fractions. For the LRSB coarse fraction, the treated material from all formulations met the performance criterion ($<1x10^{-8}$ cm/sec), with the exception of the Portland cement, bentonite, and silicate (high) formulation ($3x10^{-8}$ cm/sec). For the LRSB fine fraction, the material from all formulations met the performance criterion.

Immersion in water for 90 days had little to no detrimental effect on the UCS values for the LRSB formulations. Most formulations had an increase in UCS during the 90 day water immersion, while one formulation had a reduction in UCS greater than 25%.

Immersion in water affected the hydraulic conductivity of the formulations for the LRSB soils. Typically, immersion in water will increase the hydraulic conductivity by one to two orders of magnitude. For the LRSB Coarse Fraction, immersion in water reduced the hydraulic conductivity of the treated material to approximately $1x10^{-6}$ cm/sec, regardless of the formulation or initial hydraulic conductivity. Decreases within the expected range were seen for the hydraulic conductivity after immersion for all of the formulations on the LRSB Fine Fraction.

The gross alpha leach indices for a treated materials from the LRSB soil fractions met the performance criterion (>8). Generally, the Portland cement and silicate (high) formulation had the highest leach indices. Since the nonvolatile gross beta level in the LRSB soil fractions were below the detection limit, leach indices could not be determined for the nonvolatile gross beta contamination in the LRSB soil fractions.

The shrink/swell results indicated that the treated material from the CRSB did not exhibit significant deformation during such events. The shrink/swell values were well below the performance criterion of less than 25% of the 28-day UCS failure strain.

The volume increases for the treated LRSB material were similar to those reported for the other RSB soils and met the performance criterion of less than 50% increase in volume.

The pH values of the treated material from the LRSB fractions were high (12.4 to 12.9), exceeding the performance criterion (>10). These pH values may drop slightly over time as the treated material is exposed to carbonate in the environment.

The setting characteristics of the treated material from the LRSB soil fractions were not favorable. The temperature rises of the treated material, measured in the cure within one hour after treatment, were low (1-3 °C), mostly attributable to the low percentage of Portland cement added. During full-scale treatment, it is likely that the temperature rise of the treated material would be much larger. The treated material for all formulations appeared to flash set within four hours of mixing. Flash setting may occur during full-scale treatment and produce problems, especially with sampling of the treated material. No bleed fluid was noted for the treated material within 24 hours of treatment.

Table 4-1. Average Hydraulic Conductivity by Formulation
All Soil Fractions – 28-Day Cure

Seepage Basin	Average Hydraulic Conductivity (cm/sec)[1]			
	Formulation[2] 1	Formulation[2] 2	Formulation[2] 3	Formulation[2] 4
CRSB	2E-07	1E-07	1E-07	1E-07
KRSB	1E-08	5E-08	4E-08	8E-08
PRSB	7E-09	3E-09	7E-10	1E-08
LRSB	3E-09	5E-09	1E-09	8E-09

[1] Logarithmic average to the base 10
[2] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

Table 4-2. Average Hydraulic Conductivity by Formulation
All Soil Fractions – 28-Day Cure, 90-Day Immersion

Seepage Basin	Average Hydraulic Conductivity (cm/sec)[1]			
	Formulation[2] 1	Formulation[2] 2	Formulation[2] 3	Formulation[2] 4
CRSB	1E-06	7E-07	5E-07	3E-07
KRSB	3E-06	9E-07	2E-06	5E-06
PRSB	7E-07	1E-06	7E-07	1E-06
LRSB	1E-06	6E-07	9E-08	2E-07

[1] Logarithmic average to the base 10
[2] Formulation:
1 – Portland cement and bentonite
2 – Portland cement and 4% silicate (high)
3 – Portland cement, bentonite, and 2% silicate (low)
4 – Portland cement, bentonite, and 4% silicate (high)

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Soil Characterization

5.1.1 CRSB Soil

Four samples (Grab Sample #1, Grab Sample #2, Remaining Soil #1 and Remaining Soil #2) of the CRSB soil and samples of the four fractions (fine, coarse, Bulk Fraction #1, and Bulk Fraction #2) were subjected to physical characterization. The physical characterization of the CRSB samples indicate that the separation of the CRSB soil into the various fractions for S/S testing produced fractions which vary in their physical properties and reflect the lithologic variability which may occur within the CRSB.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide. The presence of these compounds at these low levels suggests that these chemical compounds will have little to no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The radionuclide characterization results on the CRSB soil indicated that the CRSB soils contained moderate levels of Cs-137 and Sr-90 and low levels of Pu-239/240.

5.1.2 KRSB Soil

Four samples (Grab Sample #1, Grab Sample #2, Remaining Soil #1 and Remaining Soil #2) of the KRSB soil and samples of the two fractions (fine and coarse) were subjected to physical characterization. The physical characterization of the KRSB samples indicate that the separation of the KRSB soil into fine and coarse fractions for S/S testing produced fractions which vary in their physical properties and reflect the lithologic variability which may occur within the KRSB. The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide. The presence of these compounds at these low levels suggests that these chemical compounds will have little to no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The radionuclide characterization results on the KRSB soil fractions indicated that the fine fraction had high levels of Cs-137, moderate levels of Sr-90 and low levels of Pu-239/240 and the coarse fraction contained moderate levels of Cs-137 and Sr-90 and low levels of Pu-239/240.

5.1.3 PRSB Soil

Four samples (Grab Sample #1, Grab Sample #2, Remaining Soil #1 and Remaining Soil #2) of the PRSB soil and samples of the four fractions (fine, coarse, Bulk Fraction #1, and Bulk Fraction #2) were subjected to physical characterization. The physical characterization of the PRSB samples indicate that the separation of the PRSB soil into the various fractions for S/S testing produced fractions which vary in their physical properties and reflect the lithologic variability which may occur within the PRSB.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide. The presence of these compounds at these low levels suggests that these chemical compounds will have little to no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The radionuclide characterization results on the PRSB soil fractions indicated that the fine fraction contained high levels of Cs-137, moderate levels of Sr-90, and low levels of Pu-239/240; while the other fractions contained moderate levels of Cs-137 and Sr-90 and low levels of Pu-239/240.

5.1.4 LRSB Soil

Four samples (Grab Sample #1, Grab Sample #2, Remaining Soil #1 and Remaining Soil #2) of the LRSB soil and samples of the two fractions (fine and coarse) were subjected to physical characterization. The physical characterization of the LRSB samples indicate that the separation of the LRSB soil into the various fractions for S/S testing produced fractions which vary in their physical properties and reflect the lithologic variability which may occur within the LRSB.

The chemical characterization of the Bulk Sample #1 and the Remaining Soil #1 samples indicated that the samples contained low levels of chloride, nitrite, nitrate, sulfate, and sulfide. The presence of these compounds at these low levels suggests that these chemical compounds will have little to no inhibitory effect on the cementitious reactions which occur during the curing of Portland cement. The radionuclide characterization results indicated that the LRSB fractions contained low levels of Cs-137, Sr-90, and Pu-239/240.

5.2 Stabilization/Solidification 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, with the exception of the criteria for the batching, hazardous

dust/vapor release and the gas generation. The results from the performance testing provide information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material.

5.2.1 CRSB Soil

With the exception of the hydraulic conductivity, the treated material from all formulations met the performance criteria (Table 2-1). This indicates that the four grout design mixes listed in Table 1-1 could adequately handle the variability in lithology that may be expected within the CRSB.

The hydraulic conductivity after 28 days of curing ranged from $6x10^{-7}$ to $9x10^{-9}$ cm/s for the treated material from the CRSB soil fractions. For the CRSB coarse fraction and bulk fraction #2, the Portland cement, bentonite, and sodium silicate (high) formulation had the lowest hydraulic conductivity. For the CRSB fine fraction, only the Portland cement, bentonite, and silicate (high) formulation did not meet the performance criterion. This may be an anomaly as all the other formulations for the CRSB fine fraction met the hydraulic conductivity performance criterion.

The immersion in water affected the hydraulic conductivity of the formulations for the CRSB soils, with most formulations experiencing the expected one to two order-of-magnitude increase in hydraulic conductivity.

5.2.2 KRSB Soil

With the exception of the hydraulic conductivity, the treated material from all formulations met the performance criteria (Table 2-1). This indicates that the four grout design mixes listed in Table 1-1 could adequately handle the variability in lithology that may be expected within the KRSB.

The hydraulic conductivity after 28 days of curing ranged from $2x10^{-6}$ to $2x10^{-9}$ cm/s for the treated material from the KRSB soil fractions. For the KRSB coarse fraction, the treated material from three formulations met the performance criterion ($<1x10^{-8}$ cm/sec), with the lowest value for the two formulations with high silicate. For the KRSB fine fraction, the Portland cement, bentonite, and silicate (low) formulation has a hydraulic conductivity of $2x10^{-8}$ cm/sec.

The immersion in water significantly affected the hydraulic conductivity of the all formulations for the KRSB soils, with most formulations experiencing the expected one to two order-of-magnitude increase in hydraulic conductivity.

5.2.3 PRSB Soil

With the exception of the hydraulic conductivity following 90-day immersion in water, the treated material from all formulations met the performance criterion (Table 2-1). This indicates that the four grout design mixes listed in Table 1-1 could adequately handle the variability in lithology that may be expected within the PRSB.

The average hydraulic conductivity after 28 days of curing for the treated material from the PRSB soil fractions met the performance criterion ($1x10^{-8}$ cm/sec), ranging from $6x10^{-8}$ to $4x10^{-10}$ cm/sec. The Portland cement, bentonite, and silicate (low) formulation met the hydraulic conductivity performance criterion for all of the PRSB soil fractions. The other formulations met the performance criterion on most of the PRSB soil fractions.

The immersion in water affected the hydraulic conductivity of the formulations for the PRSB soils, with most formulations experiencing the expected one to two order-of-magnitude increase in hydraulic conductivity. After immersion in water for 90 days, the treated material from PRSB soil had hydraulic conductivity values on the order of $1x10^{-6}$ cm/sec, regardless of formulation or soil fraction.

5.2.4 LRSB Soil

With the exception of the hydraulic conductivity following 90-day immersion in water, the treated material from all formulations met the performance criterion (Table 2-1). This indicates that the four grout design mixes listed in Table 1-1 could adequately handle the variability in lithology that may be expected within the KRSB.

The average hydraulic conductivity after 28 days of curing for all formulations met the performance criterion ($<1x10^{-8}$ cm/sec). Individual mixes ranged from $3x10^{-8}$ to $5x10^{-10}$ cm/sec for the treated material from the LRSB soil fractions. For the LRSB coarse fraction, the treated material from all formulations met the performance criterion, with the exception of the Portland cement, bentonite, and silicate (high) formulation ($3x10^{-8}$ cm/sec). For the LRSB fine fraction, the material from all formulations met the performance criterion.

The immersion in water significantly affected the hydraulic conductivity of the all formulations for the LRSB soils. For the LRSB Coarse Fraction, immersion in water reduced the hydraulic conductivity of the treated material to approximately $1x10^{-6}$ cm/sec, regardless of the formulation or initial hydraulic conductivity. Decreases within the expected range of one to two orders-of-magnitude were seen for the hydraulic conductivity after immersion for all of the formulations on the LRSB Fine Fraction.

5.2.5 Data Set Evaluation

The consistency of the laboratory results was evaluated by building a model that used the grain size and grout mix information to calculate individual key performance parameters. The performance parameters analyzed were hydraulic conductivity (28 and 90-day), unconfined compressive strength (14, 28, and 90-day), and leachability index. Information from all the four basins were grouped into one data set as not enough data was present at any individual basin for this analysis. A neural network was used in the analysis to identify if outliers were present in the data sets. An outlier would be identified if given similar input information of grain size and grout mix, one of the outputs was inconsistent with the rest of the information in the data set. The results of the analysis showed:

- Leachability Index – The data (100%) could be reproduced to within 10% of the laboratory data.

- UCS (14 and 28 day) – The data (100%) could be reproduced to within 25% of the laboratory data;

- UCS (90-day) – The data (47 of 48 data points, or 98%) could be reproduced to within 25% of the laboratory data. The sample from KRSB, Portland cement and bentonite, fine fraction had a comparison error of 31%.

- Hydraulic Conductivity (28-day) – The data (44 of 48 data points, or 92%) could be reproduced within one order of magnitude. Samples from KRSB (Portland cement and 4% silicate, fine fraction), KRSB (Portland cement, bentonite, and 4% silicate, fine fraction), LRSB (Portland cement and 4% silicate, fine fraction), and LRSB (Portland cement, bentonite, and 4% silicate, fine fraction) appear to be outliers when evaluating the data set as a whole.

- Hydraulic Conductivity (90-day) – The data (44 of 48 data points, or 92%) could be reproduced within one order of magnitude. Samples from KRSB in (Portland cement,

bentonite, and 2% silicate, fine fraction), KRSB (Portland cement, bentonite, and 4% silicate, fine fraction), LRSB (Portland cement, bentonite, and 2% silicate, fine fraction), and LRSB (Portland cement, bentonite, and 4% silicate, fine fraction) appear to be outliers when evaluating the data set as a whole.

In Summary, the data sets are very consistent and useful for their intended purpose. The outliers may be a result of an inconsistency with the test method or a unique feature of the basin material.

The 14 day unconfined compressive strength tests were similar in value, though slightly stronger on average to the 28-day tests. The 14-day UCS tests averaged 376 psi, with a standard deviation of 84 psi. The 28-day UCS test results averaged 416 psi, with a similar standard deviation of 83 psi. Some individual 14-day test results were stronger than 28-day test results, with one being up to 18% stronger. This apparent anomaly is not unexpected when testing fine-grained soil cements. This was compounded with the fact that only one break was made at each test duration, instead of three as is common, due to lack of available soil to test. All of the results exceed the performance requirement of 100 psi.

5.3 FULL-SCALE S/S TREATMENT

This bench-scale study has been conducted in accordance with industry practice, and the grout mix recommended for the treatment of soils in the reactor seepage basins (Section 5.3.1) has been demonstrated to be successful at the bench (i.e. laboratory) scale. Scaling this work, and the documentation of successful results, to full scale field applications adds many unknowns. These unknowns include, but are not limited to, variability in the basin chemistry and geology; S/S contractor mixing method, application, and experience; and weather during the mixing operations. While the actual construction activities during full-scale operations are outside of SAIC's control, supplemental information has been provided to deal with some of the potential unknowns which may arise during the actual field activity (Sections 5.3.2 and 5.3.3). These construction practices and lessons learned have enhanced the effectiveness of other successful S/S projects.

5.3.1 S/S Formulation

5.3.1.1 Selected Formulation

The remediation technology chosen for these basins is soil solidification/stabilization. The purpose of solidification is to produce a strong, structurally stable waste form with a reduced leach potential. The purpose of the stabilization effort is to reduce a waste's solubility and/or

chemical reactivity using a tailored reagent. Two classifications of soil stabilization techniques are possible for deployment for the basins, ex-situ and in-situ. An ex-situ method would require that the soils in the basins be excavated, mixed with the stabilizing mixture, and returned to the basin. The in-situ techniques treat the soils within the basins by mixing them in-place with augers, grout rakes or other mechanical means. Both techniques have advantages and disadvantages. For example, the ex-situ process requires a significant amount of material handling and transport, while the in-situ approach brings a portable mixing apparatus to the soil material to be stabilized. The ex-situ process provides for more complete mixing and quality assurance/quality control (QA/QC) control, while it can be difficult to control the QA/QC when using the in-situ process. BSRI has determined as part of the feasibility process that, all things considered, in-situ soil stabilization is the method of choice. The common methods for in-situ stabilization include a dual auger, a single auger, and a rake-like instrument with grout injection points at the bottom. In terms of the mixing energy imparted to the soil stabilization process, the dual auger technology best emulates the mixing of a twin shaft pug mill, a device commonly used in ex-situ material mixing. One of the keys to successful in-situ S/S is getting the grout to the bottom of the target stabilization area. These basins may require excavating areas to loosen, and/or pre-treat, soils in order for the mixing process to occur.

The recommended mixes are starting points for the final grout design, as there was not enough soil to do a complete study or mix design. The laboratory bench scale tests indicate the feasibility of pursuing the use of S/S technology for these basins. Various factors can affect the scalability of the results from the bench scale testing to full field applications, including, but not limited to; basin variability, mixing type and application, and experience of the S/S contractor. The selected vendor may modify the final mixture, since new or modifications to the S/S technology are continually occurring. It is also prudent to incorporate lessons learned from the L- and F-Area projects currently underway, into the final grout mix design process.

The Portland cement and bentonite grout mix is recommended for the full-scale S/S treatment of the CRSB, KRSB, LRSB, and PRSB soils. The S/S testing results (Section 3) for the treated material from the CRSB, KRSB, LRSB, and PRSB soils were similar and showed little variability that could be consistently attributed to the grout mix formulation composition. Therefore, reagent cost was used as the primary basis to select the recommended formulation. The reagent costs used for this comparison are listed in Appendix G.

The inclusion of sodium silicate solution as part of the S/S formulation is not recommended, since it did not consistently improve the UCS or hydraulic conductivity of the treated material as compared to the Portland cement and bentonite formulation. Although the addition of sodium

silicate solution may slightly increase the gross alpha and gross nonvolatile beta leach indices, the leach indices for the Portland cement and bentonite formulations were at least two orders of magnitude above the performance requirement. Further, the Portland cement, bentonite, and silicate formulations appeared to have higher volume increases when compared to Portland cement and bentonite and the Portland cement and silicate formulations.

The recommended formulation would involve mixing sufficient Portland cement and sodium bentonite into the soil so that these reagents account for 15% and 5%, respectively of the total weight of the soil and the reagents. The amount of water used to slurry the reagents into a grout will depend on the vendor-specific batching, grout pumping, and mixing equipment employed for the full-scale treatment.

5.3.1.2 Application of Selected Formulation

In-situ S/S is a complex process that requires significant QA/QC emphasis to maximize the probability of success. BSRI has included a significant list of QA/QC checks in the specifications for the L-Area and the F-Area projects which are recommended for incorporation into future bids. In addition, the following are suggestions are made:

- Include an equipment shakeout to see if the grout mix is compatible with equipment and make certain the pilot test works. Expand the pilot test from an equipment shakedown in one area to testing the full process in three areas chosen to represent soils with the finest grain size texture, the average grain size distribution, and the coarsest grain size. This step will assess whether or not the S/S process will work for the soil types expected in the basin, and, if failures do occur, will save the contractor from significant possible rework. Conduct the full 28 day test regime, and then make a go or no-go decision for the full-scale project. If a failure of the performance specification does occur, consider mixing the soil or adding components to blend and precondition the soil to a grain size that will work, or adjust the grout mix for individual portions of the basin.

- Consider trade-offs when designing the final grout mix. For example, soil grout matrices typically obtain higher strength and lower permeability if water is not added in excess (i.e., if free soil water could be available for the cementitous reactions) However, the workability of such a grout formulation would be poor.

- Select the time of the year that the in-situ S/S work is performed to minimize temperature extremes. Freezing retards the overall reaction rate and may damage the matrix, while

summer temperatures in excess of 100 degrees F can accelerate the reaction rate and may also ruin the final product.

- Conduct a geotechnical evaluation of the material below the area to be stabilized and determine if the S/S monolith will be subject to adverse settling, differential or otherwise, that may cause the monolith to crack.

- Control the introduction of water to the final S/S monolith via a water management system, such a cap. The design of the cap should include the results of the geotechnical evaluation to assess whether excess settlement could compromise the cap integrity.

For the selected Portland cement and bentonite formulation, the vendor would be required to calculate the volume of material to be treated with each injection or penetration of the mixing equipment. The vendor would then multiply the volume by the bulk density of the soil, as determined by the vendor, to determine the weight of soil to be treated by the injection or penetration. An example of this calculation is given below:

Footprint of mixing tool:	29 square ft
Depth of treatment:	10 ft
Volume of soil to be treated:	29*10 = 290 cubic ft (10.74 cubic yards)
Bulk Density of soil:	1.4 tons/cubic yard
Weight of Soil to be Treated:	10.74*1.4 = 15.04 tons

The weight of soil to be treated by each injection and the ratios of the reagent can then be used to calculate the amount of reagent required:

Ratio of Portland Cement:	15%
Ratio of Sodium Bentonite:	5%
Total Weight of Soil + Reagents:	15.04*[1+(15/100)+(5/100)] = 18.04 tons
Weight Portland Cement:	18.04*(15/100) = 2.71 tons
Weight Sodium Bentonite:	18.04*(5/100) = 0.90 tons

The result of this example is that the vendor would need to supply 2.71 tons of Portland cement and 0.90 tons of sodium bentonite to the 10 ft depth of soil to be treated with one injection or penetration of the mixing equipment. The amount of water needed to slurry the reagents is vendor-specific and depends on the specific batching, grout pumping and mixing equipment. The minimum amount of water used to slurry the reagents would be 1:1 by weight. For the above example, the weight of reagents is 3.61 tons (2.71 + 0.90). Therefore, the minimum water for slurrying reagents in the example is 3.61 tons (or 865 gallons).

5.3.2 Process Mixing Constraints

The major process mixing constraint for the Portland cement and bentonite grout mix is that the grout mix must be thoroughly mixed with the contaminated soil. The primary source of failure during full-scale treatment is often the lack of thorough mixing of the reagent grout and the soil. The soil types in the four reactor seepage basins ranged from sandy loams and loams to sandy clay loams. While the sandy nature of the soils make mixing of the grout and soil easier, the presence of soil material with higher clay contents indicate that high speed, high shear mixing would be required.

Mixing by excavators or rake-like attachments on excavators would not produce the high energy, high shear mixing required to thoroughly blend the grout and the soil. Jet-grouting has been effective in sandy soils and debris, but has had incomplete or inadequate mixing results in soils with higher clay contents. Auger mixer mounted either on crane bodies or excavators, would be sufficient to produce the high energy, high shear mixing required to adequate mix the grout and the reactor seepage basin soils.

Even with the auger mixing, mixing times for each column must be sufficient to thoroughly mix the injected grout and the soil. Multiple passes up and down at each column should be employed to ensure that the grout is completely mixed throughout the column. Preferably 2/3 of the grout volume for each column should be injected during the initial downward pass and the remaining 1/3 injected during the initial upward pass.

5.3.3 Construction Tolerances

5.3.3.1 Column Overlap

The overlap between the columns should be sufficient to ensure that all of the contaminated soil is treated. A minimum total overlap volume of 5% and a maximum of 10% should be considered for each of the reactor seepage basins. The minimum typically ensures that no untreated material

is left in the reactor seepage basin, while the maximum prevents the over-addition of reagents. The over-addition of reagents may lend to higher temperature rises in the treated material. The vendor should determine the positions of each column within each reactor seepage basin prior to beginning field work. Mapping of the column placement on the surface profile of each reactor seepage basin will verify that the overlap volume will be between 5 and 10%.

The position of each column should be surveyed in and recorded to verify that the placement is consistent with the vendor's treatment map. The center position of each column should be within ± 1.5 inches of the planned position. With most auger mixing equipment, this accuracy will still maintain sufficient overlap to ensure that all of the contaminated soil is treated.

5.3.3.2 Grout Batching

The grout should be produced in a batch plant capable of providing an individual grout batch for each column. 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 column, the in-situ bulk density of the reactor seepage basin soil, and the recommended S/S formulation. An example of this calculation is given in Section 5.3.1.2. 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 batching, grout pumping and mixing 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.

5.3.3.3 Moisture Content

For the soils used in the grout mix design testing, the moisture content ranged from 11 to 23% (dwb). Variability of moisture content within this range had little to no effect on the S/S testing results. During full-scale S/S application in the CRSB and KRSB, modification of the S/S treatment will not be required as long as the moisture content of the soil is greater than 10% (dwb). Soil with lower moisture contents will require the addition of water to prevent drying and cracking of the grout-treated soil. The modification for low moisture content soils can be either by the addition of water directly to the soil to be treated or by the adjustment of the volume of

water added to the grout. An example calculation to determine the amount of additional water needed is given below for a situation when the soil moisture is less than 10% (dwb):

Assumed Soil Moisture Content:	7% (dwb)
Footprint of mixing tool:	29 square ft
Depth of treatment:	10 ft
Volume of soil to be treated:	29*10 = 290 cubic ft (10.74 cubic yards)
Bulk Density of soil:	1.4 tons/cubic yard
Weight of Soil to be Treated:	10.74*1.4 = 15.04 tons
Weight of Water Present:	15.04*0.07 = 1.05 tons
Weight Water at 15% (dwb):	15.04*0.15 = 2.26 tons
Weight of Water Needed:	2.26 - 1.05 = 1.20 tons

Therefore, the amount of water to apply to the 29 square ft column treatment area is 1.20 tons (288 gallons). The water could be slowly applied to the surface and allowed to seep into the soil. Alternatively, the water could be added to the grout batch for that column.

5.3.3.4 Lithology

The objective of separating the soil material from the reactor seepage basins by soil texture prior to grout mix design testing was to allow the evaluation of lithological variation on the performance of the grout mixes. The testing results indicated that lithological variability should have little to no variability on the performance of the grout mix during full-scale S/S operations. Therefore, the Portland cement and bentonite formulation will be applicable for use over the entire CRSB, KRSB, LRSB, and PRSB with respect to lithology variations.

5.3.3.5 Temperature

Although the bench-scale testing results indicated that small temperature rises would be associated with the Portland cement and bentonite formulation, higher temperature rises are often seen during full-scale S/S operations. The selected S/S vendor should monitor the core and surface temperatures of the treated material to determine temperature rise during full-scale

treatment. Common industrial practice is to control the rate of temperature change and keep the surface temperature within final grout design parameters to minimize cracking of the grouted soil. If the vendor encounters higher temperatures, the vendor may add additional water to the grout mix. The additional water in the grout will serve as a heat sink to slow the heat rise.

5.3.3.6 Ambient Conditions

The use of the Portland cement and bentonite grout mix should not be limited by ambient conditions, with the exception of ambient temperatures below 32°F or above 100°F.

S/S operations should cease when temperatures fall below 32°F. At this point, all lines should be bled to present freezing of liquid contained in them. S/S operations can resume when warmer temperatures occur.

Ambient temperatures above 100°F may accelerate the reaction rates and ruin the final product and affect the viscosity and pumpability of the grout. Based on the vendor-specified batching and grout pumping equipment employed, the vendor may need to add additional water or a set retarder to the grout mix to decrease the viscosity and increase the pumpability of the grout. If a set retarder is used, testing should be conducted to determine the effect of the set retarder on the performance of the treated material.

5.3.3.7 Field Refinement

As required by the S/S vendor, limited field refinement of the grout mix may be done to adapt the grout mix to the vendor-specified batching, grout pumping, and mixing equipment. The field refinement can only be the addition of water or the use of a set retarder. Additional water can only be added to the grout mix to account for low soil moisture content, to lower the temperature rise of grouted soil, or to decrease the grout viscosity. A set retarder may be used to prolong the time between batching and injection of the grout mix or to decrease the viscosity of the grout. If a set retarder is used, pilot scale testing should be conducted to determine the effect of the set retarder on the performance of the treated material.

5.4 Estimated Construction Unit Cost

The costs of in-situ technology applied to the reactor seepage basins can be estimated on a per-unit-of-waste-treated basis. Multiple vendors are capable of providing in-situ S/S services to the depths necessary to treat the reactor seepage basins. The estimated unit cost is provided for the daily operation and does not include fixed project costs. The following estimate is based upon information contained in the report *Technical Assessment of In Situ Stabilization/Solidification*

Remedial Technologies for Potential Application to Soils and Sludges at the Petroleum Products Corporation Site in Pembroke Park, Broward County, Florida, EPA Contract No. 68-C5-0001, Science Applications International Corporation, October 1995. The prices and costs contained in this report are considered representative of current costs and prices. It does not consider ancillary costs associated with the project, such as air permits for the batch plant, administrative and support costs (site preparation, administrative staff, etc.), mobilization and demobilization, analytical costs for treated material and grout mix samples, nor any contingency for project uncertainties.

The cost for the S/S treatment of a cubic yd of soil is estimated to be approximately $115, as shown in Table 5-1. The estimate is based on daily production rates for a single auger system. This estimate was compared to unit costs contained in *Environmental Cost Handling Options and Solutions (ECHOS)* by R. S. Means. A direct comparison of costs was not possible; however units costs for equipment, labor, and material in ECHOS were comparable to those used to develop the above estimate. Costs not considered in this estimate could add substantially to the overall cost. For example, mobilization/demobilization could add an additional $150,000 to $200,000 to the overall project cost.

Table 5-1. Estimated Construction Unit Cost

Category	Number	Cost per Day	Total Cost per Day
Equipment			
Auger Mixing Plant		$11,500	$11,500
Batch Plant		$2,500	$2,500
Excavator		$500	$500
Grout Pump		$1,000	$1,000
		SUBTOTAL	$15,500
Labor			
Auger Operator	1	$600	$600
Batch Plant Operator	1	$475	$475
Excavator Operator	1	$500	$500
Health & Safety Officer	1	$450	$450
Site Supervisor	1	$600	$600
Field Engineer	1	$600	$600
Laborer	3	$350	$1,050
		SUBTOTAL	$4,275
Materials [1]			
Portland Cement	$85 per Ton	$5,355	$5,355
Bentonite	$200 per Ton	$4,200	$4,200
		SUBTOTAL	$9,555
		TOTAL DAILY COST	$28,655
Average Cost per Cubic Yd			**$115**

[1] Based on treating 250 cubic yards of soil per day, 1.4 tons per cubic yard of soil, and 15% Portland cement and 5% bentonite by weight in the final treated material.

This page intentionally left blank.

Appendix A

Geotechnical Testing Results for the C-, K-, L-, and PRSB

This page intentionally left blank.

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville, Tennessee 37923

May 28, 1999

This is the Certificate of Analysis for the following samples:

Project ID:	**SAIC Savannah River Site**
Project Number:	777304.00010500
Date Received by Lab:	December 23, 1998 and January 19, 1999
Number of Samples:	One hundred thirty-four (134)
Sample Type:	Bulk and stabilized soils

I. Introduction/Case Narrative

One hundred thirty-four soil samples were received by the IT Geotechnical Laboratory between December 23, 1998 and January 19, 1999. Fourteen bulk samples were submitted for determination of moisture content, particle-size distribution, Atterberg limits, specific gravity, and engineering soil classification (USCS). One hundred twenty stabilized soil cylinder sample were submitted for determination of unconfined compressive strength (USC), coefficient of permeability (hydraulic conductivity), and one-dimensional expansion/shrinkage. UCS tests were performed at 28 day specimen age, and after specimens were immersed in water for 90 days after an initial 28 day cure. Permeability and expansion/shrinkage tests were performed at 28 day specimen age.

Please see Appendix A, Sample Number Cross Reference List; Appendix B, Analysis Results; Appendix C, Chain-of-Custody and Request-for-Analysis Record; and Appendix D, Variance Reports. Appendices are divided by blue sheets. Sections within appendices are divided by green sheets.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

II. Analytical Results/Methodology

REFERENCES:

Annual Book of ASTM Standards, Section 4, Construction, Volume 04.08, *Soil and Rock (I)*, and Volume 04.09, *Soil and Rock (II)*, 1998.

United States Army Corps of Engineers, *Laboratory Soils Testing*, Engineer Manual (EM) 1110-2-1906, Appendix II, 1970.

Requested Methods:

Particle-Size Distribution of Soils	**ASTM D 422**
Specific Gravity of Soils	**ASTM D 854**
Unconfined Compressive Strength of Cohesive Soil	**ASTM D 2166**
Water (Moisture) Content of Soil and Rock	**ASTM D 2216**
Classification of Soils for Engineering Purposes (United Soil Classification System)	**ASTM D 2487**
One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures	**ASTM D 3877**
Liquid Limit, Plastic Limit and Plasticity Index of Soils	**ASTM D 4318**
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter	**ASTM D 5084**
Particle-Size Distribution of Soils	**ASTM D 422**

Additional Method

Unit Weights, Porosity, Void Ratio, and Degree of Saturation	**USACOE**

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 heterogeneous 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.

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

- 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

Unless noted otherwise, moisture content information is determined on the dry sample basis. As-received water content data is reported as ancillary information.

Permeability

A specific gravity value of 2.65 was assumed for use in permeability calculations where applicable.

Steady-state requirement: Section 8.5.3 (constant head test) requires at least four values of hydraulic conductivity be obtained in which (1) the ratio of outflow to inflow rate is between 0.75 and 1.25, and (2) the hydraulic conductivity is steady. The test values are considered to be steady when four consecutive tests fall within ± 25% of the mean value for $k \geq 1 \times 10^{-8}$ cm/s, or within ± 50% of the mean value for $k < 1 \times 10^{-8}$ cm/s, and a plot of the hydraulic conductivity versus time shows no significant upward or downward trend. Of the specimens aged 28 days, sample numbers ETDC-, ETDC-7871, ETDC-7874, ETDC-7877, ETDC-7879, ETDC-7970 ETDC-7973 and ETDC-7974 did not meet the steady-state requirements of ASTM D 5084 due to one or more tests falling outside the specification limits. Of the specimens aged 28 days followed by a 90 day immersion period, sample numbers ETDC-7822, ETDC-7827 and ETDC-7833 did not meet the steady-state requirements of ASTM D 5084 due to one or more tests falling outside the specification limits

In addition, no sample was determined to be at least 95% saturated as estimated by the b-value method outlined in section 8.3.3.1. Incompressible materials such as those tested here often do not yield a high b-value even though saturated, as discussed in Note 8 of the method.

Expansion/Shrinkage

The sample material did not fit the sample criteria of ASTM D 3877. The method assumes natural bulk soils will be processed and compacted into test rings for testing. Samples were received as solidified cylinders which were placed into rings by cutting to length and forcing the ring over the

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

specimen. Most specimens were of such a hard consistency that placement into the rings caused voids around the specimen periphery and/or upper/lower surfaces. For this reason, specimen densities are not reported here.

Expansion test specimens were loaded into consolidation cells and water was added to the cells to saturate the specimens. The initial seating load was placed on each specimen and the degree of deflection recorded after the necessary elapsed time. Most expansion specimens consolidated under the initial seating load. For dial readings indicating expansion, the reading was corrected for swelling of the filter papers used in the cell. Thus, all expansion samples were found to consolidate under the initial load, and/or no expansion was observed. Because no expansion was observed, no further loads were added to the specimens, no expansion curves were generated, and samples were judged to be non-expansive.

No raw sample was available for determination of shrinkage factors by ASTM D 427. This information is required in sections 9.2 (height shrinkage) and 9.3 (volume shrinkage) for determining how much to air-dry the specimens in shrinkage testing. All samples were tested using the height shrinkage method.

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville, Tennessee 37923

April 19, 1999

This is the Certificate of Analysis for the following samples:

Project ID:	**SAIC Savannah River Site**
Project Number:	777304.00010500
Date Received by Lab:	November 23 through December 15, 1998
Number of Samples:	One hundred fifty-eight (158)
Sample Type:	Bulk and stabilized soils

I. Introduction/Case Narrative

One hundred fifty-eight soil samples were received by the IT Geotechnical Laboratory between November 23 and December 15, 1998. Fourteen bulk samples were submitted for determination of moisture content, particle-size distribution, Atterberg limits, specific gravity, and engineering soil classification (USCS). One hundred forty-four stabilized soil cylinder sample were submitted for determination of unconfined compressive strength (USC), coefficient of permeability (hydraulic conductivity), and one-dimensional expansion/shrinkage. UCS tests were performed at 14 and 28 day specimen ages, and after specimens were immersed in water for 90 days after an initial 28 day cure. Permeability and expansion/shrinkage tests were performed at 28 day specimen age, and after specimens were immersed in water for 90 days after the initial 28 day cure.

Please see Appendix A, Sample Number Cross Reference List; Appendix B, Analysis Results; Appendix C, Chain-of-Custody and Request-for-Analysis Record; and Appendix D, Variance Reports. Appendices are divided by blue sheets. Sections within appendices are divided by green sheets.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

II. Analytical Results/Methodology

REFERENCES:

Annual Book of ASTM Standards, Section 4, Construction, Volume 04.08, *Soil and Rock (I)*, and Volume 04.09, *Soil and Rock (II)*, 1998.

United States Army Corps of Engineers, *Laboratory Soils Testing*, Engineer Manual (EM) 1110-2-1906, Appendix II, 1970.

Requested Methods:

Particle-Size Distribution of Soils	**ASTM D 422**
Specific Gravity of Soils	**ASTM D 854**
Unconfined Compressive Strength of Cohesive Soil	**ASTM D 2166**
Water (Moisture) Content of Soil and Rock	**ASTM D 2216**
Classification of Soils for Engineering Purposes (United Soil Classification System)	**ASTM D 2487**
One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures	**ASTM D 3877**
Liquid Limit, Plastic Limit and Plasticity Index of Soils	**ASTM D 4318**
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter	**ASTM D 5084**
Particle-Size Distribution of Soils	**ASTM D 422**

Additional Method

Unit Weights, Porosity, Void Ratio, and Degree of Saturation	**USACOE**

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 heterogeneous 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.

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

- 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

Unless noted otherwise, moisture content information is determined on the dry sample basis. As-received water content data is reported as ancillary information.

Permeability

A specific gravity value of 2.65 was assumed for use in permeability and phase relation calculations where applicable.

Steady-state requirement: Section 8.5.3 (constant head test) requires at least four values of hydraulic conductivity be obtained in which (1) the ratio of outflow to inflow rate is between 0.75 and 1.25, and (2) the hydraulic conductivity is steady. The test values are considered to be steady when four consecutive tests fall within ± 25% of the mean value for $k \geq 1 \times 10^{-8}$ cm/s, or within ± 50% of the mean value for $k < 1 \times 10^{-8}$ cm/s, and a plot of the hydraulic conductivity versus time shows no significant upward or downward trend. Of the specimens aged 28 days, sample numbers ETDC-8178, ETDC-8081, ETDC-8082, ETDC-8085, ETDC-8086, and ETDC-8093 did not meet the steady-state requirements of ASTM D 5084 due to one or more tests falling outside the specification limits. Of the specimens aged 28 days followed by a 90 day immersion period, sample numbers ETDC-8124 and ETDC-8242 did not meet the steady-state requirements of ASTM D 5084 due to one or more tests falling outside the specification limits.

In addition, no sample was determined to be at least 95% saturated as estimated by the b-value method outlined in section 8.3.3.1. Incompressible materials such as those tested here often do not yield a high b-value even though saturated, as discussed in Note 8 of the method.

Sample number ETDC-8080 did not yield positive flow in the effluent burette during any test. One or more tests did not yield positive flow in the effluent burette for other samples, as well. Negative flow was observed in both influent and effluent in all cases, and this phenomenon was not attributable to leakage in the permeameter/pressure panel system.

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

Expansion/Shrinkage

The sample material did not fit the sample criteria of ASTM D 3877. The method assumes natural bulk soils will be processed and compacted into test rings for testing. Samples were received as solidified cylinders, which were placed into rings by cutting to length and forcing the ring over the specimen. Most specimens were of such a hard consistency that placement into the rings caused voids around the specimen periphery and/or upper/lower surfaces. For this reason, specimen densities are not reported here.

After test specimens were placed into rings, the specimens were mounted in consolidation cells. Water was added to the cells to saturate the specimens. The initial seating load was placed on each specimen and the degree of deflection (as measured by a dial indicator) recorded after the necessary elapsed time. Most expansion specimens consolidated under the initial seating load. For dial readings indicating expansion, the reading was corrected for swelling of the filter papers used in the cell. Thus, all expansion samples were found to consolidate under the initial load, and/or no expansion was observed. Because no expansion was observed, no further loads were added to the specimens, no expansion curves were generated, and samples were judged to be non-expansive.

No raw sample was available for determination of shrinkage factors by ASTM D 427. This information is required in sections 9.2 (height shrinkage) and 9.3 (volume shrinkage) for determining how far to air-dry the specimens in shrinkage testing. All samples were tested using the height shrinkage method.

Attachment A

Sample Number Cross-Reference

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-7805	C311F00	Stabilized Soil
ETDC-7806	C321F00	Stabilized Soil
ETDC-7807	C331F00	Stabilized Soil
ETDC-7808	C341F00	Stabilized Soil
ETDC-7809	C411F00	Stabilized Soil
ETDC-7810	C421F00	Stabilized Soil
ETDC-7811	C431F00	Stabilized Soil
ETDC-7812	C441F00	Stabilized Soil
ETDC-7813	C511F00	Stabilized Soil
ETDC-7814	C521F00	Stabilized Soil
ETDC-7815	C531F00	Stabilized Soil
ETDC-7816	C541F00	Stabilized Soil
ETDC-7817	C611F00	Stabilized Soil
ETDC-7818	C621F00	Stabilized Soil
ETDC-7819	C631F00	Stabilized Soil
ETDC-7820	C641F00	Stabilized Soil
ETDC-7821	C312K00	Stabilized Soil
ETDC-7822	C322K00	Stabilized Soil
ETDC-7823	C332K00	Stabilized Soil
ETDC-7824	C342K00	Stabilized Soil
ETDC-7825	C412K00	Stabilized Soil
ETDC-7826	C422K00	Stabilized Soil
ETDC-7827	C432K00	Stabilized Soil
ETDC-7828	C442K00	Stabilized Soil
ETDC-7829	C512K00	Stabilized Soil
ETDC-7830	C522K00	Stabilized Soil
ETDC-7831	C532K00	Stabilized Soil
ETDC-7832	C542K00	Stabilized Soil
ETDC-7833	C612K00	Stabilized Soil
ETDC-7834	C622K00	Stabilized Soil
ETDC-7835	C632K00	Stabilized Soil
ETDC-7836	C642K00	Stabilized Soil
ETDC-7837	C313F00	Stabilized Soil

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-7838	C323F00	Stabilized Soil
ETDC-7839	C333F00	Stabilized Soil
ETDC-7840	C343F00	Stabilized Soil
ETDC-7841	C413F00	Stabilized Soil
ETDC-7842	C423F00	Stabilized Soil
ETDC-7843	C433F00	Stabilized Soil
ETDC-7844	C443F00	Stabilized Soil
ETDC-7845	C513F00	Stabilized Soil
ETDC-7846	C523F00	Stabilized Soil
ETDC-7847	C533F00	Stabilized Soil
ETDC-7848	C543F00	Stabilized Soil
ETDC-7849	C613F00	Stabilized Soil
ETDC-7850	C623F00	Stabilized Soil
ETDC-7851	C633F00	Stabilized Soil
ETDC-7852	C643F00	Stabilized Soil
ETDC-7853	C313G00	Stabilized Soil
ETDC-7854	C323G00	Stabilized Soil
ETDC-7855	C333G00	Stabilized Soil
ETDC-7856	C343G00	Stabilized Soil
ETDC-7857	C413G00	Stabilized Soil
ETDC-7858	C423G00	Stabilized Soil
ETDC-7859	C433G00	Stabilized Soil
ETDC-7860	C443G00	Stabilized Soil
ETDC-7861	C513G00	Stabilized Soil
ETDC-7862	C523G00	Stabilized Soil
ETDC-7863	C533G00	Stabilized Soil
ETDC-7864	C543G00	Stabilized Soil
ETDC-7865	C613G00	Stabilized Soil
ETDC-7866	C623G00	Stabilized Soil
ETDC-7867	C633G00	Stabilized Soil
ETDC-7868	C643G00	Stabilized Soil
ETDC-7869	C412G00	Stabilized Soil
ETDC-7870	C422G00	Stabilized Soil

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-7871	C432G00	Stabilized Soil
ETDC-7872	C442G00	Stabilized Soil
ETDC-7873	C512G00	Stabilized Soil
ETDC-7874	C522G00	Stabilized Soil
ETDC-7875	C532G00	Stabilized Soil
ETDC-7876	C542G00	Stabilized Soil
ETDC-7877	C612G00	Stabilized Soil
ETDC-7878	C622G00	Stabilized Soil
ETDC-7879	C632G00	Stabilized Soil
ETDC-7880	C642G00	Stabilized Soil
ETDC-7881	C312G00	Stabilized Soil
ETDC-7882	C322G00	Stabilized Soil
ETDC-7883	C332G00	Stabilized Soil
ETDC-7884	C342G00	Stabilized Soil
ETDC-7885	C312F00	Stabilized Soil
ETDC-7886	C322F00	Stabilized Soil
ETDC-7887	C332F00	Stabilized Soil
ETDC-7888	C342F00	Stabilized Soil
ETDC-7889	C412F00	Stabilized Soil
ETDC-7890	C422F00	Stabilized Soil
ETDC-7891	C432F00	Stabilized Soil
ETDC-7892	C442F00	Stabilized Soil
ETDC-7893	C512F00	Stabilized Soil
ETDC-7894	C522F00	Stabilized Soil
ETDC-7895	C532F00	Stabilized Soil
ETDC-7896	C542F00	Stabilized Soil
ETDC-7897	C612F00	Stabilized Soil
ETDC-7898	C622F00	Stabilized Soil
ETDC-7899	C632F00	Stabilized Soil
ETDC-7900	C642F00	Stabilized Soil
ETDC-7902	C100Q00	Soil
ETDC-7903	C200Q00	Soil
ETDC-7904	C300Q00	Soil

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-7905	C400Q00	Soil
ETDC-7906	C500Q00	Soil
ETDC-7907	C600Q00	Soil
ETDC-7908	C700Q00	Soil
ETDC-7909	C800Q00	Soil
ETDC-7910	K100Q00	Soil
ETDC-7911	K200Q00	Soil
ETDC-7912	K300Q00	Soil
ETDC-7913	K400Q00	Soil
ETDC-7914	K700Q00	Soil
ETDC-7915	K800Q00	Soil
ETDC-7948	K311F00	Stabilized Soil
ETDC-7949	K321F00	Stabilized Soil
ETDC-7950	K331F00	Stabilized Soil
ETDC-7951	K341F00	Stabilized Soil
ETDC-7952	K411F00	Stabilized Soil
ETDC-7953	K421F00	Stabilized Soil
ETDC-7954	K431F00	Stabilized Soil
ETDC-7955	K441F00	Stabilized Soil
ETDC-7967	K312K00	Stabilized Soil
ETDC-7968	K322K00	Stabilized Soil
ETDC-7969	K332K00	Stabilized Soil
ETDC-7970	K342K00	Stabilized Soil
ETDC-7971	K412K00	Stabilized Soil
ETDC-7972	K422K00	Stabilized Soil
ETDC-7973	K432K00	Stabilized Soil
ETDC-7974	K442K00	Stabilized Soil
ETDC-7975	K312F00	Stabilized Soil
ETDC-7976	K322F00	Stabilized Soil
ETDC-7977	K332F00	Stabilized Soil
ETDC-7978	K342F00	Stabilized Soil
ETDC-7979	K412F00	Stabilized Soil

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-7980	K422F00	Stabilized Soil
ETDC-7981	K432F00	Stabilized Soil
ETDC-7982	K442F00	Stabilized Soil
ETDC-7983	K312G00	Stabilized Soil
ETDC-7984	K322G00	Stabilized Soil
ETDC-7985	K332G00	Stabilized Soil
ETDC-7986	K342G00	Stabilized Soil
ETDC-7987	K412G00	Stabilized Soil
ETDC-7988	K422G00	Stabilized Soil
ETDC-7989	K432G00	Stabilized Soil
ETDC-7990	K442G00	Stabilized Soil
ETDC-7991	K313F00	Stabilized Soil
ETDC-7992	K323F00	Stabilized Soil
ETDC-7993	K333F00	Stabilized Soil
ETDC-7994	K343F00	Stabilized Soil
ETDC-7995	K413F00	Stabilized Soil
ETDC-7996	K423F00	Stabilized Soil
ETDC-7997	K433F00	Stabilized Soil
ETDC-7998	K443F00	Stabilized Soil
ETDC-7999	K313G00	Stabilized Soil
ETDC-8000	K323G00	Stabilized Soil
ETDC-8001	K333G00	Stabilized Soil
ETDC-8002	K343G00	Stabilized Soil
ETDC-8003	K413G00	Stabilized Soil
ETDC-8004	K423G00	Stabilized Soil
ETDC-8005	K433G00	Stabilized Soil
ETDC-8006	K443G00	Stabilized Soil

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-8009	L100Q00	Bulk raw soil
ETDC-8010	L200Q00	Bulk raw soil
ETDC-8011	L300Q00	Bulk raw soil
ETDC-8012	L400Q00	Bulk raw soil
ETDC-8013	L700Q00	Bulk raw soil
ETDC-8014	L800Q00	Bulk raw soil
ETDC-8015	P100Q00	Bulk raw soil
ETDC-8016	P200Q00	Bulk raw soil
ETDC-8017	P300Q00	Bulk raw soil
ETDC-8018	P400Q00	Bulk raw soil
ETDC-8019	P500Q00	Bulk raw soil
ETDC-8020	P600Q00	Bulk raw soil
ETDC-8021	P700Q00	Bulk raw soil
ETDC-8022	P800Q00	Bulk raw soil
ETDC-8023	P313F00	Stabilized Soil
ETDC-8024	P323F00	Stabilized Soil
ETDC-8025	P333F00	Stabilized Soil
ETDC-8026	P343F00	Stabilized Soil
ETDC-8027	P413F00	Stabilized Soil
ETDC-8028	P423F00	Stabilized Soil
ETDC-8029	P433F00	Stabilized Soil
ETDC-8030	P443F00	Stabilized Soil
ETDC-8031	P513F00	Stabilized Soil
ETDC-8032	P523F00	Stabilized Soil
ETDC-8033	P533F00	Stabilized Soil
ETDC-8034	P543F00	Stabilized Soil
ETDC-8035	P613F00	Stabilized Soil
ETDC-8036	P623F00	Stabilized Soil
ETDC-8037	P633F00	Stabilized Soil
ETDC-8038	P643F00	Stabilized Soil

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-8039	L313F00	Stabilized Soil
ETDC-8040	L323F00	Stabilized Soil
ETDC-8041	L333F00	Stabilized Soil
ETDC-8042	L343F00	Stabilized Soil
ETDC-8043	L413F00	Stabilized Soil
ETDC-8044	L423F00	Stabilized Soil
ETDC-8045	L433F00	Stabilized Soil
ETDC-8046	L443F00	Stabilized Soil
ETDC-8047	P312F00	Stabilized Soil
ETDC-8048	P322F00	Stabilized Soil
ETDC-8049	P332F00	Stabilized Soil
ETDC-8050	P342F00	Stabilized Soil
ETDC-8051	P412F00	Stabilized Soil
ETDC-8052	P422F00	Stabilized Soil
ETDC-8053	P432F00	Stabilized Soil
ETDC-8054	P442F00	Stabilized Soil
ETDC-8055	P512F00	Stabilized Soil
ETDC-8056	P522F00	Stabilized Soil
ETDC-8057	P532F00	Stabilized Soil
ETDC-8058	P542F00	Stabilized Soil
ETDC-8059	P612F00	Stabilized Soil
ETDC-8060	P622F00	Stabilized Soil
ETDC-8061	P632F00	Stabilized Soil
ETDC-8062	P642F00	Stabilized Soil
ETDC-8063	L312F00	Stabilized Soil
ETDC-8064	L322F00	Stabilized Soil
ETDC-8065	L332F00	Stabilized Soil
ETDC-8066	L342F00	Stabilized Soil
ETDC-8067	L412F00	Stabilized Soil
ETDC-8068	L422F00	Stabilized Soil
ETDC-8069	L432F00	Stabilized Soil
ETDC-8070	L442F00	Stabilized Soil

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-8071	P312K00	Stabilized Soil
ETDC-8072	P322K00	Stabilized Soil
ETDC-8073	P332K00	Stabilized Soil
ETDC-8074	P342K00	Stabilized Soil
ETDC-8075	P412K00	Stabilized Soil
ETDC-8076	P422K00	Stabilized Soil
ETDC-8077	P432K00	Stabilized Soil
ETDC-8078	P442K00	Stabilized Soil
ETDC-8079	P512K00	Stabilized Soil
ETDC-8080	P522K00	Stabilized Soil
ETDC-8081	P532K00	Stabilized Soil
ETDC-8082	P542K00	Stabilized Soil
ETDC-8083	P612K00	Stabilized Soil
ETDC-8084	P622K00	Stabilized Soil
ETDC-8085	P632K00	Stabilized Soil
ETDC-8086	P642K00	Stabilized Soil
ETDC-8087	L312K00	Stabilized Soil
ETDC-8088	L322K00	Stabilized Soil
ETDC-8089	L332K00	Stabilized Soil
ETDC-8090	L342K00	Stabilized Soil
ETDC-8091	L412K00	Stabilized Soil
ETDC-8092	L422K00	Stabilized Soil
ETDC-8093	L432K00	Stabilized Soil
ETDC-8094	L442K00	Stabilized Soil
ETDC-8095	P312G00	Stabilized Soil
ETDC-8096	P322G00	Stabilized Soil
ETDC-8097	P332G00	Stabilized Soil
ETDC-8098	P342G00	Stabilized Soil
ETDC-8099	P412G00	Stabilized Soil
ETDC-8100	P422G00	Stabilized Soil
ETDC-8101	P432G00	Stabilized Soil
ETDC-8102	P442G00	Stabilized Soil

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-8103	P512G00	Stabilized Soil
ETDC-8104	P522G00	Stabilized Soil
ETDC-8105	P532G00	Stabilized Soil
ETDC-8106	P542G00	Stabilized Soil
ETDC-8107	P612G00	Stabilized Soil
ETDC-8108	P622G00	Stabilized Soil
ETDC-8109	P632G00	Stabilized Soil
ETDC-8110	P642G00	Stabilized Soil
ETDC-8111	L312G00	Stabilized Soil
ETDC-8112	L322G00	Stabilized Soil
ETDC-8113	L332G00	Stabilized Soil
ETDC-8114	L342G00	Stabilized Soil
ETDC-8115	L412G00	Stabilized Soil
ETDC-8116	L422G00	Stabilized Soil
ETDC-8117	L432G00	Stabilized Soil
ETDC-8118	L442G00	Stabilized Soil
ETDC-8119	P313G00	Stabilized Soil
ETDC-8120	P323G00	Stabilized Soil
ETDC-8121	P333G00	Stabilized Soil
ETDC-8122	P343G00	Stabilized Soil
ETDC-8123	P413G00	Stabilized Soil
ETDC-8124	P423G00	Stabilized Soil
ETDC-8125	P433G00	Stabilized Soil
ETDC-8126	P443G00	Stabilized Soil
ETDC-8127	P513G00	Stabilized Soil
ETDC-8128	P523G00	Stabilized Soil
ETDC-8129	P533G00	Stabilized Soil
ETDC-8130	P543G00	Stabilized Soil
ETDC-8131	P613G00	Stabilized Soil
ETDC-8132	P623G00	Stabilized Soil
ETDC-8133	P633G00	Stabilized Soil
ETDC-8134	P643G00	Stabilized Soil

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
ETDC-8135	L313G00	Stabilized Soil
ETDC-8136	L323G00	Stabilized Soil
ETDC-8137	L333G00	Stabilized Soil
ETDC-8138	L343G00	Stabilized Soil
ETDC-8139	L413G00	Stabilized Soil
ETDC-8140	L423G00	Stabilized Soil
ETDC-8141	L433G00	Stabilized Soil
ETDC-8142	L443G00	Stabilized Soil

Attachment B

Analysis Results

C Series
Index Test Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

MOISTURE CONTENT

PROJECT NAME
SAIC - Savannah River

PROJECT NUMBER
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	MOISTURE, % ASTM D 2216	MOISTURE , % SW846	SOLIDS, % SW846
ETDC-7902	C100Q00	14.5	12.7	87.3
ETDC-7903	C200Q00	18.5	15.6	84.4
ETDC-7904	C300Q00	12.3	10.9	89.1
ETDC-7905	C400Q00	20.0	16.7	83.3
ETDC-7906	C500Q00	14.5	12.7	87.3
ETDC-7907	C600Q00	14.5	12.7	87.3
ETDC-7908	C700Q00	12.6	11.2	88.8
ETDC-7909	C800Q00	13.1	11.6	88.4

ASTM D 2216 results are based on dry sample weight.
SW846 results are based on wet sample weight.
Solids content is determined by subtracting the SW846 moisture (%) from 100.

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME:
SAIC / SAVANNAH RIVER

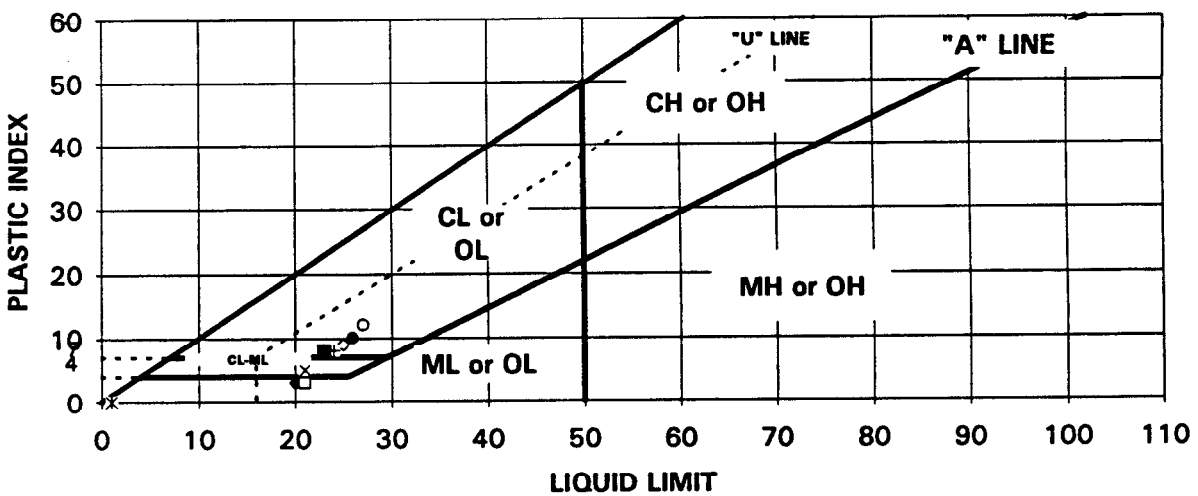
PROJECT NO.
777304.00010500

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
ETDC-7902 ●	C100Q00	26	16	10	CL
ETDC-7903 ◆	C200Q00	20	17	3	ML
ETDC-7904 □	C300Q00	21	18	3	ML
ETDC-7905 ◊	C400Q00	25	16	9	CL
ETDC-7906 +	C500Q00	24	16	8	CL
ETDC-7907 ○	C600Q00	27	15	12	CL
ETDC-7908 ■	C700Q00	23	15	8	CL
ETDC-7909 ×	C800Q00	21	16	5	CL-ML
△					
*					

*NP = Nonplastic

PLASTICITY CHART



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SPECIFIC GRAVITY
ASTM D 854

PROJECT NAME:
SAIC / SAVANNAH RIVER

PROJECT NUMBER:
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	SPECIFIC GRAVITY
ETDC-7902	C100Q00	2.6440
ETDC-7903	C200Q00	2.6353
ETDC-7904	C300Q00	2.6593
ETDC-7905	C400Q00	2.6439
ETDC-7906	C500Q00	2.6413
ETDC-7907	C600Q00	2.6352
ETDC-7908	C700Q00	2.6508
ETDC-7909	C800Q00	2.6412

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SOIL CLASSIFICATION
ASTM D 2487

PROJECT NAME: SAIC - Savannah River **PROJECT NO:** 777304.00010500

	ETDC NUMBER:	CLIENT NUMBER:	GROUP SYMBOL:	CLASSIFICATION-GROUP NAME:
SAMPLE 1:	ETDC-7902	C100Q00	SC	CLAYEY SAND
SAMPLE 2:	ETDC-7903	C200Q00	SM	SILTY SAND
SAMPLE 3:	ETDC-7904	C300Q00	SM	SILTY SAND
SAMPLE 4:	ETDC-7905	C400Q00	SC	CLAYEY SAND
SAMPLE 5:	ETDC-7906	C500Q00	SC	CLAYEY SAND
SAMPLE 6:	ETDC-7907	C600Q00	SC	CLAYEY SAND
SAMPLE 7:	ETDC-7908	C700Q00	SC	CLAYEY SAND
SAMPLE 8:	ETDC-7909	C800Q00	SC-SM	SILTY, CLAYEY SAND
SAMPLE 9:				
SAMPLE 10:				

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C100Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7902
Specific Gravity =	2.6440	Moisture Content =	14.5%
		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	98.6%
#4	4.750	97.6%
#10	2.000	95.1%

FINE

Sieve No.	Diameter mm	Percent Finer
#20	0.850	80.2%
#40	0.425	56.7%
#60	0.250	42.0%
#100	0.149	33.7%
#140	0.106	29.5%
#200	0.075	26.5%

HYDROMETER ANALYSIS

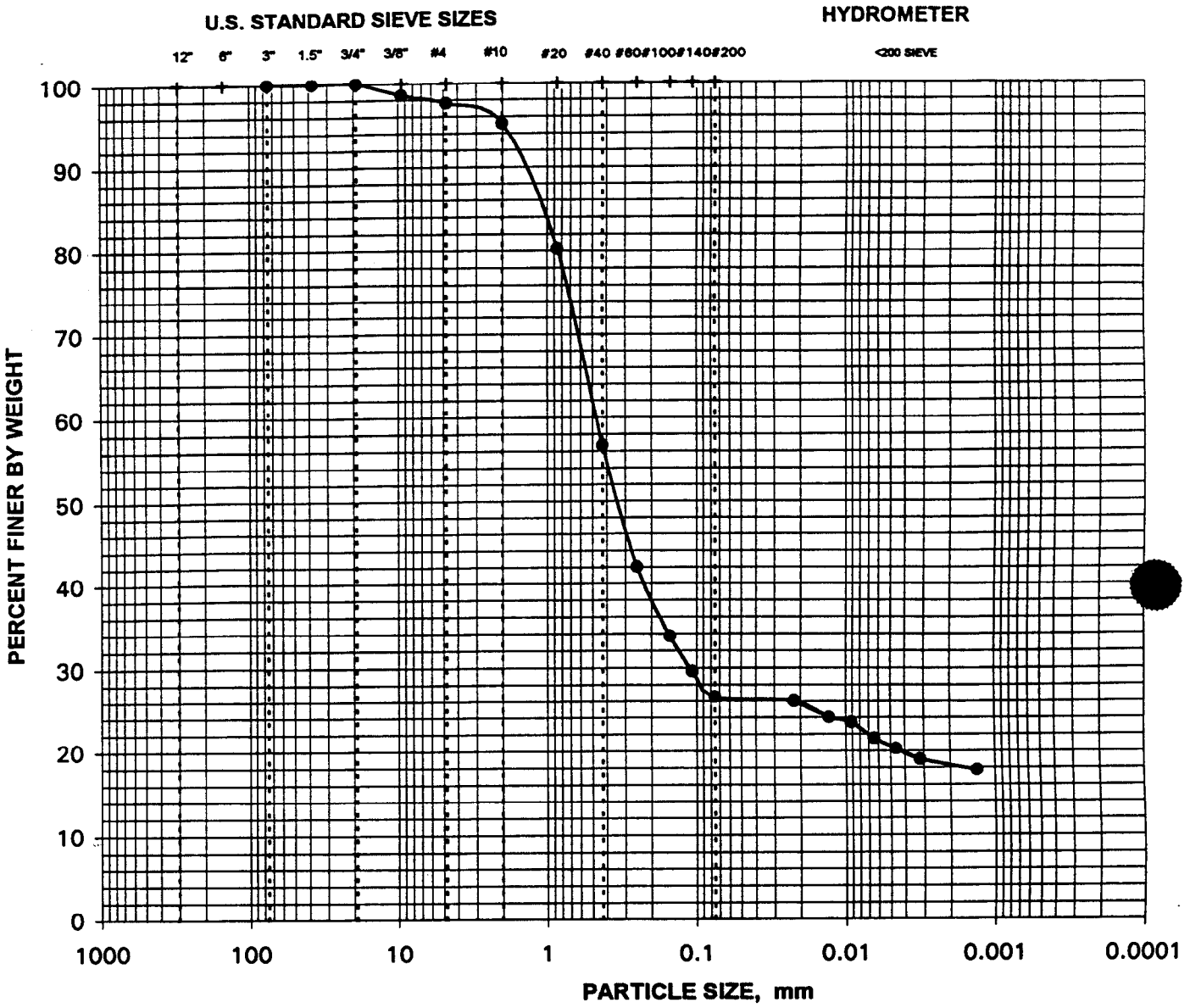
HYDROMETER

Diameter mm	Percent Finer
0.02197	26.0%
0.01282	24.1%
0.00910	23.4%
0.00640	21.5%
0.00456	20.3%
0.00315	19.0%
0.00132	17.7%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C100Q00

IT LAB SAMPLE NO.: ETDC-7902

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C200Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7903
Specific Gravity =	2.6353	Moisture Content =	18.5%
		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	100.0%
	0.375"	9.500	98.1%
	#4	4.750	95.3%
	#10	2.000	91.2%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	82.6%
	#40	0.425	64.4%
	#60	0.250	45.0%
	#100	0.149	29.2%
	#140	0.106	22.3%
	#200	0.075	18.4%

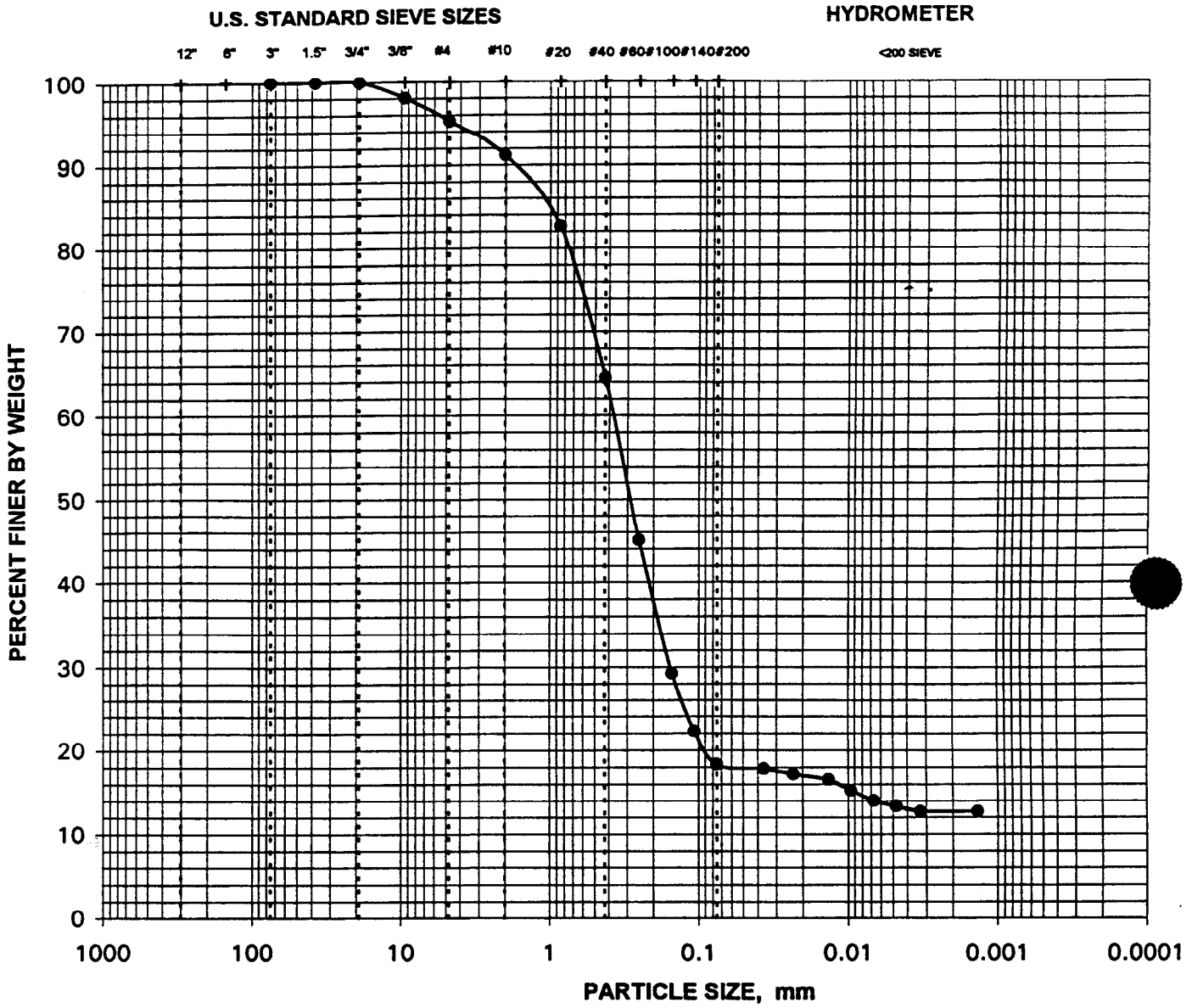
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03623	17.8%
	0.02300	17.2%
	0.01333	16.5%
	0.00946	15.3%
	0.00666	14.0%
	0.00472	13.4%
	0.00324	12.7%
	0.00135	12.7%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C200Q00

IT LAB SAMPLE NO.: ETDC-7903

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C300Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7904

Specific Gravity = 2.6593

Moisture Content = 12.3%
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	98.6%
	#4	4.750	97.7%
	#10	2.000	94.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	83.6%
	#40	0.425	58.0%
	#60	0.250	39.6%
	#100	0.149	27.8%
	#140	0.106	22.2%
	#200	0.075	18.5%

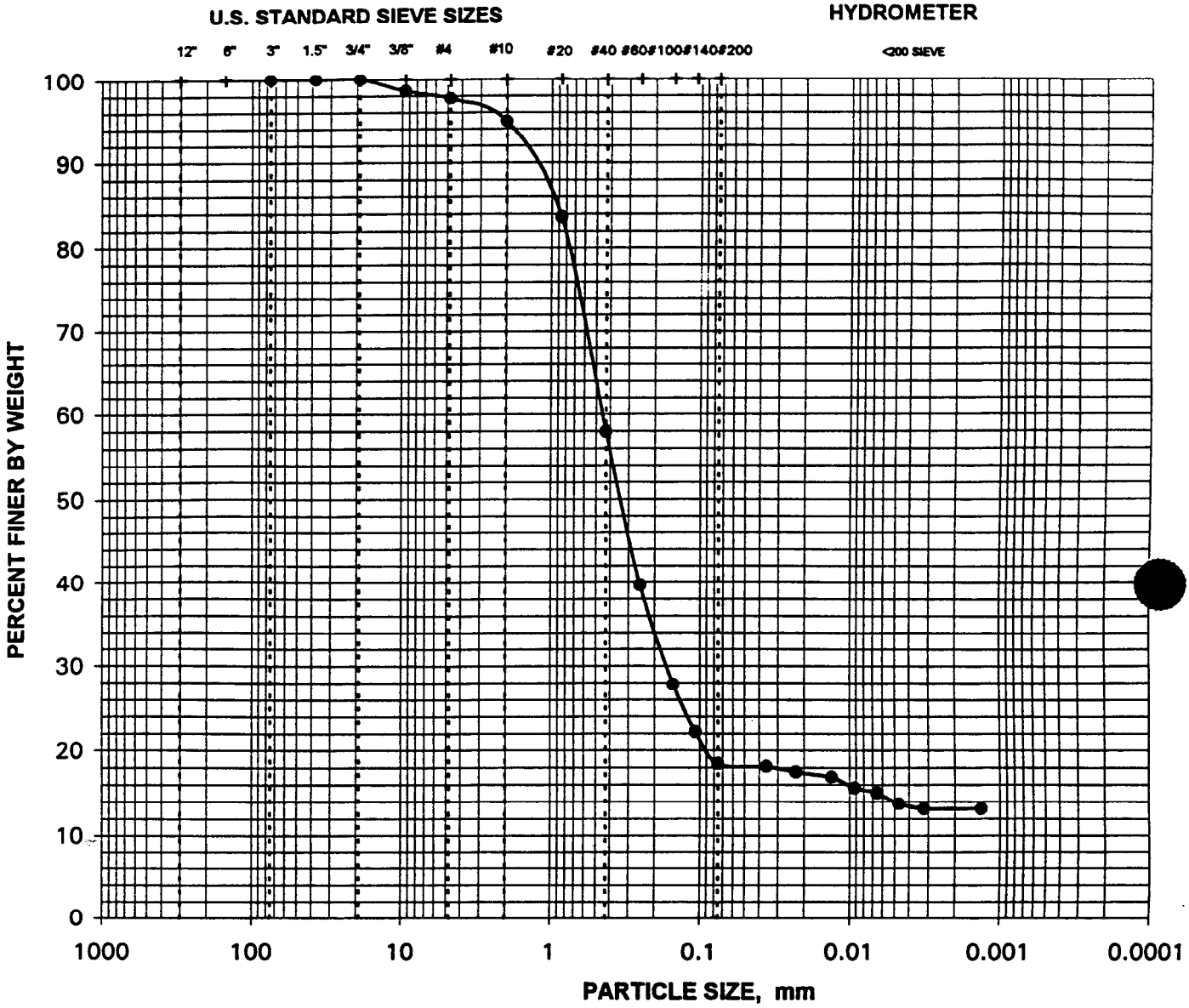
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03560	18.2%
	0.02256	17.5%
	0.01307	16.9%
	0.00918	15.7%
	0.00651	15.0%
	0.00464	13.8%
	0.00318	13.2%
	0.00133	13.2%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C300Q00

IT LAB SAMPLE NO.: ETDC-7904

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C400Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7905

Specific Gravity = 2.6439

Moisture Content = 20.0%
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	99.3%
	#4	4.750	98.1%
	#10	2.000	95.2%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	85.9%
	#40	0.425	67.1%
	#60	0.250	50.9%
	#100	0.149	38.3%
	#140	0.106	32.0%
	#200	0.075	27.6%

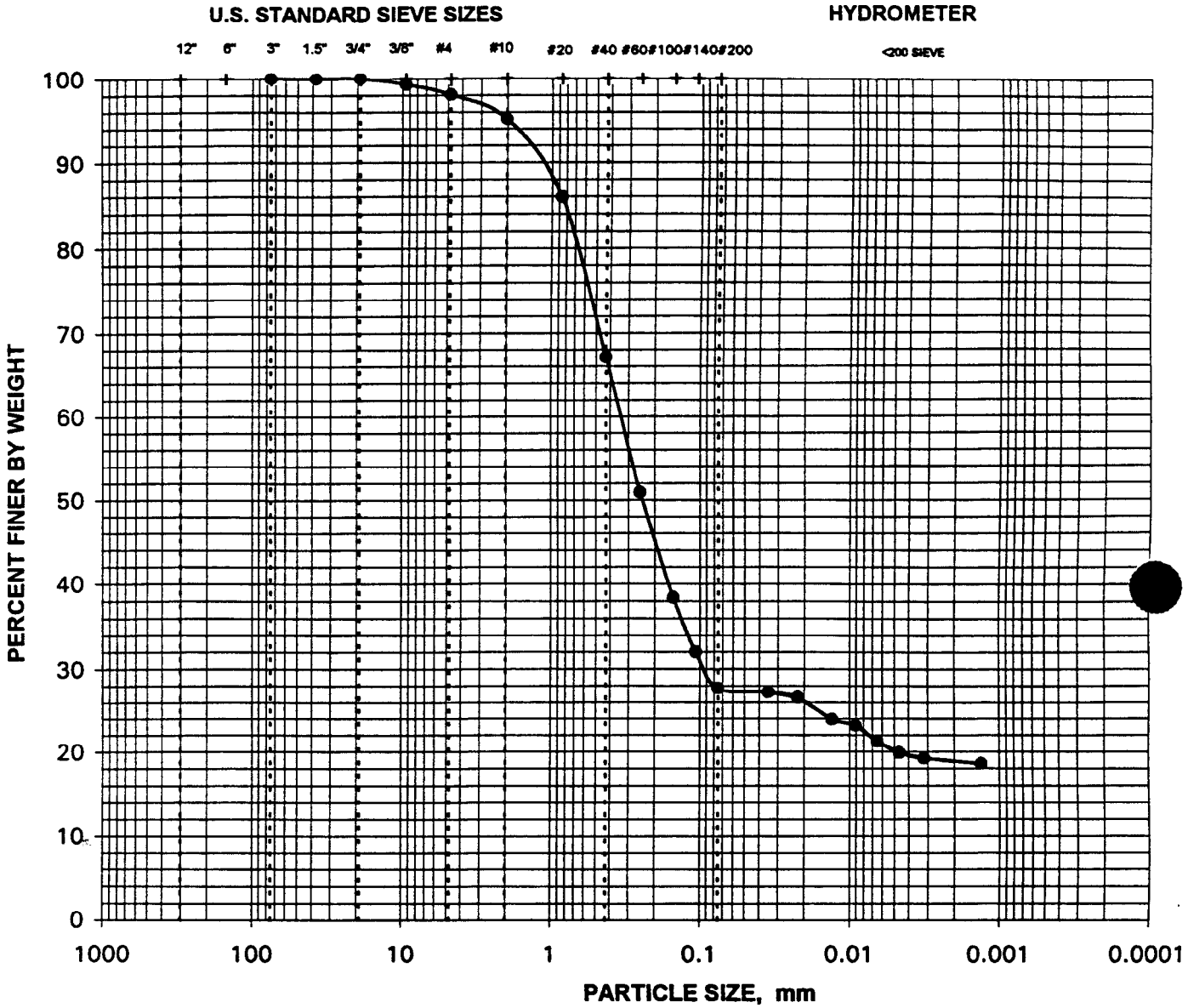
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03473	27.2%
	0.02201	26.5%
	0.01292	23.9%
	0.00904	23.2%
	0.00645	21.2%
	0.00460	19.9%
	0.00315	19.2%
	0.00132	18.6%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C400Q00

IT LAB SAMPLE NO.: ETDC-7905

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C500Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7906
Specific Gravity =	2.6413	Moisture Content =	14.5%
		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	100.0%
	0.375"	9.500	99.3%
	#4	4.750	98.0%
	#10	2.000	95.2%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.4%
	#40	0.425	61.8%
	#60	0.250	43.7%
	#100	0.149	31.1%
	#140	0.106	25.1%
	#200	0.075	21.2%

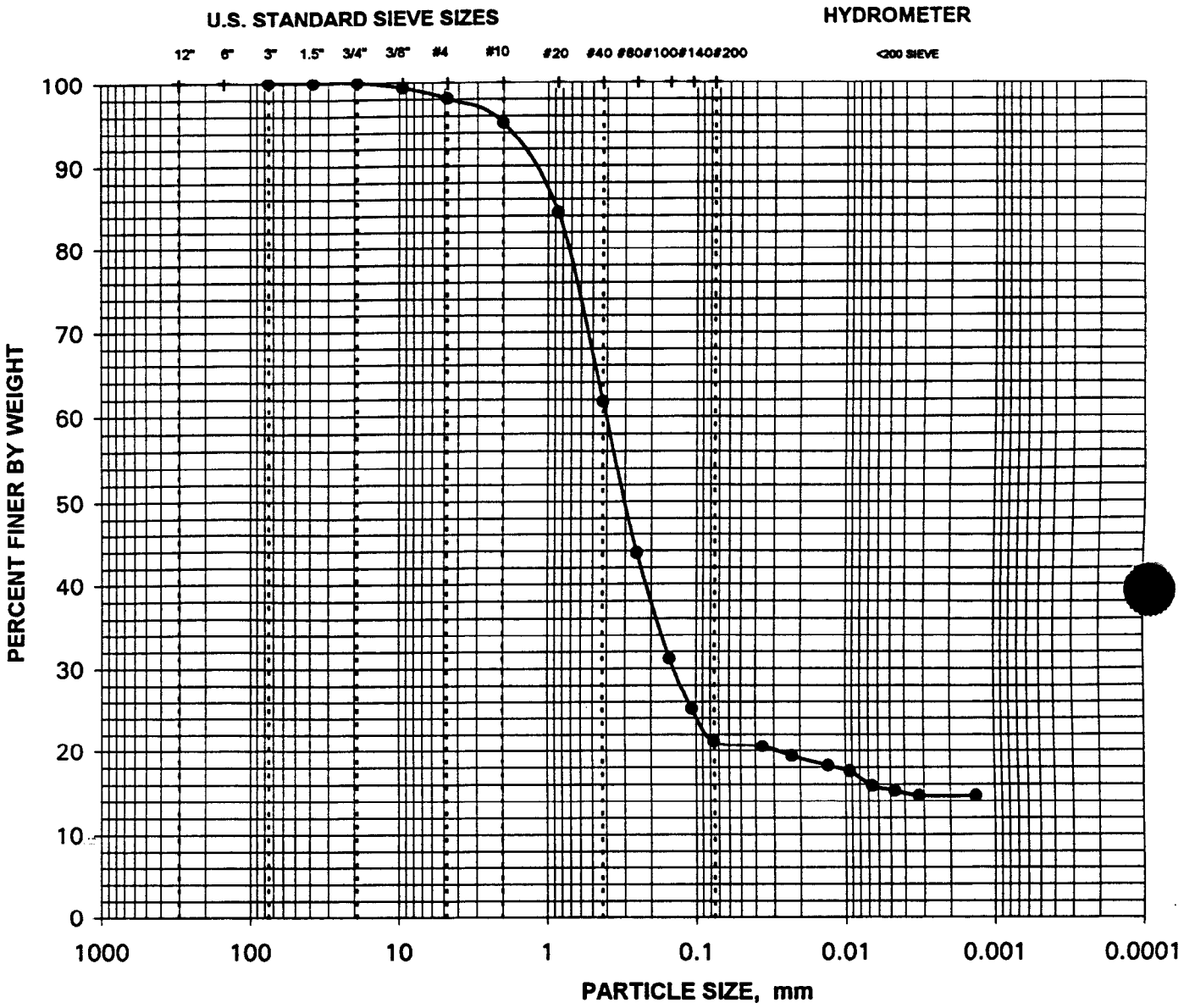
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03545	20.5%
	0.02256	19.4%
	0.01296	18.2%
	0.00920	17.6%
	0.00656	15.8%
	0.00465	15.3%
	0.00319	14.7%
	0.00133	14.7%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C500Q00

IT LAB SAMPLE NO.: ETDC-7906

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / Savannah River	Client Sample No.	C600Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7907
Specific Gravity =	2.6352	Moisture Content =	14.5%
		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	98.2%
	0.375"	9.500	97.2%
	#4	4.750	95.5%
	#10	2.000	92.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	80.7%
	#40	0.425	58.7%
	#60	0.250	42.0%
	#100	0.149	30.2%
	#140	0.106	24.5%
	#200	0.075	20.7%

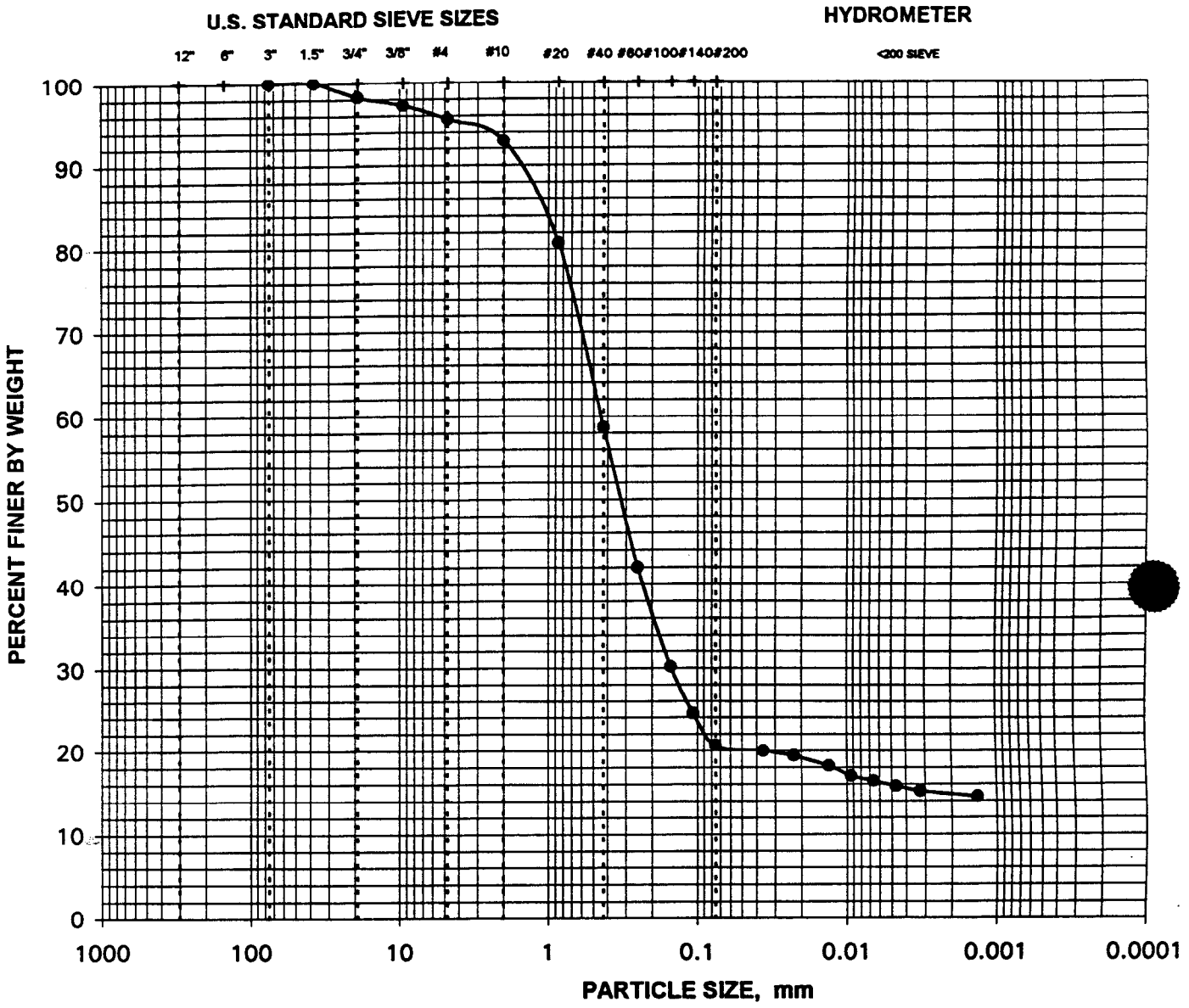
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03567	20.0%
	0.02236	19.4%
	0.01301	18.2%
	0.00924	17.0%
	0.00656	16.4%
	0.00465	15.8%
	0.00319	15.2%
	0.00133	14.6%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / Savannah River



CLIENT SAMPLE NO.: C600Q00

IT LAB SAMPLE NO.: ETDC-7907

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C700Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7908
Specific Gravity =	2.6508	Moisture Content =	12.6%
		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	92.5%
	0.375"	9.500	90.9%
	#4	4.750	90.2%
	#10	2.000	87.5%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	77.7%
	#40	0.425	57.5%
	#60	0.250	40.0%
	#100	0.149	27.9%
	#140	0.106	22.4%
	#200	0.075	19.0%

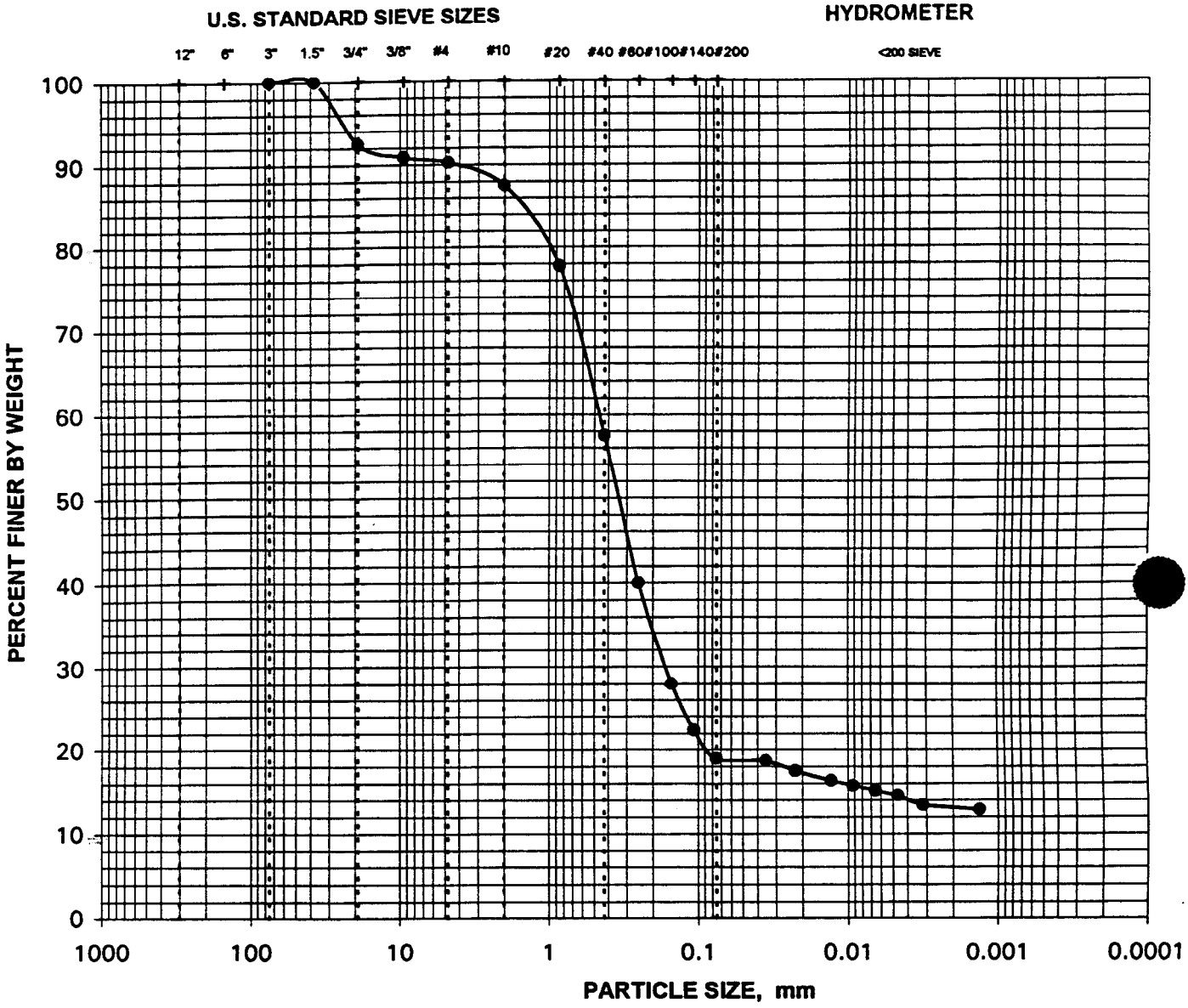
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03483	18.7%
	0.02220	17.5%
	0.01287	16.4%
	0.00913	15.8%
	0.00648	15.2%
	0.00459	14.6%
	0.00316	13.4%
	0.00132	12.9%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / SAVANNAH RIVER



CLIENT SAMPLE NO.: C700Q00

IT LAB SAMPLE NO.: ETDC-7908

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	CLAY <2 microns

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC / Savannah River	Client Sample No.	C800Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-7909
Specific Gravity =	2.6394	Moisture Content =	13.1%
		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	95.0%
	0.375"	9.500	90.4%
	#4	4.750	88.8%
	#10	2.000	85.7%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	76.2%
	#40	0.425	55.2%
	#60	0.250	38.9%
	#100	0.149	27.4%
	#140	0.106	22.0%
	#200	0.075	18.7%

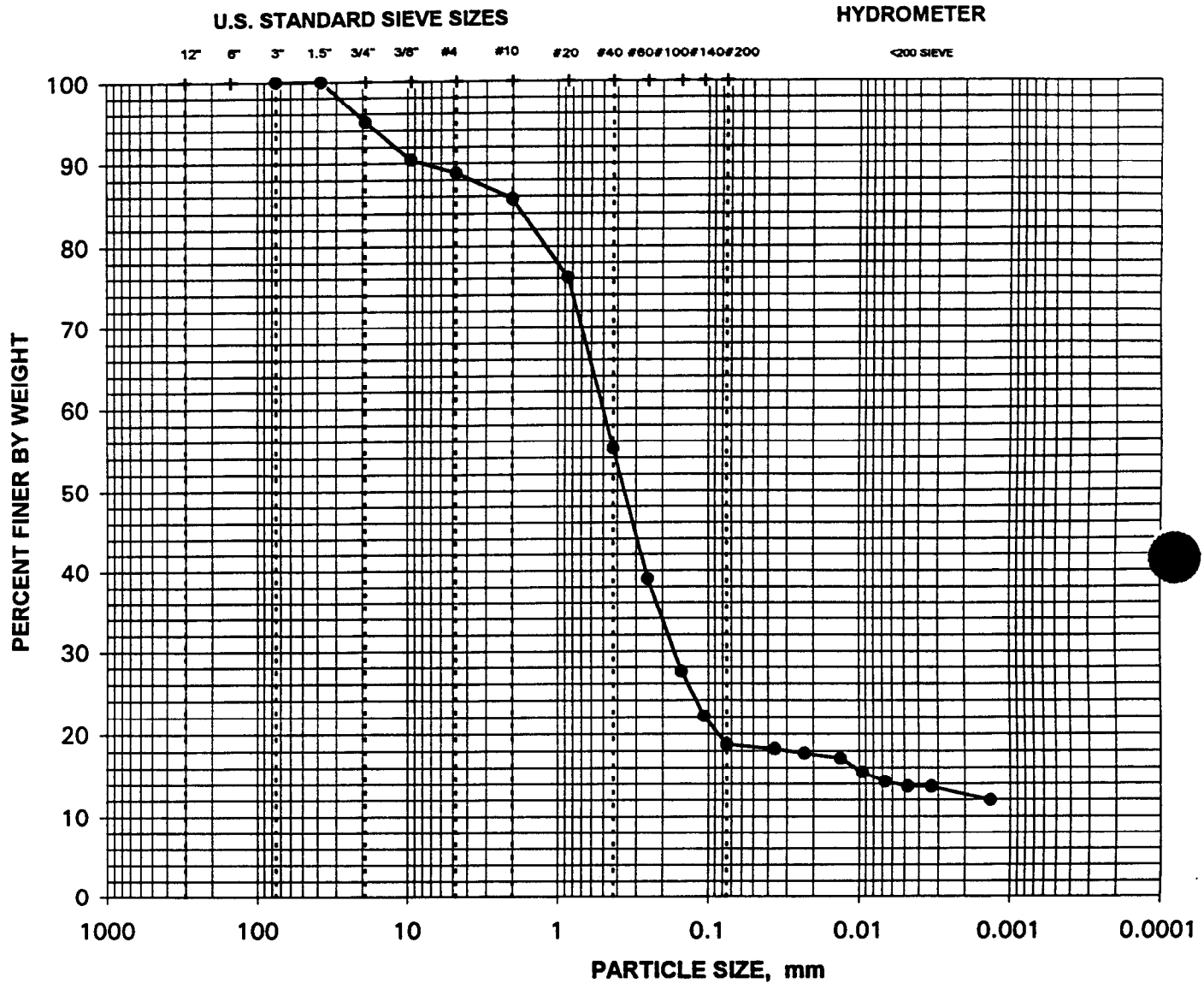
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03581	18.2%
	0.02274	17.6%
	0.01318	17.0%
	0.00939	15.3%
	0.00668	14.2%
	0.00473	13.6%
	0.00328	13.6%
	0.00135	11.9%

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC / Savannah River



CLIENT SAMPLE NO.: C800Q00

IT LAB SAMPLE NO.: ETDC-7909

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns CLAY <2 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	

C Series
14 Day UCS Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

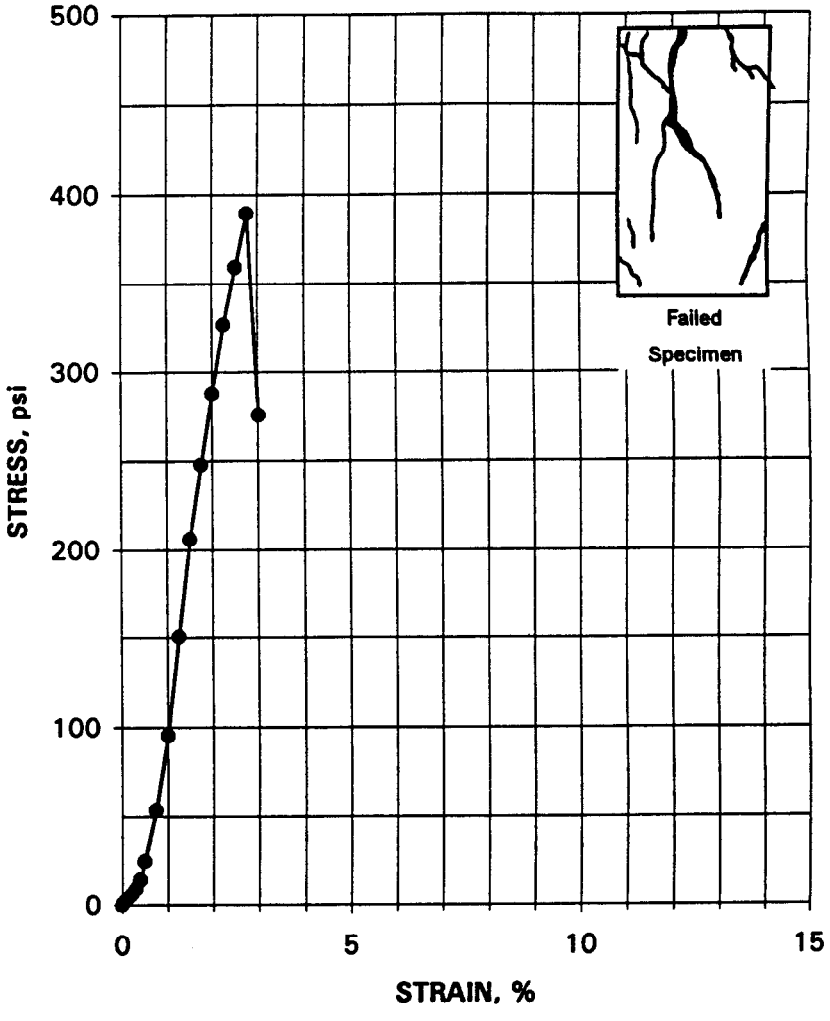
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C311F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7805

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9735
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0045
		Specimen Weight, g.	383.70
STRESS AT FAILURE, psi	**389.5**	Moisture Content, %	28.7
STRAIN AT FAILURE, %	**2.8**	Wet Unit Weight, pcf.	116.6
		Dry Unit Weight, pcf.	90.6
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.8
0.20	5.7
0.30	8.8
0.40	14.2
0.50	24.9
0.76	53.5
1.01	95.4
1.26	150.2
1.51	206.0
1.76	247.5
2.01	287.5
2.27	326.7
2.52	359.3
2.77	389.5
3.02	275.4
3.27	243.4



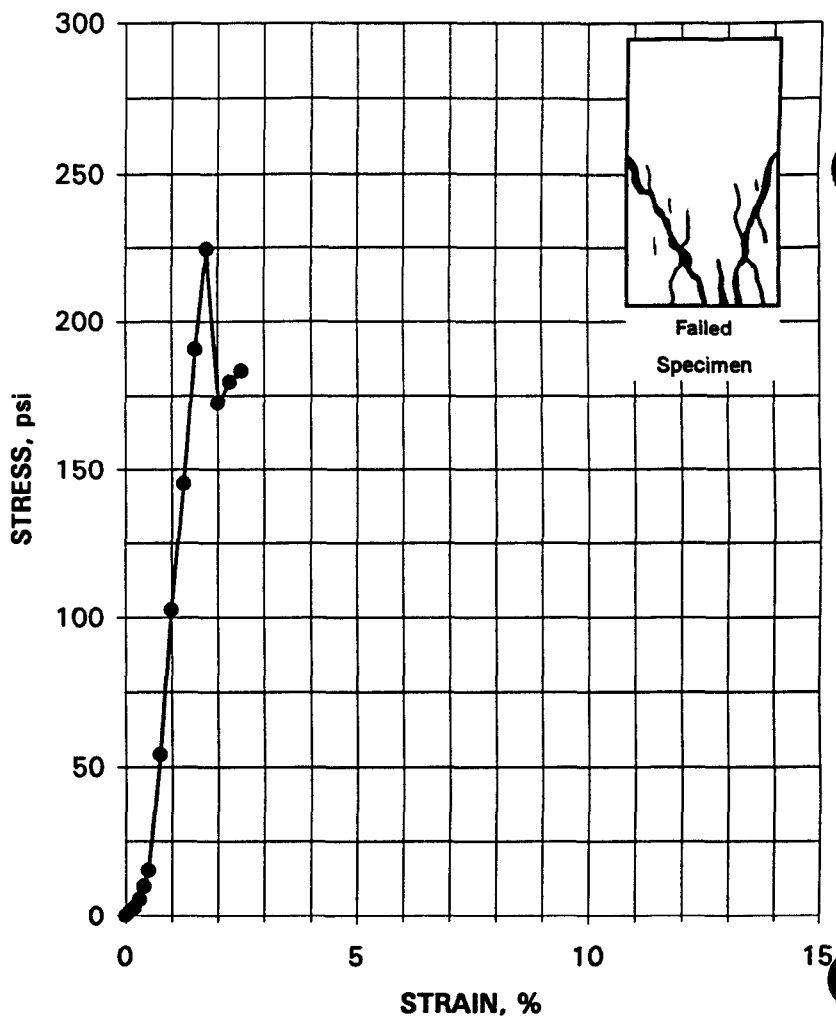
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C321F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7806

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9803
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0073
		Specimen Weight, g.	380.45
STRESS AT FAILURE, psi	**224.4**	Moisture Content, %	31.9
STRAIN AT FAILURE, %	**1.8**	Wet Unit Weight, pcf.	115.1
		Dry Unit Weight, pcf.	87.3
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	2.8
0.30	5.7
0.40	9.8
0.50	15.1
0.75	53.9
1.00	102.6
1.26	145.1
1.51	190.5
1.76	224.4
2.01	172.5
2.26	179.4
2.51	183.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

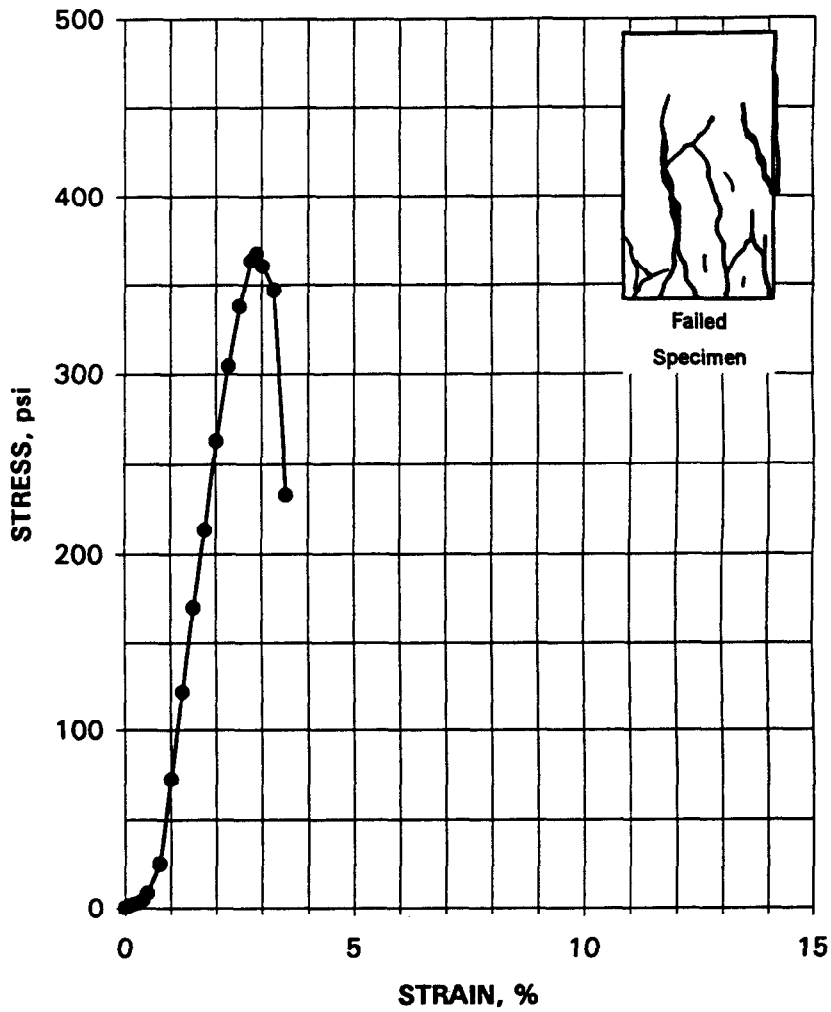
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C331F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7807

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9677
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0027
		Specimen Weight, g.	372.74
STRESS AT FAILURE, psi	**367.4**	Moisture Content, %	32.6
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	113.6
		Dry Unit Weight, pcf.	85.7
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.0
0.20	2.2
0.30	2.8
0.40	4.7
0.50	8.5
0.76	24.9
1.01	72.3
1.26	121.3
1.51	169.5
1.76	213.3
2.02	262.8
2.27	304.4
2.52	338.2
2.77	363.6
2.90	367.4
3.02	360.8
3.28	347.3
3.53	232.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

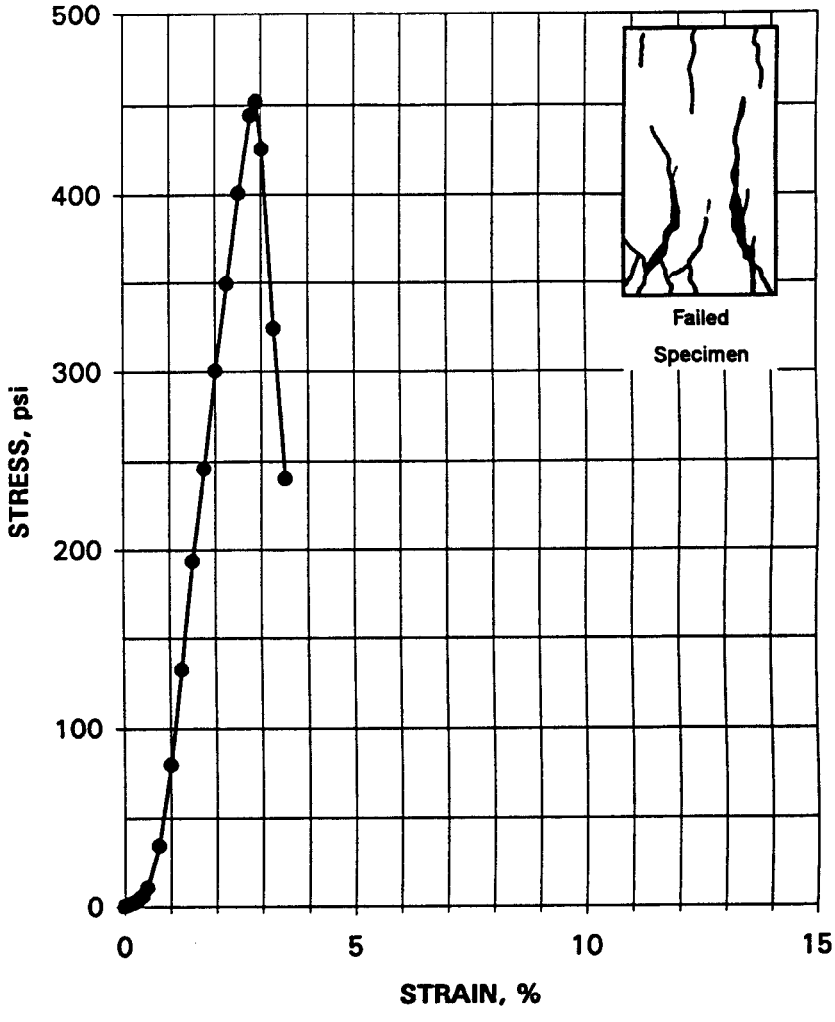
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C341F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7808

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9723
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0057
		Specimen Weight, g.	379.13
STRESS AT FAILURE, psi	**451.8**	Moisture Content, %	31.2
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	115.1
		Dry Unit Weight, pcf.	87.7
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	0.9
0.20	2.2
0.30	3.8
0.40	6.0
0.50	10.7
0.76	34.6
1.01	79.6
1.26	131.9
1.51	193.6
1.76	245.6
2.01	300.5
2.27	349.6
2.52	400.8
2.77	444.4
2.90	451.8
3.02	425.4
3.27	324.5
3.52	239.7



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

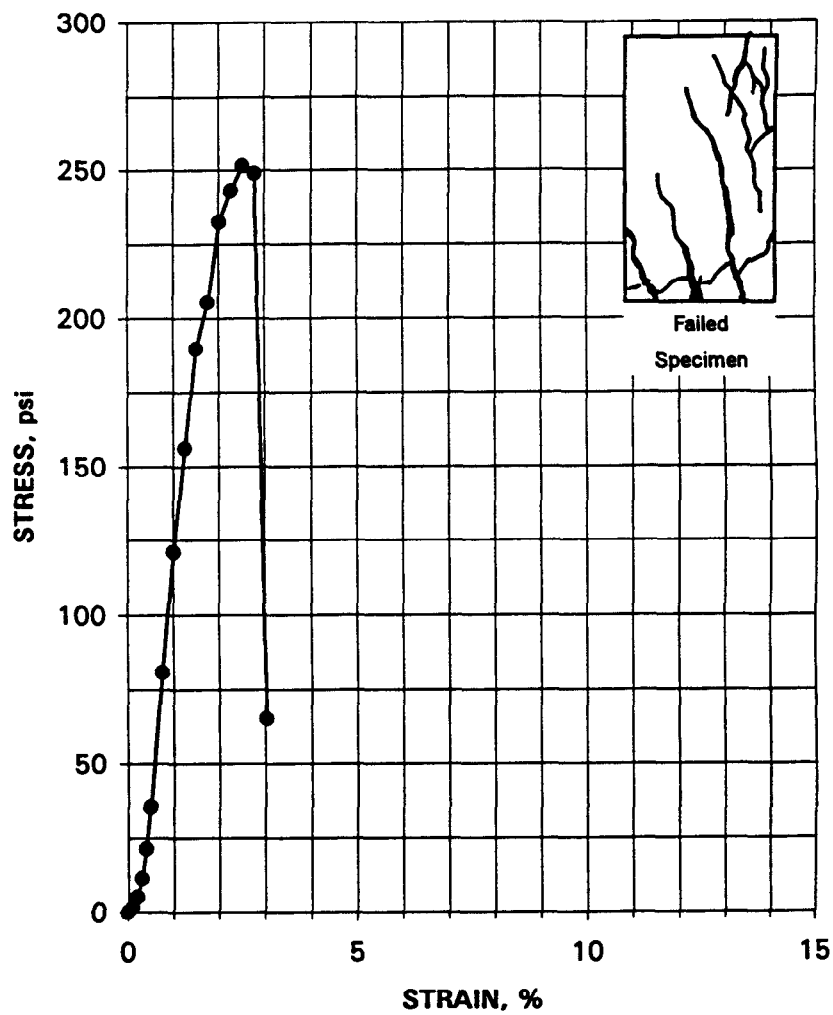
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C411F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7809

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9545
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	375.60
STRESS AT FAILURE, psi	**251.4**	Moisture Content, %	31.9
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	115.0
		Dry Unit Weight, pcf.	87.2
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	5.1
0.30	11.4
0.40	21.5
0.51	35.4
0.76	81.0
1.01	121.1
1.26	155.9
1.52	189.6
1.77	205.3
2.02	232.5
2.28	243.1
2.53	251.4
2.78	248.9
3.03	65.3



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

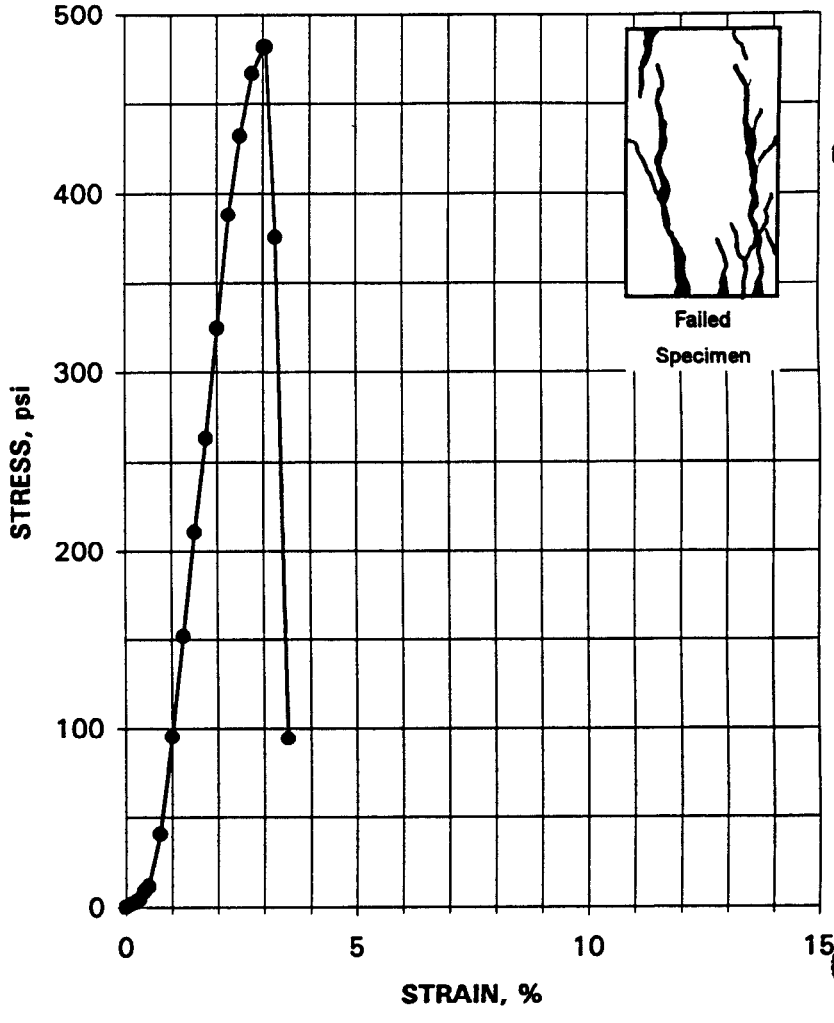
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C421F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7810

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9770
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0087
		Specimen Weight, g.	375.60
STRESS AT FAILURE, psi	**481.8**	Moisture Content, %	25.5
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	113.6
		Dry Unit Weight, pcf.	90.5
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.8
0.30	4.4
0.40	8.5
0.50	11.3
0.75	40.7
1.01	95.3
1.26	151.7
1.51	211.0
1.76	263.2
2.01	325.3
2.26	388.0
2.51	432.2
2.77	467.0
3.02	481.7
3.07	481.8
3.27	375.5
3.52	94.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

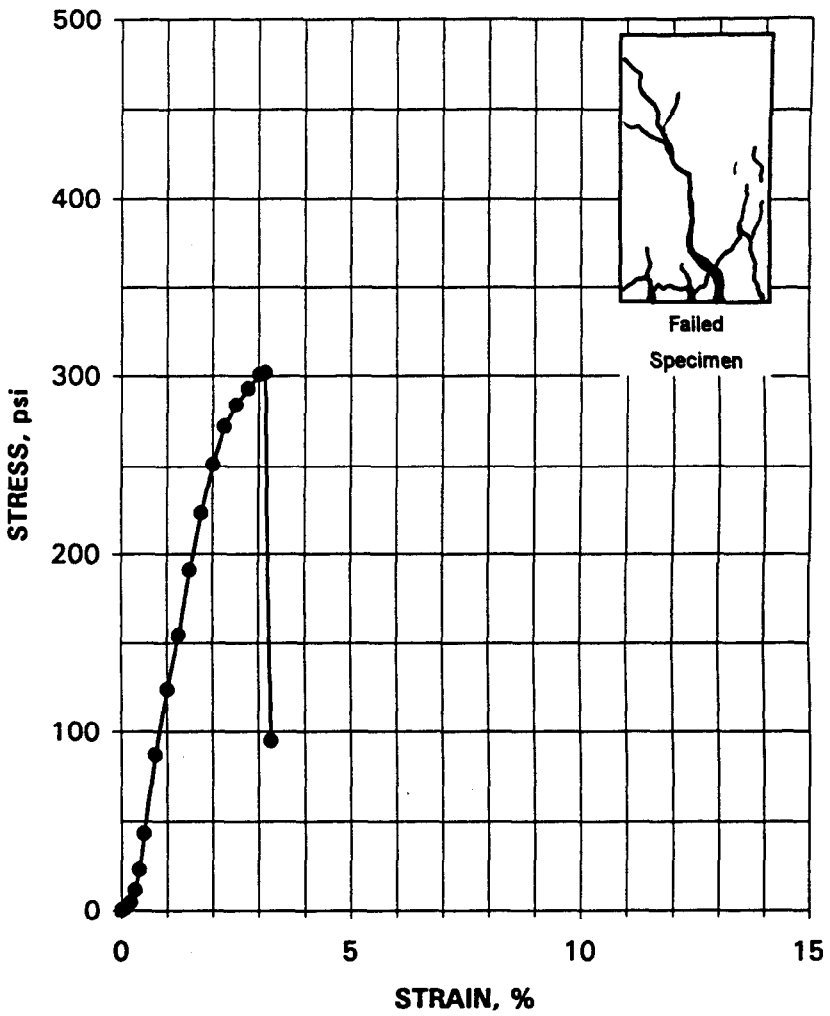
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C431F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7811

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9772
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0035
		Specimen Weight, g.	359.96
STRESS AT FAILURE, psi	**302.0**	Moisture Content, %	37.7
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	109.4
		Dry Unit Weight, pcf.	79.4
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	4.7
0.30	11.4
0.40	22.7
0.50	43.2
0.75	87.2
1.01	123.4
1.26	154.1
1.51	190.9
1.76	223.4
2.01	250.8
2.26	271.9
2.51	283.9
2.77	293.0
3.02	300.9
3.14	302.0
3.27	94.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

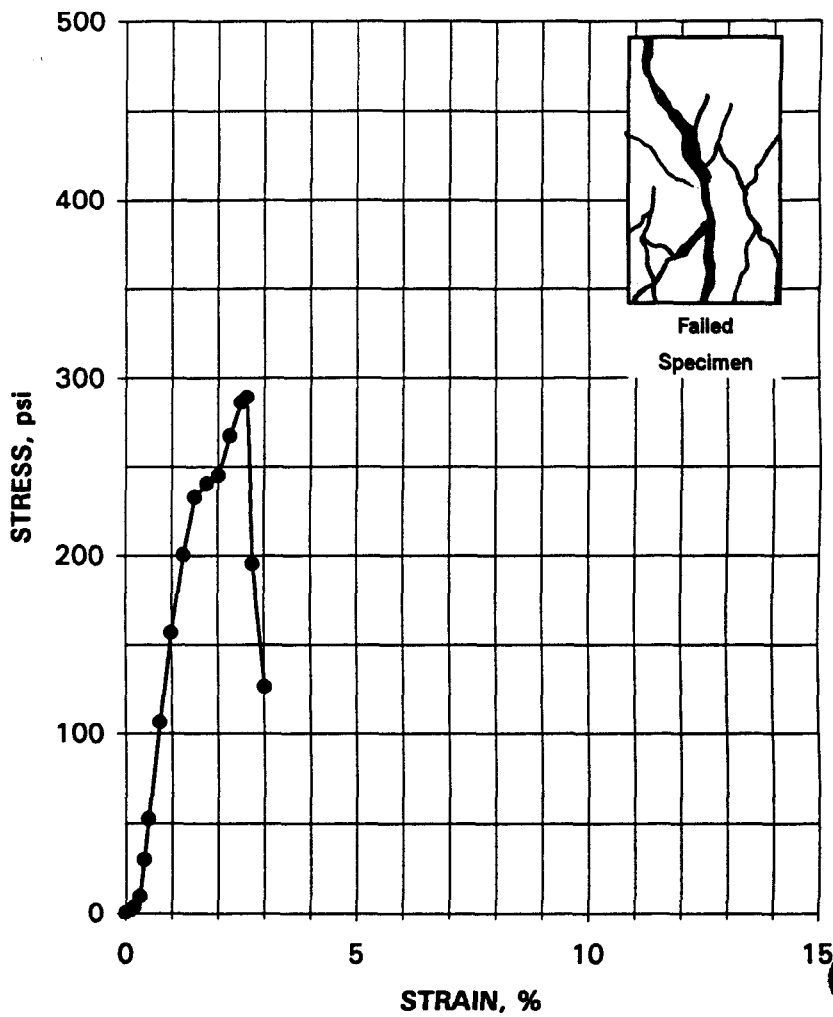
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C441F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7812

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9753
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0060
		Specimen Weight, g.	363.54
STRESS AT FAILURE, psi	**289.0**	Moisture Content, %	37.1
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	110.3
		Dry Unit Weight, pcf.	80.4
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.5
0.30	9.5
0.40	29.6
0.50	52.6
0.75	106.5
1.01	156.9
1.26	200.3
1.51	232.8
1.76	240.3
2.01	244.9
2.26	267.5
2.52	285.9
2.64	289.0
2.77	195.4
3.02	126.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

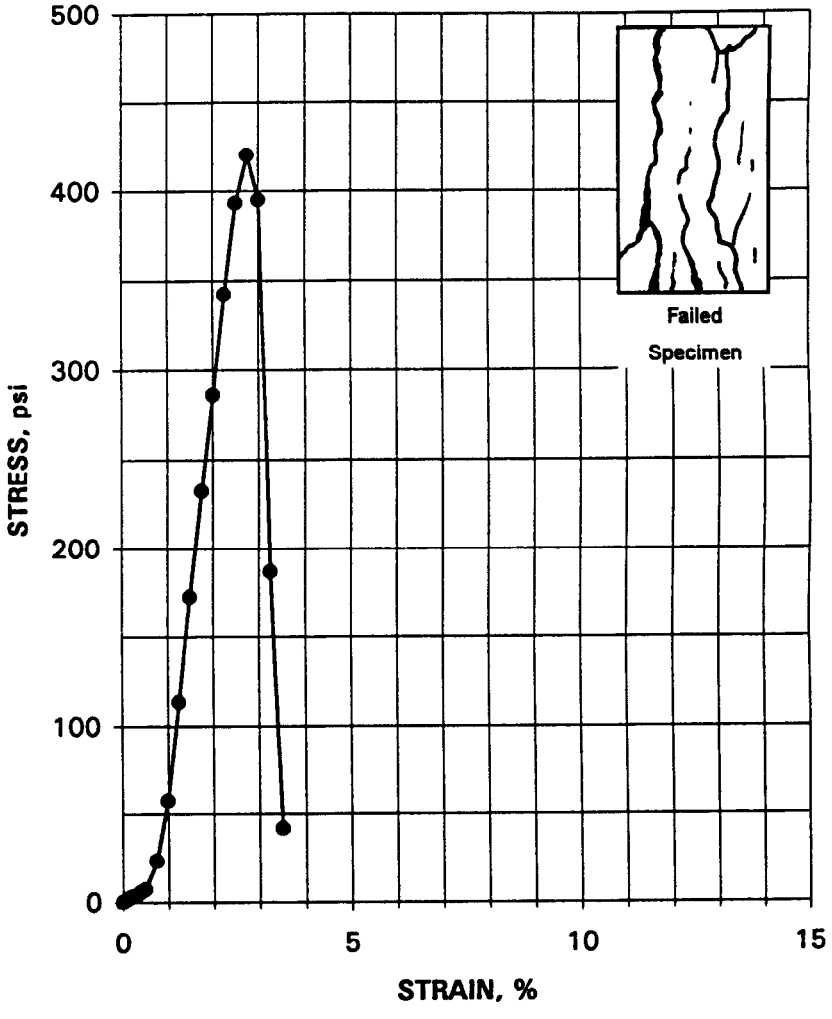
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C511F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7813

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9895
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0010
		Specimen Weight, g.	382.28
STRESS AT FAILURE, psi	**419.9**	Moisture Content, %	29.4
STRAIN AT FAILURE, %	**2.8**	Wet Unit Weight, pcf.	116.1
		Dry Unit Weight, pcf.	89.7
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.9
0.30	3.5
0.40	5.7
0.50	7.0
0.75	23.7
1.00	57.9
1.25	113.0
1.50	172.3
1.75	232.1
2.01	286.1
2.26	342.2
2.51	393.4
2.76	419.9
3.01	395.1
3.26	186.7
3.51	41.7



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

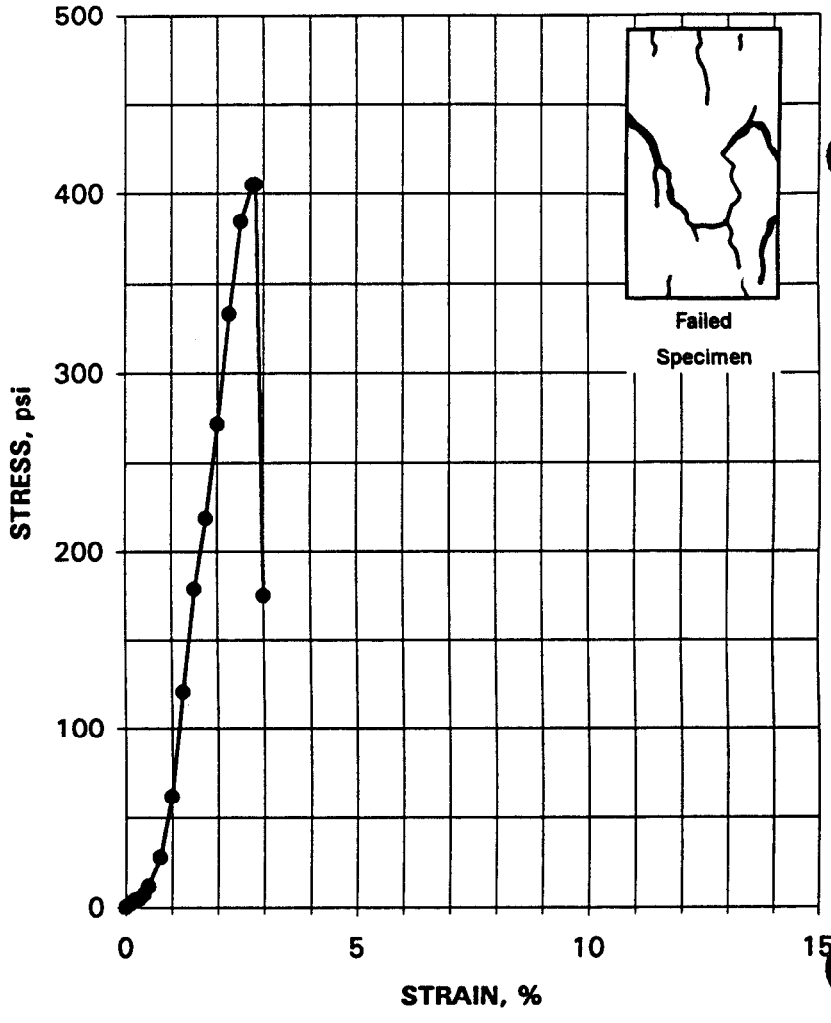
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C521F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7814

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9882
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0038
		Specimen Weight, g.	389.72
STRESS AT FAILURE, psi	**405.2**	Moisture Content, %	27.1
STRAIN AT FAILURE, %	**2.8**	Wet Unit Weight, pcf.	118.1
		Dry Unit Weight, pcf.	92.9
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.9
0.20	3.8
0.30	4.7
0.40	7.3
0.50	11.4
0.75	28.0
1.00	61.8
1.25	120.2
1.50	179.0
1.76	218.4
2.01	271.3
2.26	333.2
2.51	384.3
2.76	404.9
2.83	405.2
3.01	175.3



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

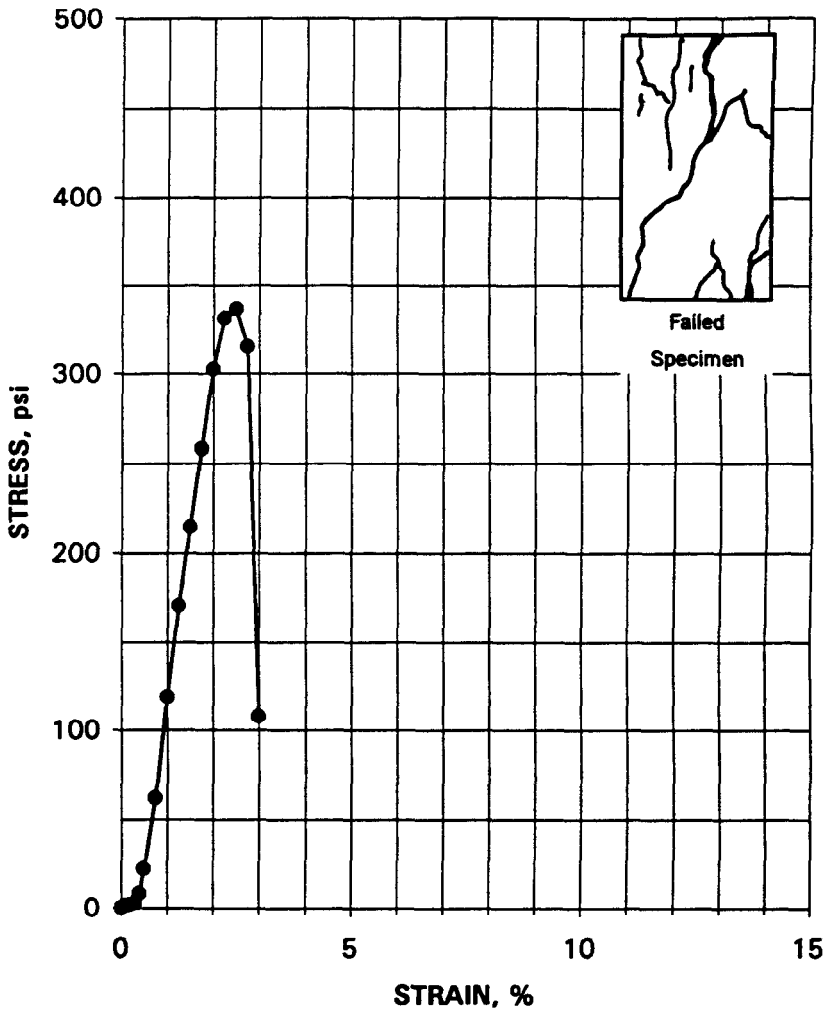
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C531F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7815

Specimen Mold Date	11/11/98	Specimen Height, in.	4.0020
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	370.48
STRESS AT FAILURE, psi	**336.4**	Moisture Content, %	34.6
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	112.1
		Dry Unit Weight, pcf.	83.2
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	1.9
0.30	2.9
0.40	8.2
0.50	22.1
0.75	62.1
1.00	118.6
1.25	170.3
1.50	214.7
1.75	258.4
2.00	302.6
2.25	331.0
2.50	336.4
2.75	315.1
3.00	107.9



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

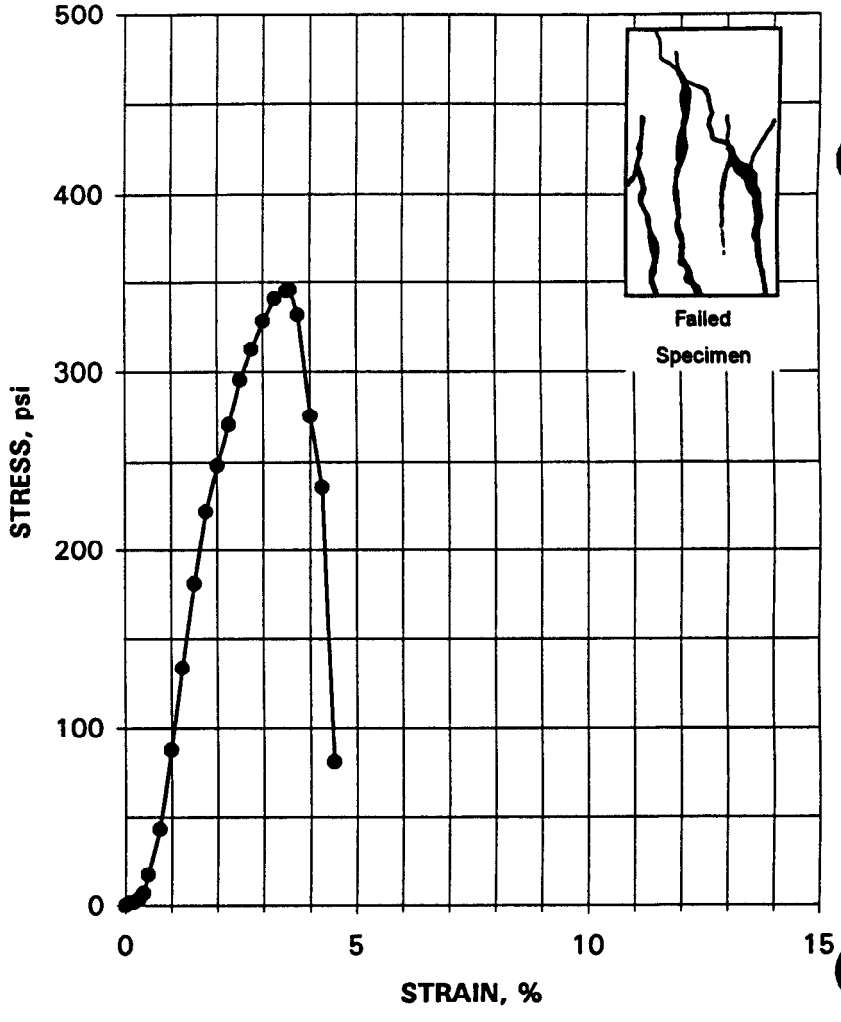
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C541F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7816

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9857
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0055
		Specimen Weight, g.	377.04
STRESS AT FAILURE, psi	**345.8**	Moisture Content, %	32.0
STRAIN AT FAILURE, %	**3.6**	Wet Unit Weight, pcf.	114.1
		Dry Unit Weight, pcf.	86.4
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	1.9
0.30	3.5
0.40	6.9
0.50	17.0
0.75	43.0
1.00	87.4
1.25	133.5
1.51	180.8
1.76	222.1
2.01	248.2
2.26	271.1
2.51	296.0
2.76	312.8
3.01	328.2
3.26	340.8
3.51	345.2
3.59	345.8
3.76	332.1
4.01	275.6
4.27	235.5
4.52	81.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

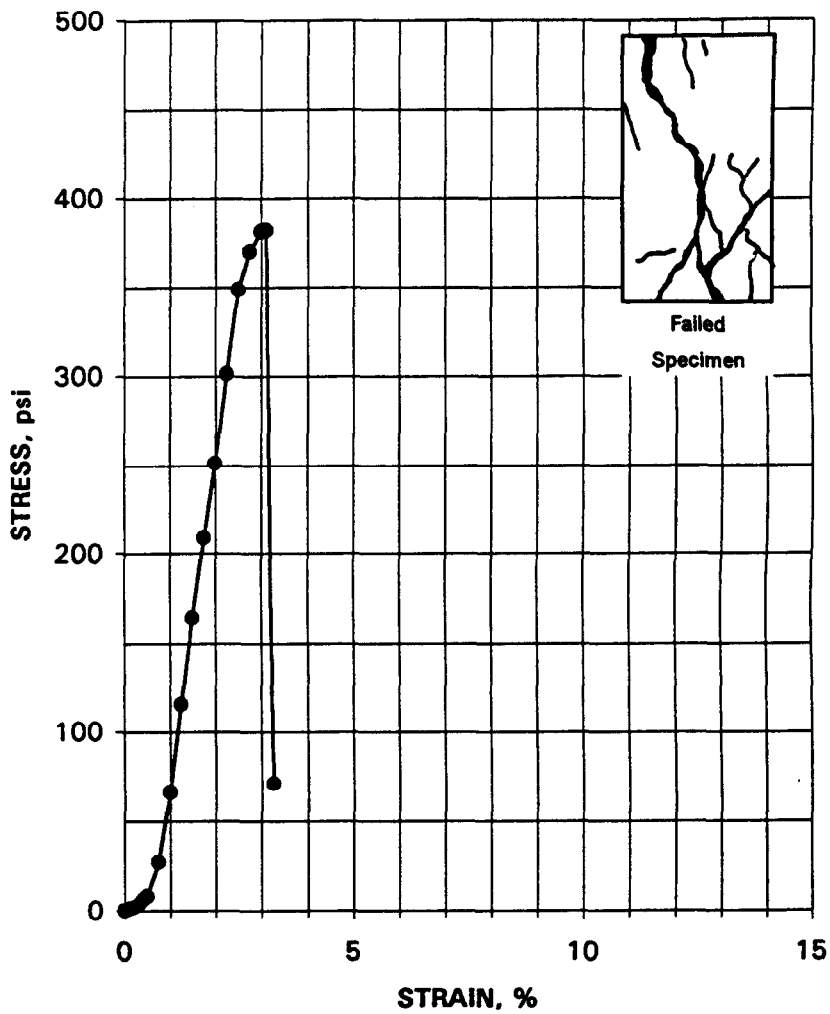
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C611F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7817

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9982
Specimen Test Date	11/25/98	Specimen Diameter, in.	1.9998
		Specimen Weight, g.	384.62
STRESS AT FAILURE, psi	**382.2**	Moisture Content, %	29.0
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	116.7
		Dry Unit Weight, pcf.	90.5
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.0
0.20	1.9
0.30	3.2
0.40	6.0
0.50	8.2
0.75	27.2
1.00	65.9
1.25	115.7
1.50	164.3
1.75	208.6
2.00	251.2
2.25	301.5
2.50	349.2
2.75	370.3
3.00	381.4
3.10	382.2
3.25	71.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

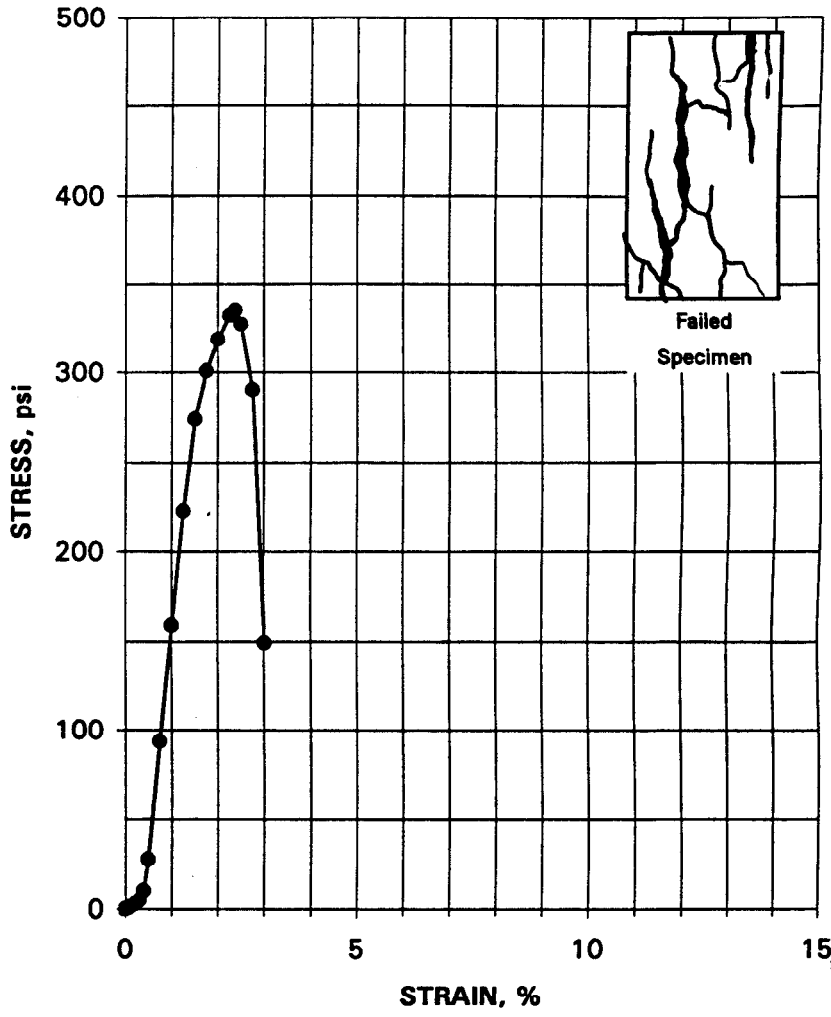
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C621F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7818

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9797
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0073
		Specimen Weight, g.	395.47
STRESS AT FAILURE, psi	**335.3**	Moisture Content, %	26.1
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	119.6
		Dry Unit Weight, pcf.	94.9
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	0.9
0.20	2.8
0.30	4.7
0.40	10.1
0.50	27.4
0.75	93.5
1.01	158.9
1.26	222.8
1.51	273.3
1.76	300.8
2.01	318.6
2.26	332.3
2.39	335.3
2.51	327.1
2.76	290.0
3.02	149.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

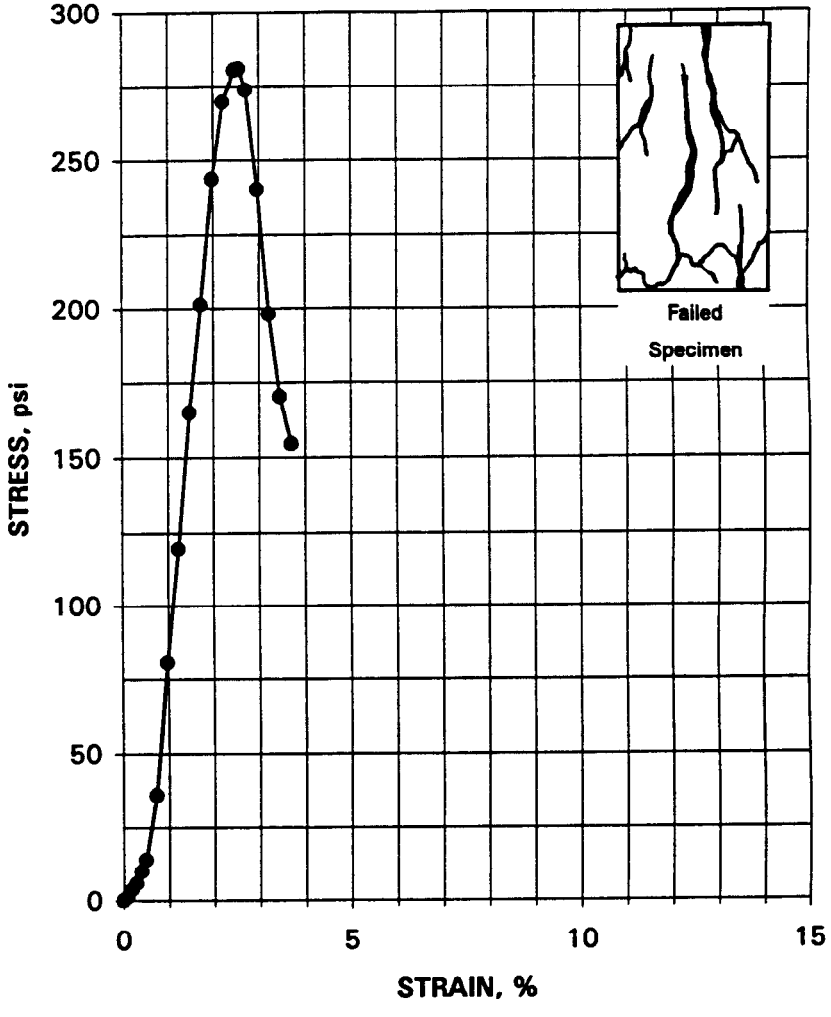
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C631F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7819

Specimen Mold Date	11/11/98	Specimen Height, in.	4.0413
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0015
		Specimen Weight, g.	373.82
STRESS AT FAILURE, psi	**280.9**	Moisture Content, %	34.1
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	112.0
		Dry Unit Weight, pcf.	83.5
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.8
0.30	6.0
0.40	10.1
0.49	14.2
0.74	36.0
0.99	80.9
1.24	119.3
1.48	165.0
1.73	201.1
1.98	243.6
2.23	269.7
2.47	280.5
2.57	280.9
2.72	273.9
2.97	240.2
3.22	198.1
3.46	170.3
3.71	154.5



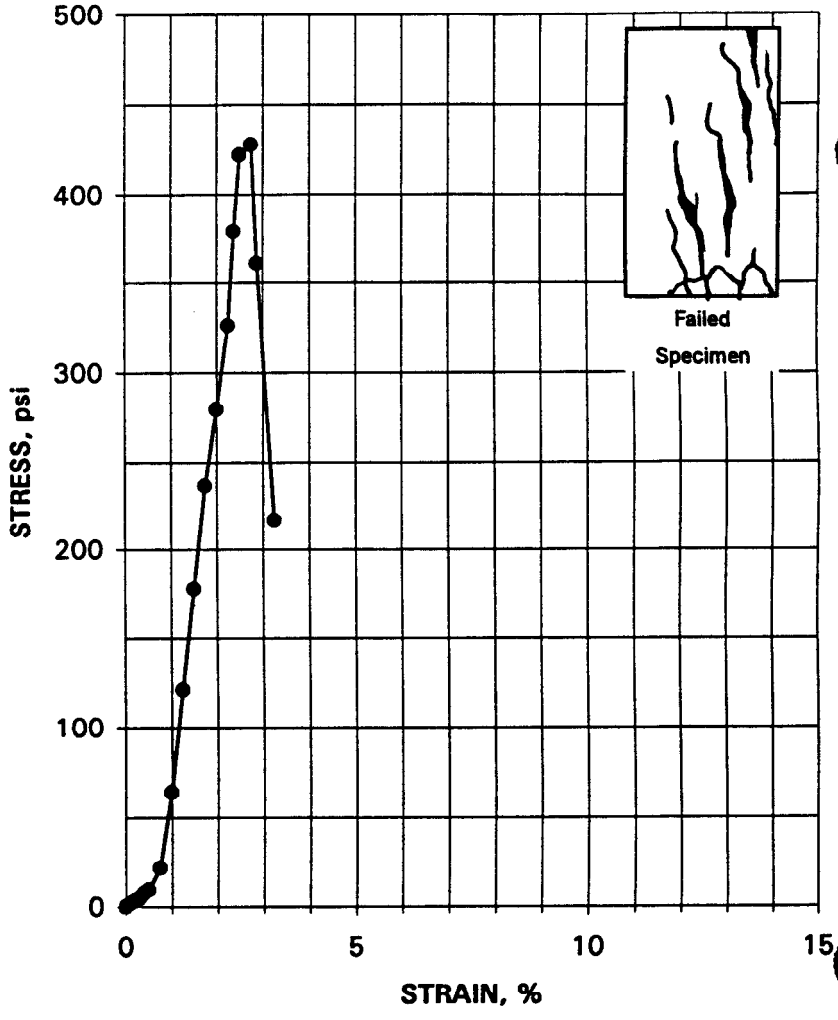
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14 DAY CURE

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C641F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7820

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9922
Specimen Test Date	11/25/98	Specimen Diameter, in.	2.0070
		Specimen Weight, g.	377.09
STRESS AT FAILURE, psi	**427.9**	Moisture Content, %	32.1
STRAIN AT FAILURE, %	**2.8**	Wet Unit Weight, pcf.	113.8
		Dry Unit Weight, pcf.	86.1
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.9
0.20	3.2
0.30	4.7
0.40	7.6
0.50	9.4
0.75	21.3
1.00	64.5
1.25	121.1
1.50	177.8
1.75	236.3
2.00	279.7
2.25	326.0
2.38	378.9
2.50	422.2
2.76	427.9
2.88	361.0
3.26	216.8



C Series
28 Day UCS Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

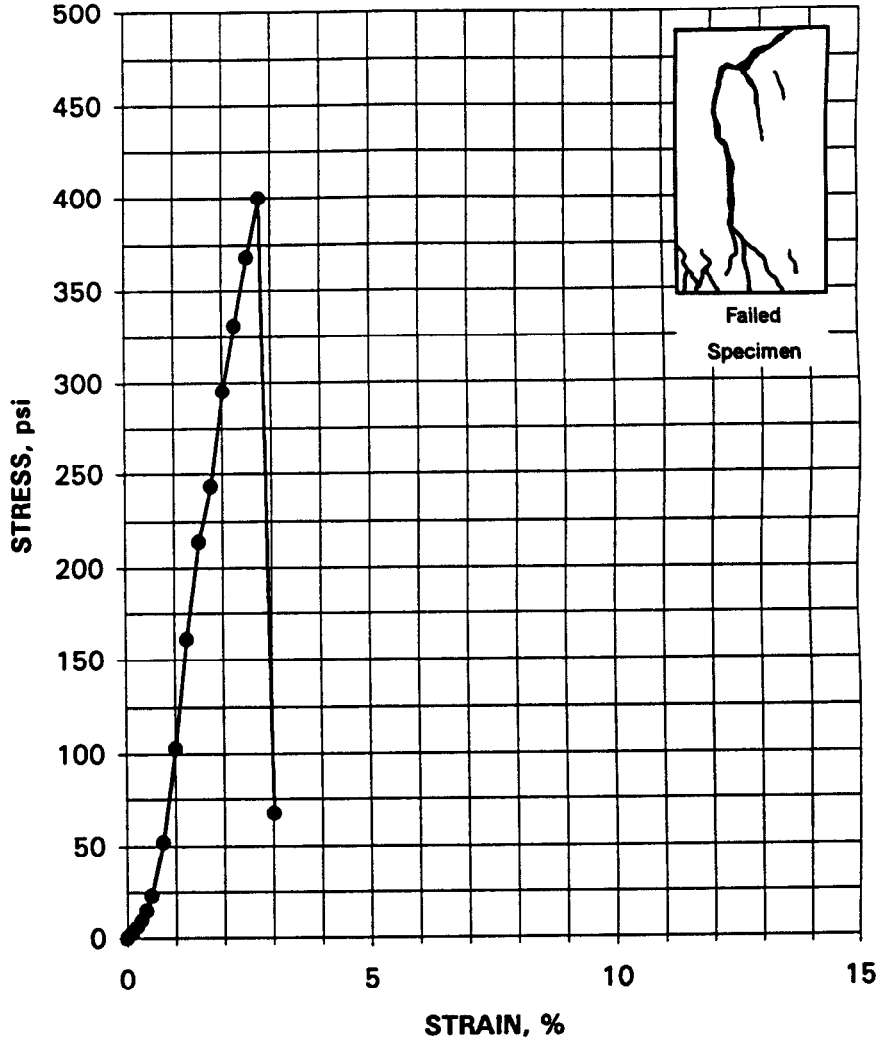
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C312F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7885

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9573
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0042
		Specimen Weight, g.	383.11
STRESS AT FAILURE, psi	**399.7**	Moisture Content, %	28.2
STRAIN AT FAILURE, %	**2.8**	Wet Unit Weight, pcf.	116.9
		Dry Unit Weight, pcf.	91.2
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.9
0.20	5.7
0.30	9.5
0.40	15.2
0.51	23.0
0.76	52.2
1.01	102.6
1.26	160.9
1.52	213.8
1.77	243.2
2.02	295.1
2.27	330.8
2.53	368.3
2.78	399.7
3.03	67.6



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

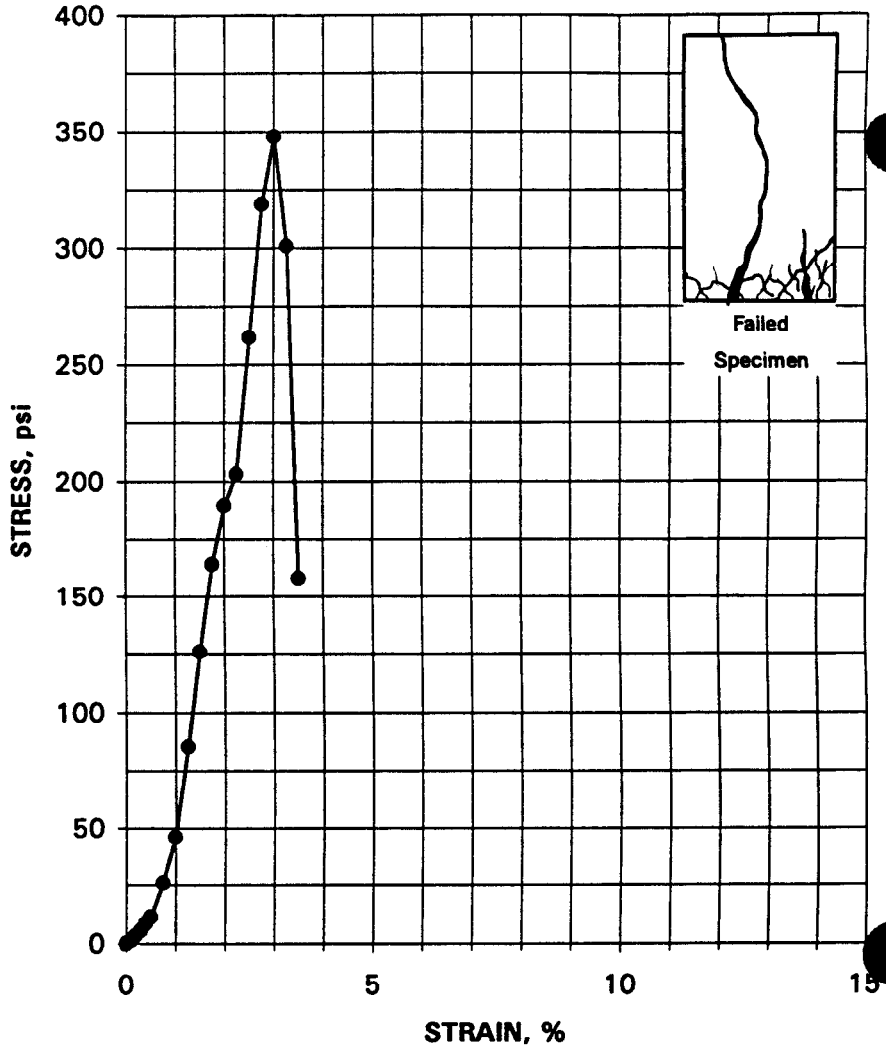
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C322F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7886

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9743
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0058
		Specimen Weight, g.	385.95
STRESS AT FAILURE, psi	**347.7**	Moisture Content, %	29.0
STRAIN AT FAILURE, %	**3.0**	Wet Unit Weight, pcf.	117.1
		Dry Unit Weight, pcf.	90.7
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.2
0.30	5.4
0.40	8.5
0.50	11.3
0.75	25.8
1.01	46.1
1.26	85.0
1.51	125.6
1.76	163.8
2.01	189.8
2.26	202.9
2.52	261.6
2.77	318.8
3.02	347.7
3.27	300.91
3.52	157.85



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

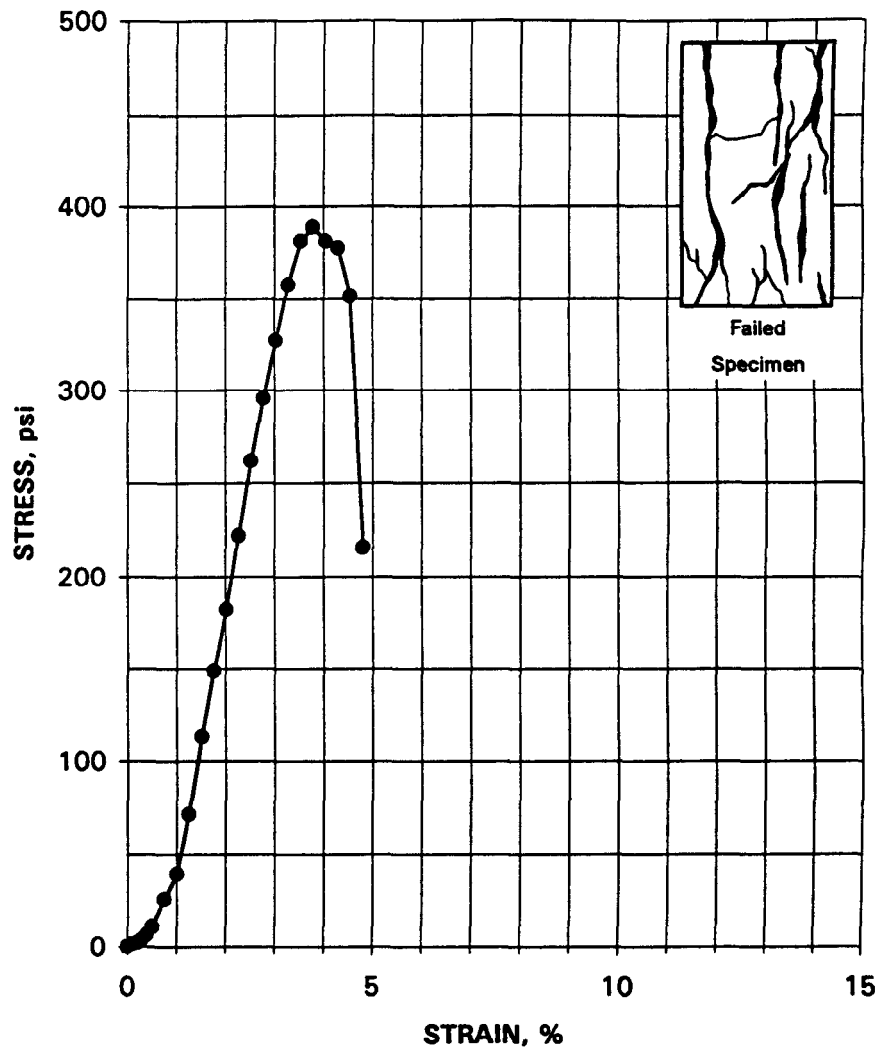
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C332F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7887

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9550
Specimen Test Date	12/9/98	Specimen Diameter, in.	1.9977
		Specimen Weight, g.	372.17
STRESS AT FAILURE, psi	**388.9**	Moisture Content, %	32.5
STRAIN AT FAILURE, %	**3.8**	Wet Unit Weight, pcf.	114.4
		Dry Unit Weight, pcf.	86.4
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.2
0.30	3.8
0.40	6.7
0.51	10.5
0.76	25.6
1.01	39.5
1.26	71.8
1.52	113.1
1.77	148.9
2.02	181.9
2.28	222.0
2.53	262.2
2.78	295.6
3.03	327.0
3.29	357.63
3.54	381.31
3.79	388.91
4.05	381.46
4.30	377.71
4.55	351.43
4.80	215.65



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

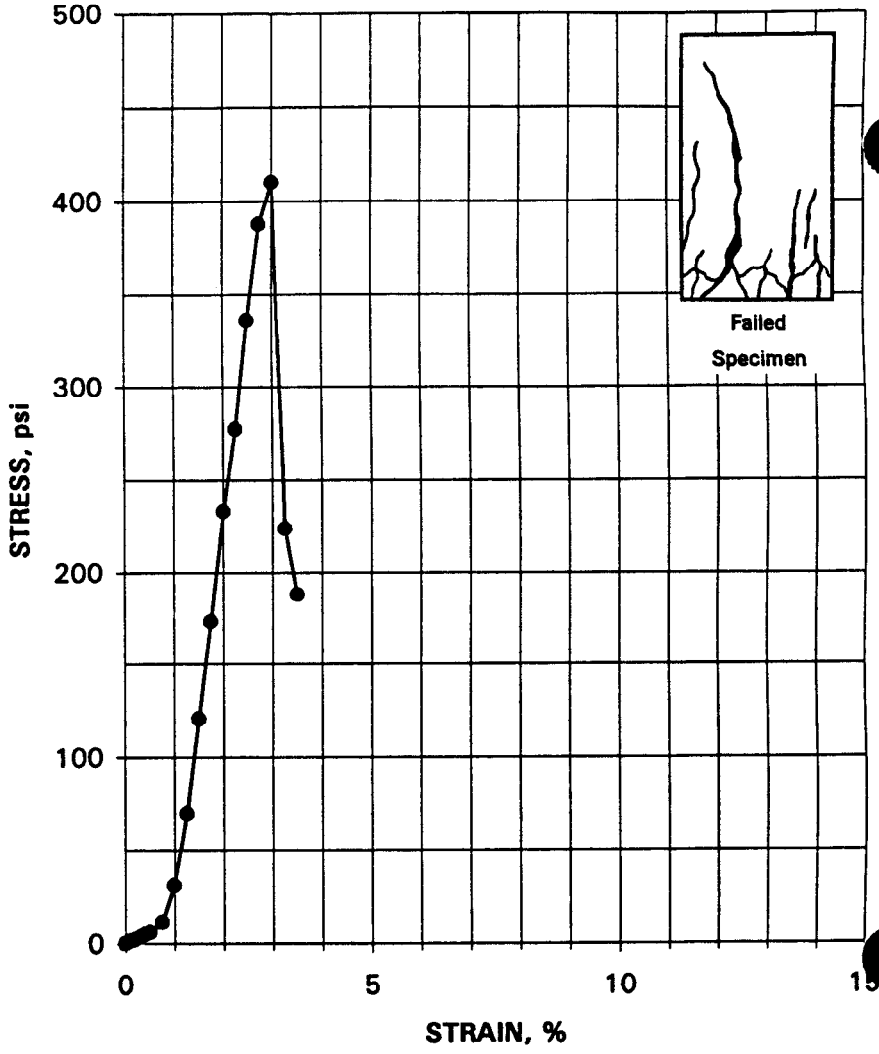
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C342F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7888

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9870
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0090
		Specimen Weight, g.	379.62
STRESS AT FAILURE, psi	**410.0**	Moisture Content, %	31.0
STRAIN AT FAILURE, %	**3.0**	Wet Unit Weight, pcf.	114.4
		Dry Unit Weight, pcf.	87.3
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.2
0.30	3.5
0.40	4.7
0.50	6.0
0.75	11.3
1.00	30.9
1.25	69.5
1.50	120.9
1.76	173.2
2.01	233.4
2.26	276.9
2.51	335.8
2.76	387.7
3.01	410.0
3.26	224.00
3.51	188.11



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

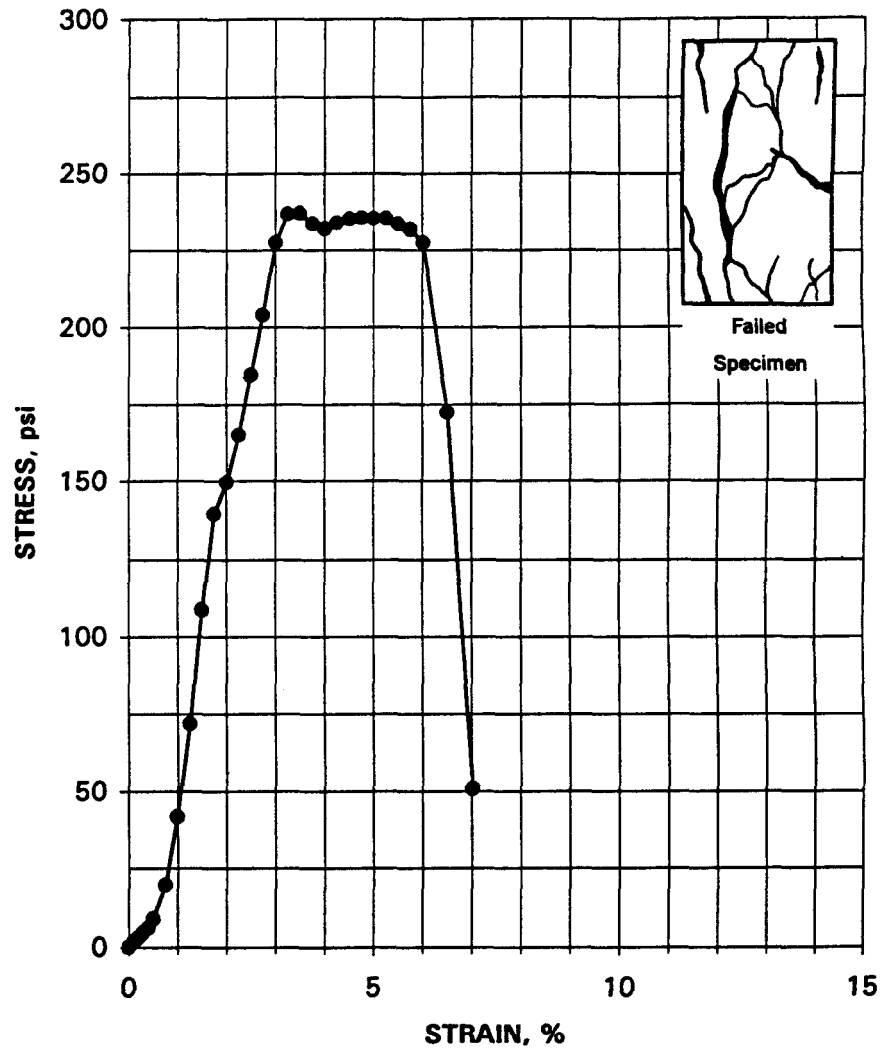
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C412F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7889

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9862
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0045
		Specimen Weight, g.	375.96
STRESS AT FAILURE, psi	**237.0**	Moisture Content, %	31.7
STRAIN AT FAILURE, %	**3.5**	Wet Unit Weight, pcf.	113.9
		Dry Unit Weight, pcf.	86.4
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	2.8
0.30	4.4
0.40	6.0
0.50	8.8
0.75	19.8
1.00	41.7
1.25	72.0
1.51	108.6
1.76	139.5
2.01	149.7
2.26	165.1
2.51	184.7
2.76	204.0
3.01	227.4
3.51	236.96
4.01	232.08
3.76	233.60
4.52	235.10
5.02	235.37
5.52	233.53
6.02	230.56
6.52	175.17
7.02	51.63



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

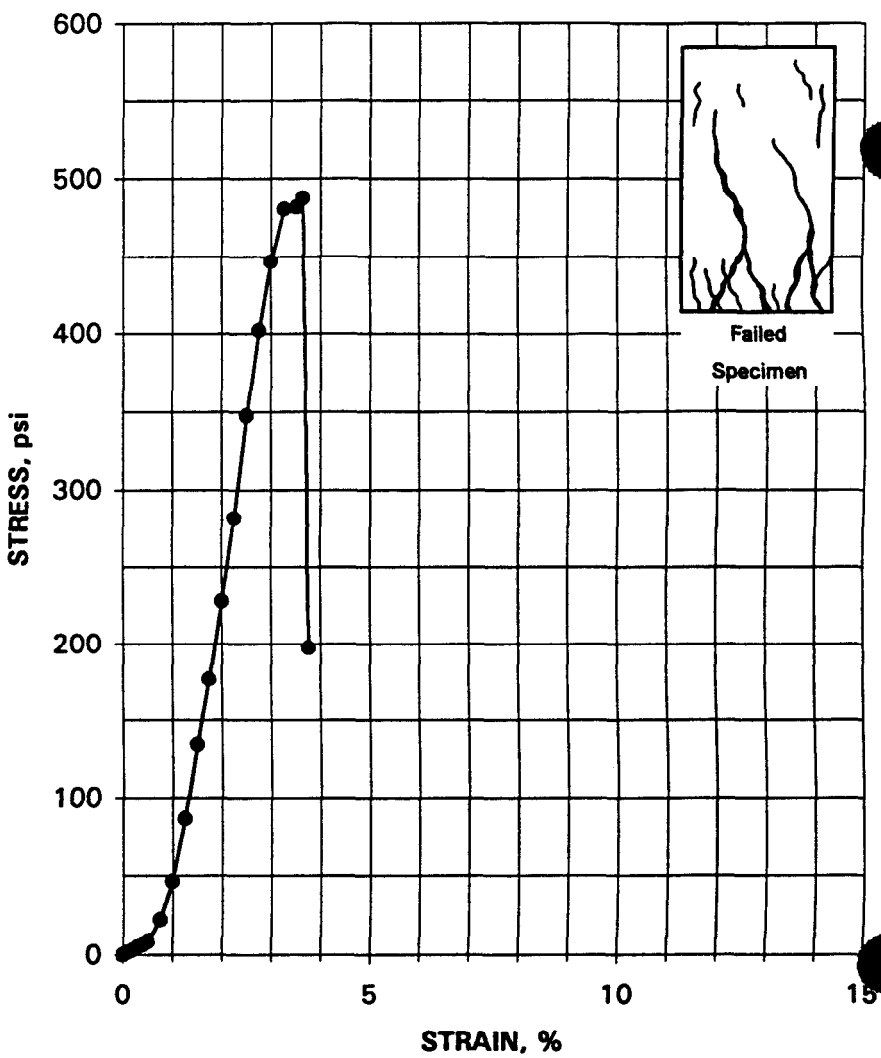
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C422F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7890

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9788
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0070
		Specimen Weight, g.	393.02
STRESS AT FAILURE, psi	**487.0**	Moisture Content, %	25.5
STRAIN AT FAILURE, %	**3.6**	Wet Unit Weight, pcf.	119.0
		Dry Unit Weight, pcf.	94.8
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	2.8
0.30	4.7
0.40	6.0
0.50	8.2
0.75	22.0
1.01	46.3
1.26	86.8
1.51	134.2
1.76	177.0
2.01	227.3
2.26	281.4
2.51	347.3
2.76	402.0
3.02	447.0
3.27	480.1
3.52	481.2
3.64	487.0
3.77	197.7



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

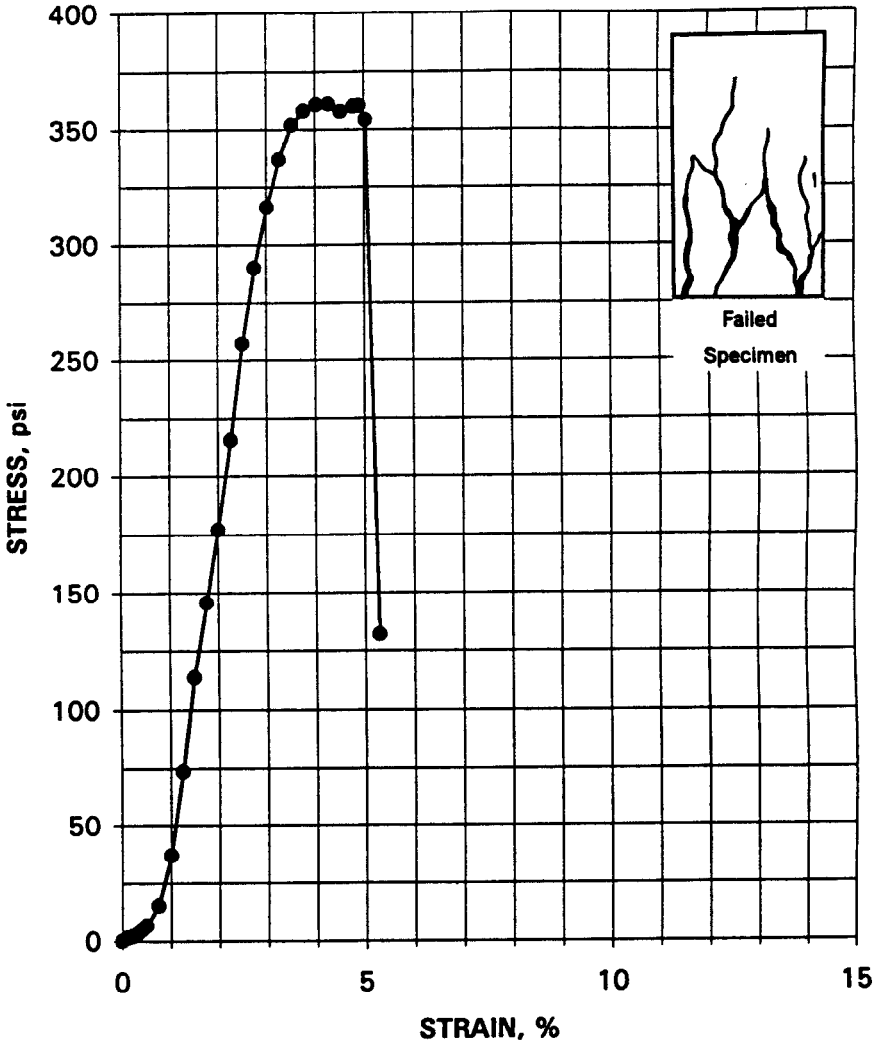
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C432F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7891

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9675
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0083
		Specimen Weight, g.	358.07
STRESS AT FAILURE, psi	**360.8**	Moisture Content, %	37.6
STRAIN AT FAILURE, %	**4.3**	Wet Unit Weight, pcf.	108.6
		Dry Unit Weight, pcf.	78.9
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	1.9
0.30	2.8
0.40	4.7
0.50	6.6
0.76	15.0
1.01	36.9
1.26	73.6
1.51	113.5
1.76	145.4
2.02	177.2
2.27	215.7
2.52	257.3
2.77	290.0
3.02	315.9
3.28	336.8
3.53	351.7
3.78	357.8
4.03	360.5
4.28	360.8
4.54	357.7
4.79	359.8
4.91	360.2
5.04	354.0
5.29	131.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

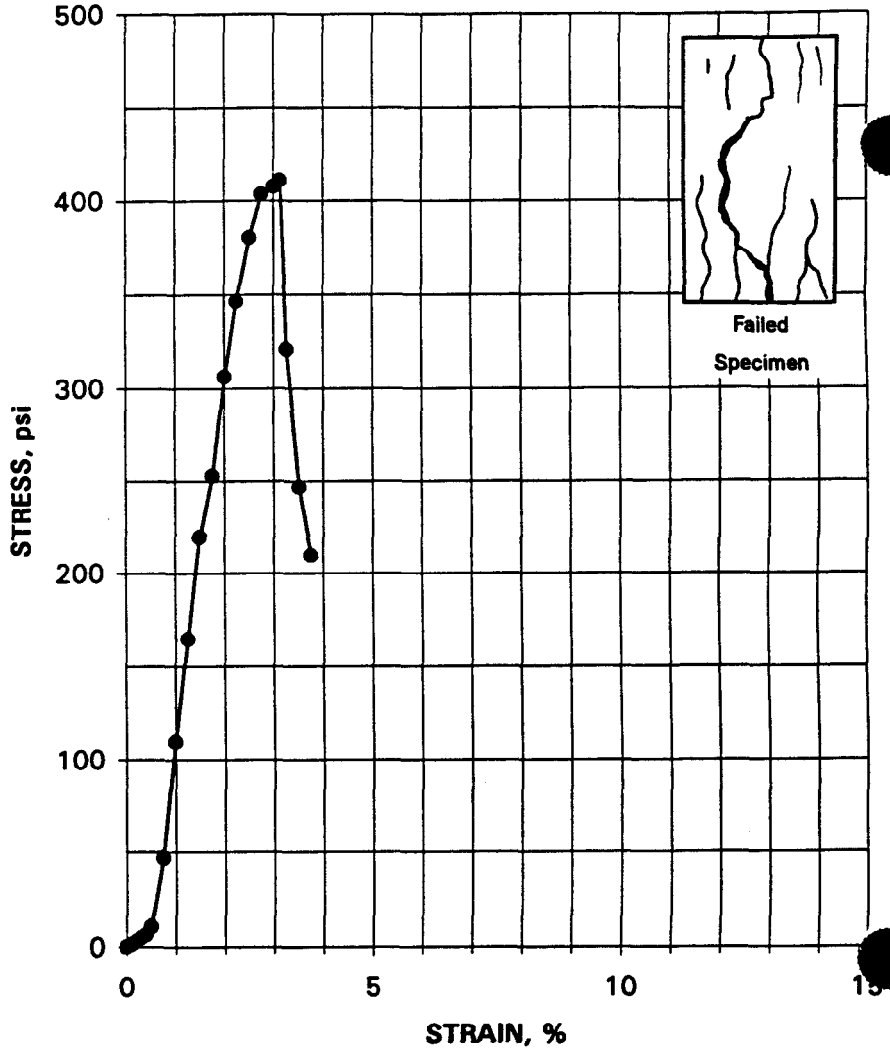
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C442F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7892

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9762
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0097
		Specimen Weight, g.	364.54
STRESS AT FAILURE, psi	**410.7**	Moisture Content, %	36.0
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	110.1
		Dry Unit Weight, pcf.	81.0
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.8
0.30	4.7
0.40	6.6
0.50	10.7
0.75	46.9
1.01	109.9
1.26	164.4
1.51	219.5
1.76	252.4
2.01	306.1
2.26	346.3
2.51	380.2
2.77	403.4
3.02	407.6
3.14	410.7
3.27	320.5
3.52	246.4
3.77	209.6



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

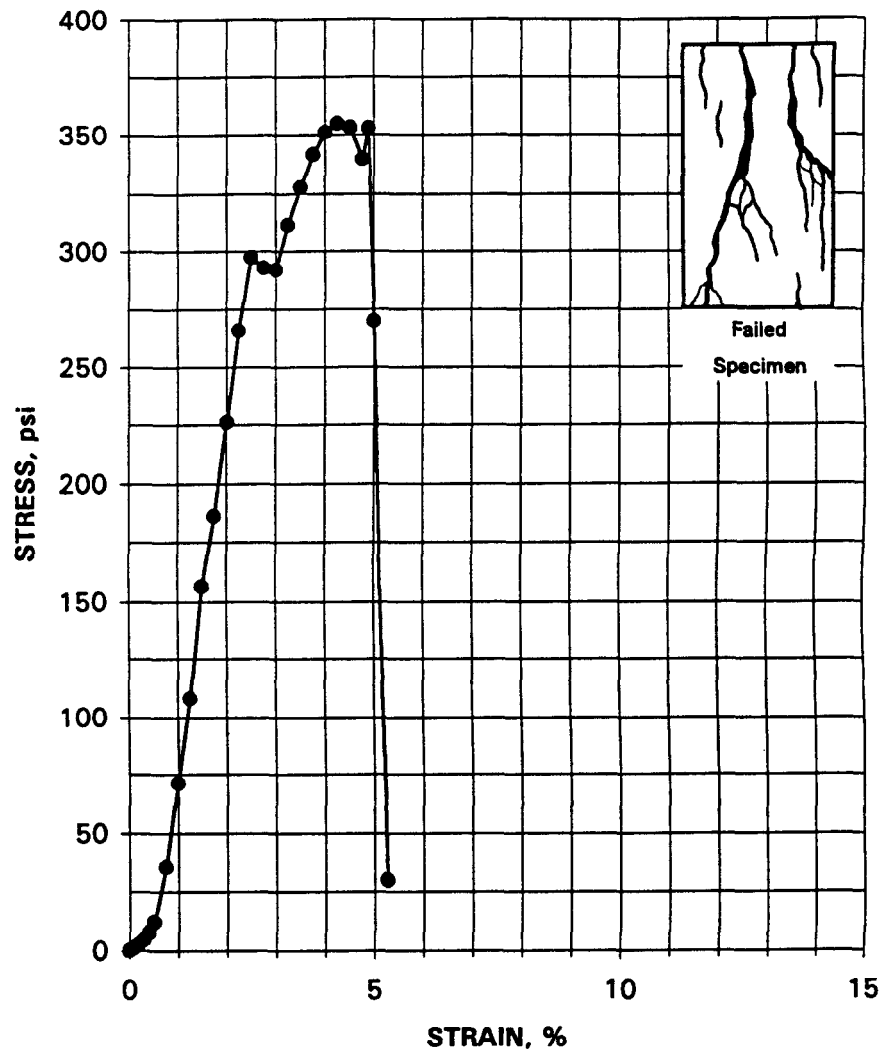
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C512F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7893

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9848
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0063
		Specimen Weight, g.	384.57
STRESS AT FAILURE, psi	**354.6**	Moisture Content, %	27.5
STRAIN AT FAILURE, %	**4.3**	Wet Unit Weight, pcf.	116.3
		Dry Unit Weight, pcf.	91.2
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.8
0.30	4.7
0.40	7.6
0.50	12.0
0.75	35.5
1.00	71.4
1.25	108.1
1.51	156.4
1.76	186.4
2.01	226.0
2.26	265.6
2.51	297.3
2.76	292.8
3.01	291.7
3.26	311.2
3.51	327.8
3.76	341.2
4.02	351.0
4.27	354.6
4.52	353.1
4.77	339.5
4.89	352.9
5.02	269.8
5.27	30.0



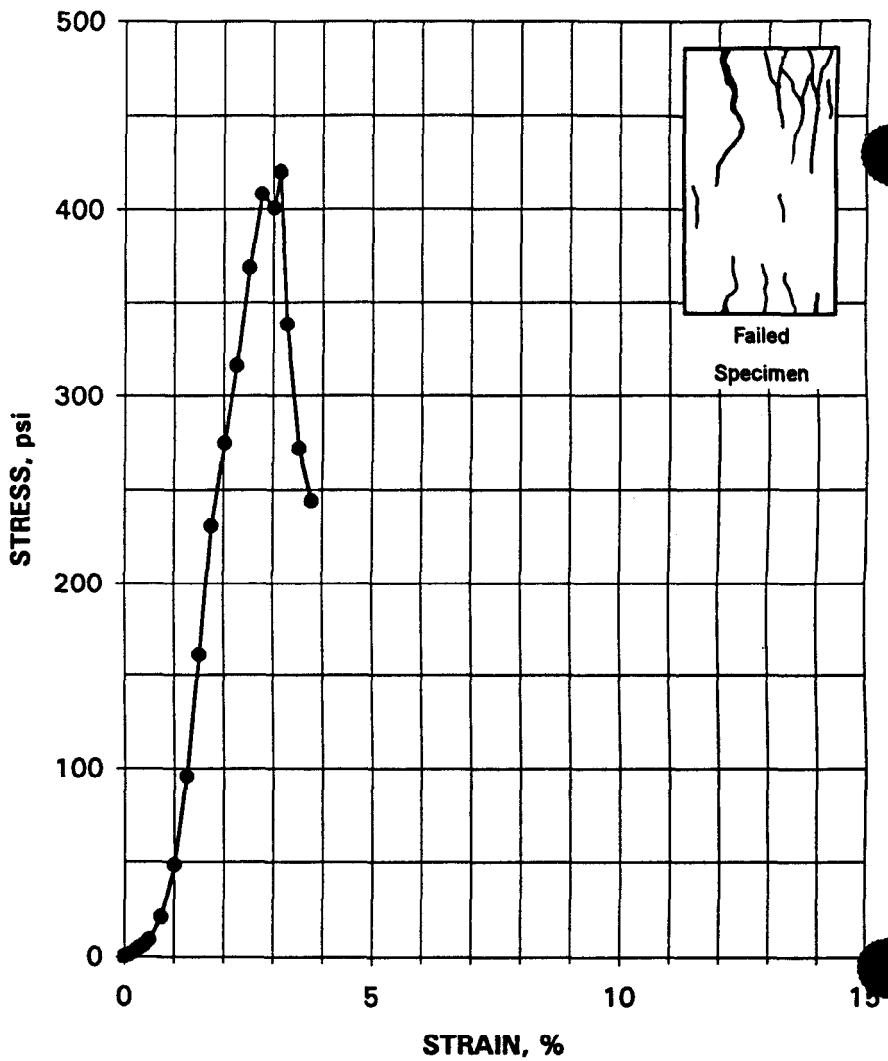
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C522F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7894

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9588
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0070
		Specimen Weight, g.	389.92
STRESS AT FAILURE, psi	**420.3**	Moisture Content, %	26.2
STRAIN AT FAILURE, %	**3.2**	Wet Unit Weight, pcf.	118.6
		Dry Unit Weight, pcf.	94.0
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	0.9
0.20	2.8
0.30	4.4
0.40	6.3
0.51	8.8
0.76	20.7
1.01	48.5
1.26	95.5
1.52	160.6
1.77	230.7
2.02	275.0
2.27	316.0
2.53	368.5
2.78	408.1
3.03	400.6
3.16	420.3
3.28	338.1
3.54	272.0
3.79	244.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

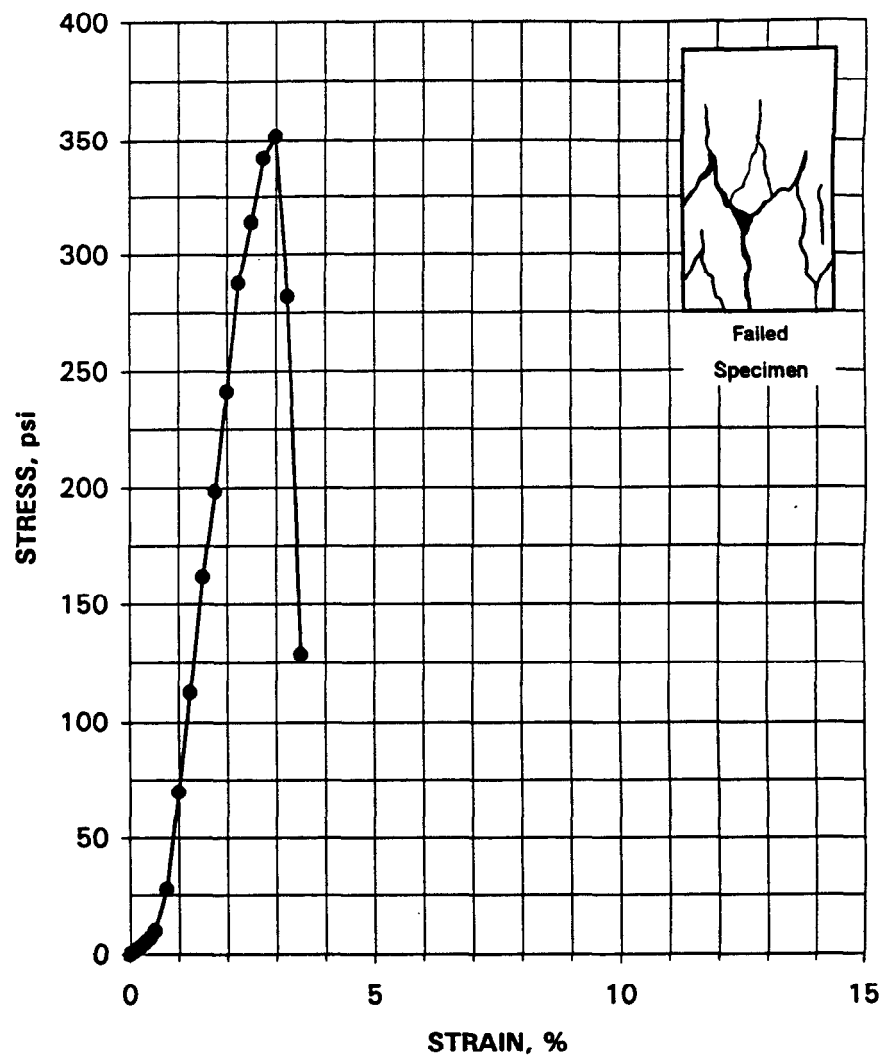
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C532F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7895

Specimen Mold Date	11/11/98	Specimen Height, in.	4.0000
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0057
		Specimen Weight, g.	371.22
STRESS AT FAILURE, psi	**351.5**	Moisture Content, %	34.1
STRAIN AT FAILURE, %	**3.0**	Wet Unit Weight, pcf.	111.9
		Dry Unit Weight, pcf.	83.5
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.8
0.30	4.7
0.40	6.6
0.50	9.4
0.75	27.6
1.00	69.6
1.25	112.5
1.50	161.5
1.75	198.4
2.00	241.0
2.25	287.4
2.50	313.5
2.75	341.7
3.00	351.5
3.25	281.7
3.50	128.6



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

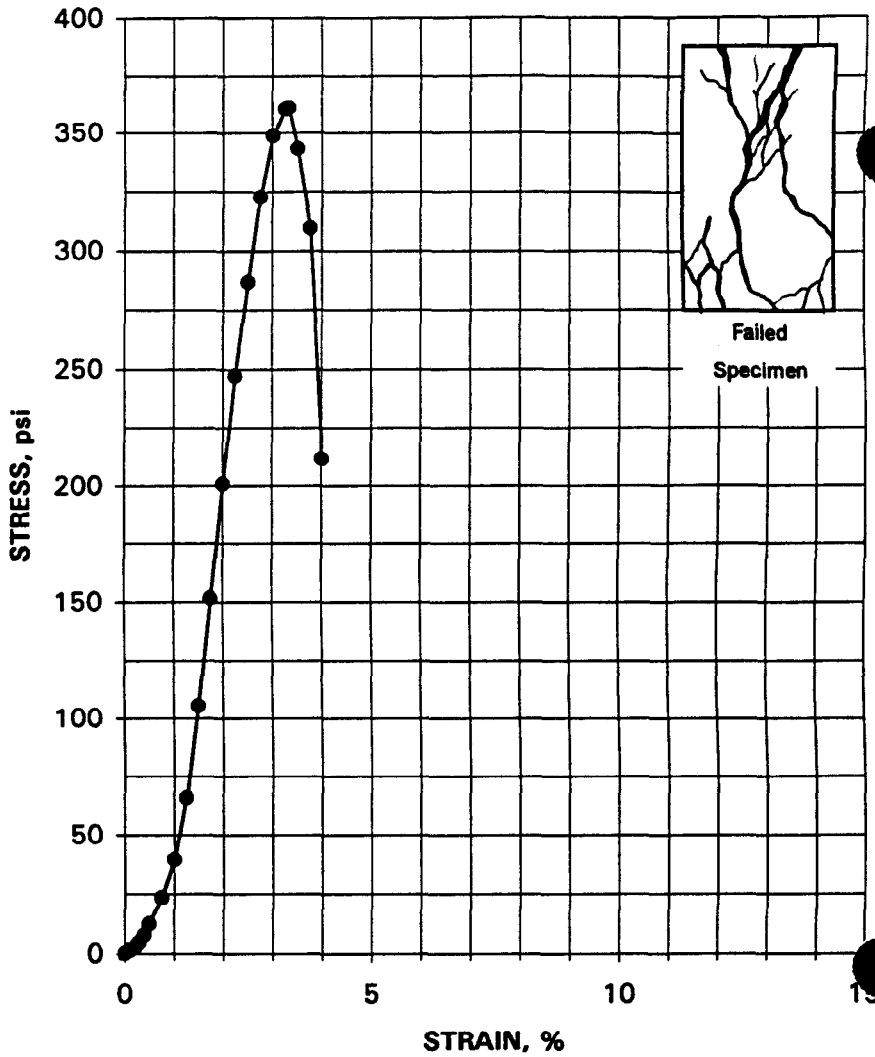
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C542F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7896

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9717
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0023
		Specimen Weight, g.	385.01
STRESS AT FAILURE, psi	**361.0**	Moisture Content, %	28.0
STRAIN AT FAILURE, %	**3.3**	Wet Unit Weight, pcf.	117.3
		Dry Unit Weight, pcf.	91.6
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.5
0.30	4.7
0.40	7.6
0.50	12.3
0.76	23.3
1.01	39.6
1.26	65.5
1.51	105.4
1.76	151.6
2.01	200.7
2.27	247.4
2.52	286.7
2.77	322.7
3.02	348.6
3.27	360.6
3.35	361.0
3.52	343.1
3.78	309.5
4.03	211.5



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

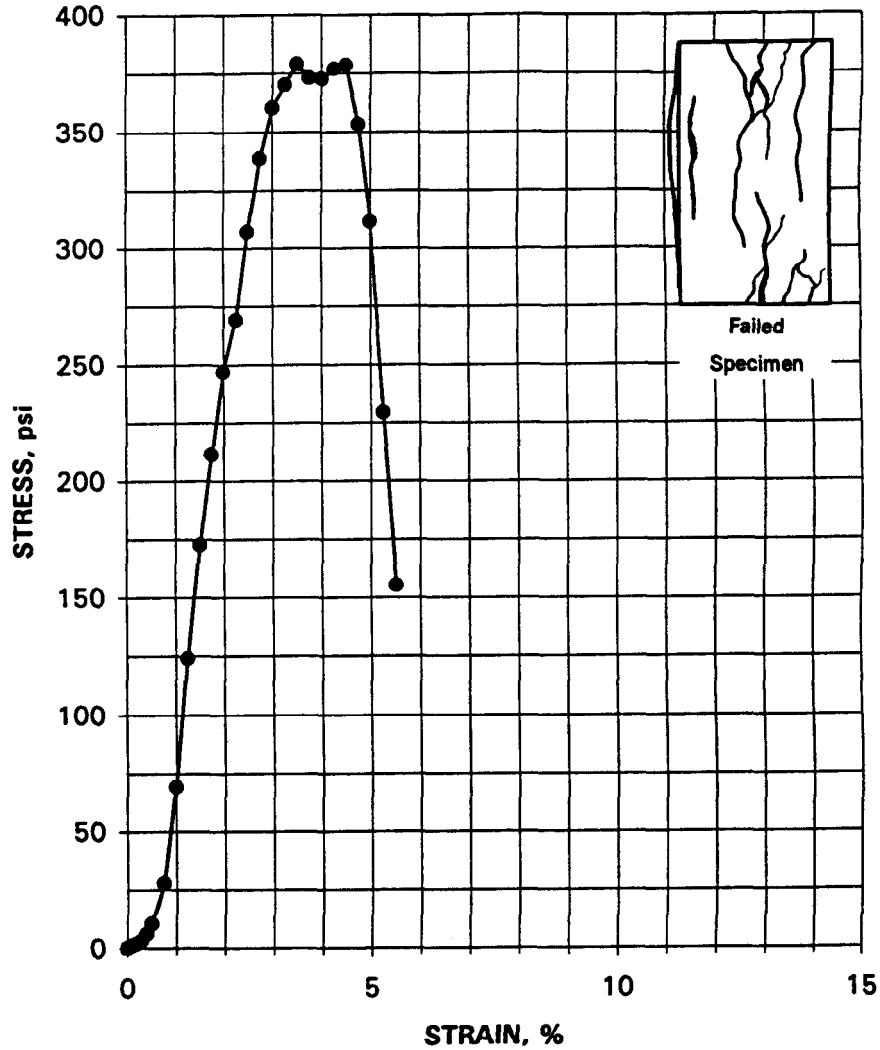
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C612F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7897

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9903
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0005
		Specimen Weight, g.	384.46
STRESS AT FAILURE, psi	**379.1**	Moisture Content, %	27.9
STRAIN AT FAILURE, %	**3.5**	Wet Unit Weight, pcf.	116.8
		Dry Unit Weight, pcf.	91.3
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.0
0.20	1.9
0.30	3.2
0.40	6.0
0.50	10.4
0.75	27.8
1.00	69.0
1.25	123.8
1.50	172.7
1.75	211.3
2.00	246.9
2.26	269.0
2.51	307.1
2.76	338.5
3.01	360.1
3.26	370.0
3.51	379.1
3.76	372.9
4.01	372.6
4.26	376.8
4.51	378.5
4.76	353.3
5.01	311.6
5.26	229.4
5.51	155.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

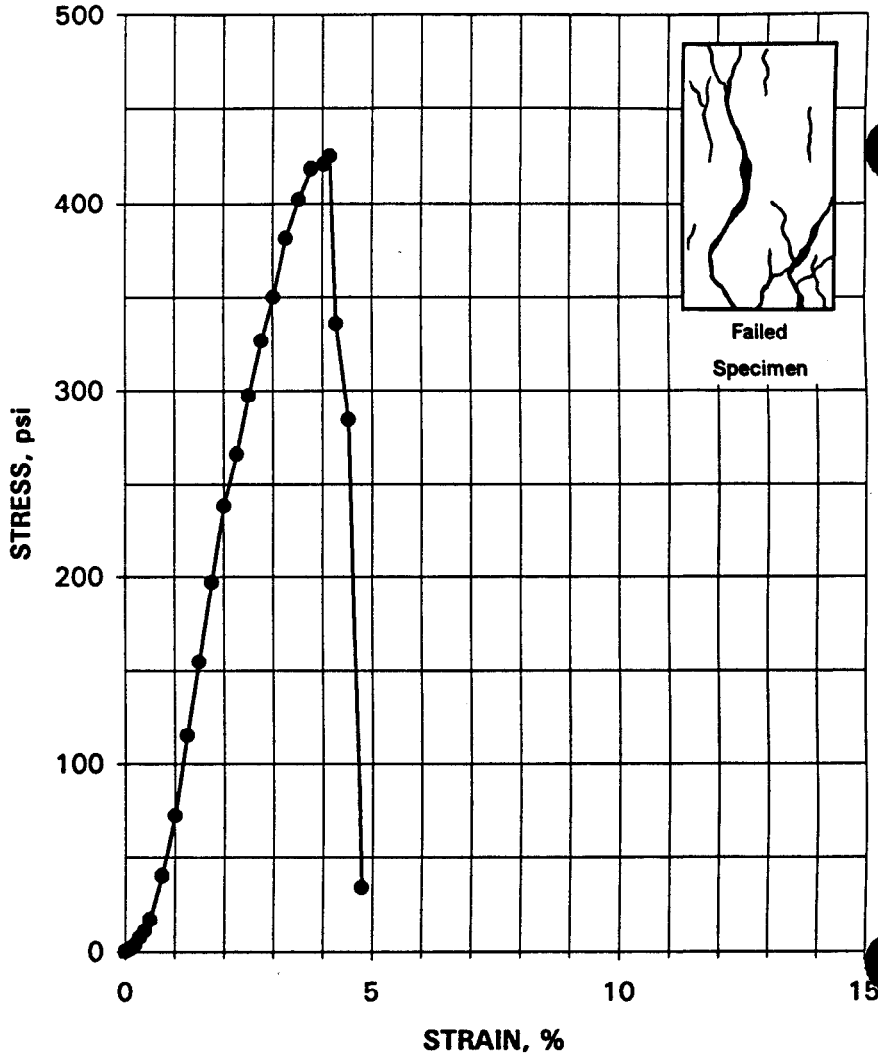
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C622F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7898

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9667
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0043
		Specimen Weight, g.	389.68
STRESS AT FAILURE, psi	**424.3**	Moisture Content, %	26.4
STRAIN AT FAILURE, %	**4.2**	Wet Unit Weight, pcf.	118.6
		Dry Unit Weight, pcf.	93.9
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.8
0.30	7.6
0.40	11.4
0.50	17.0
0.76	39.9
1.01	72.2
1.26	114.8
1.51	154.8
1.76	197.1
2.02	238.5
2.27	266.4
2.52	297.2
2.77	326.6
3.03	350.1
3.28	381.3
3.53	402.1
3.78	418.1
4.03	420.3
4.16	424.3
4.29	335.8
4.54	284.4
4.79	33.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

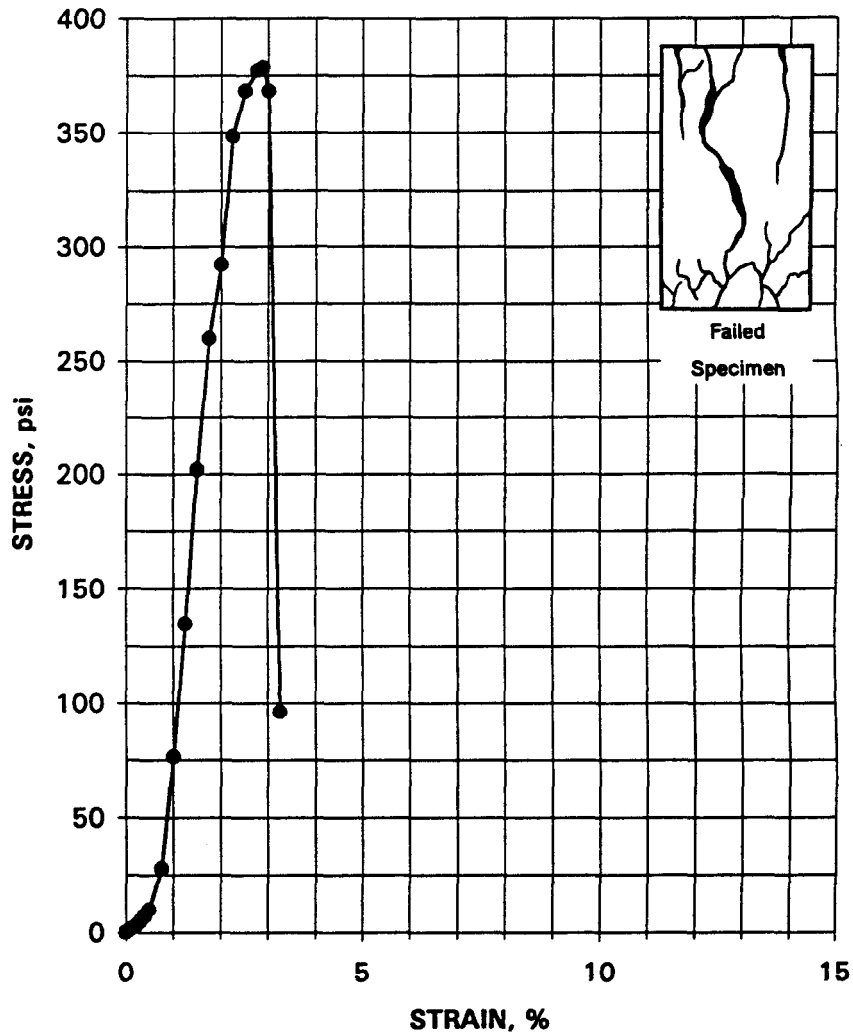
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C632F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7899

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9785
Specimen Test Date	12/9/98	Specimen Diameter, in.	1.9993
		Specimen Weight, g.	366.83
STRESS AT FAILURE, psi	**378.6**	Moisture Content, %	34.1
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	111.9
		Dry Unit Weight, pcf.	83.4
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.9
0.30	4.8
0.40	7.3
0.50	10.1
0.75	27.8
1.01	76.3
1.26	134.9
1.51	201.7
1.76	259.7
2.01	291.8
2.26	348.4
2.51	368.0
2.76	377.2
2.89	378.6
3.02	367.9
3.27	96.1



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

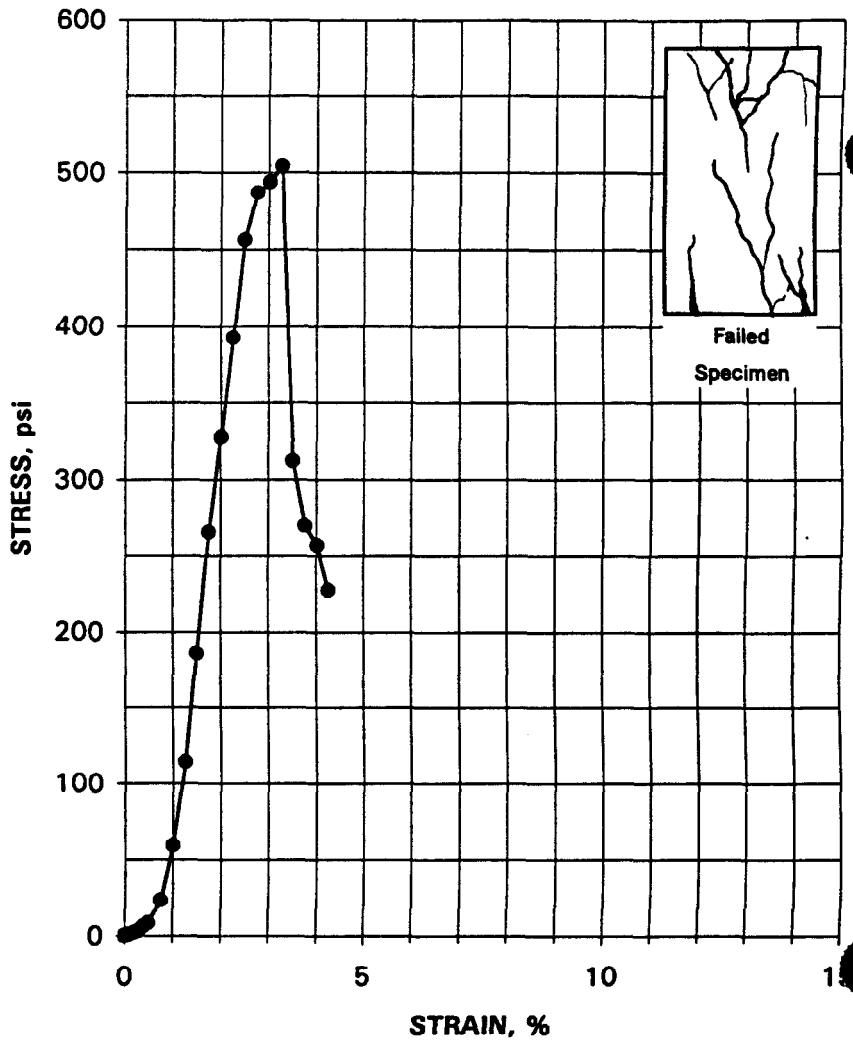
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	C642F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7900

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9718
Specimen Test Date	12/9/98	Specimen Diameter, in.	2.0077
		Specimen Weight, g.	374.14
STRESS AT FAILURE, psi	**504.1**	Moisture Content, %	31.2
STRAIN AT FAILURE, %	**3.3**	Wet Unit Weight, pcf.	113.4
		Dry Unit Weight, pcf.	86.4
		Rate of Strain, in./min.	0.0300

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	0.9
0.20	1.9
0.30	3.5
0.40	6.3
0.50	8.5
0.76	23.2
1.01	59.7
1.26	114.2
1.51	185.4
1.76	265.6
2.01	327.8
2.27	392.4
2.52	456.0
2.77	486.5
3.02	493.5
3.27	504.1
3.52	311.8
3.78	269.9
4.03	256.8
4.28	227.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

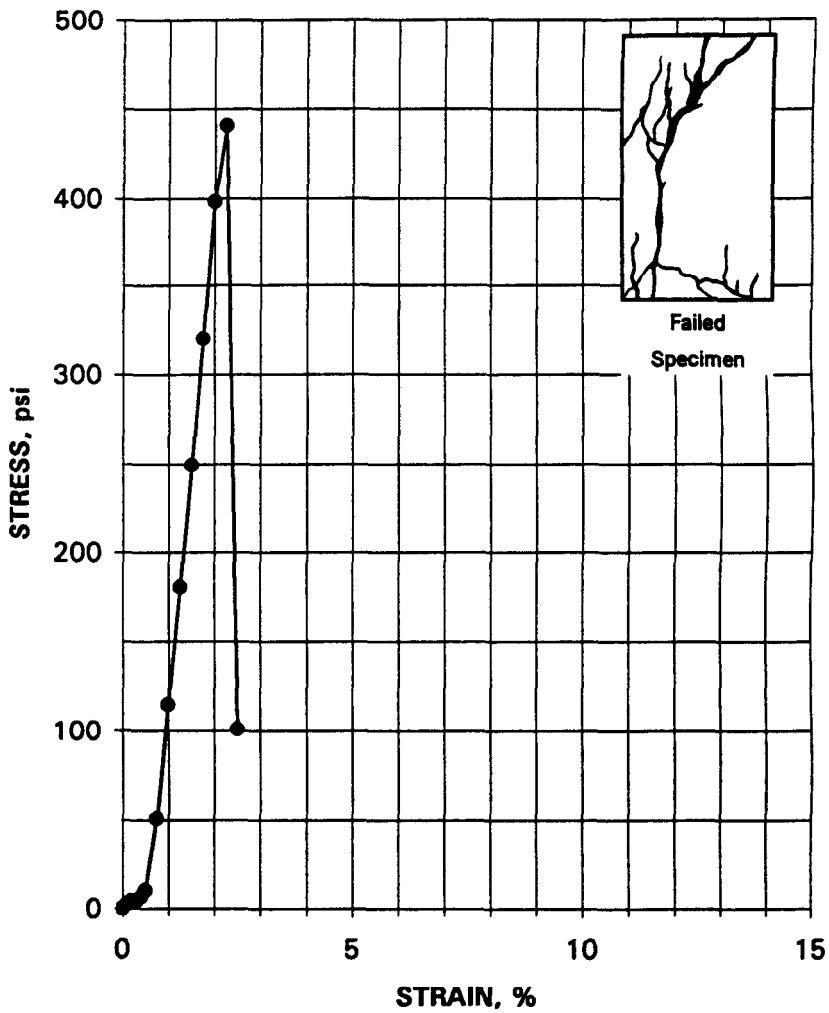
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C313F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7837

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9860
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0000
		Specimen Weight, g.	390.62
STRESS AT FAILURE, psi	**440.9**	Moisture Content, %	30.7
STRAIN AT FAILURE, %	**2.3**	Wet Unit Weight, pcf.	118.6
		Dry Unit Weight, pcf.	90.7
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	4.4
0.30	4.4
0.40	6.3
0.50	10.1
0.75	50.5
1.00	114.7
1.25	181.0
1.51	249.2
1.76	320.2
2.01	398.3
2.26	440.9
2.51	100.9



C Series
90 Day Immersion UCS Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

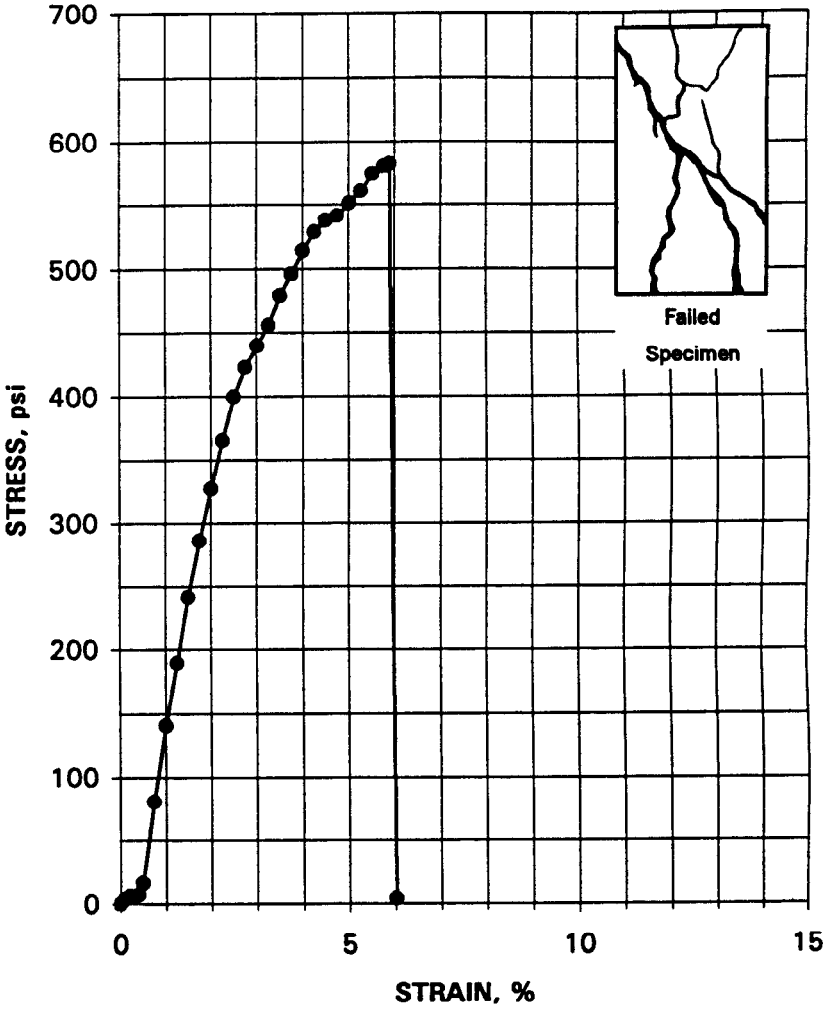
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C323F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7838

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9767
Specimen Test Date	3/9/99	Specimen Diameter, in.	1.9985
		Specimen Weight, g.	396.65
STRESS AT FAILURE, psi	**581.9**	Moisture Content, %	27.4
STRAIN AT FAILURE, %	**5.9**	Wet Unit Weight, pcf.	120.6
		Dry Unit Weight, pcf.	94.7
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	6.0
0.30	5.7
0.40	7.0
0.50	15.9
0.75	80.7
1.01	141.1
1.26	189.5
1.51	241.1
1.76	285.6
2.01	326.7
2.26	365.2
2.51	399.7
2.76	422.8
3.02	439.6
3.27	455.8
3.52	478.9
3.77	496.0
4.02	514.0
4.27	528.6
4.52	537.5
4.78	541.0
5.03	551.0
5.28	560.4
5.53	574.3
5.78	580.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

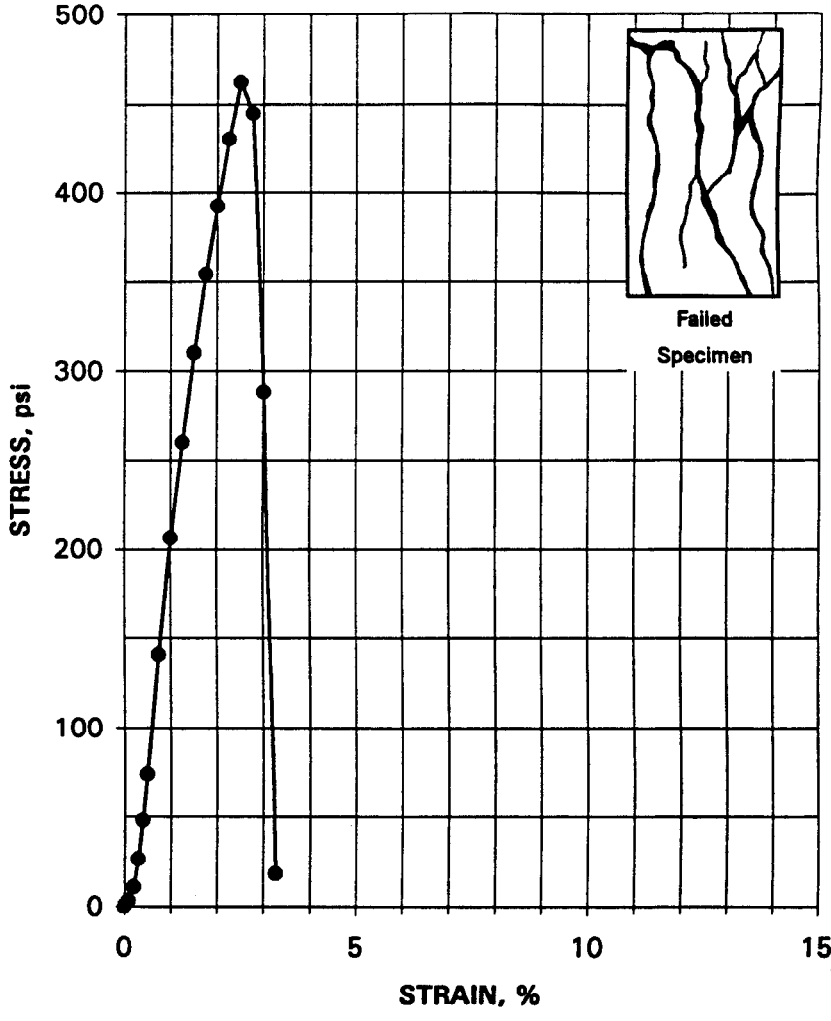
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C333F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7839

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9792
Specimen Test Date	3/9/99	Specimen Diameter, in.	1.9975
		Specimen Weight, g.	378.57
STRESS AT FAILURE, psi	**462.6**	Moisture Content, %	34.9
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	115.4
		Dry Unit Weight, pcf.	85.6
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.2
0.20	10.8
0.30	26.4
0.40	48.0
0.50	74.0
0.75	140.6
1.01	206.3
1.26	260.0
1.51	310.2
1.76	354.6
2.01	392.1
2.26	430.1
2.52	462.6
2.77	444.6
3.02	288.4
3.27	18.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

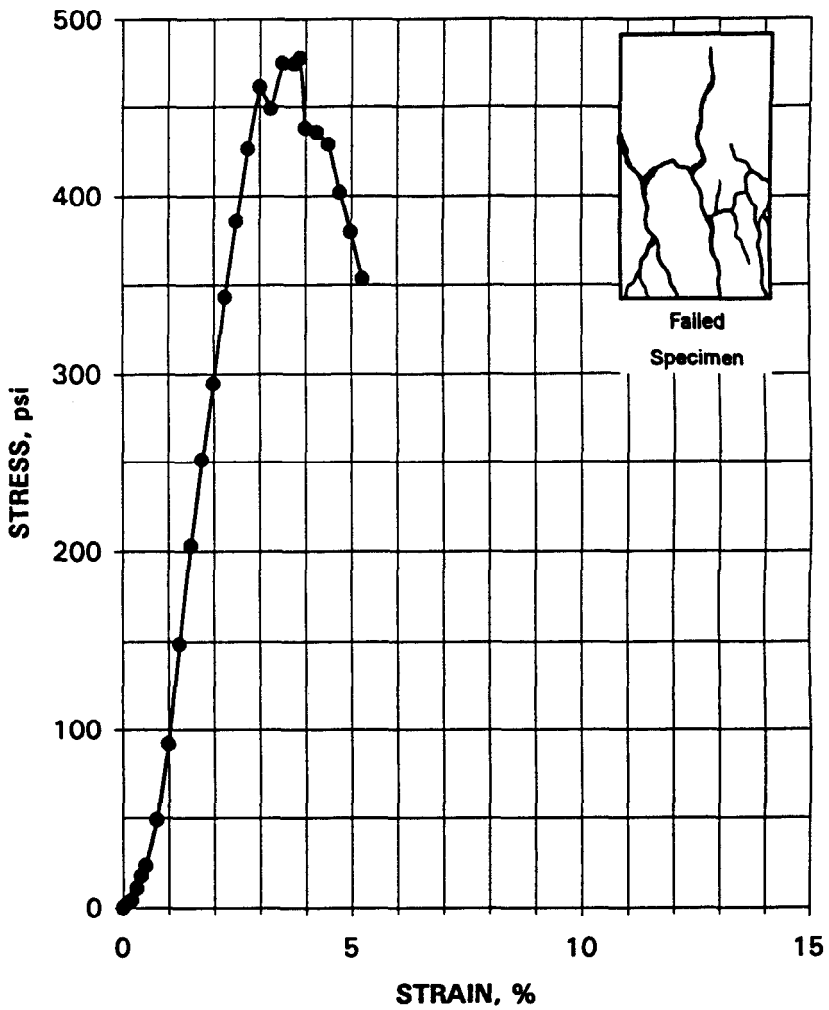
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C343F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7840

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9998
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0032
		Specimen Weight, g.	384.10
STRESS AT FAILURE, psi	**478.0**	Moisture Content, %	33.1
STRAIN AT FAILURE, %	**3.9**	Wet Unit Weight, pcf.	115.7
		Dry Unit Weight, pcf.	86.9
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	4.4
0.30	10.8
0.40	17.4
0.50	23.0
0.75	48.8
1.00	91.7
1.25	148.5
1.50	202.8
1.75	251.0
2.00	294.5
2.25	343.0
2.50	385.8
2.75	426.1
3.00	461.1
3.25	448.8
3.50	474.9
3.75	474.6
3.87	478.0
4.00	437.7
4.25	435.4
4.50	428.5
4.75	401.7
5.00	379.8
5.25	353.3



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

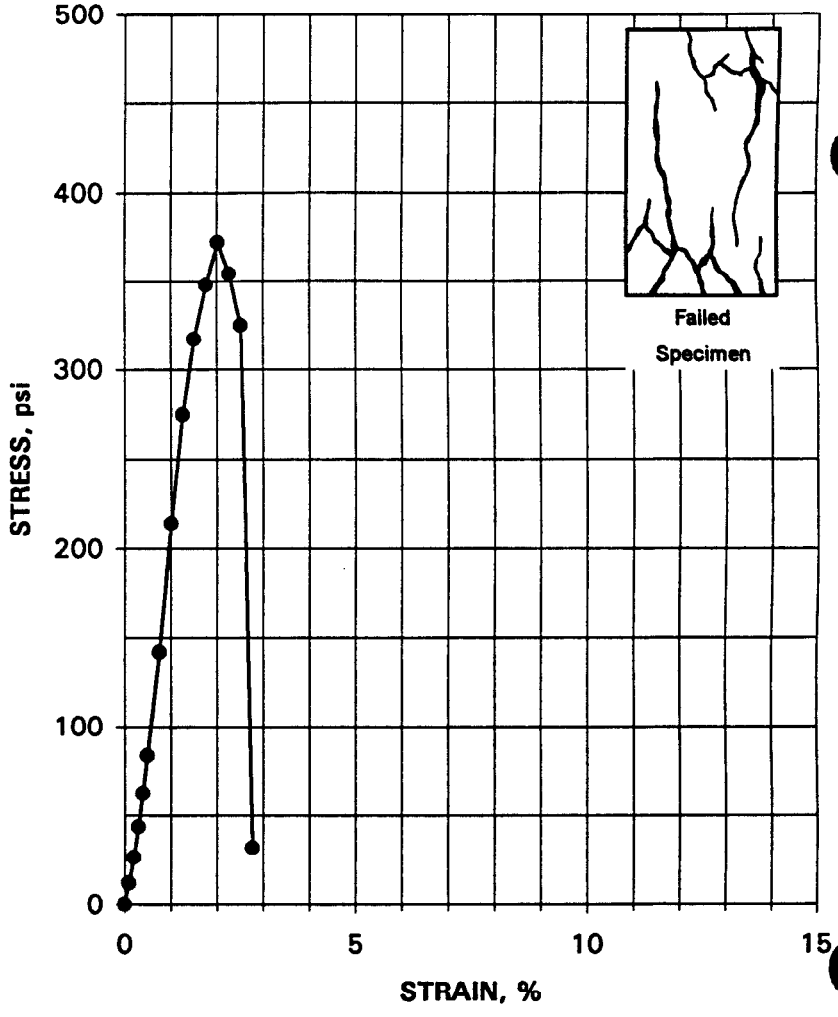
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C413F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7841

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9530
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0017
		Specimen Weight, g.	382.53
STRESS AT FAILURE, psi	**372.4**	Moisture Content, %	33.7
STRAIN AT FAILURE, %	**2.0**	Wet Unit Weight, pcf.	117.0
		Dry Unit Weight, pcf.	87.5
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	11.7
0.20	26.3
0.30	43.7
0.40	62.7
0.51	83.8
0.76	141.9
1.01	214.2
1.27	274.2
1.52	316.7
1.77	348.0
2.02	372.4
2.28	354.3
2.53	324.6
2.78	31.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

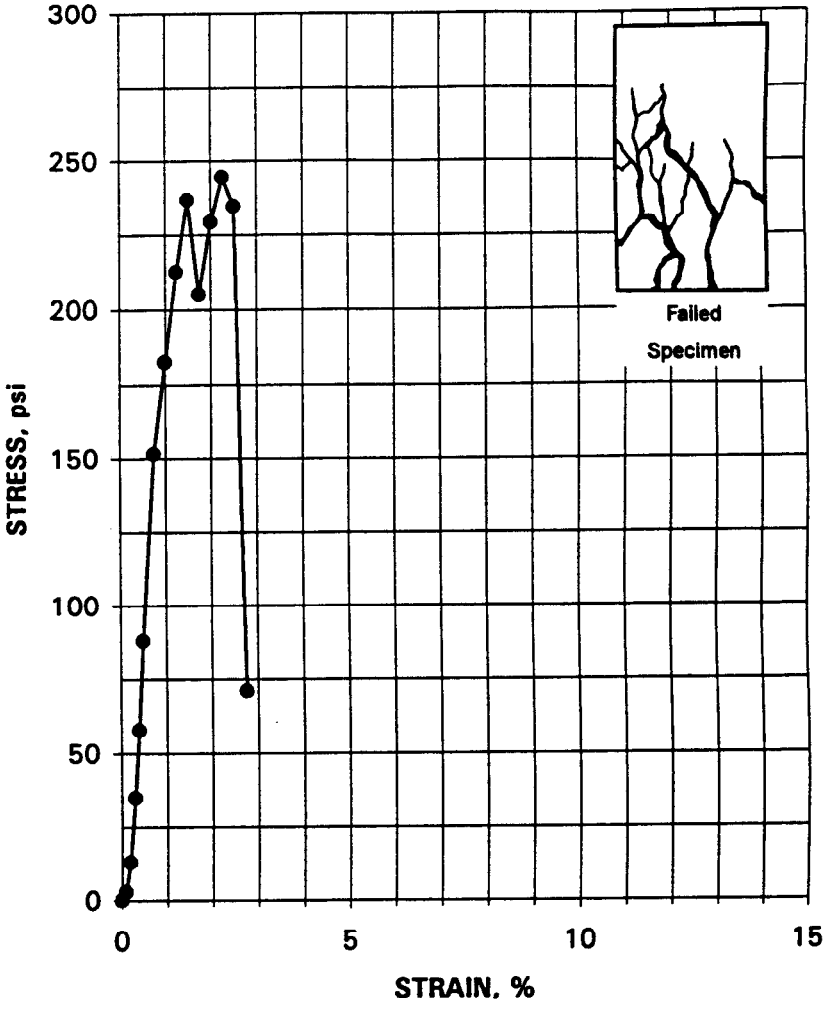
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C423F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7842

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9880
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0055
		Specimen Weight, g.	383.24
STRESS AT FAILURE, psi	**244.4**	Moisture Content, %	33.5
STRAIN AT FAILURE, %	**2.3**	Wet Unit Weight, pcf.	115.1
		Dry Unit Weight, pcf.	86.2
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.8
0.20	13.0
0.30	34.7
0.40	58.0
0.50	87.9
0.75	151.4
1.00	182.4
1.25	212.6
1.51	236.7
1.76	205.0
2.01	229.2
2.26	244.4
2.51	234.6
2.76	71.1



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

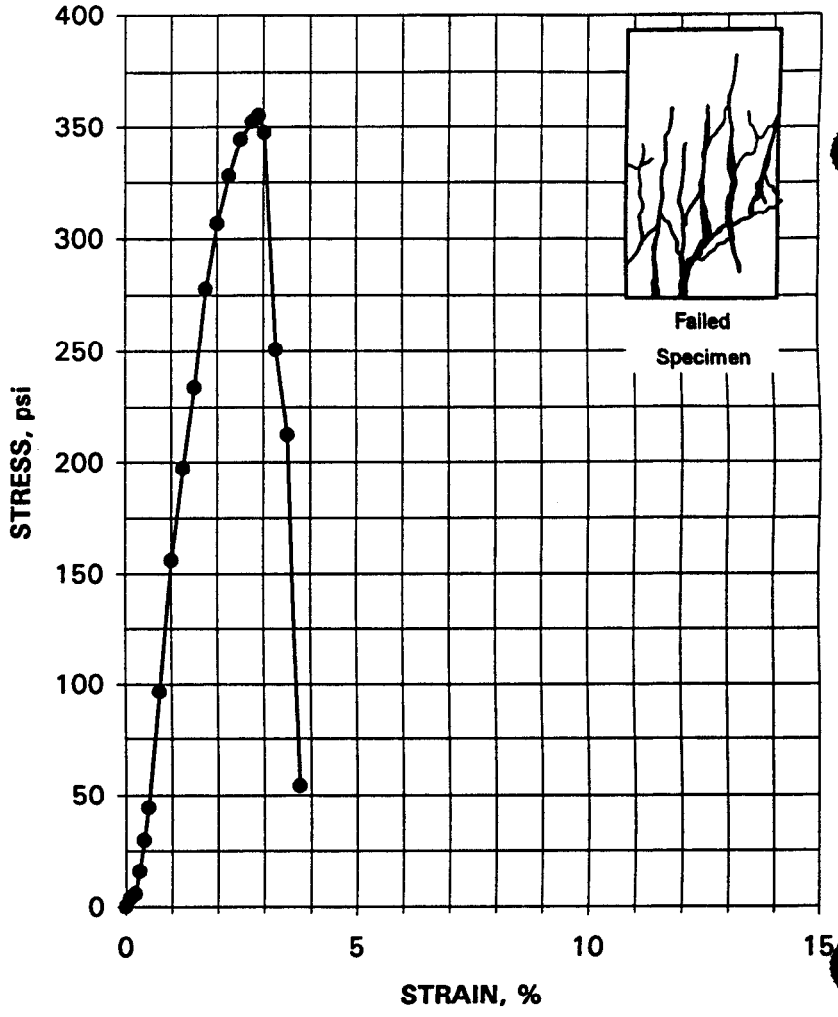
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C433F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7843

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9818
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	379.62
STRESS AT FAILURE, psi	**355.1**	Moisture Content, %	41.6
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	115.0
		Dry Unit Weight, pcf.	81.2
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	5.7
0.30	15.8
0.40	29.7
0.50	44.3
0.75	96.5
1.01	156.0
1.26	197.0
1.51	233.7
1.76	277.8
2.01	306.6
2.26	327.9
2.51	344.4
2.77	352.4
2.89	355.1
3.02	347.5
3.27	250.8
3.52	212.1
3.77	54.1



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

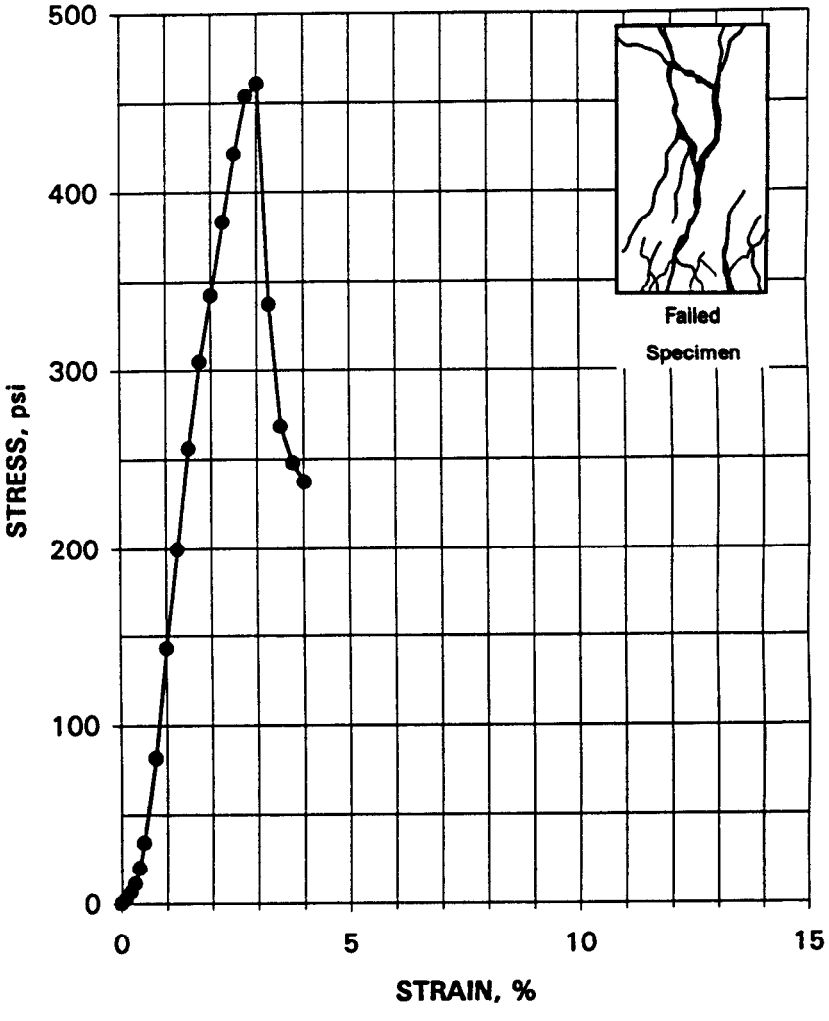
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C443F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7844

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9682
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0122
		Specimen Weight, g.	367.07
STRESS AT FAILURE, psi	**460.8**	Moisture Content, %	39.7
STRAIN AT FAILURE, %	**3.0**	Wet Unit Weight, pcf.	110.8
		Dry Unit Weight, pcf.	79.3
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	6.3
0.30	11.3
0.40	20.0
0.50	34.4
0.76	81.5
1.01	142.6
1.26	199.3
1.51	255.8
1.76	304.9
2.02	342.0
2.27	383.3
2.52	421.5
2.77	453.7
3.02	460.8
3.27	337.0
3.53	267.9
3.78	247.8
4.03	236.9



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

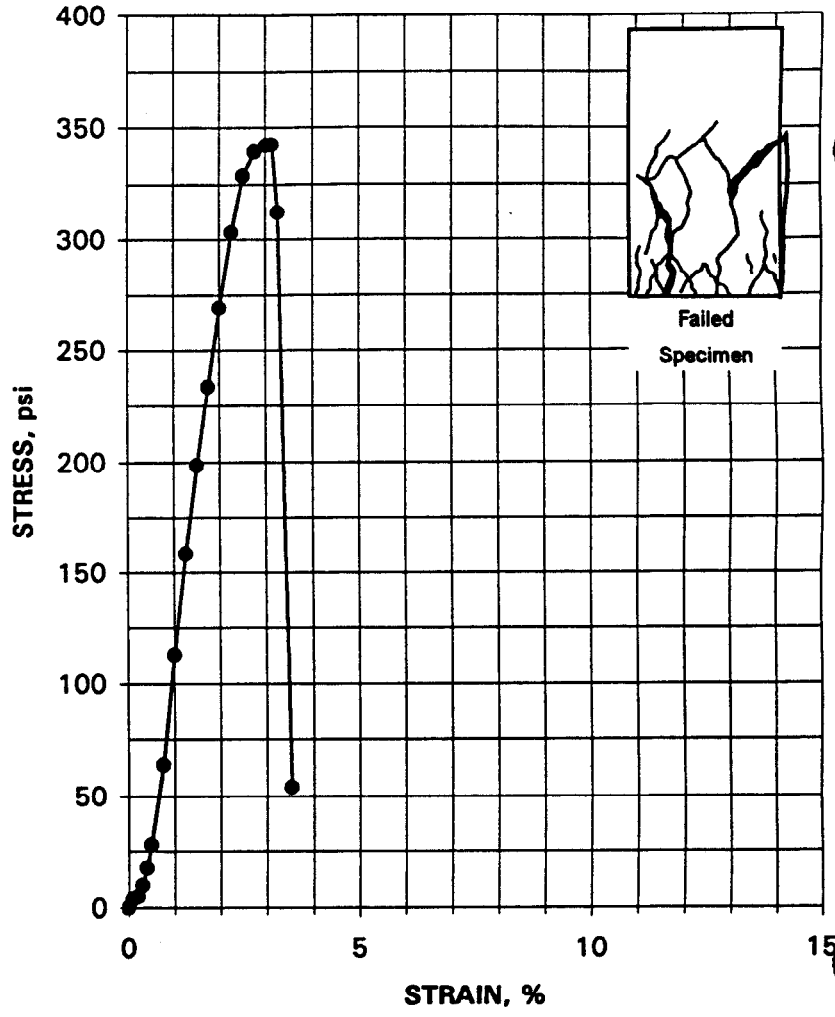
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C513F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7845

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9667
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0007
		Specimen Weight, g.	388.49
STRESS AT FAILURE, psi	**342.3**	Moisture Content, %	31.8
STRAIN AT FAILURE, %	**3.2**	Wet Unit Weight, pcf.	117.9
		Dry Unit Weight, pcf.	89.4
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	4.8
0.30	9.8
0.40	17.4
0.50	27.9
0.76	64.1
1.01	113.0
1.26	158.3
1.51	198.3
1.76	233.4
2.02	269.3
2.27	303.1
2.52	328.7
2.77	339.3
3.03	342.1
3.15	342.3
3.28	312.3
3.53	54.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

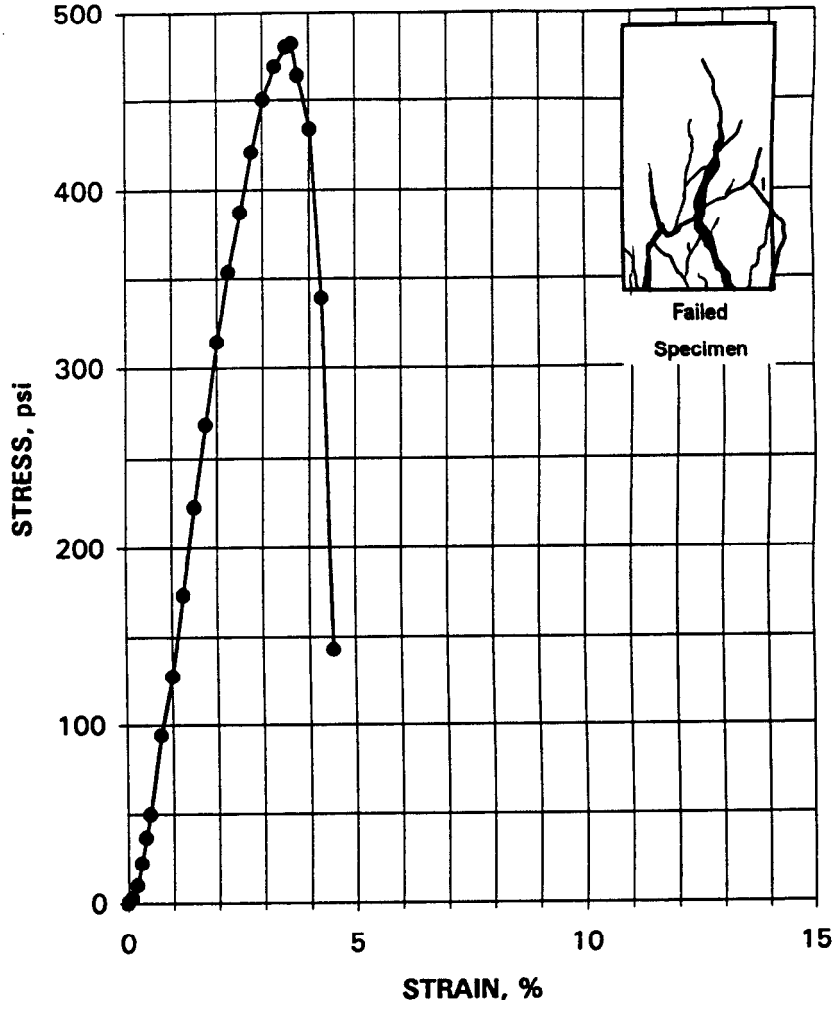
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C523F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7846

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9750
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0027
		Specimen Weight, g.	391.78
STRESS AT FAILURE, psi	**481.8**	Moisture Content, %	28.0
STRAIN AT FAILURE, %	**3.6**	Wet Unit Weight, pcf.	118.4
		Dry Unit Weight, pcf.	92.5
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.9
0.20	10.1
0.30	22.5
0.40	36.7
0.50	49.6
0.76	93.9
1.01	127.3
1.26	174.0
1.51	222.3
1.76	267.9
2.01	314.5
2.27	353.7
2.52	387.1
2.77	421.0
3.02	450.1
3.27	468.9
3.52	479.9
3.65	481.8
3.78	464.0
4.03	433.9
4.28	338.8
4.53	142.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

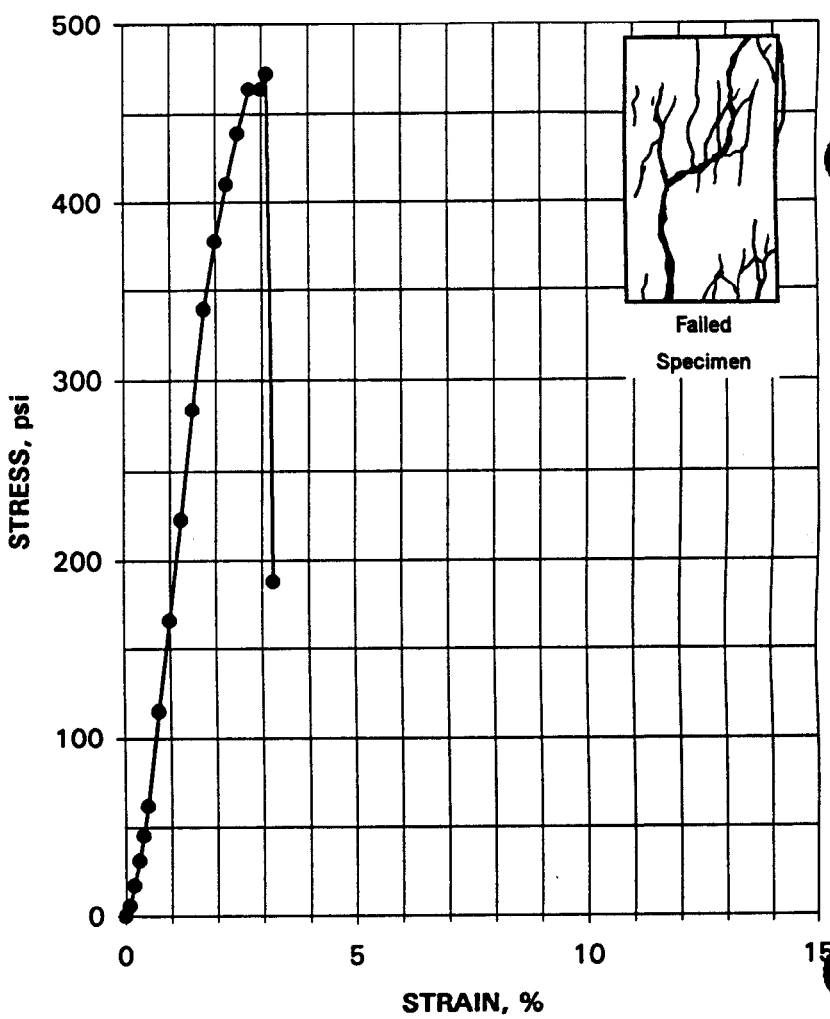
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C533F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7847

Specimen Mold Date	11/11/98	Specimen Height, in.	4.0135
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0015
		Specimen Weight, g.	375.26
STRESS AT FAILURE, psi	**472.4**	Moisture Content, %	37.3
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	112.9
		Dry Unit Weight, pcf.	82.2
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.7
0.20	17.1
0.30	31.4
0.40	45.3
0.50	61.7
0.75	114.5
1.00	165.8
1.25	223.2
1.50	283.6
1.75	339.5
2.00	377.5
2.25	410.1
2.49	439.1
2.74	464.0
2.99	464.0
3.12	472.4
3.24	188.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

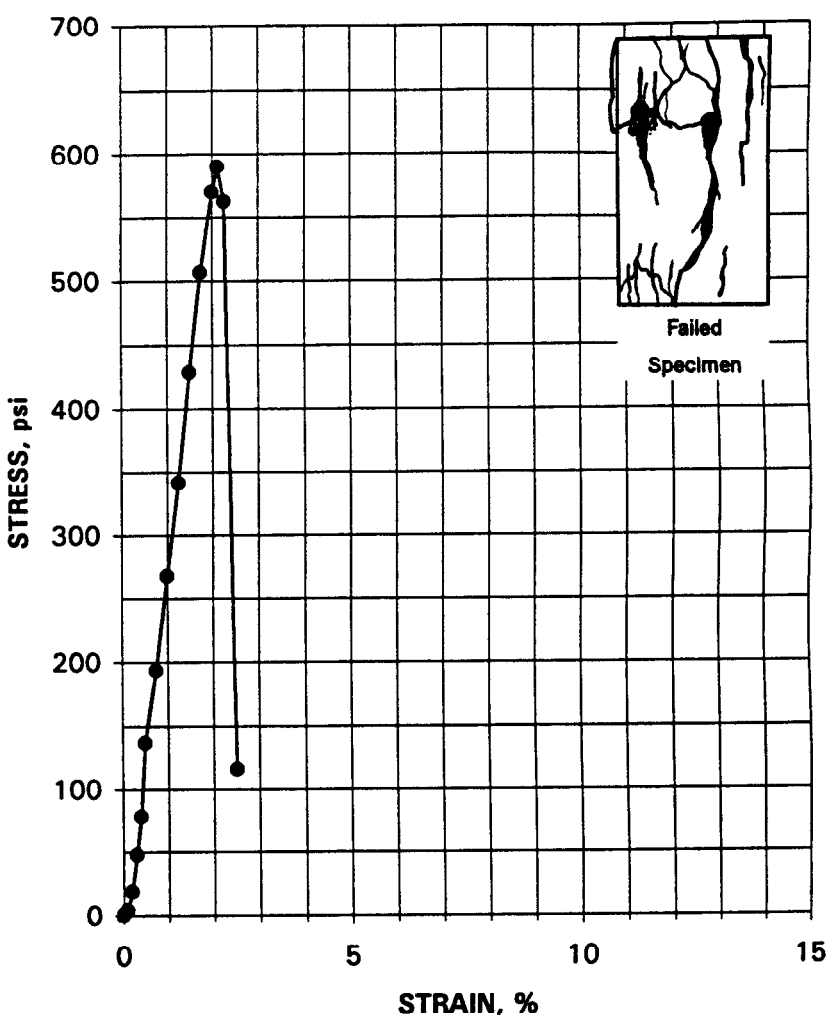
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C543F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7848

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9968
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0068
		Specimen Weight, g.	379.95
STRESS AT FAILURE, psi	**590.1**	Moisture Content, %	34.2
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	113.4
		Dry Unit Weight, pcf.	84.5
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	18.6
0.30	47.6
0.40	77.8
0.50	137.1
0.75	193.3
1.00	267.3
1.25	341.2
1.50	428.8
1.75	506.6
2.00	570.1
2.13	590.1
2.25	562.7
2.50	115.6



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

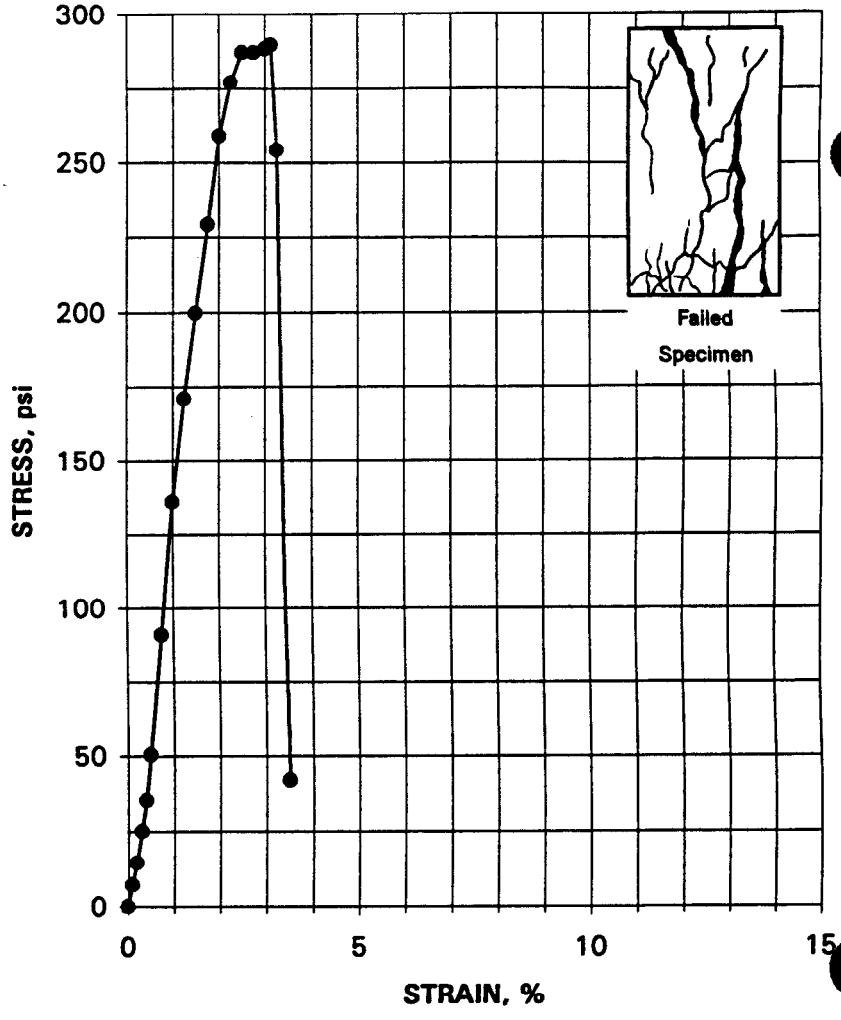
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C613F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7849

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9903
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0028
		Specimen Weight, g.	391.23
STRESS AT FAILURE, psi	**289.6**	Moisture Content, %	31.1
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	118.4
		Dry Unit Weight, pcf.	90.3
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	7.3
0.20	14.6
0.30	25.0
0.40	35.4
0.50	50.2
0.75	91.0
1.00	136.1
1.25	170.8
1.50	199.8
1.75	229.2
2.00	258.8
2.26	277.1
2.51	287.2
2.76	287.1
3.01	288.5
3.13	289.6
3.26	254.3
3.51	42.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

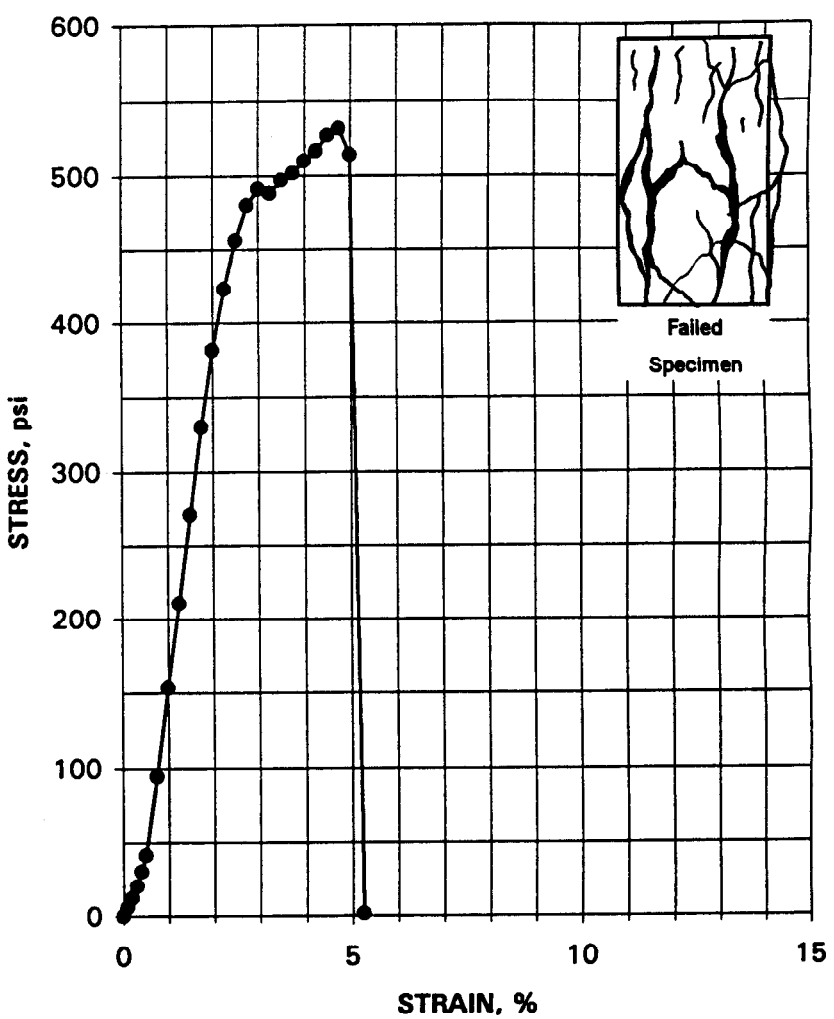
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C623F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7850

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9942
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0058
		Specimen Weight, g.	394.99
STRESS AT FAILURE, psi	**531.7**	Moisture Content, %	28.8
STRAIN AT FAILURE, %	**4.8**	Wet Unit Weight, pcf.	119.0
		Dry Unit Weight, pcf.	92.4
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	6.0
0.20	12.6
0.30	20.5
0.40	30.3
0.50	41.6
0.75	94.9
1.00	153.2
1.25	210.6
1.50	270.6
1.75	329.9
2.00	382.1
2.25	423.2
2.50	456.0
2.75	480.1
3.00	491.4
3.25	488.0
3.51	496.8
3.76	501.6
4.01	509.4
4.26	516.6
4.51	526.7
4.76	531.7
5.01	514.1
5.26	1.5



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

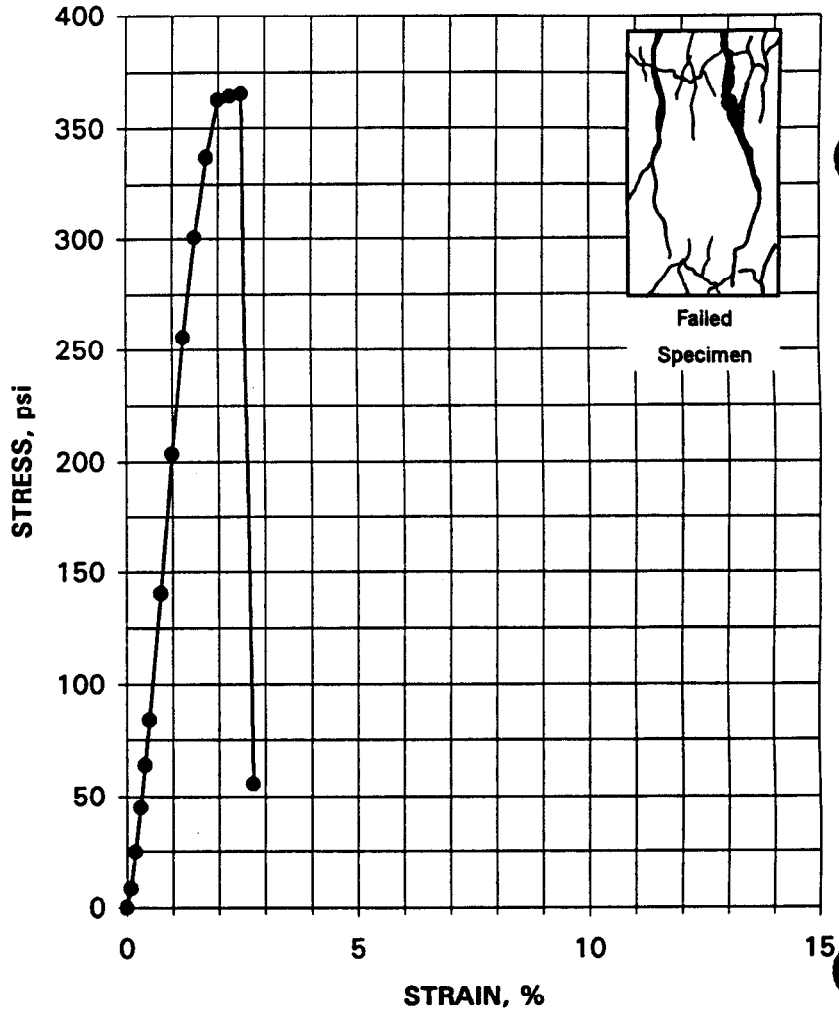
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C633F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7851

Specimen Mold Date	11/11/98	Specimen Height, in.	4.0198
Specimen Test Date	3/9/99	Specimen Diameter, in.	1.9993
		Specimen Weight, g.	376.10
STRESS AT FAILURE, psi	**365.2**	Moisture Content, %	37.2
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	113.0
		Dry Unit Weight, pcf.	82.3
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	8.3
0.20	24.8
0.30	44.8
0.40	64.1
0.50	84.3
0.75	140.4
1.00	203.4
1.25	255.4
1.50	300.6
1.74	336.8
1.99	362.4
2.24	364.0
2.49	365.2
2.74	55.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

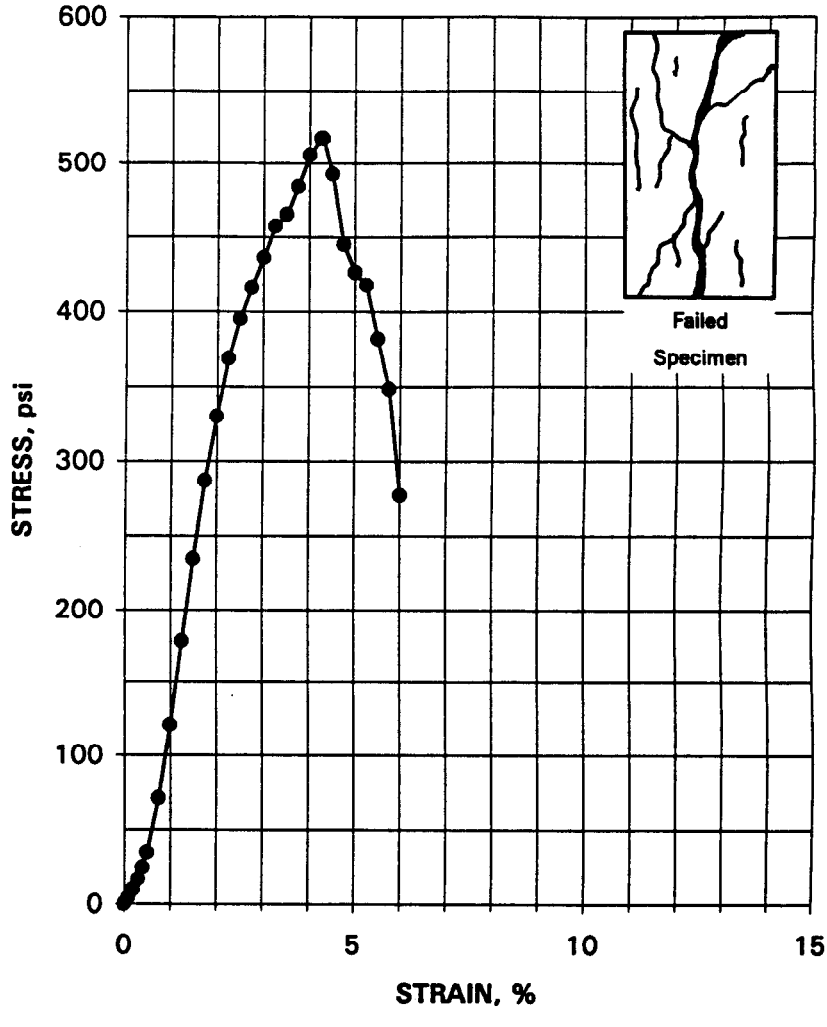
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY IMMERSION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	C634F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7852

Specimen Mold Date	11/11/98	Specimen Height, in.	3.9902
Specimen Test Date	3/9/99	Specimen Diameter, in.	2.0082
		Specimen Weight, g.	382.27
STRESS AT FAILURE, psi	**517.2**	Moisture Content, %	34.3
STRAIN AT FAILURE, %	**4.3**	Wet Unit Weight, pcf.	116.1
		Dry Unit Weight, pcf.	86.4
		Rate of Strain, in./min.	0.0360

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.1
0.20	9.8
0.30	16.7
0.40	24.8
0.50	34.9
0.75	71.4
1.00	120.6
1.25	178.3
1.50	234.2
1.75	286.6
2.00	329.8
2.26	368.8
2.51	395.2
2.76	416.0
3.01	436.4
3.26	457.2
3.51	465.5
3.76	484.4
4.01	505.5
4.26	517.2
4.31	517.2
4.51	492.6
4.76	445.3
5.01	426.2
5.26	417.9
5.51	382.1



C Series
28 Day Expansion/Shrinkage Results

Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures ASTM D 3877

28-Day Cure

Geo Lab Sample No.	Knoxville Lab Sample No.	Expansion, %	Expansion Result	Shrinkage, %
ETDC-7821	C312K00	-0.049%	No expansion	-0.24
ETDC-7822	C322K00	-0.280%	No expansion	Insufficient sample
ETDC-7823	C332K00	-0.007%	No expansion	-1.34
ETDC-7824	C342K00	-0.027%	No expansion	-1.36
ETDC-7825	C412K00	-0.033%	No expansion	Insufficient sample
ETDC-7826	C422K00	-0.063%	No expansion	-0.79
ETDC-7827	C432K00	-0.299%	No expansion	-1.35
ETDC-7828	C442K00	Insufficient sample	Not available	-2.29
ETDC-7829	C512K00	-0.168%	No expansion	-3.38
ETDC-7830	C522K00	-0.250%	No expansion	-0.44
ETDC-7831	C532K00	-0.048%	No expansion	-2.89
ETDC-7832	C542K00	-0.048%	No expansion	-1.09
ETDC-7833	C612K00	-0.035%	No expansion	-4.29
ETDC-7834	C622K00	-0.041%	No expansion	-0.71
ETDC-7835	C632K00	-0.123%	No expansion	-0.32
ETDC-7836	C642K00	-0.187%	No expansion	-1.01

C Series
28 Day Permeability Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

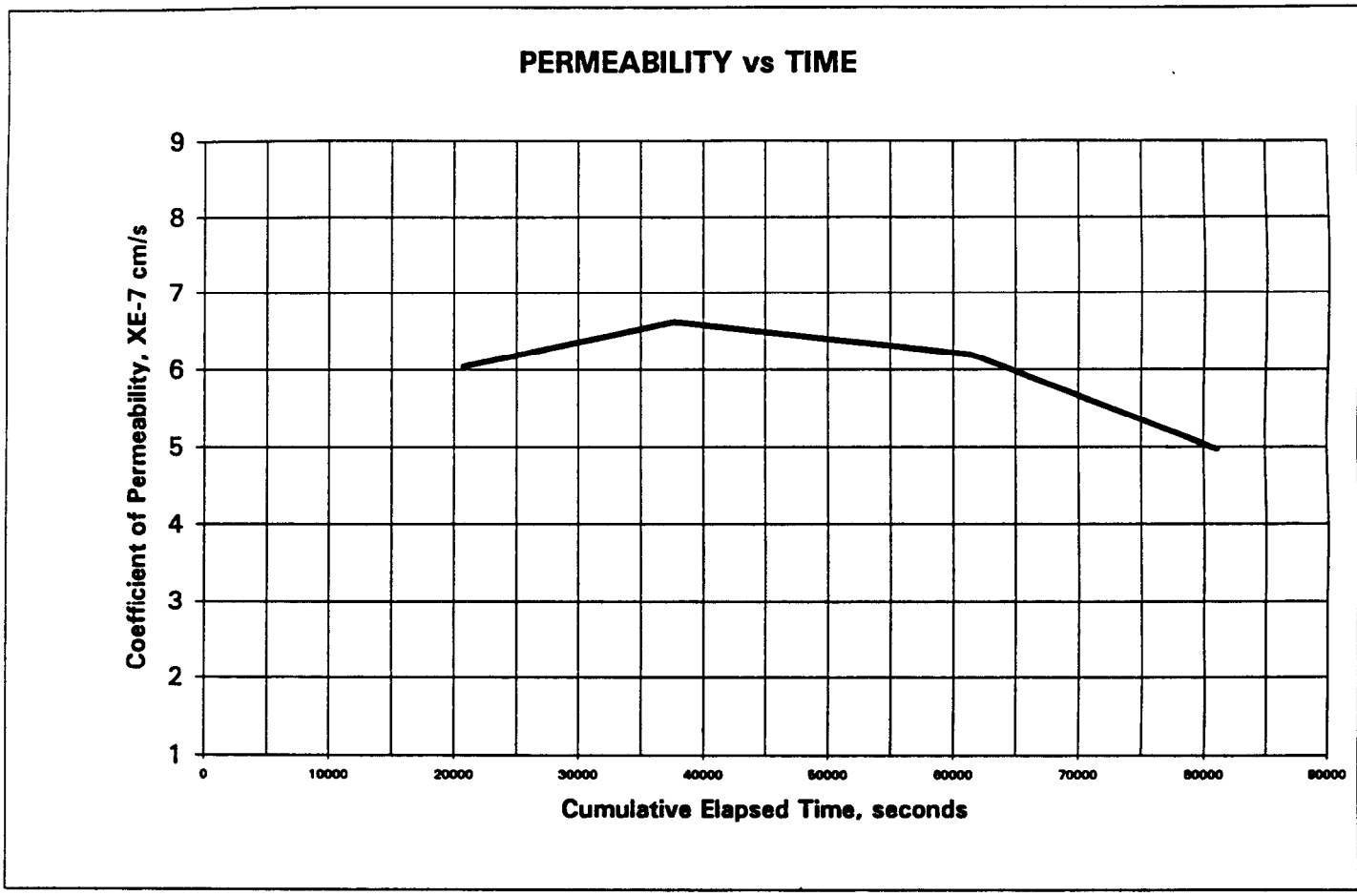
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C412G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7869

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	7.92		Hydraulic gradient	17.8
Wet weight of specimen, g.	651.85	660.19	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.2648		Max. consolidation stress, psi	4.0
Water content, %	31.1	33.9	Total backpressure, psi	2.0
Wet unit weight, pcf	113.5		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	86.6		Sample molded	11/11/98
Estimated degree of saturation, %	90.6		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Four tests performed	

Coefficient of Permeability, cm/s	6.0E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

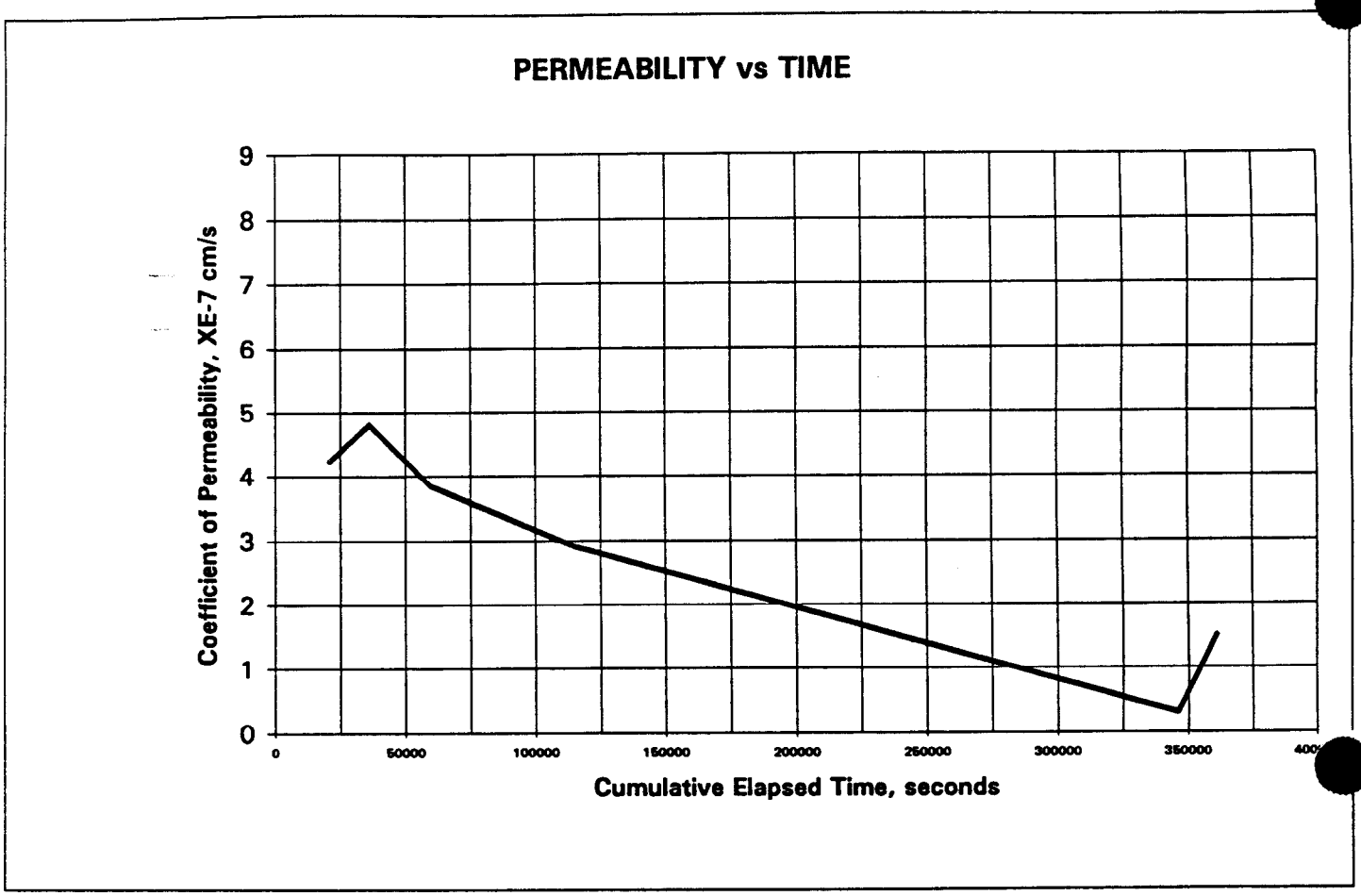
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C422G00
IT LAB SAMPLE NO. ETDC-7870

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	7.17	
Wet weight of specimen, g.	594.81	598.62
Specimen cross-sect. area, cm^2	45.1034	
Water content, %	30.2	27.6
Wet unit weight, pcf	114.8	
Dry unit weight, pcf	88.2	
Estimated degree of saturation, %	91.4	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	19.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	12/7/98
Six tests performed	

Coefficient of Permeability, cm/s 3.9E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

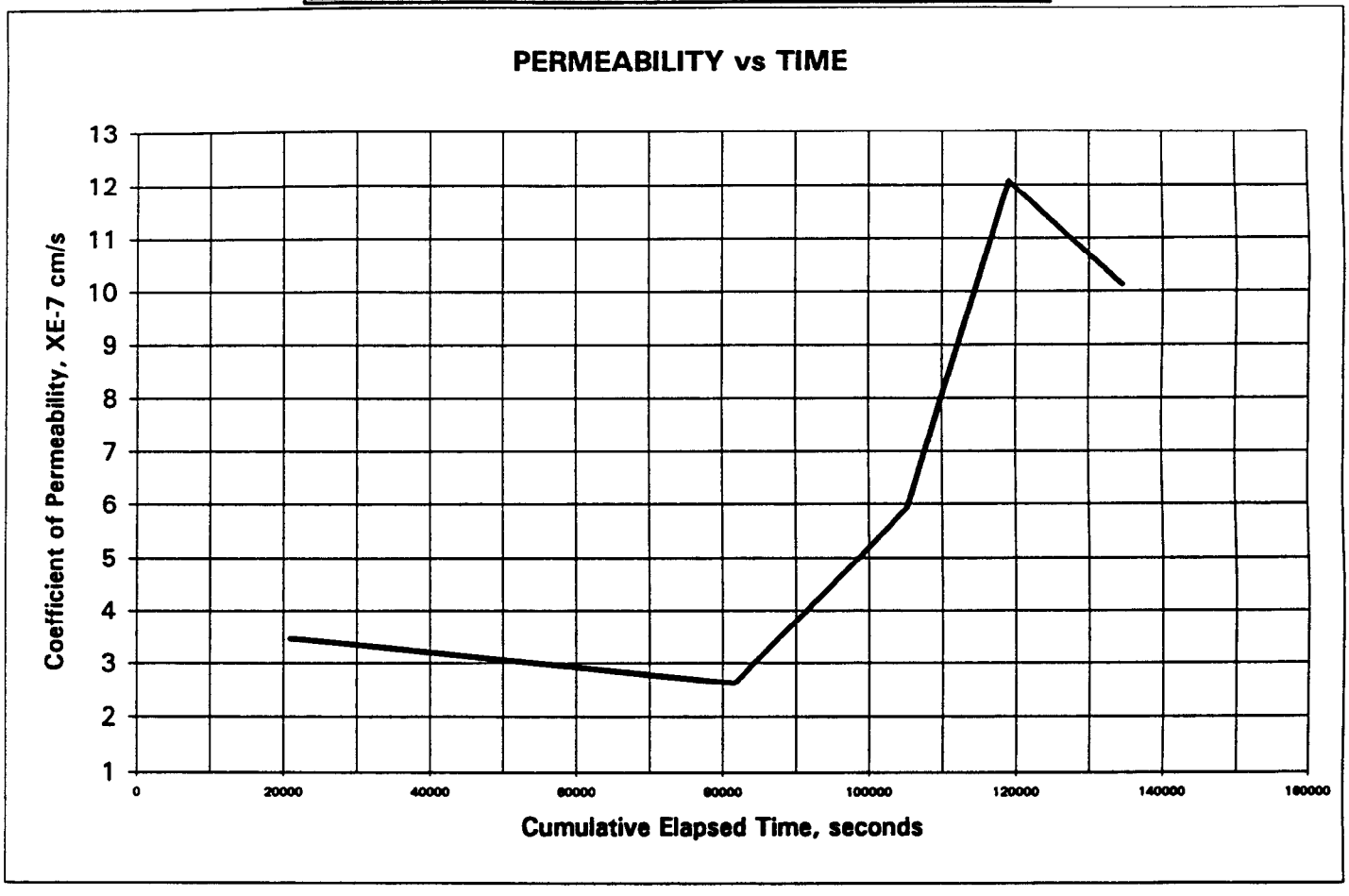
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C432G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7871

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	9.81		Hydraulic gradient	14.3
Wet weight of specimen, g.	776.04	785.5	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.2800		Max. consolidation stress, psi	4.0
Water content, %	38.2	40.7	Total backpressure, psi	2.0
Wet unit weight, pcf	109.1		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	78.9		Sample molded	11/11/98
Estimated degree of saturation, %	92.4		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Five tests performed	

Coefficient of Permeability, cm/s 4.0E-07



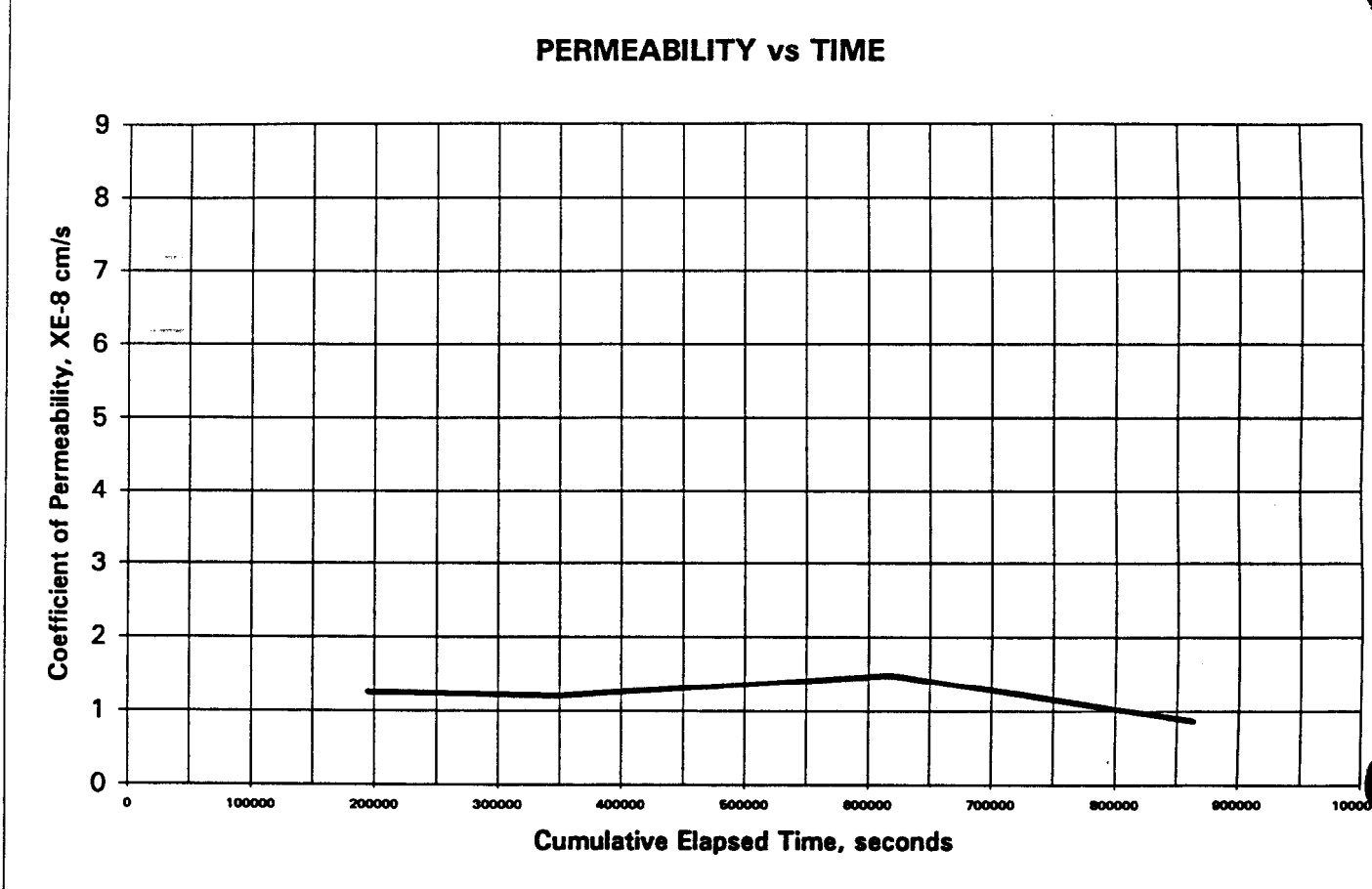
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C442G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7872

	INITIAL	FINAL		
Specimen diameter, cm	7.61			
Specimen length, cm	8.40		Hydraulic gradient	16.7
Wet weight of specimen, g.	668.3	675.68	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.5226		Max. consolidation stress, psi	4.0
Water content, %	37.7	39.2	Total backpressure, psi	2.0
Wet unit weight, pcf	109.0		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	79.2		Sample molded	11/11/98
Estimated degree of saturation, %	91.8		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Four tests performed	

Coefficient of Permeability, cm/s	1.2E-08



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

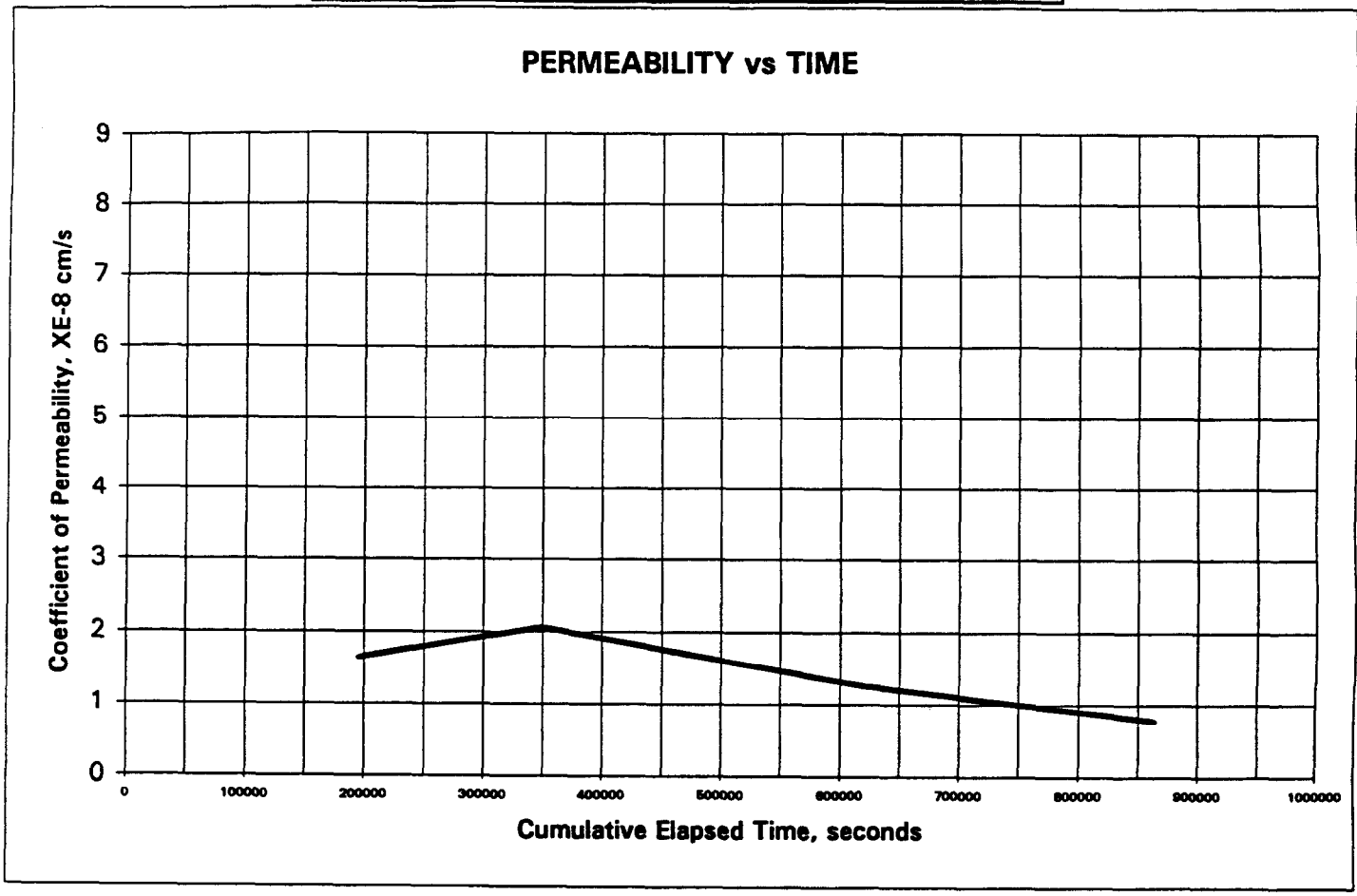
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C512G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7873

	INITIAL	FINAL		
Specimen diameter, cm	7.60			
Specimen length, cm	6.92		Hydraulic gradient	20.3
Wet weight of specimen, g.	580.86	585.75	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.4012		Max. consolidation stress, psi	5.0
Water content, %	28.6	30.3	Total backpressure, psi	2.0
Wet unit weight, pcf	115.4		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	89.8		Sample molded	11/11/98
Estimated degree of saturation, %	89.8		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Four tests performed	

Coefficient of Permeability, cm/s	1.7E-08



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

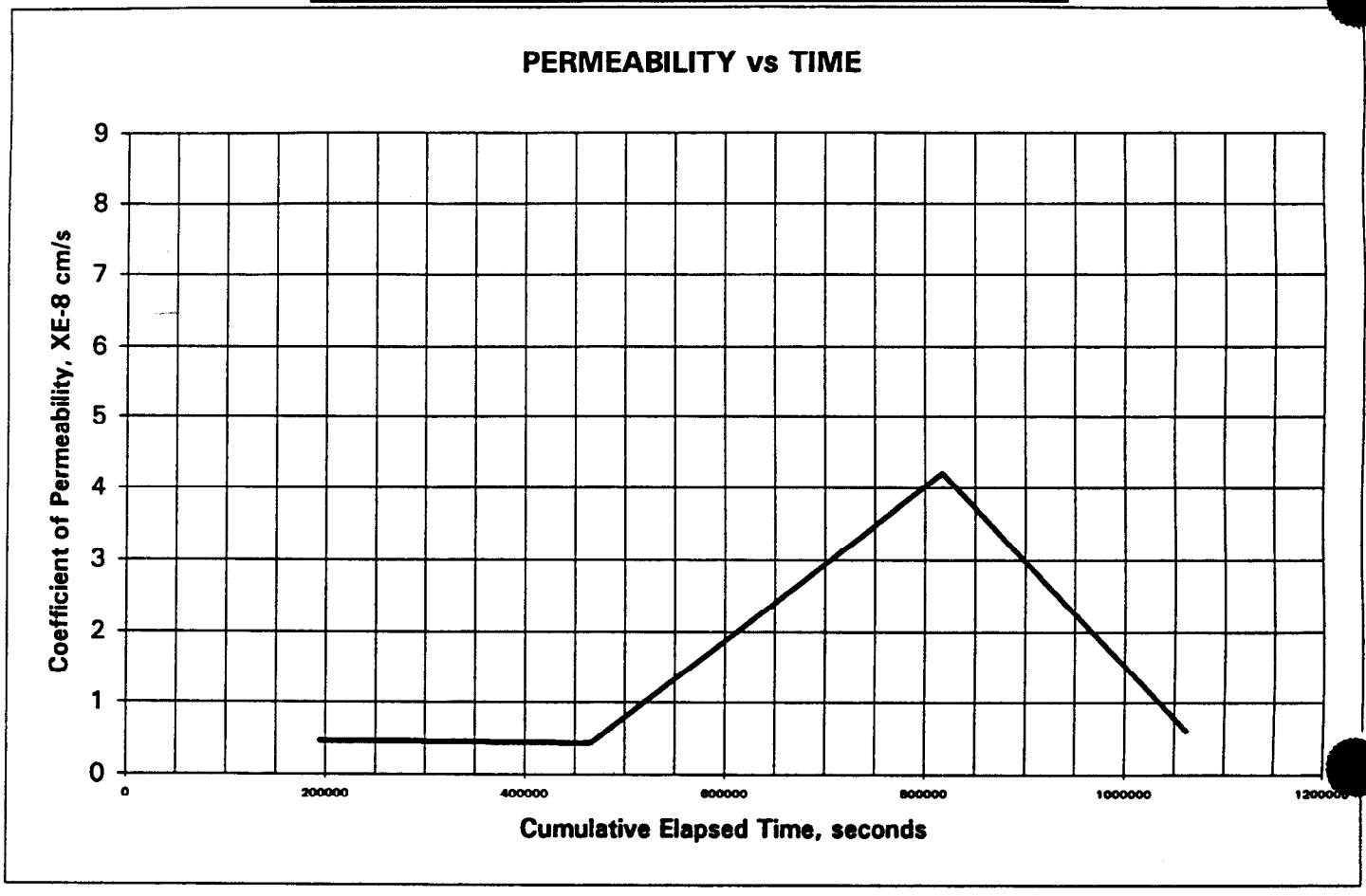
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C522G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7874

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	6.96		Hydraulic gradient	20.2
Wet weight of specimen, g.	591.87	597.48	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.2194		Max. consolidation stress, psi	5.0
Water content, %	24.7	28.7	Total backpressure, psi	2.0
Wet unit weight, pcf	117.4		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	94.1		Sample molded	11/11/98
Estimated degree of saturation, %	86.4		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Four tests performed	

Coefficient of Permeability, cm/s 1.4E-08



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

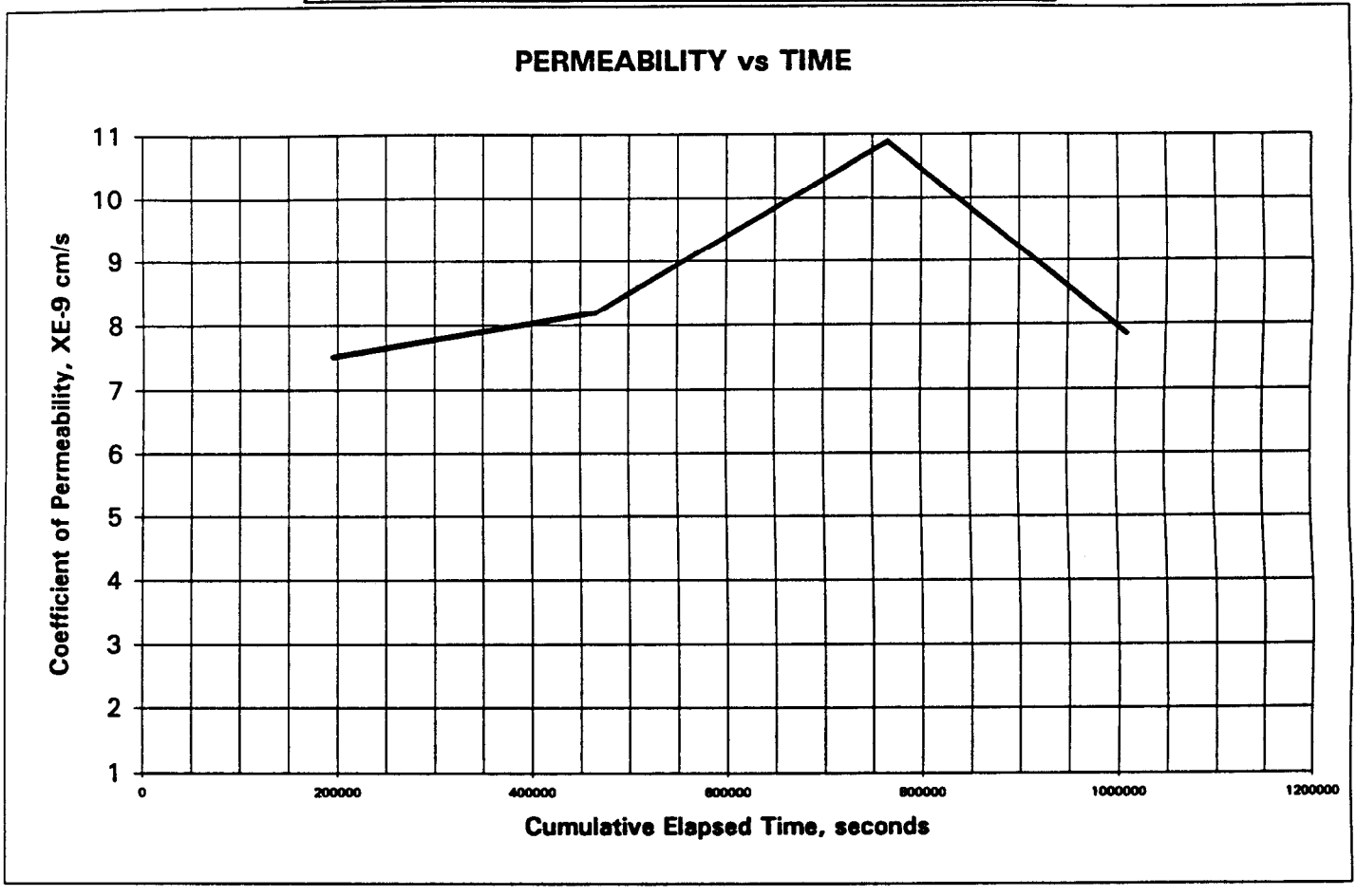
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C532G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7875

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	9.16	
Wet weight of specimen, g.	752.54	759.62
Specimen cross-sect. area, cm^2	45.2497	
Water content, %	33.2	34.5
Wet unit weight, pcf	113.4	
Dry unit weight, pcf	85.1	
Estimated degree of saturation, %	93.3	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	15.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	12/7/98
Four tests performed	

Coefficient of Permeability, cm/s **8.6E-09**



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

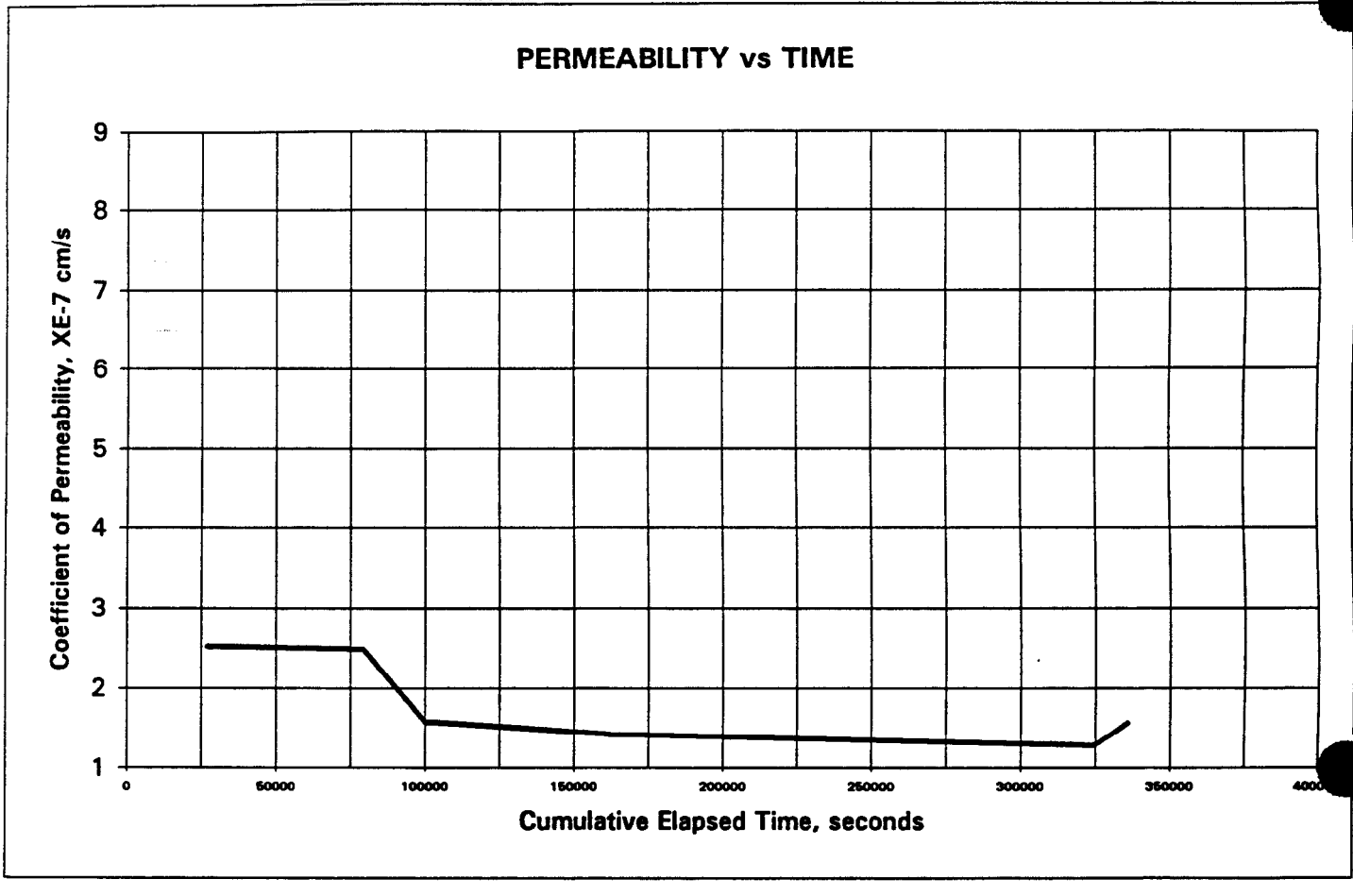
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C542G00
IT LAB SAMPLE NO. ETDC-7876

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	8.93	
Wet weight of specimen, g.	737.79	745.76
Specimen cross-sect. area, cm^2	45.3962	
Water content, %	31.5	33.3
Wet unit weight, pcf	113.6	
Dry unit weight, pcf	86.4	
Estimated degree of saturation, %	91.2	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	15.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	12/7/98
Six tests performed	

Coefficient of Permeability, cm/s 1.5E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

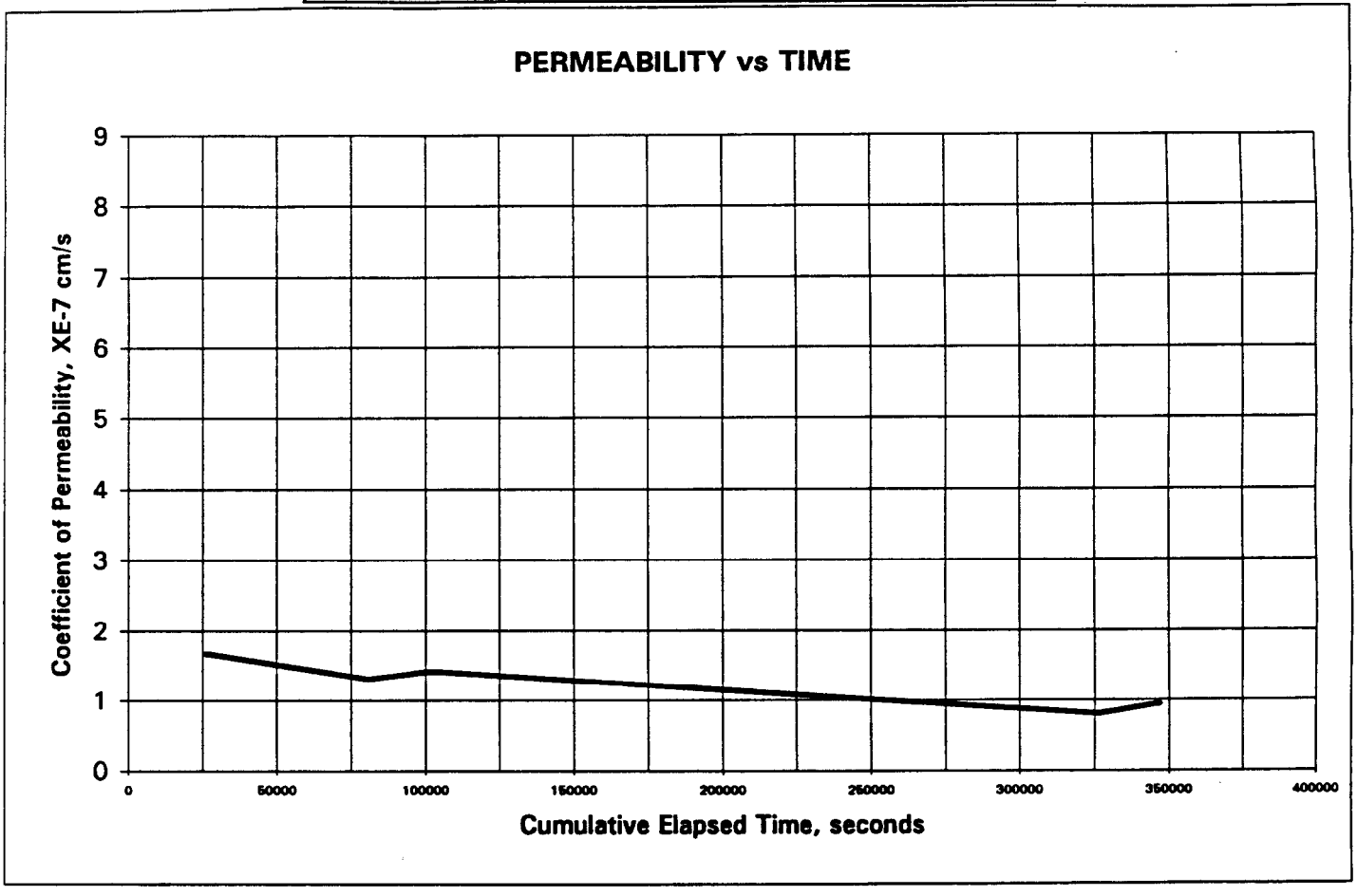
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C612G00
IT LAB SAMPLE NO. ETDC-7877

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	7.57	
Wet weight of specimen, g.	634.35	643.69
Specimen cross-sect. area, cm^2	45.0933	
Water content, %	24.5	31.1
Wet unit weight, pcf	116.0	
Dry unit weight, pcf	93.2	
Estimated degree of saturation, %	83.8	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	18.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	12/7/98
Five tests performed	

Coefficient of Permeability, cm/s 1.5E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

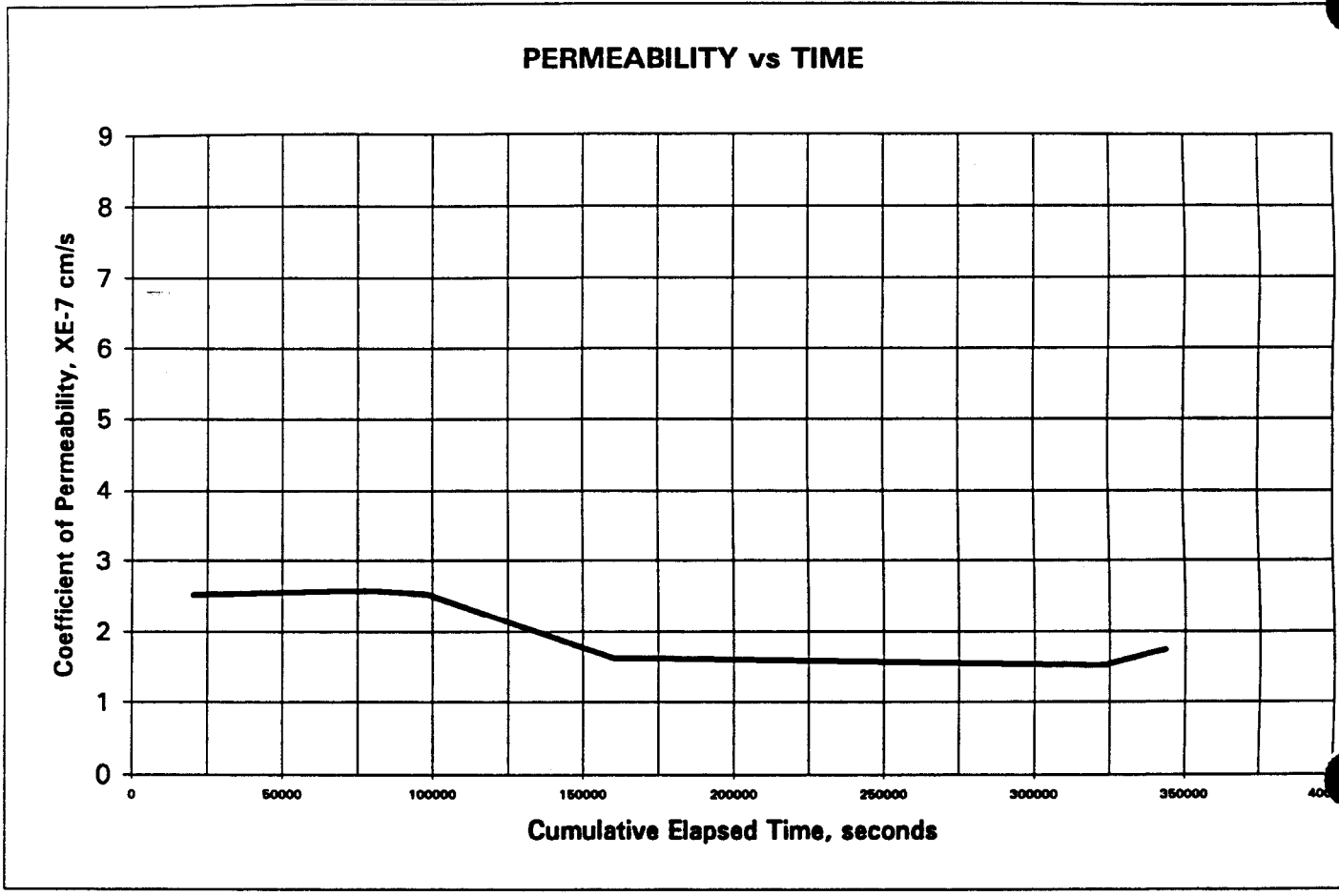
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C622G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7878

	INITIAL	FINAL		
Specimen diameter, cm	7.57			
Specimen length, cm	7.09		Hydraulic gradient	19.8
Wet weight of specimen, g.	563.94	610.48	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.0631		Max. consolidation stress, psi	4.0
Water content, %	18.9	28.8	Total backpressure, psi	2.0
Wet unit weight, pcf	110.1		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	92.6		Sample molded	11/11/98
Estimated degree of saturation, %	63.8		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Six tests performed	

Coefficient of Permeability, cm/s 2.3E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

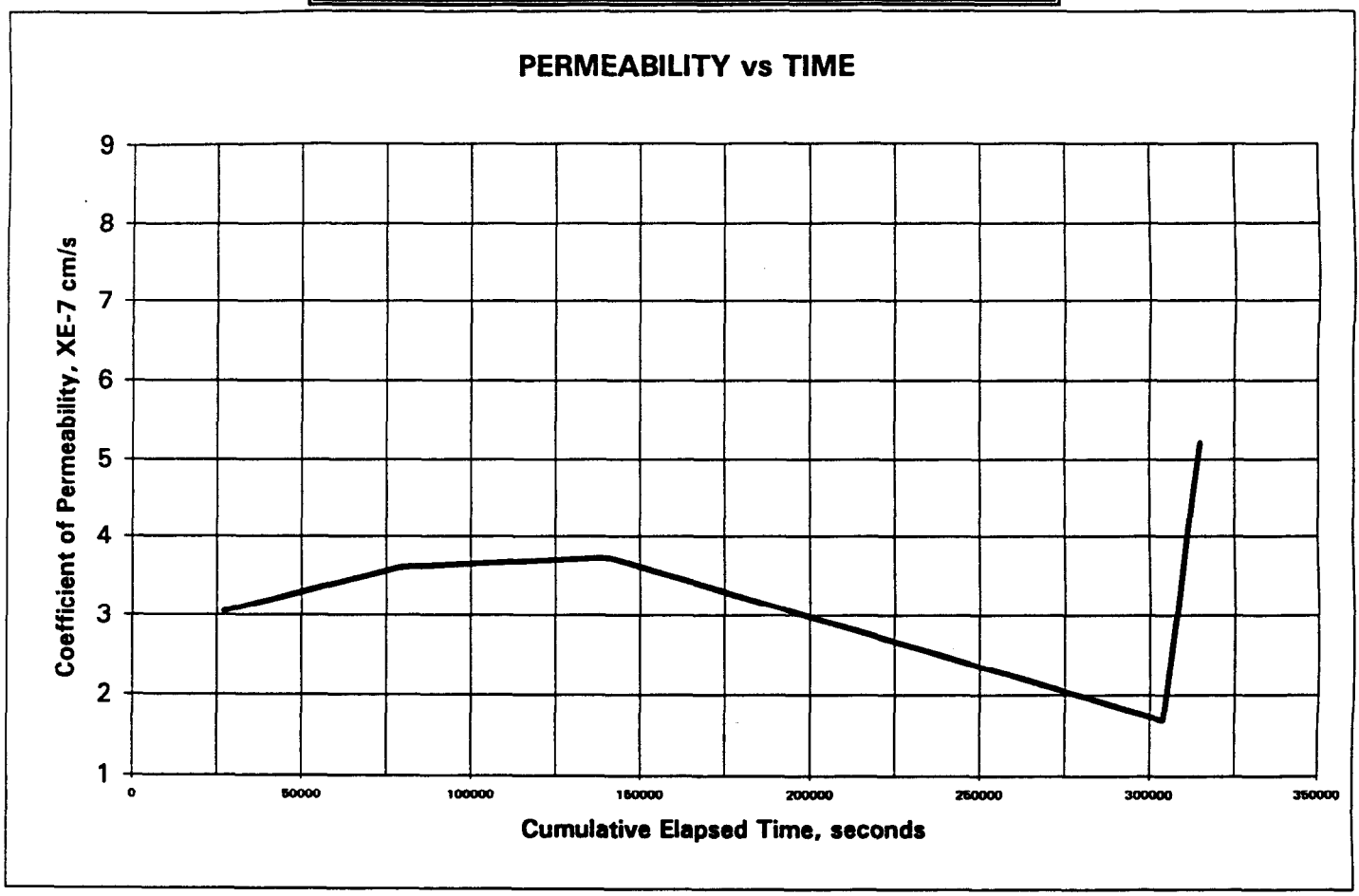
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C632G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7879

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	9.72		Hydraulic gradient	14.5
Wet weight of specimen, g.	800.91	812.2	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.2446		Max. consolidation stress, psi	4.0
Water content, %	32.3	34.8	Total backpressure, psi	2.0
Wet unit weight, pcf	113.7		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	85.9		Sample molded	11/11/98
Estimated degree of saturation, %	92.7		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Five tests performed	

Coefficient of Permeability, cm/s	3.0E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

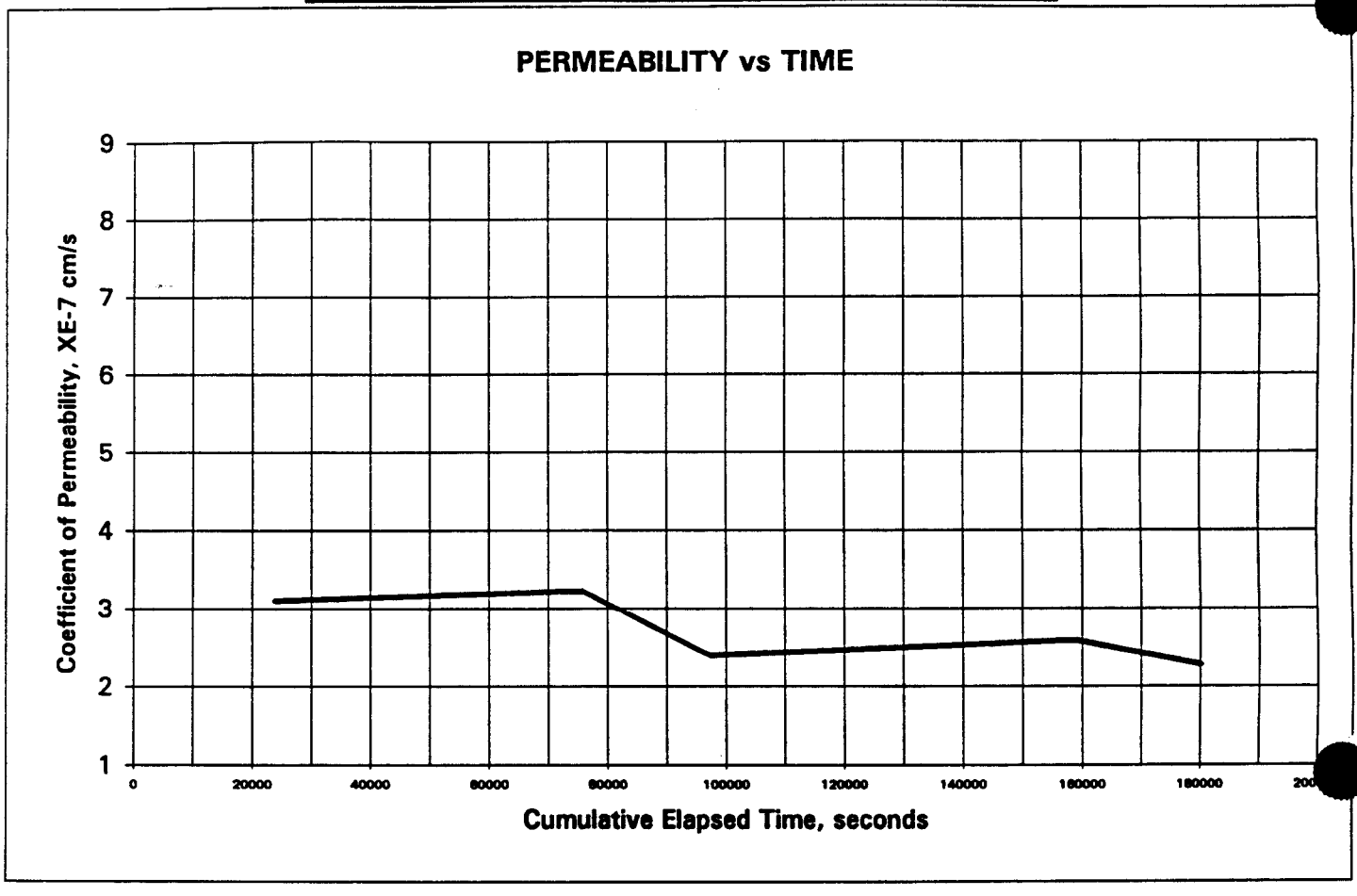
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C642G00
IT LAB SAMPLE NO. ETDC-7880

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	9.20		Hydraulic gradient	15.3
Wet weight of specimen, g.	759.35	768.13	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.3002		Max. consolidation stress, psi	5.0
Water content, %	26.8	34.1	Total backpressure, psi	2.0
Wet unit weight, pcf	113.8		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	89.7		Sample molded	11/11/98
Estimated degree of saturation, %	84.1		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Five tests performed	

Coefficient of Permeability, cm/s 2.8E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

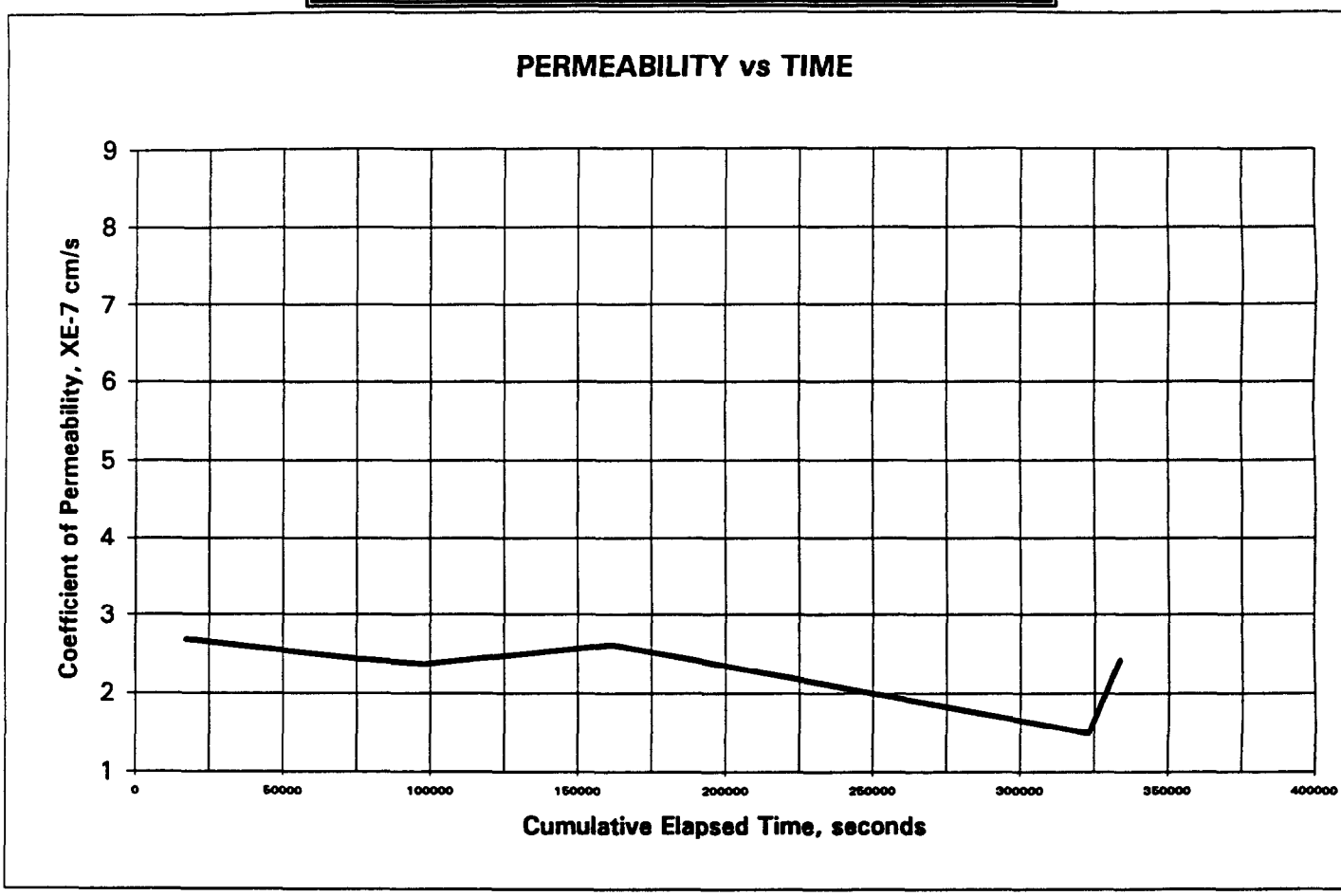
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C312G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7881

	INITIAL	FINAL		
Specimen diameter, cm	7.55			
Specimen length, cm	6.68		Hydraulic gradient	21.1
Wet weight of specimen, g.	572.19	572.23	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	44.7463		Max. consolidation stress, psi	4.0
Water content, %	26.9	30.3	Total backpressure, psi	2.0
Wet unit weight, pcf	119.4		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	94.1		Sample molded	11/11/98
Estimated degree of saturation, %	94.0		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Six tests performed	

Coefficient of Permeability, cm/s	2.5E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

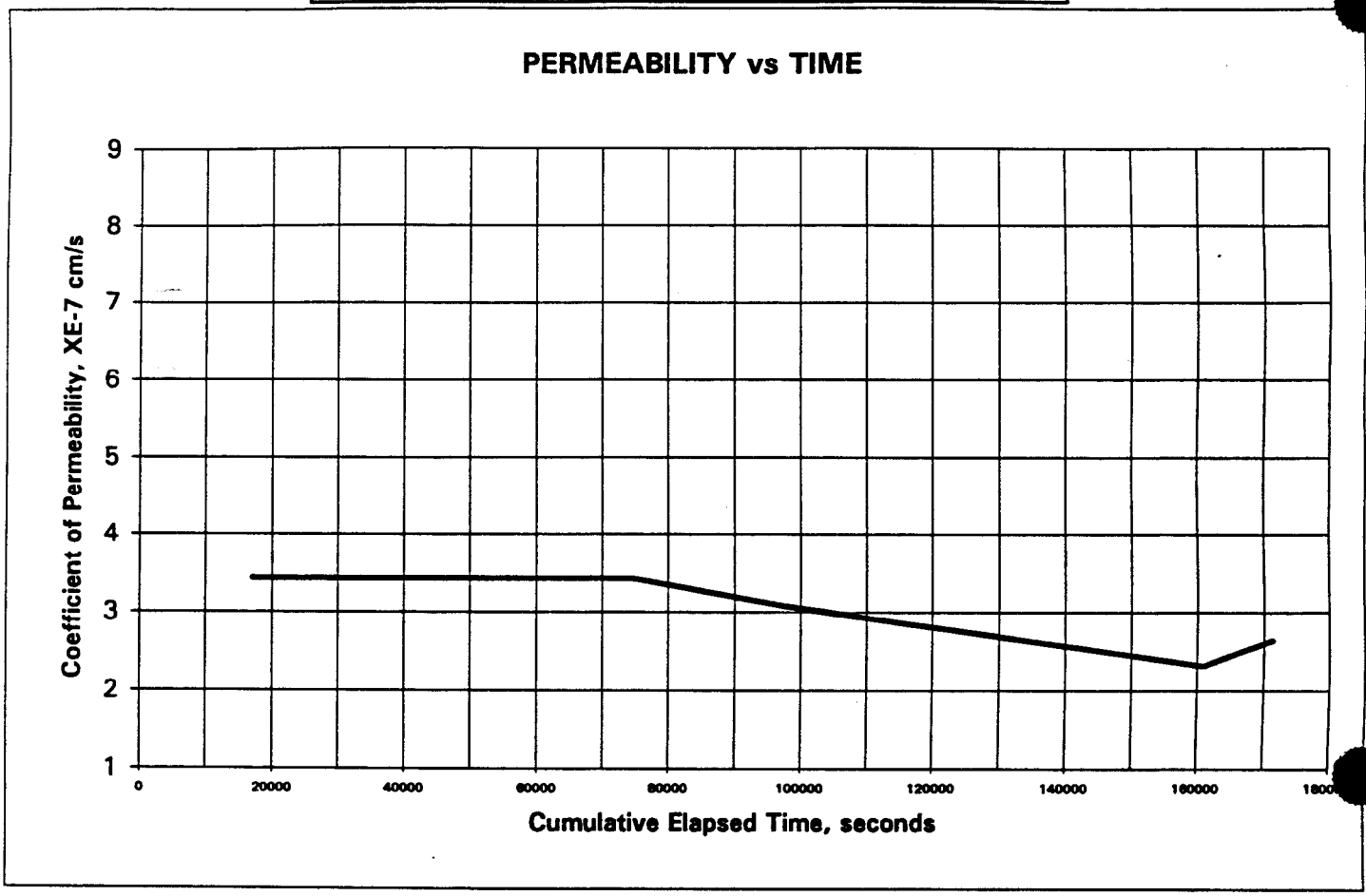
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C322G00
IT LAB SAMPLE NO. ETDC-7882

	INITIAL	FINAL		
Specimen diameter, cm	7.59			
Specimen length, cm	7.13		Hydraulic gradient	19.7
Wet weight of specimen, g.	611.92	617.94	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.1891		Max. consolidation stress, psi	4.0
Water content, %	23.8	27.5	Total backpressure, psi	2.0
Wet unit weight, pcf	118.5		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	95.7		Sample molded	11/11/98
Estimated degree of saturation, %	86.6		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Five tests performed	

Coefficient of Permeability, cm/s 3.1E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

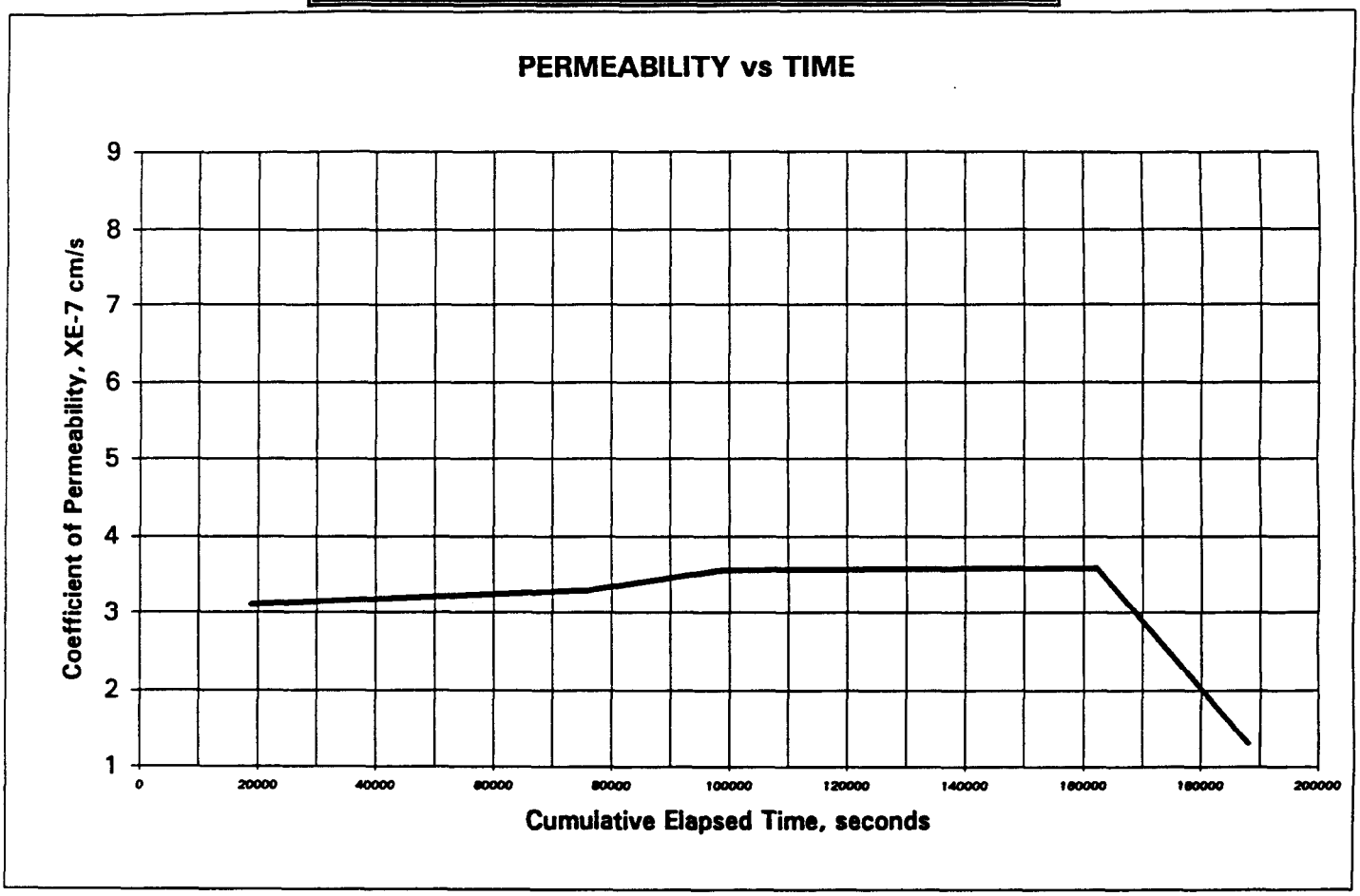
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C332G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7883

	INITIAL	FINAL		
Specimen diameter, cm	7.58			
Specimen length, cm	8.88		Hydraulic gradient	15.8
Wet weight of specimen, g.	727.73	736.88	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.1337		Max. consolidation stress, psi	4.0
Water content, %	33.4	34.9	Total backpressure, psi	2.0
Wet unit weight, pcf	113.3		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	85.0		Sample molded	11/11/98
Estimated degree of saturation, %	93.4		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Five tests performed	

Coefficient of Permeability, cm/s	3.4E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

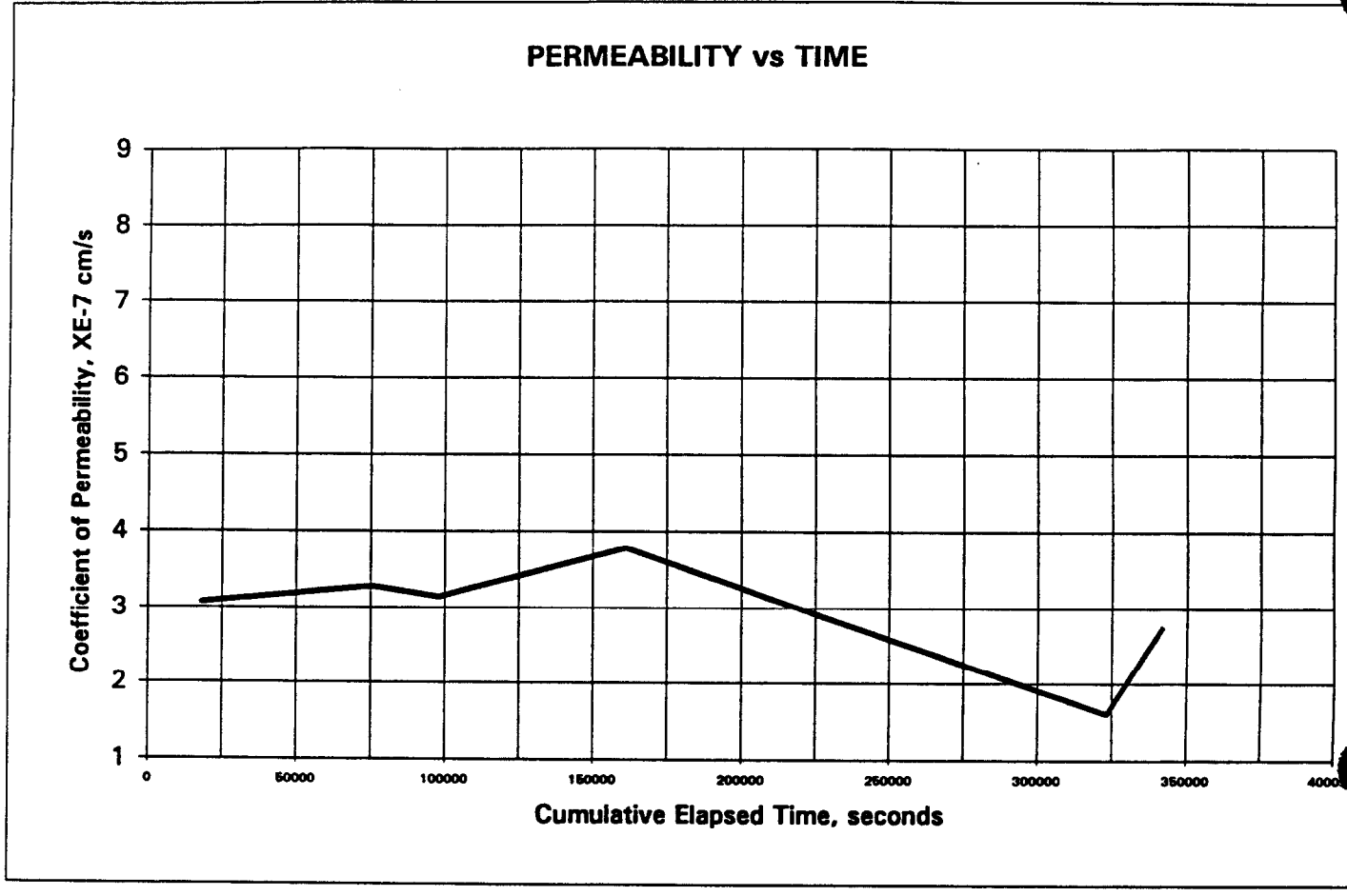
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C342G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7884

	INITIAL	FINAL		
Specimen diameter, cm	7.60			
Specimen length, cm	8.79		Hydraulic gradient	16.0
Wet weight of specimen, g.	732.89	739.85	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.3103		Max. consolidation stress, psi	4.0
Water content, %	29.2	32.9	Total backpressure, psi	2.0
Wet unit weight, pcf	114.9		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	88.9		Sample molded	11/11/98
Estimated degree of saturation, %	89.9		Sample set up	12/7/98
Estimated spec. gravity of solids	2.65		Six tests performed	

Coefficient of Permeability, cm/s 3.3E-07



C Series
90 Day Immersion Permeability Results

Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

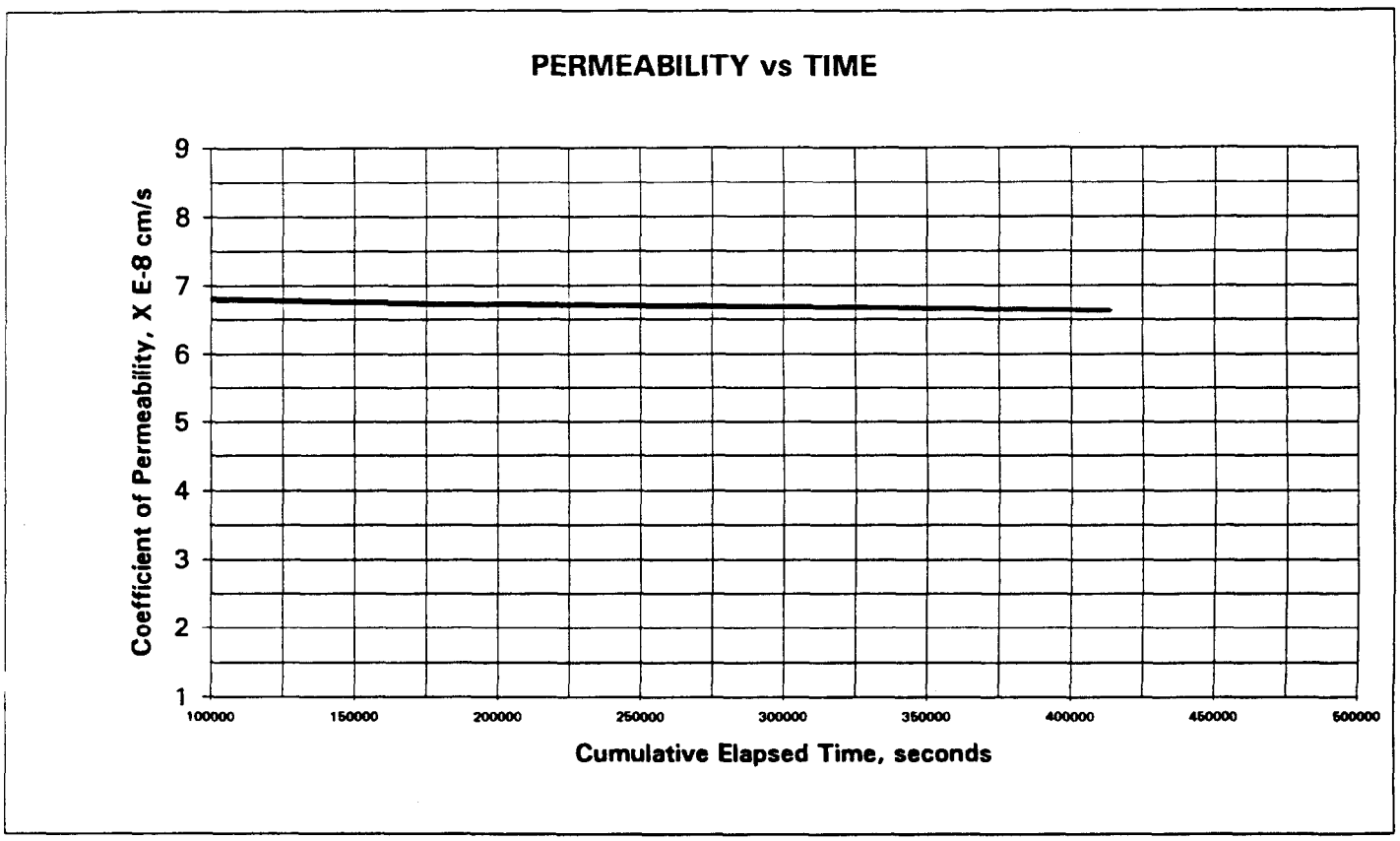
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C313G00
IT LAB SAMPLE NO. ETDC-7853

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.07	
Wet weight of specimen, g.	389.2	388.36
Specimen cross-sect. area, cm^2	20.2953	
Water content, %	31.1	30.8
Wet unit weight, pcf	118.9	
Dry unit weight, pcf	90.7	
Estimated degree of saturation, %	100.0	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Four tests performed	

Coefficient of Permeability, cm/s 6.7E-08



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED
HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

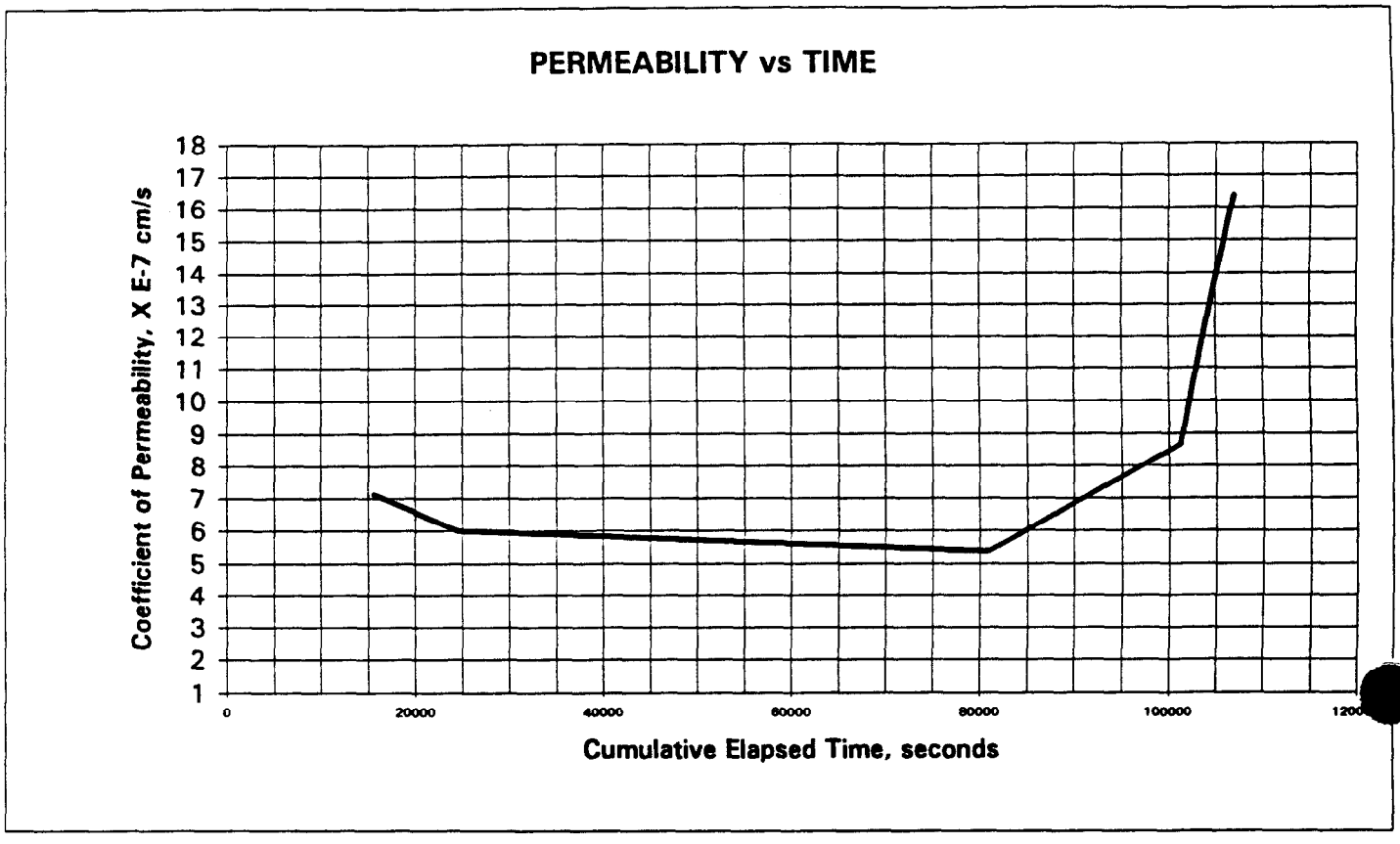
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C323G00
IT LAB SAMPLE NO. ETDC-7854

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.09	
Wet weight of specimen, g.	396.1	396.47
Specimen cross-sect. area, cm^2	20.4613	
Water content, %	28.0	28.1
Wet unit weight, pcf	119.7	
Dry unit weight, pcf	93.5	
Estimated degree of saturation, %	96.6	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Five tests performed	

Coefficient of Permeability, cm/s 6.2E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

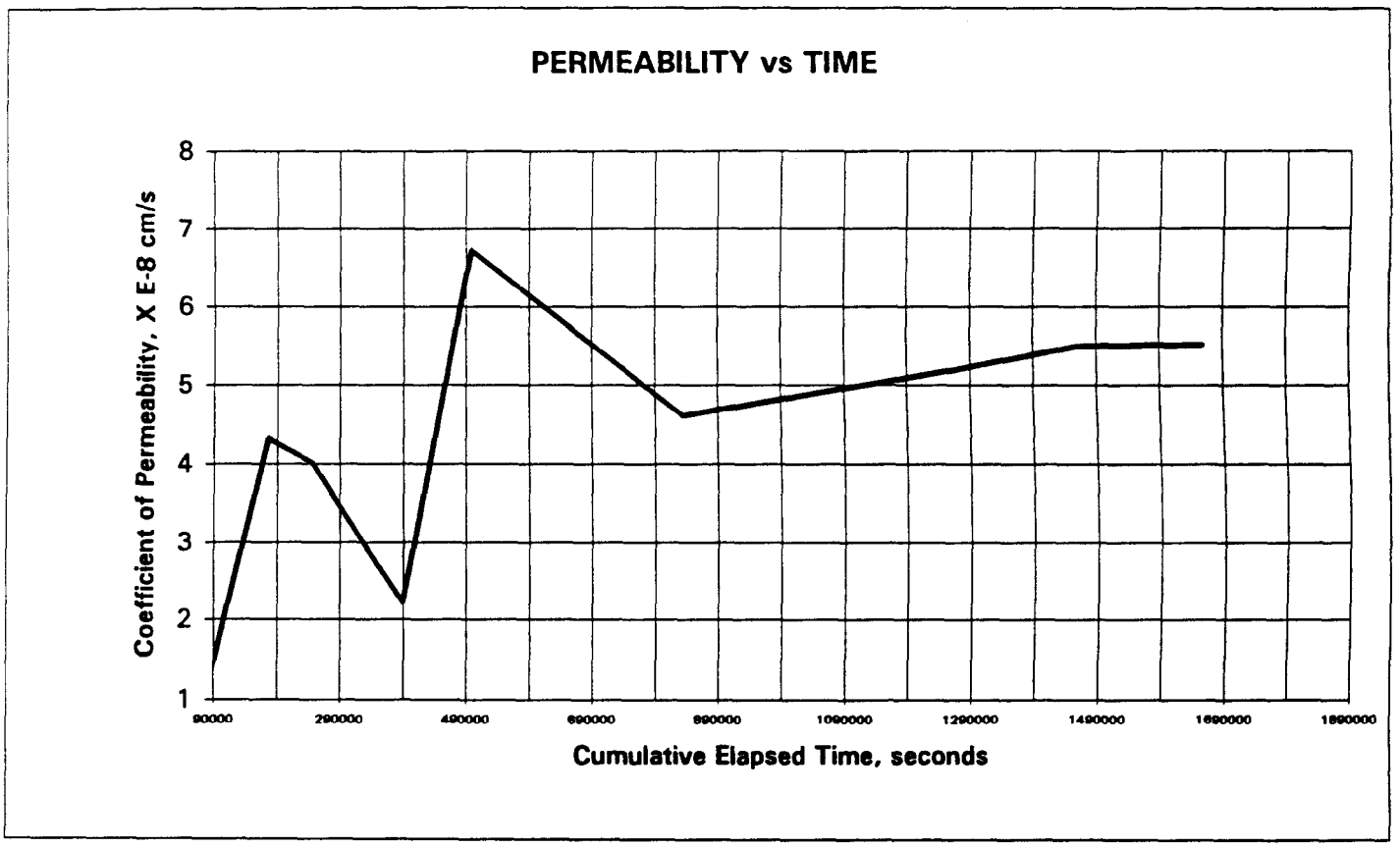
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C333G00
IT LAB SAMPLE NO. ETDC-7855

	INITIAL	FINAL
Specimen diameter, cm	5.04	
Specimen length, cm	10.11	
Wet weight of specimen, g.	376.7	376.3
Specimen cross-sect. area, cm^2	19.9520	
Water content, %	35.4	35.2
Wet unit weight, pcf	116.6	
Dry unit weight, pcf	86.1	
Estimated degree of saturation, %	101.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Nine tests performed	

Coefficient of Permeability, cm/s 5.2E-08



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED
HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

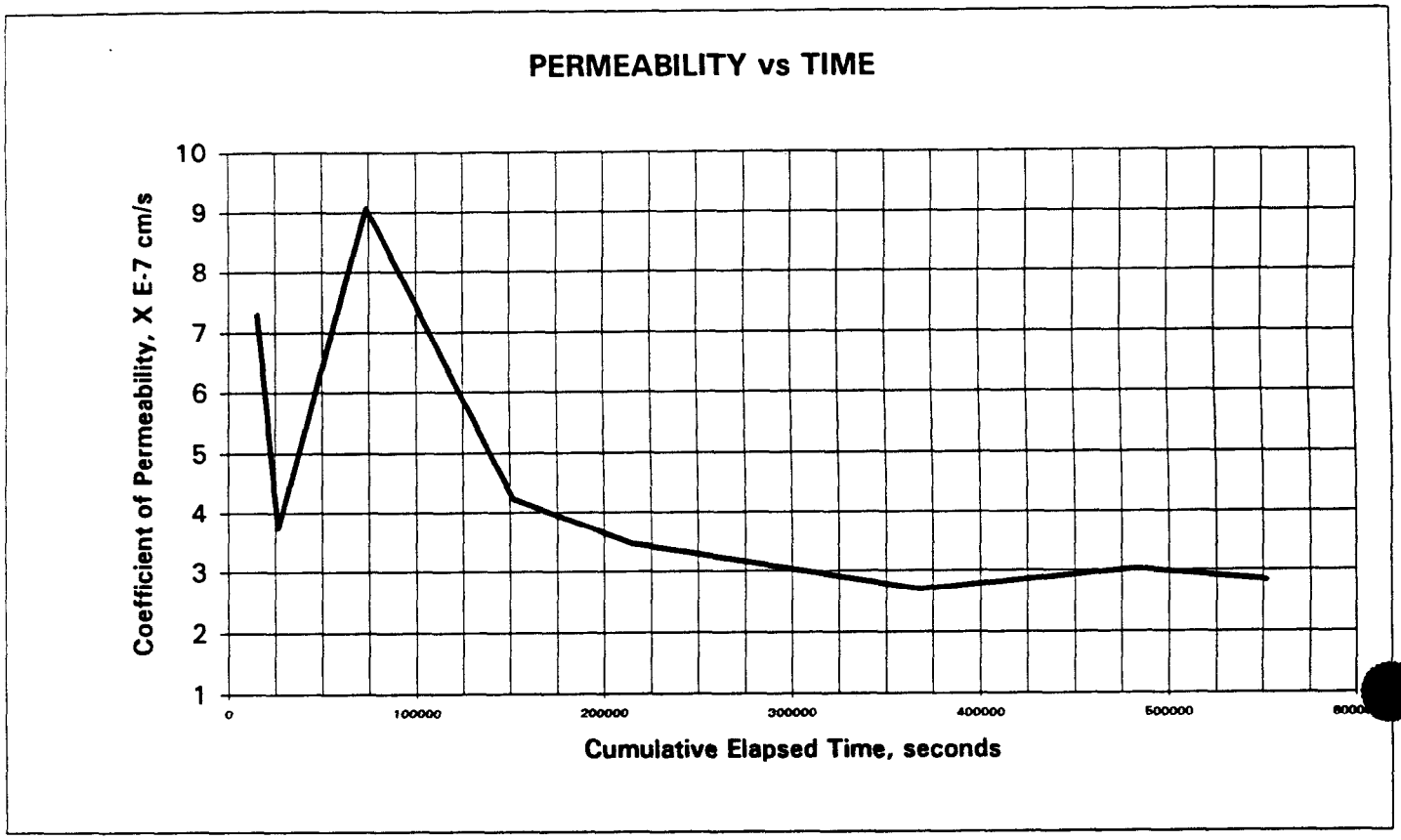
CLIENT SAMPLE NO. C343G00
IT LAB SAMPLE NO. ETDC-7856

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.11	
Wet weight of specimen, g.	383.39	383.72
Specimen cross-sect. area, cm^2	20.4376	
Water content, %	32.7	32.8
Wet unit weight, pcf	115.9	
Dry unit weight, pcf	87.3	
Estimated degree of saturation, %	96.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Eight tests performed	

Coefficient of Permeability, cm/s	3.0E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

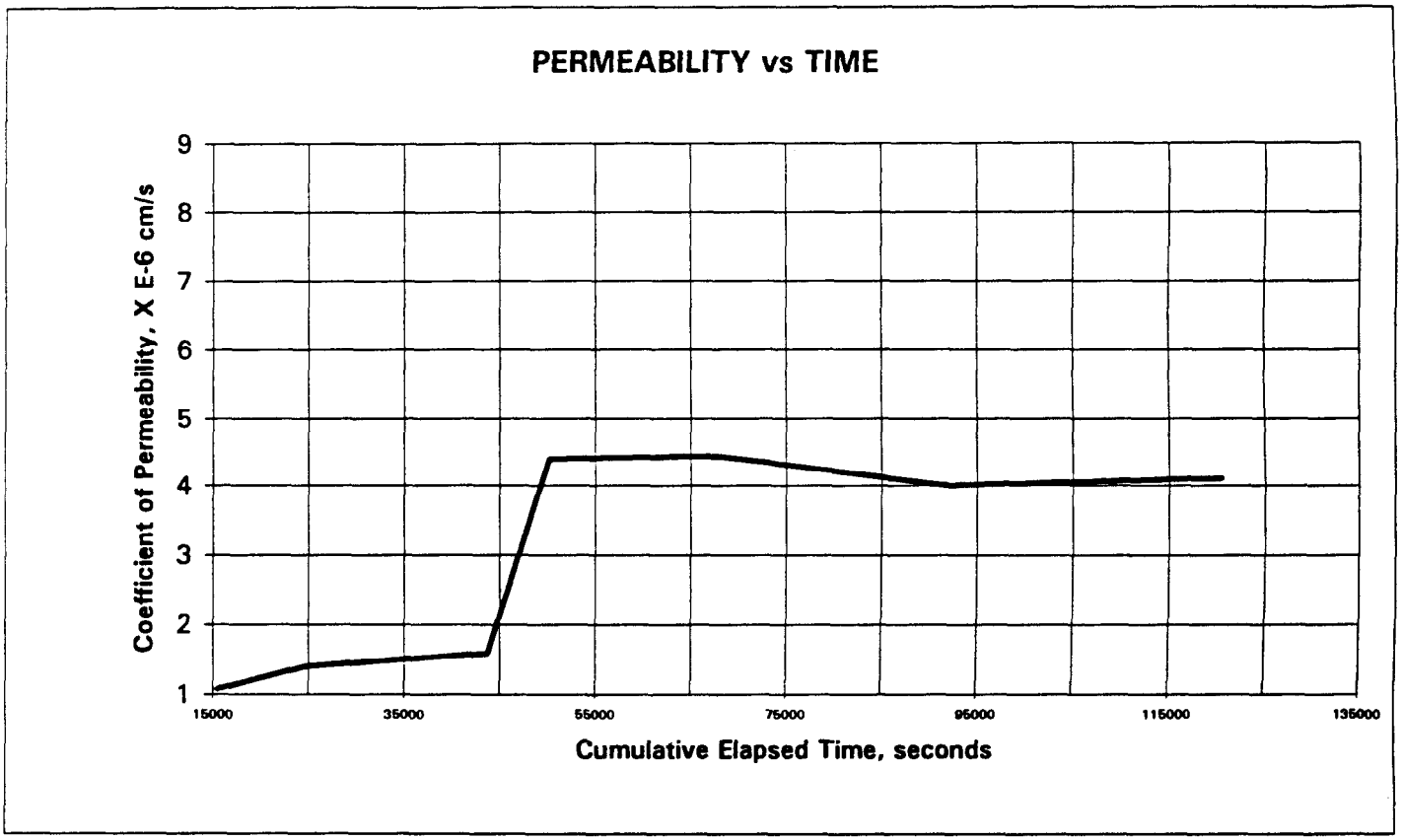
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C413G00
IT LAB SAMPLE NO. ETDC-7857

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.09	
Wet weight of specimen, g.	382.78	382.74
Specimen cross-sect. area, cm^2	20.3224	
Water content, %	34.7	34.6
Wet unit weight, pcf	116.6	
Dry unit weight, pcf	86.6	
Estimated degree of saturation, %	100.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Seven tests performed	

Coefficient of Permeability, cm/s 4.2E-06



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

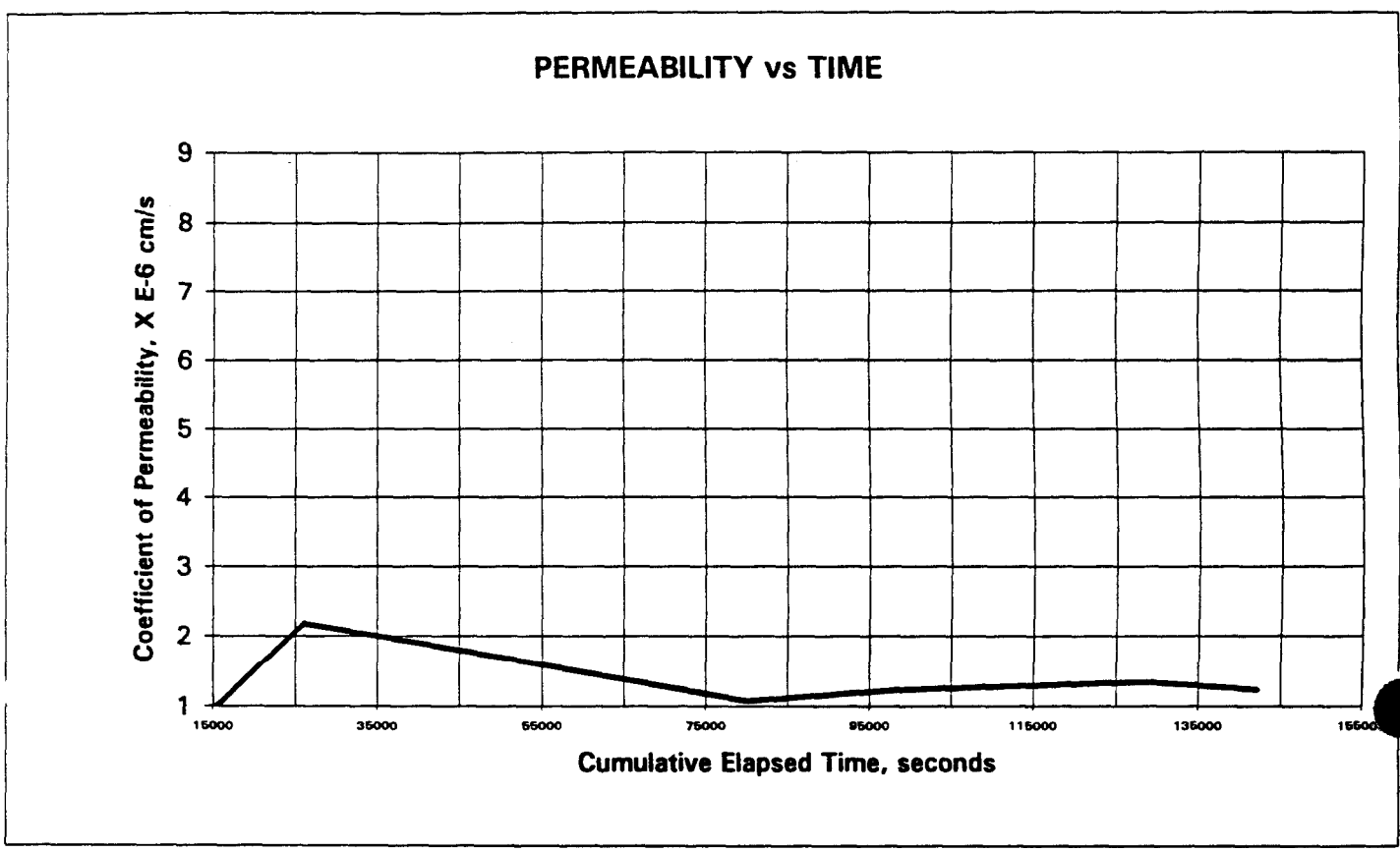
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C423G00
IT LAB SAMPLE NO. ETDC-7858

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.10	
Wet weight of specimen, g.	381.59	384.98
Specimen cross-sect. area, cm^2	20.4003	
Water content, %	31.5	32.7
Wet unit weight, pcf	115.6	
Dry unit weight, pcf	87.9	
Estimated degree of saturation, %	94.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Six tests performed	

Coefficient of Permeability, cm/s 1.2E-06



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

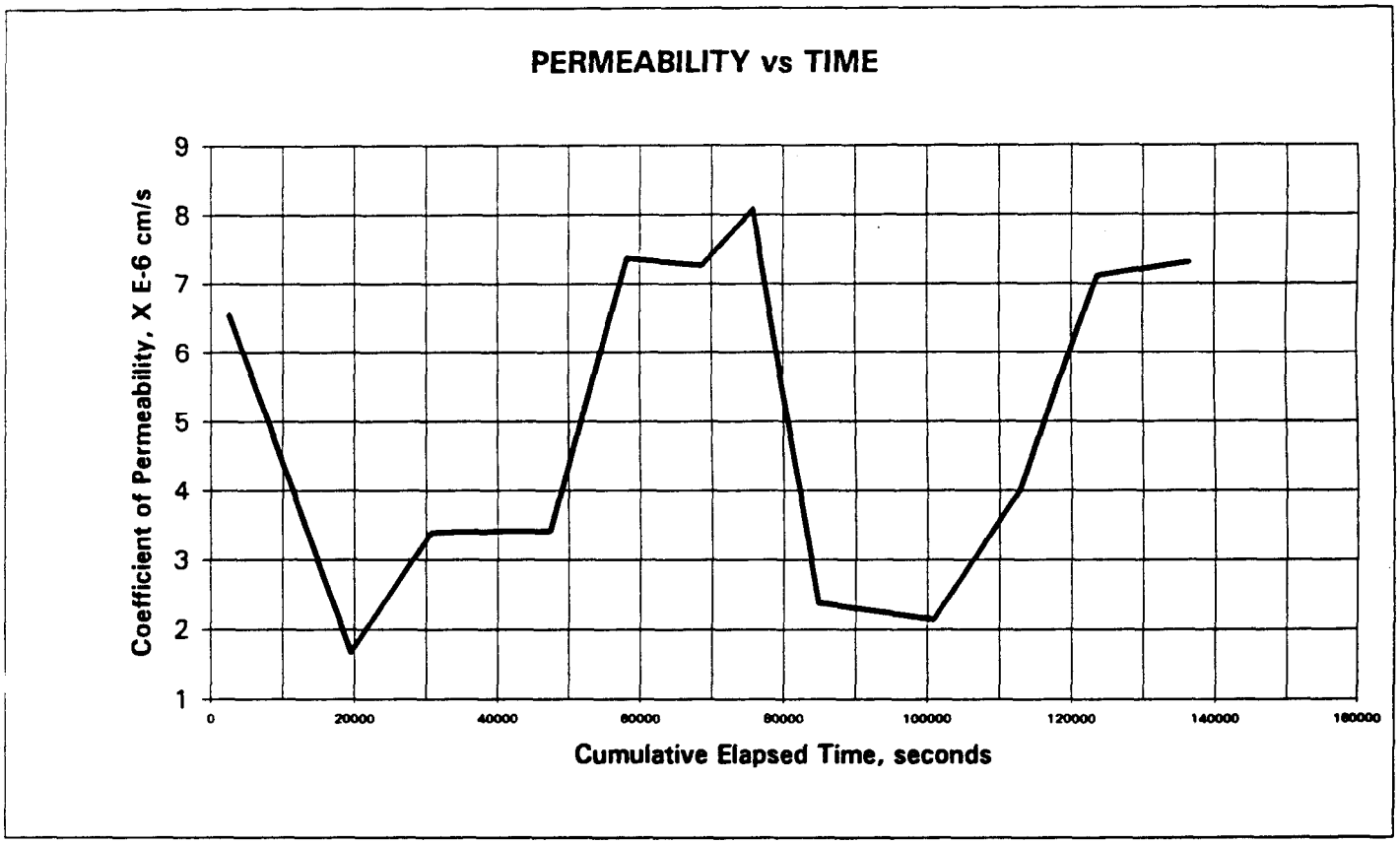
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C433G00
IT LAB SAMPLE NO. ETDC-7859

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.08	
Wet weight of specimen, g.	365.06	365.46
Specimen cross-sect. area, cm^2	20.4003	
Water content, %	40.9	41.0
Wet unit weight, pcf	110.9	
Dry unit weight, pcf	78.7	
Estimated degree of saturation, %	98.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Thirteen tests performed	

Coefficient of Permeability, cm/s 2.8E-06



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

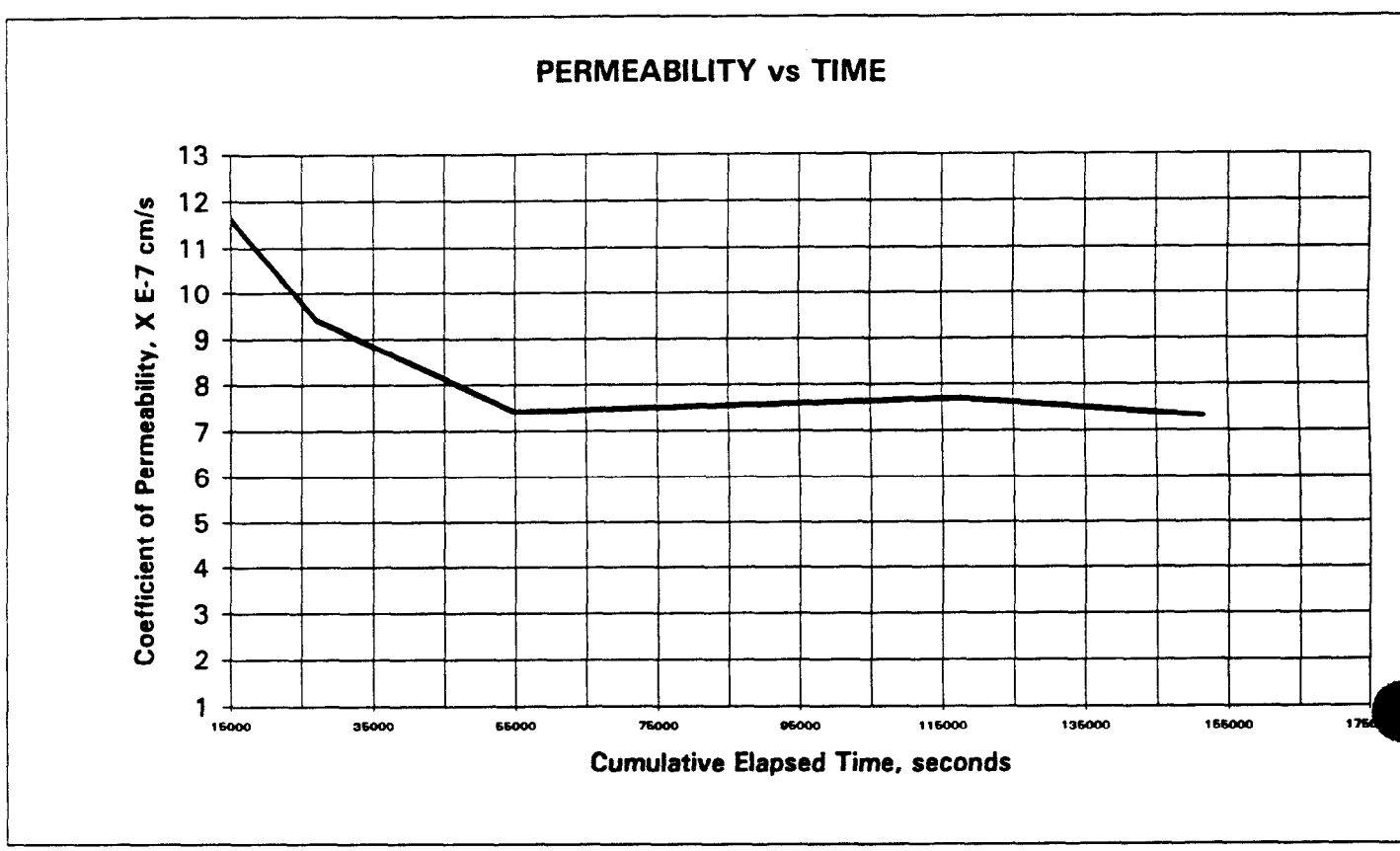
CLIENT SAMPLE NO. C443G00
IT LAB SAMPLE NO. ETDC-7860

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.09	
Wet weight of specimen, g.	373.42	373.29
Specimen cross-sect. area, cm^2	20.4342	
Water content, %	37.5	37.4
Wet unit weight, pcf	113.0	
Dry unit weight, pcf	82.2	
Estimated degree of saturation, %	98.1	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Five tests performed	

Coefficient of Permeability, cm/s 7.5E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

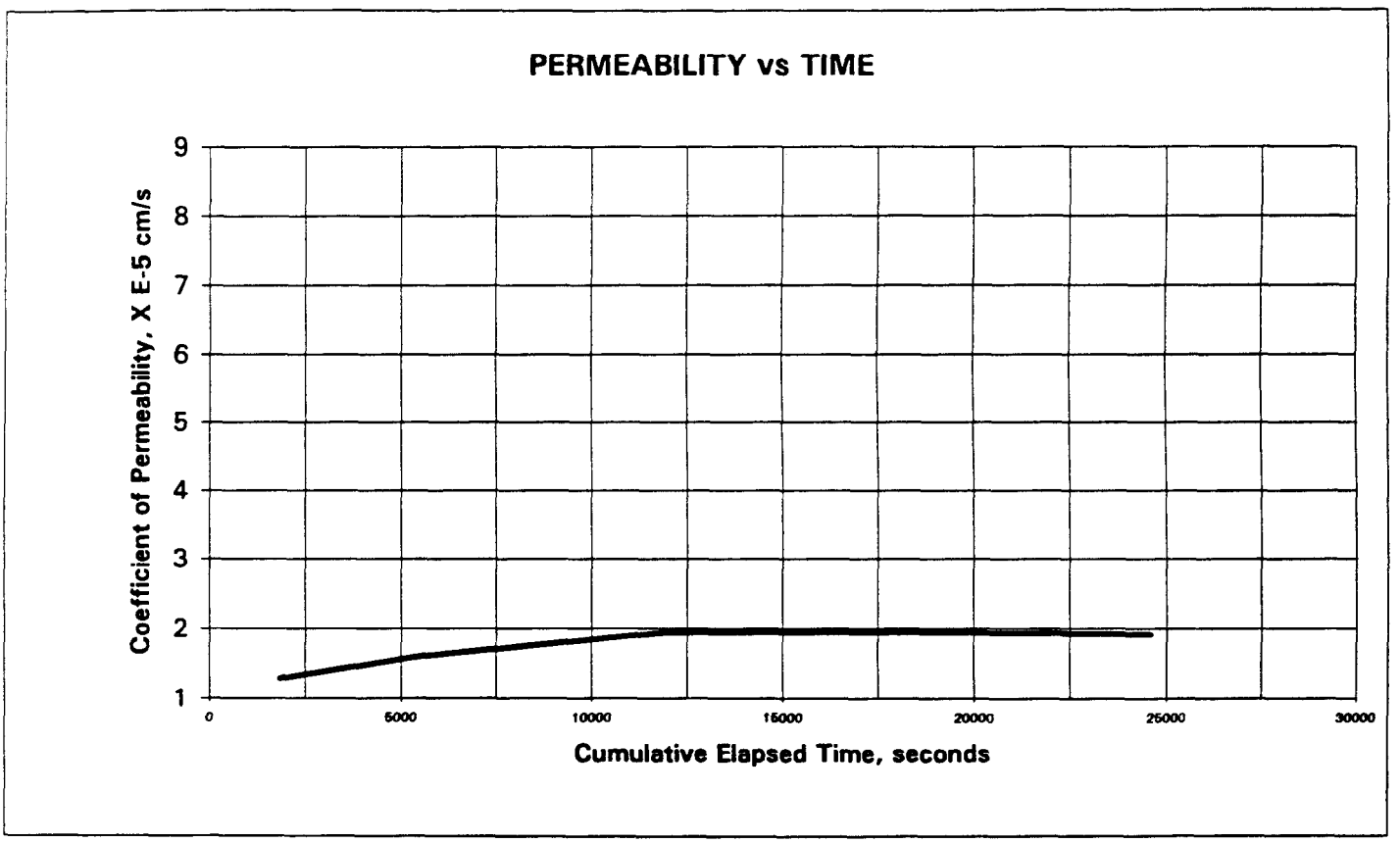
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C513G00
IT LAB SAMPLE NO. ETDC-7861

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.03	
Wet weight of specimen, g.	387.85	387.99
Specimen cross-sect. area, cm^2	20.3325	
Water content, %	31.7	31.7
Wet unit weight, pcf	118.7	
Dry unit weight, pcf	90.2	
Estimated degree of saturation, %	100.5	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	28.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Five tests performed	

Coefficient of Permeability, cm/s 1.8E-05



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

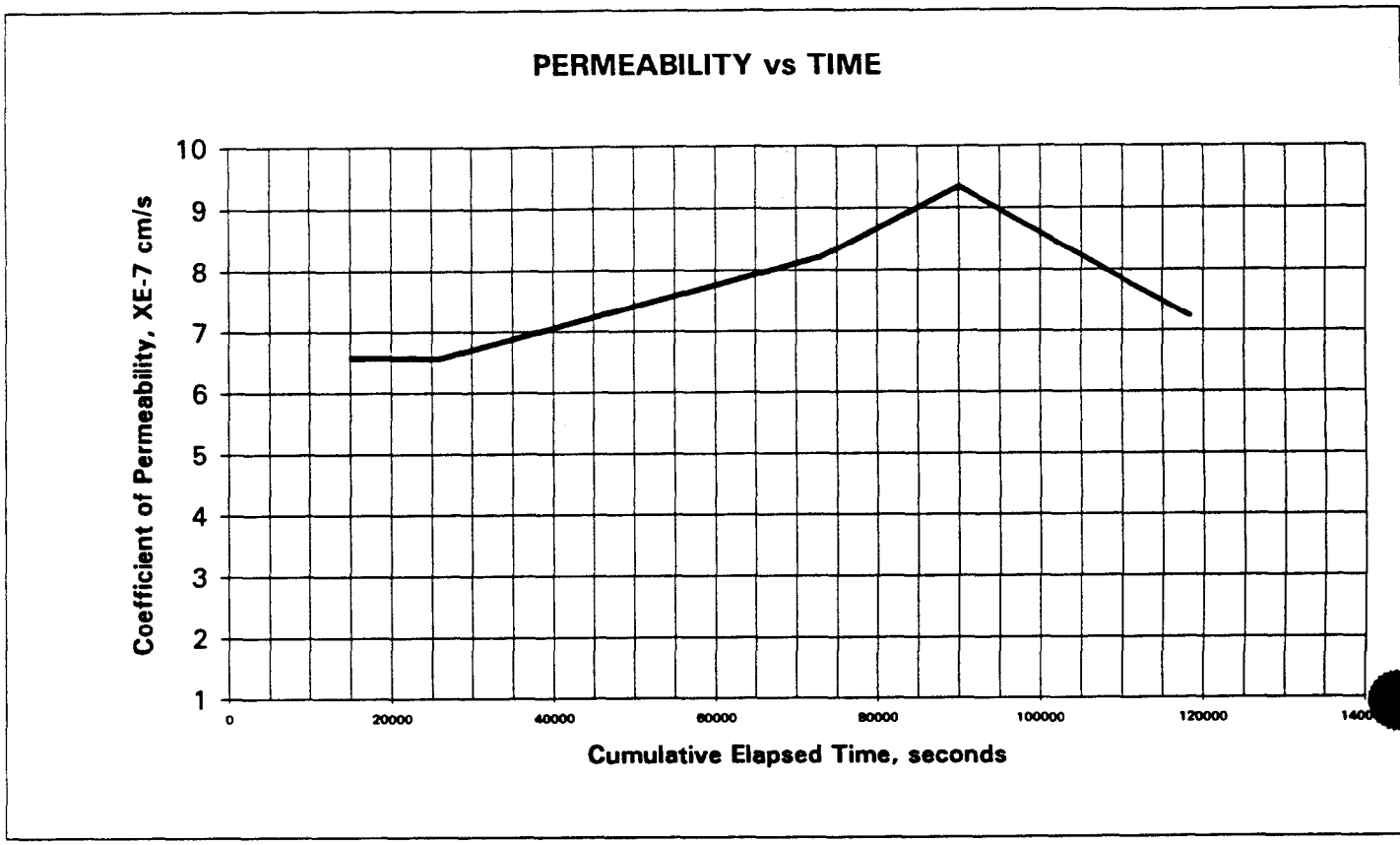
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C523G00
IT LAB SAMPLE NO. ETDC-7862

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.17	
Wet weight of specimen, g.	395.1	395.73
Specimen cross-sect. area, cm^2	20.3698	
Water content, %	28.9	29.1
Wet unit weight, pcf	119.1	
Dry unit weight, pcf	92.4	
Estimated degree of saturation, %	96.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Four tests performed	

Coefficient of Permeability, cm/s 7.7E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

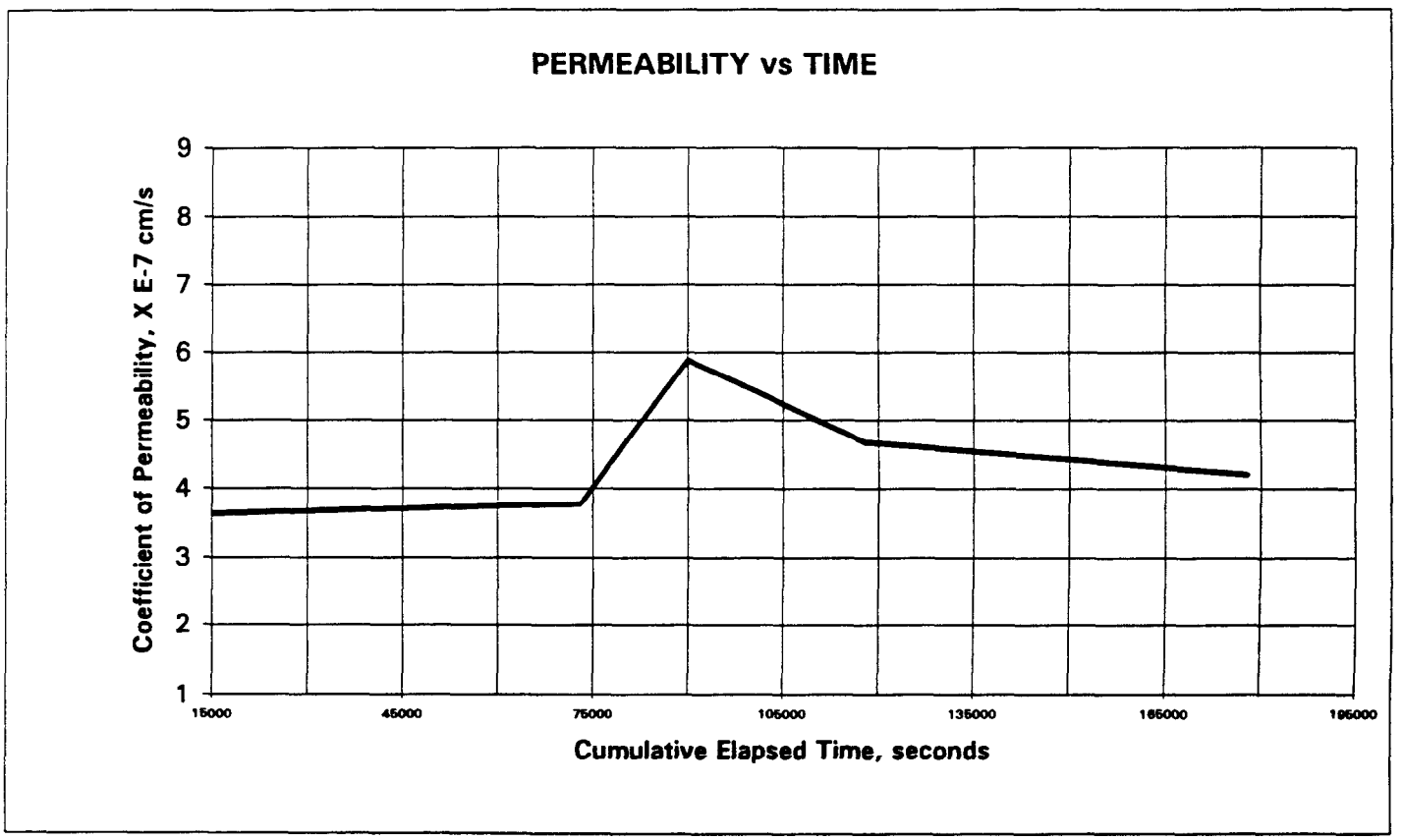
PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	C533G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-7863

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.15	
Wet weight of specimen, g.	375.31	374.96
Specimen cross-sect. area, cm^2	20.4036	
Water content, %	37.2	37.1
Wet unit weight, pcf	113.1	
Dry unit weight, pcf	82.5	
Estimated degree of saturation, %	98.0	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Seven tests performed	

Coefficient of Permeability, cm/s	4.7E-07



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED
HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

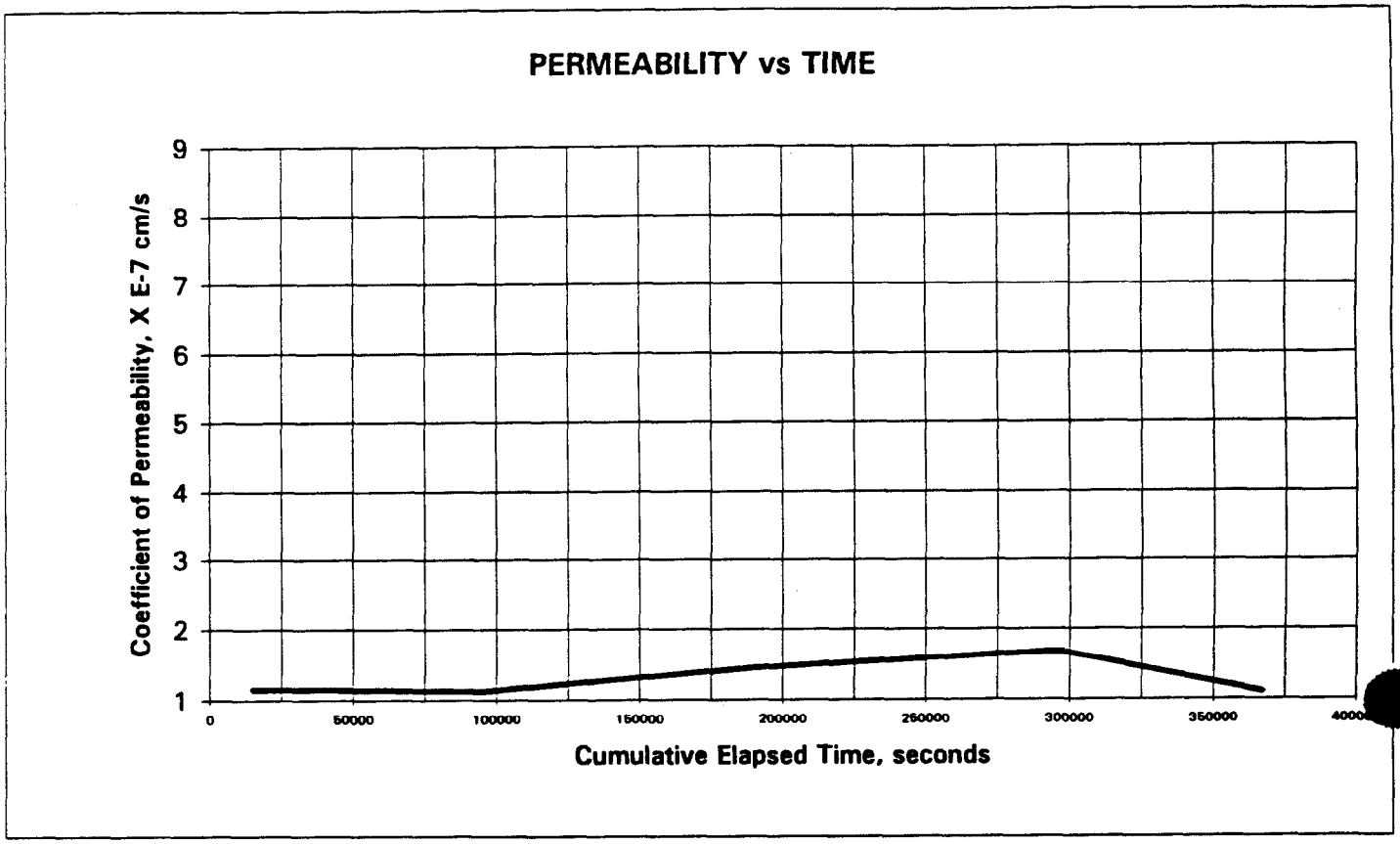
CLIENT SAMPLE NO. C543G00
IT LAB SAMPLE NO. ETDC-7864

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.16	
Wet weight of specimen, g.	381.78	382.28
Specimen cross-sect. area, cm^2	20.4511	
Water content, %	34.2	34.4
Wet unit weight, pcf	114.7	
Dry unit weight, pcf	85.5	
Estimated degree of saturation, %	96.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Five tests performed	

Coefficient of Permeability, cm/s 1.3E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED
HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

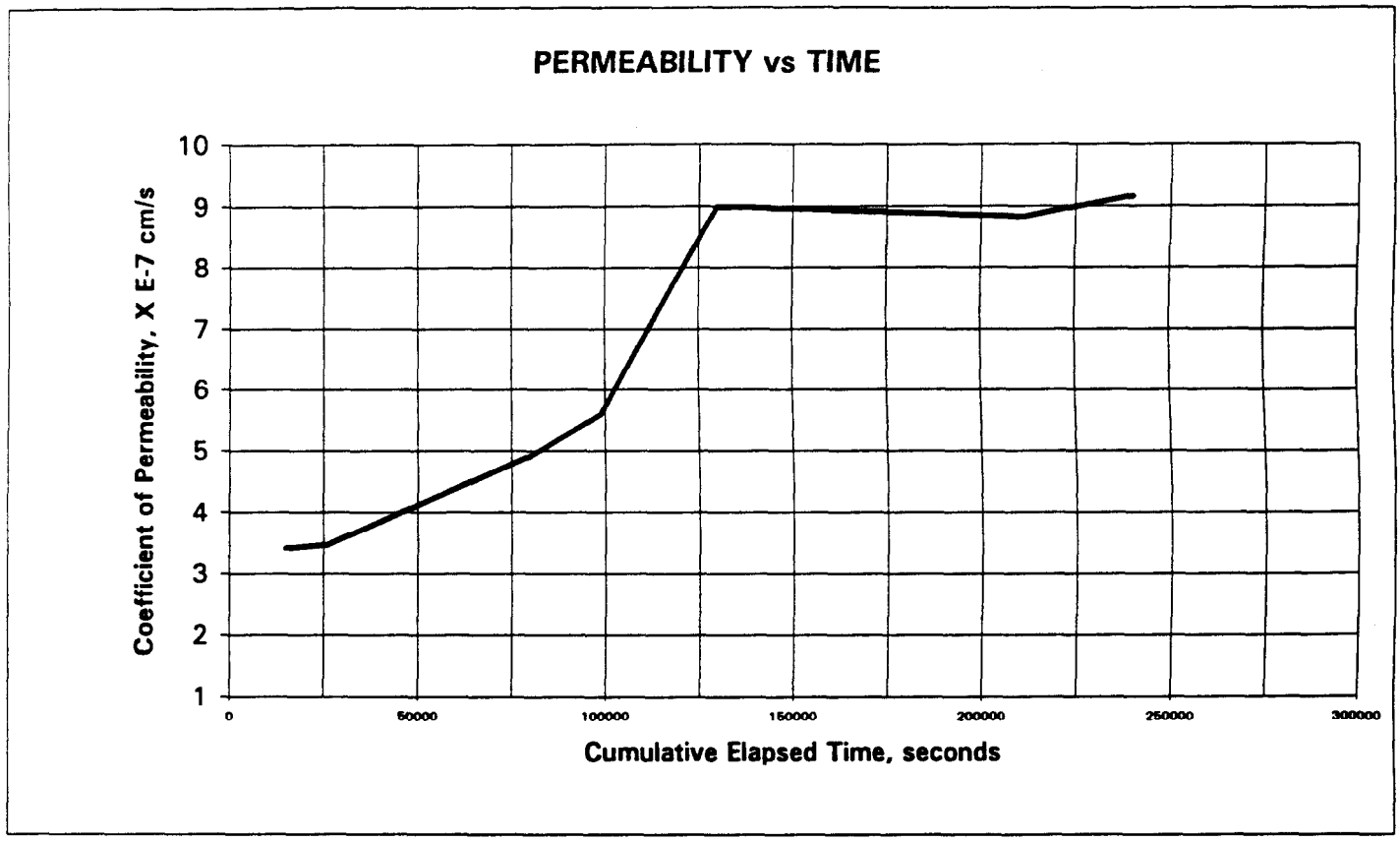
CLIENT SAMPLE NO. C613G00
IT LAB SAMPLE NO. ETDC-7865

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	7.09	
Wet weight of specimen, g.	265	269.7
Specimen cross-sect. area, cm^2	20.4477	
Water content, %	35.8	32.0
Wet unit weight, pcf	114.1	
Dry unit weight, pcf	84.0	
Estimated degree of saturation, %	97.9	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	49.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Eight tests performed	

Coefficient of Permeability, cm/s 9.0E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

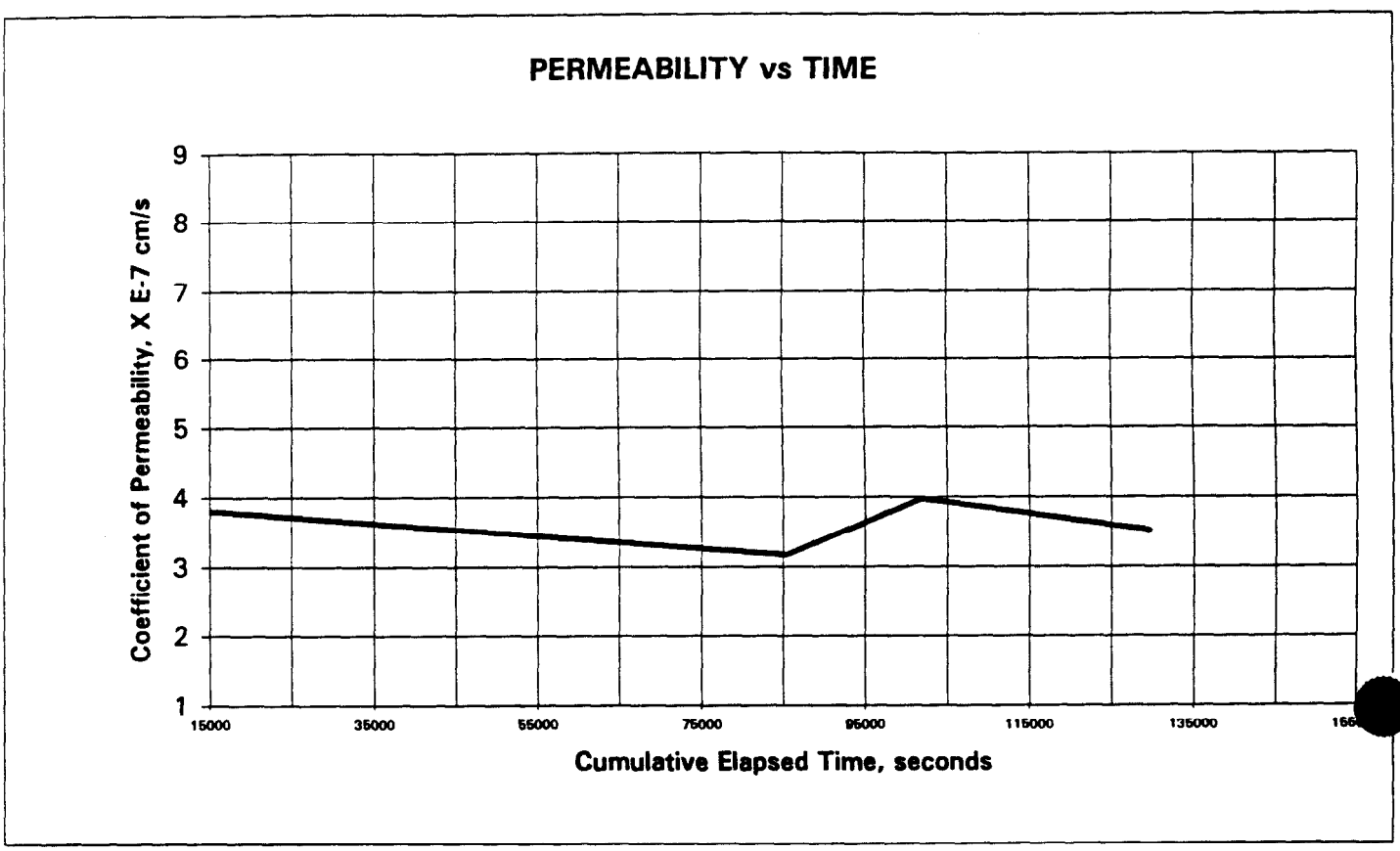
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C623G00
IT LAB SAMPLE NO. ETDC-7866

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.09	
Wet weight of specimen, g.	392.34	392.71
Specimen cross-sect. area, cm^2	20.3799	
Water content, %	29.3	29.4
Wet unit weight, pcf	119.1	
Dry unit weight, pcf	92.1	
Estimated degree of saturation, %	97.5	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Four tests performed	

Coefficient of Permeability, cm/s 3.6E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

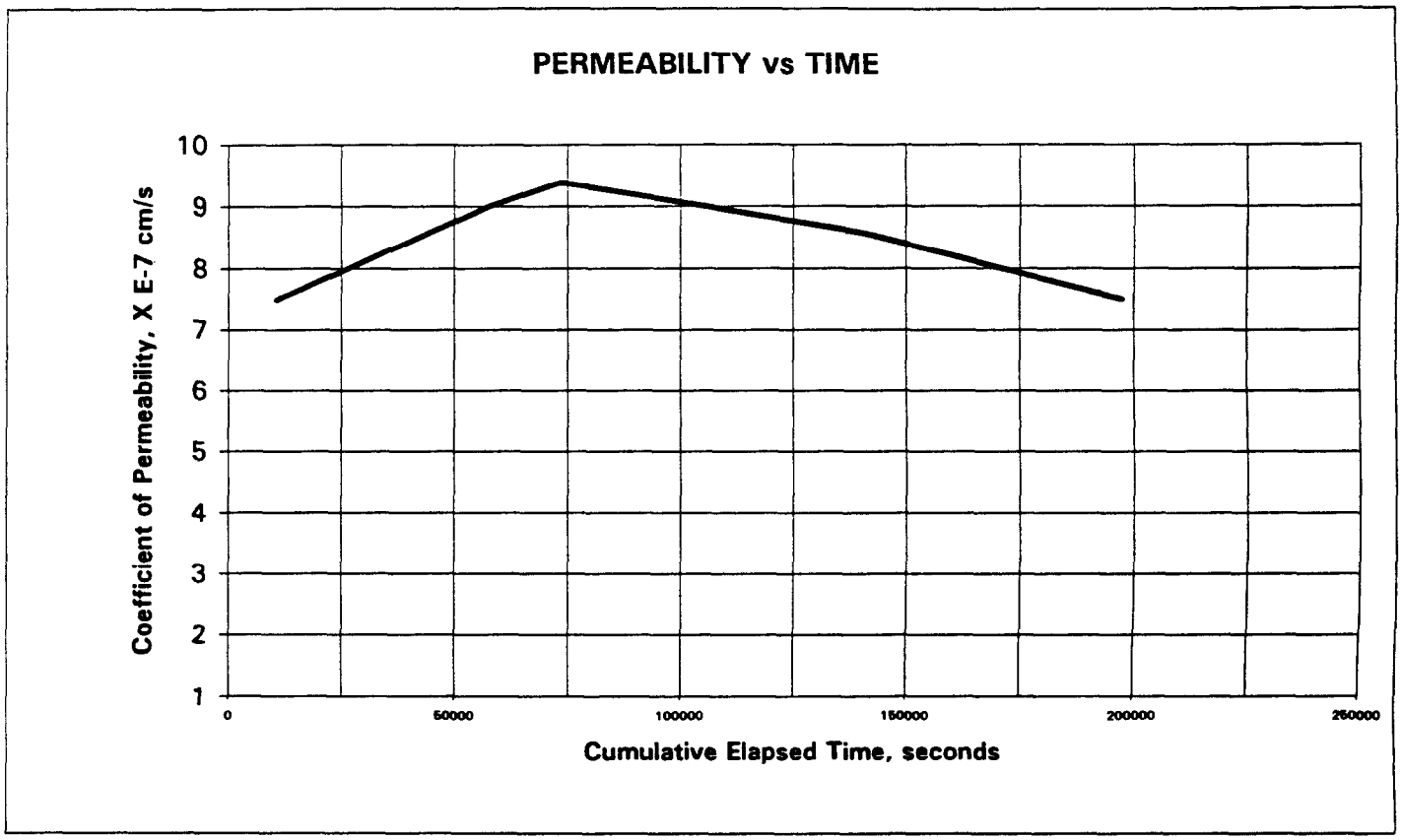
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C633G00
IT LAB SAMPLE NO. ETDC-7867

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.13	
Wet weight of specimen, g.	374.18	374.79
Specimen cross-sect. area, cm^2	20.4240	
Water content, %	37.8	38.0
Wet unit weight, pcf	112.9	
Dry unit weight, pcf	81.9	
Estimated degree of saturation, %	98.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	34.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/9/99
Five tests performed	

Coefficient of Permeability, cm/s 8.6E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

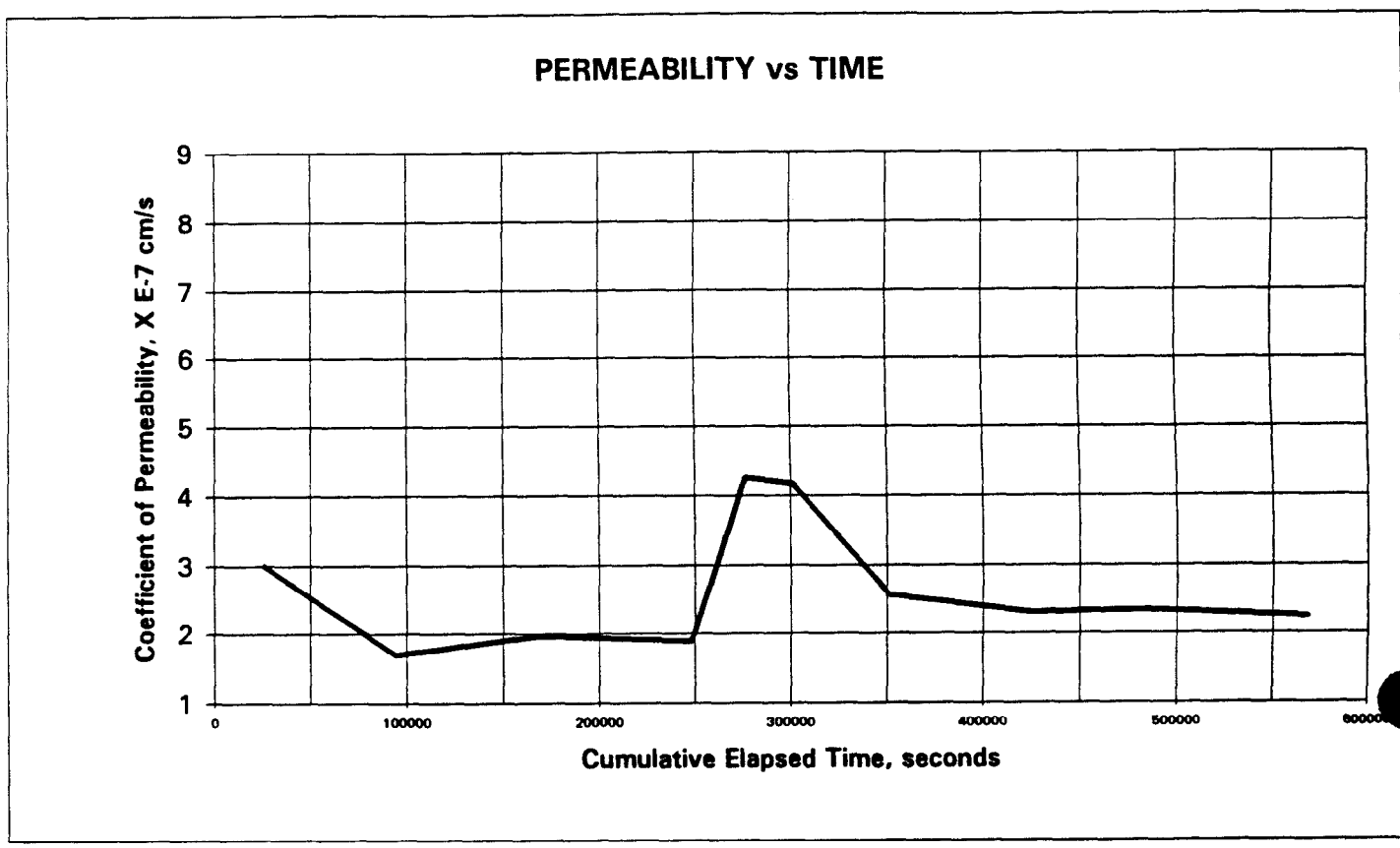
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. C643G00
IT LAB SAMPLE NO. ETDC-7868

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.13	
Wet weight of specimen, g.	381.27	381.56
Specimen cross-sect. area, cm^2	20.4003	
Water content, %	34.8	34.9
Wet unit weight, pcf	115.2	
Dry unit weight, pcf	85.5	
Estimated degree of saturation, %	98.4	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

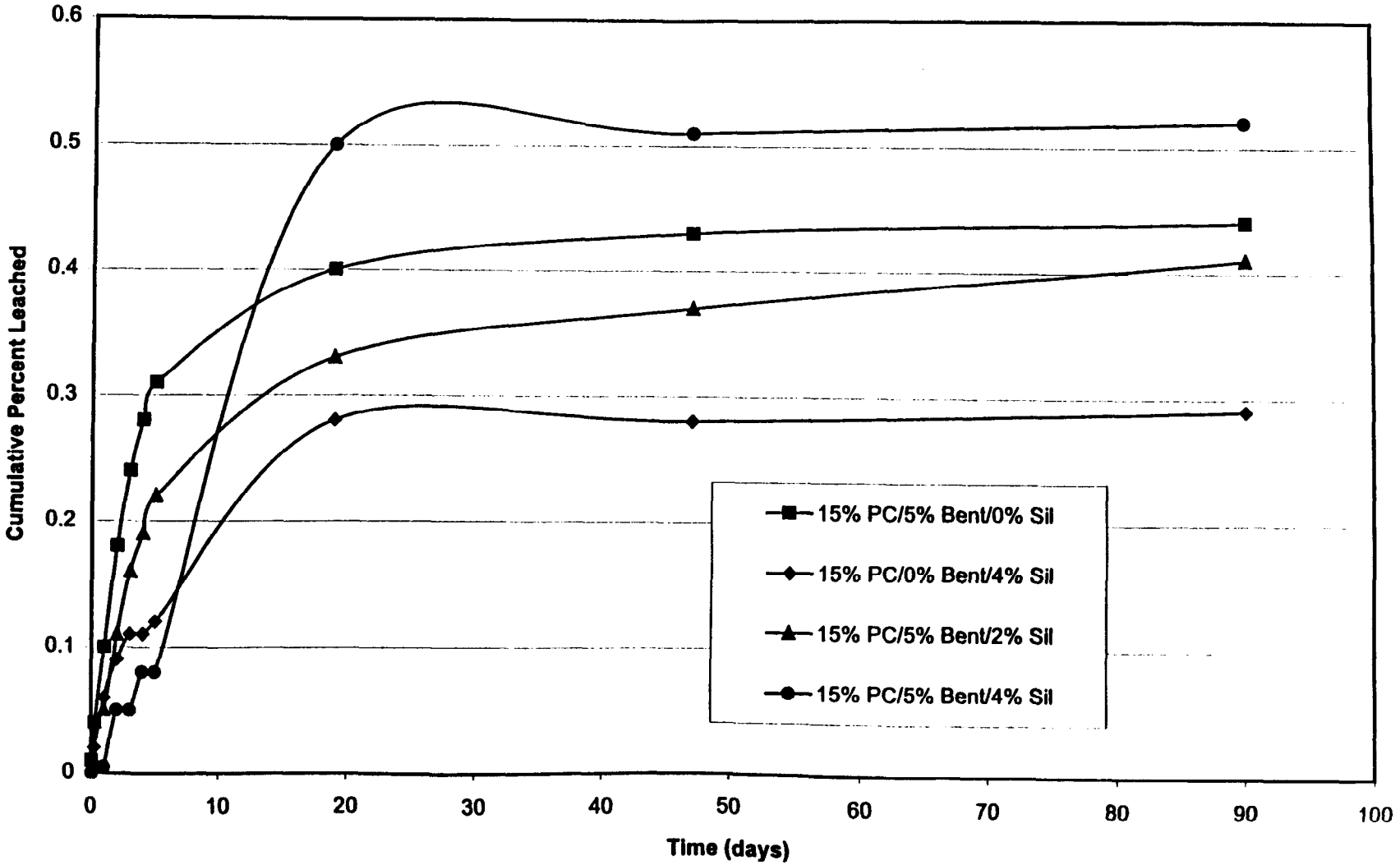
Hydraulic gradient	34.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/11/98
Sample set up	3/8/99
Ten tests performed	

Coefficient of Permeability, cm/s 2.4E-07

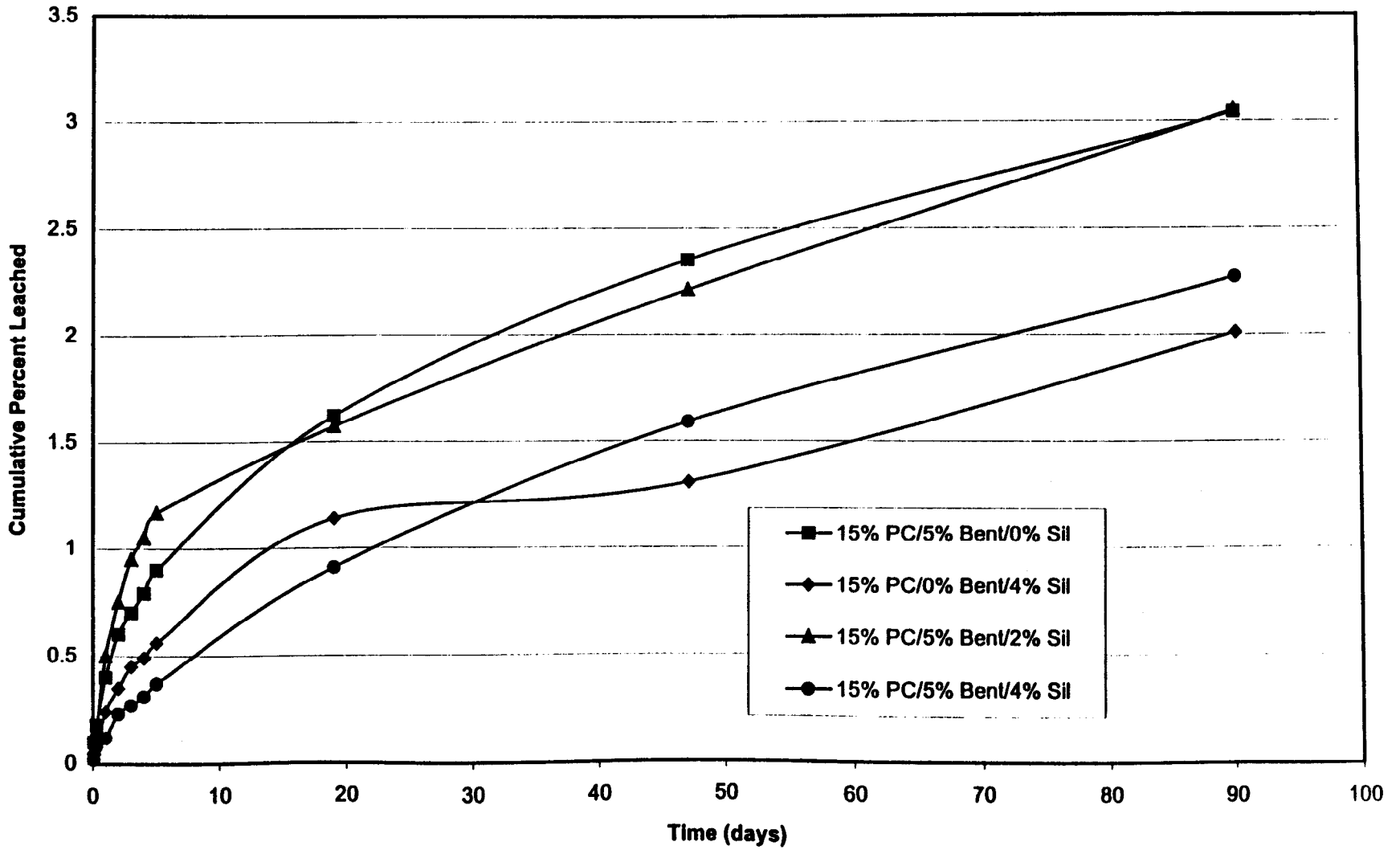


C Series
Leach Index

Gross Alpha Leaching for the Coarse Fraction from CRSB Soil



Gross Beta Leaching for the Coarse Fraction from the CSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C312

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	384
Initial Contaminant Level (pCi):	5184		
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	0.343	0.6174	0.000119	1.910E-12	11.72
7	18000	14835	0.8	1.4400	0.000278	1.370E-11	10.86
24	61200	51231	1.8	3.2400	0.000625	2.072E-11	10.68
48	86400	125894	2.19	3.9420	0.000760	3.782E-11	10.42
72	86400	213818	1.84	3.3120	0.000639	4.535E-11	10.34
96	86400	300849	1.21	2.1780	0.000420	2.759E-11	10.56
120	86400	387596	0.776	1.3968	0.000269	1.462E-11	10.84
456	1209600	939462	2.43	4.3740	0.000844	1.773E-12	11.75
1128	2419200	2716550	0.999	1.7982	0.000347	2.166E-13	12.66
2160	3715200	5768861	0.268	0.4824	0.000093	1.404E-14	13.85

Average Leach Index: 11.37

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C312

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 170

Sample Weight (g): 384

Initial Contaminant Level (pCi): 65280

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	36.3	65.3400	0.001001	1.349E-10	9.87
7	18000	14835	28.1	50.5800	0.000775	1.066E-10	9.97
24	61200	51231	81.6	146.8800	0.002250	2.686E-10	9.57
48	86400	125894	72.8	131.0400	0.002007	2.636E-10	9.58
72	86400	213818	35.5	63.9000	0.000979	1.064E-10	9.97
96	86400	300849	31.5	56.7000	0.000869	1.179E-10	9.93
120	86400	387596	39.4	70.9200	0.001086	2.377E-10	9.62
456	1209600	939462	263	473.4000	0.007252	1.310E-10	9.88
1128	2419200	2716550	264	475.2000	0.007279	9.540E-11	10.02
2160	3715200	5768861	249	448.2000	0.006866	7.641E-11	10.12

Average Leach Index: 9.85

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C322

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g): 13.5

Sample Weight (g): 391.07

Initial Contaminant Level (pCi): 5279.445

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	0.254	0.4572	0.000087	1.010E-12	12.00
7	18000	14835	0.432	0.7776	0.000147	3.853E-12	11.41
24	61200	51231	0.932	1.6776	0.000318	5.357E-12	11.27
48	86400	125894	0.879	1.5822	0.000300	5.875E-12	11.23
72	86400	213818	0.599	1.0782	0.000204	4.633E-12	11.33
96	86400	300849	0.125	0.2250	0.000043	2.839E-13	12.55
120	86400	387596	0.24	0.4320	0.000082	1.348E-12	11.87
456	1209600	939462	4.63	8.3340	0.001579	6.206E-12	11.21
1128	2419200	2716550	0.1	0.1800	0.000034	2.093E-15	14.68
2160	3715200	5768861	0.475	0.8550	0.000162	4.252E-14	13.37

Average Leach Index: 12.09

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C322

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 170

Sample Weight (g): 391.07

Initial Contaminant Level (pCi): 66481.9

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	17.8	32.0400	0.000482	3.128E-11	10.50
7	18000	14835	10.8	19.4400	0.000292	1.518E-11	10.82
24	61200	51231	61.4	110.5200	0.001662	1.466E-10	9.83
48	86400	125894	41	73.8000	0.001110	8.060E-11	10.09
72	86400	213818	35.7	64.2600	0.000967	1.038E-10	9.98
96	86400	300849	14.2	25.5600	0.000384	2.310E-11	10.64
120	86400	387596	26	46.8000	0.000704	9.979E-11	10.00
456	1209600	939462	215	387.0000	0.005821	8.439E-11	10.07
1128	2419200	2716550	61.7	111.0600	0.001671	5.024E-12	11.30
2160	3715200	5768861	258	464.4000	0.006985	7.910E-11	10.10

Average Leach Index: 10.33

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C332

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	374.39
Initial Contaminant Level (pCi):	5054.265		
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	0.354	0.6372	0.000126	2.140E-12	11.67
7	18000	14835	0.741	1.3338	0.000264	1.237E-11	10.91
24	61200	51231	0.347	0.6246	0.000124	8.102E-13	12.09
48	86400	125894	1.57	2.8260	0.000559	2.045E-11	10.69
72	86400	213818	1.37	2.4660	0.000488	2.645E-11	10.58
96	86400	300849	1.09	1.9620	0.000388	2.355E-11	10.63
120	86400	387596	0.679	1.2222	0.000242	1.178E-11	10.93
456	1209600	939462	2.99	5.3820	0.001065	2.824E-12	11.55
1128	2419200	2716550	1.22	2.1960	0.000434	3.399E-13	12.47
2160	3715200	5768861	1.19	2.1420	0.000424	2.911E-13	12.54

Average Leach Index: 11.40

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C332

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 170

Sample Weight (g): 374.39

Initial Contaminant Level (pCi): 63646.3

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	25.8	46.4400	0.000730	7.170E-11	10.14
7	18000	14835	30.5	54.9000	0.000863	1.321E-10	9.88
24	61200	51231	119	214.2000	0.003365	6.009E-10	9.22
48	86400	125894	89.9	161.8200	0.002542	4.228E-10	9.37
72	86400	213818	72.4	130.3200	0.002048	4.658E-10	9.33
96	86400	300849	33	59.4000	0.000933	1.361E-10	9.87
120	86400	387596	43.3	77.9400	0.001225	3.020E-10	9.52
456	1209600	939462	143	257.4000	0.004044	4.073E-11	10.39
1128	2419200	2716550	224	403.2000	0.006335	7.225E-11	10.14
2160	3715200	5768861	296	532.8000	0.008371	1.136E-10	9.94

Average Leach Index: 9.78

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C342

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	373.1
Initial Contaminant Level (pCi):	5036.85		
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	0.1	0.1800	0.000036	1.720E-13	12.76
7	18000	14835	0.133	0.2394	0.000048	4.012E-13	12.40
24	61200	51231	0.1	0.1800	0.000036	6.775E-14	13.17
48	86400	125894	0.94	1.6920	0.000336	7.381E-12	11.13
72	86400	213818	0.231	0.4158	0.000083	7.571E-13	12.12
96	86400	300849	0.61	1.0980	0.000218	7.428E-12	11.13
120	86400	387596	0.116	0.2088	0.000041	3.461E-13	12.46
456	1209600	939462	11.9	21.4200	0.004253	4.504E-11	10.35
1128	2419200	2716550	0.1	0.1800	0.000036	2.299E-15	14.64
2160	3715200	5768861	0.708	1.2744	0.000253	1.038E-13	12.98

Average Leach Index: 12.31

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C342

Analyst: PRL Date: 15-Apr-99

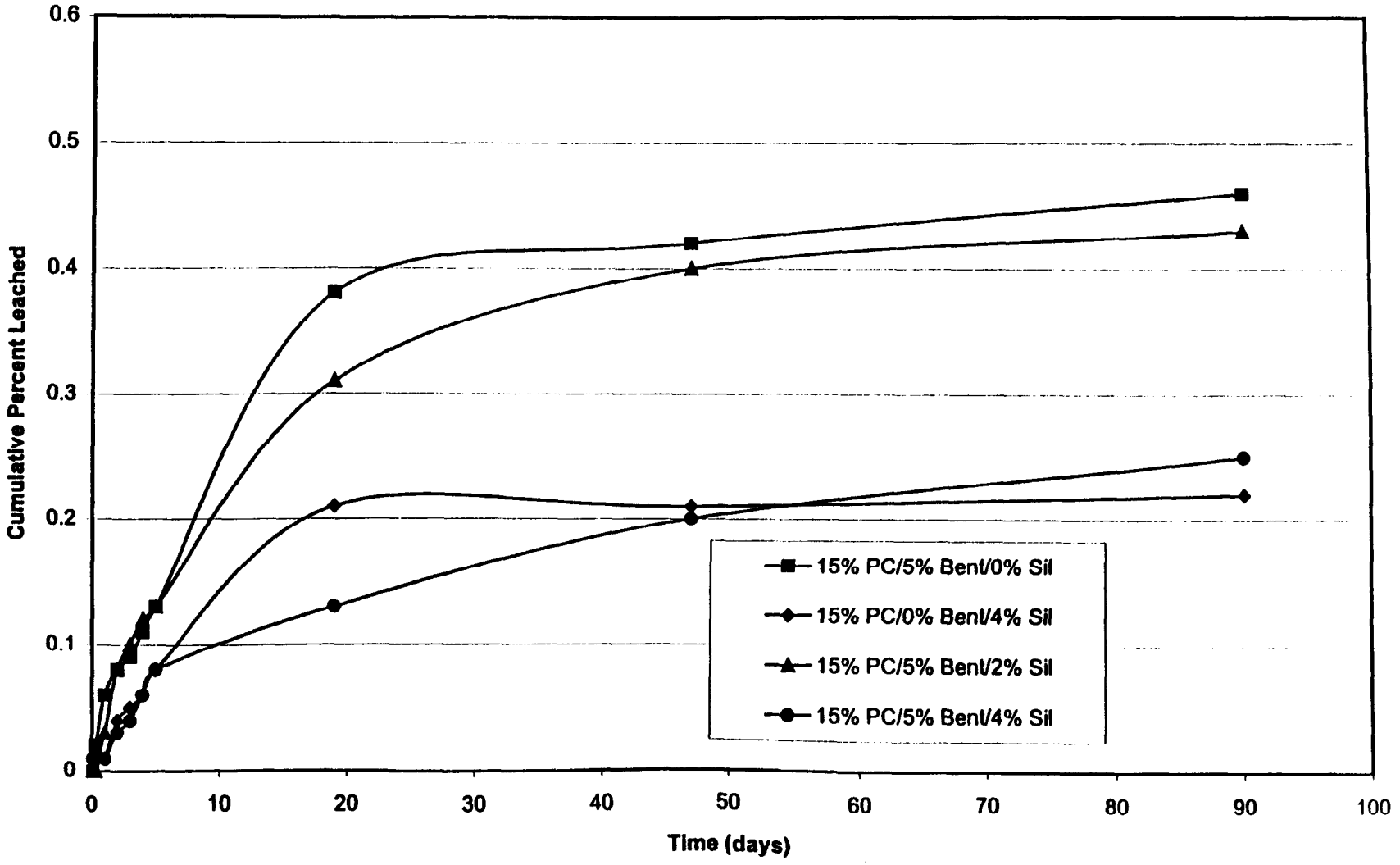
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	170	Sample Weight (g):	380.15
Initial Contaminant Level (pCi):	64625.5		
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		

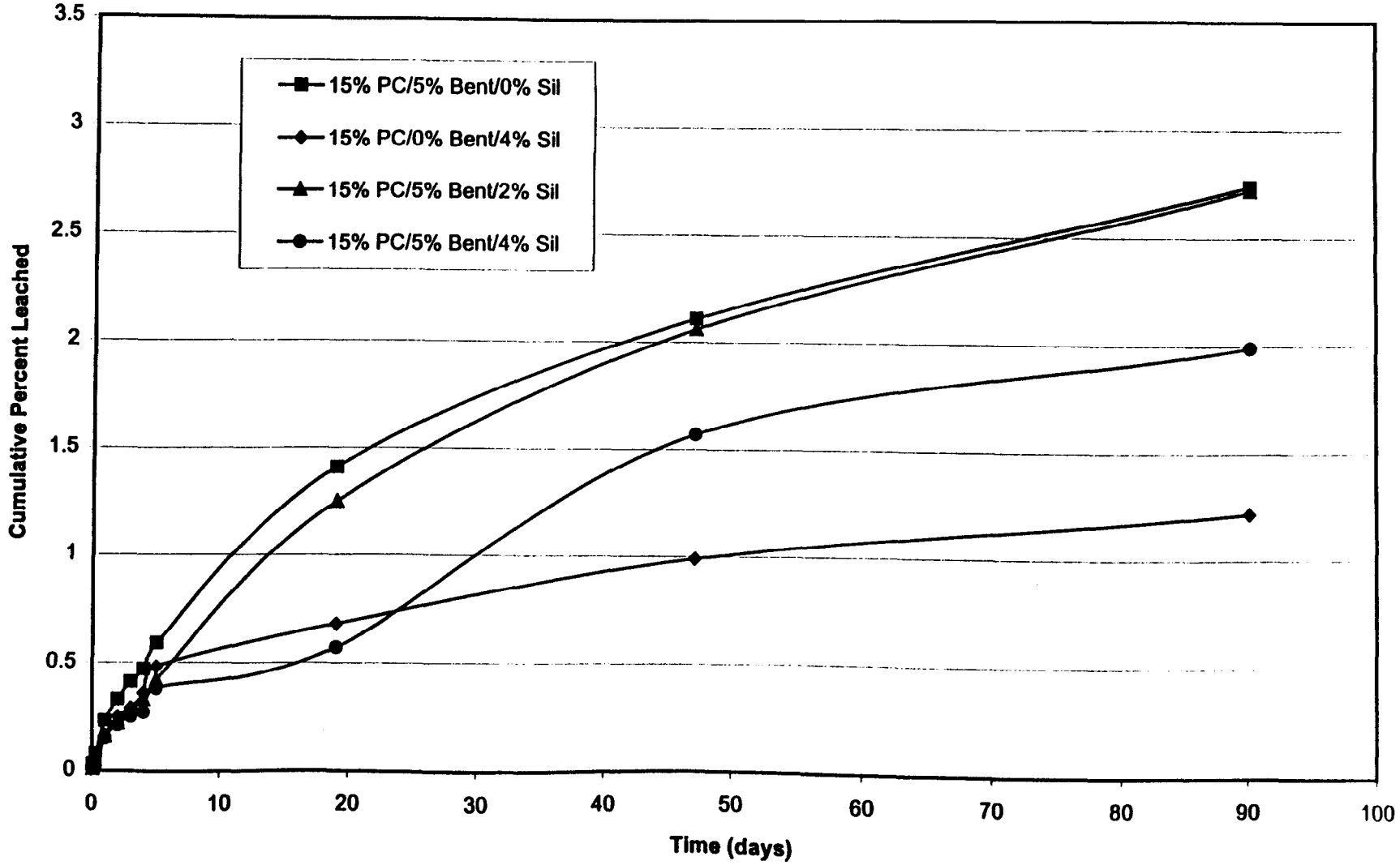
Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	7.55	13.5900	0.000210	5.955E-12	11.23
7	18000	14835	19.9	35.8200	0.000554	5.456E-11	10.26
24	61200	51231	17.2	30.9600	0.000479	1.218E-11	10.91
48	86400	125894	37.4	67.3200	0.001042	7.098E-11	10.15
72	86400	213818	14.6	26.2800	0.000407	1.837E-11	10.74
96	86400	300849	14.7	26.4600	0.000409	2.620E-11	10.58
120	86400	387596	22.2	39.9600	0.000618	7.699E-11	10.11
456	1209600	939462	192	345.6000	0.005348	7.122E-11	10.15
1128	2419200	2716550	246	442.8000	0.006852	8.452E-11	10.07
2160	3715200	5768861	243	437.4000	0.006768	7.426E-11	10.13

Average Leach Index: 10.43

Gross Alpha Leaching for the Fine Fraction from CRSB Soil



Gross Beta Leaching for the Fine Fraction from the CSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C412

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	16.1	Sample Weight (g):	373.1
Initial Contaminant Level (pCi):	6006.91		
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	1.28	2.3040	0.000384	1.981E-11	10.70
7	18000	14835	0.609	1.0962	0.000182	5.914E-12	11.23
24	61200	51231	0.548	0.9864	0.000164	1.431E-12	11.84
48	86400	125894	0.261	0.4698	0.000078	4.001E-13	12.40
72	86400	213818	2.14	3.8520	0.000641	4.568E-11	10.34
96	86400	300849	1.09	1.9620	0.000327	1.668E-11	10.78
120	86400	387596	0.64	1.1520	0.000192	7.407E-12	11.13
456	1209600	939462	6.13	11.0340	0.001837	8.403E-12	11.08
1128	2419200	2716550	1.28	2.3040	0.000383558	2.64852E-13	12.58
2160	3715200	5768861	1.5	2.7000	0.000449482	3.27504E-13	12.48

Average Leach Index: 11.46

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C412

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 224

Sample Weight (g): 373.1

Initial Contaminant Level (pCi): 83574.4

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	39.1	70.3800	0.000842	9.550E-11	10.02
7	18000	14835	26.1	46.9800	0.000562	5.612E-11	10.25
24	61200	51231	82.3	148.1400	0.001773	1.667E-10	9.78
48	86400	125894	57.9	104.2200	0.001247	1.017E-10	9.99
72	86400	213818	56.4	101.5200	0.001215	1.639E-10	9.79
96	86400	300849	58.6	105.4800	0.001262	2.490E-10	9.60
120	86400	387596	28.3	50.9400	0.000610	7.482E-11	10.13
456	1209600	939462	307	552.6000	0.006612	1.089E-10	9.96
1128	2419200	2716550	325	585.0000	0.007000	8.821E-11	10.05
2160	3715200	5768861	290	522.0000	0.006246	6.324E-11	10.20

Average Leach Index: 9.98

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C422

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	16.1	Sample Weight (g):	381.91
Initial Contaminant Level (pCi):	6148.751		
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	0.4	0.7200	0.000117	1.847E-12	11.73
7	18000	14835	0.562	1.0116	0.000165	4.807E-12	11.32
24	61200	51231	0.739	1.3302	0.000216	2.483E-12	11.61
48	86400	125894	0.736	1.3248	0.000215	3.036E-12	11.52
72	86400	213818	0.678	1.2204	0.000198	4.376E-12	11.36
96	86400	300849	0.528	0.9504	0.000155	3.734E-12	11.43
120	86400	387596	0.261	0.4698	0.000076	1.176E-12	11.93
456	1209600	939462	3.24	5.8320	0.000948	2.240E-12	11.65
1128	2419200	2716550	0.1	0.1800	0.000029	1.543E-15	14.81
2160	3715200	5768861	0.188	0.3384	0.000055	4.910E-15	14.31

Average Leach Index: 12.17

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C422

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	224	Sample Weight (g):	381.91
Initial Contaminant Level (pCi):	85547.84		
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	32.1	57.7800	0.000675	6.143E-11	10.21
7	18000	14835	21.4	38.5200	0.000450	3.600E-11	10.44
24	61200	51231	65.9	118.6200	0.001387	1.020E-10	9.99
48	86400	125894	53.9	97.0200	0.001134	8.413E-11	10.08
72	86400	213818	19.9	35.8200	0.000419	1.948E-11	10.71
96	86400	300849	29.5	53.1000	0.000621	6.022E-11	10.22
120	86400	387596	13.5	24.3000	0.000284	1.625E-11	10.79
456	1209600	939462	84.9	152.8200	0.001786	7.947E-12	11.10
1128	2419200	2716550	149	268.2000	0.003135	1.769E-11	10.75
2160	3715200	5768861	108	194.4000	0.002272	8.371E-12	11.08

Average Leach Index: 10.54

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C432

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	16.1	Sample Weight (g):	360.4
Initial Contaminant Level (pCi):	5802.44		
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	0.509	0.9162	0.000158	3.358E-12	11.47
7	18000	14835	0.514	0.9252	0.000159	4.515E-12	11.35
24	61200	51231	0.534	0.9612	0.000166	1.456E-12	11.84
48	86400	125894	0.582	1.0476	0.000181	2.132E-12	11.67
72	86400	213818	1.24	2.2320	0.000385	1.644E-11	10.78
96	86400	300849	0.597	1.0746	0.000185	5.361E-12	11.27
120	86400	387596	0.1	0.1800	0.000031	1.938E-13	12.71
456	1209600	939462	6.05	10.8900	0.001877	8.772E-12	11.06
1128	2419200	2716550	2.93	5.2740	0.000909	1.487E-12	11.83
2160	3715200	5768861	0.954	1.7172	0.000296	1.420E-13	12.85

Average Leach Index: 11.68

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C432

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	224	Sample Weight (g):	360.4
Initial Contaminant Level (pCi):	80729.6		
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	57.6	103.6800	0.001284	2.221E-10	9.65
7	18000	14835	29.4	52.9200	0.000656	7.631E-11	10.12
24	61200	51231	77.9	140.2200	0.001737	1.600E-10	9.80
48	86400	125894	68.8	123.8400	0.001534	1.539E-10	9.81
72	86400	213818	53	95.4000	0.001182	1.551E-10	9.81
96	86400	300849	39	70.2000	0.000870	1.182E-10	9.93
120	86400	387596	33.3	59.9400	0.000742	1.110E-10	9.95
456	1209600	939462	200	360.0000	0.004459	4.952E-11	10.31
1128	2419200	2716550	367	660.6000	0.008183	1.205E-10	9.92
2160	3715200	5768861	293	527.4000	0.006533	6.918E-11	10.16

Average Leach Index: 9.95

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C442

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	16.1	Sample Weight (g):	365.56
Initial Contaminant Level (pCi):	5885.516		
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	0.162	0.2916	0.000050	3.306E-13	12.48
7	18000	14835	0.565	1.0170	0.000173	5.303E-12	11.28
24	61200	51231	0.572	1.0296	0.000175	1.624E-12	11.79
48	86400	125894	0.201	0.3618	0.000061	2.472E-13	12.61
72	86400	213818	1.13	2.0340	0.000346	1.327E-11	10.88
96	86400	300849	0.547	0.9846	0.000167	4.375E-12	11.36
120	86400	387596	0.221	0.3978	0.000068	9.200E-13	12.04
456	1209600	939462	0.813	1.4634	0.000249	1.540E-13	12.81
1128	2419200	2716550	2.43	4.3740	0.000743	9.943E-13	12.00
2160	3715200	5768861	1.62	2.9160	0.000495	3.979E-13	12.40

Average Leach Index: 11.96

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C442

Analyst: PRL Date: 15-Apr-99

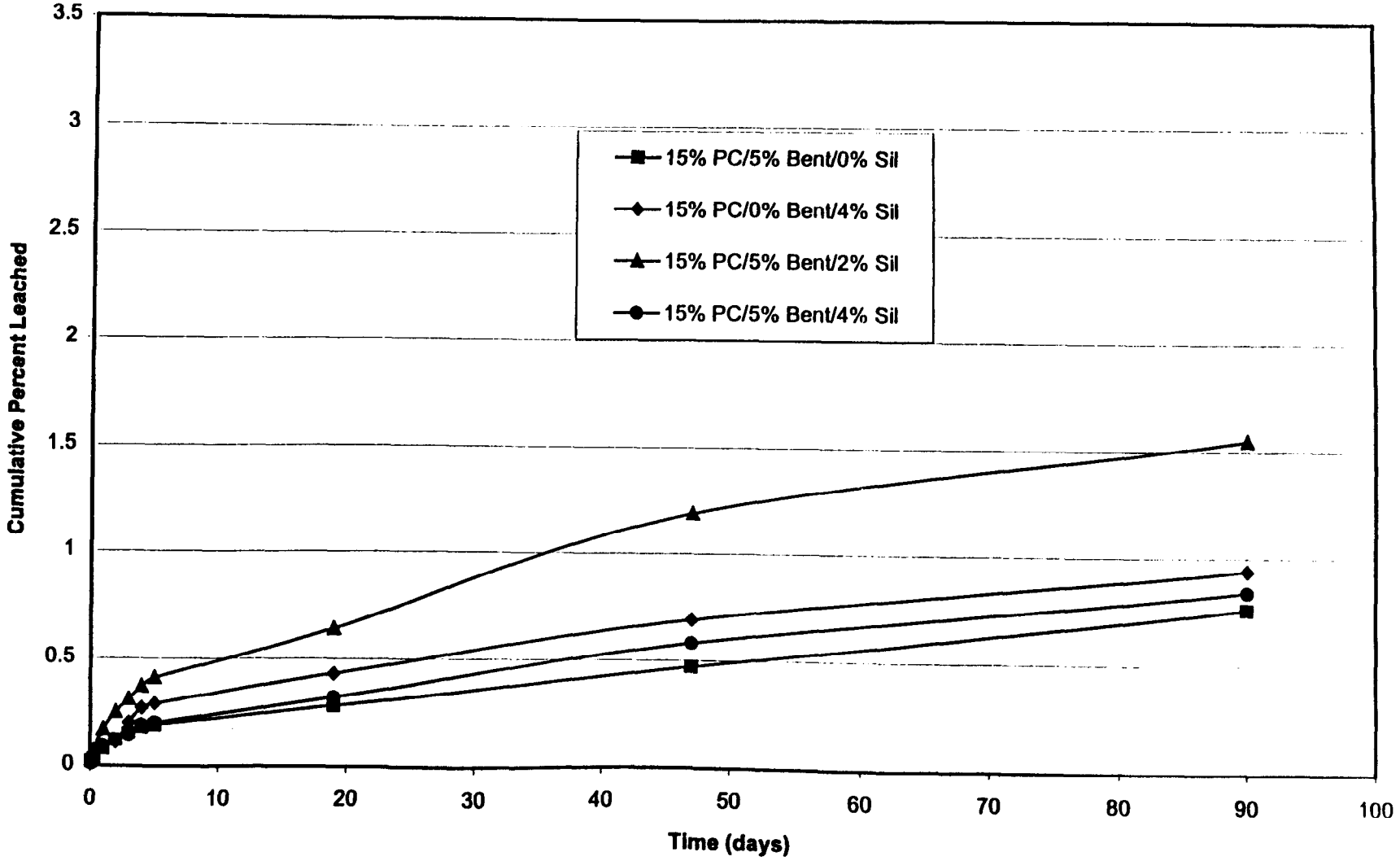
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	224	Sample Weight (g):	365.56
Initial Contaminant Level (pCi):	81885.44		
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		

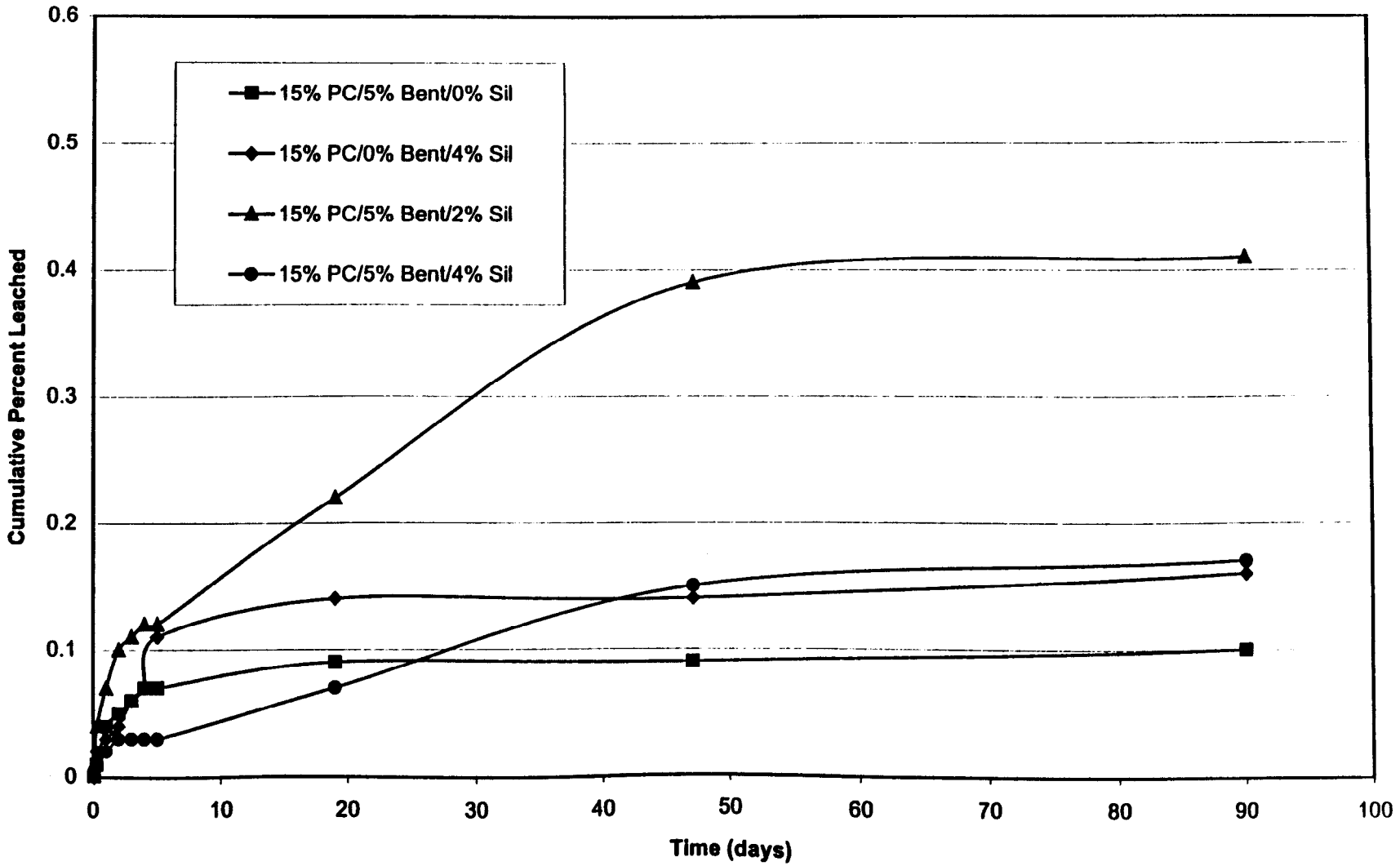
Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	24	43.2000	0.000528	3.748E-11	10.43
7	18000	14835	20.5	36.9000	0.000451	3.606E-11	10.44
24	61200	51231	39.3	70.7400	0.000864	3.959E-11	10.40
48	86400	125894	20.6	37.0800	0.000453	1.341E-11	10.87
72	86400	213818	34.4	61.9200	0.000756	6.352E-11	10.20
96	86400	300849	29	52.2000	0.000637	6.352E-11	10.20
120	86400	387596	21.1	37.9800	0.000464	4.332E-11	10.36
456	1209600	939462	69.1	124.3800	0.001519	5.746E-12	11.24
1128	2419200	2716550	456	820.8000	0.010024	1.809E-10	9.74
2160	3715200	5768861	190	342.0000	0.004177	2.828E-11	10.55

Average Leach Index: 10.44

Gross Beta Leaching for the Bulk Fraction #1 from the CSRB Soil



Gross Alpha Leaching for the Bulk Fraction #1 from the CRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C512

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	24.3	Sample Weight (g):	377.37
Initial Contaminant Level (pCi):	9170.091		
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	0.055	0.0990	0.000011	1.570E-14	13.80
7	18000	14835	0.372	0.6696	0.000073	9.469E-13	12.02
24	61200	51231	1.49	2.6820	0.000292	4.538E-12	11.34
48	86400	125894	0.74	1.3320	0.000145	1.380E-12	11.86
72	86400	213818	0.613	1.1034	0.000120	1.608E-12	11.79
96	86400	300849	0.153	0.2754	0.000030	1.410E-13	12.85
120	86400	387596	0.1	0.1800	0.000020	7.759E-14	13.11
456	1209600	939462	0.819	1.4742	0.000161	6.436E-14	13.19
1128	2419200	2716550	0.1	0.1800	0.000020	6.936E-16	15.16
2160	3715200	5768861	0.9	1.6200	0.000177	5.059E-14	13.30

Average Leach Index: 12.84

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C512

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 284

Initial Contaminant Level (pCi): 107173.08

Monolith Height (cm): 10

Monolith Surface Area (cm^2): 176.72

Monolith Volume (cm^3): 196.35

Sample Weight (g): 377.37

Monolith Diameter (cm): 5

Leachate Volume (mL): 1800

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	9.58	17.2440	0.000161	3.486E-12	11.46
7	18000	14835	8.03	14.4540	0.000135	3.230E-12	11.49
24	61200	51231	30.5	54.9000	0.000512	1.392E-11	10.86
48	86400	125894	25	45.0000	0.000420	1.153E-11	10.94
72	86400	213818	14.8	26.6400	0.000249	6.864E-12	11.16
96	86400	300849	18	32.4000	0.000302	1.429E-11	10.85
120	86400	387596	9.28	16.7040	0.000156	4.892E-12	11.31
456	1209600	939462	54.2	97.5600	0.000910	2.064E-12	11.69
1128	2419200	2716550	111	199.8000	0.001864	6.257E-12	11.20
2160	3715200	5768861	174	313.2000	0.002922	1.384E-11	10.86

Average Leach Index: 11.18

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C522

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	24.3	Sample Weight (g):	392.65
Initial Contaminant Level (pCi):	9541.395		
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	0.194	0.3492	0.000037	1.804E-13	12.74
7	18000	14835	0.627	1.1286	0.000118	2.485E-12	11.60
24	61200	51231	1	1.8000	0.000189	1.888E-12	11.72
48	86400	125894	0.164	0.2952	0.000031	6.261E-14	13.20
72	86400	213818	1.28	2.3040	0.000241	6.478E-12	11.19
96	86400	300849	0.633	1.1394	0.000119	2.229E-12	11.65
120	86400	387596	1.78	3.2040	0.000336	2.271E-11	10.64
456	1209600	939462	1.67	3.0060	0.000315	2.472E-13	12.61
1128	2419200	2716550	0.1	0.1800	0.000019	6.407E-16	15.19
2160	3715200	5768861	0.885	1.5930	0.000167	4.519E-14	13.35

Average Leach Index: 12.39

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C522

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 284

Sample Weight (g): 392.65

Initial Contaminant Level (pCi): 111512.6

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	10.7	19.2600	0.000173	4.017E-12	11.40
7	18000	14835	6.77	12.1860	0.000109	2.121E-12	11.67
24	61200	51231	35.7	64.2600	0.000576	1.762E-11	10.75
48	86400	125894	16.4	29.5200	0.000265	4.584E-12	11.34
72	86400	213818	57.3	103.1400	0.000925	9.504E-11	10.02
96	86400	300849	37.6	67.6800	0.000607	5.758E-11	10.24
120	86400	387596	13.1	23.5800	0.000211	9.004E-12	11.05
456	1209600	939462	88.5	159.3000	0.001429	5.082E-12	11.29
1128	2419200	2716550	163	293.4000	0.002631	1.246E-11	10.90
2160	3715200	5768861	155	279.0000	0.002502	1.015E-11	10.99

Average Leach Index: 10.97

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C532

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	24.3	Sample Weight (g):	370.81
Initial Contaminant Level (pCi):	9010.683		
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	0.422	0.7596	0.000084	9.570E-13	12.02
7	18000	14835	1.47	2.6460	0.000294	1.531E-11	10.81
24	61200	51231	1.6	2.8800	0.000320	5.420E-12	11.27
48	86400	125894	1.54	2.7720	0.000308	6.190E-12	11.21
72	86400	213818	0.453	0.8154	0.000090	9.097E-13	12.04
96	86400	300849	0.302	0.5436	0.000060	5.689E-13	12.24
120	86400	387596	0.236	0.4248	0.000047	4.476E-13	12.35
456	1209600	939462	5	9.0000	0.000999	2.484E-12	11.60
1128	2419200	2716550	8.59	15.4620	0.001715963	5.30098E-12	11.28
2160	3715200	5768861	0.865	1.5570	0.000172795	4.84009E-14	13.32

Average Leach Index: 11.81

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C532

Analyst: PRL **Date:** 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	284	Sample Weight (g):	370.81
Initial Contaminant Level (pCi):	105310.04		
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	16.5	29.7000	0.000282	1.071E-11	10.97
7	18000	14835	25.1	45.1800	0.000429	3.269E-11	10.49
24	61200	51231	56.5	101.7000	0.000966	4.948E-11	10.31
48	86400	125894	50.8	91.4400	0.000868	4.931E-11	10.31
72	86400	213818	32	57.6000	0.000547	3.323E-11	10.48
96	86400	300849	34.9	62.8200	0.000597	5.562E-11	10.25
120	86400	387596	23.3	41.9400	0.000398	3.194E-11	10.50
456	1209600	939462	133	239.4000	0.002273	1.287E-11	10.89
1128	2419200	2716550	326	586.8000	0.005572	5.590E-11	10.25
2160	3715200	5768861	206	370.8000	0.003521	2.010E-11	10.70

Average Leach Index: 10.52

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C542

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	24.3	Sample Weight (g):	376.34
Initial Contaminant Level (pCi):	9145.062		
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	0.1	0.1800	0.000020	5.217E-14	13.28
7	18000	14835	0.468	0.8424	0.000092	1.507E-12	11.82
24	61200	51231	0.533	0.9594	0.000105	5.839E-13	12.23
48	86400	125894	0.172	0.3096	0.000034	7.497E-14	13.13
72	86400	213818	0.106	0.1908	0.000021	4.836E-14	13.32
96	86400	300849	0.165	0.2970	0.000032	1.649E-13	12.78
120	86400	387596	0.1	0.1800	0.000020	7.802E-14	13.11
456	1209600	939462	1.71	3.0780	0.000337	2.821E-13	12.55
1128	2419200	2716550	4.26	7.6680	0.000838	1.266E-12	11.90
2160	3715200	5768861	0.801	1.4418	0.000158	4.029E-14	13.39

Average Leach Index: 12.75

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C542

Analyst: PRL **Date:** 15-Apr-99

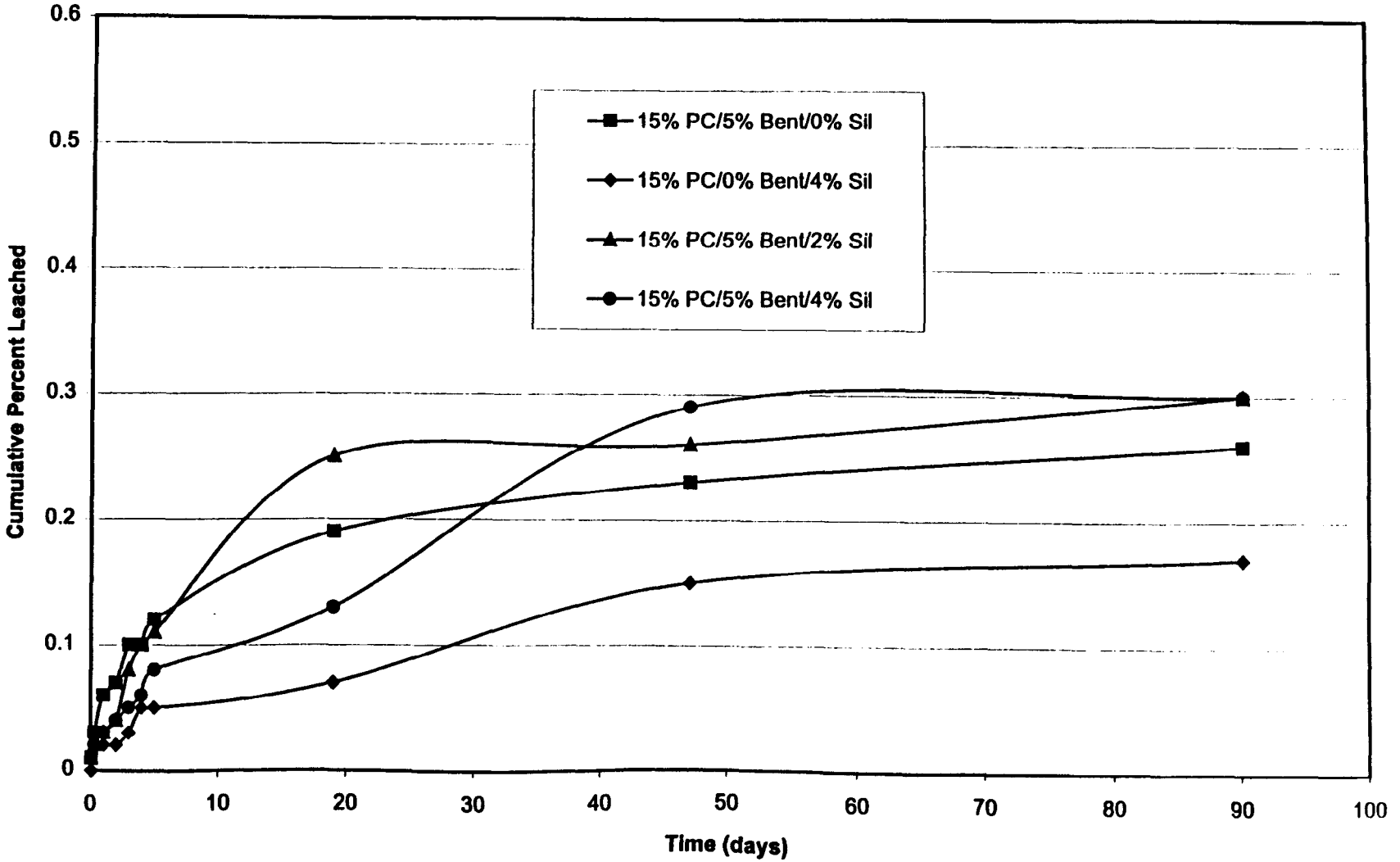
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	284	Sample Weight (g):	376.34
Initial Contaminant Level (pCi):	106880.56		
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		

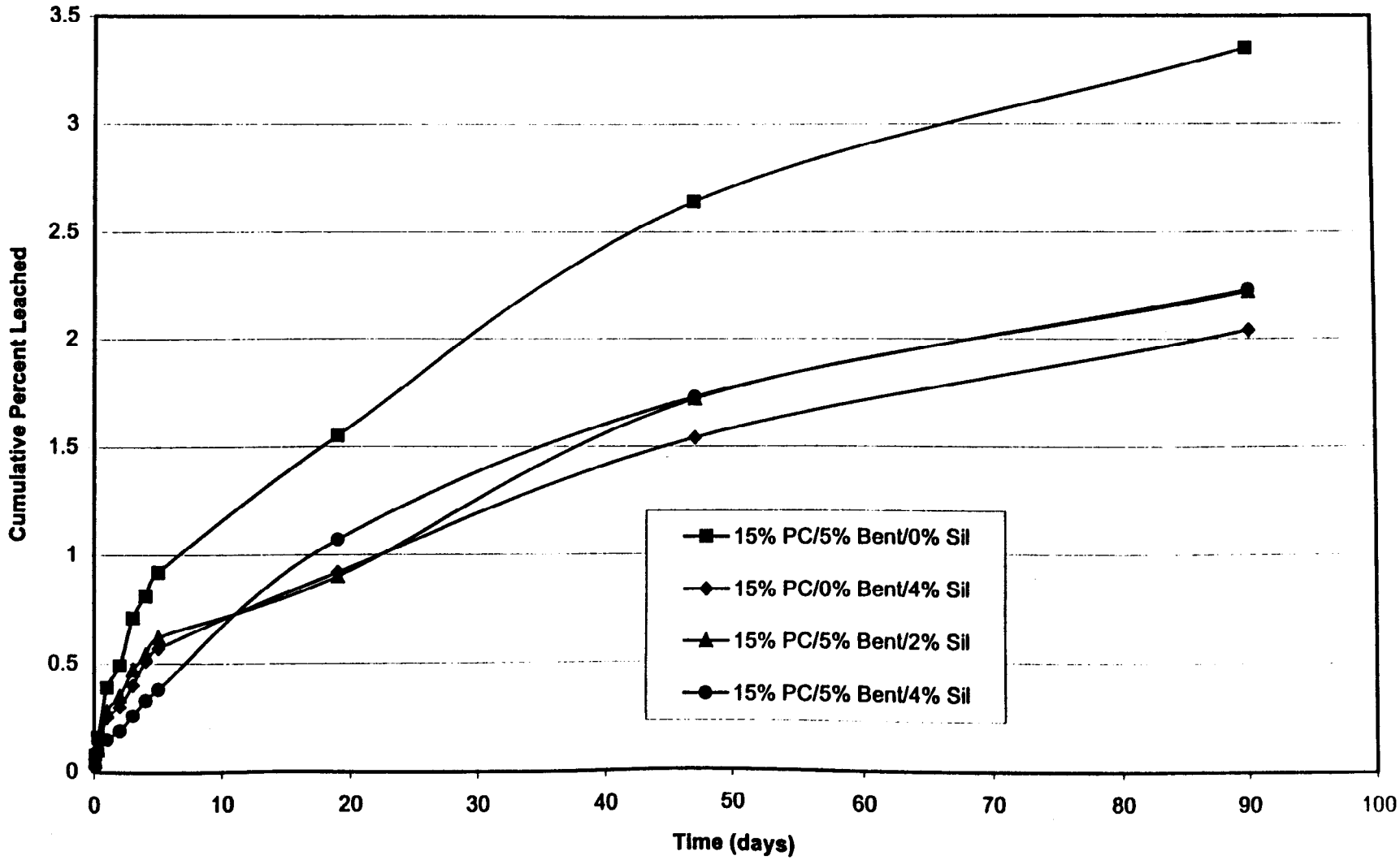
Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	7.88	14.1840	0.000133	2.372E-12	11.62
7	18000	14835	12.7	22.8600	0.000214	8.124E-12	11.09
24	61200	51231	32.6	58.6800	0.000549	1.599E-11	10.80
48	86400	125894	18.3	32.9400	0.000308	6.213E-12	11.21
72	86400	213818	13.5	24.3000	0.000227	5.742E-12	11.24
96	86400	300849	26.6	47.8800	0.000448	3.137E-11	10.50
120	86400	387596	10.1	18.1800	0.000170	5.827E-12	11.23
456	1209600	939462	71.1	127.9800	0.001197	3.571E-12	11.45
1128	2419200	2716550	154	277.2000	0.002594	1.211E-11	10.92
2160	3715200	5768861	154	277.2000	0.002594	1.090E-11	10.96

Average Leach Index: 11.14

Gross Alpha Leaching for the Bulk Fraction #2 from the CRSB Soil



Gross Beta Leaching for the Bulk Fraction #2 from the CSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C612

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	23.2	Sample Weight (g):	387.5
Initial Contaminant Level (pCi):	8990		
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	0.575	1.0350	0.000115	1.785E-12	11.75
7	18000	14835	0.866	1.5588	0.000173	5.339E-12	11.27
24	61200	51231	1.47	2.6460	0.000294	4.596E-12	11.34
48	86400	125894	0.76	1.3680	0.000152	1.515E-12	11.82
72	86400	213818	1.47	2.6460	0.000294	9.624E-12	11.02
96	86400	300849	0.1	0.1800	0.000020	6.266E-14	13.20
120	86400	387596	0.91	1.6380	0.000182	6.685E-12	11.17
456	1209600	939462	3.53	6.3540	0.000707	1.244E-12	11.91
1128	2419200	2716550	1.73	3.1140	0.000346	2.160E-13	12.67
2160	3715200	5768861	1.44	2.5920	0.000288	1.348E-13	12.87

Average Leach Index: 11.90

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C612

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	182	Sample Weight (g):	387.5
Initial Contaminant Level (pCi):	70525		
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	31.2	56.1600	0.000796	8.540E-11	10.07
7	18000	14835	31.3	56.3400	0.000799	1.133E-10	9.95
24	61200	51231	89.5	161.1000	0.002284	2.768E-10	9.56
48	86400	125894	41.6	74.8800	0.001062	7.374E-11	10.13
72	86400	213818	84.8	152.6400	0.002164	5.204E-10	9.28
96	86400	300849	38.9	70.0200	0.000993	1.541E-10	9.81
120	86400	387596	44.8	80.6400	0.001143	2.633E-10	9.58
456	1209600	939462	245	441.0000	0.006253	9.738E-11	10.01
1128	2419200	2716550	427	768.6000	0.010898	2.138E-10	9.67
2160	3715200	5768861	278	500.4000	0.007095	8.161E-11	10.09

Average Leach Index: 9.81

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C622

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	23.2	Sample Weight (g):	389.37
Initial Contaminant Level (pCi):	9033.384		
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	0.25	0.4500	0.000050	3.342E-13	12.48
7	18000	14835	0.544	0.9792	0.000108	2.087E-12	11.68
24	61200	51231	0.107	0.1926	0.000021	2.412E-14	13.62
48	86400	125894	0.0216	0.0389	0.000004	1.212E-15	14.92
72	86400	213818	0.811	1.4598	0.000162	2.901E-12	11.54
96	86400	300849	0.568	1.0224	0.000113	2.002E-12	11.70
120	86400	387596	0.217	0.3906	0.000043	3.765E-13	12.42
456	1209600	939462	1.14	2.0520	0.000227	1.285E-13	12.89
1128	2419200	2716550	4.05	7.2900	0.000807007	1.17245E-12	11.93
2160	3715200	5768861	0.63	1.1340	0.000125534	2.55456E-14	13.59

Average Leach Index: 12.68

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C622

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	182	Sample Weight (g):	389.37
Initial Contaminant Level (pCi):	70865.34		
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	24.7	44.4600	0.000627	5.301E-11	10.28
7	18000	14835	19	34.2000	0.000483	4.136E-11	10.38
24	61200	51231	54.9	98.8200	0.001394	1.032E-10	9.99
48	86400	125894	19.3	34.7400	0.000490	1.572E-11	10.80
72	86400	213818	39.1	70.3800	0.000993	1.096E-10	9.96
96	86400	300849	44.5	80.1000	0.001130	1.997E-10	9.70
120	86400	387596	22.7	40.8600	0.000577	6.695E-11	10.17
456	1209600	939462	139	250.2000	0.003531	3.104E-11	10.51
1128	2419200	2716550	245	441.0000	0.006223	6.972E-11	10.16
2160	3715200	5768861	194	349.2000	0.004928	3.936E-11	10.40

Average Leach Index: 10.24

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C632

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	23.2	Sample Weight (g):	367.95
Initial Contaminant Level (pCi):	8536.44		
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	0.478	0.8604	0.000101	1.368E-12	11.86
7	18000	14835	0.442	0.7956	0.000093	1.543E-12	11.81
24	61200	51231	0.72	1.2960	0.000152	1.223E-12	11.91
48	86400	125894	0.451	0.8118	0.000095	5.915E-13	12.23
72	86400	213818	1.81	3.2580	0.000382	1.618E-11	10.79
96	86400	300849	0.786	1.4148	0.000166	4.294E-12	11.37
120	86400	387596	0.538	0.9684	0.000113	2.592E-12	11.59
456	1209600	939462	6.41	11.5380	0.001352	4.550E-12	11.34
1128	2419200	2716550	0.749	1.3482	0.000158	4.491E-14	13.35
2160	3715200	5768861	1.78	3.2040	0.000375	2.284E-13	12.64

Average Leach Index: 11.89

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C632

Analyst: PRL **Date:** 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	182	Sample Weight (g):	367.95
Initial Contaminant Level (pCi):	66966.9		
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	17	30.6000	0.000457	2.812E-11	10.55
7	18000	14835	18.6	33.4800	0.000500	4.439E-11	10.35
24	61200	51231	67.4	121.3200	0.001812	1.741E-10	9.76
48	86400	125894	27.7	49.8600	0.000745	3.626E-11	10.44
72	86400	213818	44.3	79.7400	0.001191	1.575E-10	9.80
96	86400	300849	24.8	44.6400	0.000667	6.946E-11	10.16
120	86400	387596	29.1	52.3800	0.000782	1.232E-10	9.91
456	1209600	939462	105	189.0000	0.002822	1.984E-11	10.70
1128	2419200	2716550	305	549.0000	0.008198	1.210E-10	9.92
2160	3715200	5768861	187	336.6000	0.005026	4.095E-11	10.39

Average Leach Index: 10.20

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C642

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	23.2	Sample Weight (g):	378.12
Initial Contaminant Level (pCi):	8772.384		
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	0.367	0.6606	0.000075	7.637E-13	12.12
7	18000	14835	0.365	0.6570	0.000075	9.961E-13	12.00
24	61200	51231	0.781	1.4058	0.000160	1.362E-12	11.87
48	86400	125894	0.305	0.5490	0.000063	2.562E-13	12.59
72	86400	213818	0.783	1.4094	0.000161	2.868E-12	11.54
96	86400	300849	0.561	1.0098	0.000115	2.071E-12	11.68
120	86400	387596	0.886	1.5948	0.000182	6.656E-12	11.18
456	1209600	939462	2.51	4.5180	0.000515	6.606E-13	12.18
1128	2419200	2716550	7.41	13.3380	0.001520	4.162E-12	11.38
2160	3715200	5768861	0.456	0.8208	0.000094	1.419E-14	13.85

Average Leach Index: 12.04

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: C642

Analyst: PRL **Date:** 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	182	Sample Weight (g):	378.12
Initial Contaminant Level (pCi):	68817.84		
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	11.2	20.1600	0.000293	1.156E-11	10.94
7	18000	14835	21.4	38.5200	0.000560	5.564E-11	10.25
24	61200	51231	24.3	43.7400	0.000636	2.143E-11	10.67
48	86400	125894	15.6	28.0800	0.000408	1.089E-11	10.96
72	86400	213818	25.8	46.4400	0.000675	5.059E-11	10.30
96	86400	300849	27.5	49.5000	0.000719	8.087E-11	10.09
120	86400	387596	20.2	36.3600	0.000528	5.622E-11	10.25
456	1209600	939462	263	473.4000	0.006879	1.178E-10	9.93
1128	2419200	2716550	251	451.8000	0.006565	7.759E-11	10.11
2160	3715200	5768861	194	349.2000	0.005074	4.174E-11	10.38

Average Leach Index: 10.39

ATTACHMENT
~~Appendix~~ C

Chain-of-Custody & Request-for-Analysis

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426618
Page 1 of 2

Project Name/No.[1] SAIC 777304 000/85500
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] PAUL LOZA
Purchase Order No.[6]
Required Report Date[11] 12/4/98

Samples Shipment Date[7] 11/23/98
Lab Destination[8] ETDC
Lab Contact[9] RALPH LOCO
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]
Report to:[10]

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C311F00	STAG. SOIL	11/11/98 1600	2"X4" MAC	200ML	NONE	UCS (14 DAY)	ETDC 7805	
C321F00							ETDC 7806	
C331F00							ETDC 7807	
C341F00							ETDC 7808	
C411F00							ETDC 7809	
C421F00							ETDC 7810	
C431F00							ETDC 7811	
C441F00							ETDC 7812	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☑ Rush ☐

QC Level:[27]
I. ☐ II. ☑ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) [signature] Date: 11/23/98 Time: 1030	1. Received by[28] (Signature/Affiliation) IT/ETDC Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29] (2) samples marked C421 F00

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426618

Page 2 of 2

Project Name SALE

Project No. 777304.000105.00

Samples Shipment Date 11/23/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
C511F00	SOIL. SOIL.	1600 11/11/98	2x4" BRASS	200ML	NONE	VOCS (14 DAY)	ETDC 7813	
C521F00	↓	↓	↓	↓	↓	↓	ETDC 7814	
C531F00							ETDC 7815	
C541F00							ETDC 7816	
C611F00							ETDC 7817	
C621F00							ETDC 7818	
C631F00							ETDC 7819	
C641F00							ETDC 7820	

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426623
Page 1 of 2

Project Name/No.[1] JAIC 777304
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LEAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 11/23/98
Lab Destination[8] ETDC
Lab Contact[9] R. COLE
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]
Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C312K00	STAG. SOIL	1600 11/11/98	2x4 MOLD	200ML	NONE	PERMEABILITY RE SHRINK/SWELL 4-19-99 28 DAY, THEN IMMERSE FOR 90 DAYS	ETDC 7821	
C322K00	↓	↓	↓	↓	↓	↓	ETDC 7822	
C332K00							ETDC 7823	
C342K00							ETDC 7824	
C412K00							ETDC 7825	
C422K00							ETDC 7826	
C432K00							ETDC 7827	
C442K00	↓	↓	↓	↓	↓	↓	ETDC 7828	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ___ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation)	Date: Time:	1. Received by[28] (Signature/Affiliation) Don Hinsley IT/ETDC	Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments:[29] 28 Days = 12/9/98

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426623
Page 2 of 2

Project Name SAIC

Project No. 777304

Samples Shipment Date 11/23/98

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Pre-servative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]
C512K00	STAS. SOIL	1600 11/11/98	2x4 MOLD	200ML	NONE	PERMEABILITY ~~SHRINK/SWELL~~	ETDC 7829	
C522K00 (22 PM)	↓	↓	↓	↓	↓	28 DAY, THE 90 DAY IMMERSE	ETDC 7830	
C532K00	↓	↓	↓	↓	↓	↓	ETDC 7831	
C542K00	↓	↓	↓	↓	↓	↓	ETDC 7832	
C612K00	↓	↓	↓	↓	↓	↓	ETDC 7833	
C622K00	↓	↓	↓	↓	↓	↓	ETDC 7834	
C632K00	↓	↓	↓	↓	↓	↓	ETDC 7835	
C642K00	↓	↓	↓	↓	↓	↓	ETDC 7836	

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426620
Page 1 of 2

Project Name/No.[1] 777304/SAIC
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. Cobb
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 11/23/98
Lab Destination[8] ETDC
Lab Contact[9] R. Cobb
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]
Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C313F00	SIMS SOIL	1600 11/11/98	2x4 MOPS	200mL	NONE	UCS (IMMERSION AT 28 DAY, TEST AFTER 90 DAYS IMMERSED)	ETDC 7837	
C323F00	↓	↓	↓	↓	↓	↓	ETDC 7838	
C333F00							ETDC 7839	
C343F00							ETDC 7840	
C413F00							ETDC 7841	
C423F00							ETDC 7842	
C433F00							ETDC 7843	
C443F00	↓	↓	↓	↓	↓	↓	ETDC 7844	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation)	Date: Time:	1. Received by[28] (Signature/Affiliation) IT/ETDC	Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments:[29] 28 DAYS = 12/9/98
TEST @ 90 DAYS IMMERSED 2/9/99

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426620

Page 2 of 2

Project Name 777304

Project No. SAIC

Samples Shipment Date 11/29/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
C513F00	STAS SOIL	1600 11/11/98	2x4 JARS	200ML	NONE	UCS (IMMERSION AT 28 DAY, TEST AFTER 90 DAYS IMMERSED)	ETDC 7845	
C523F00							ETDC 7846	
C533F00							ETDC 7847	
C543F00							ETDC 7848	
C613F00							ETDC 7849	
C623F00							ETDC 7850	
C633F00							ETDC 7851	
C643F00							ETDC 7852	

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

2

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426622
Page 1 of 2

Project Name/No.[1] SAIC 777304
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LEAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 11/23/98
Lab Destination[8] ETDC
Lab Contact[9] R. Corio
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]

Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C313G00	STAB SOIL	1600 11/11/98	346 WIDE	500ML	NONE	SHRINK/SWELL @ 28 DAYS ~~PERMEABILITY (FLEXIBLE WALL) AFTER 28 DAY TEST AFTER 90 DAYS (PROPOSED)~~ cc 4-19-99	ETDC 7853	
C323G00							ETDC 7854	
C333G00							ETDC 7855	
C343G00							ETDC 7856	
C413G00							ETDC 7857	
C423G00							ETDC 7858	
C433G00							ETDC 7859	
C443G00							ETDC 7860	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) Date: Time:	1. Received by[28] (Signature/Affiliation) IT/ETDC Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29] 28 DAYS = 12/9/98

*See back of form for special instructions

2

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426622
Page 2 of 2

Project Name SAIC

Project No. 777304

Samples Shipment Date 11/23/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
C513G00	STAB. SOIL	1600 11/11/98	3x6 MOLD	500ML	NONE	SHRINK/SWELL @ 28 ~~PERMEABILITY~~ DAYS	ETDC 7861	
C523G00						~~[illegible] AT 28 DAY,~~ ~~TEST [illegible] 90 DAYS [illegible]~~ RC 4-14-99	ETDC 7862	
C533G00							ETDC 7863	
C543G00							ETDC 7864	
C613G00							ETDC 7865	
C623G00							ETDC 7866	
C633G00							ETDC 7867	
C643G00							ETDC 7868	

FOR LAB USE ONLY

FOR LAB USE ONLY

FOR LAB USE ONLY

FOR LAB USE ONLY

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions.

3

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426621
Page 1 of 2

Project Name/No. 1
Sample Team Members 2
Profit Center No. 3
Project Manager 4
Purchase Order No. 6
Required Report Date 11

Samples Shipment Date 7
Lab Destination 8
Lab Contact 9
Project Contact/Phone 12
Carrier/Waybill No. 13

Bill to: 5

Report to: 10

ONE CONTAINER PER LINE

Sample Number 14	Sample Description/Type 15	Date/Time Collected 16	Container Type 17	Sample Volume 18	Pre-servative 19	Requested Testing Program 20	Condition on Receipt 21	Disposal Record No. 22
C412G00	STAS SOIL	1600 11/11/98	3x6 MOLD	500 ML	NONE	PERMEABILITY (28 DAY)	ETDC 7869	
C422G00	↓	↓	↓	↓	↓	↓	ETDC 7870	
C432G00	↓	↓	↓	↓	↓	↓	ETDC 7871	
C442G00	↓	↓	↓	↓	↓	↓	ETDC 7872	
C512G00	↓	↓	↓	↓	↓	↓	ETDC 7873	
C522G00	↓	↓	↓	↓	↓	↓	ETDC 7874	
C532G00	↓	↓	↓	↓	↓	↓	ETDC 7875	
C542G00	↓	↓	↓	↓	↓	↓	ETDC 7876	

Special Instructions: 23

Possible Hazard Identification: 24
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal: 25
Return to Client ☐ Disposal by Lab ☐ Archive ___ (mos.)

Turnaround Time Required: 26
Normal ☐ Rush ☐

QC Level: 27
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by 28 (Signature/Affiliation)	Date: Time:	1. Received by 28 (Signature/Affiliation) Don Hinkley IT/ETDC	Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments: 29 28 DAYS = 12/9/98

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426621
Page 2 of 2

Project Name SAIC

Project No. 777304

Samples Shipment Date 11/23/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
C612G00	STAB SOIL	1600 11/11/98	3x6 MOS	500 ML	NONE	PERMEABILITY C22 ONLY	ETDC 7877	
C622G00							ETDC 7878	
C632G00							ETDC 7879	
C642G00							ETDC 7880	
C712G00							ETDC 7881	
C322G00							ETDC 7882	
C332G00							ETDC 7883	
C342G00							ETDC 7884	

White: To accompany samples
Yellow: Field copy

*See back of form for special instructions.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426619
Page 1 of 2

Project Name/No.[1] SALC 777304
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LOAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 11/23/98
Lab Destination[8] ETDC
Lab Contact[9] RALPH COLE
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]

Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C3ZTF00 (12PM)	STAG. SOIL	11/14/98 (1600)	2"x4" MOD	200mL	NONE	UCS (28 DAY)	ETDC 7885	
C322F00							ETDC 7886	
C332F00							ETDC 7887	
C342F00							ETDC 7888	
C412F00							ETDC 7889	
C422F00							ETDC 7890	
C432F00							ETDC 7891	
C442F00							ETDC 7892	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☑ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) [signature] Date: 11/23/98 Time: 1030	1. Received by[28] (Signature/Affiliation) DON HINKLEY / ETDC Date: 11-23-98 Time: 1100
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29] 28 DAYS = 12/9/98

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426619
Page 2 of 2

Project Name SAIC

Project No. 777304

Samples Shipment Date 11/23/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
C512 Foo	STAS. SOIL	1600 11/11/98	2"x4" WAB	200ml	None	UCS (28 DAY)	ETDC 7893	
C522 Foo							ETDC 7894	
C532 Foo							ETDC 7895	
C542 Foo							ETDC 7896	
C612 Foo							ETDC 7897	
C622 Foo							ETDC 7898	
C632 Foo							ETDC 7899	
C642 Foo							ETDC 7900	

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426624
Page 1 of 2

Project Name/No.[1] SAIC 777304 00010500
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LEAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 11/24/98
Lab Destination[8]
Lab Contact[9] R. COLE
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]

Report to:[10]

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
C100Q00	SOIL	0800 11/24/98	BAG 1-GALLON	1-L	NONE	ATTERBERG LIMITS, GRAIN SIZE W/HYDROMETER, MOISTURE CONTENT, SPECIFIC GRAVITY, USCS CLASSIFICATION	ETDC 7902	
C200Q00							ETDC 7903	
C300Q00							ETDC 7904	
C400Q00							ETDC 7905	
C500Q00							ETDC 7906	
C600Q00							ETDC 7907	
C700Q00							ETDC 7908	
C800Q00							ETDC 7909	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify): ____

1. Relinquished by[28] (Signature/Affiliation)	Date: Time:	1. Received by[28] DON Hamberg IT/ETDC	Date: 11-24-98 Time: 0930
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments:[29]

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426624

Project Name SAIC

Project No. 77730Y.00010500

Samples Shipment Date 11/24/98

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Preservative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]
K100G00	SOIL	0800 11/24/98	1-GALLON BAG	1-L	NONE	ATTERBERG LIMITS, GRAIN SIZE W/ HYDROMETER, MOISTURE CONTENT, SPECIFIC GRAVITY, USCS CLASSIFICATION	ETDC 7910	
K200G00							ETDC 7911	
K300G00							ETDC 7912	
K400G00							ETDC 7913	
K700G00							ETDC 7914	
K800G00							ETDC 7915	

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426868
Page 1 of ___

Project Name/No.[1] SALK/SAS 777304
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LOAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7]
Lab Destination[8] ETDC
Lab Contact[9] R. CARR
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]

Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
K311F00	SIAS. Soil	11/25/98	2x4 MOLD	200mL	NONE	UCS	ETDC 7948	
K321F00							ETDC 7949	
K331F00							ETDC 7950	
K341F00							ETDC 7951	
K411F00							ETDC 7952	
K421F00							ETDC 7953	
K431F00							ETDC 7954	
K441F00							ETDC 7955	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☑

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation)	Date: 12/11/98 Time: 0900	1. Received by[28] (Signature/Affiliation)	Date: 12-11-98 Time: 0900
2. Relinquished by (Signature/Affiliation) FT Corp	Date: 12/11/98 Time: 0955	2. Received by (Signature/Affiliation) IT ETDC	Date: 12-11-98 Time: 0955
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments:[29]
16 DAY AGE ON DEC. 11, 1998

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

777304.00010500

Reference Document No. 426869
Page 1 of 3

Project Name/No.[1] SAIC WSRC
Sample Team Members[2] Bennett
Profit Center No.[3] 6585001
Project Manager[4] Paul Leak
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7]
Lab Destination[8] ETDC
Lab Contact[9] RALPH Cole
Project Contact/Phone[12] Paul Leak
Carrier/Waybill No.[13] HAND

Bill to:[5] 777304:00010500
Report to:[10] Paul Leak

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
K312 K00 M00	Solidified Soil	11/25/98	Plastic	2"x4"	None	Shrink/Swell at 28 Days PERMEABILITY RC 4.14.99	ETDC 7967	
K322 K00 M00							ETDC 7968	
K332 K00 M00							ETDC 7969	
K342 K00 M00							ETDC 7970	
K412 K00 M00							ETDC 7971	
K422 K00 M00							ETDC 7972	
K432 K00 M00							ETDC 7973	
K442 K00 M00							ETDC 7974	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ___ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) P Clegg BSM	Date: 12/15/98 Time: 0955	1. Received by[28] (Signature/Affiliation) [illegible] ETDC	Date: 12/15/98 Time: 1000
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments[29]

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426869
Page 2 of 3

Project Name SAIC WSRC

Project No. 777304

Samples Shipment Date

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
K312 F00	Solidified Soil	11/25/98	Plastic	2"x4"	None	UCS at 28 Days	ETDC 7975	
K322 F00							ETDC 7976	
K332 F00							ETDC 7977	
K342 F00							ETDC 7978	
K412 F00							ETDC 7979	
K422 F00							ETDC 7980	
K432 F00							ETDC 7981	
K442 F00							ETDC 7982	
K312 G00			Plastic	3"x6"		Permeability @ 28 Days STRING SWEAR RE 4-14-99	ETDC 7983	
K322 G00							ETDC 7984	
K332 G00							ETDC 7985	
K342 G00							ETDC 7986	
K412 G00							ETDC 7987	
K422 G00							ETDC 7988	
K432 G00							ETDC 7989	
K442 G00							ETDC 7990	
				ND	12/4/98			
			Next page					

White: To accompany samples Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426869
Page 3 of 3

Project Name SAIC WSRC Project No. 777304 Samples Shipment Date

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21]	Disposal[22] Record No.
K313F00	Solid, Fixed Soil	11/25/98	Plastic	2"x4"	None	Immerse to 28 Days HCS after 90 Days of Immersion	ETDC 7991	
K323F00							ETDC 7992	
K333F00							ETDC 7993	
MD 12/4/98 K343F00							ETDC 7994	
K413F00							ETDC 7995	
K423F00							ETDC 7996	
K433F00							ETDC 7997	
K443F00							ETDC 7998	
K313G00				3"x6"		Immerse @ 28 Days Perm after 90 Days of immersion	ETDC 7999	
K323G00							ETDC 8000	
K333G00							ETDC 8001	
K343G00							ETDC 8002	
K413G00							ETDC 8003	
K423G00							ETDC 8004	
K433G00							ETDC 8005	
K443G00							ETDC 8006	
				MD	12/4/98			

White: To accompany samples Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426631
Page 1 of ___

Project Name/No.[1] 777307.0001.0500 | Samples Shipment Date[7] | Bill to:[5]

Sample Team Members[2] | Lab Destination[8] |

Profit Center No.[3] | Lab Contact[9] R. COLE |

Project Manager[4] P. LOAR | Project Contact/Phone[12] | Report to:[10]

Purchase Order No.[6] | Carrier/Waybill No.[13] |

Required Report Date[11]

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
L100Q00	SOIL	12/21/98	TIME 0700	1-L	NONE	GRAIN SIZE W/ HYDROMETER, SPECIFIC GRAVITY, MOISTURE ATTERBURG LIMITS	ETDC 8009	
L200Q00	↓		0705	↓	↓	↓	ETDC 8010	
L300Q00			0710				ETDC 8011	
L400Q00			0715				ETDC 8012	
L700Q00			0720				ETDC 8013	
L800Q00	↓		0725	↓	↓	↓	ETDC 8014	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ___ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) Date: Time:	1. Received by[28] Don Hensley ITEC Date: 12-23-98 Time: 0900
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29]

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 42663

Project Name SAIC/SES

Project No. 777304.000105 00

Samples Shipment Date 12/23/98

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
P100Q00	SOIL	12/21/98 0820	1-GAL BAG	1-L	NONE	GRAIN SIZE W/ HYDROMETER SPECIFIC GRAVITY, MOISTURE ATTERBURG LIMITS	ETDC 8015	
P200Q00	↓	0825	↓	↓	↓	↓	ETDC 8016	
P300Q00		0900					ETDC 8017	
P400Q00		0905					ETDC 8018	
P500Q00		0910					ETDC 8019	
P600Q00		0915					ETDC 8020	
P700Q00		0920					ETDC 8021	
P800Q00		0925					ETDC 8022	

White: To accompany samples Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426647
Page 1 of 2

Project Name/No.[1] SAIC 777304.0010.3000 | Samples Shipment Date[7] 1/19/99 | Bill to:[5]

Sample Team Members[2] | Lab Destination[8] GEO

Profit Center No.[3] | Lab Contact[9] R. Cobb

Project Manager[4] P. LONG | Project Contact/Phone[12] | Report to:[10]

Purchase Order No.[6] | Carrier/Waybill No.[13]

Required Report Date[11]

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
P313F00	STAS SOIL	1/19/99 0810	2X4 MAG	200mL	NONE	IMMEASE IN WATER FOR 90 DAY, TWEN UCS	ETDC 8023	
P323F00							ETDC 8024	
P333F00							ETDC 8025	
P343F00							ETDC 8026	
P413F00							ETDC 8027	
P423F00							ETDC 8028	
P433F00							ETDC 8029	
P443F00							ETDC 8030	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation)	Date: Time:	1. Received by[28] Don Hankey IT/ETDC	Date: 1-19-99 Time: 0900
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments:[29]

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426699

Page 2 of 2

Project Name SALC

Project No. 777304.00105000

Samples Shipment Date 1/19/99

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
P513F00	STAS, SOIL	1/19/99 0810	2x4 MAS	200ML	NONE	IMMERSION IN WATER FOR 90 DAYS, TCLP	ETDC 8031	
P523F00							ETDC 8032	
P533F00							ETDC 8033	
P543F00							ETDC 8034	
P613F00							ETDC 8035	
P623F00							ETDC 8036	
P633F00							ETDC 8037	
P634F00							ETDC 8038	
L313F00							ETDC 8039	
L323F00							ETDC 8040	
L333F00							ETDC 8041	
L343F00							ETDC 8042	
L413F00							ETDC 8043	
L423F00							ETDC 8044	
L433F00							ETDC 8045	
L443F00							ETDC 8046	
							USE	

White: To accompany samples Yellow: Field copy

*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426648
Page 1 of 2

Project Name/No.[1] SAIC 777304 00105000
Sample Team Members[2]
Profit Center No.[3]
Project Manager[4] P. LEAR
Purchase Order No.[6]
Required Report Date[11]

Samples Shipment Date[7] 1/19/99
Lab Destination[8] GEO
Lab Contact[9] L. COLE
Project Contact/Phone[12]
Carrier/Waybill No.[13]

Bill to:[5]
Report to:[10]

White: To accompany samples
Yellow: Field copy

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
P312F00	STAG. SOIL	1/19/99 0815	2x4 MACO	200ML	NONE	UCS @ 28 DAY	ETDC 8047	
P322F00							ETDC 8048	
P332F00							ETDC 8049	
P342F00							ETDC 8050	
P412F00							ETDC 8051	
P422F00							ETDC 8052	
P432F00							ETDC 8053	
P442F00							ETDC 8054	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) Date: Time:	1. Received by[28] (Signature/Affiliation) IT/ETEC Date: 1-19-99 Time: 0900
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29]

*See back of form for special instructions.

MCA 3/15/91

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426648
Page 2 of 2

Project Name SALC 777304.00105000

Project No. _____

Samples Shipment Date 1/19/99

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Pre-servative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]
P512F00	STAB SOIL	1/19/99 0815	2x4 MOLD	200ml	NONE	UCS @ 28 DAY	ETDC 8055	
P522F00							ETDC 8056	LAB ONLY
P532F00							ETDC 8057	
P542F00							ETDC 8058	LAB ONLY
P612F00							ETDC 8059	
P622F00							ETDC 8060	LAB ONLY
P632F00							ETDC 8061	
P642F00							ETDC 8062	
L ~~K~~312F00							ETDC 8063	LAB ONLY
L ~~K~~322F00							ETDC 8064	
L ~~K~~332F00							ETDC 8065	LAB ONLY
L ~~K~~342F00							ETDC 8066	
L ~~K~~412F00							ETDC 8067	LAB ONLY
L ~~K~~422F00							ETDC 8068	
L ~~K~~432F00							ETDC 8069	LAB ONLY
L ~~K~~442F00							ETDC 8070	

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426649
Page 1 of 2

Project Name/No. 1 SAIC 777304.00105000
Samples Shipment Date 7 1/19/99
Bill to: 5
Sample Team Members 2
Lab Destination 8 GEO
Profit Center No. 3
Lab Contact 9 R. Cole
Project Manager 4 P. Lear
Project Contact/Phone 12
Report to: 10
Purchase Order No. 6
Carrier/Waybill No. 13
Required Report Date 11

ONE CONTAINER PER LINE

Sample Number 14	Sample Description/Type 15	Date/Time Collected 16	Container Type 17	Sample Volume 18	Pre-servative 19	Requested Testing Program 20	Condition on Receipt 21	Disposal Record No. 22
P312K00	STAS. SOIL	1/19/99 0830	2x4 MOLD	200ML	NONE	~~SHRINK/SWELL~~ DH 1-19-99 HYDRAULIC CONDUCTIVITY	ETDC 8071	
P322K00	↓	↓	↓	↓	↓	↓	ETDC 8072	
P332K00	↓	↓	↓	↓	↓	↓	ETDC 8073	
P342K00	↓	↓	↓	↓	↓	↓	ETDC 8074	
P412K00	↓	↓	↓	↓	↓	↓	ETDC 8075	
P422K00	↓	↓	↓	↓	↓	↓	ETDC 8076	
P432K00	↓	↓	↓	↓	↓	↓	ETDC 8077	
P442K00	↓	↓	↓	↓	↓	↓	ETDC 8078	

Special Instructions: 23

Possible Hazard Identification: 24
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal: 25
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required: 26
Normal ☐ Rush ☐

QC Level: 27
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by 28 (Signature/Affiliation)	Date: Time:	1. Received by 28 Don Hunley (Signature/Affiliation) IT/ETDC	Date: 1-19-99 Time: 0900
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments: 29

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426649
Page 2 of 2

Project Name SALC

Project No. 777304.00105000

Samples Shipment Date 1/19/99

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21]	Disposal[22] Record No.
P512K00	STAB. SOIL	1/19/99 0830	2x4 MOLD	200ML	NONE	PERMEABILITY SHRINK/SWELL RC 3-30-99	ETDC 8079	
P522K00							ETDC 8080	LAB ONLY
P532K00							ETDC 8081	
P542K00							ETDC 8082	LAB ONLY
P612K00							ETDC 8083	
P622K00							ETDC 8084	
P632K00							ETDC 8085	LAB ONLY
P642K00							ETDC 8086	
L312K00							ETDC 8087	LAB ONLY
L322K00							ETDC 8088	
L332K00							ETDC 8089	
L342K00							ETDC 8090	LAB ONLY
L412K00							ETDC 8091	
L422K00							ETDC 8092	LAB ONLY
L432K00							ETDC 8093	
L442K00							ETDC 8094	
							EXP USE	LAB ONLY

White: To accompany samples
Yellow: Field copy

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426646
Page 1 of 2

Project Name/No.[1] SAIC 777304.0005.08 Samples Shipment Date[7] 1/19/99 Bill to:[5]

Sample Team Members[2] Lab Destination[8] GEO

Profit Center No.[3] Lab Contact[9] R. COLE

Project Manager[4] P. LONG Project Contact/Phone[12] Report to:[10]

Purchase Order No.[6] Carrier/Waybill No.[13]

Required Report Date[11]

ONE CONTAINER PER LINE

Sample Number[14]	Sample Description/Type[15]	Date/Time Collected[16]	Container Type[17]	Sample Volume[18]	Preservative[19]	Requested Testing Program[20]	Condition on Receipt[21]	Disposal Record No.[22]
P312G00	STAG. SOIL	1/19/99 0820	3x6 per 2x4 MOLD	1000 per 200 mL	NONE	SHANNON/SWETT PAH 1-12-99	ETDC 8095	
P322G00	↓	↓	↓	↓	↓	↓	ETDC 8096	
P332G00							ETDC 8097	
P342G00							ETDC 8098	
P412G00							ETDC 8099	
P422G00							ETDC 8100	
P432G00							ETDC 8101	
P442G00	↓	↓	↓	↓	↓	↓	ETDC 8102	

Special Instructions:[23]

Possible Hazard Identification:[24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:[25]
Return to Client ☐ Disposal by Lab ☐ Archive ____ (mos.)

Turnaround Time Required:[26]
Normal ☐ Rush ☐

QC Level:[27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by[28] (Signature/Affiliation) Date: Time:	1. Received by[28] DON Hankey T/ETDC Date: 1-19-99 Time: 0900
2. Relinquished by (Signature/Affiliation) Date: Time:	2. Received by (Signature/Affiliation) Date: Time:
3. Relinquished by (Signature/Affiliation) Date: Time:	3. Received by (Signature/Affiliation) Date: Time:

Comments:[29] P's MOLDED 12/22/98 L's MOLDED 12/21/98

White: To accompany samples Yellow: Field copy

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 926646
Page 2 of 2

Project Name 777304

Project No. 00105000

Samples Shipment Date 1/19/99

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Pre-servative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]
P512G00	STAB. SOIL	1/19/99 0820	3x6 oz 2x4 MOLD	1000 ml 2 oz	NONE	HYDRAULIC CONDUCTIVITY	ETDC 8103	
P522G00							ETDC 8104	LAB ONLY
P532G00							ETDC 8105	
P542G00							ETDC 8106	LAB ONLY
P612G00							ETDC 8107	
P622G00							ETDC 8108	
P632G00							ETDC 8109	LAB ONLY
P642G00							ETDC 8110	
L312G00							ETDC 8111	LAB ONLY
L322G00							ETDC 8112	
L332G00							ETDC 8113	
L342G00							ETDC 8114	LAB ONLY
L412G00							ETDC 8115	
L422G00							ETDC 8116	LAB ONLY
L432G00							ETDC 8117	
L442G00							ETDC 8118	
							USE	LAB ONLY

White: To accompany samples

Yellow: Field copy

*See back of form for special instructions.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426645
Page 1 of 2

Project Name/No. 1 777304.00105000
Sample Team Members 2
Profit Center No. 3
Project Manager 4 P. LEAR
Purchase Order No. 6
Required Report Date 11

Samples Shipment Date 7 1/19/99
Lab Destination 8 GEO
Lab Contact 9 R. COLE
Project Contact/Phone 12
Carrier/Waybill No. 13

Bill to: 5
Report to: 10

ONE CONTAINER PER LINE

Sample Number 14	Sample Description/Type 15	Date/Time Collected 16	Container Type 17	Sample Volume 18	Pre-servative 19	Requested Testing Program 20	Condition on Receipt 21	Disposal Record No. 22
P313G00	STAB. SOIL	1/19/99 0825	3x6 MOLD	1000ML	NONE	IMMERSION IN WATER FOR 90 DAYS THEN HYDRAULIC CONDUCTIVITY	ETDC 8119	
P323G00	↓	↓	↓	↓	↓	↓	ETDC 8120	
P333G00	↓	↓	↓	↓	↓	↓	ETDC 8121	
P343G00	↓	↓	↓	↓	↓	↓	ETDC 8122	
P413G00	↓	↓	↓	↓	↓	↓	ETDC 8123	
P423G00	↓	↓	↓	↓	↓	↓	ETDC 8124	
P433G00	↓	↓	↓	↓	↓	↓	ETDC 8125	
P443G00	↓	↓	↓	↓	↓	↓	ETDC 8126	

Special Instructions: 23

Possible Hazard Identification: 24
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal: 25
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required: 26
Normal ☐ Rush ☐

QC Level: 27
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by 28 (Signature/Affiliation)	Date: Time:	1. Received by 28 (Signature/Affiliation) [signature] T/ETDC	Date: 1-19-99 Time: 0900
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments: 29

White: To accompany samples
Yellow: Field copy
*See back of form for special instructions

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (cont.)*

Reference Document No.[30] 426645

Project Name 277304

Project No. 00105000

Samples Shipment Date 1/19/99

ONE CONTAINER PER LINE

Sample[14] Number	Sample[15] Description/Type	Date/Time[16] Collected	Container[17] Type	Sample[18] Volume	Pre-[19] servative	Requested Testing[20] Program	Condition on[21] Receipt	Disposal[22] Record No.
P573G00	STAIN. SOIL	1/19/99 0815	3x6 MMS	1000ML	NONE	IMMERSION IN WATER FOR 90 DAYS THE HYDRAULIC CONDUCTIVITY	ETDC 8127	
P523G00							ETDC 8128	
P533G00							ETDC 8129	
P543G00							ETDC 8130	
P613G00							ETDC 8131	
P623G00							ETDC 8132	
P633G00							ETDC 8133	
P643G00							ETDC 8134	
L313G00							ETDC 8135	
L323G00							ETDC 8136	
L333G00							ETDC 8137	
L343G00							ETDC 8138	
L413G00							ETDC 8139	
L423G00							ETDC 8140	
L433G00							ETDC 8141	
L443G00							ETDC 8142	

White: To accompany samples Yellow: Field copy

*See back of form for special instructions.

ATTACHMENT

~~Appendix~~ D

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: SAK SAVANNAH RIVER Project No.: 777304.00010500	Date: 12-17-98	Page 1 of 1 Report No.: ETDC-074-99

Nonconformance/Variance Description (include requirement violated)

EXPANSION/SHRINKAGE By ASTM D3877

Samples DO NOT MEET THE REQUIREMENTS of THE METHOD BECAUSE WE ARE COTING CURED MATERIAL AND PLACING INTO RINGS INSTEAD OF COMPACTING FRESH MATERIAL INTO RINGS. ALSO, NO EXPANSION IS BEING OBSERVED SO SUGGEST NO FURTHER LOADING TAKE PLACE. NO EXPANSION CORRECT WILL BE REPORTED.

Identified by RALPH COLE

Root Cause

N/A

Corrective Action (include expected completion date)

N/A DETAIL CIRCUMSTANCE IN REPORT.

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 LOGAN NOTIFIED 12-17-98 VIA TELEPHONE
RESPONSE WAS TO DO THE BEST WE CAN, RFA DOES NOT CONSIDER MATERIAL BEING TESTED

Notified by RALPH COLE Date 12/17/98

Corrective action completed by RALPH COLE Date 4-19-99

Corrective action approved by

Laboratory Supervisor _____ Date 12-17-98

Project Manager _____ Date 12-17-98

QA Comments

QAO Approval _____ Date 4-19-99

Use back of page for additional space. Attach additional pages if necessary.

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: SAIC SAVANNAH RIVER	Date: 1/20/99	Page 1 of 1
	Project No.: 777304.00010500		Report No.: ETOC-075

Nonconformance/Variance Description (include requirement violated)

PERMEABILITY TESTS BY ASTM D 5084
STEADY STATE REQUIREMENT of SECTION 8.5.3 NOT BEING ATTAINED WITHIN REQUIRED TURNAROUND TIME. (NEED EQUIPMENT FOR NEXT BATCH of SAMPLES).

Identified by DON HUSKEY

Root Cause

MANY SAMPLES HAVE VERY LOW PERMEATION RATES, REQUIRING EXTENDED TEST TIMES AND. THUS, FEWER TESTS CAN BE PERFORMED WITHIN TURNAROUND TIME.

Corrective Action (include expected completion date)

NOTE CONDITION IN REPORT

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 LEHR, VERBAL DURING VISIT. RESPONSE WAS THAT TEST CRITERIA (FOR CLIENT REQUIREMENTS) ARE BEING MET AND WE CAN GO AHEAD AND STOP TESTS WHEN NECESSARY.

Notified by RALPH COLE Date 1/20/99

Corrective action completed by RALPH COLE Date 4-19-99

Corrective action approved by

Laboratory Supervisor _____ Date 1/20/99

Project Manager _____ Date 1/20/99

QA Comments

QAO Approval _____ Date 4-19-99

Use back of page for additional space. Attach additional pages if necessary.

Appendix B

Sampling Notes

This page intentionally left blank.

Project Name SAIC/SRS

Project Number 777304

1175:005

11/03/98

CRSB SOIL SAMPLES COMPOSITED IN PLASTIC PANS (2' x 3')
GRAB SAMPLES (C100G00 AND C200G00) TAKEN FOR GEOTECHNICAL
CHARACTERIZATION & C100C00 TAKEN FOR INORGANIC ANALYSIS.

CLAYEY MATERIAL SEGREGATED BY REMOVING VISIBLE "CLAY BALLS"
FROM 1 OF THE 2 TRAYS TO MAKE FINE FRACTION FOR
MIX DESIGN TESTING. FINE FRACTION SAMPLED FOR CHARACTERIZATION
MATERIAL REMAINING IN THE TRAY BECAME THE COARSE FRACTION
AND WAS SAMPLED FOR CHARACTERIZATION (C~~4~~3 PM 11/3/98 00G00, C~~4~~3 PM 11/3/98 00B00 &
C~~4~~3 PM 11/3/98 00A00).

MATERIAL IN OTHER TRAY WAS HOMOGENIZED & SPLIT INTO 2 BULK
FRACTIONS. EACH FRACTION WAS SAMPLED FOR CHARACTERIZATION
(SEE FIGURE 6.1 IN WORKPLAN FOR SAMPLE NUMBERING). THE
REMAINING SAMPLE IN TRAY WAS SAMPLED FOR CHARACTERIZATION

KRSB SOIL SAMPLES PLACED IN 2 PLASTIC PANS. A SAMPLE OF
THE "CLAY BALLS" AND LOAMY SAND TAKEN FOR CHARACTERIZATION
INORGANIC ANALYSIS.

CLAYEY MATERIAL SEGREGATED BY REMOVING VISIBLE "CLAY B
FROM THE PANS TO MAKE A FINE FRACTION. THE FINE
FRACTION WAS SAMPLED FOR CHARACTERIZATION. MATERIAL
REMAINING IN TRAY BECAME THE COARSE FRACTION AND
WAS SAMPLED FOR CHARACTERIZATION.

DUE TO LOW SAMPLE VOLUME, NO BULK FRACTIONS PRODUCED
REMAINING SOIL IN TRAY WAS SAMPLED FOR CHARACTERIZATION
SEE FIGURE 6.1 IN WORKPLAN FOR SAMPLE NUMBERING.

PM 11/3/

NOTE: PRSB & LRSB SOIL FRACTIONATED IN
SAME MANNER ON 12/18/98. PM 12/18/98

Entries by [signature] Date 11/3/98

oject Name SAIC/SRS

oject Number 777304

1175:006

11/~~10~~ 11/98
MB 11/11/98

Grout mixes For "C" Reactor Seepage basin were prepared using the Formulation design From the work plan. WSRC-RP98-4184 Rev. 0 Oct 1998 page 7

Due to the amount of Sample the work plan Formulation was modified For using 2500 g of Soil, Water was Added equal to the weight of the Dry Reagents (PC & Bentonite)

Adjusted weights are as Follows

SAIC WSRC Seepage Basin C Formulations					
Formulation	Soil	Portland Cement	Sodium Bentonite	Sodium Silicate	Water
1	2500	468.75	156.25	0	625
2	2500	463.13	0	123.75	463.125
3	2500	481.25	160	64.375	641.25
4	2500	493.75	164.375	131.875	658.125

MB

8/13/98
11 MB 11/13/98

ntries by R Lengy BH

Date 8/13/98

Project Name SMC/SLS

Project Number 77230

1175:007

Mixes were prepared in a Kitchen Aid mixer using a Spade Blade. Molds were Filled in thirds Sample Numbers Followed the plan in the work PLAN.

Base Form #	Room temp. (°C)	mix temp. (°C)	Comments
C41	19.5	21	wet not Fluid Too wet for Comp.
C42	20	20	wetter Than 1
C43	19	20	Hard to mix add 100ml
C44	20	21	
C31	20	22	
C32	20	22	
C33	20	21	ADDed 100ml H
C34	20	21	
C51	20	22	
C52	20	22	
C53	20	22	ADDed 100ml H
C54	20	22	
C61	20	22	
C62	20	21	
C63	20	21	ADDed 100ml H_2
C64	20	21	

Time of Set

all mixes < 4.5 TSF @ 6 hrs
at 16 hrs > 4.5 TSF

NO liquid bleed at 16 hrs.

Entries by [signature]

Date 11/13/98

[signature] 11/14/98

Project Name SAIC/SCS

Project Number 77730

1175:008

RAW Density

C3 - Vol. 2inch Dia x (4-2 7/16) height
mass - 174.20g
Density - 2.17 g/ml

C4 - 2 x 4 inch cylinder
mass - 413.85 g
Density - 2.01 g/ml

C5 - 2 x 4 inch cylinder
mass 415.23 g
Density - 2.02 g/ml

C6 - 2 x 4" cylinder
mass - 411.33 g
Density - 2.00 g/ml

11/13/98

Entries by _____ Date 11/13/98

CHECKED PAR 11/14/98

Project Name SALC/SES

Project Number 777306

1175:009

11/17/98

Samples were ~~ch~~ crushed using a ~~mallet~~ mallet. Twenty grams of each was weighed into a 50 ml plastic cup. 20 ml of H_2O (D.I) was added to ea the paste was stired w/ a tongue depressor. The pH meter was calibrated w/ 7 & 10 buffers. The slope = 98% buffer chk. 7 → 7.02 10 → 10.0

Sample	pH
C520J00	12.80
C340J00	12.78
C420J00	12.81
C410J00	12.40
C530J00	12.59
C620J00	12.72
C440J00	12.72
C630J00	12.62
C320J00	12.68
C610J00	12.32
C430J00	12.56
C310J00	12.30
C640J00	12.68
C510J00	12.28
C330J00	12.52
C540J00	12.63

11/17/98

Entries by _____ Date 11/17/98

1175:010

ct Name SAIC/SES

ct Number 777304

K Basin Formulations.
Samples K3 and K4

	A	B	C	D K	E	F
1	SAIC WSRC Seepage Basin Formulations					
2	ormulatio	Soil	Portland Cement	Sodium Bentonite	Sodium Silicate	Water
3	1	2500	468.75	156.25	0	625
4	2	2500	463.125	0	123.75	463.125
5	3	2500	481.25	160	64.375	641.25
6	4	2500	493.75	164.375	131.875	658.125

Mix	Room temp	Mix Temp		(TSF) PP on 11/30	PH on 12/4
K31	19	21		>4.5	12.64
K32	19	20		>4.5	12.52
K33	19	21	+ 100 ml H_2O	>4.5	12.69
K34	19	21		>4.5	12.40
K41	19	21		>4.5	12.75
K42	19	21		>4.5	12.61
K43	19	21	+ 100 ml H_2O	>4.5	12.78
				>4.5	
				>4.5	12.43

RAW Density

K4 - 421.44 g IN 2x4 Cylinder mold

K3 - 387.27 g IN 2x4 cylinder.

No bleed or Set @ 4 hrs

No bleed after 24 hrs

PH meter cal w/ 7 & 10 slope = 99

7 → 7.00 10 = 9.98

12/18/98

Date 12/19/98

tries by

IT/EFS/1-4-97/WSRC.XLS, Sheet2

Page 1 of 1

PRINT DATE:11/24/98, 3:08 PM

Project Name SAIC WSRC

Project Number 27720

1175:01

ANS 16.1 Mold wts (28 Day Anal).

12/15/98

Sample	mass
K442H00	371.24
K312H00	395.89
K332H00	382.58
K412H00	376.63
K432H00	366.14
K322H00	392.15
K342H00	383.07
K422H00	386.11

Molds placed in 2 plock bags until Start of Extraction.

12/17/98. Red/Ox ~~Pont~~ Potential VSD 12/17/98.

25g of Sample mixed w 25g of water
Redox measured immediately.
Std. (200 ± 10) read 205 mv
Sample K340E00 read −10.0 mv
K410E00 read −7.0 mv
Samples shaken on platform shaker (low)
Started @ 1510.
Stopped @ 0915 12/18/98.

200 std → 190 mv

K340E00 read 0.00
K410E00 read 0.00
both Samples Emulsed so water was added.
Readings Did not change.

Entries by [signature] Date 12/17/9

ject Name SAIC/SRS

ject Number 777304

1175:012

12/21/98

Mix		Room temp	Mix temp	Other
L P31	MB 12/21/98	20°	23°	
L P32	MB 12/21/98	20°	21°	
L P33	MB 12/21/98	~~20°~~ 21° MB 12/21/98	22°	+100 ml H_2O
L P34	MB 12/21/98	20°	21°	
L41		20°	23°	
L42		20°	21°	
L43		20°	22°	+100 ml H_2O
L44		20°	22°	

All mixes set less than 4 hrs

12/22/98

P31	18°	23°	
P32	15°	21°	
P33	18°	21°	581.25g H
P34	18°	20°	
P41	18°	21	
P42	15°	20°	
P43	18°	20°	+100 ml H_2O
P44	15°	20°	
P51	15°	21°	
P52	18°	19°	
P53	15°	19°	+100 mls H_2O
P54	15°	19°	
P61	15°	20°	
P62	18	20°	
P63	18	20°	+100 ml H_2O
P64	18	20	

Entries by [signature] Date 12/22/98

[illegible] 12/23/98

Project Name SAIC / SRS

Project Number 777301

1175:013

SAIC WSRC BASIN L & P Formulations

SAIC WSRC Seepage Basin L Formulations					
Formulation	Soil	Portland Cement	Sodium Bentonite	Sodium Silicate	Water
1	2500	468.75	156.25	0	625
2	2500	463.13	0	123.75	463.125
3	2500	481.25	160	64.375	641.25
4	2500	493.75	164.375	131.875	658.125

12/22/98 MB 12/22/98

SAIC WSRC Seepage Basin P Formulations					
Formulation	Soil	Portland Cement	Sodium Bentonite	Sodium Silicate	Water
1	2500	468.75	156.25	0	625
2	2500	463.13	0	123.75	463.125
3	2500	481.25	160	64.375	641.25
4	2500	493.75	164.375	131.875	658.125

12/22/98 MB 12/22/98

Entries by _____ Date 12/22/98

CHECKED MB 12/23/98

ject Name

ject Number 127304

1175.014

12/23/99 20g OF CRUSHED MATERIAL WAS MIXED WITH 20 mL OF DI WATER. PASTE STIRRED AND pH MEASURED.

SAMPLE	pH		pH
P310J00	12.45	L410J00	12.52
P320J00	12.61	L420J00	12.57
P330J00	12.77	L430J00	12.62
P340J00	12.68	L440J00	12.85
P410J00	12.50		
P420J00	12.68		
P430J00	12.83		
P440J00	12.87		
P510J00	12.39		
P520J00	12.62		
P530J00	12.73		
P540J00	12.86		
P610J00	12.41		
P620J00	12.40		
P630J00	12.73		
P640J00	12.84		
L310J00	12.55		
L320J00	12.73		
L330J00	12.68		
L340J00	12.82		

pH METER WAS CALIBRATED WITH 7 & 10 BUFFERS
CHECK BUFFER READINGS WERE 6.99 AND 10.01.

PAL 12/23/98

Entries by [signature] Date 12/23/98

Project Name SRIC/BRS

Project Number 77730V

1175:01

12/23/98 COMPLETED PORTION OF SOIL FRACTIONS FOR LRSF AND PASE IN 2"x4" MOLDS (RIGHT CYLINDER)

L3	416.75 g
L4	420.43 g
P3	409.62 g
P4	413.79 g
P5	405.56 g
P6	417.31 g

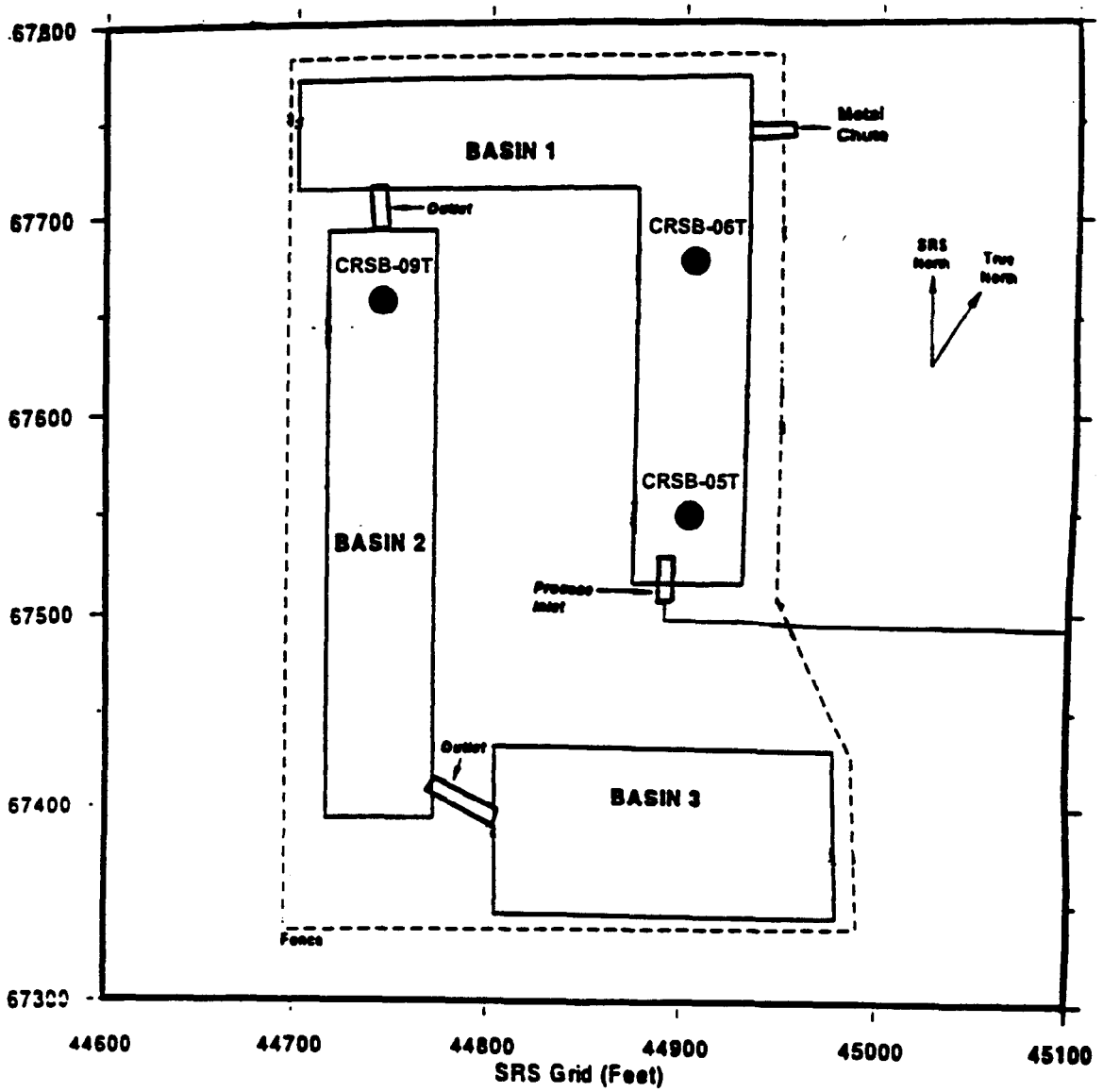
GRR 12/23/98

Entries by [signature] Date 12/23/98

Appendix C

CSRB Sampling Map

This page intentionally left blank.



● - Soil Sampling Locations

C-Reactor Seepage Basins Proposed Sampling Locations

Appendix D

Test Procedures

This page intentionally left blank.

United States Department of Energy

Savannah River Site

SOIL STABILIZATION/SOLIDIFICATION GROUT MIX DESIGN STUDY FOR THE C-, K-, L-, AND P-REACTOR SEEPAGE BASINS CLOSURE PROJECT WORK PLAN (U)

WSRC-RP-98-4184

Revision 0

October 1998

Westinghouse Savannah River Company
Savannah River Site
Aiken, S.C. 29808

SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

Prepared for U.S. Department of Energy Under
Contract DE-AC09-96SR18500

TABLE OF CONTENTS

LIST OF TABLES iii

LIST OF FIGURES iii

LIST OF ACRONYMS iv

1.0 PROJECT DESCRIPTION 1
- 1.1 Background 1
- 1.2 C-Reactor Seepage Basins 2
- 1.3 K-Reactor Seepage Basin 3
- 1.4 L-Reactor Seepage Basin 3
- 1.5 P-Reactor Seepage Basins 3
- 1.6 Related Immobilization Investigation at LAOCB 4

2.0 STUDY AND TEST OBJECTIVES 8
- 2.1 Objectives 8
- 2.2 Study Performance Standards 8

3.0 PREPLANNING ACTIVITIES/TECHNICAL APPROACH 11

4.0 EQUIPMENT, MATERIALS, AND FACILITIES 13
- 4.1 Equipment 13
- 4.2 Materials 13
- 4.3 Facilities 13

5.0 SAMPLE TRANSPORTATION AND TRACKING 15
- 5.1 Sample Transportation 15
- 5.2 Sample Chain-of-Custody 16
- 5.3 Sample Labeling 16

6.0 BENCH-SCALE S/S TESTING 19
- 6.1 Phase I Testing 19
  - 6.1.1 Treatability Testing on CRSB Soils 19
  - 6.1.2 Treatability Testing on KRSB Soils 20
- 6.2 Phase II Testing 20
  - 6.2.1 Treatability Testing on LRSB Soils 20
  - 6.2.2 Treatability Testing on PRSB Soils 21
- 6.3 Grout Mix Design 22
- 6.4 Stabilization Formulation Development 22
- 6.5 Performance Testing 22

7.0 DATA MANAGEMENT AND QUALITY ASSURANCE 30
7.1 Control of Data 30
7.2 Data Review and Verification 30
7.3 Data Reporting 30
7.4 Data Evaluation 31
7.5 Data Interpretation 31

8.0 HEALTH AND SAFETY 32
8.1 Project Description and Planning 32
8.2 Chemical Hygiene Plan 32
8.3 Key Point Cards 32
8.4 Bench-Scale Experimental Review 33
8.5 Radiation Protection Plan 33

9.0 SCHEDULE 34

10.0 RESIDUAL WASTE MANAGEMENT 37
10.1 Responsibility and Training 37
10.2 Sample Management And Storage 38
10.3 Waste Minimization 38
10.4 Estimated Residual Quantities 39
10.5 Residual Characterization and Classification 39
10.6 Residuals Storage and Disposal 39
10.7 Effluents 39
10.8 Emergency Response and Spill Management 39

11.0 REFERENCES 41

APPENDIX A Technology Development Laboratory's Chemical Hygiene Plan

APPENDIX B Technology Development Laboratory's QA Manual

APPENDIX C Specific Technology Development Laboratory Standard Operating Procedures

LIST OF TABLES

Table 1-1 Grout Design Mixes for the Reactor Seepage Basin Soils 7

Table 2-1 Performance Criteria for the S/S Treated Material 10

Table 5-1 Treatability Testing Sample Numbering Scheme 18

Table 6-1 Samples Generated During Treatability Testing of CRSB Soil Samples 26

Table 6-2 Samples Generated During Treatability Testing of KRSB Soil Samples 27

Table 6-3 Samples Generated During Treatability Testing of LRSB Soil Samples 28

Table 6-4 Samples Generated During Treatability Testing of KRSB Soil Samples 29

Table 9-1 Schedule for S/S Treatability Testing on the Reactor Seepage Basin Soils 36

LIST OF FIGURES

Figure 5-1 Copy of Analysis Request and Chain of Custody Record 17

Figure 6-1 Flowchart for the Segregation of the Reactor Seepage Basin Soils 24

Figure 6-2 Flowchart for Formulation Testing on Reactor Seepage Basin Soils 25

LIST OF ACRONYMS

ACI	American Concrete Institute
ANS	American Nuclear Society
ASTM	American Society for Testing and Materials
CHP	Chemical Hygiene Plan
Co	Cobalt
COC	Constituents of Concern
CRSB	C-Area Reactor Seepage Basin
Cs	Cesium
DOE	Department of Energy
ETDC	Environmental Technology Development Center
°F	Degrees Fahrenheit
g	Gram
HASP	Health and Safety Plan
HEPA	High efficiency particulate air
HMTR	Hazardous Materials Transportation Regulations
IT	International Technology Corporation
KRSB	K-Area Reactor Seepage Basin
LAOCB	L-Area Oil and Chemical Basin
lbs/hr	Pounds per hour
LRSB	L-Area Reactor Seepage Basin
mg/kg	milligrams per kilograms
mL	milliliter
NIST	National Institute for Standards and Technology
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
pCi/g	picoCuries per gram
PHSS	Project Health and Safety Summary
POR	Pilot operations room
PPE	Personal Protection Equipment
ppm	Parts per million
PRSB	P-Area Reactor Seepage Basin
Psia	pounds per square inch ambient
PTSM	Principal Threat Source Materials
Pu	Plutonium
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RCS	Regulatory Compliance Specialist
RMA	Radiological Material Area
ROD	Record of Decision

LIST OF ACRONYMS (Continued)

rpm	Revolutions per minute
RPP	Radiation Protection Program
RSC	Radiation Safety Committee
RSO	Radiological Safety Officer
RWP	Radiation Work Permit
SAIC	Science Applications International Company
SCDHEC	South Carolina Department of Health and Environmental Control
SOP	Standard Operating Procedure
Sr	Strontium
SRS	Savannah River Site
S/S	Stabilization/Solidification
TAL	Technology Applications Laboratories
TDL	Technology Development Laboratory
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
WSRC	Westinghouse Savannah River Company

1.0 PROJECT DESCRIPTION

1.1 Background

Between 1957 and 1991, reactor seepage basins received low-level radioactive purge water from the disassembly basins present at each of the Savannah River Site (SRS) production reactors. This water purge was necessary to keep the tritium concentration in the disassembly basin water within safe levels for operating personnel. Before the use of mixed-bed deionizers and sand filters began in the 1960s, purge water was pumped directly from the disassembly basins to the seepage basins. From 1970 to 1978, the seepage basins for active reactors were bypassed, and the filtered, deionized purge water was discharged directly into nearby streams. In 1978, the C-Reactor Seepage Basin (CRSB), L-Reactor Seepage Basin (LRSB), and P-Reactor Seepage Basins (PRSBs) were reactivated. The K-Reactor Seepage Basin (KRSB) was used from 1957 to 1960 only. After that time, water was purged from the K-Area Disassembly Basin to the K-Area Retention Basin. The R-Area seepage basins have been filled, covered with asphalt, and are not considered in this study. Although still open, none of the other four basins have been active since 1991.

Although many radionuclides were discharged to the basins, almost all of the radioactivity was due to tritium. Tritium is highly mobile, and it migrated relatively quickly from the basins via leaching. Most of the remaining radioactivity is the result of small amounts of cobalt (Co)-60, strontium (Sr)-90, cesium (Cs)-137, and alpha emitters such as plutonium (Pu)-239/240. Given the relatively short half-life of Co-60, the other three isotopes are of more concern with respect to future leaching to groundwater. Under the "Plug-In Record of Decision (ROD)" approach, the selected remediation technology for CRSB, KRSB, LRSB and PRSB is that the soils beneath the basins be remediated by in-situ stabilization/solidification (S/S) treatment, backfilled with clean soil, and covered with a low-permeability soil cover system. A S/S grout mix utilizing various reagents and additives/admixtures is required for the definitive remediation design. The S/S grout mix designs developed and recommended during this task will be used for in situ S/S of the various constituents of concern (COCs) in the subject basins.

The CRSB, KRSB, LRSB and PRSBs are scheduled for closure during the next several years. The Plug-In Proposed Plan WSRC-RP-98-4098, Revision 0, dated June 1998 and the Plug-In Proposed Plan WSRC-RP-98-4099, Revision 0, dated June 1998, identify the selected remediation technology for closure. At present, these two documents have not been approved by the United States Environmental Protection Agency (US EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) and are still in the review cycle.

However, Westinghouse Savannah River Company (WSRC) believes that the remediation technology recommended in these referenced documents is appropriate for the given sites. The selected remediation technology recommends that the soils beneath the basins be remediated with in-situ S/S treatment, the basins backfilled with clean soil, and covered with a low-permeability soil cover system. The results of a previous study (Section 1.6) identified preliminary S/S grout mixes utilizing various reagents (e.g., Portland cement, bentonite, and soluble silicates) for the in-situ S/S treatment of the basin soils. A final, recommended S/S grout mix will be developed for each of the four reactor seepage basins using the results of this task.

To develop the final, recommended S/S grout mix, a phased approach will be taken. Initial treatability testing on the CSRB and KRSB soils will involve four grout formulations of Portland cement, bentonite, and soluble silicates in various combinations. Each formulation will be tested on soil material to encompass the expected variation in lithology and geotechnical properties within the reactor seepage basins. In Phase II, four formulations will be tested on the LRSB and PRSB soils, again using soil material which encompasses the expected variation in lithology and geotechnical properties for each area.

1.2 C-Reactor Seepage Basins

The CRSBs are three unlined basins which were constructed in the late 1950s and operated from 1959 to 1970. Wastewater from the reactor disassembly basin was discharged into the southeastern end of L-shaped Basin No. 1. This L-shaped basin slopes to the north and west where a cascade overflow pipe located in the top of the basin wall connects it to Basin No. 2. Basin No. 2 also has a similar cascade overflow into Basin No. 3 located in its southeastern corner. Basin No. 3 would have received wastewater if Basins No. 1 and 2 were nearly full.

Radiation surveys and shallow soil sampling indicate that Basin No. 3 was used sparingly. Grouting is not included in the remedial action plan for the soil Basin No. 3. Therefore, Basin No. 3 will not be discussed further in this document.

From 1970 to 1978, disassembly basin wastewater was mixed with large volumes of heat exchanger cooling water and discharged to streams. After improvements in the treatment of disassembly basin wastewater by the addition of deionization and filtering treatment processes, wastewater discharge to the seepage basins resumed in 1987. The basins have not received wastewater since 1987.

The Principal Threat Source Materials (PTSM) are Cs-137 and Co-60. Basin No. 1 contains the highest concentrations of these radioactive sources, with the highest detected concentrations found in the 4 to 6 ft depth range below the existing basin bottom. Basin No. 2 contains the radioactive sources, but at lesser concentrations. The highest detected concentrations were found in the 1 to 4 ft depth range below the basin's existing bottom. Carbon-14, though not a PTSM, was detected in all three basins. Co-60 was detected in Basin No. 1 in the 0 to 1 ft depth range. Cobalt-60 has a short half-life (5 ¼ yrs). Because it decays in a relatively short time compared to the other PTSMs, it will not be considered in this study.

1.3 K-Reactor Seepage Basin

The KRSB was constructed in 1957 as an unlined basin to receive low-level radioactive wastewater from disassembly basin purges at the K-Reactor. The K-Reactor disassembly basin discharged by gravity to the east side of the KRSB.

The PTSM are Cs-137 and Sr-90. Approximately 83 percent of the non-volatile beta activity is in the top 1 ft of soil, 90 percent in the top 3 ft of soil, and at least 95 percent of the activity is above a depth of 7 feet.

1.4 L-Reactor Seepage Basin

The LRSB is an unlined, L-shaped earthen basin used for the disposal of low-level radioactive purge water from the L-Reactor disassembly basin. The LRSB received purge water from 1958 until 1968, when L-Reactor was placed on warm standby. Between 1985 and 1988, mixed bed deionizers and sand filters intercepted the purge water prior to discharge to the LRSB. In 1991, L-Reactor was placed in shutdown status.

In 1978, four soil samples were obtained from inside the LRSB. These samples were found to contain Co-60 (1,052.2 picoCuries per gram [pCi/g]), Cs-137 (258 pCi/g) and Sr-90 (70.6 pCi/g).

1.5 P-Reactor Seepage Basins

The PRSB consists of three unlined basins located to the west of the P-Reactor perimeter fence. Two 400 foot underground process sewer lines extended from the P-Reactor disassembly basin to Basin 1. When Basin 1 filled to capacity, it overflowed through a 12-inch metal sewer line into Basin 2. Likewise, Basin 2 overflowed into Basin 3. A "hot chute", a 20 to 25 foot long

polyvinyl chloride (PVC) pipe, is located in the north wall of Basin 2 and extends the outside of the basin perimeter fence into the basin.

The basins were used from 1957 to 1970 to dispose of low-level radioactive process purge water from the reactor disassembly basins. From 1970 to 1978, the seepage basins were bypassed, and filtered deionized purge water was discharged directly into Steel Creek. In 1978, discharge of process purge water to the basins was resumed. The basins have not received wastewater since the P-Reactor was shut down for repairs in 1991.

In 1972, radionuclides were analyzed in a limited number of soil cores taken to a depth of 1.5 feet. Maximum Cs-137 activities of 7,100 pCi/g were noted. In 1976, five surface soil samples (4-inch deep) were taken from each seepage basin. The maximum Cs-137 activity was observed to be 4,400 pCi/g and the maximum Sr-89/90 concentration was 600 pCi/g. In 1978, sixteen borings were advanced to a maximum depth of 20 feet. These samples were analyzed for Co-60, Cs-137, and Sr-90. The highest activities were measured in Basins 1 and 2, with elevated activity levels in the top 5 feet.

1.6 Related Immobilization Investigation At LAOCB

A soil stabilization Final Corrective Measure/Remedial Action has been proposed to stabilize waste materials within the L-Area Oil and Chemical Basin (LAOCB). A laboratory-scale immobilization study was conducted to evaluate the effectiveness of S/S reagents in immobilizing radionuclides present in the LAOCB. The similarity of the soils and COCs present at the LAOCB and reactor seepage basins suggest that immobilization studies for the LAOCB are very relevant to addressing the soil stabilization to the C-, K-, L- and P-Area reactor seepage basins.

The results of the LAOCB study provide a firm foundation for the immobilization studies proposed at CRSB, KRSB, LRSB, and PRSB. The radionuclides of concern in the LAOCB included all the PTSMs identified in the C-, K-, L- and P-Area reactor seepage basins: Cs-137, Sr-90, and Pu-239/240. The LAOCB also contained additional radionuclides not identified as PTSMs in the reactor seepage basins: (americium-241; Co-60; and uranium-234, -235, and –238) (WSRC, 1996).

The LAOCB soil characteristics were defined using samples obtained using a remote vibracore sampler. An organic-rich sludge/sediment layer is present at the surface to a depth of 0.5 ft. Beneath this layer is a very fine to medium grained sandy silt/silty sand layer, which includes

various percentages of clay (WSRC, 1996). The soils in the four reactor seepage basins are similar to the LAOCB soils.

The LRSB is proximate to the LAOCB and has the same types of soils. The soils in the vicinity of the CRSB, KRSB and PRSB are classified as belonging to the Udorthent and Blanton soil series (WSRC, 1992, 1997, 1998). Udorthents are disturbed soils, derived as spoil or refuse from excavations and major construction activities. Udorthents generally include gravel, sand, and clay. The Blanton soil series is the predominant type at SRS, covering 21 percent of the SRS area. (WSRC, 1992) Blantons are moderately permeable soils found in sandy and loamy sediments of the Coastal Plains (WSRC, 1998). The walls C-, K-, L- and P-Area reactor seepage basins were visually inspected, and the lithologies were found to be similar, further supporting the LAOCB study applicability.

The LAOCB immobilization study was conducted in phases, including reagent screening, reagent optimization, and extended performance testing. The purpose of the screening phase of the study was to evaluate mixing characteristics and performance of six possible mixtures. The mixtures evaluated included mixes of Portland Cement, Portland Cement/Flyash, Portland Cement/Bentonite, Portland Cement/Silicate, Portland Cement/Hematite and Portland Cement/Apatite. Based on the results of reagent screening, three reagent combinations were selected for further study: Portland Cement, Portland Cement/Bentonite, and Portland Cement/Silicate (WSRC, 1996).

The objective of the second phase was to determine the optimum dosage ratios of the three selected reagents. High mixes appeared to reduce the leachability of COCs more appreciably than low mixes. Consequently, high mixes were retained for further evaluation in extended performance testing.

The objective of the extended performance testing was to determine long-term performance of soils treated with the high mixes of the three selected reagent combinations. Significant results of this phase of testing are as follows:

- The unconfined compressive strengths of all three mixes exceeded the Nuclear Regulatory Commission (NRC) guidelines (compressive strength of at least 500 psia).
- The compressive strength of all three mixtures were significantly reduced by the 90-day water immersion. The greatest reduction in average compressive strength was seen in the Portland Cement sample which was reduced by 89 percent to 450 psia.

- The three mixtures all effectively reduced the leachability of gross alpha beta (reduced the leachability to below 20 percent).

The study results suggest that both bentonite and silicate additives significantly increase the effectiveness of the Portland Cement at reducing the leachability of radionuclides of concern. Based on these findings, this work plan defines the detailed confirmatory tests to determine which mixes would meet the performance requirements.

The LAOCB study recommended mixes using a combination of Portland cement, bentonite, and sodium silicate be tested to determine the mixture which will be most effective for the least cost. Dosage ratios of 0.15 Portland cement to 0.05 bentonite to 0.04 silicate (fraction of total weight), respectively, were recommended for further evaluation in the pilot study. Because of the relatively high cost of sodium silicate, it was also recommended that a lower sodium silicate dosage ratio of 0.02 be evaluated to determine how much benefit is achieved by adding more sodium silicate.

Based on the results of the LAOCB study, four grout mixes have been identified for evaluation in this study: Portland cement and bentonite; Portland cement and sodium silicate; Portland cement, bentonite and sodium silicate (low); and Portland cement, bentonite, and sodium silicate (high). The specific formulations for each mix are shown in Table 1-1.

Table 1-1 Grout Design Mixes for the Reactor Seepage Basin Soils

Formulation	Soil	Portland Cement		Sodium Bentonite		Sodium Silicate	
	(g)	(g)	(% by weight)	(g)	(% by weight)	(g)	(% by weight)
1	4,000	750	15	250	5	0	0
2	4,000	741	15	0	0	198	4
3	4,000	770	15	256	5	103	2
4	4,000	790	15	263	5	211	4

2.0 STUDY AND TEST OBJECTIVES

2.1 Objectives

The purpose of this study is to perform bench-scale (laboratory-scale) studies to develop grout mix designs which can stabilize and solidify the radiological contaminants in the CRSB, KRSB, LRSB, and PRSB soils. One or more S/S grout mix designs may be required, as appropriate, for each seepage basin site. The grout mixes developed and recommended during this task will be used for in-situ S/S. It is expected that the depth of S/S will not exceed 20 ft below the existing basin bottoms and in most cases will probably be less than 10 ft. The study will be implemented in two phases. The first phase of work, designated Phase I, will be implemented between November 1998 and March 1999 using the CRSB and KRSB soils. With Phase I substantially complete, Phase II will be implemented between February 1999 and June 1999 using the LRSB and PRSB soils.

Initial treatability testing (Phase I) on the CRSB and KRSB soils will involve four formulations involving Portland cement, bentonite, and soluble silicates in various combinations. Each formulation will be replicated on soil materials which reflect the expected variability in lithology and geotechnical properties within a given reactor seepage basin. In Phase II, the same four formulations will be tested on the LRSB and PRSB soils, again on soils which represent the expected variability in lithology and geotechnical properties within a given reactor seepage basin.

The grout mix recommended for each reactor seepage basin will be the one that will produce a stabilized waste monolith (grouted waste) which meets performance requirements/acceptance criteria (Section 2.2). Acceptable construction tolerances and mixing process constraints (if any) will be defined. Field optimization tests are not expected to be necessary as long as the construction tolerances, PTSMs, and mixing process constraints identified as a result of this study are not exceeded.

2.2 Study Performance Standards

The primary goal of the S/S treatment is to minimize the mobility of the PTSMs. S/S is a performance-based remedial approach since it does not reduce the total mass of the PTSMs and cannot in itself achieve concentration-based remedial objectives. The performance standards for the S/S treatment of the soils underneath the CRSB, KRSB, LRSB, and PRSB are given in Table 2-1.

Additional performance parameters such as total carbonation activity, sulfates, sulfides, sulfite, chloride, nitrate, nitrite, nitric compounds, boric compounds, and oxidation/reduction potential had been considered for the S/S treated material. Total carbonation activity would be required to demonstrate that the stabilized material contains sufficient carbonation to maintain an alkaline pH. The Portland cement (15 percent of the total treated weight) added as part of the S/S grout mix will produce a sufficient total carbonation activity level to satisfy this criteria. Therefore, the determination of total carbonation activity on the S/S treated material will not supply any useful information.

When high salt content wastes are stabilized, the sulfate, sulfide, sulfite, sulfide, nitrate, nitrite, and nitric and boric compound levels are of concern, as the presence of these chemical species in high (>50,000 milligram/kilogram [mg/kg]) levels can affect the physical properties of the final S/S treated material. However, there is no indication that the soils underneath the CRSB and KRSB contain high levels of the chemical species. Furthermore, previous S/S treatability work on the LAOCB soils indicated minimal anion leaching from similar S/S treated soils using similar reagents. Therefore, performance criteria for these chemical species would not influence the physical stability of the S/S treated material. Soils will be analyzed to verify that none of these compounds are present at levels which would affect the S/S treated material.

Certain contaminants, such as arsenic, chromium, and selenium, can easily exist in a number of valance states. The immobilization of these contaminants can be affected by the oxidation/ reduction potential of the S/S treated material. The immobilization of the PTSMs are not affected by their valance state, therefore the oxidation/reduction potential of the S/S treated material will not affect its performance. Therefore, performance criteria for these parameters will not be determined in this study.

Table 2-1 Performance Criteria for the S/S Treated Material

Parameter	Criteria	Standard Test Method
Batching Weight Precision	≤ 5 %	NIST traceable
Batching Mix Ratio Variation	≤ 0.5 gal/lb	NIST traceable
Unconfined Compressive Strength at 14 days Cure	>100 psi	ASTM D 2166
Unconfined Compressive Strength at 28 days Cure	>100 psi	ASTM D 2166
Unconfined Compressive Strength after Water Immersion for 90 days	>100 psi	ASTM D 2166, immersion per NRC guidelines
Hydraulic Conductivity at 28 days Cure	<1x10E-08 cm/sec	ASTM D 5084
Hydraulic Conductivity after Water Immersion for 90 days	<1x10E-08 cm/sec	ASTM D 5084, immersion per NRC guidelines
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	ANS 16.1
Detection Limit for Gross Alpha	6 pCi/ml	Gas Flow
Detection Limits for Nonvolatile Beta	15 pCi/ml	Gas Flow
Temperature at Core and Surface	<100 °F	ASTM C 1064
pH	>10.0	ASTM D 4972
Shrink/Swell	<25% of 28-day UCS failure strain	ASTM D 3877
Bleed Fluid	<0.5%	ANS 55.1 or EPA 9095
Volume Increase	<50%	None
Hazardous dust/vapor release	--	Per OSHA Standards
Gas generation due to chemical, biological, organic, thermal, and radiation sources	Lesser of: 0.5 moles/cf/yr or 800 moles/cf total	Per 10 CFR 60 or Per NUREG-CR-2333
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

3.0 PREPLANNING ACTIVITIES/TECHNICAL APPROACH

The technical approach to the S/S treatability testing on the soil from the four reactor seepage basins is based on the similarity of the chemical nature of the contaminants of concern and the method of contamination for each reactor seepage basin. Therefore, the S/S grout mix design for the reactor seepage basins will not have to compensate for variability in radionuclides, heavy metals, organic, or inorganic constituents. The major variability which the S/S mix design must compensate for is the variability in lithology which may be present within the reactor seepage basins in each of the four areas.

The samples used for the LAOCB treatability testing consisted of reddish and tan sandy soil, reddish and tan sandy soil (80%) mixed with small amounts of olive green clay (20%), and olive green clay (80%) mixed with reddish sandy soil (20%). Since the reactor seepage basins are located in areas of similar lithology to the LAOCB, it is likely that a similar range in soil material will be encountered for the CRSB, KRSB, LRSB, and PRSB soils. The S/S grout mix design must be demonstrated to handle this range in lithological properties.

The technical approach to the treatability testing will be to divide or segregate the soils from each reactor seepage basin into fractions, which represent the range of lithology represented by the sample material. This will be accomplished by physically segregating the soil sample material from each reactor seepage basin to fractions which are primarily coarse (sandy), fractions which are primarily fine (clayey), and two fractions which represent the overall bulk combination of coarse and fine soil material (bulk fractions). The bulk fraction samples will represent the typical or expected lithological conditions, while the fine and coarse fraction samples will represent the worst case extremes.

For the CRSB and PRSB soils, sufficient material has been collected to allow the physical segregation discussed above. For the KRSB and LRSB soils, the quantity of soil available for performing the tests is limited. Therefore, the KRSB and LRSB soils will be segregated into only coarse and fine fraction samples, representing the extremes in lithology for the these reactor seepage basins.

The fractions resulting from the physical segregation of the soil material from each reactor seepage basin will be used in the S/S grout mix design testing. During this testing, four grout mixes (Portland cement/Bentonite, Portland cement/high Silicate, Portland cement/Bentonite/ high Silicate, and Portland cement/low Silicate) will be used on each fraction of each reactor

seepage basin. The S/S treated material from each soil/grout mixing will be subjected to physical and chemical testing to determine if it meets the performance criteria (Table 2.1).

- Section 6.0 discusses how this technical approach will be applied to each of the reactor seepage basin soils.

4.0 EQUIPMENT, MATERIALS, AND FACILITIES

4.1 Equipment

The equipment to be used in the laboratory-scale S/S treatability testing includes:

- 3 foot by 6 foot metal tray,
- Stainless steel mixing bowls,
- 5 quart planetary mixer,
- 3 inch by 6 inch right cylinder plastic molds,
- 2 inch by 4 inch right cylinder plastic molds,
- Stainless steel spatulas,
- Laboratory balances, and
- Graduated cylinders.

4.2 Materials

The reagents to be used during the laboratory-scale S/S treatability testing includes:

- Type I Portland cement,
- Sodium bentonite, and
- Type N soluble silicates.

The personal protective equipment to be used during the treatability study includes:

- Nitrile gloves,
- Tyvek coveralls, and
- Tyvek boot covers.

4.3 Facilities

The laboratory-scale S/S treatability testing will be conducted at the International Technology, Corp. (IT) Technology Development Laboratory (TDL) in Knoxville, TN. Geotechnical testing on the CRSB and KRSB soils and the S/S treated materials will be conducted at IT's Environmental Technology Development Center (ETDC) in Oak Ridge, TN.

The TDL and ETDC each maintain a Radioactive Materials License from the State of Tennessee and operate under the treatability exemption in 40 CFR 261.4. Both facilities have a U.S. Dept. of Agriculture Animal and Plant Health Inspection Services agreement for the importation of foreign and domestic soils.

Treatability studies and other activities are performed under the relevant permits, licenses, or exemptions. The Technology Applications Laboratories (TAL) Director is responsible for verifying that TAL facilities maintain the required permits and licenses to meet specific requirements. Access to each facility is strictly controlled.

The TDL was designed to allow bench-scale testing of physical and chemical treatment processes on radioactive, hazardous and mixed waste samples. This laboratory has four isolated negative-pressure cubicles that contain fume hoods and laboratory benches constructed of materials selected for easy decontamination. Each cubicle's ventilation system is equipped with both high efficiency particulate air (HEPA) and activated carbon bed housings to allow proper selection of effluent controls. The drains from the sinks in this laboratory are connected to a collection tank.

The ETDC has features that ensure the handling of mixed and hazardous waste materials will not have an adverse impact on personnel safety or the environment. The mixed waste treatability testing laboratories have been designed and constructed to facilitate cleanup and decontamination activities. Local ventilation through HEPA filters is supported by area ventilation systems that utilize a double HEPA filtration system prior to discharge. Liquid discharges from treatment processes are collected into holding tanks for analysis prior to discharge. Personnel contamination monitoring stations are in place to prevent the spread of radioactive contamination to uncontrolled areas.

Instrumentation and geotechnical laboratories used for the analyses of radioactive, hazardous, and mixed waste samples are maintained in a controlled area.

An instrument calibration laboratory is used for calibration of portable radiation protection instrumentation. This laboratory is equipped with a variety of National Institute for Standards and Technology (NIST) traceable sealed and plated sources and test equipment. Access and radiation control features include warning lights, radiological postings, key restrictions and shielding.

5.0 SAMPLE TRANSPORTATION AND TRACKING

5.1 Sample Transportation

Soil samples from CRSB, KRSB, LRSB, and PRSB will be transported by licensed shipper from the Radiological Material Area (RMA) at Building 772-7B, SRS, to the ETDC. Chains of custody will be used to ensure that samples are properly identified, including boring number, depth below ground surface sample was taken, and the date. A Shipping Order, per United States Department of Transportation (US DOT) requirements, is required for off-site shipment and will be provided by the SRS Hazardous Materials Transportation Regulator (HMTR).

Chain of custody forms will accompany the sample shipment. Upon receipt at the ETDC, the soil samples will each be given a unique sample number and logged into the ETDC sample inventory system. The unique sample number will be used to track materials such as samples, test-residues, test products and reagents throughout the project.

Upon receipt, the outside of each container will be smeared to measure external contamination, and the dose rate at the surface of the containers will be measured. Until the contaminated soil is characterized, the gross alpha and non-volatile beta radiation data received from WSRC will be used for assigning radiological categories to the drum and any sub-samples taken from the containers. The containers will be then moved to the pilot operations room (POR) at the ETDC. This room is designed for pilot-scale testing and has high air turnover. The air exhausted from the POR is treated by HEPA filters and vapor phase carbon before discharge. In the POR, the containers will be opened to visibly assess the condition of the contents. A grab sample of soil will be collected and analyzed for gross alpha/beta activity as a comparison to data supplied by WSRC.

After the container is opened, the contaminated soil will be dumped into a three foot wide by six foot long metal tray with other soil material from the same seepage basin. The soil material will be separated in fractions representing the variability of lithology and geotechnical properties present in the soil from each reactor seepage basin (See Sections 3.0, 6.1.1 and 6.2.1 for further details). The remaining contaminated soil will be mixed by hand using a garden hoe until it is visually uniform. Any debris or oversize material (greater than 6 inches) will be removed from the soil and stored separately. The homogenized soil fractions will be put in five-gallon buckets and will be transferred to the TDL for bench-scale studies.

Procedures for laboratory sample receipt, custody, coding, tracking, handling, and storage are in Standard Operating Procedure (SOP) PDGADM0005, Appendix C.

5.2 Sample Chain-Of-Custody

A strict chain-of-custody record shall be maintained for all samples received at the TDL or the ETDC. The treatability facilities are controlled-access facilities, with multiple secured sample storage areas.

Sample transfers external to the treatability facility will be accompanied by a combined Analysis Request and Chain-of-Custody Record (Figure 5-1). Samples transferred to the treatability analytical department or Geotechnical Laboratory will also be accompanied by an Analysis Request and Chain-of-Custody Record. Instructions for completing the form are on the back of the form.

Copies of all Analysis Request and Chain-of-Custody Records will be maintained in the project file.

5.3 Sample Labeling

Samples collected will have a unique sample identification which describes the reactor seepage basin, the soil fraction or subsample, the formulation, applicable cure period, testing to be conducted on the sample, and any subsample required for the applicable testing. Table 5-1 details the sample numbering categories and their applicable codes.

For example, Sample Number C422F00 would be the unconfined compressive strength sample, cured 28 days, from the cement + bentonite + low silicate formulation from the fine fraction of the CRSB soil material. Likewise, Sample L612H02 would be the second leachate subsample from the ANS 16.1 leachability test on the treated material, cured 28 days, from the cement + bentonite formulation on the bulk fraction of the LRSB soil material.

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 426822
Page 1 of ___

Project Name/No. [1]
Sample Team Members [2] ✓
Profit Center No. [3]
Project Manager [4]
Purchase Order No. [6]
Required Report Date [11]

Samples Shipment Date [7]
Lab Destination [8]
Lab Contact [9]
Project Contact/Phone [12]
Carrier/Waybill No. [13]

Bill to: [5]

Report to: [10]

White To accompany samples Yellow Field copy *See back of form for special instructions

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Preservative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]

Special Instructions: [23]

Possible Hazard Identification: [24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal: [25]
Return to Client ☐ Disposal by Lab ☐ Archive (mos.)

Turnaround Time Required: [26]
Normal ☐ Rush ☐

QC Level: [27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by [28] (Signature/Affiliation)	Date: Time:	1. Received by [28] (Signature/Affiliation)	Date: Time:
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments: [29]

Figure 5-1. Copy of Analysis Request and Chain of Custody Record

Table 5-1 Treatability Testing Sample Numbering Scheme

Category	Code	Category	Code
Reactor	C = CRSB	Test	A = Cs-137, Sr-90, Pu-239,240
	K = KRSB		B = gross alpha, nonvolatile beta
	L = LRSB		C = Inorganics
	P = PRSB		D = Total carbonation activity
Subsample	1 = Grab 1		E = Oxidation/reduction potential
	2 = Grab 2		F = Unconfined Compressive Strength
	3 = Coarse		G = Hydraulic Conductivity
	4 = Fine		H = ANS 16.1 Leachability
	5 = Typical 1		I = Temperature
	6 = Typical 2		J = pH
	7 = Typical 3		K = Shrink/Swell
	8 = Typical 4		L = Bleed Volume
Formulation	0 = Not Applicable		M = Volume Increase
	1= PC + bentonite		N = Setting
	2 = Cement + bentonite + low silicate		Q = Geotechnical
	3 = Cement + bentonite + high silicate		
	4 = Cement + high silicate		
Cure Period	0 = Not Applicable	Test Subsample	00 - when test not "H"
	1 = 14 days		01 = 2 hours
	2 = 28 days		02 = 7 hours
	3 = 90 days immersed		03 = 1 day
			04 = 2 days
			05 = 3 days
			06 = 4 days
			07 = 5 days
			08 = 19 days
			09 = 47 days
			10 = 90 days

6.0 BENCH-SCALE S/S TESTING

The bench-scale treatability testing will demonstrate how the treated material from the selected S/S grout mix designs performs with respect to the performance criteria listed in Table 2.1. The technical approach used for selecting the soil fractions for S/S testing is described in Section 3.0.

6.1 Phase I Testing

The first phase of the S/S treatability study on the reactor seepage basin soils will involve the soils from the CRSBs and KRSB (due to the early scheduled closure for these basins). The flowcharts in Figures 6.1 and 6.2 demonstrate the progression of the treatability testing.

6.1.1 Treatability Testing on CRSB Soils

Step 1. The soil material from the CRSB will be dumped into a three foot wide by six foot long metal tray. Two 1-quart samples which appear representative of the soil material in the tray will be collected for geotechnical and characterization analysis (Table 6-1).

Step 2. The soil material will be segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation is to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This will ensure that the performance of the mix designs is evaluated against the potential variability in lithology within the CRSB.

Clayey material will be segregated and combined to make a fine fraction sample for mix design testing. Coarse material will be segregated and combined to make a coarse fraction sample for mix design testing. The remaining material will be homogenized and two bulk fraction samples for mix design testing will be prepared. Two one-quart samples will be collected for geotechnical analysis, if there is a sufficient quantity of soil remaining.

Step 3. The four fractions (coarse, fine, and 2 bulk) will be used for formulation mix design testing. Four formulations will be made on each fraction (Table 1-1).

6.1.2 Treatability Testing on KRSB Soils

Step 1. The soil material from the KRSB will be dumped into a three foot wide by six foot long metal tray. Two 1-quart samples which appear representative of the soil material in the tray will be collected for geotechnical and characterization analysis (Table 6-2).

Step 2. The soil material will be segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation is to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This will ensure that the performance of the mix designs is evaluated against the potential variability in lithology within the KRSB.

Clayey material will be segregated and combined to make a fine fraction sample for mix design testing. Coarse material will be segregated and combined to make a coarse fraction sample for mix design testing. The remaining material will be homogenized and two 1-quart samples will be collected for geotechnical analysis.

Step 3. The two fractions (coarse and fine) segregated above will be used for formulation mix design testing. Four formulations will be made on each fraction (Table 1-1).

6.2 Phase II Testing

The second phase of the S/S treatability study on the reactor seepage basin soils will involve the soils from the LRSB and PRSB. The second phase will begin during the latter part of the Phase I testing (see Section 9 for the schedule). The flowcharts in Figures 6.1 and 6.2 demonstrate the progression of the treatability testing.

6.2.1 Treatability Testing on LRSB Soils

Step 1. The soil material from the LRSB will be dumped into a three foot wide by six foot long metal tray. Two 1-quart samples which appear representative of the soil material in the tray will be collected for geotechnical and characterization analysis (Table 6-3).

Step 2. The soil material will be segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation is to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This will ensure that

the performance of the mix designs is evaluated against the potential variability in lithology within the LRSB.

Clayey material will be segregated and combined to make a fine fraction sample for mix design testing. Coarse material will be segregated and combined to make a coarse fraction sample for mix design testing. The remaining material will be homogenized and two 1-quart samples will be collected for geotechnical analysis.

Step 3. The fractions (coarse and fine) segregated above will be used for formulation mix design testing. Four formulations will be made on each fraction (Table 1-1).

6.2.2 Treatability Testing on PRSB Soils

Step 1. The soil material from the PRSB will be dumped into a three foot wide by six foot long metal tray. Two 1-quart samples which appear representative of the soil material in the tray will be collected for geotechnical and characterization analysis (Table 6-4).

Step 2. The soil material will be segregated by lithological properties into samples for formulation mix design testing. The objective of this segregation is to produce samples for mix design testing which bracket the anticipated range in lithologic properties. This will ensure that the performance of the mix designs is evaluated against the potential variability in lithology within the PRSB.

Clayey material will be segregated and combined to make a fine fraction sample for mix design testing. Coarse material will be segregated and combined to make a coarse fraction sample for mix design testing. The remaining material will be homogenized and two bulk fraction samples for mix design testing. If sufficient material remains, two 1-quart samples collected for geotechnical analysis.

Step 3. The four fractions (coarse, fine, and 2 bulk) will be used for formulation mix design testing. Four formulations will be made on each fraction (Table 1-1).

6.3 Grout Mix Design

The S/S grout mixes for each basin using the CRSB, KRSB, LRSB, and PRSB soils, selected S S additives (admixture), and other S/S grout mix components will be developed as presented below. During Phase I, four mixes will be considered for CRSB and KRSB. They are:

- Portland Cement/ Bentonite
- Portland Cement/ Silicate
- Portland Cement/ Bentonite/high Silicate
- Portland Cement/ Bentonite/low Silicate

In developing the mixes, the components (including cementitious and pozzolanic components and their chemical constituents) will be of high quality and of known composition and commercially available. The manufacturer's technical product information and certification of compliance including conformance determined per American Society of Testing and Materials (ASTM) and American Concrete Institute (ACI) test standards will be included as an appendix to the final report. All cementitious and pozzolanic components shall be chemically stable and shall be environmentally nonhazardous before and after their S/S applications.

6.4 Stabilization Formulation Development

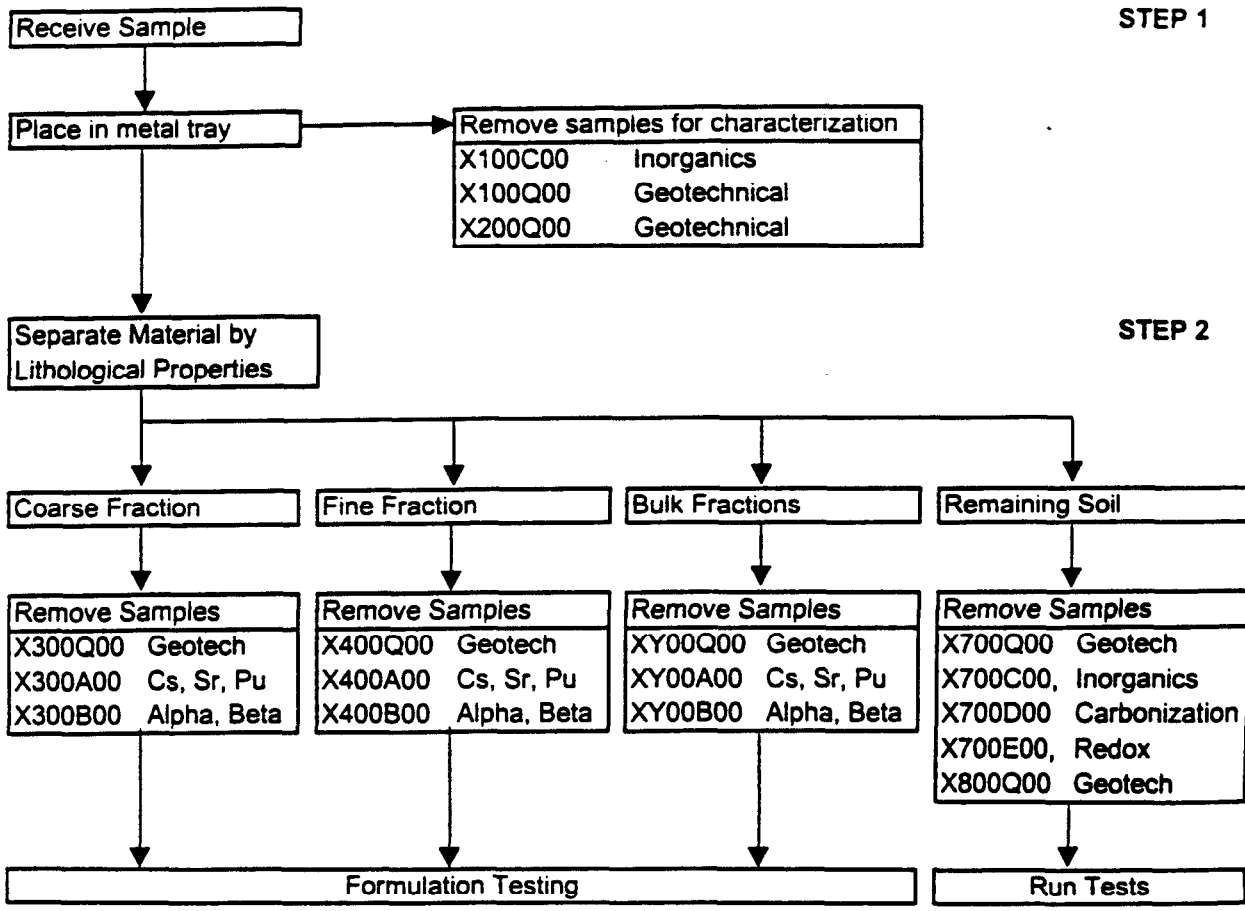
Each formulation will be mixed in a planetary mixer. A 4,000 g aliquot of seepage basin soil will be added to the mixing bowl. The dry reagents will be weighed out, blended, and mixed into 1,000 milliliters (ml) of water. Soluble silicate or an additional 200 ml of water will be added to the reagent slurry. The reagent slurry will then be added to the soil in the mixing bowl. The soil and reagent slurry will be mixed at 30-40 revolutions per minute (rpm) for 1 to 2 minutes to produce a homogeneous treated material.

The treated material will be poured into appropriate molds for performance testing, vibrated to remove air pockets, and capped to minimize moisture loss. The molded material will be allowed to cure at ambient laboratory temperature (approximately 72°F) in sealed coolers.

6.5 Performance Testing

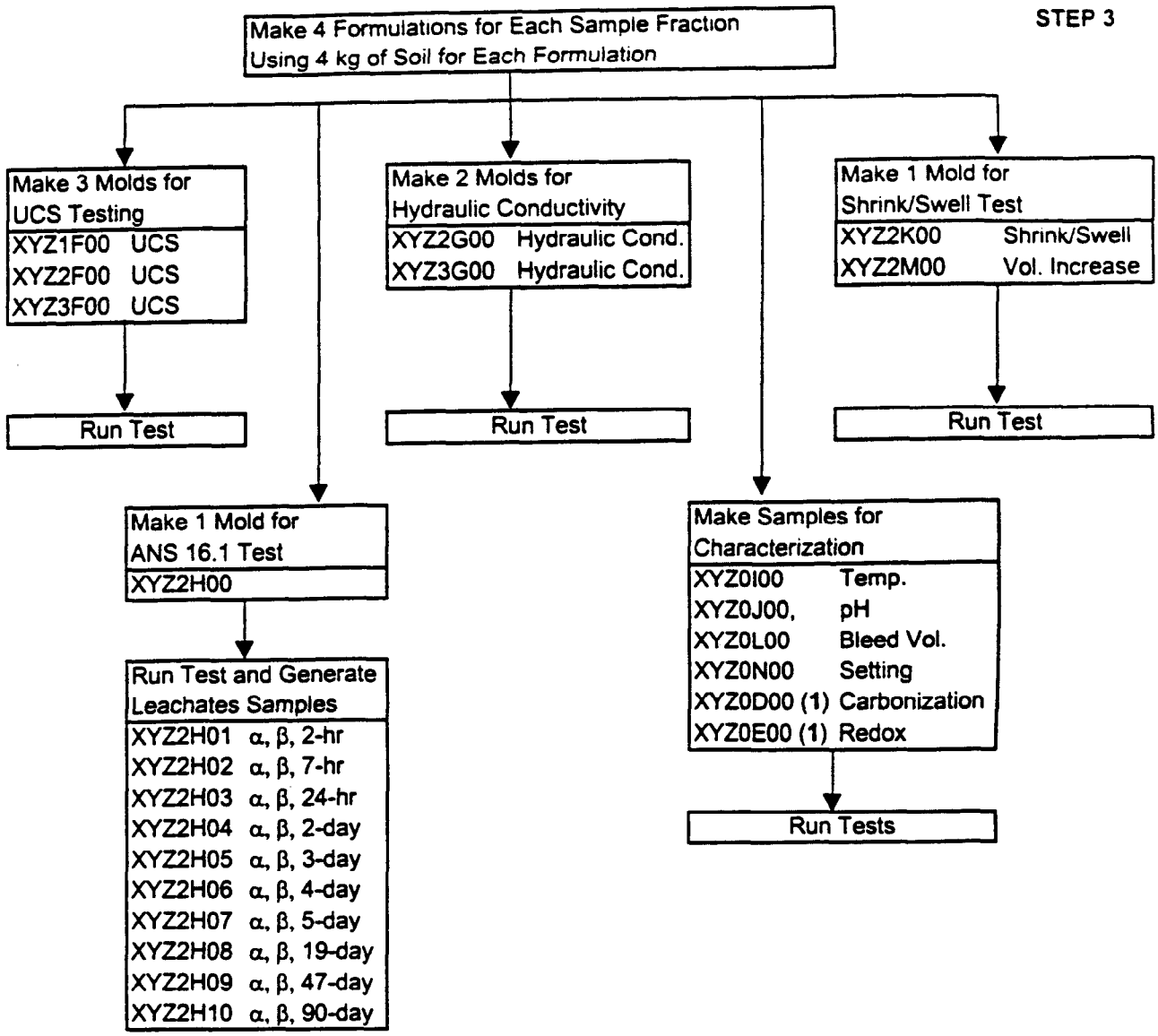
The cured treated material will be subjected to the performance criteria testing listed in Tables 6.1, 6.3, 6.4 and 6.5 for Step 3. The testing listed is the same as performance criteria (Table 2.1)

for the final stabilized waste material, with the exception of the criteria for the batching, hazardous dust/vapor release and the gas generation. The results from the performance testing will provide information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material. The methods for performance testing are listed in the tables.



X = C, K, L, or P (Reactor)
Y = 5 or 6 (Subsample)

Figure 6-1. Flowchart for the Segregation of the Reactor Seepage Basin Soils



(1) Only on two randomly selected formulations
X = C, K, L, or P (Reactor)
Y = 3, 4, 5, or 6 (Subsample)
Z = 1, 2, 3, or 4 (Formulation)
UCS = Unconfined Compressive Strength

Figure 6-2. Flowchart for Formulation Testing on Reactor Seepage Basin Soils

Table 6-1 Samples Generated During Treatability Testing of CRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	8	2	6	
Grain Size Distribution	ASTM D422	8	2	6	
Moisture Content	ASTM D2216	8	2	6	
Specific Gravity	ASTM D854	8	2	6	
USCS Soil Classification	ASTM D2487	8	2	6	
Cesium-137	Gamma Spectroscopy	4		4	
Plutonium 239,240	Alpha Spectroscopy	4		4	
Strontium 90	Gas Flow	4		4	
Gross Alpha (For ANS 16.1)	Gas Flow	164		4	160
Nonvolatile Beta (For ANS 16.1)	Gas Flow	164		4	160
Leachability Index	ANS 16.1	16			16
Total Boric Compounds	TBD	1	1		
Total Carbonation Activity	TBD	2	1		1
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitric Compounds	TBD	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	2	1		1
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	16			16
UCS @ 28 days cure	ASTM D2166	16			16
UCS @ 90 days immersion	ASTM D2166	16			16
Hydraulic Conductivity @ 28 days	ASTM D5084	16			16
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	16			16
Temperature	ASTM C1064	16			16
pH	SW-846 Method 9045C	16			16
Shrinkage/Swell	ASTM D3877	16			16
Bleed Fluid	SW-846 Method 9095	16			16
Set Time	ASTM C191	16			16

Table 6-2 Samples Generated During Treatability Testing of KRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	6	2	4	
Grain Size Distribution	ASTM D422	6	2	4	
Moisture Content	ASTM D2216	6	2	4	
Specific Gravity	ASTM D854	6	2	4	
USCS Soil Classification	ASTM D2487	6	2	4	
Cesium-137	Gamma Spectroscopy	2		2	
Plutonium 239,240	Alpha Spectroscopy	2		2	
Strontium 90	Gas Flow	2		2	
Gross Alpha (For ANS 16.1)	Gas Flow	82		2	80
Nonvolatile Beta (For ANS 16.1)	Gas Flow	82		2	80
Leachability Index	ANS 16.1	8			8
Total Boric Compounds	TBD	1	1		
Total Carbonation Activity	TBD	2	1		1
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitric Compounds	TBD	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	2	1		1
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	8			8
UCS @ 28 days cure	ASTM D2166	8			8
UCS @ 90 days immersion	ASTM D2166	8			8
Hydraulic Conductivity @ 28 days	ASTM D5084	8			8
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	8			8
Temperature	ASTM C1064	8			8
pH	SW-846 Method 9045C	8			8
Shrinkage/Swell	ASTM D3877	8			8
Bleed Fluid	SW-846 Method 9095	8			8
Set Time	ASTM C191	8			8

Table 6-3 Samples Generated During Treatability Testing of LRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	8	2	6	
Grain Size Distribution	ASTM D422	8	2	6	
Moisture Content	ASTM D2216	8	2	6	
Specific Gravity	ASTM D854	8	2	6	
USCS Soil Classification	ASTM D2487	8	2	6	
Cesium-137	Gamma Spectroscopy	4		4	
Plutonium 239,240	Alpha Spectroscopy	4		4	
Strontium 90	Gas Flow	4		4	
Gross Alpha (For ANS 16.1)	Gas Flow	164		4	160
Nonvolatile Beta (For ANS 16.1)	Gas Flow	164		4	160
Leachability Index	ANS 16.1	16			16
Total Boric Compounds	TBD	1	1		
Total Carbonation Activity	TBD	2	1		1
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitric Compounds	TBD	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	2	1		1
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	16			16
UCS @ 28 days cure	ASTM D2166	16			16
UCS @ 90 days immersion	ASTM D2166	16			16
Hydraulic Conductivity @ 28 days	ASTM D5084	16			16
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	16			16
Temperature	ASTM C1064	16			16
pH	SW-846 Method 9045C	16			16
Shrinkage/Swell	ASTM D3877	16			16
Bleed Fluid	SW-846 Method 9095	16			16
Set Time	ASTM C191	16			16

Table 6-4 Samples Generated During Treatability Testing of PRSB Soil Samples

Testing Parameters	Method	Number of Tests			
		Total	Step 1	Step 2	Step 3
Atterberg Limits	ASTM D 4318	6	2	4	
Grain Size Distribution	ASTM D422	6	2	4	
Moisture Content	ASTM D2216	6	2	4	
Specific Gravity	ASTM D854	6	2	4	
USCS Soil Classification	ASTM D2487	6	2	4	
Cesium-137	Gamma Spectroscopy	2		2	
Plutonium 239,240	Alpha Spectroscopy	2		2	
Strontium 90	Gas Flow	2		2	
Gross Alpha (For ANS 16.1)	Gas Flow	82		2	80
Nonvolatile Beta (For ANS 16.1)	Gas Flow	82		2	80
Leachability Index	ANS 16.1	8			8
Total Boric Compounds	TBD	1	1		
Total Carbonation Activity	TBD	2	1		1
Chloride Compounds	SW-846 Method 9056	1	1		
Nitrate	SW-846 Method 9056	1	1		
Nitric Compounds	TBD	1	1		
Nitrite	ASTM D9056	1	1		
Oxidation/Reduction State	ASTM D1498	2	1		1
Sulfate	SW-846 Method 9056	1	1		
Sulfide	SW-846 Method 9034	1	1		
UCS @ 14 days cure	ASTM D2166	8			8
UCS @ 28 days cure	ASTM D2166	8			8
USC @ 90 days immersion	ASTM D2166	8			8
Hydraulic Conductivity @ 28 days	ASTM D5084	8			8
Hydraulic Conductivity @ 90 days immersion	ASTM D5084	8			8
Temperature	ASTM C1064	8			8
pH	SW-846 Method 9045C	8			8
Shrinkage/Swell	ASTM D3877	8			8
Bleed Fluid	SW-846 Method 9095	8			8
Set Time	ASTM C191	8			8

7.0 DATA MANAGEMENT AND QUALITY ASSURANCE

The treatability testing for the CRSB, KRSB, LRSB, and PRSB soils will be conducted under IT's Technical Application Laboratories Quality Assurance (QA) program, as outlined in it's Quality Assurance Manual (Appendix B). Data management for the treatability testing will include control of data, review of analytical and testing results, and manual compilation, organization and entry of data into Excel spreadsheets for presentation and analysis.

7.1 Control Of Data

Sampling logs and laboratory notebooks will be controlled as per the laboratory SOP's TDL1503, "Analytical Logbook Recording Procedures," and TDL1504, "Laboratory Notebook Recording Procedures."

All data collected, including supplier/manufacturer information, data collection forms/sheets and laboratory analytical reports, will be sent to the project file. The project manager will have control of the project file.

7.2 Data Review And Verification

Data obtained from sampling logs, laboratory notebooks, data collection forms/sheets and testing laboratories will be reviewed for correctness and reasonableness prior to use. Data from commercial laboratories will also be reviewed with respect to laboratory internal Quality Control (QC) results to assess quality of data to assure data quality objectives are met and determine any data qualification needs.

One hundred percent of data transcriptions will be checked.

All calculations performed by software will be verified independently, either by hand or by entering data of known result into the software.

7.3 Data Reporting

Data collected for each formulation will be grouped and tabulated for summary presentation and examination.

Key process data from the formulations will also be tabulated for summary presentation, examination and overall process variable/performance determination. The final stabilized waste

characteristics for the formulations will be tabulated for summary presentation, examination and overall process waste characteristics determination.

7.4 Data Evaluation

Data obtained from sampling logs, laboratory notebooks, data collection forms/sheets and testing laboratories will be reviewed for correctness and reasonableness prior to use. Results from commercial laboratories will also be reviewed with respect to laboratory internal QC results to assess quality of data to assure data quality objectives are met and determine any data qualification needs.

Formulation development results will be evaluated for consistency with expected trends with key variables.

Data from performance testing will be evaluated by comparing results of replicate formulations of the mixes listed in Table 1-1. Data is expected to be predictable, based on formulation development results, reproducible, and provide consistent results within a reasonable variation. Where possible, results from replicate formulations will be evaluated statistically to determine mean values and standard deviations.

7.5 Data Interpretation

Data interpretation will be performed by senior technical personnel on the project. Interpretation will be aided by the generation of performance indicators and variable relationships so that trends may be determined. Data trends are used to predict effects on performance due to changes in key variables or operating conditions. Treatment criteria for evaluation of formulations are listed in Table 2.1. Results are expected to be reproducible and provide consistent results within a reasonable variation.

8.0 HEALTH AND SAFETY

The health and safety programs in place at the IT/TAL comply with the Occupational Safety and Health Administration (OSHA) standard for laboratories, 29 CFR 1910.1450, Occupational Exposures to Hazardous Chemicals in Laboratories and the Tennessee State Regulations for Protection Against Radiation. The following procedures and programs have been implemented in order to assure compliance with these regulatory requirements.

8.1 Project Description And Planning

The Project Description and Planning Summary Forms are used to document project-specific requirements, including health and safety requirements, and communicate those requirements to project staff. One of the forms, the Project Health and Safety Summary (PHSS), describes sample and equipment hazards, procedural requirements, and personal protective equipment (PPE) requirements. The PHSS will specify the need for keypoint cards, system reviews, work permits, and/or license amendments. The PHSS is approved by the Health and Safety Professional.

8.2 Chemical Hygiene Plan

Laboratory operations at the IT/TAL laboratories are conducted under the requirements of the facility Chemical Hygiene Plan (CHP). The CHP includes the necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals in use in their work area. The CHP, supplied in Appendix A, describes basic safe work practices, training and hazard communication requirements, procedures for work with regulated chemicals, the use of engineering controls and personal protective equipment, emergency procedures, medical surveillance, inspections and record keeping requirements. The CHP serves as the umbrella under which routine laboratory operations are conducted. Health and safety aspects of projects involving unique or higher hazard situations may be addressed in project-specific health and safety plans (HASP).

8.3 Key Point Cards

Key Point Cards are used to document equipment hazards, emergency shut down procedures and procedure or project specific hazards. The Key Point Card is the primary safety checklist for all TDL laboratory activities. It must be completed prior to performing any treatability testing or

analytical procedure. The complete Key Point Card is posted in the work area where the activity will occur.

8.4 Bench-Scale Experimental Review

A safety review is required before initiating work with new and/or unfamiliar chemicals and reaction setups. This review is performed with the supervisor and other key personnel who are familiar with the type of experiment. A Bench-Scale Experimental Review Checklist form is be reviewed with the appropriate supervisor.

8.5 Radiation Protection Plan

Both the ETDC and the TDL are licensed by the Tennessee Division of Radiological Health (TDRH) to perform analytical procedures and treatability testing on radioactively contaminated materials. These activities are performed in accordance with the state approved Radiation Protection Program (RPP). The elements of the RPP include training, exposure limits, monitoring and survey requirements, exposure control and radioactive material control.

As described above, the PHSS documents if the project involves radioactive materials and the associated requirements for receiving and working with the materials. The facility Radiation Safety Officer (RSO) will determine if a license amendment is required and will issue an Authorization Number for receipt of the materials once it is verified that the samples meet license limits. Samples are screened and classified upon receipt to assess radiological hazards and to verify sample activity. The RSO specifies work requirements including the need for a Radiation Work Permit (RWP), special monitoring, project-specific training, and PPE. Pilot scale operations involving radioactive materials are reviewed and approved by the Radiation Safety Committee (RSC).

In addition to project specific requirements, routine radiological surveys and personnel monitoring are performed to verify the effectiveness of radiation hazard control measures.

9.0 SCHEDULE

The project has several milestones associated with completion of tasks. The project tasks with estimated times for completion are listed in the Table 9-1.

When the initial Phase I performance testing results are available for the S/S treated CRSB and KRSB soils, a briefing package will be produced, summarizing the data and its significance toward the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated material. A workshop covering this briefing package will be scheduled at the SRS.

At the completion of Phase I of the S/S treatability testing, a report will be prepared detailing observations and procedures from the treatability study, and the results of the performance tests. This report will include specific recommendations concerning full-scale treatment of the soils. The report will include, but is not limited to the following sections:

Project Description

- Introduction
- Waste units description
- Soil characteristics

Study Objectives

- Objectives
- Performance criteria

Study Approach

- Soil characterization
- Grout mix design
- Formulation development
- Performance testing
- Deviations from the work plan

Data Analysis and Interpretation

- Soil characterization

- Grout mix design/formulation development
- Performance testing

Full-Scale Delivery Systems

- Reagents
- Delivery systems

Conclusions and Recommendations

- Summary of findings
- Recommendations

At the completion of Phase II of the S/S treatability testing, the final report will be revised and reissued to include the Phase II results, conclusions, and recommendations.

Table 9-1 Schedule for S/S Treatability Testing on the Reactor Seepage Basin Soils

Schedule Milestone	Date
Receipt of CRSB, KRSB, LRSB, and PRSB Samples From SRS	November 4, 1998
Initiation of Phase I Treatability Testing	November 8, 1998
Submittal of Draft Phase I Briefing Package to WSRC	December 21, 1998
Submittal of Final Phase I Briefing Package to WSRC	January 11, 1999
Submittal of Draft Phase I Report To WSRC	February 2, 1999
Initiation of Phase II Treatability Testing	February 8, 1999
Submittal of Final Phase I Report to WSRC	March 21, 1999
Submittal of Draft Phase II Report to WSRC	May 10, 1999
Submittal of Final Phase II Report to WSRC	July 5, 1999

10.0 RESIDUAL WASTE MANAGEMENT

This project involves treatability testing of soil from two Reactor Seepage Basins, provided to IT. When testing is completed, all residuals will be containerized and transported back to the SRS.

IT's Waste Management program was developed to ensure that throughout the stabilization demonstration, waste minimization technologies are utilized to the fullest and that residuals generated at the end of the demonstration are properly managed. In addition, the program ensures that the treatability testing is conducted in full compliance with the regulations of the Tennessee Division of Solid Waste Management and the TDRH.

The elements of this plan include:

- Responsibilities and training
- Sample management and storage

Waste Minimization

- Estimated residual quantities
- Residuals characterization and classification
- Residual storage and disposal
- Effluents
- Emergency response and spill management.

10.1 RESPONSIBILITY AND TRAINING

IT's Regulatory Compliance Specialist (RCS) will oversee the receipt, on-site management and return of the soil samples and residuals for both the TDL and ETDC, thus ensuring full accountability for the sample between the bench-scale and pilot-scale efforts. Employees of the TDL and the ETDC have received facility-specific training in Resource Conservation and Recovery Act (RCRA) hazardous waste compliance, radioactive materials handling, and U.S. DOT hazardous materials general awareness.

10.2 SAMPLE MANAGEMENT AND STORAGE

The soil samples will be received at the ETDC in Oak Ridge directly from SRS. The containers containing the sample material will be stored in "Isolator" drums as a means of secondary containment and will be kept in Room 1. Shortly after receipt, the samples will be sampled for geotechnical testing and the remaining soil homogenized per the Work Plan. Portions of the untreated soil material will be transported by IT vehicle with chain-of-custody documentation and appropriate US DOT labeling and packaging to the TDL in Knoxville for bench-scale testing. All samples will be returned from the TDL to the ETDC in a similar manner after this phase of the study is complete. No samples will be retained at the TDL. Transfers will be coordinated, prepared, recorded, and supervised by the RCS. Liquids will be held in secondary containment capable of holding 100 percent of their volume to prohibit the spread of contamination in the event of a spill. See Section 10.8, Emergency Response and Spill Management, for more details.

10.3 WASTE MINIMIZATION

The ETDC Waste Minimization Policy is " . . to reduce all radioactive, hazardous, and nonhazardous wastes to the minimum levels technically and economically practical while maintaining full compliance with all federal and state waste regulations." ETDC's Waste Minimization Policy is driven by management's awareness of IT's environmental responsibility, public image, long-term liability, and waste management costs. The policy is implemented by the concerted efforts of the IT technical staff. IT has demonstrated that performing initial bench-scale treatability tests with reduced sample quantities, utilizing effective nonhazardous chemical substitutes whenever possible, and considering beneficial reuse or reclamation options are all effective means to minimize the quantity of hazardous and radioactive wastes generated. These and other waste minimization techniques have been incorporated into the Work Plan to eliminate hazardous wastes and reduce radioactive waste volume.

Because much of waste minimization is simply increased efficiency, several IT preliminary procedures ensure that the pilot-scale treatment testing is performed as efficiently as possible. A fraction of the sample will first be treated in a bench-scale system similar to the pilot-scale system. These bench scale results will be used to refine the operating parameters of the IT pilot system. Before sample is introduced into the pilot system, wipe samples are taken and inspection of the equipment is performed to certify that the system is free of prior contaminants.

10.4 ESTIMATED RESIDUAL QUANTITIES

Previous project experience enables IT to estimate the total volume and types of residuals expected from testing these samples. Based on information received from SAIC and WSRC and the IT Work Plan, the volume of unused soil, treating residuals, and laboratory generated waste will be approximately 40 gallons per reactor basin.

10.5 RESIDUAL CHARACTERIZATION AND CLASSIFICATION

Since all of the unused samples and residuals will be returned to the SRS, there will be no need to characterize and classify the residuals, other than for correct and proper shipping. The RCS will classify the residuals based on data provided by WSRC, process knowledge, and post-treatment analyses.

10.6 RESIDUALS STORAGE AND DISPOSAL

All residuals will be properly containerized in appropriate shipping containers, segregated, and accumulated in the ETDC. The residuals will be shipped back to SRS via a licensed shipper. Eventual disposition will be the responsibility of WSRC.

10.7 EFFLUENTS

Emissions of radioactive materials in effluents from the ETDC are regulated by the TDRH and the Oak Ridge Public Works. No radioactive liquids are discharged from the facility to the ground or sewer. Gaseous emissions are discharged following treatment through vents that are continuously sampled for radioactive materials to ensure compliance with the Tennessee SRPAR.

Based on Tennessee Air Pollution Control Regulations and on ETDC's off-gas treatment system, no air discharge permit or associated monitoring is required.

10.8 EMERGENCY RESPONSE AND SPILL MANAGEMENT

The TDL and the ETDC have a current Emergency Action and Fire Prevention Plan that is designed to adequately cover projects such as this demonstration. This plan is to be implemented in the case of any emergency or spill at the TDL or the ETDC that may adversely affect human health or the environment. Preparedness or prevention as well as emergency response provisions are addressed in these emergency plans in the event of a fire/ explosion, spill/release, or natural

disaster. State and local agencies requested to provide emergency assistance are listed with their phone numbers in the Plan, and these names and numbers are posted adjacent to facility telephones. Both TDL and ETDC personnel are currently trained and familiar with the procedures of the Plan. IT's project-specific HSP identifies potential hazards associated with the project, thereby increasing the worker's preparedness and prevention awareness. Trained Primary and Alternate Emergency Coordinators have been assigned for 24-hour response, and emergency response equipment is readily accessible in all work areas.

11.0 REFERENCES

WSRC. 1992. *Phase II RCRA Facility Investigation/Remedial Investigation Plan for the P-Area Burning/Rubble Pit (131-P) (U).* WSRC-RP-91-1123, Rev. 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC 29808.

WSRC. 1996. *Laboratory-Scale Immobilization Study Report for the L-Area Oil and Chemical Basin 904-83G (U).* WSRC-RP-95-15, Rev. 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC 29808.

WSRC. 1997. *Remedial Investigation Report and Baseline Risk Assessment for the K-Reactor Seepage Basins (U).* WSRC-RP-96-871, Rev. 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC 29808.

WSRC. 1998. *ASCAD™ RI Work Plan for the C-Reactor Seepage Basins (904-66G, 904-67G, and 904-68G) (U).* WSRC-RP-97-431, Rev. 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC 29808.

Appendix E

Analytical Methods

This page intentionally left blank.

INTERNATIONAL TECHNOLOGY CORPORATION

PROCESS DEVELOPMENT GROUP

Standard Operating Procedure

Title: **Particle-Size Distribution of Soils**

Prepared by: [signature] **Date:** 4/02/93

Reviewed by: [signature] **Date:** 4-05-93
Technical Specialist

Operations approval: [signature] **Date:** 4/22/93
Group Leader/Manager

Interim approval: [signature] **Date:** 9/28/93
Quality Assurance Officer

Management approval: [signature] **Date:** 9/29/93
Manager, Process Development Group

APPROVED FOR INTERIM USE

CONTROLLED COPY NO.____

Environmental Technology Development Center
P.O. Box 4339 • 1570 Bear Creek Road • Oak Ridge, Tennessee 37830 • 615-482-6497 • FAX: 615-482-1890

IT Corporation is a wholly owned subsidiary of International Technology Corporation

Particle-Size Distribution of Soils

1.0 Scope and Objectives

1.1 This procedure covers the determination of the particle size distribution of soils and is in general accordance with ASTM D 422.

1.2 This procedure covers two methods for quantifying particle sizes. For particles coarser than the No.200 (75 μm) sieve, the particle size is determined by sieving; for particles finer than the No.200 sieve, the particle size distribution is calculated from hydrometer data.

1.3 This method is a necessary index test for soils, for it presents the relative proportions of different sizes of particles. From this test it is possible to determine the size ranges likely to control the engineering properties of the soil.

1.4 Values stated in SI units shall be regarded as standard except as noted.

2.0 Definitions

2.1 ASTM - American Society of Testing and Materials

2.2 Coarse Fraction - The portion of the soil specimen retained on the No.10 sieve.

2.3 Composite Analysis - A particle size test combining the sieve and hydrometer (sedimentation) analyses.

2.4 Fine Fraction - The portion of the soil specimen finer than the No.10 sieve.

2.5 Hydrometer Analysis - Same as sedimentation analysis. The portion of the test procedure covering the silt and clay sample fraction.

2.6 Hygroscopic Moisture - The amount of water, expressed as a percentage, not removed from a soil specimen by air drying, or by oven drying at a temperature less than 110 ±5°C.

3.0 Methodology

3.1 Summary - The sieve and hydrometer portions of this method combine to cover a range of particle sizes from 3.5 inch diameter cobbles to clays in the 1 micron range. Sieving is performed on the portion of the test specimen coarser than the No.200 sieve. Particles are separated into different size ranges using a series of sieves with standard openings. A sedimentation procedure is used for the silt and clay portion of the specimen. The density of the suspension is determined using a soil hydrometer and the readings are converted to particle size. Final results are customarily presented graphically as cumulative percent finer than diameters.

3.2 Interferences or Potential Problem Areas

3.2.1 Sample portions prepared for sedimentation analysis normally require chemical dispersion prior to mechanical dispersion. Sodium hexametaphosphate solution is the most common dispersion agent. Solutions of this salt, if acidic, will gradually revert or hydrolyze to the orthophosphate form resulting in decreased dispersive action. Fresh dispersant solution shall be prepared, or the solution pH adjusted to 8 or 9 using sodium carbonate, at least every 30 days.

3.2.2 The hydrometer readings recorded in the sedimentation analysis are an indirect measurement of the quantity of particles in suspension and are subject to errors due to turbidity, density currents, and soluble minerals contained in the soil sample. Results determined after the 5 minute reading are normally reliable. However, other factors influence the settling velocities of particles finer than 1 micron, nullifying several of the assumptions made by Stoke's Law. Results below the 1 micron size interval may not be valid.

3.2.3 Hydrometer specimens containing organic debris frequently foam excessively during mechanical agitation. Some foams may have the consistency of shaving cream and be long lasting, hiding the portion of the hydrometer stem at which readings are taken. An Ivory soap sliver dipped quickly into the foam, or a few drops of isopropyl alcohol will usually hasten the dissipation of the foam. If these measures do not dissipate the

foam quickly, it will be necessary to allow the foam to dissipate on its own, and hydrometer readings started when feasible. Write "foam" in any data entry blocks where readings were not obtained due to excessive foam.

3.3 Sample Requirements, Handling, and Preservation

3.3.1 All samples submitted for analysis must be of sufficient volume as to allow ample material for index tests and multiple specimen preparation.

3.3.2 Samples submitted for analysis should be sufficiently large as to yield quantities of material retained on the No.10 sieve according to the following table.

Nominal Dia. of Largest Particles, in. (mm)	Approximate Minimum Mass of Portion, g.
⅜ (9.5)	500
¾ (19.0)	1000
1 (25.4)	2000
1½ (38.1)	3000
2 (50.8)	4000
3 (76.2)	5000

3.3.3 The portion passing the No.10 sieve shall weigh at least 120 grams for sandy soils and at least 60 grams for silty and clayey soils.

3.3.4 Separation of the soil particles may be made using the No.4, the No.40, or the No.200 sieve instead of the No.10 sieve as required by material or client specifications.

3.3.5 Specimens shall be prepared from representative samples as soon as practicable after sample receipt.

3.3.6 Samples may be sealed against moisture loss and stored for up to six months in an area not subject to temperature extremes (lower than 1°C or higher than 35°C).

3.4 Required Equipment and Reagents

3.4.1 Balance - A mechanical or electronic balance accurate to 0.02 grams or 0.1%, whichever is greater. Readability shall be to 0.01 grams for weights below 1 kg, to 0.1 gram for weights between 1 kg and 4 kg, and to 1 gram for weights above 4 kg.

3.4.2 Stirring Apparatus - A mechanically operated stirring device in which an electric motor turns a vertical shaft at a speed of not less than 10,000 rpm without load. The shaft shall be equipped with a replaceable stirring paddle made of metal, plastic, or hard rubber. The shaft shall be of such length that the stirring paddle will operate not less than ¾ inch nor more than 1½ inches above the bottom of the dispersion cup. A special dispersion cup equipped with four opposing sets of wire baffles shall be provided to hold the sample being dispersed.

3.4.3 Drying Oven - An oven, either gravity or forced convection, capable of maintaining an internal temperature of 110 ±5°C.

3.4.4 Thermometer - A thermometer capable of measuring temperatures over the range prevailing during the hydrometer test shall be used. Thermometers shall be graduated in 0.5°C divisions and be accurate to ±1°C.

3.4.5 Hydrometer - An ASTM soil hydrometer, graduated to read in either specific gravity or grams per liter of suspension. The hydrometer shall conform to the requirements of ASTM E 100 for type 151H or 152H. Dimensions of both types are the same; the scales, however, differ.

3.4.6 Sedimentation Cylinder - A volumetric glass cylinder approximately 18 inches in height and 2½ inches in diameter. The cylinder shall have a volume of 1000 ml with an inside diameter such that the 1000 ml mark is 36 ±2 cm from the inside bottom.

3.4.7 Sieves - A series of square-mesh woven-wire cloth sieves conforming to the requirements of ASTM E 11.

3.4.8 Water Bath or Constant Temperature Room - A water bath or constant temperature room for maintaining the soil suspension at a constant temperature during the hydrometer analysis. An insulated tank capable of maintaining the temperature of the suspension at a constant temperature at or near 20°C is satisfactory. The hydrometer analysis may be performed in a room of controlled temperature.

3.4.9 Mortar and Rubber-Covered Pestle - A large ceramic mortar and rubber-covered pestle or soil mill with rubber-covered bars (Hogentogler model S9131 or equivalent).

3.4.10 Sieve Shaker - A mechanical device designed to hold a stack of sieves and shake the stack in an orbital motion.

3.4.11 Dispersing Agent - A solution of sodium hexametaphosphate prepared by thoroughly mixing 40 grams of commercial grade sodium hexametaphosphate into sufficient deionized water to form 1 liter of solution.

3.4.12 Miscellaneous equipment - Miscellaneous equipment, including but not limited to, spatulas, aluminum pans, wash bottles, size 12 rubber stopper, etc.

3.5 Calibration Requirements

3.5.1 Balance calibrations shall be verified quarterly in accordance with SOP PDGADM0002.

3.5.2 Thermometer calibrations shall be verified annually in accordance with SOP PDGADM0008.

3.5.3 Sieves shall be maintained in accordance with SOP PDGGEO0023.

3.5.4 Sieve shakers shall be calibrated in accordance with SOP PDGGEO0032.

3.5.5 Hydrometer calibrations shall be verified in accordance with SOP PDGGEO0033.

3.6 Quality Control Requirements

3.6.1 Balances - Brass weights shall be used to verify the accuracy of each balance before use or

daily, whichever is less, and the result recorded in the balance log book. Brass weights shall meet OIML Class M_2 specifications or better and shall be checked quarterly in accordance with SOP PDGADM0003.

3.6.2 Ovens - Temperatures of ovens in use shall be recorded daily in accordance with SOP PDGADM0006.

3.6.3 Visually inspect the integrity of sieves before use. Ensure loose particles are dislodged from the wire mesh and that the number of blocked openings is not greater than 5% of the mesh area. No.200 and finer sieves shall be replaced annually. Other sieves shall be replaced as required.

3.6.4 Nonconformance/variance reports - In accordance with SOP PDGADM0009, nonconformance/variance reports shall be used to document any discrepancies in the performance or specifications of this procedure.

3.7 Health and Safety - Sample material containing hazardous, radiological, or mixed contaminants shall be handled in accordance with current facility Health and Safety directives. Engineering controls shall be used whenever possible to reduce personnel exposure to sample hazards (i.e., sample prepared inside vented hood space, sample extruder enclosure adequately ventilated, etc.). Personal protective equipment shall be used as necessary to prevent personnel exposure to hazards. As a minimum, appropriate protective gloves shall be worn by personnel handling contaminated sample material, in addition to safety glasses required of all personnel in the laboratory at all times. When in doubt as to the hazards involved in any operation, consult with the Geotechnical Laboratory Manager or Health and Safety Officer before proceeding.

3.8 Sample Preparation

3.8.1 Air-dry the soil sample to be tested until friable. Alternatively, the sample may be oven dried at a temperature not exceeding 60°C. Record the weight of the dry soil as "dry weight of soil" uncorrected for hygroscopic moisture.

3.8.2 Thoroughly disaggregate the dry soil lumps by grinding in a mortar with rubber-covered pestle

or soil mill with rubber-covered bars. Sieve the ground soil over a No.10 sieve. Regrind the portion retained on the sieve and pass over the sieve again. Take care not to lose any soil particles while handling.

3.8.3 Place the portion of the sample retained on the No.10 sieve in a covered container and add sufficient water to cover the specimen.

3.8.4 Remove a portion of the material passing the No.10 sieve weighing approximately 60 grams for clayey soils, to 120 grams for sandy soils. Record the weight of the soil removed as "weight of hydrometer specimen" uncorrected for hygroscopic moisture. Place the soil in a beaker of at least 250 ml capacity and cover with approximately 120 ml of the sodium hexametaphosphate solution. All hydrometer specimens to be run at the same time should contain the same amount of sodium hexametaphosphate solution. Allow to soak for at least 16 hours.

3.8.5 Determine the hygroscopic moisture content of the air-dried soil passing the No.10 sieve. Weigh a portion of the remaining soil of at least 15 grams, once the hydrometer portion has been weighed. This sample shall be dried in an oven at 110 ±5°C and the water content determined in accordance with SOP PDGGEO0019.

3.9 Coarse Sieve Analysis

3.9.1 After the material retained on the No.10 sieve has soaked overnight, wash the entire portion on a No.10 sieve with a water spray to remove small particles adhering the coarse fraction. Retain and label the wash water for disposal.

3.9.2 Oven dry the washed specimen in an oven at 110 ±5°C to a constant weight.

3.9.3 Arrange a nest of sieves covering the sizes of the particles to be tested. Place the coarsest sieve on top and other sieves in decreasing order. Place a sieve pan on the bottom of the sieve stack. Pour the dry coarse fraction over a nest of sieves to separate the specimen into a series of fractions. Place a sieve cover on top of the top sieve. Separation of particles may be

achieved using the 3 inch, 2 inch, 1½ inch, 1 inch, ¾ inch, ⅜ inch, No.4, and No.10 sieves. This arrangement may be modified as necessary to meet project specifications or the properties of the test sample.

3.9.4 Sieving of the sample shall be performed by means of a lateral and vertical motion of the sieve, followed by a jarring action. This will ensure continuous sample movement over the entire surface of the sieve. At no time shall the sample fragments be forced through the sieve, or manipulated in any way by hand. The sieving operation shall continue until no more than 1 mass % of the material retained on a sieve passes that sieve during 1 minute of sieving. When mechanical sieving is employed, a check on the accuracy of the sieving operation may be secured by following the practices covered in the hand method of sieving.

3.9.5 At the end of the sieving operation, successively remove and invert each sieve on a flat surface and brush the retained particles out of the sieve mesh. Weigh and record the weight of the particles retained on each sieve.

3.10 Hydrometer Correction

3.10.1 Hydrometer readings are based on distilled or demineralized water. The sodium hexametaphosphate dispersing solution added to the fine fraction results in a liquid having a specific gravity appreciably greater than that of distilled or demineralized water. The hydrometer correction measures the difference between the hydrometer reading in the dispersant and the reading in water for subtraction from data readings.

3.10.2 Prepare a 1000 ml solution of sodium hexametaphosphate by pouring 120 ml of the 40 g/liter solution in a glass sedimentation cylinder. Add demineralized water until the contents reaches the 1000 ml mark. Place a No.12 or No.13 rubber stopper over the open end of the cylinder and agitate by hand, turning the cylinder upside down and back several times. Place the cylinder in the constant-temperature water bath or in the area where the sedimentation tests will be performed. Once the

temperature of the solution becomes constant, insert the hydrometer. Allow the temperature of the hydrometer to equilibrate and record the hydrometer reading as observed at the top of the meniscus formed on the stem. Record this reading as the hydrometer correction factor. For hydrometer type 151H the correction factor is the difference between this reading and one; for hydrometer type 152H the correction factor is the difference between the reading and zero.

3.11 Sedimentation Analysis

3.11.1 Upon completion of the soaking period, thoroughly disperse the sample using the stirring apparatus. Transfer the beaker contents into the dispersion cup. Ensure that no residue remains in the beaker by flushing the contents using distilled or demineralized water. If necessary, add distilled or demineralized water to the dispersion cup such that it is approximately half full. Stir the soil-water slurry for a period of 1 minute.

3.11.2 Immediately transfer the soil/water mixture into a glass sedimentation cylinder. Add distilled or demineralized water to the 1000 ml mark.

3.11.3 Block the open end of the glass cylinder using a rubber stopper. Agitate the mixture by turning the cylinder upside down and back for a period of 1 minute counting for approximately 60 turns. Each upside down-and-back motion counts as two turns.

3.11.4 After the cylinder containing the soil/water slurry has been shaken for 60 seconds, place the glass cylinder in a convenient location (in the water bath or on a lab bench not subject to vibration). Draw the bottom of the rubber stopper across the rim of the cylinder to scrape off particles adhering to the stopper. Start the elapsed time at the end of the hand agitation period and record hydrometer readings at elapsed times of 0.5, 1, 2, 5, 15, 30, 60, 250, and 1440 minutes. Time intervals may be varied as needed, or as required to produce results corresponding to specific particle diameters.

3.11.5 Take hydrometer readings by inserting the hydrometer into the soil/water mixture

approximately 25 to 30 seconds prior to the reading time. Lower the hydrometer slowly into the suspension to avoid disturbing settling particles in the solution. Lower the hydrometer to the approximate depth expected for the reading. Wait until the hydrometer is stable and not touching the side of the cylinder. Read the hydrometer at the top of the meniscus formed on the hydrometer stem. Record the reading. Slowly remove the hydrometer from the soil/water suspension and place it with a spinning motion in a graduate of clean distilled or demineralized water. Avoid leaving the hydrometer in a specimen cylinder for more than a few minutes to prevent particles from accumulating on the hydrometer bulb. If large floating particles adhere to the hydrometer after it is withdrawn from the specimen, wipe the hydrometer with a paper towel before placing it in the cylinder of water.

3.11.6 At every reading interval after the 30 second reading, record the temperature of the suspension by inserting a thermometer into the suspension. Take care not to agitate the suspension beyond that necessary to obtain the temperature. Temperatures after the 1 hour reading may be recorded from a thermometer immersed in a sedimentation cylinder containing dilute dispersant.

3.11.7 Upon completion of all the required hydrometer readings, transfer the contents of the sedimentation cylinder into a No.200 sieve and wash with tap water until the wash water is clear. Place the residue in a drying pan and dry overnight in an oven at a temperature of 110 ±5°C.

3.11.8 Perform a sieve analysis of the portion retained on the No.200 sieve in accordance with section 3.9 using No.20, No.40, No.60, No.100, No.140, and No.200 sieves. The number and size of sieves used may be adjusted to suit client or material requirements.

3.12 Calculations

3.12.1 Correct the weight of material used for the hydrometer analysis and the total specimen weight for hygroscopic moisture by dividing

these weights by 1 plus the hygroscopic moisture content expressed as a fraction.

3.12.2 Coarse Fraction Sieve Analysis

3.12.2.1 Calculate the percentage of the specimen passing the No.10 sieve by dividing the weight of material passing the No.10 sieve by the total weight of material originally separated on the No. 10 sieve. Multiply the result by 100. To determine the weight passing the No.10 sieve, subtract the quantity retained on the No.10 sieve from the original weight.

3.12.2.2 To determine the total weight of material passing the No.4 sieve, add to the weight of the soil passing the No.10 sieve the quantity of the fraction passing the No.4 sieve and retained on the No.10 sieve. For the remaining sieves, determine the percentages passing in a similar manner.

3.12.2.3 To calculate the total percentage passing for each sieve, divide the total quantity passing, as described above, by the total weight of the sample. Multiply the result by 100.

3.12.3 Percentages of Soil in Suspension

3.12.3.1 Determine the weight of a total sample represented by the weight of soil used in the hydrometer test, by dividing the oven-dry weight used by the percentage passing the No.10 sieve, and multiplying the result by 100. This represents the weight W in the equation for percentage remaining in suspension.

3.12.3.2 The percentage of soil remaining in suspension at the level where the hydrometer is measuring the density of the suspension may be determined as follows:

3.12.2.7.1 For hydrometer type 151H:

$$P = \left[\frac{100,000}{W} * \frac{G}{(G-G_1)}\right](R-G_1)$$

3.12.2.7.2 For hydrometer type 152H:

$$P = \frac{Ra}{W} * 100$$

where:

a = correction factor to be applied to the reading of hydrometer 152H. Factor computed based on a specific gravity of 2.65.(Correction factors are provided in Table 1),

P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension,

R = hydrometer reading with correction applied (see section 3.8.5),

W = oven-dry weight of soil in a total test sample represented by quantity of soil dispersed (see section 3.9.6), g,

G = specific gravity of the soil particles as determined by the method appropriate to the sample being tested,

G_1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation produces no significant effect, and in the second instance, the correction factor R is based on a value of one for G_1.

3.12.4 Particle Diameters - The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading is calculated according to Stokes' law. The result of this determination is based on the premise that a particle of this diameter was at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. The particle size calculated represents the diameter of a sphere that would fall at the same rate as the soil particles. This assumption is validated by Stokes' law in that it considers the terminal velocity of a single sphere falling in an infinity of liquid. Calculate the diameter of soil particles as follows:

$$D=K\sqrt{\frac{L}{T}}$$

where:

D = diameter of particle, mm

K = constant depending on the temperature of the suspension and the specific gravity of the soil particles. Values of K for a range of temperatures and specific gravities are given in Table 2. The value of K does not change for a series of readings constituting a test, while values of L and T do vary.

L = Effective depth. The distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. (For a given hydrometer and sedimentation cylinder, values vary according to the hydrometer readings. Values of effective depth are given in Table 3.

T = interval of time from beginning of sedimentation to the taking of the reading, min.

3.12.5 Fine Sieve Analysis

3.12.5.1 For sieve analysis values of portion finer than the No.10 sieve (the hydrometer portion), first determine the weight of the portion that would have been retained on the No.10 sieve had it not been removed. This weight equals the total percentage retained on the No.10 sieve (100 minus total percentage passing) times the weight of the total sample represented by the weight of soil used and the result divided by 100.

3.12.5.2 Calculate the total weight of the specimen passing the No. 200 sieve. Add weights retained on all the sieves (including the No.10) and subtract the result from the weight of the total dry specimen.

3.12.5.3 Calculate the total weights passing each of the other sieves as described in section 3.12.2.

3.12.5.4 Calculate the total percentages passing by dividing the total quantity passing (3.12.5.3) by the total dry weight of the specimen, and multiply the result by 100.

3.12.6 Once the hydrometer analysis is complete, a graph of the test results shall be prepared by plotting the diameters of the particles on a logarithmic scale as the abscissa and the percentages finer than the corresponding diameters to an arithmetic scale as the ordinate. The preparation of the graph may be omitted if the hydrometer test is not performed. In this case, any values may be obtained directly from the tabulated data.

3.12.7 A validated computer spreadsheet is currently in use for calculating and graphing all required data.

4.0 Forms - A copy of the data recording form used in conjunction with this procedure is included in Appendix A.

5.0 References

5.1 ASTM Procedures

5.1.1 D 422 - Method for Particle-Size Analysis of Soils

5.1.2 E 11 - Specifications for Wire-Cloth Sieves for Testing Purposes

5.1.3 E 100 - Specification for ASTM Hydrometers

5.2 IT Standard Operating Procedures

5.2.1 PDGADM0002 - Balance Calibration and Maintenance

5.2.2 PDGADM0003 - Use and Maintenance of Class S and Brass Weights

5.2.3 PDGADM0006 - Verification of Oven and Refrigerator Temperatures

5.2.4 PDGADM0008 - Verification of Thermometer Calibration

5.2.5 PDGADM0009 - Nonconformance/Variance Reports

5.2.6 PDGGEO0019 - Moisture Content of Soil and

Geotechnical Purposes

5.2.7 PDGGEO0023 - Sieve Specification, Calibration, and Inspection

5.2.8 PDGGEO0032 - Calibration of Sieve Shakers

5.2.9 PDGGEO0033 - Calibration of Soil Hydrometers

TABLE 1

Values of Correction Factor, a,
for Different Specific Gravities of Soil Particles

Specific Gravity	Correction Factor
2.95	0.94
2.90	0.95
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.03
2.45	1.05

Table 2

Values of *K*
Used in Equation for Computing Particle Diameters

Temp.	Specific Gravity of Soil Particles								
°C	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01530	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.01323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01255	0.01208	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

Table 3

Values of *L* , Effective Depth

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Efective Depth, *L*, cm	Actual Hydrometer Reading	Efective Depth, *L*, cm	Actual Hydrometer Reading	Efective Depth, *L*, cm
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5	36	10.4
1.006	14.7	6	15.3	37	10.2
1.007	14.4	7	15.2	38	10.1
1.008	14.2	8	15.0	39	9.9
1.009	13.9	9	14.8	40	9.7
1.010	13.7	10	14.7	41	9.6
1.011	13.4	11	14.5	42	9.4
1.012	13.1	12	14.3	43	9.2
1.013	12.9	13	14.2	44	9.1
1.014	12.6	14	14.0	45	8.9
1.015	12.3	15	13.8	46	8.8
1.016	12.1	16	13.7	47	8.6
1.017	11.8	17	13.5	48	8.4
1.018	11.5	18	13.3	49	8.3
1.019	11.3	19	13.2	50	8.1
1.020	11.0	20	13.0	51	7.9
1.021	10.7	21	12.9	52	7.8
1.022	10.5	22	12.7	53	7.6
1.023	10.2	23	12.5	54	7.4
1.024	10.0	24	12.4	55	7.3
1.025	9.7	25	12.2	56	7.1
1.026	9.4	26	12.0	57	7.0
1.027	9.2	27	11.9	58	6.8
1.028	8.9	28	11.7	59	6.6
1.029	8.6	29	11.5	60	6.5
1.030	8.4	30	11.4		
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

APPENDIX A

DATA COLLECTION FORM

Computer Entry By _____ Date _____

Entry/Transcription Check _____ Date _____

Project Name _____

Project Number _____

IT/ETDC Sample No _____

Coarse sieves by: _____

Date : _____

PARTICLE SIZE ANALYSIS ASTM D422

SOP PDGGEO0020

Fine sieves by: _____

Date : _____

	Sieve Opening mm	Sieve No.	Cumulative Wt of Mat'l Retained, g.
C	75	3"	
O	37.5	1.5"	
A	19	3/4"	
R	9.5	3/8	
S	4.75	#4	
E	2	#10	

	Sieve Opening mm	Sieve No.	Cumulative Wt of Mat'l Retained, g.
	0.85	#20	
F	0.425	#40	
I	0.25	#60	
N	0.150	#100	
E	0.106	#140	
	0.075	#200	

Hydrometer Analysis Performed By _____

Sample Prepped By _____ Date _____

	Date 199_	Clock Time	Elapsed Time	Temp C	Hydrometer Reading
			0 min.		
H			0.5		
Y			1		
D			2		
R			5		
O			15		
M			30		
E			60		
T			120		
E			250		
R			1440		

A Calculated Dry Wt of Hydrometer Sample, g (B/P)	
B Wt of Air-Dried Sample, Hydrometer	
C Calc Total Dry Sample Wt, g (D/1+P)	
D Total Wt of Air-Dry Soil, g	
E ASTM Hydrometer Type	151H 152H
F Hydrometer Serial Number	
G Thermometer Serial Number	
H Hydrometer Correction Factor	
K HYGROSCOPIC MOISTURE CONTENT	
L Tare Number	
M Tare Wieght, grams	
N Wt Air-Dry Sample + Tare, g.	
O Wt Oven-Dried Sample + Tare, g.	
P Hygroscopic Moisture Content, %	

Hydrometer Readings Recorded as follows: ASTM 151H - (Scale reading-1)x100
ASTM 152H - Scale reading/100

Designation: D 422 – 63 (Reapproved 1990)ε1

Standard Test Method for Particle-Size Analysis of Soils[1]

This standard is issued under the fixed designation D 422; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—Section 19 was added editorially in September 1990.

1. Scope

1.1 This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 μm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 μm is determined by a sedimentation process, using a hydrometer to secure the necessary data (Notes 1 and 2).

NOTE 1—Separation may be made on the No. 4 (4.75-mm), No. 40 (425-μm), or No. 200 (75-μm) sieve instead of the No. 10. For whatever sieve used, the size shall be indicated in the report.

NOTE 2—Two types of dispersion devices are provided: (*1*) a high-speed mechanical stirrer, and (*2*) air dispersion. Extensive investigations indicate that air-dispersion devices produce a more positive dispersion of plastic soils below the 20-μm size and appreciably less degradation on all sizes when used with sandy soils. Because of the definite advantages favoring air dispersion, its use is recommended. The results from the two types of devices differ in magnitude, depending upon soil type, leading to marked differences in particle size distribution, especially for sizes finer than 20 μm.

2. Referenced Documents

2.1 *ASTM Standards:*

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

E 100 Specification for ASTM Hydrometers[4]

3. Apparatus

3.1 *Balances*—A balance sensitive to 0.01 g for weighing the material passing a No. 10 (2.00-mm) sieve, and a balance sensitive to 0.1 % of the mass of the sample to be weighed for weighing the material retained on a No. 10 sieve.

3.2 *Stirring Apparatus*—Either apparatus A or B may be used.

3.2.1 Apparatus A shall consist of a mechanically operated stirring device in which a suitably mounted electric motor turns a vertical shaft at a speed of not less than 10 000 rpm without load. The shaft shall be equipped with a replaceable stirring paddle made of metal, plastic, or hard rubber, as shown in Fig. 1. The shaft shall be of such length that the stirring paddle will operate not less than ¾ in. (19.0 mm) nor more than 1½ in. (38.1 mm) above the bottom of the dispersion cup. A special dispersion cup conforming to either of the designs shown in Fig. 2 shall be provided to hold the sample while it is being dispersed.

3.2.2 Apparatus B shall consist of an air-jet dispersion cup[5] (Note 3) conforming to the general details shown in Fig. 3 (Notes 4 and 5).

NOTE 3—The amount of air required by an air-jet dispersion cup is of the order of 2 ft³/min; some small air compressors are not capable of supplying sufficient air to operate a cup.

NOTE 4—Another air-type dispersion device, known as a dispersion tube, developed by Chu and Davidson at Iowa State College, has been shown to give results equivalent to those secured by the air-jet dispersion cups. When it is used, soaking of the sample can be done in the sedimentation cylinder, thus eliminating the need for transferring the slurry. When the air-dispersion tube is used, it shall be so indicated in the report.

NOTE 5—Water may condense in air lines when not in use. This water must be removed, either by using a water trap on the air line, or by blowing the water out of the line before using any of the air for dispersion purposes.

3.3 *Hydrometer*—An ASTM hydrometer, graduated to read in either specific gravity of the suspension or grams per litre of suspension, and conforming to the requirements for hydrometers 151H or 152H in Specifications E 100. Dimensions of both hydrometers are the same, the scale being the only item of difference.

3.4 *Sedimentation Cylinder*—A glass cylinder essentially 18 in. (457 mm) in height and 2½ in. (63.5 mm) in diameter, and marked for a volume of 1000 mL. The inside diameter shall be such that the 1000-mL mark is 36 ± 2 cm from the bottom on the inside.

3.5 *Thermometer*—A thermometer accurate to 1°F (0.5°C).

3.6 *Sieves*—A series of sieves, of square-mesh woven-wire cloth, conforming to the requirements of Specification E 11. A full set of sieves includes the following (Note 6):

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

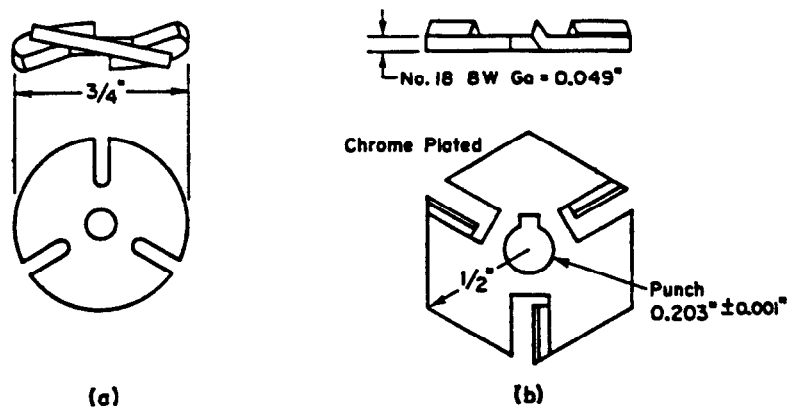
Current edition approved Nov. 21, 1963. Originally published 1935. Replaces D 422 – 62.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] Detailed working drawings for this cup are available at a nominal cost from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103. Order Adjunct No. 12-404220-00.



Metric Equivalents					
in.	0.001	0.049	0.203	½	¾
mm	0.03	1.24	5.16	12.7	19.0

FIG. 1 Detail of Stirring Paddles

3-in. (75-mm)	No. 10 (2.00-mm)
2-in. (50-mm)	No. 20 (850-μm)
1½-in. (37.5-mm)	No. 40 (425-μm)
1-in. (25.0-mm)	No. 60 (250-μm)
¾-in. (19.0-mm)	No. 140 (106-μm)
⅜-in. (9.5-mm)	No. 200 (75-μm)
No. 4 (4.75-mm)	

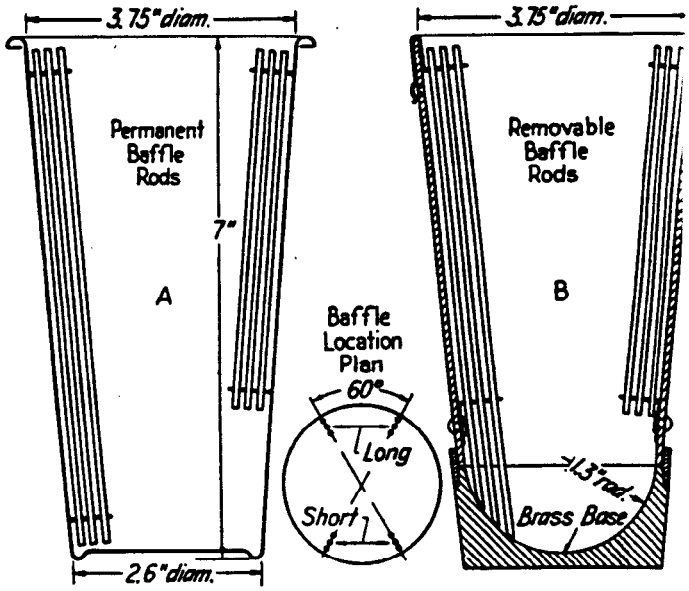
NOTE 6—A set of sieves giving uniform spacing of points for the graph, as required in Section 17, may be used if desired. This set consists of the following sieves:

3-in. (75-mm)	No. 16 (1.18-mm)
1½-in. (37.5-mm)	No. 30 (600-μm)
¾-in. (19.0-mm)	No. 50 (300-μm)
⅜-in. (9.5-mm)	No. 100 (150-μm)
No. 4 (4.75-mm)	No. 200 (75-μm)
No. 8 (2.36-mm)	

3.7 *Water Bath or Constant-Temperature Room*—A water bath or constant-temperature room for maintaining the soil suspension at a constant temperature during the hydrometer analysis. A satisfactory water tank is an insulated tank that maintains the temperature of the suspension at a convenient constant temperature at or near 68°F (20°C). Such a device is illustrated in Fig. 4. In cases where the work is performed in a room at an automatically controlled constant temperature, the water bath is not necessary.

3.8 *Beaker*—A beaker of 250-mL capacity.

3.9 *Timing Device*—A watch or clock with a second hand.



Metric Equivalents			
in.	1.3	2.6	3.75
mm	33	66	95.2

FIG. 2 Dispersion Cups of Apparatus

4. Dispersing Agent

4.1 A solution of sodium hexametaphosphate (sometimes called sodium metaphosphate) shall be used in distilled or demineralized water, at the rate of 40 g of sodium hexametaphosphate/litre of solution (Note 7).

NOTE 7—Solutions of this salt, if acidic, slowly revert or hydrolyze back to the orthophosphate form with a resultant decrease in dispersive action. Solutions should be prepared frequently (at least once a month) or adjusted to pH of 8 or 9 by means of sodium carbonate. Bottles containing solutions should have the date of preparation marked on them.

4.2 All water used shall be either distilled or demineralized water. The water for a hydrometer test shall be brought to the temperature that is expected to prevai during the hydrometer test. For example, if the sedimenta tion cylinder is to be placed in the water bath, the distilled o demineralized water to be used shall be brought to the temperature of the controlled water bath; or, if the sedimen tation cylinder is used in a room with controlled tempera ture, the water for the test shall be at the temperature of the room. The basic temperature for the hydrometer test is 68°F (20°C). Small variations of temperature do not introduce differences that are of practical significance and do no prevent the use of corrections derived as prescribed.

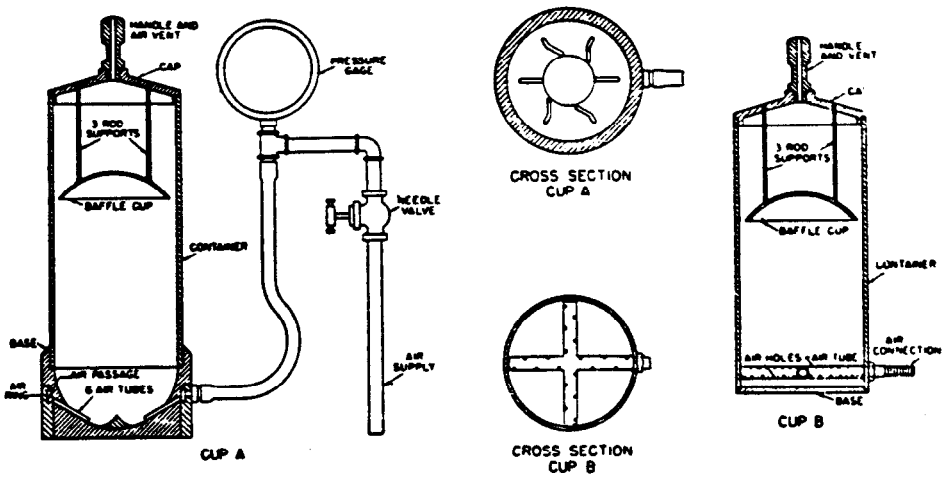


FIG. 3 Air-Jet Dispersion Cups of Apparatus B

5. Test Sample

5.1 Prepare the test sample for mechanical analysis as outlined in Practice D 421. During the preparation procedure the sample is divided into two portions. One portion contains only particles retained on the No. 10 (2.00-mm) sieve while the other portion contains only particles passing the No. 10 sieve. The mass of air-dried soil selected for purpose of tests, as prescribed in Practice D 421, shall be sufficient to yield quantities for mechanical analysis as follows:

5.1.1 The size of the portion retained on the No. 10 sieve shall depend on the maximum size of particle, according to the following schedule:

Nominal Diameter of Largest Particles, in. (mm)	Approximate Minimum Mass of Portion, g
⅜ (9.5)	500
¾ (19.0)	1000
1 (25.4)	2000
1½ (38.1)	3000
2 (50.8)	4000
3 (76.2)	5000

5.1.2 The size of the portion passing the No. 10 sieve shall be approximately 115 g for sandy soils and approximately 65 g for silt and clay soils.

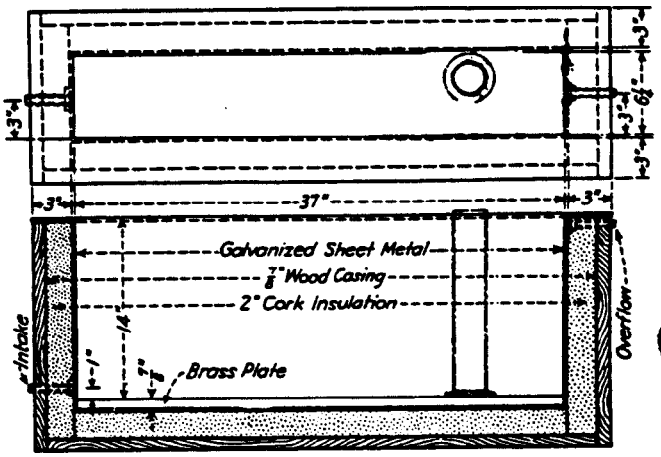
5.2 Provision is made in Section 5 of Practice D 421 for weighing of the air-dry soil selected for purpose of tests, the separation of the soil on the No. 10 sieve by dry-sieving and washing, and the weighing of the washed and dried fraction retained on the No. 10 sieve. From these two masses the percentages retained and passing the No. 10 sieve can be calculated in accordance with 12.1.

NOTE 8—A check on the mass values and the thoroughness of pulverization of the clods may be secured by weighing the portion passing the No. 10 sieve and adding this value to the mass of the washed and oven-dried portion retained on the No. 10 sieve.

SIEVE ANALYSIS OF PORTION RETAINED ON NO. 10 (2.00-mm) SIEVE

6. Procedure

6.1 Separate the portion retained on the No. 10 (2.00-mm) sieve into a series of fractions using the 3-in. (75-mm), 2-in. (50-mm), 1½-in. (37.5-mm), 1-in. (25.0-mm), ¾-in. (19.0-mm), ⅜-in. (9.5-mm), No. 4 (4.75-mm), and No. 10 sieves, or as many as may be needed depending on the sample, or upon the specifications for the material under test.



Metric Equivalents

in.	⅞	1	3	6¼	14	37
mm	22.2	25.4	76.2	158.2	356	940

FIG. 4 Insulated Water Bath

6.2 Conduct the sieving operation by means of a lateral and vertical motion of the sieve, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments in the sample through the sieve by hand. Continue sieving until not more than 1 mass % of the residue on a sieve passes that sieve during 1 min of sieving. When mechanical sieving is used, test the thoroughness of sieving by using the hand method of sieving as described above.

6.3 Determine the mass of each fraction on a balance conforming to the requirements of 3.1. At the end of weighing, the sum of the masses retained on all the sieves used should equal closely the original mass of the quantity sieved.

HYDROMETER AND SIEVE ANALYSIS OF PORTION PASSING THE NO. 10 (2.00-mm) SIEVE

7. Determination of Composite Correction for Hydrometer Reading

7.1 Equations for percentages of soil remaining in suspension, as given in 14.3, are based on the use of distilled or demineralized water. A dispersing agent is used in the water, however, and the specific gravity of the resulting liquid is appreciably greater than that of distilled or demineralized water.

7.1.1 Both soil hydrometers are calibrated at 68°F (20°C), and variations in temperature from this standard temperature produce inaccuracies in the actual hydrometer readings. The amount of the inaccuracy increases as the variation from the standard temperature increases.

7.1.2 Hydrometers are graduated by the manufacturer to be read at the bottom of the meniscus formed by the liquid on the stem. Since it is not possible to secure readings of soil suspensions at the bottom of the meniscus, readings must be taken at the top and a correction applied.

7.1.3 The net amount of the corrections for the three items enumerated is designated as the composite correction, and may be determined experimentally.

7.2 For convenience, a graph or table of composite corrections for a series of 1° temperature differences for the range of expected test temperatures may be prepared and used as needed. Measurement of the composite corrections may be made at two temperatures spanning the range of expected test temperatures, and corrections for the intermediate temperatures calculated assuming a straight-line relationship between the two observed values.

7.3 Prepare 1000 mL of liquid composed of distilled or demineralized water and dispersing agent in the same proportion as will prevail in the sedimentation (hydrometer) test. Place the liquid in a sedimentation cyclinder and the cylinder in the constant-temperature water bath, set for one of the two temperatures to be used. When the temperature of the liquid becomes constant, insert the hydrometer, and, after a short interval to permit the hydrometer to come to the temperature of the liquid, read the hydrometer at the top of the meniscus formed on the stem. For hydrometer 151H the composite correction is the difference between this reading and one; for hydrometer 152H it is the difference between the reading and zero. Bring the liquid and the hydrometer to the other temperature to be used, and secure the composite correction as before.

8. Hygroscopic Moisture

8.1 When the sample is weighed for the hydrometer test, weigh out an auxiliary portion of from 10 to 15 g in a small metal or glass container, dry the sample to a constant mass in an oven at 230 ± 9°F (110 ± 5°C), and weigh again. Record the masses.

9. Dispersion of Soil Sample

9.1 When the soil is mostly of the clay and silt sizes, weigh out a sample of air-dry soil of approximately 50 g. When the soil is mostly sand the sample should be approximately 100 g.

9.2 Place the sample in the 250-mL beaker and cover w 125 mL of sodium hexametaphosphate solution (40 g/ Stir until the soil is thoroughly wetted. Allow to soak for least 16 h.

9.3 At the end of the soaking period, disperse the sam further, using either stirring apparatus A or B. If stirr apparatus A is used, transfer the soil - water slurry from beaker into the special dispersion cup shown in Fig. washing any residue from the beaker into the cup w distilled or demineralized water (Note 9). Add distilled demineralized water, if necessary, so that the cup is m than half full. Stir for a period of 1 min.

NOTE 9—A large size syringe is a convenient device for handling water in the washing operation. Other devices include the wash-w bottle and a hose with nozzle connected to a pressurized distilled w tank.

9.4 If stirring apparatus B (Fig. 3) is used, remove cover cap and connect the cup to a compressed air supply means of a rubber hose. A air gage must be on the li between the cup and the control valve. Open the cont valve so that the gage indicates 1 psi (7 kPa) pressure (N 10). Transfer the soil - water slurry from the beaker to air-jet dispersion cup by washing with distilled demineralized water. Add distilled or demineralized water necessary, so that the total volume in the cup is 250 mL, b no more.

NOTE 10—The initial air pressure of 1 psi is required to prevent soil - water mixture from entering the air-jet chamber when the mixt is transferred to the dispersion cup.

9.5 Place the cover cap on the cup and open the control valve until the gage pressure is 20 psi (140 kP Disperse the soil according to the following schedule:

Plasticity Index	Dispersion Period, min
Under 5	5
6 to 20	10
Over 20	15

Soils containing large percentages of mica need be dispers for only 1 min. After the dispersion period, reduce the ga pressure to 1 psi preparatory to transfer of soil - water slu to the sedimentation cylinder.

10. Hydrometer Test

10.1 Immediately after dispersion, transfer the soil - wa slurry to the glass sedimentation cylinder, and add distill or demineralized water until the total volume is 1000 mL

10.2 Using the palm of the hand over the open end of t cylinder (or a rubber stopper in the open end), turn t cylinder upside down and back for a period of 1 min complete the agitation of the slurry (Note 11). At the end 1 min set the cylinder in a convenient location and ta hydrometer readings at the following intervals of ti (measured from the beginning of sedimentation), or as ma as may be needed, depending on the sample or the specifi tion for the material under test: 2, 5, 15, 30, 60, 250, a 1440 min. If the controlled water bath is used, the sedime tation cylinder should be placed in the bath between the and 5-min readings.

NOTE 11—The number of turns during this minute should approximately 60, counting the turn upside down and back as two tur

Any soil remaining in the bottom of the cylinder during the first few turns should be loosened by vigorous shaking of the cylinder while it is in the inverted position.

10.3 When it is desired to take a hydrometer reading, carefully insert the hydrometer about 20 to 25 s before the reading is due to approximately the depth it will have when the reading is taken. As soon as the reading is taken, carefully remove the hydrometer and place it with a spinning motion in a graduate of clean distilled or demineralized water.

NOTE 12—It is important to remove the hydrometer immediately after each reading. Readings shall be taken at the top of the meniscus formed by the suspension around the stem, since it is not possible to secure readings at the bottom of the meniscus.

10.4 After each reading, take the temperature of the suspension by inserting the thermometer into the suspension.

11. Sieve Analysis

11.1 After taking the final hydrometer reading, transfer the suspension to a No. 200 (75-μm) sieve and wash with tap water until the wash water is clear. Transfer the material on the No. 200 sieve to a suitable container, dry in an oven at 230 ± 9°F (110 ± 5°C) and make a sieve analysis of the portion retained, using as many sieves as desired, or required for the material, or upon the specification of the material under test.

CALCULATIONS AND REPORT

12. Sieve Analysis Values for the Portion Coarser than the No. 10 (2.00-mm) Sieve

12.1 Calculate the percentage passing the No. 10 sieve by dividing the mass passing the No. 10 sieve by the mass of soil originally split on the No. 10 sieve, and multiplying the result by 100. To obtain the mass passing the No. 10 sieve, subtract the mass retained on the No. 10 sieve from the original mass.

12.2 To secure the total mass of soil passing the No. 4 (4.75-mm) sieve, add to the mass of the material passing the No. 10 sieve the mass of the fraction passing the No. 4 sieve and retained on the No. 10 sieve. To secure the total mass of soil passing the ⅜-in. (9.5-mm) sieve, add to the total mass of soil passing the No. 4 sieve, the mass of the fraction passing the ⅜-in. sieve and retained on the No. 4 sieve. For the remaining sieves, continue the calculations in the same manner.

12.3 To determine the total percentage passing for each sieve, divide the total mass passing (see 12.2) by the total mass of sample and multiply the result by 100.

13. Hygroscopic Moisture Correction Factor

13.1 The hydroscopic moisture correction factor is the ratio between the mass of the oven-dried sample and the air-dry mass before drying. It is a number less than one, except when there is no hygroscopic moisture.

14. Percentages of Soil in Suspension

14.1 Calculate the oven-dry mass of soil used in the hydrometer analysis by multiplying the air-dry mass by the hygroscopic moisture correction factor.

14.2 Calculate the mass of a total sample represented by the mass of soil used in the hydrometer test, by dividing the oven-dry mass used by the percentage passing the No. 10 (2.00-mm) sieve, and multiplying the result by 100. This value is the weight W in the equation for percentage remaining in suspension.

TABLE 1 Values of Correction Factor, a, for Different Specific Gravities of Soil Particles[A]

Specific Gravity	Correction Factor[A]
2.95	0.94
2.90	0.95
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.03
2.45	1.05

[A] For use in equation for percentage of soil remaining in suspension when using Hydrometer 152H.

14.3 The percentage of soil remaining in suspension at the level at which the hydrometer is measuring the density of the suspension may be calculated as follows (Note 13): For hydrometer 151H:

$$P = [(100\,000/W) \times G/(G - G_1)](R - G_1)$$

NOTE 13—The bracketed portion of the equation for hydrometer 151H is constant for a series of readings and may be calculated first and then multiplied by the portion in the parentheses.

For hydrometer 152H:

$$P = (Ra/W) \times 100$$

where:

a = correction faction to be applied to the reading of hydrometer 152H. (Values shown on the scale are computed using a specific gravity of 2.65. Correction factors are given in Table 1),

P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension,

R = hydrometer reading with composite correction applied (Section 7),

W = oven-dry mass of soil in a total test sample represented by mass of soil dispersed (see 14.2), g,

G = specific gravity of the soil particles, and

G_1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation produces no significant effect, and in the second instance, the composite correction for R is based on a value of one for G_1.

15. Diameter of Soil Particles

15.1 The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading shall be calculated according to Stokes' law (Note 14), on the basis that a particle of this diameter was at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. According to Stokes' law:

$$D = \sqrt{[30n/980(G - G_1)]} \times L/T$$

where:

D = diameter of particle, mm,

n = coefficient of viscosity of the suspending medium (in this case water) in poises (varies with changes in temperature of the suspending medium),

L = distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. (For a given hydrometer and sedimentation cylinder, values vary according to the hydrometer readings. This distance is known as effective depth (Table 2)),

T = interval of time from beginning of sedimentation to the taking of the reading, min,

G = specific gravity of soil particles, and

G_1 = specific gravity (relative density) of suspending medium (value may be used as 1.000 for all practical purposes).

NOTE 14—Since Stokes' law considers the terminal velocity of a single sphere falling in an infinity of liquid, the sizes calculated represent the diameter of spheres that would fall at the same rate as the soil particles.

15.2 For convenience in calculations the above equation may be written as follows:

$$D = K\sqrt{L/T}$$

where:

K = constant depending on the temperature of the suspension and the specific gravity of the soil particles. Values of K for a range of temperatures and specific gravities are given in Table 3. The value of K does not change for a series of readings constituting a test, while values of L and T do vary.

15.3 Values of D may be computed with sufficient accuracy, using an ordinary 10-in. slide rule.

NOTE 15—The value of L is divided by T using the A- and B-scales, the square root being indicated on the D-scale. Without ascertaining the value of the square root it may be multiplied by K, using either the C- or CI-scale.

16. Sieve Analysis Values for Portion Finer than No. 10 (2.00-mm) Sieve

16.1 Calculation of percentages passing the various sieves used in sieving the portion of the sample from the hydrometer test involves several steps. The first step is to calculate the mass of the fraction that would have been retained on the No. 10 sieve had it not been removed. This mass is equal to the total percentage retained on the No. 10 sieve (100 minus total percentage passing) times the mass of the total sample represented by the mass of soil used (as calculated in 14.2), and the result divided by 100.

16.2 Calculate next the total mass passing the No. 200 sieve. Add together the fractional masses retained on all the sieves, including the No. 10 sieve, and subtract this sum from the mass of the total sample (as calculated in 14.2).

16.3 Calculate next the total masses passing each of the other sieves, in a manner similar to that given in 12.2.

16.4 Calculate last the total percentages passing by dividing the total mass passing (as calculated in 16.3) by the total mass of sample (as calculated in 14.2), and multiply the result by 100.

17. Graph

17.1 When the hydrometer analysis is performed, a graph of the test results shall be made, plotting the diameters of the particles on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters to ar

TABLE 2 Values of Effective Depth Based on Hydrometer and Sedimentation Cylinder of Specified Sizes[A]

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5		
1.006	14.7	6	15.3	36	10.4
1.007	14.4	7	15.2	37	10.2
1.008	14.2	8	15.0	38	10.1
1.009	13.9	9	14.8	39	9.9
1.010	13.7	10	14.7	40	9.7
1.011	13.4	11	14.5	41	9.6
1.012	13.1	12	14.3	42	9.4
1.013	12.9	13	14.2	43	9.2
1.014	12.6	14	14.0	44	9.1
1.015	12.3	15	13.8	45	8.9
1.016	12.1	16	13.7	46	8.8
1.017	11.8	17	13.5	47	8.6
1.018	11.5	18	13.3	48	8.4
1.019	11.3	19	13.2	49	8.3
1.020	11.0	20	13.0	50	8.1
1.021	10.7	21	12.9	51	7.9
1.022	10.5	22	12.7	52	7.8
1.023	10.2	23	12.5	53	7.6
1.024	10.0	24	12.4	54	7.4
1.025	9.7	25	12.2	55	7.3
1.026	9.4	26	12.0	56	7.1
1.027	9.2	27	11.9	57	7.0
1.028	8.9	28	11.7	58	6.8
1.029	8.6	29	11.5	59	6.6
1.030	8.4	30	11.4	60	6.5
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

[A] Values of effective depth are calculated from the equation:

$$L = L_1 + \tfrac{1}{2}\,[L_2 - (V_B/A)]$$

where:

L = effective depth, cm,

L_1 = distance along the stem of the hydrometer from the top of the bulb to th mark for a hydrometer reading, cm,

L_2 = overall length of the hydrometer bulb, cm,

V_B = volume of hydrometer bulb, cm^3, and

A = cross-sectional area of sedimentation cylinder, cm^2

Values used in calculating the values in Table 2 are as follows:

For both hydrometers, 151H and 152H:

L_2 = 14.0 cm

V_B = 67.0 cm^3

A = 27.8 cm^2

For hydrometer 151H:

L_1 = 10.5 cm for a reading of 1.000

= 2.3 cm for a reading of 1.031

For hydrometer 152H:

L_1 = 10.5 cm for a reading of 0 g/litre

= 2.3 cm for a reading of 50 g/litre

TABLE 3 Values of K for Use in Equation for Computing Diameter of Particle in Hydrometer Analysis

Temperature, °C	Specific Gravity of Soil Particles								
	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.1323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01255	0.01206	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

arithmetic scale as the ordinate. When the hydrometer analysis is not made on a portion of the soil, the preparation of the graph is optional, since values may be secured directly from tabulated data.

18. Report

18.1 The report shall include the following:

18.1.1 Maximum size of particles,

18.1.2 Percentage passing (or retained on) each sieve, which may be tabulated or presented by plotting on a graph (Note 16),

18.1.3 Description of sand and gravel particles:

18.1.3.1 Shape—rounded or angular,

18.1.3.2 Hardness—hard and durable, soft, or weathered and friable,

18.1.4 Specific gravity, if unusually high or low,

18.1.5 Any difficulty in dispersing the fraction passing the No. 10 (2.00-mm) sieve, indicating any change in type and amount of dispersing agent, and

18.1.6 The dispersion device used and the length of the dispersion period.

NOTE 16—This tabulation of graph represents the gradation of the sample tested. If particles larger than those contained in the sample were removed before testing, the report shall so state giving the amount and maximum size.

18.2 For materials tested for compliance with definite specifications, the fractions called for in such specifications shall be reported. The fractions smaller than the No. 10 sieve shall be read from the graph.

18.3 For materials for which compliance with definite specifications is not indicated and when the soil is composed almost entirely of particles passing the No. 4 (4.75-mm) sieve, the results read from the graph may be reported as follows:

(1) Gravel, passing 3-in. and retained on No. 4 sieve ..... %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve ..... %
  (a) Coarse sand, passing No. 4 sieve and retained on No. 10 sieve ..... %
  (b) Medium sand, passing No. 10 sieve and retained on No. 40 sieve ..... %
  (c) Fine sand, passing No. 40 sieve and retained on No. 200 sieve ..... %
(3) Silt size, 0.074 to 0.005 mm ..... %
(4) Clay size, smaller than 0.005 mm ..... %
  Colloids, smaller than 0.001 mm ..... %

18.4 For materials for which compliance with definite specifications is not indicated and when the soil contains material retained on the No. 4 sieve sufficient to require a sieve analysis on that portion, the results may be reported as follows (Note 17):

SIEVE ANALYSIS

Sieve Size	Percentage Passing
3-in.	.....
2-in.	.....
1½-in.	.....
1-in.	.....
¾-in.	.....
⅜-in.	.....
No. 4 (4.75-mm)	.....
No. 10 (2.00-mm)	.....
No. 40 (425-μm)	.....
No. 200 (75-μm)	.....

HYDROMETER ANALYSIS

0.074 mm	.....
0.005 mm	.....
0.001 mm	.....

NOTE 17—No. 8 (2.36-mm) and No. 50 (300-μm) sieves may be substituted for No. 10 and No. 40 sieves.

19. Keywords

19.1 grain-size; hydrometer analysis; hygroscopic moisture; particle-size; sieve analysis

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

INTERNATIONAL TECHNOLOGY CORPORATION

PROCESS DEVELOPMENT GROUP

Standard Operating Procedure

Title: **Atterberg Limits: Liquid Limit and Plastic Limit**

Prepared by: _____ **Date:** 4-02-93

Reviewed by: _____ **Date:** 4/04/93
Technical Specialist

Operations approval: _____ **Date:** 4/13/93
Group Leader/Manager

Interim approval: _____ **Date:** 9/28/93
Quality Assurance Officer

Management approval: _____ **Date:** 9/29/93
Manager, Process Development Group

APPROVED FOR INTERIM USE

CONTROLLED COPY NO.____

Environmental Technology Development Center
P.O. Box 4339 • 1570 Bear Creek Road • Oak Ridge, Tennessee 37830 • 615-482-6497 • FAX: 615-482-1890

IT Corporation is a wholly owned subsidiary of International Technology Corporation

Atterberg Limits: Liquid Limit and Plastic Limit

1.0 Scope and Objectives

1.1 This test method covers the determination of the liquid limit, plastic limit, and plasticity index of cohesive soils and is in general accordance with ASTM D 4318.

1.2 The liquid limit, plastic limit, and plasticity index define the boundaries of consistency for plastic soils and are primary tools for soil classification.

1.3 This test method requires judgements be made by the person performing the tests based on previous experience with similar soils. This procedure assumes that the person performing the test has attained a degree of competence beyond the entry level in geotechnical testing procedures. Persons who are not familiar with the equipment or general procedures contained herein shall not perform this procedure without direct supervision of a qualified associate.

1.4 Values stated in SI units shall be regarded as standard except as noted.

2.0 Definitions

2.1 ASTM - American Society of Testing and Materials

2.2 Atterberg Limits - Originally, seven "limits of consistency" of fine-grained soils were defined by Albert Atterberg. Current usage of the term refers only to liquid limit, plastic limit, and occasionally, shrinkage limit.

2.3 Consistency - The relative ease with which a soil can be deformed.

2.4 Liquid Limit (LL) - The liquid limit of a soil is defined as the moisture content defining the boundary between the liquid and plastic states of the soil.

2.5 Plastic Limit (PL) - The plastic limit is defined as the moisture content defining the boundary between the plastic and brittle solid states of the soil.

2.6 Plastic Soil - A soil which exhibits plasticity over a wide range of moisture contents and will retain its

2.7 Plasticity Index (PI) - The plasticity index is defined as the range of water contents over which the soil exhibits plasticity.

3.0 Methodology

3.1 Summary

3.1.1 The soil sample is processed to remove all particles coarser than the No.40 (425 micron) sieve. The liquid limit is determined by spreading the moist sample in a standard brass cup, dividing the soil pat using a grooving tool, and dropping the brass cup repeatedly on a standard base material from a standard height. The number of drops necessary to close the groove in the soil pat is recorded and the moisture content of the soil pat determined. Trials are performed until the groove closes over a ½ inch width at 20-30 drops of the brass cup and a correction factor applied to the result to determine the moisture content corresponding to a blow count of 25. An alternative method determines the moisture content corresponding to the 25-blow intercept of a best-fit line drawn through the results of three trials at differing blow counts. The moisture content corresponding to groove closure at 25 blows is taken as the liquid limit.

3.1.2 The plastic limit is determined by rolling an ellipsoidal mass of soil into ⅛-inch diameter threads on a glass plate. The soil is pressed back together and re-rolled until the soil crumbles before reaching a diameter of ⅛-inch. The plastic limit is calculated as the moisture content at which the soil thread crumbles.

3.1.3 The plasticity index is numerically equal to the difference between the liquid limit and the plastic limit.

3.2 Interferences or Potential Problem Areas - Soils that are prepared by initial oven-drying of the material may alter the Atterberg results of naturally occurring soils.

3.3 Sample Requirements and Handling

3.3.1 All samples submitted for analysis must yield approximately 200-300 grams of material finer than the No.40 (425 micron) sieve. Because only the soil

fraction finer than the No.40 sieve is used to determine the Atterberg limits, coarse-grained soils require substantially greater initial sample sizes than do predominately clay samples.

3.3.2 Samples may be sealed against moisture loss and stored for up to six months in an area not subject to temperature extremes (lower than 1°C or higher than 35°C).

3.4 Required Equipment and Reagents

3.4.1 Balance - An electronic or mechanical balance accurate to 0.02 grams or ±0.1%, whichever is greater.

3.4.2 Drying Oven - An oven, either gravity or forced-convection, capable of maintaining an internal temperature of 110 ±5°C.

3.4.3 Liquid Limit Device - Liquid limit trials are performed using a mechanical device consisting of a brass cup suspended from a carriage designed to control the drop of the cup onto a hard synthetic base. The device may be manually operated or powered by an electric motor. ELE/Soiltest models CL-204, CL-205, or equivalent are suitable.

3.4.4 Grooving Tool - A grooving tool made of noncorrosive metal is used to place a groove in the soil pat. The tool may be either the Cassagrande flat-type or the wedge-type as specified by USACE EM-1110-2-1906 Appendix III (respectively, ELE/Soiltest model CL-220 and model CL-218A, or equivalent). The consistency of the soil will determine the choice of tool for a particular soil.

3.4.5 Gauge Block - A metal 10 ±0.05 mm thick is used to determine the height of drop of the brass cup. The gauge block may be incorporated into the grooving tool,

3.4.6 Porcelain Dish - A porcelain dish approximately 5-6 inches in diameter is used to mix and store the soil while curing.

3.4.7 Spatula - A spatula with a metal blade approximately ¾ inches wide and 4-5 inches long is used to mix and spread the soil in the brass cup.

3.4.8 Ground Glass Plate - A glass plate approximately 12 inches square and ¼ inch thick with a sandblasted or ground upper surface is used for rolling plastic limit material.

3.4.9 Sieve - An 8 inch diameter No.40 (425 micron) stainless steel mesh sieve is used to separate coarse particles from the test soil.

3.4.10 Water - All water shall be ASTM Type II or better.

3.4.11 Miscellaneous equipment - Miscellaneous equipment, including but not limited to, moisture tins, wash bottle, rubber spatula, etc., as required.

3.5 Calibration Requirements

3.5.1 Balance calibrations shall be verified annually in accordance with SOP PDGADM0002.

3.5.2 Liquid limit devices shall be calibrated annually in accordance with SOP PDGGEO0022, and daily or before use, whichever is greater, as follows: Lift the cup by turning the hand crank until the cup follower is at the top of the cam. Insert a 10 mm gauge block between the cup and base. Turn the hand crank several times. If the cup does not rise the drop height is too low. If the cup rises and drops, producing a loud ringing sound, the height of the drop is too high. Adjust the cup drop height to 10 ±0.2 mm, if needed, by loosening the adjustment screw and moving the carriage in or out as necessary to produce the desired drop height. Tighten the adjustment screw and recheck the drop height. The drop height is right if a soft click is heard while turning the hand crank with the gauge block in position. The drop height may also be verified by raising the cup, inserting the gauge block, and visually, or with feeler gauges, determining the height of the cup above the gauge block.

3.6 Quality Control Requirements

3.6.1 Balances - Brass weights shall be used to verify the accuracy of each balance before use or daily, whichever is less, and the result recorded in the balance log book. Brass weights shall meet OIML Class M_2 specifications or better and shall be checked monthly in accordance with SOP PDGADM0003.

3.6.2 Ovens - Temperatures of ovens in use shall be recorded daily in accordance with SOP PDGADM0006.

3.6.3 Grooving tools shall be checked annually for proper dimensions and excessive tip wear.

3.6.4 Sieves shall be maintained in accordance with SOP PDGGEO0023.

3.6.5 Nonconformance/variance reports - In accordance with SOP PDGADM0009, nonconformance/variance reports shall be used to document any discrepancies in the performance or specifications of this procedure.

3.7 Health and Safety - Sample material containing hazardous, radiological, or mixed contaminants shall be handled in accordance with current facility Health and Safety directives. Engineering controls shall be used whenever possible to reduce personnel exposure to sample hazards (i.e., sample prepared inside vented hood space, sample extruder enclosure adequately ventilated, etc.). Personal protective equipment shall be used as necessary to prevent personnel exposure to hazards. As a minimum, appropriate protective gloves shall be worn by personnel handling contaminated sample material, in addition to safety glasses required of all personnel in the laboratory at all times. When in doubt as to the hazards involved in any operation, consult with the Geotechnical Laboratory Manager or Health and Safety Officer before proceeding.

3.8 Specimen Preparation

3.8.1 The laboratory manager or client shall specify the specimen preparation method to be used from one of the following methods:

3.8.1.1 Remove a portion of the soil to be tested and push through the No.40 sieve. Discard coarse particles retained on the sieve.

3.8.1.2 Air-dry the soil to be tested until friable. Grind in a mortar using a rubber-covered pestle and pass the material over the No.40 sieve. Regrind material retained on the sieve until no appreciable soil passes the sieve.

3.8.1.3 When initial sample size is small and additional analyses are requested (moisture content, particle-size, specific gravity,

etc.), oven-dry the entire sample and remove material finer than the No.40 sieve from the soil not used in the other analyses. Oven-drying may alter the test results for certain soils. This procedure shall be used with caution.

3.8.2 Thoroughly mix the soil passing the No.40 sieve in the porcelain dish and wet or dry the soil to a moisture content that will allow groove closure at 25-30 drops of the liquid limit cup. Store the specimen in a covered container for at least 16 hours or overnight to allow all soil particles to achieve moisture equilibrium.

3.9 One-Point Liquid Limit

3.9.1 After the soil has seasoned for at least 16 hours, thoroughly remix the soil to be tested. Using the metal spatula, press the soil into the brass cup taking care to avoid entrapping air. Spread the soil to a thickness of approximately 10 mm using as few strokes of the spatula as possible. The upper surface of the soil pat in the cup shall be essentially flat and horizontal.

3.9.2 Bisect the soil pat from the highest point to the lowest point of the cup using the grooving tool. Draw the grooving tool beveled edge first in an arc, maintaining the tool handle perpendicular to the cup. If the soil cannot be cut in one stroke of the grooving tool without tearing, several strokes may be used in alternating directions and at increasing cutting depths. Take care to prevent sliding of the soil pat against the bottom of the cup.

3.9.3 Ensure that the bottom of the cup and surface of the base are free of debris. Raise and drop the cup by turning the handle at a rate of approximately 2 drops per second until the two halves of the soil pat come into contact along a distance of ½ inch.

3.9.4 Verify the validity of the trial by observing that both halves of the soil pat have flowed approximately equal amounts. A bulge in one half of the soil pat probably indicates the presence of entrapped air and is justification for a retrial. Likewise, ensure that the soil has flowed and not slipped along the soil/metal boundary of the cup. If a retrial is necessary, remove the soil from the

cup and remix the soil. Clean the cup and grooving tool with water and dry with a towel between trials.

3.9.5 If the number of blows necessary to close the groove along a distance of ½ inch is more than 30, add a small amount of water to the soil and mix thoroughly. Repeat trials at successively higher moisture contents until the number of blows required to close the groove along a distance of ½ inch is between 20 and 30 drops.

3.9.6 If the number of blows necessary to close the groove along a distance of ½ inch is less than 20, spread the soil in a thin layer on the ground glass plate and allow to dry. Frequent stirring is required to ensure uniform drying and at no time shall the soil be allowed to crust. Repeat trials at successively lower moisture contents until the number of blows required to close the groove along a distance of ½ inch is between 20 and 30 drops.

3.9.7 Once groove closure has been established at a blow count of 20-30 blows, record the number of blows. Remove a section of soil from the cup approximately ½ inch wide and running the breadth of the cup. Place this section in a moisture tin and perform a moisture content analysis in accordance with SOP PDGGE00019.

3.9.8 Perform another trial at the same moisture content to verify the result. If the second attempt yields a drop count differing by more than 2 blows, remix the entire soil portion and perform additional trials until two successive trials yield blow counts not differing by more than two blows. Some soils require lengthy mixing to achieve duplicable results.

3.10 Multi-Point Liquid Limit

3.10.1 Considerable judgement may be necessary when adjusting the moisture content of the soil to the desired consistency and in recognizing potential problems as they occur. Inexperienced operators will usually benefit from performing the multi-point test.

3.10.2 Proceed as in 3.9 except adjust the initial moisture content of the specimen to 25-35 blows during initial mixing. A minimum of three trials

covering a blow count range of 15 to 35 are required. One trial shall be performed resulting in a blow count of 25-35, another trial resulting in a blow count of 20-30, and another trial resulting in a blow count of 15-25. Begin trials with the blow count in the range of 25-35. Add small amounts of water to the soil and mix thoroughly between trials.

3.11 Plastic Limit

3.11.1 Remove a portion of soil used in the liquid limit test weighing approximately 30 grams. This material may be obtained after the initial mixing or after completion of the liquid limit test. For expediency, the soil should not be so moist as to be sticky but should deform easily under light finger pressure without cracking. Divide this portion into two approximately equal portions and put one half into an air-tight container or cover with a moist towel.

3.11.2 Form the soil into an ellipsoidal mass and roll on the ground glass plate into a ⅛ inch diameter thread. Regroup all the thread sections and press together into an ellipsoidal mass. Continue rolling and regrouping the threads until the soil begins to fracture and crumble before it reaches a diameter of ⅛ inch. When the amount of fractured soil exceeds one-half of the total amount being tested, place all thread sections and crumbs in a moisture tin and perform a moisture content determination in accordance with SOP PDGGE00019.

3.11.3 Perform the same procedure of rolling and rerolling for the duplicate portion set aside above. Perform plastic limit tests until two results differ by no more than 1.5% moisture content.

3.12 Calculations

3.12.1 Calculate the one-point liquid limit, LL, as follows:

$$LL = K(W_N)$$

where:
K = a factor given in Table 1
W_N = water content corresponding to N
N = number of blows

The liquid limit is the average of the two trial liquid limit values. Report results to the nearest whole number.

3.12.2 Multi-point liquid limit - Plot the relationship between the moisture content of the liquid limit specimens to the number of blows on a semilogarithmic graph with moisture content in percent on the abscissa and the number of blows on the logarithmic ordinate. Draw a best fit straight line through the points. Take the moisture content corresponding to the 25 blow intercept as the liquid limit.

3.12.3 The plastic limit, *PL*, is equal to the average moisture content of the plastic limit trials.

3.12.4 Calculate the plasticity index, *PI*, as follows:

$$PI = LL - PL$$

where:
LL = liquid limit
PL = plastic limit

3.12.5 Report liquid limit and plasticity index results rounded to whole numbers unless otherwise requested by the client. Plastic limit is not normally reported.

4.0 Forms - A copy of the data form used in conjunction with this procedure is included in Appendix A.

5.0 References

5.1 ASTM Procedure: D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils

5.2 United States Army Corps of Engineers Procedure: EM-1110-2-1906, Appendix III, Liquid and Plastic Limits

5.3 IT Standard Operating Procedures

5.3.1 PDGADM0002 - Balance Calibration and Maintenance

5.3.2 PDGADM0003 - Use and Maintenance of Class S and Brass Weights

5.3.3 PDGADM0006 - Verification of Oven and Refrigerator Temperatures

APPENDIX A

DATA COLLECTION FORM

5.3.4 PDGADM0009 - Nonconformance/Variance Reports

5.3.5 PDGGEO0019 - Moisture Content of Soil and Rock

5.3.6 PDGGEO0022 - Calibration and Inspection of Liquid Limit Device

5.3.7 PDGGEO0023 - Sieve Specification, Calibration, and Inspection

TABLE I
Factors for Obtaining Liquid Limit from Water Content and Number of Drops at Groove Closure

N Number of Drops	K (Factor for Liquid Limit)
20	0.974
21	0.979
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014
29	1.018
30	1.022

IT INTERNATIONAL TECHNOLOGY CORPORATION

Specimen Prep by: _____ Date _____
Tested by: _____ Date _____
Calc./Entry by: _____ Date _____
Checked by: _____ Date _____

ATTERBERG LIMITS

ASTM D 4318 SOP PDGGEO0021

Project _____

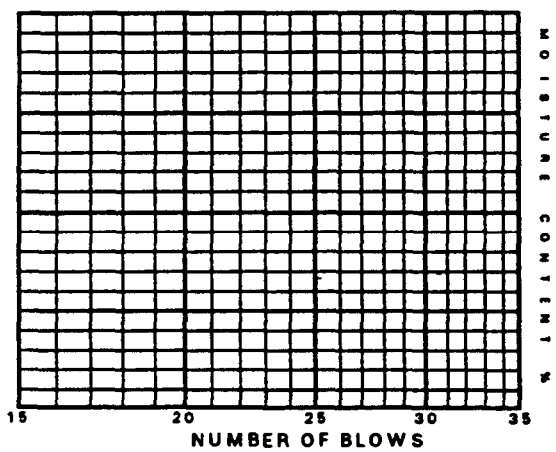
Project No. _____ Sample No. _____

LIQUID LIMIT					
Test No.	1	2	3	4	5
Blow Range	25 - 35	20 - 30	15 - 25		
Tare No.					
Tare Wt. g					
Wt Tare + Wet Soil,g					
Wt Tare + Dry Soil, g					
Wt of Water, g					
Wt of Dry Soil, g					
Water Content, %					
No. Blows					
N Factor (if used)					
Liquid Limit					

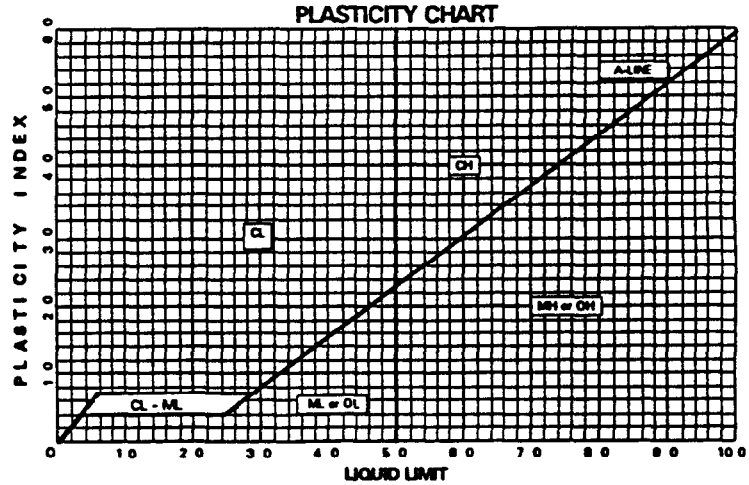
PLASTIC LIMIT			
Test No.	1	2	3
Tare Name			
Tare Wt. g			
Wt Tare + Wet Soil, g			
Wt Tare + Dry Soil, g			
Wt of Water, g			
Wt of Dry Soil, g			
Water Content, %			

RESULTS SUMMARY	
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
USCS SYMBOL	

FLOW CHART



PLASTICITY CHART



Designation: D 4318 – 95a

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[1]

This standard is issued under the fixed designation D 4318; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers the determination of the liquid limit, plastic limit, and the plasticity index of soils as defined in Section 3.

1.1.1 Two procedures for preparing test specimens are provided as follows: *Wet preparation procedure*, as described in 10.1. *Dry preparation procedure*, as described in 10.2. The procedure to be used shall be specified by the requesting authority. If no procedure is specified, use the wet preparation procedure.

1.1.2 Two methods for determining the liquid limit are provided as follows: *Method A*, Multipoint test as described in Sections 11 and 12. *Method B*, One-point test as described in Sections 14 and 15. The method to be used shall be specified by the requesting authority. If no method is specified, use Method A.

1.1.3 The plastic limit test procedure is described in Sections 16, 17, and 18. The plastic limit test is performed on material prepared for the liquid limit test.

1.1.4 The procedure for calculating the plasticity index is given in Section 19.

1.2 The liquid limit and plastic limit of soils (along with the shrinkage limit) are often collectively referred to as the Atterberg limits. These limits distinguished the boundaries of the several consistency states of plastic soils.

1.3 The multipoint liquid limit method is generally more precise than the one-point method. It is recommended that the multipoint method be used in cases where results may be subject to dispute, or where greater precision is required.

1.4 Because the one-point method requires the operator to judge when the test specimen is approximately at its liquid limit, it is particularly not recommended for use by inexperienced operators.

1.5 The correlations on which the calculations of the one-point method are based may not be valid for certain soils, such as organic soils or soils from a marine environment. It is strongly recommended that the liquid limit of these soils be determined by the multipoint method.

1.6 The liquid and plastic limits of many soils that have been allowed to dry before testing may be considerably different from values obtained on undried samples. If the liquid and plastic limits of soils are used to correlate or estimate the engineering behavior of soils in their natural moist state, samples should not be permitted to dry before testing unless data on dried samples are specifically desired.

1.7 The composition and concentration of soluble salts in a soil affect the values of the liquid and plastic limits as well as the water content values of soils (see Method D 2216). Special consideration should therefore be given to soils from a marine environment or other sources where high soluble salt concentrations may be present. The degree to which the salts present in these soils are diluted or concentrated must be given careful consideration.

1.8 Since the tests described herein are performed only on that portion of a soil which passes the 425-μm (No. 40) sieve, the relative contribution of this portion of the soil to the properties of the sample as a whole must be considered when using these tests to evaluate properties of a soil.

1.9 The values stated in acceptable metric units are to be regarded as the standard. The values given in parentheses are for information only.

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials[2]

C 702 Methods for Reducing Field Samples of Aggregate to Testing Size[3]

D 75 Practice for Sampling Aggregates[2]

D 420 Practice for Investigating and Sampling Soil and Rock for Engineering Purposes[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1241 Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses[2]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 3282 Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes[3]

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

Current edition approved Dec. 10, 1995. Published April 1996. Originally published as D 4318 – 83. Last previous edition D 4318 – 95.

[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.08.

* A Summary of Changes section appears at the end of standard.

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil and Rock Testing[3]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[2]

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions of terms in this test method are in accordance with Terminology D 653.

3.2 *Description of Terms Specific to This Standard:*

3.2.1 *Atterberg limits*—Originally, six "limits of consistency" of fine-grained soils were defined by Albert Atterberg: the upper limit of viscous flow, the liquid limit, the sticky limit, the cohesion limit, the plastic limit, and the shrinkage limit. In current engineering usage, the term usually refers only to the liquid limit, plastic limit, and in some references, the shrinkage limit.

3.2.2 *consistency*—the relative ease with which a soil can be deformed.

3.2.3 *liquid limit (LL, w_L)*—the water content, in percent, of a soil at the arbitrarily defined boundary between the semi-liquid and plastic states.

3.2.3.1 *Discussion*—The undrained shear strength of soil at the liquid limit is considered to be approximately 2 kPa (0.28 psi).

3.2.4 *plastic limit (PL, w_p)*—the water content, in percent, of a soil at the boundary between the plastic and semi-solid states.

3.2.5 *plastic soil*—a soil which has a range of water content over which it exhibits plasticity and which will retain its shape on drying.

3.2.6 *plasticity index (PI)*—the range of water content over which a soil behaves plastically. Numerically, it is the difference between the liquid limit and the plastic limit.

3.2.7 *liquidity index*—the ratio, expressed as a percentage of (1) the natural water content of a soil minus its plastic limit, to (2) its plasticity index.

3.2.8 *activity number (A)*—the ratio of (1) the plasticity index of a soil to (2) the percent by weight of particles having an equivalent diameter smaller than 0.002 mm.

4. Summary of Test Method

4.1 The sample is processed to remove any material retained on a 425-μm (No. 40) sieve. The liquid limit is determined by performing trials in which a portion of the sample is spread in a brass cup, divided in two by a grooving tool, and then allowed to flow together from the shocks caused by repeatedly dropping the cup in a standard mechanical device. The multipoint liquid limit, Method A, requires three or more trials over a range of water contents to be performed and the data from the trials plotted or calculated to make a relationship from which the liquid limit is determined. The one-point liquid limit, Method B, uses the data from two trials at one water content multiplied by a correction factor to determine the liquid limit.

4.2 The plastic limit is determined by alternately pressing together and rolling into a 3.2-mm (⅛-in.) diameter thread a small portion of plastic soil until its water content is reduced to a point at which the thread crumbles and can no longer be pressed together and rerolled. The water content of the soil at this point is reported as the plastic limit.

4.3 The plasticity index is calculated as the difference between the liquid limit and the plastic limit.

5. Significance and Use

5.1 This test method is used as an integral part of several engineering classification systems to characterize the fine-grained fractions of soils (see Test Method D 2487 and Practice D 3282) and to specify the fine-grained fraction of construction materials (see Specification D 1241). The liquid limit, plastic limit, and plasticity index of soils are also used extensively, either individually or together, with other soil properties to correlate with engineering behavior such as compressibility, permeability, compactibility, shrink-swell, and shear strength.

5.2 The liquid and plastic limits of a soil can be used with the natural water content of the soil to express its relative consistency or liquidity index and can be used with the percentage finer than 2-μm size to determine its activity number.

5.3 These methods are sometimes used to evaluate the weathering characteristics of clay-shale materials. When subjected to repeated wetting and drying cycles, the liquid limits of these materials tend to increase. The amount of increase is considered to be a measure of a shale's susceptibility to weathering.

5.4 The liquid limit of a soil containing substantial amounts of organic matter decreases dramatically when the soil is oven-dried before testing. Comparison of the liquid limit of a sample before and after oven-drying can therefore be used as a qualitative measure of organic matter content of a soil.

6. Apparatus

6.1 *Liquid Limit Device*—A mechanical device consisting of a brass cup suspended from a carriage designed to control its drop onto a hard rubber base. Figure 1 shows the essential features and critical dimensions of the device. The device may be operated by either a hand crank or electric motor.

6.1.1 *Base*—A hard rubber base having a D Durometer hardness of 80 to 90, and a resilience such that an 8-mm (5/16-in.) diameter polished steel ball, when dropped from a height of 25 cm (9.84 in.) will have an average rebound of at least 77 % but no more than 90 %. Conduct resilience tests on the finished base with the feet attached. Details for measuring the resilience of the base are given in Appendix A.

6.1.2 *Rubber Feet*, supporting the base, designed to provide isolation of the base from the work surface, and having an A Durometer hardness no greater than 60 as measured on the finished feet attached to the base.

6.1.3 *Cup*, brass, with a weight, including cup hanger, of 185 to 215 g.

6.1.4 *Cam*—designed to raise the cup smoothly and continuously to its maximum height, over a distance of at least 180° of cam rotation, without developing an upward or downward velocity of the cup when the cam follower leavesthe cam. (The preferred cam motion is a uniformly accelerated lift curve.)

NOTE 1—The cam and follower design in Fig. 1 is for uniformly accelerated (parabolic) motion after contact and assures that the cup has no velocity at drop off. Other cam designs also provide this feature and

DIMENSIONS

LETTER	A [A]	B [A]	C [A]	E [A]	F	G	H	J [A]	K [A]	L [A]	M [A]
MM	54 ± 0.5	2 ± 0.1	27 ± 0.5	56 ± 2.0	32	10	16	60 ± 1.0	50 ± 2.0	150 ± 2.0	125 ± 2.0

LETTER	N	P	R	T	U [A]	V	W	Z
MM	24	28	24	45	47 ± 1.0	3.8	13	6.5

[A] ESSENTIAL DIMENSIONS

CAM ANGLE DEGREES	CAM RADIUS
0	0.742 R
30	0.753 R
60	0.764 R
90	0.773 R
120	0.784 R
150	0.796 R
180	0.818 R
210	0.854 R
240	0.901 R
270	0.945R
300	0.974R
330	0.995R
360	1.000R

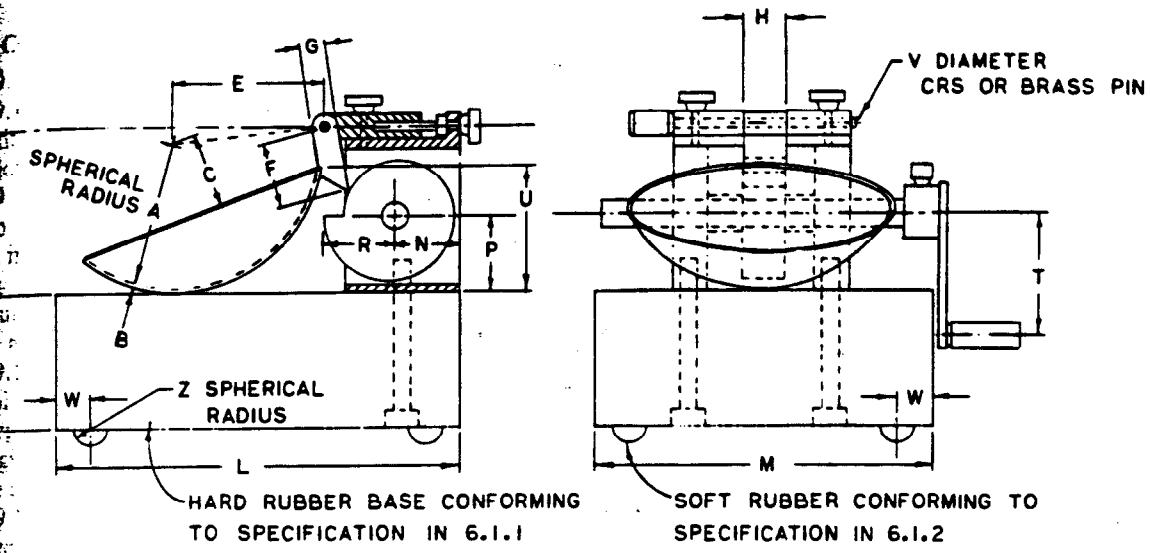


FIG. 1 Hand-Operated Liquid Limit Device

...y be used. However, if the cam-follower lift pattern is not known, ...o velocity at drop off can be assured by carefully filing or machining ...cam and follower so that the cup height remains constant over the ... 20 to 45° of cam rotation.

6.1.5 *Carriage*, constructed in a way that allows convenient but secure adjustment of the height of drop of the cup to 10 mm (0.394 in.), and designed such that the cup and cup hanger assembly is only attached to the carriage by means of a removable pin.

6.1.6 *Motor Drive (Optional)*—As an alternative to the hand crank shown in Fig. 1, the device may be equipped with a motor to turn the cam. Such a motor must turn the cam at 2 ± 0.1 revolutions per second and must be isolated from the rest of the device by rubber mounts or in some other way that prevents vibration from the motor being transmitted to the rest of the apparatus. It must be equipped with an ON-OFF switch and a means of conveniently positioning the cam for height of drop adjustments. The results obtained using a motor-driven device must not differ from those obtained using a manually operated device.

6.2 *Flat Grooving Tool*—A tool made of plastic or noncorroding-metal having the dimensions shown in Fig. 2. The design of the tool may vary as long as the essential dimensions are maintained. The tool may, but need not, incorporate the gage for adjusting the height of drop of the liquid limit device.

NOTE 2—Prior to the adoption of this test method, a curved grooving tool was specified as part of the apparatus for performing the liquid limit test. The curved tool is not considered to be as accurate as the flat tool described in 6.2 since it does not control the depth of the soil in the liquid limit cup. However, there are some data which indicate that typically the liquid limit is slightly increased when the flat tool is used instead of the curved tool.

6.3 *Gage*—A metal gage block for adjusting the height of drop of the cup, having the dimensions shown in Fig. 3. The design of the tool may vary provided the gage will rest securely on the base without being susceptible to rocking, and the edge which contacts the cup during adjustment is straight, at least 10 mm (3/8 in.) wide, and without bevel or radius.

6.4 *Containers*—Small corrosion-resistant containers with snug-fitting lids for water content specimens. Aluminum or stainless steel cans 2.5 cm (1 in.) high by 5 cm (2 in.) in diameter are appropriate.

6.5 *Balance*, conforming to Specification D 4753, Class GP1.

6.6 *Storage Container*—A container in which to store the prepared soil specimen that will not contaminate the specimen in any way, and will prevent moisture loss. A porcelain, glass, or plastic dish about 11.4 cm (4½ in.) in diameter and a plastic bag large enough to enclose the dish and be folded over is adequate.

6.7 *Ground Glass Plate*—A ground glass plate at least 30 cm (12 in.) square by 1 cm (3/8 in.) thick for rolling plastic limit threads.

6.8 *Spatula*—A spatula or pill knife having a blade ... 2 cm (¾ in.) wide, and about 10 to 13 cm (3 to 4 in. ...g.

6.9 *Sieve*—A 20.3-cm (8-in.) diameter, 425-μm (No. 40)

DIMENSIONS

LETTER	A[Δ]	B[Δ]	C[Δ]	D[Δ]	E[Δ]	F[Δ]
MM	2 ± 0.1	11 ± 0.2	40 ± 0.5	8 ± 0.1	50 ± 0.5	2 ± 0.1

LETTER	G	H	J	K[Δ]	L[Δ]	N
MM	10 MINIMUM	13	60	0 ± 0.05	60 DEG ± 1 DEG	20

[Δ] ESSENTIAL DIMENSIONS

[□] BACK AT LEAST 15 MM FROM TIP

NOTE: DIMENSION A SHOULD BE 1.9–2.0 AND DIMENSION D SHOULD BE 8.0–8.1 WHEN NEW TO ALLOW FOR ADEQUATE SERVICE LIFE

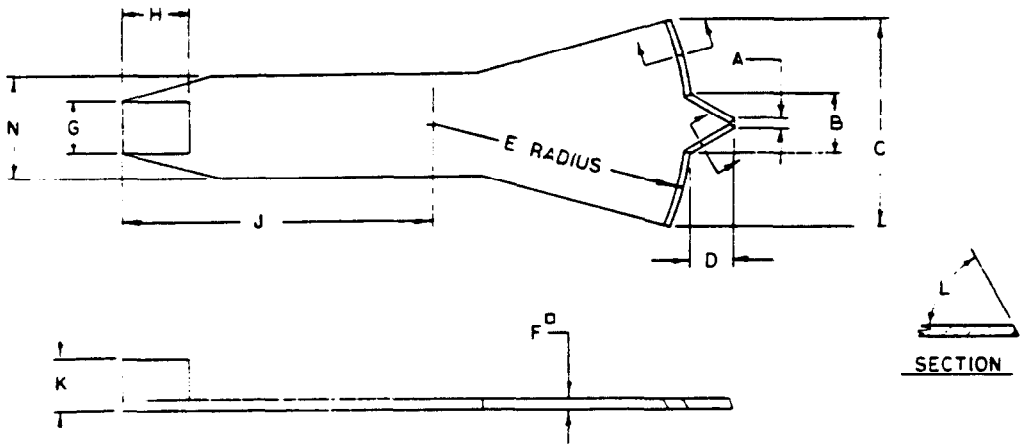
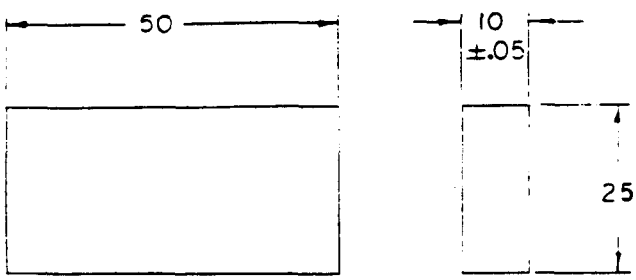


FIG. 2 Grooving Tool (Optional Height-of-Drop Gage Attached)



DIMENSIONS IN MILLIMETRES

FIG. 3 Height of Drop Gage

sieve conforming to the requirements of Specification E 11 and having a rim at least 5 cm (2 in.) above the mesh. A 2-mm (No. 10) sieve meeting the same requirements may also be needed.

6.10 *Wash Bottle*, or similar container for adding controlled amounts of water to soil and washing fines from coarse particles.

6.11 *Drying Oven*, thermostatically controlled, preferably of the forced-draft type, capable of continuously maintaining a temperature of 110 ± 5°C (230 ± 9°F) throughout the drying chamber.

6.12 *Washing Pan*, round, flat-bottomed, at least 7.6 cm (3 in.) deep, and slightly larger at the bottom than a 20.3-cm (8-in.) diameter sieve.

7. Reagents and Materials

7.1 *Purity of Water*—Where distilled water is referred to in this test method, either distilled or demineralized water may be used.

8. Sampling

8.1 Samples may be taken from any location that satisfies testing needs. However, Methods C 702, Practice D 75, and Practice D 420 should be used as guides for selecting and preserving samples from various types of sampling operations. Samples which will be prepared using the wet preparation procedure (10.1) must be kept at their natural water content prior to preparation.

8.2 Where sampling operations have preserved the natural stratification of a sample, the various strata must be kept separated and tests performed on the particular stratum of interest with as little contamination as possible from other strata. Where a mixture of materials will be used in construction, combine the various components in such proportions that the resultant sample represents the actual construction case.

8.3 Where data from this test method are to be used for correlation with other laboratory or field test data, use the

material as used for these tests where possible.

(1) Obtain a representative portion from the total sample sufficient to provide 150 to 200 g of material passing the 425-μm (No. 40) sieve. Free flowing samples may be reduced by the methods of quartering or splitting. Cohesive samples shall be mixed thoroughly in a pan with a spatula, or scoop and a representative portion scooped from the total mass by taking one or more sweeps with a scoop through the mixed mass.

Calibration of Apparatus

9.1 *Inspection of Wear:*

9.1.1 *Liquid Limit Device*—Determine that the liquid limit device is clean and in good working order. Check the following specific points.

9.1.1.1 *Wear of Base*—The spot on the base where the cup makes contact should be worn no greater than 10 mm (⅜ in.) in diameter. If the wear spot is greater than this, the base can be machined to remove the worn spot provided the resurfacing does not make the base thinner than specified in 5.1 and the other dimensional relationships are maintained.

9.1.1.2 *Wear of Cup*—Replace the cup when the grooving tool has worn a depression in the cup 0.1 mm (0.004 in.) deep or when the rim of the cup has been reduced to half its original thickness. Verify that the cup is firmly attached to the cup hanger.

9.1.1.3 *Wear of Cup Hanger*—Verify that the cup hanger pivot does not bind and is not worn to an extent that allows more than 3 mm (⅛ in.) side-to-side movement of the lowest point on the rim.

9.1.1.4 *Wear of Cam*—The cam shall not be worn to an extent that the cup drops before the cup hanger (cam follower) loses contact with the cam.

9.1.2 *Grooving Tools*—Inspect grooving tools for wear on a frequent and regular basis. The rapidity of wear depends on the material from which the tool is made and the types of soils being tested. Soils containing a large proportion of sand particles may cause rapid wear of grooving tools; therefore, when testing these materials, tools should be inspected more frequently than for other soils.

NOTE 3—The width of the tip of grooving tools is conveniently checked using a pocket-sized measuring magnifier equipped with a millimetre scale. Magnifiers of this type are available from most laboratory supply companies. The depth of the tip of grooving tools can be checked using the depth measuring feature of vernier calipers.

9.2 *Adjustment of Height of Drop*—Adjust the height of drop of the cup so that the point on the cup that comes in contact with the base rises to a height of 10 ± 0.2 mm. See Fig. 4 for proper location of the gage relative to the cup during adjustment.

NOTE 4—A convenient procedure for adjusting the height of drop is as follows: place a piece of masking tape across the outside bottom of the cup parallel with the axis of the cup hanger pivot. The edge of the tape away from the cup hanger should bisect the spot on the cup that contacts the base. For new cups, placing a piece of carbon paper on the base and allowing the cup to drop several times will mark the contact spot. Attach the cup to the device and turn the crank until the cup is raised to its maximum height. Slide the height gage under the cup from the front and observe whether the gage contacts the cup or the tape. (See Fig. 4.) If the tape and cup are both contacted, the height of drop is approximately correct. If not, adjust the cup until simultaneous contact is made. Check adjustment by turning the crank at 2 revolutions per second while holding the gage in position against the tape and cup. If a faint ringing or clicking sound is heard without the cup rising from the gage, the adjustment is correct. If no ringing is heard or if the cup rises from the gage, readjust the height of drop. If the cup rocks on the gage during this checking operation, the cam follower pivot is excessively worn and the worn parts should be replaced. Always remove tape after completion of adjustment operation.

10. Preparation of Test Specimens

10.1 *Wet Preparation*—Except where the dry method of specimen preparation is specified (10.2), prepare specimens for test as described in the following sections.

10.1.1 *Samples Passing the 425-μm (No. 40) Sieve:*

10.1.1.1 When by visual and manual procedures it is determined that the sample has little or no material retained on a 425-μm (No. 40) sieve, prepare a specimen of 150 to 200 g by mixing thoroughly with distilled or demineralized water on the glass plate using the spatula. If desired, some of the soil in a storage dish with a small amount of water to soften the soil before the start of mixing. Adjust the water content of the soil to bring it to a consistency that would require 25 to 35 blows of the liquid limit device to close the groove (Note 5).

10.1.1.2 If, during mixing, a small percentage of material is encountered that would be retained on a 425-μm (No. 40) sieve, remove these particles by hand (if possible). If it is impractical to remove the coarser material by hand, remove small percentages (less than about 15 %) of coarser material by working the specimen through a 425-μm sieve using a piece of rubber sheeting, rubber stopper, or other convenient

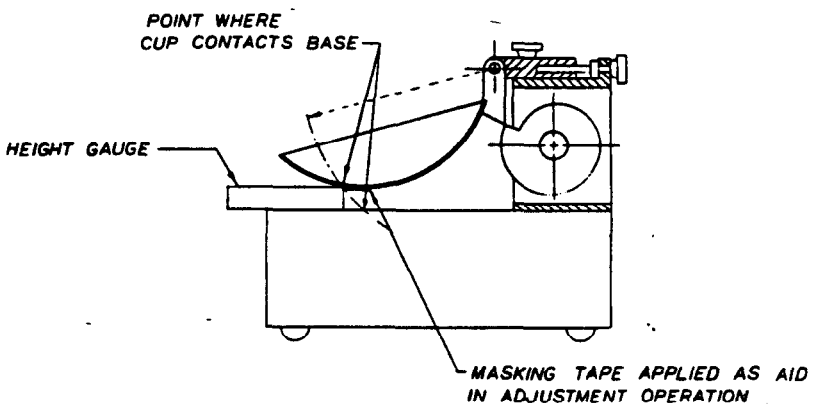


FIG. 4 Calibration for Height of Drop

K Series
28 Day UCS Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

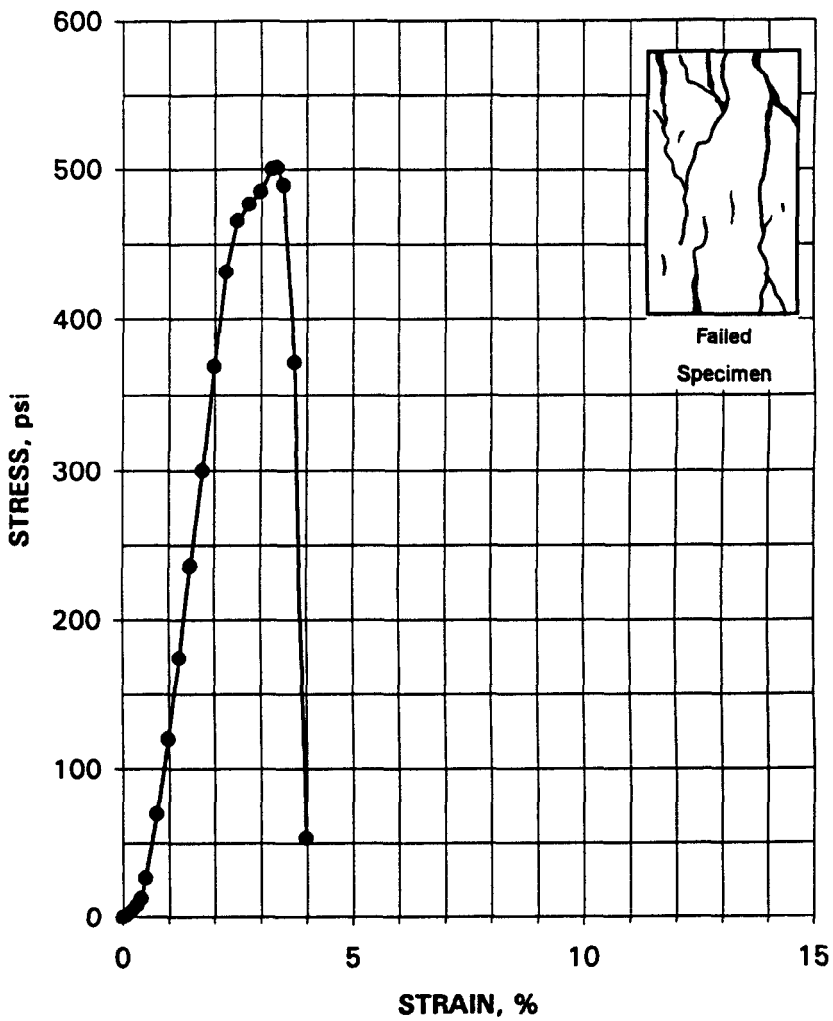
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K312F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7975

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0130
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	394.06
STRESS AT FAILURE, psi	**500.7**	Moisture Content, %	24.4
STRAIN AT FAILURE, %	**3.4**	Wet Unit Weight, pcf.	118.9
		Dry Unit Weight, pcf.	95.5
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	4.1
0.30	8.2
0.40	12.7
0.50	26.2
0.75	69.7
1.00	119.5
1.25	174.1
1.50	235.9
1.74	299.6
1.99	368.6
2.24	431.4
2.49	465.6
2.74	476.4
2.99	485.1
3.24	499.8
3.36	500.7
3.49	489.0
3.74	370.9
3.99	53.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

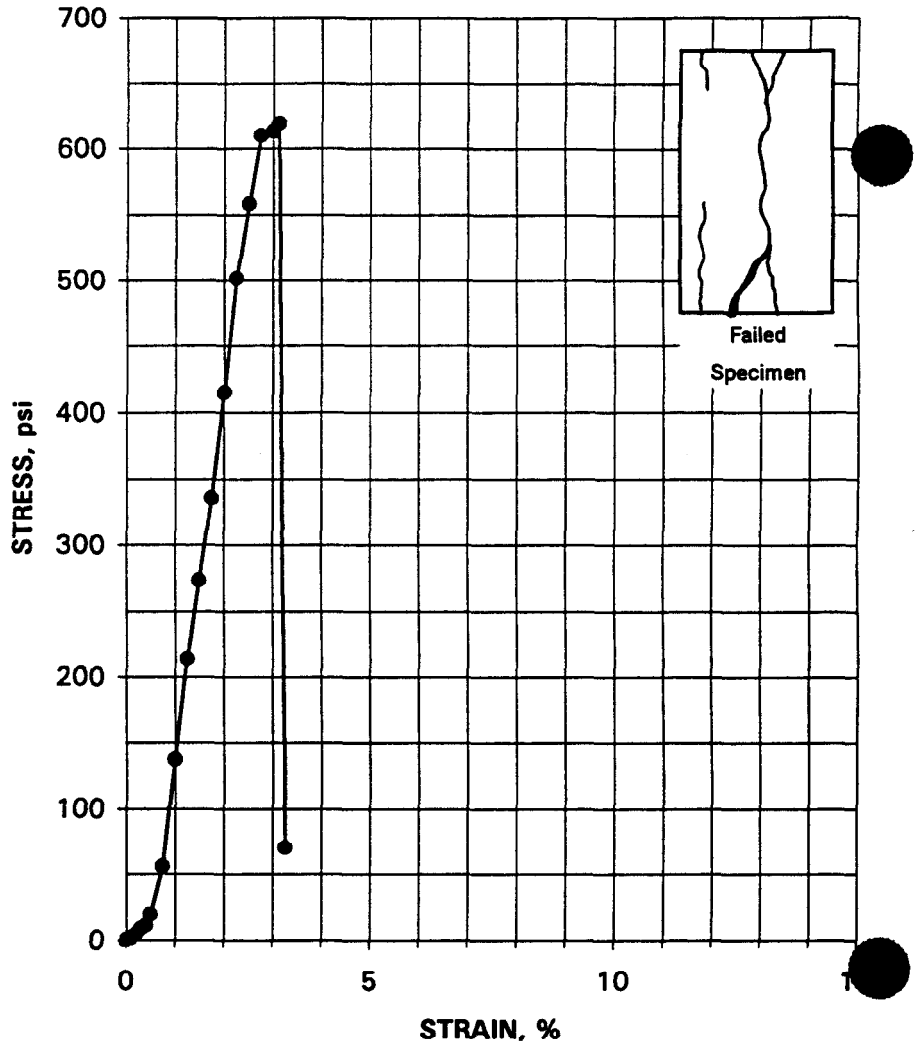
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K322F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7976

Specimen Mold Date	11/25/98	Specimen Height, in.	3.9860
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0025
		Specimen Weight, g.	392.08
STRESS AT FAILURE, psi	**619.1**	Moisture Content, %	22.9
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	119.0
		Dry Unit Weight, pcf.	96.9
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	4.4
0.30	8.9
0.40	11.1
0.50	19.3
0.75	56.1
1.00	137.7
1.25	213.8
1.51	273.6
1.76	336.0
2.01	414.8
2.26	501.2
2.51	558.1
2.76	609.8
3.01	613.1
3.14	619.1
3.26	70.6



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

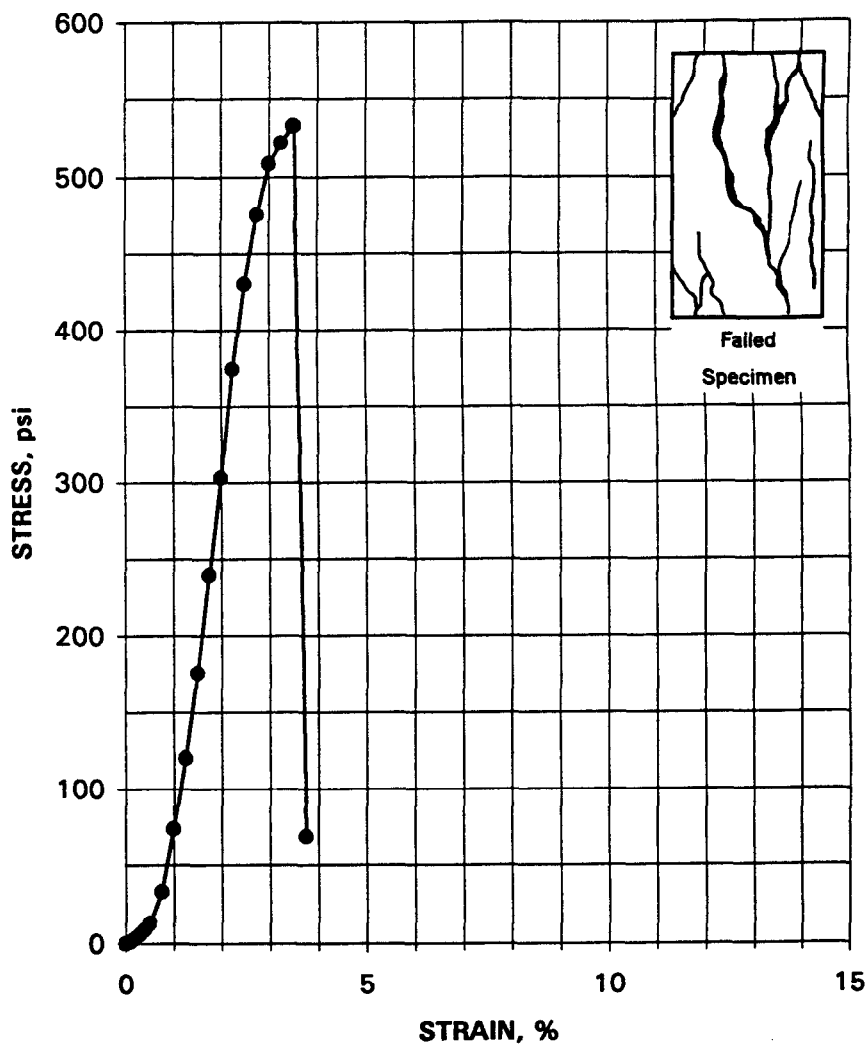
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K332F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7977

Specimen Mold Date	11/25/98	Specimen Height, in.	3.9955
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0048
		Specimen Weight, g.	380.58
STRESS AT FAILURE, psi	**532.7**	Moisture Content, %	28.8
STRAIN AT FAILURE, %	**3.5**	Wet Unit Weight, pcf.	115.0
		Dry Unit Weight, pcf.	89.2
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.5
0.30	6.0
0.40	8.5
0.50	12.9
0.75	33.0
1.00	73.7
1.25	119.8
1.50	175.4
1.75	239.6
2.00	302.7
2.25	374.7
2.50	429.9
2.75	475.3
3.00	507.9
3.25	521.3
3.50	532.5
3.53	532.7
3.75	68.9



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

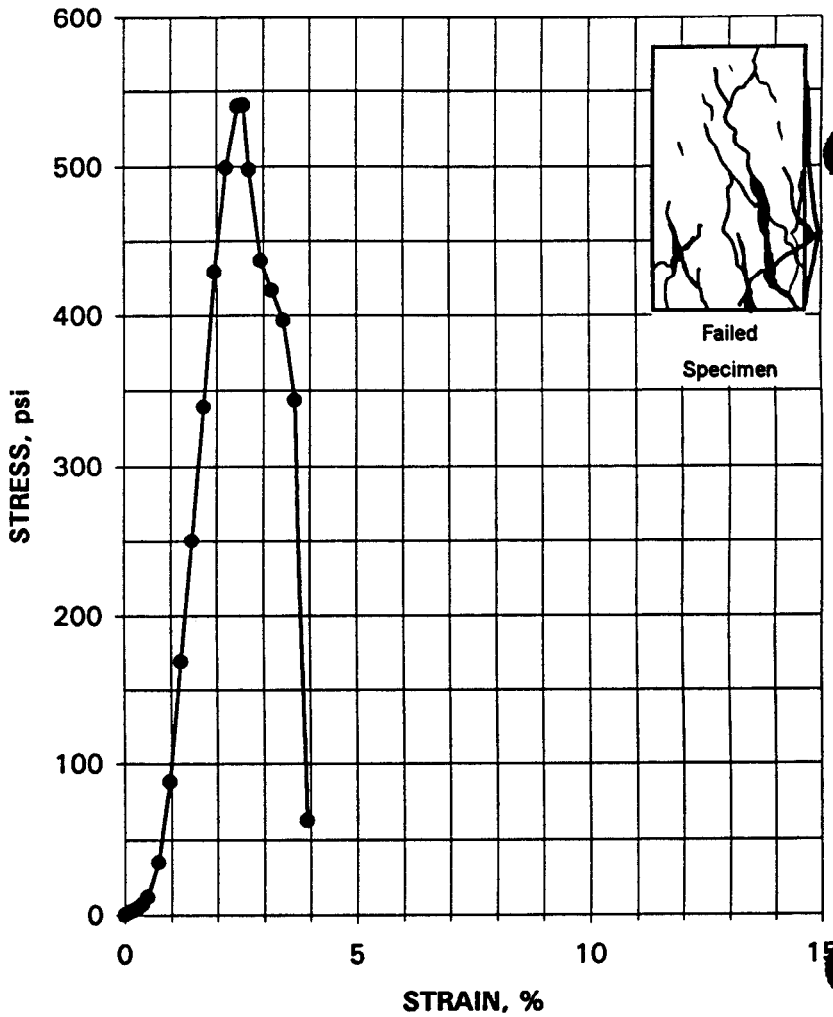
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K342F00
Project No.	777304.000105	IT Lab Specimen No.	ETDC-7978

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0780
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0100
		Specimen Weight, g.	386.61
STRESS AT FAILURE, psi	**541.0**	Moisture Content, %	28.1
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	113.8
		Dry Unit Weight, pcf.	88.9
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	2.8
0.29	4.7
0.39	7.2
0.49	11.9
0.74	35.0
0.98	88.3
1.23	169.3
1.47	250.3
1.72	338.9
1.96	429.2
2.21	499.3
2.45	540.1
2.57	541.0
2.70	497.7
2.94	436.8
3.19	416.5
3.43	396.5
3.68	343.6
3.92	62.4



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

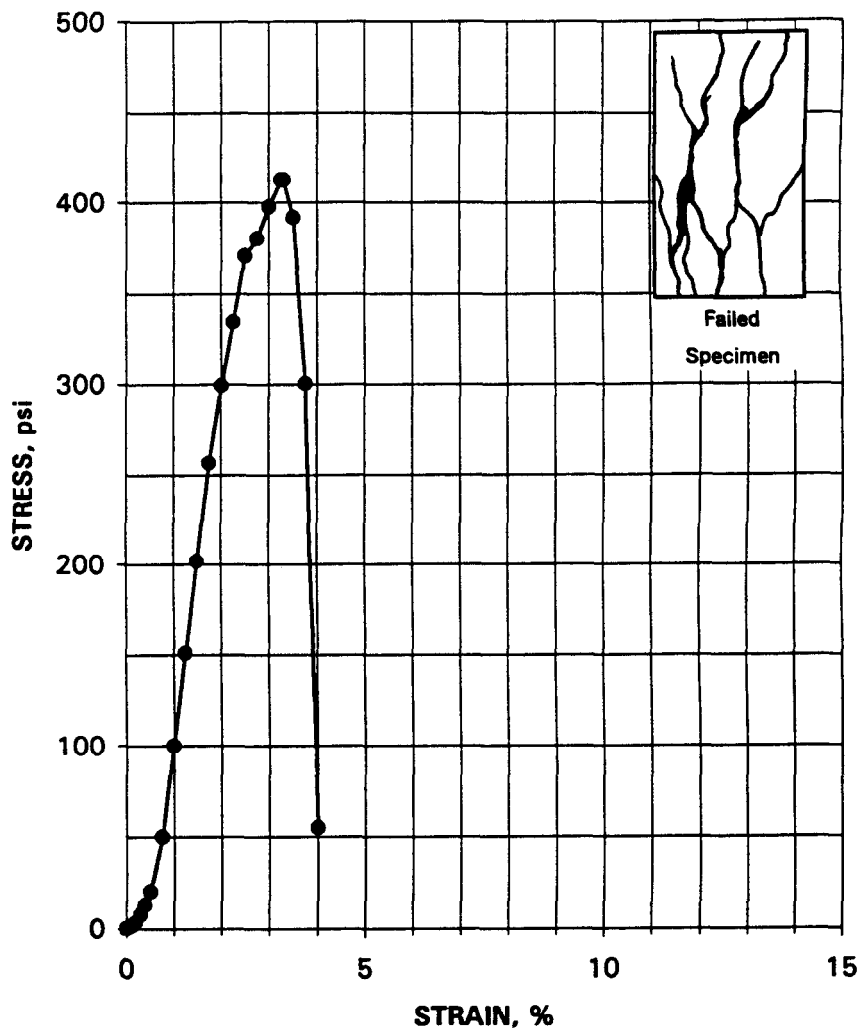
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K412F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7979

Specimen Mold Date	11/25/98	Specimen Height, in.	3.9872
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	374.50
STRESS AT FAILURE, psi	412.2	Moisture Content, %	31.3
STRAIN AT FAILURE, %	3.3	Wet Unit Weight, pcf.	113.7
		Dry Unit Weight, pcf.	86.6
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	3.5
0.30	7.6
0.40	13.0
0.50	19.9
0.75	50.1
1.00	100.0
1.25	150.9
1.50	201.8
1.76	256.5
2.01	299.5
2.26	334.4
2.51	370.4
2.76	380.0
3.01	397.5
3.26	412.1
3.31	412.2
3.51	391.4
3.76	300.5
4.01	54.9



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

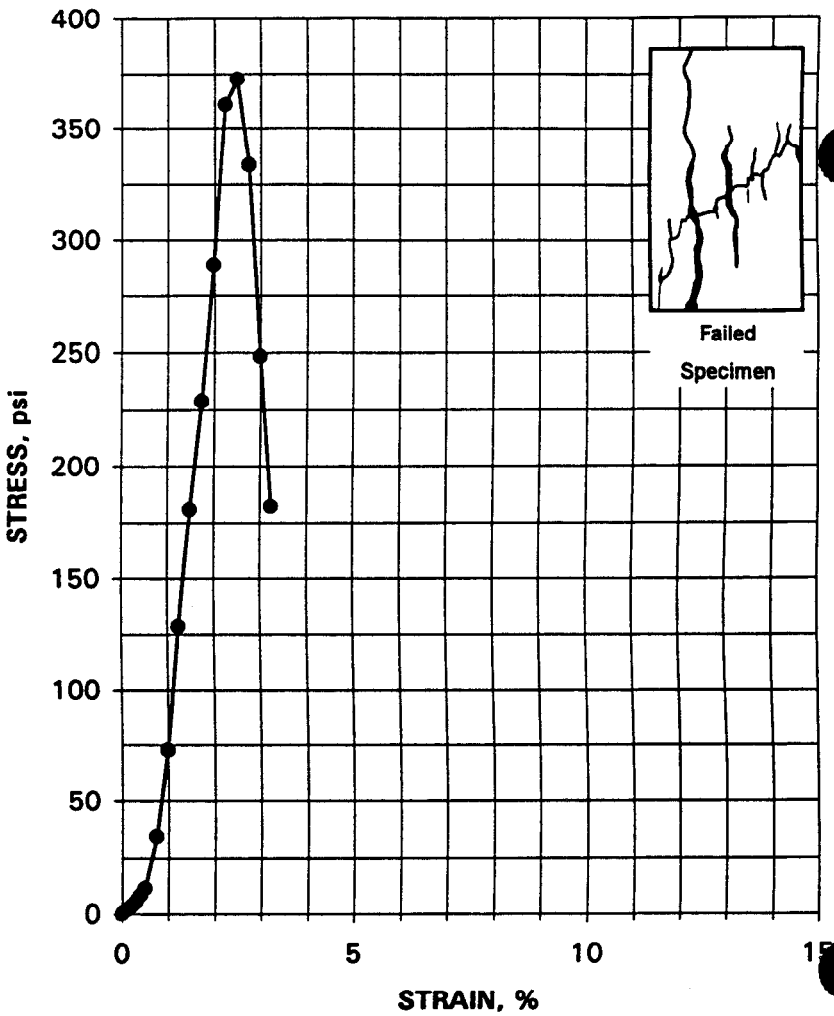
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K422F00
Project No.	777304.000105	IT Lab Specimen No.	ETDC-7980

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0145
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0093
		Specimen Weight, g.	388.24
STRESS AT FAILURE, psi	**372.4**	Moisture Content, %	30.6
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	116.2
		Dry Unit Weight, pcf.	89.0
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	3.1
0.30	5.3
0.40	8.2
0.50	11.3
0.75	34.4
1.00	72.7
1.25	128.3
1.49	180.8
1.74	229.0
1.99	289.0
2.24	360.7
2.49	372.4
2.74	333.4
2.99	248.4
3.24	182.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

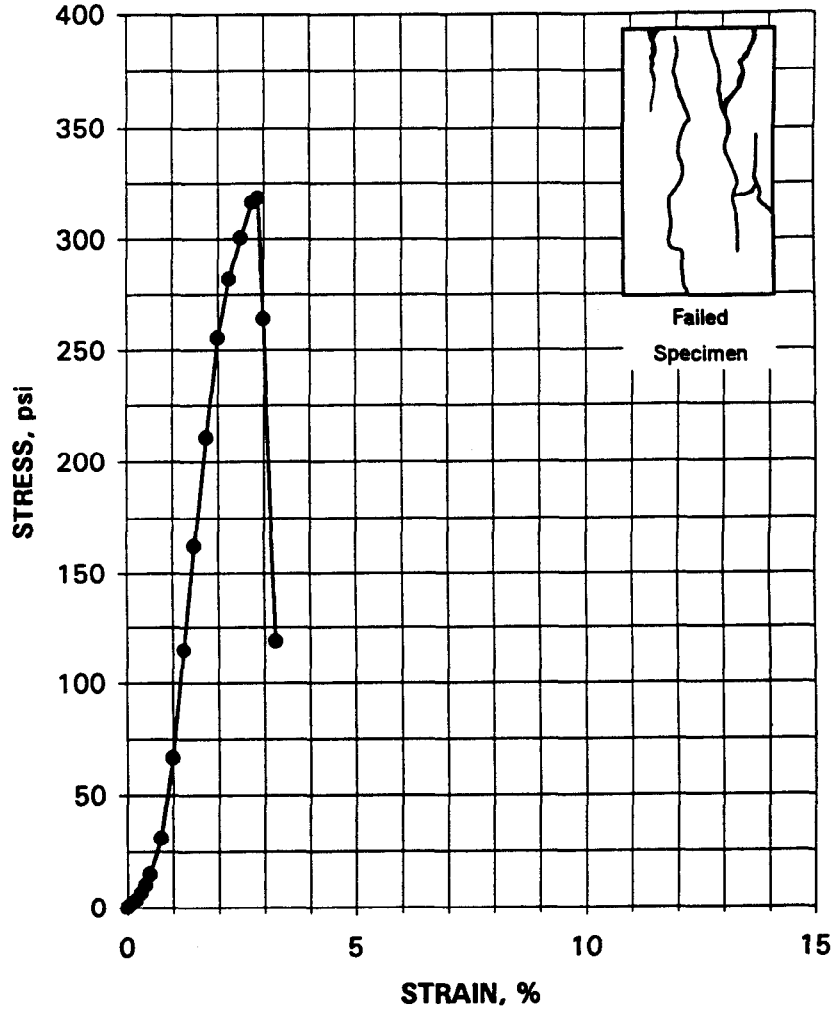
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K432F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7981

Specimen Mold Date	11/25/98	Specimen Height, in.	3.9977
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0110
		Specimen Weight, g.	365.78
STRESS AT FAILURE, psi	**318.3**	Moisture Content, %	36.5
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	109.8
		Dry Unit Weight, pcf.	80.4
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	3.5
0.30	6.6
0.40	10.3
0.50	15.0
0.75	30.9
1.00	66.7
1.25	114.4
1.50	162.2
1.75	211.0
2.00	255.2
2.25	281.9
2.50	300.5
2.75	316.3
2.88	318.3
3.00	264.2
3.25	118.8



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

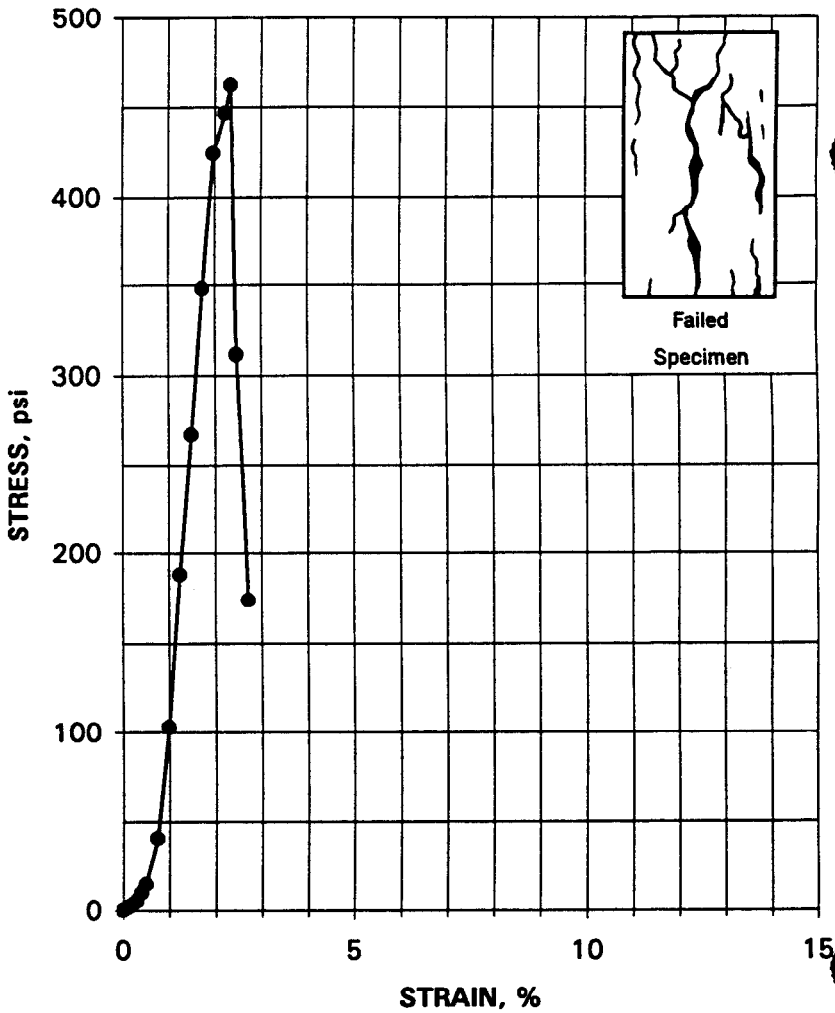
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	K442F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7982

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0300
Specimen Test Date	12/23/98	Specimen Diameter, in.	2.0073
		Specimen Weight, g.	373.62
STRESS AT FAILURE, psi	**462.2**	Moisture Content, %	35.1
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	111.6
		Dry Unit Weight, pcf.	82.6
		Rate of Strain, in./min.	0.0240

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.3
0.20	2.8
0.30	5.4
0.40	9.8
0.50	14.5
0.74	40.8
0.99	102.9
1.24	187.9
1.49	267.1
1.74	347.8
1.99	424.0
2.23	446.7
2.36	462.2
2.48	311.2
2.73	173.7



K Series
90 Day Immersion UCS Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

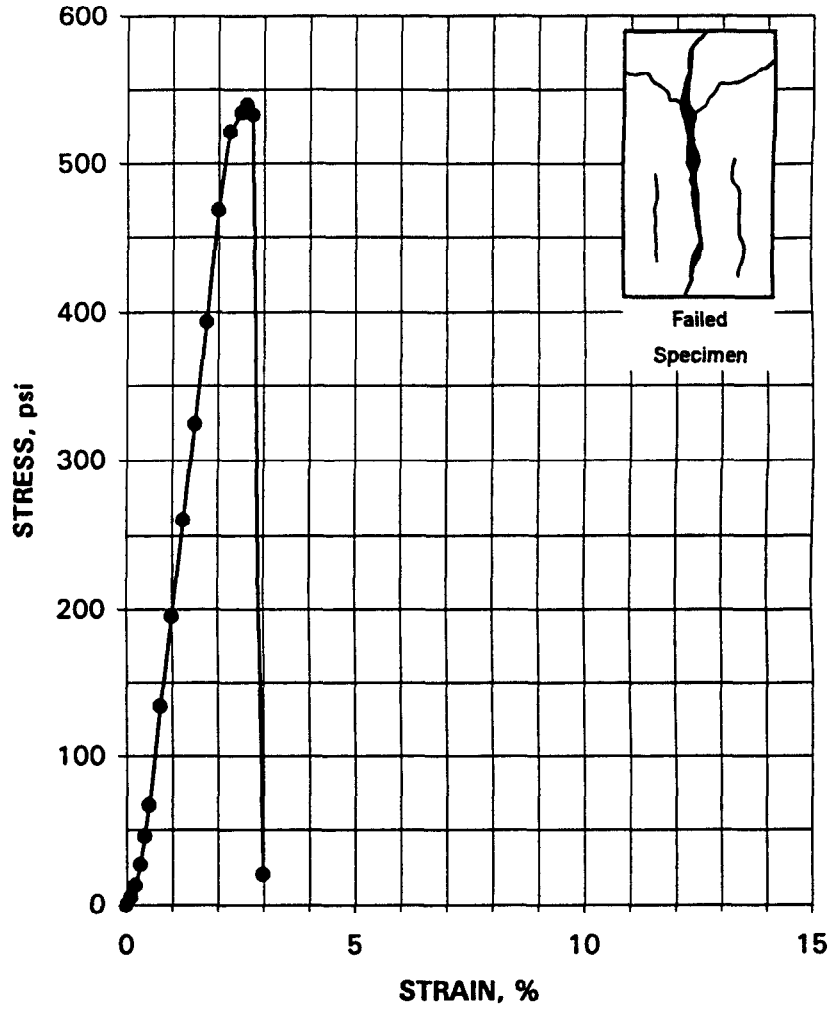
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K313F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7991

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0095
Specimen Test Date	3/23/99	Specimen Diameter, in.	1.9992
		Specimen Weight, g.	402.53
STRESS AT FAILURE, psi	**539.5**	Moisture Content, %	26.6
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	121.9
		Dry Unit Weight, pcf.	96.2
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.1
0.20	12.7
0.30	26.4
0.40	46.0
0.50	66.6
0.75	134.1
1.00	195.2
1.25	260.5
1.50	324.2
1.75	393.5
2.00	468.0
2.24	521.6
2.49	534.6
2.62	539.5
2.74	533.2
2.99	20.1



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

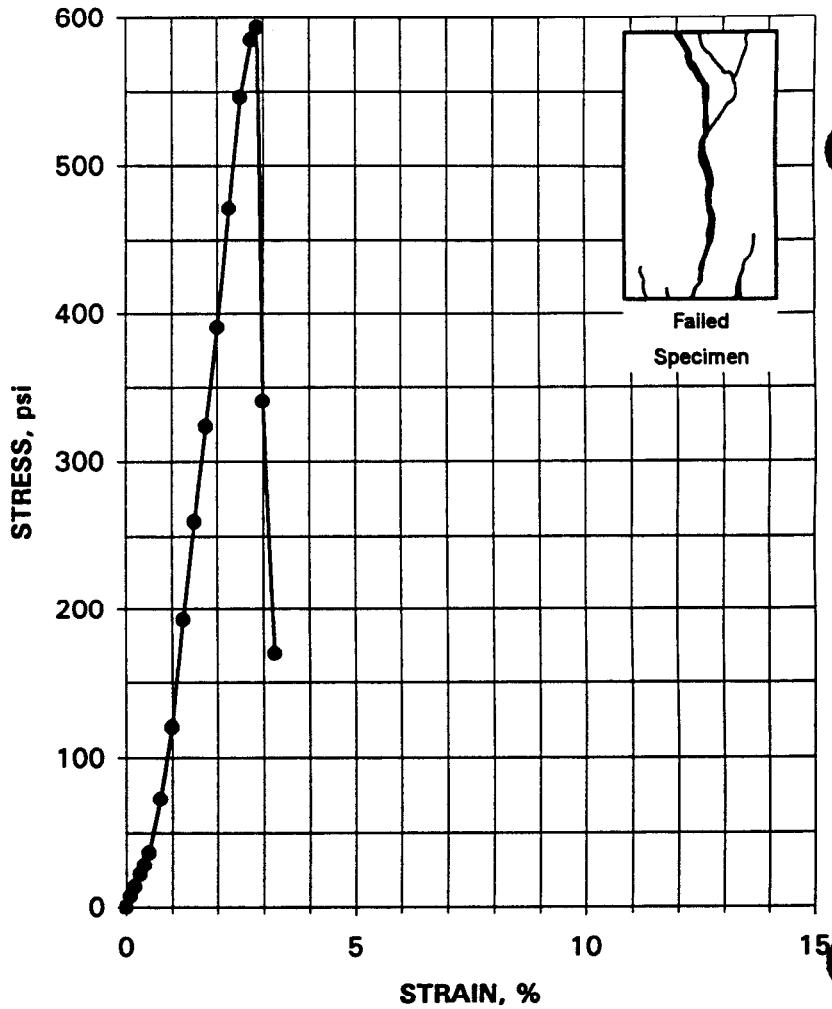
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K323F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7992

Specimen Mold Date	11/25/98	Specimen Height, in.	3.9962
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0088
		Specimen Weight, g.	397.93
STRESS AT FAILURE, psi	**593.3**	Moisture Content, %	24.8
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	119.7
		Dry Unit Weight, pcf.	95.9
		Rate of Strain, in./min.	0.0440

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	7.2
0.20	13.5
0.30	21.7
0.40	28.3
0.50	36.7
0.75	72.7
1.00	120.6
1.25	192.5
1.50	259.5
1.75	323.3
2.00	390.8
2.25	470.9
2.50	546.3
2.75	585.1
2.88	593.3
3.00	340.3
3.25	169.7



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

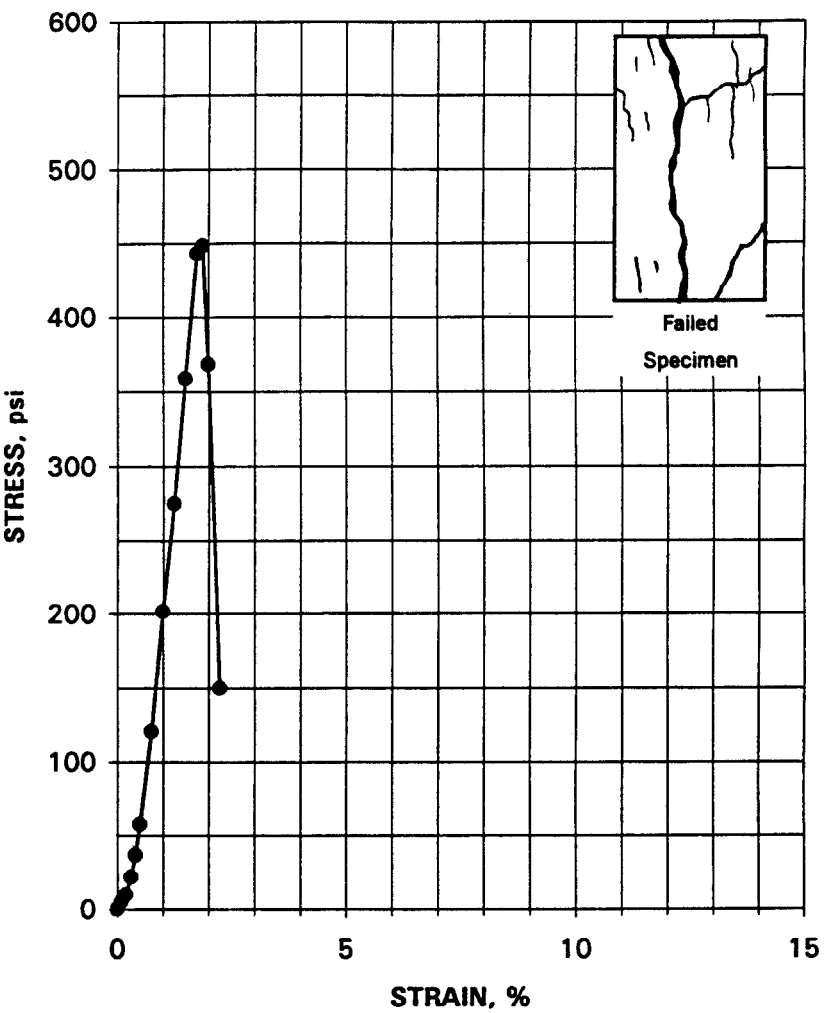
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K333F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7993

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0040
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0078
		Specimen Weight, g.	385.96
STRESS AT FAILURE, psi	**448.4**	Moisture Content, %	31.2
STRAIN AT FAILURE, %	**1.9**	Wet Unit Weight, pcf.	116.0
		Dry Unit Weight, pcf.	88.4
		Rate of Strain, in./min.	0.0440

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.0
0.20	9.8
0.30	21.7
0.40	36.8
0.50	57.5
0.75	121.0
1.00	202.0
1.25	274.8
1.50	358.7
1.75	443.1
1.87	448.4
2.00	368.0
2.25	150.0



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

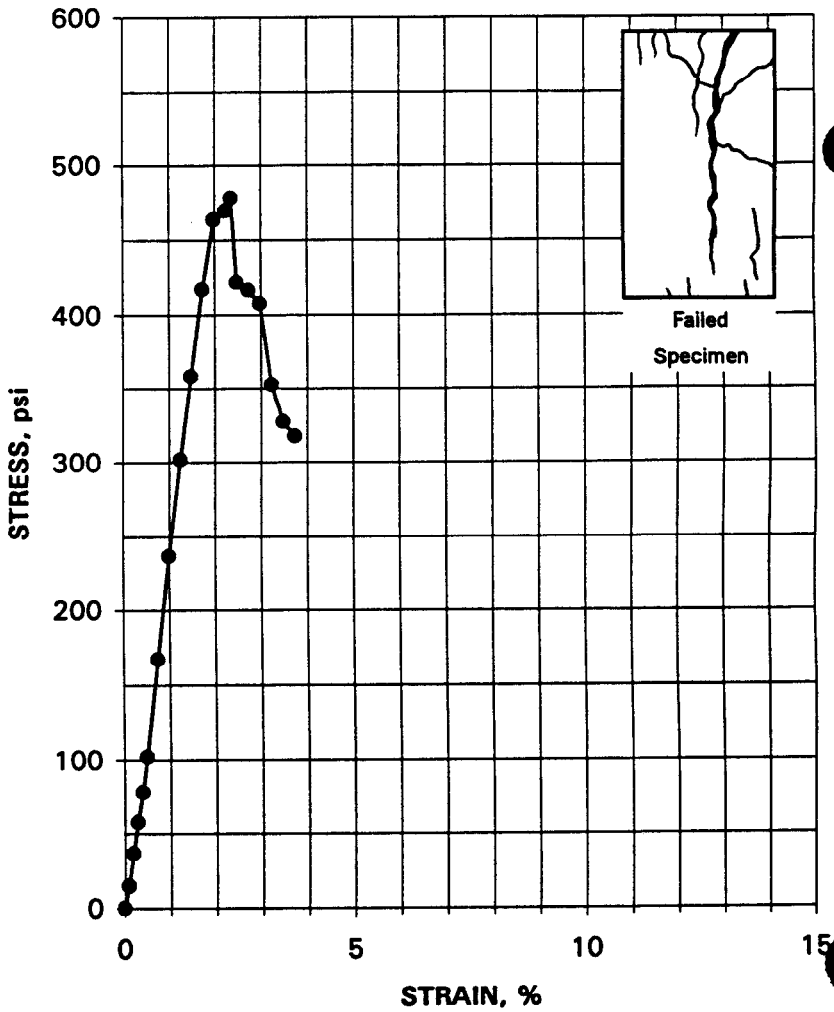
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K343F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7994

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0218
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0050
		Specimen Weight, g.	387.28
STRESS AT FAILURE, psi	**477.8**	Moisture Content, %	29.9
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	116.2
		Dry Unit Weight, pcf.	89.4
		Rate of Strain, in./min.	0.0440

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	15.2
0.20	36.7
0.30	57.8
0.40	77.9
0.50	102.1
0.75	167.2
0.99	236.4
1.24	301.8
1.49	358.5
1.74	417.0
1.99	463.2
2.24	469.1
2.36	477.8
2.49	421.6
2.74	416.5
2.98	407.8
3.23	352.8
3.48	327.4
3.73	317.7



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

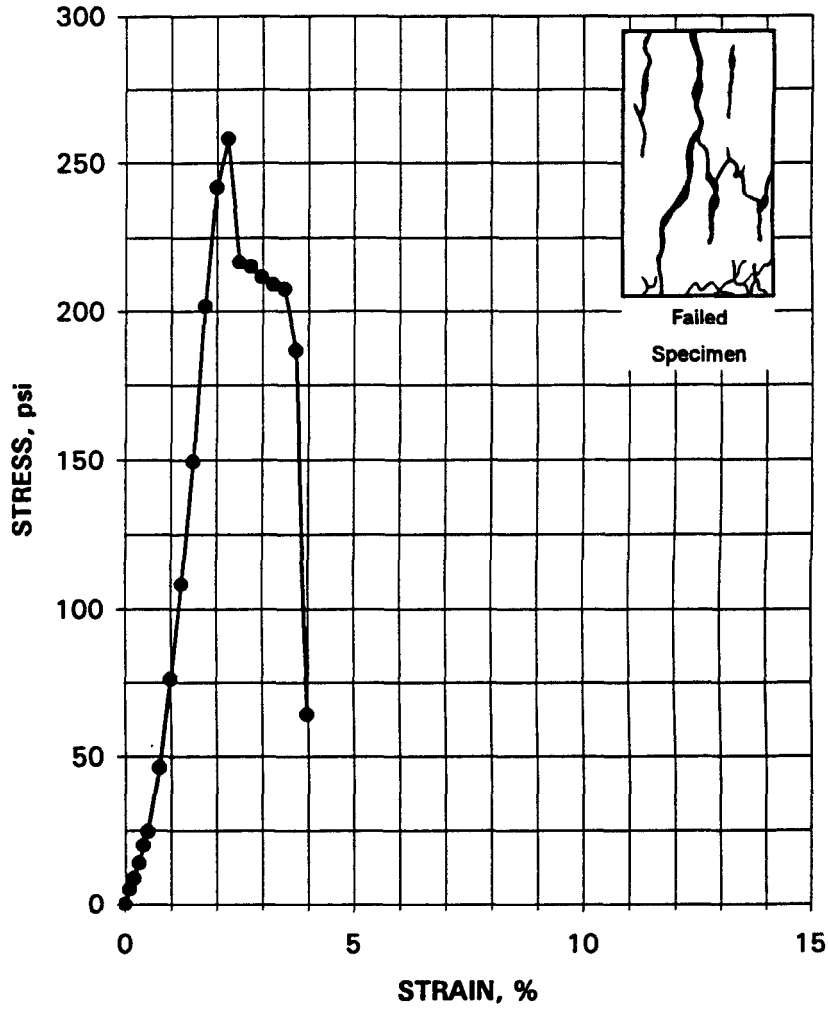
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K413F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7995

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0098
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0055
		Specimen Weight, g.	384.10
STRESS AT FAILURE, psi	**258.1**	Moisture Content, %	33.9
STRAIN AT FAILURE, %	**2.2**	Wet Unit Weight, pcf.	115.5
		Dry Unit Weight, pcf.	86.3
		Rate of Strain, in./min.	0.0440

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.1
0.20	8.8
0.30	13.9
0.40	19.9
0.50	24.6
0.75	46.2
1.00	76.2
1.25	108.5
1.50	149.4
1.75	201.6
2.00	242.0
2.24	258.1
2.49	216.7
2.74	215.2
2.99	211.6
3.24	208.9
3.49	207.4
3.74	186.5
3.99	64.1



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

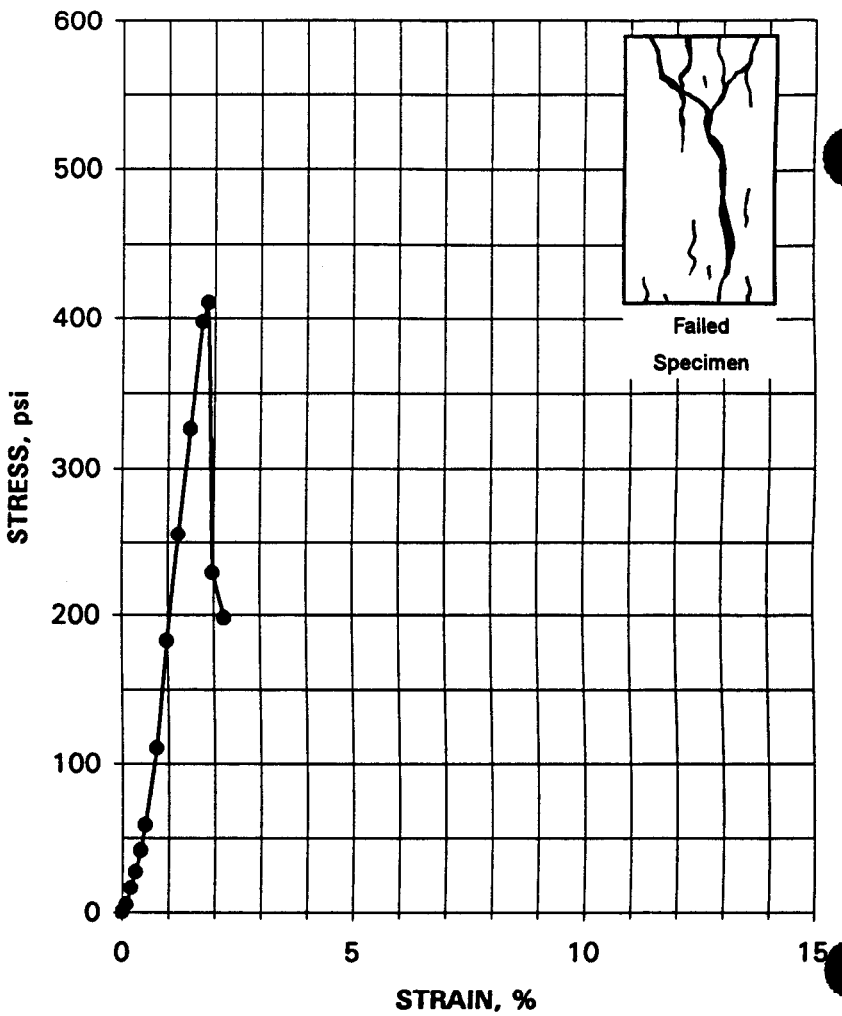
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K423F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7996

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0323
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0098
		Specimen Weight, g.	393.49
STRESS AT FAILURE, psi	**410.2**	Moisture Content, %	31.5
STRAIN AT FAILURE, %	**1.9**	Wet Unit Weight, pcf.	117.2
		Dry Unit Weight, pcf.	89.1
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.4
0.20	16.4
0.30	27.0
0.40	42.1
0.50	58.7
0.74	110.1
0.99	183.2
1.24	255.6
1.49	326.0
1.74	397.4
1.86	410.2
1.98	229.2
2.23	198.2



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

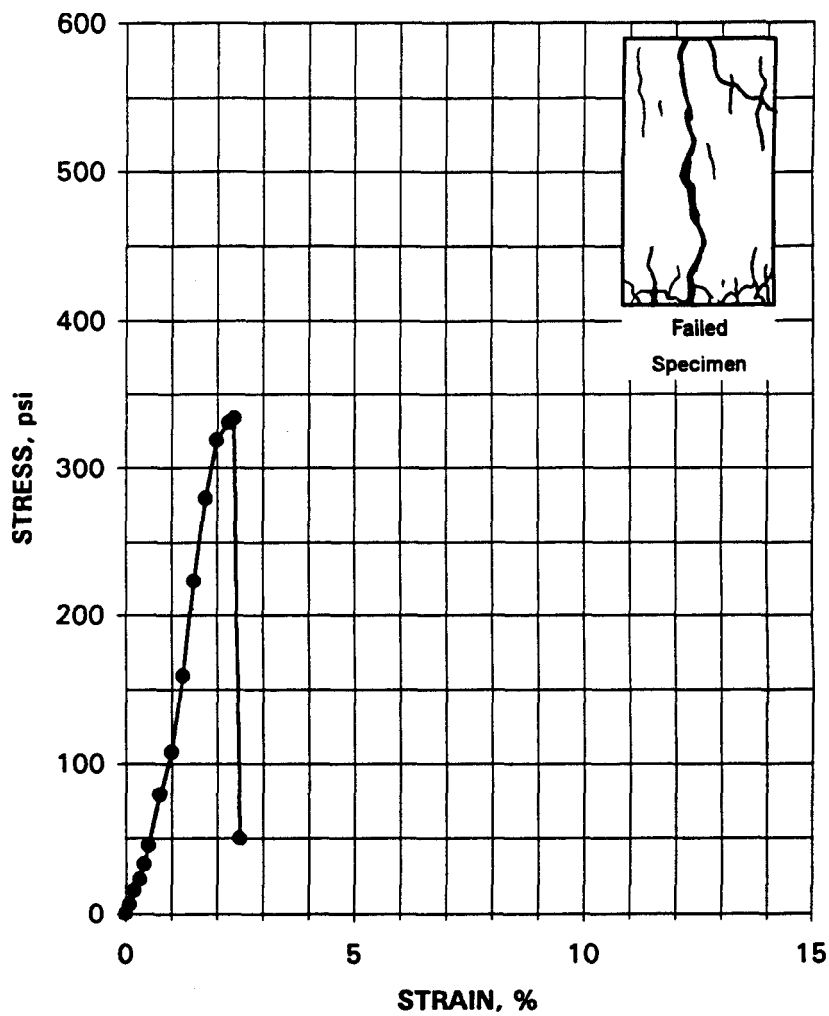
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K433F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7997

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0040
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0110
		Specimen Weight, g.	369.98
STRESS AT FAILURE, psi	**333.5**	Moisture Content, %	40.6
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	110.8
		Dry Unit Weight, pcf.	78.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	6.3
0.20	15.4
0.30	22.9
0.40	32.6
0.50	45.4
0.75	79.1
1.00	107.5
1.25	159.2
1.50	223.9
1.75	279.9
2.00	318.7
2.25	330.2
2.37	333.5
2.50	50.3



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

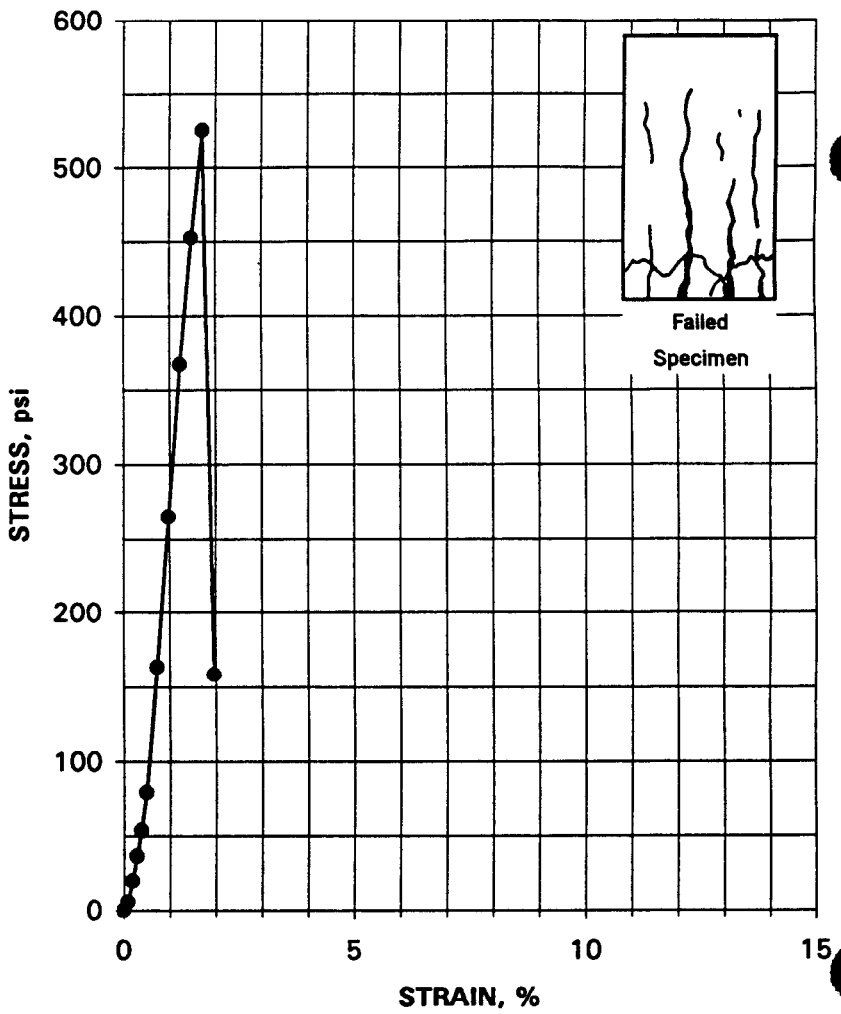
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28 DAY CURE, 90 DAY SATURATION

Project Name	SAIC / SAVANNAH RIVER	Client Sample No.	K443F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-7998

Specimen Mold Date	11/25/98	Specimen Height, in.	4.0532
Specimen Test Date	3/23/99	Specimen Diameter, in.	2.0087
		Specimen Weight, g.	376.10
STRESS AT FAILURE, psi	**525.3**	Moisture Content, %	37.0
STRAIN AT FAILURE, %	**1.7**	Wet Unit Weight, pcf.	111.6
		Dry Unit Weight, pcf.	81.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.7
0.20	19.5
0.30	36.8
0.39	53.7
0.49	79.1
0.74	163.5
0.99	264.6
1.23	366.8
1.48	452.7
1.73	525.3
1.97	158.4



K Series
28 Day Expansion/Shrinkage Results

Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures ASTM D 3877

28-Day Cure

Geo Lab Sample No.	Knoxville Lab Sample No.	Expansion, %	Expansion Result	Shrinkage, %
ETDC-7967	K312K00	-0.001	No expansion	-0.64
ETDC-7968	K322K00	0.000	No expansion	Insufficient sample
ETDC-7969	K332K00	-0.003	No expansion	-4.11
ETDC-7970	K342K00	-0.001	No expansion	-1.06
ETDC-7971	K412K00	-0.001	No expansion	-0.39
ETDC-7972	K422K00	0.000	No expansion	-0.34
ETDC-7973	K432K00	-0.001	No expansion	Insufficient sample
ETDC-7974	K442K00	-0.004	No expansion	-0.2

K Series
28 Day Permeability Results

Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

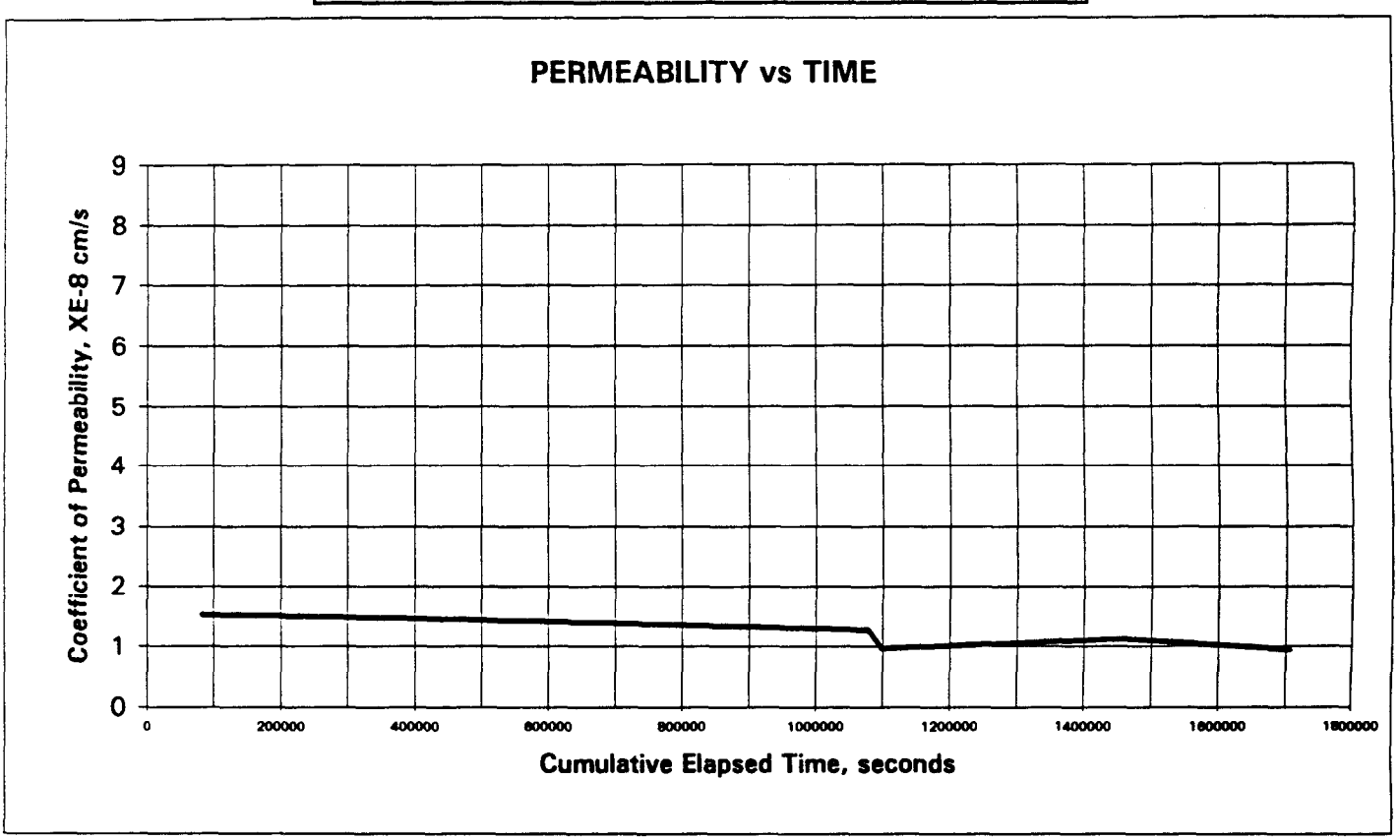
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K312G00
IT LAB SAMPLE NO. ETDC-7983

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.13	
Wet weight of specimen, g.	393.12	400.46
Specimen cross-sect. area, cm^2	20.2683	
Water content, %	25.0	27.3
Wet unit weight, pcf	119.5	
Dry unit weight, pcf	95.6	
Estimated degree of saturation, %	90.6	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	20.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Six tests performed	

Coefficient of Permeability, cm/s 1.1E-08



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

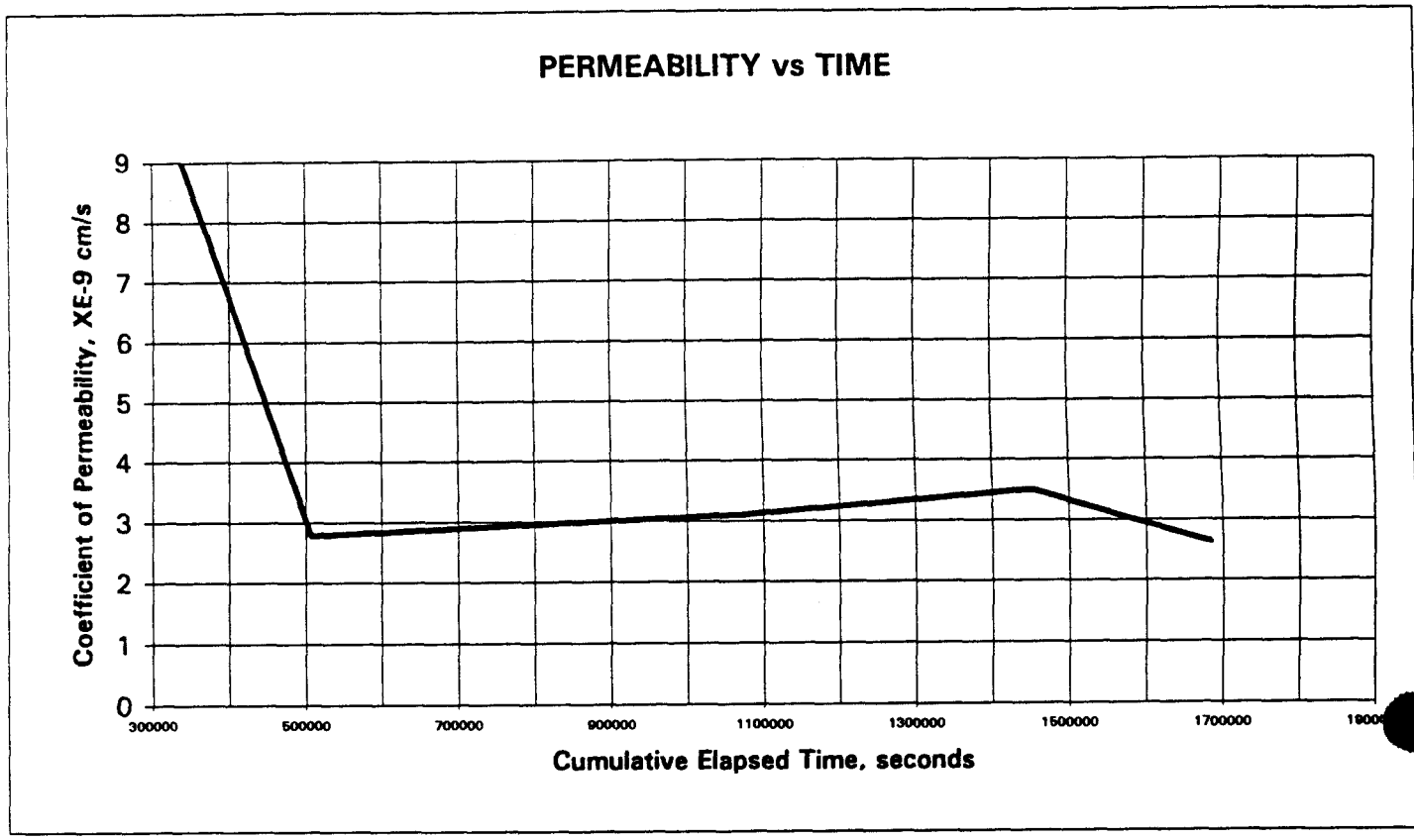
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. K322G00
IT LAB SAMPLE NO. ETDC-7984

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.19	
Wet weight of specimen, g.	392.63	400.08
Specimen cross-sect. area, cm^2	20.3055	
Water content, %	23.1	25.5
Wet unit weight, pcf	118.5	
Dry unit weight, pcf	96.2	
Estimated degree of saturation, %	85.2	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	20.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Five tests performed	

Coefficient of Permeability, cm/s 3.0E-09



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

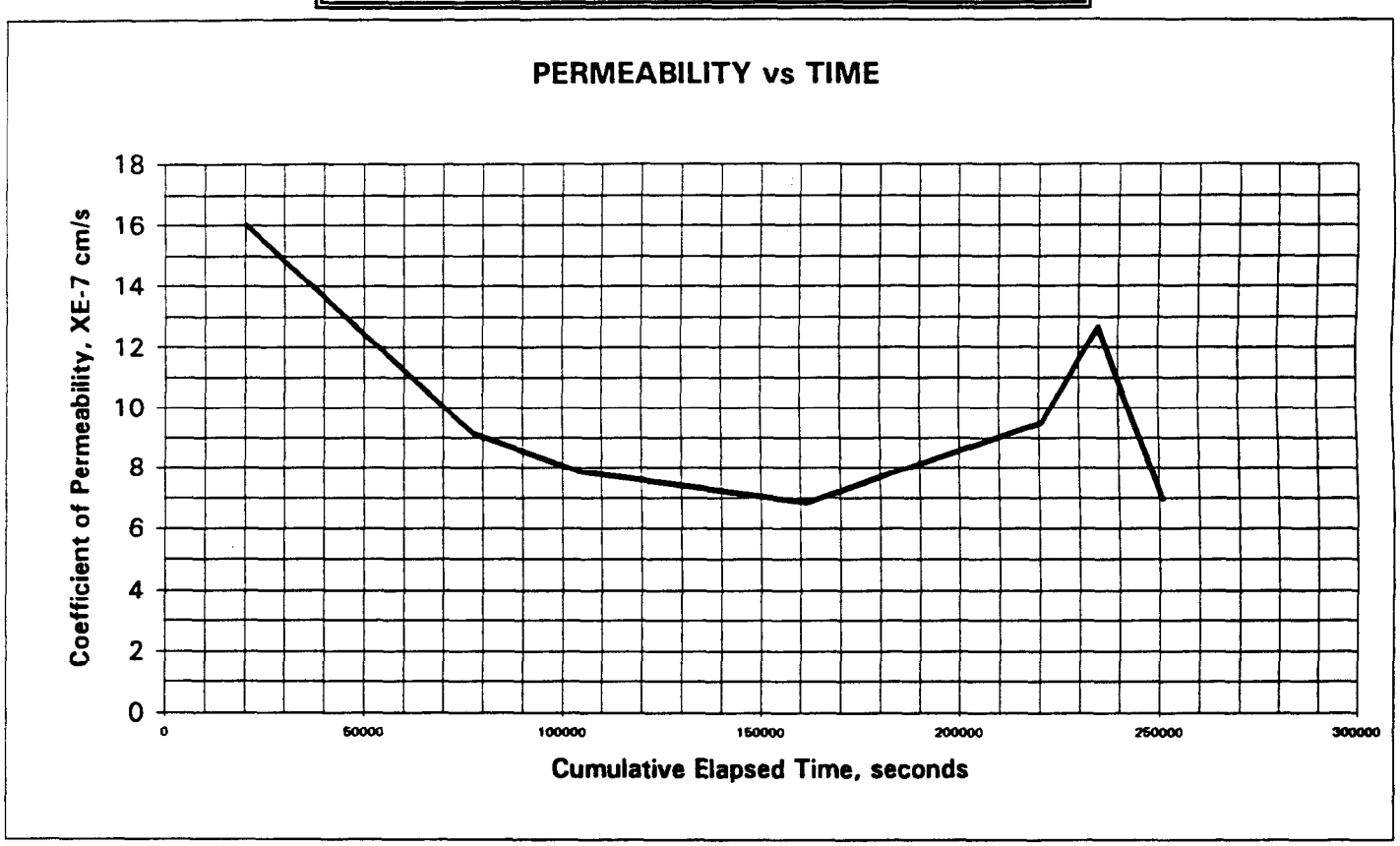
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K332G00
IT LAB SAMPLE NO. ETDC-7985

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.19	
Wet weight of specimen, g.	382.69	387.1
Specimen cross-sect. area, cm^2	20.2818	
Water content, %	29.7	31.2
Wet unit weight, pcf	115.6	
Dry unit weight, pcf	89.1	
Estimated degree of saturation, %	92.0	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	13.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Seven tests performed	

Coefficient of Permeability, cm/s 8.3E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

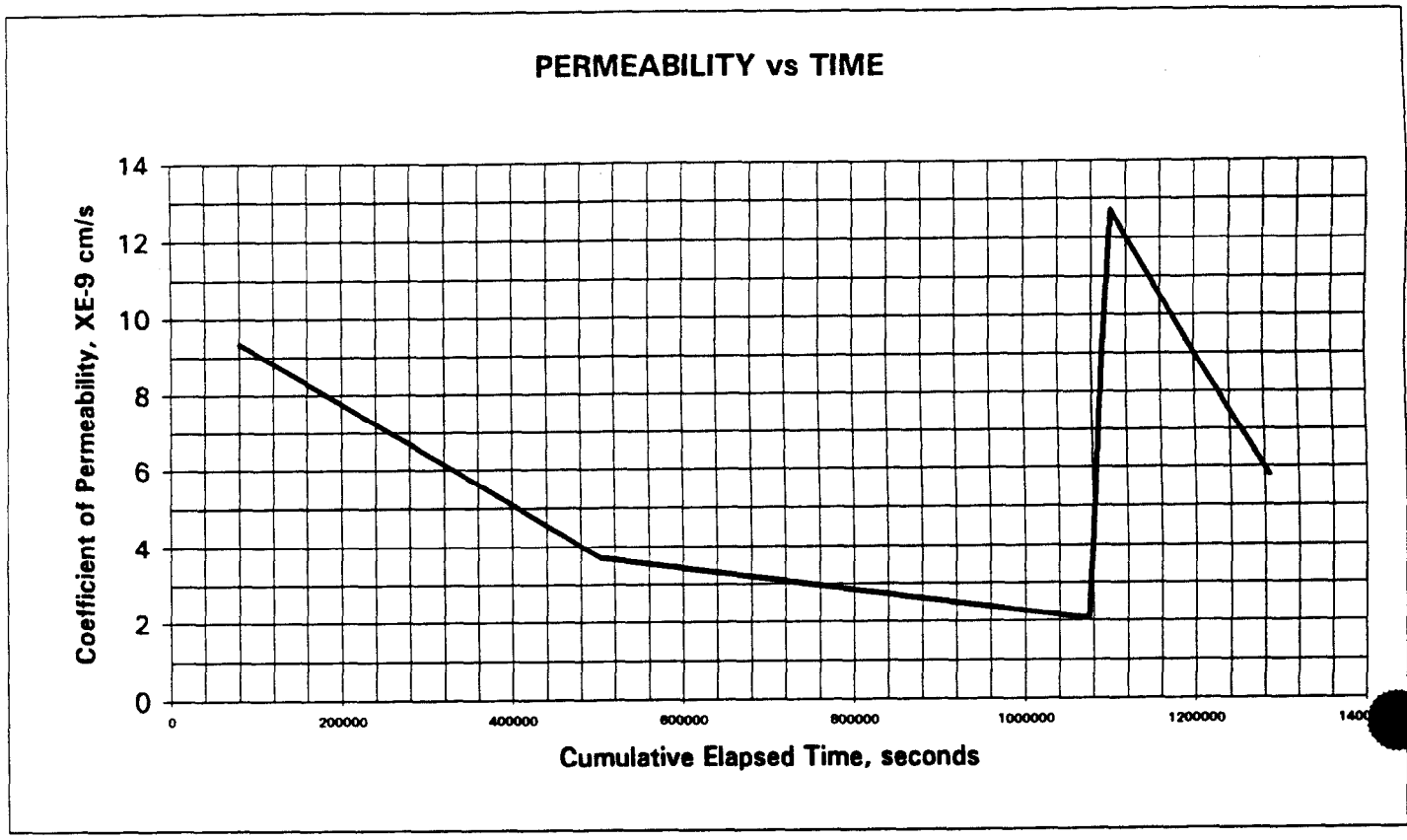
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. K342G00
IT LAB SAMPLE NO. ETDC-7986

	INITIAL	FINAL
Specimen diameter, cm	5.12	
Specimen length, cm	10.22	
Wet weight of specimen, g.	383.2	388.96
Specimen cross-sect. area, cm^2	20.5530	
Water content, %	28.1	30.0
Wet unit weight, pcf	113.9	
Dry unit weight, pcf	88.9	
Estimated degree of saturation, %	86.5	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	13.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Five tests performed	

Coefficient of Permeability, cm/s 2.9E-09



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

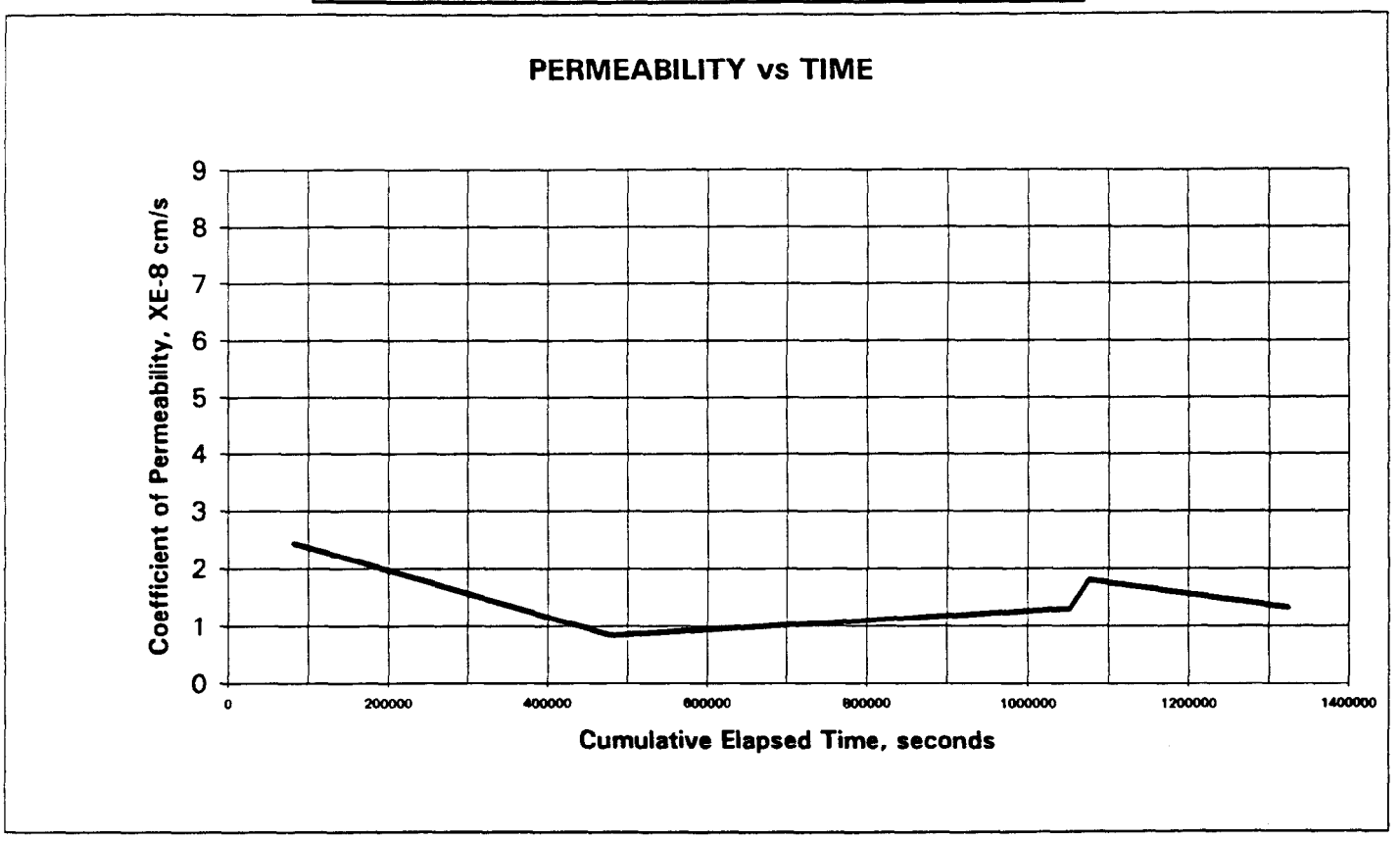
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K412G00
IT LAB SAMPLE NO. ETDC-7987

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.15	
Wet weight of specimen, g.	376.86	383.39
Specimen cross-sect. area, cm^2	20.2751	
Water content, %	30.7	33.0
Wet unit weight, pcf	114.4	
Dry unit weight, pcf	87.5	
Estimated degree of saturation, %	91.4	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	20.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Five tests performed	

Coefficient of Permeability, cm/s 1.5E-08



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

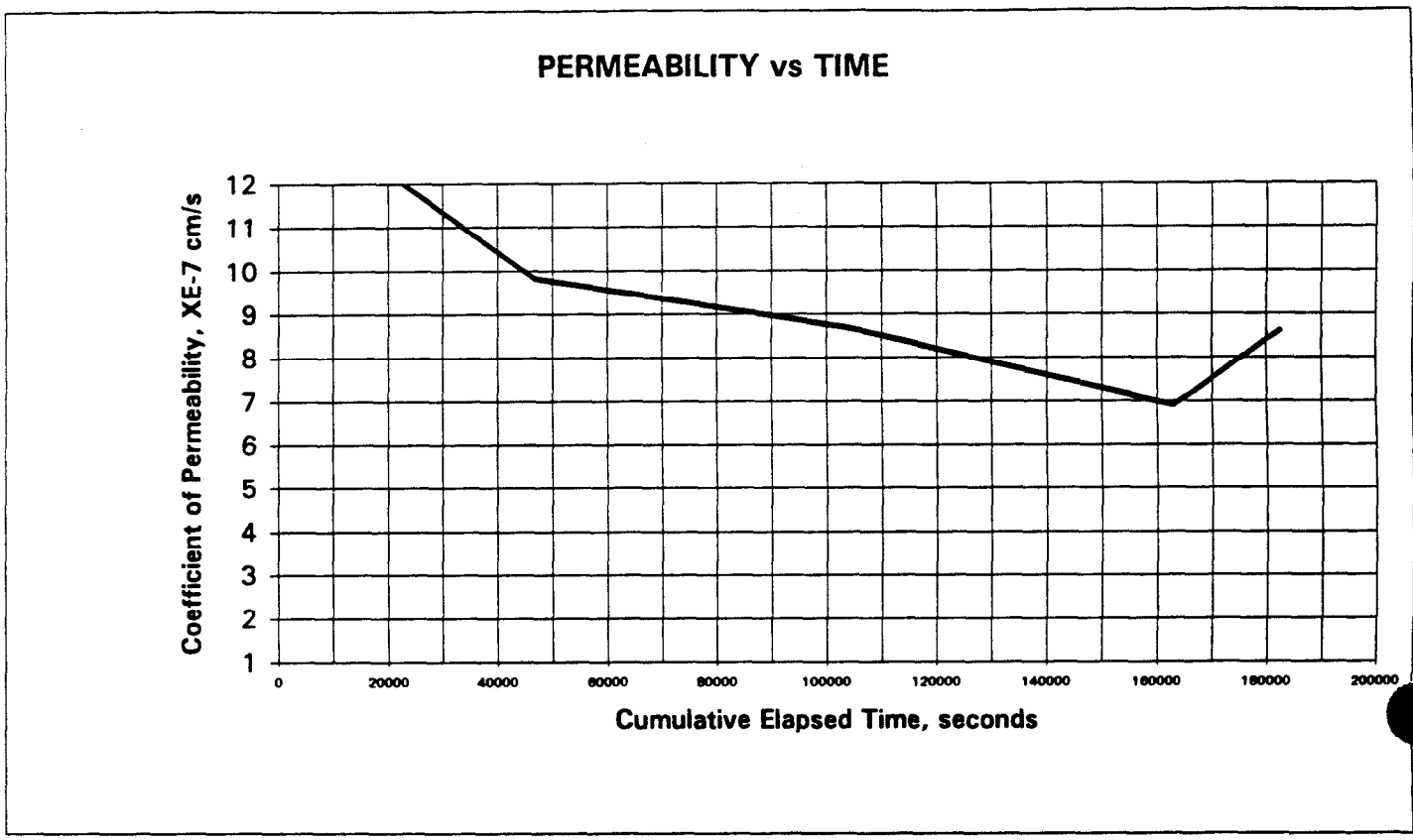
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. K422G00
IT LAB SAMPLE NO. ETDC-7988

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.17	
Wet weight of specimen, g.	386.26	389.97
Specimen cross-sect. area, cm^2	20.3630	
Water content, %	30.5	31.7
Wet unit weight, pcf	116.5	
Dry unit weight, pcf	89.3	
Estimated degree of saturation, %	94.7	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	13.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Five tests performed	

Coefficient of Permeability, cm/s 9.3E-07



Paul Lear
IT Corporation
April 19, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

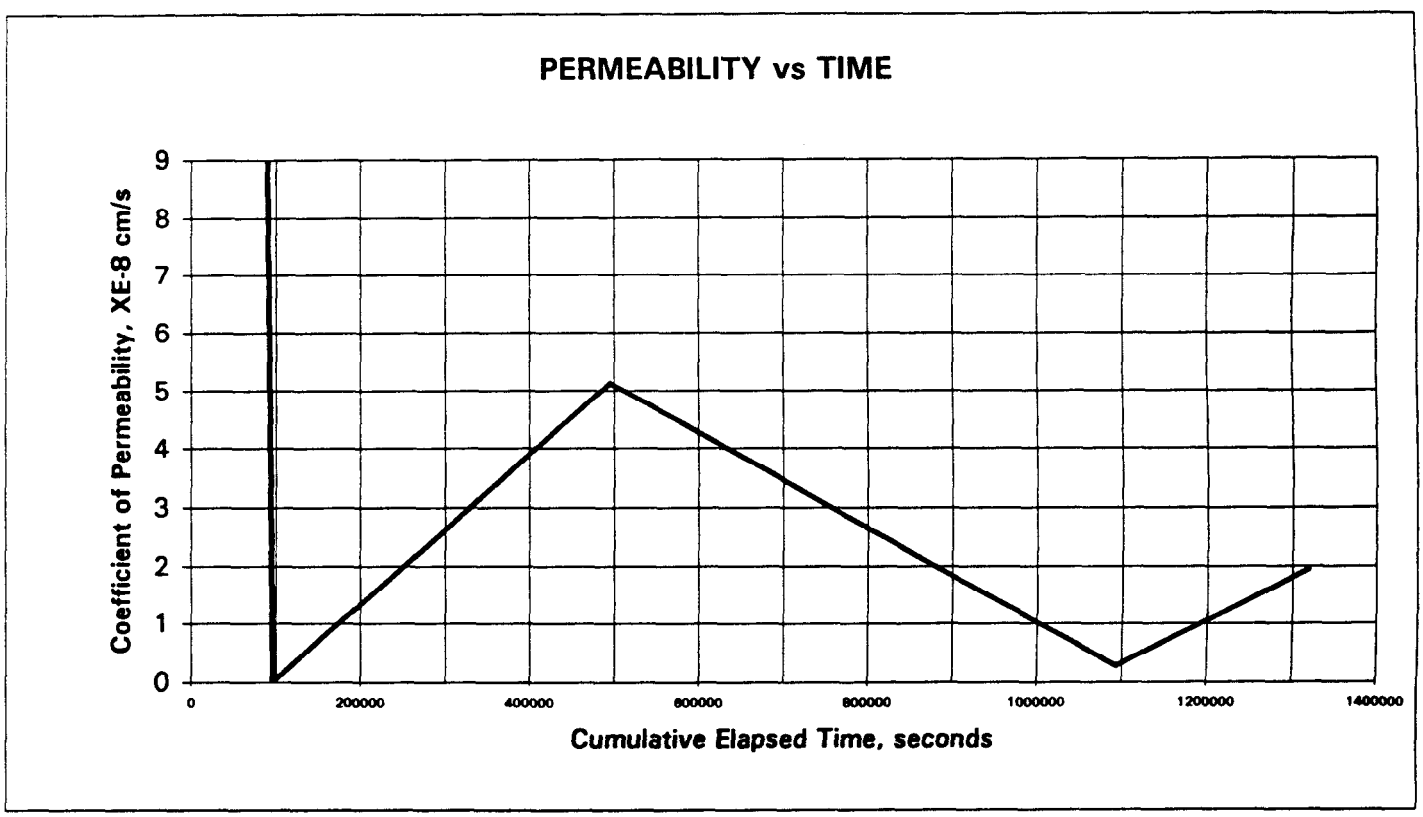
CLIENT SAMPLE NO. K432G00
IT LAB SAMPLE NO. ETDC-7989

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.18	
Wet weight of specimen, g.	368.73	374.34
Specimen cross-sect. area, cm^2	20.3528	
Water content, %	36.8	38.9
Wet unit weight, pcf	111.1	
Dry unit weight, pcf	81.2	
Estimated degree of saturation, %	94.0	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	7.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Six tests performed	

Coefficient of Permeability, cm/s 1.9E-09

Result is average of last two tests.



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

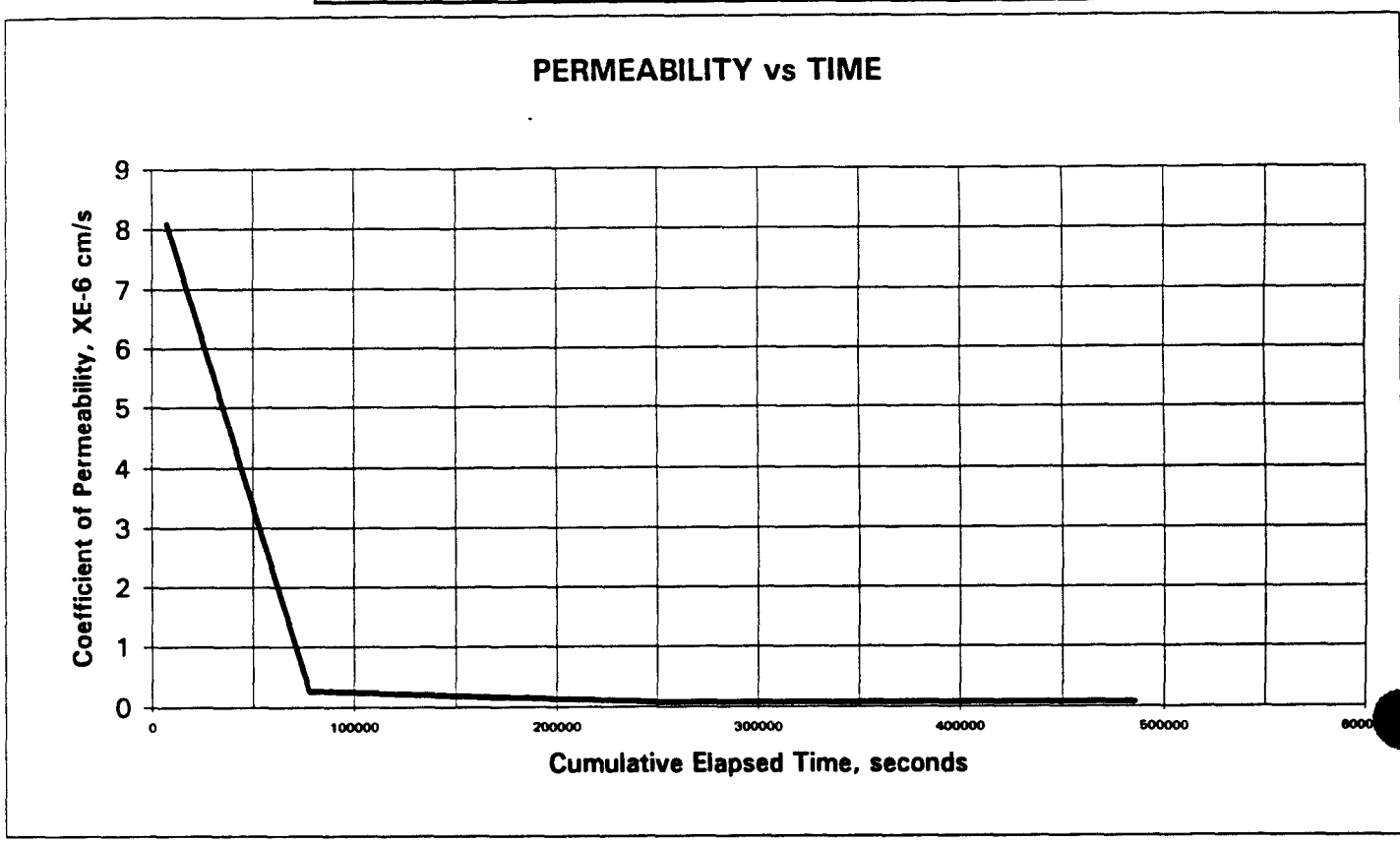
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. K442G00
IT LAB SAMPLE NO. ETDC-7990

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.25	
Wet weight of specimen, g.	371.68	376.28
Specimen cross-sect. area, cm^2	20.4511	
Water content, %	35.4	37.1
Wet unit weight, pcf	110.7	
Dry unit weight, pcf	81.7	
Estimated degree of saturation, %	91.6	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	13.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/98
Sample set up	12/23/98
Six tests performed	

Coefficient of Permeability, cm/s	2.2E-06



K Series
90 Day Immersion Permeability Results

Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

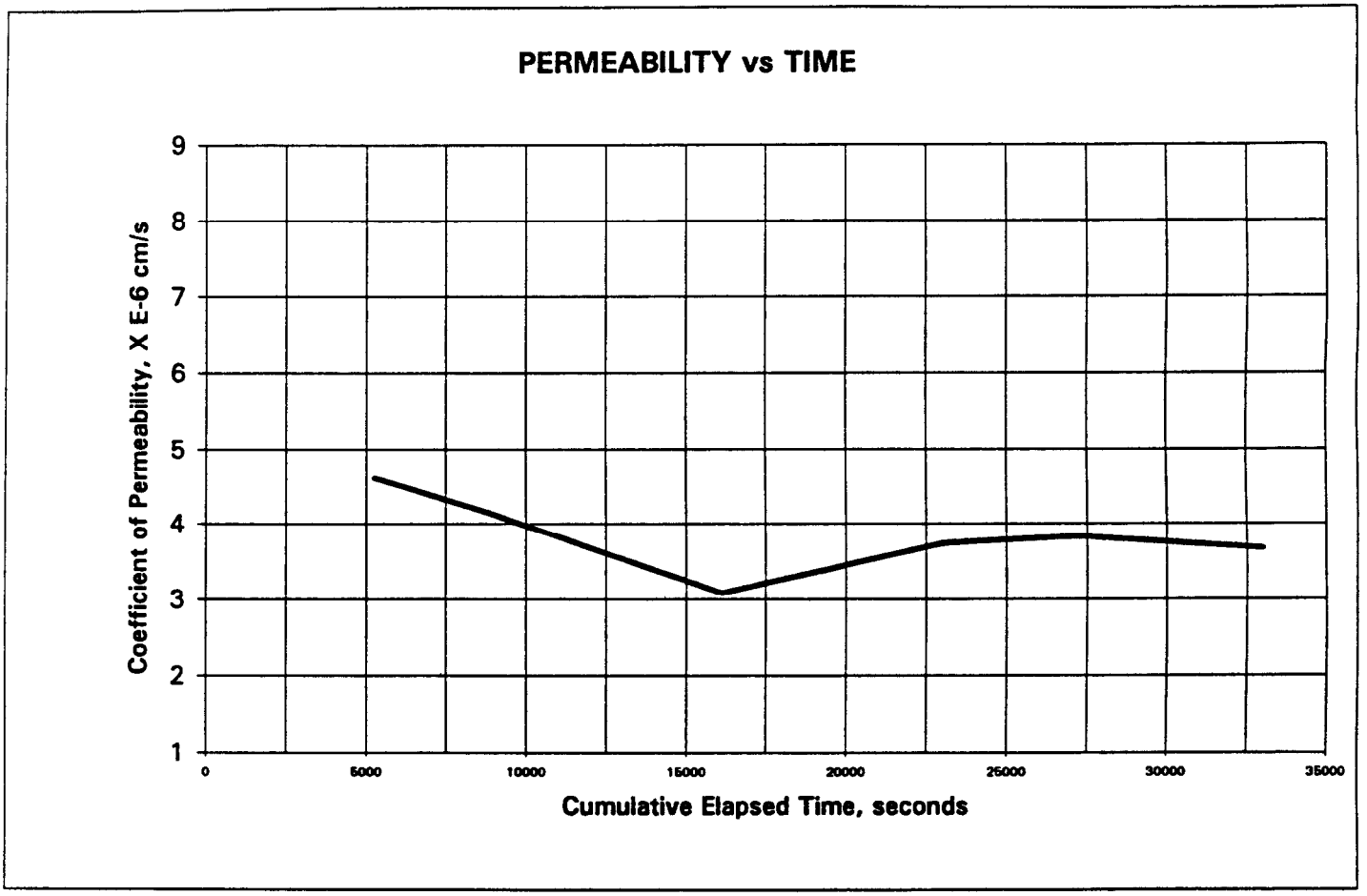
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K313G00
IT LAB SAMPLE NO. ETDC-7999

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	7.62	
Wet weight of specimen, g.	666.83	666.83
Specimen cross-sect. area, cm^2	45.3204	
Water content, %		26.0
Wet unit weight, pcf	120.5	
Dry unit weight, pcf		
Estimated degree of saturation, %		
Estimated spec. gravity of solids	2.6500	

Initial conditions are post-soak, pre-test

Hydraulic gradient	18.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Six tests performed	

Coefficient of Permeability, cm/s 3.6E-06



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

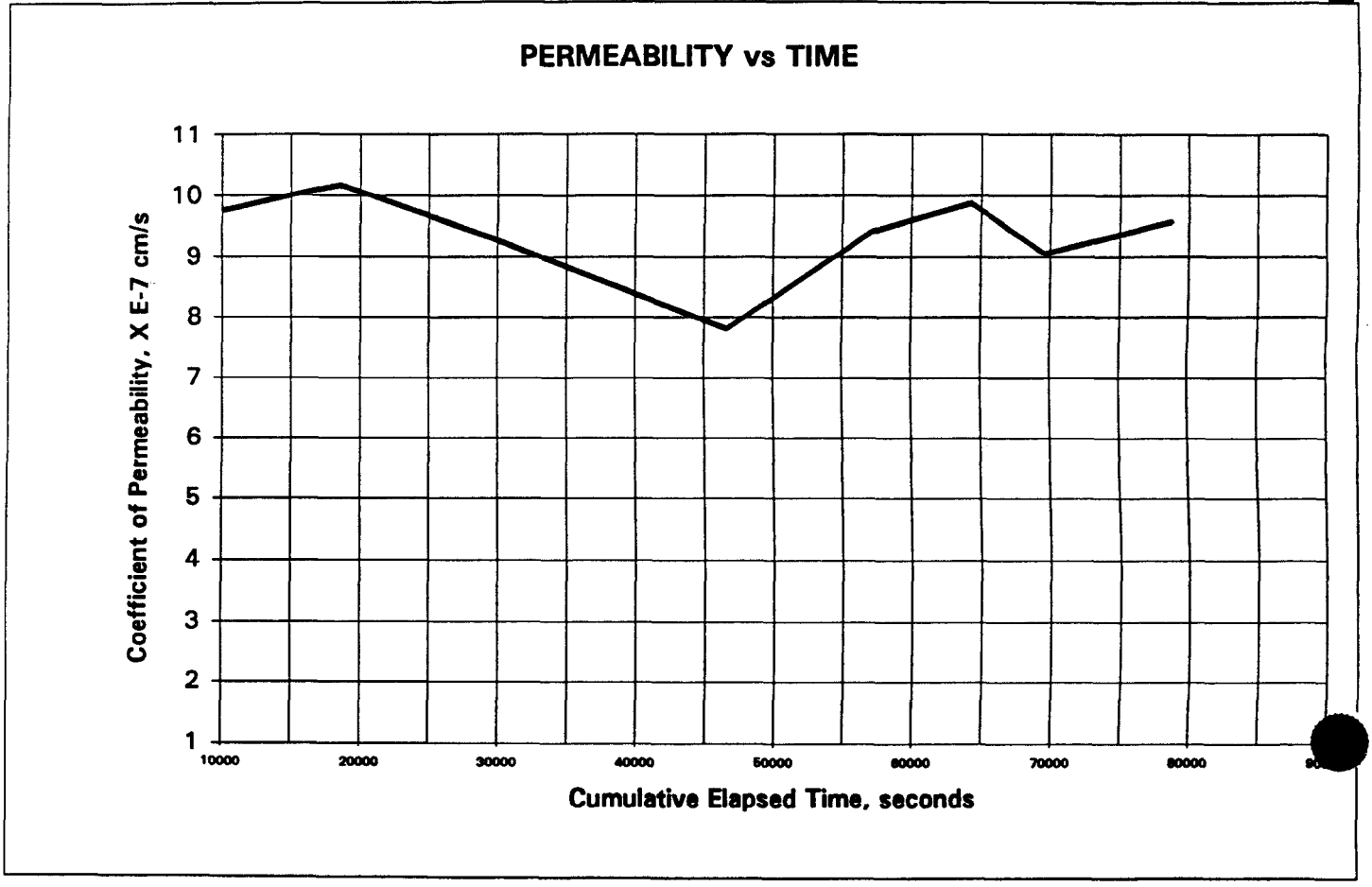
PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	K323G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8000

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	6.79	
Wet weight of specimen, g.	587.98	590.36
Specimen cross-sect. area, cm^2	45.2295	
Water content, %	23.9	24.4
Wet unit weight, pcf	119.5	
Dry unit weight, pcf	96.4	
Estimated degree of saturation, %	88.6	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	31.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Eight tests performed	

Coefficient of Permeability, cm/s	9.0E-07



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

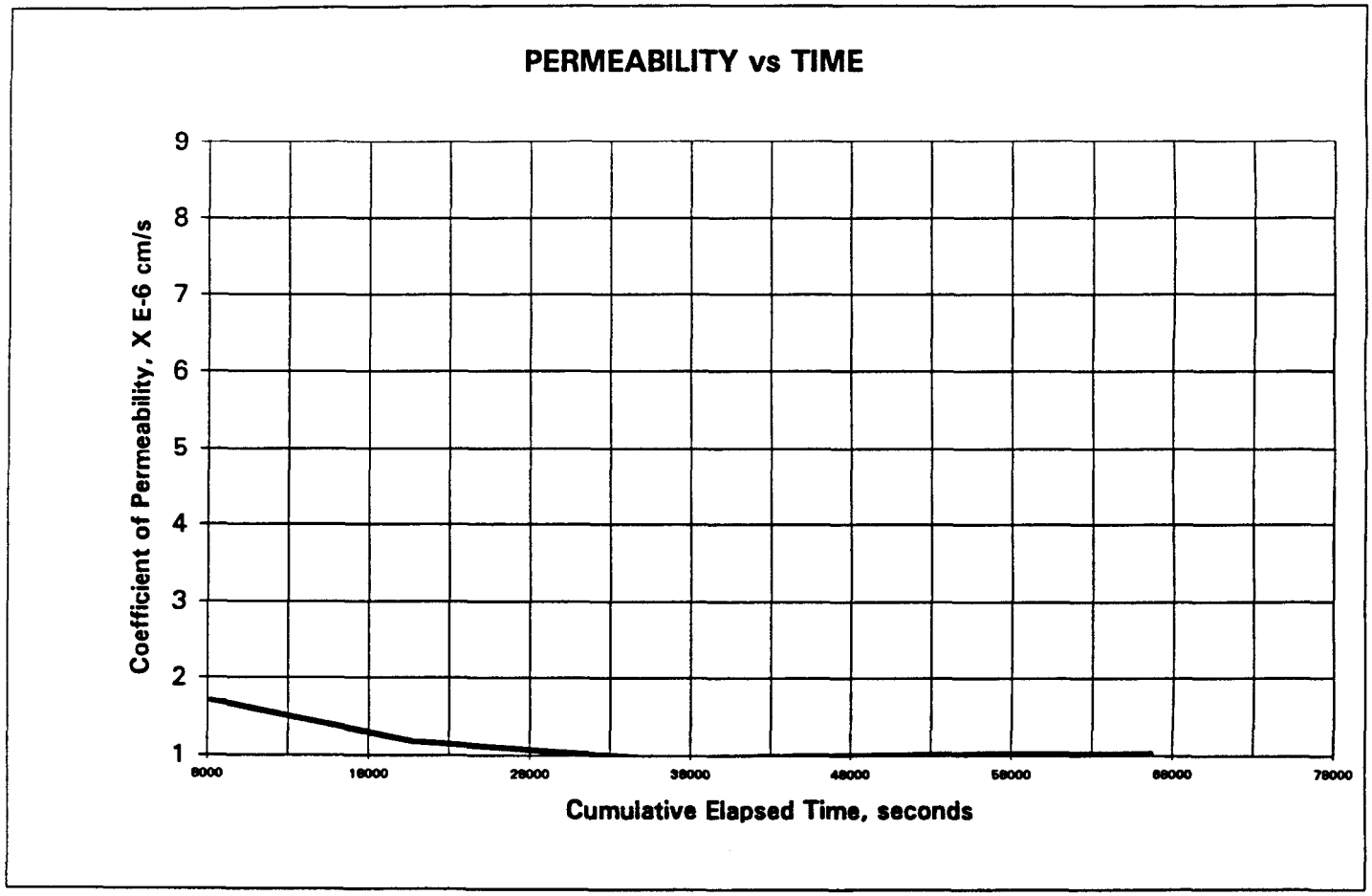
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K333G00
IT LAB SAMPLE NO. ETDC-8001

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	9.06	
Wet weight of specimen, g.	763.78	765.03
Specimen cross-sect. area, cm^2	45.3153	
Water content, %	31.5	31.7
Wet unit weight, pcf	116.1	
Dry unit weight, pcf	88.3	
Estimated degree of saturation, %	95.5	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	15.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Five tests performed	

Coefficient of Permeability, cm/s 1.0E-06



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

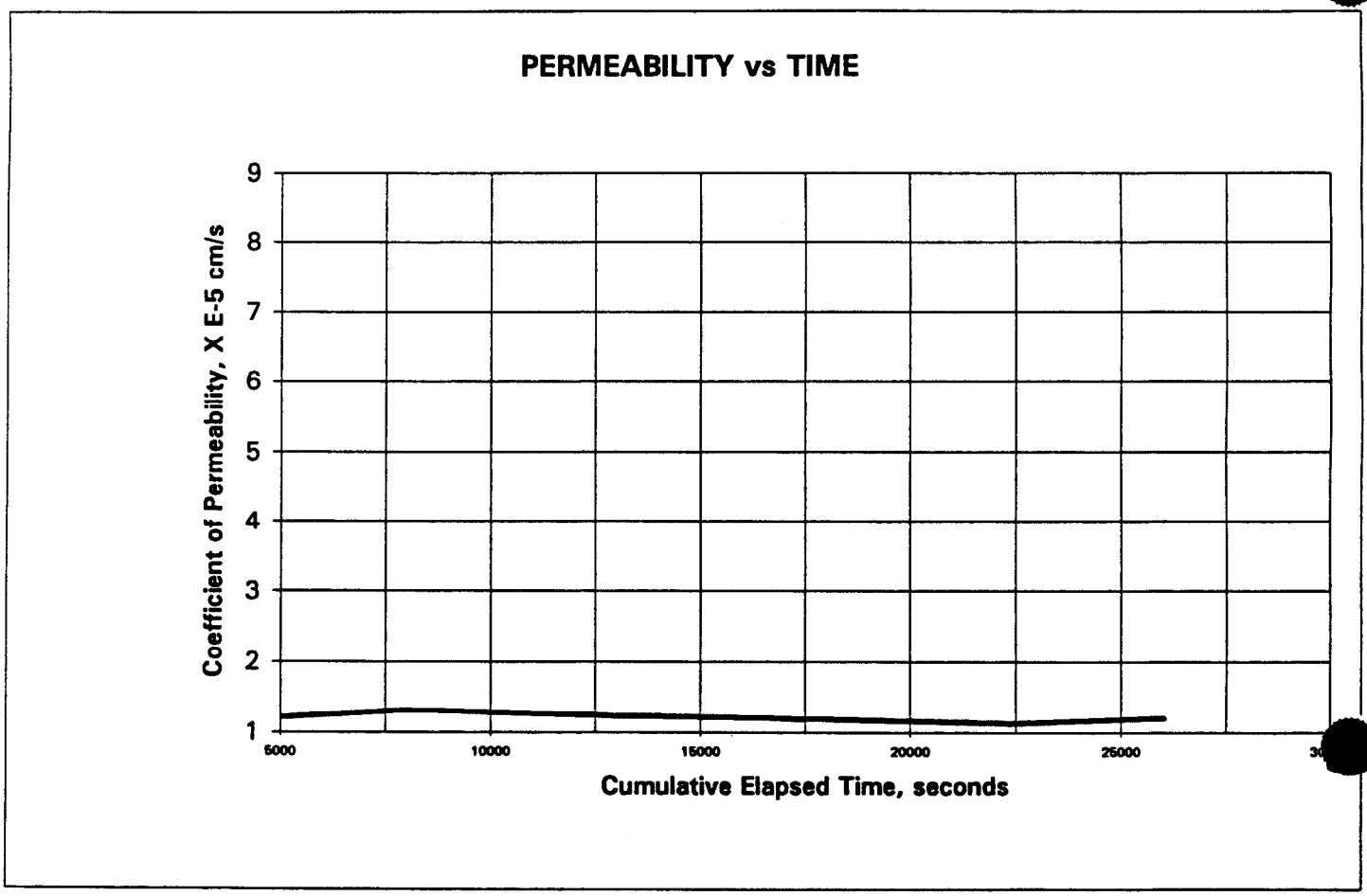
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K343G00
IT LAB SAMPLE NO. ETDC-8002

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	9.28	
Wet weight of specimen, g.	781	784.46
Specimen cross-sect. area, cm^2	45.1841	
Water content, %	27.0	27.6
Wet unit weight, pcf	116.2	
Dry unit weight, pcf	91.5	
Estimated degree of saturation, %	88.6	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	7.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Six tests performed	

Coefficient of Permeability, cm/s 1.2E-05



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

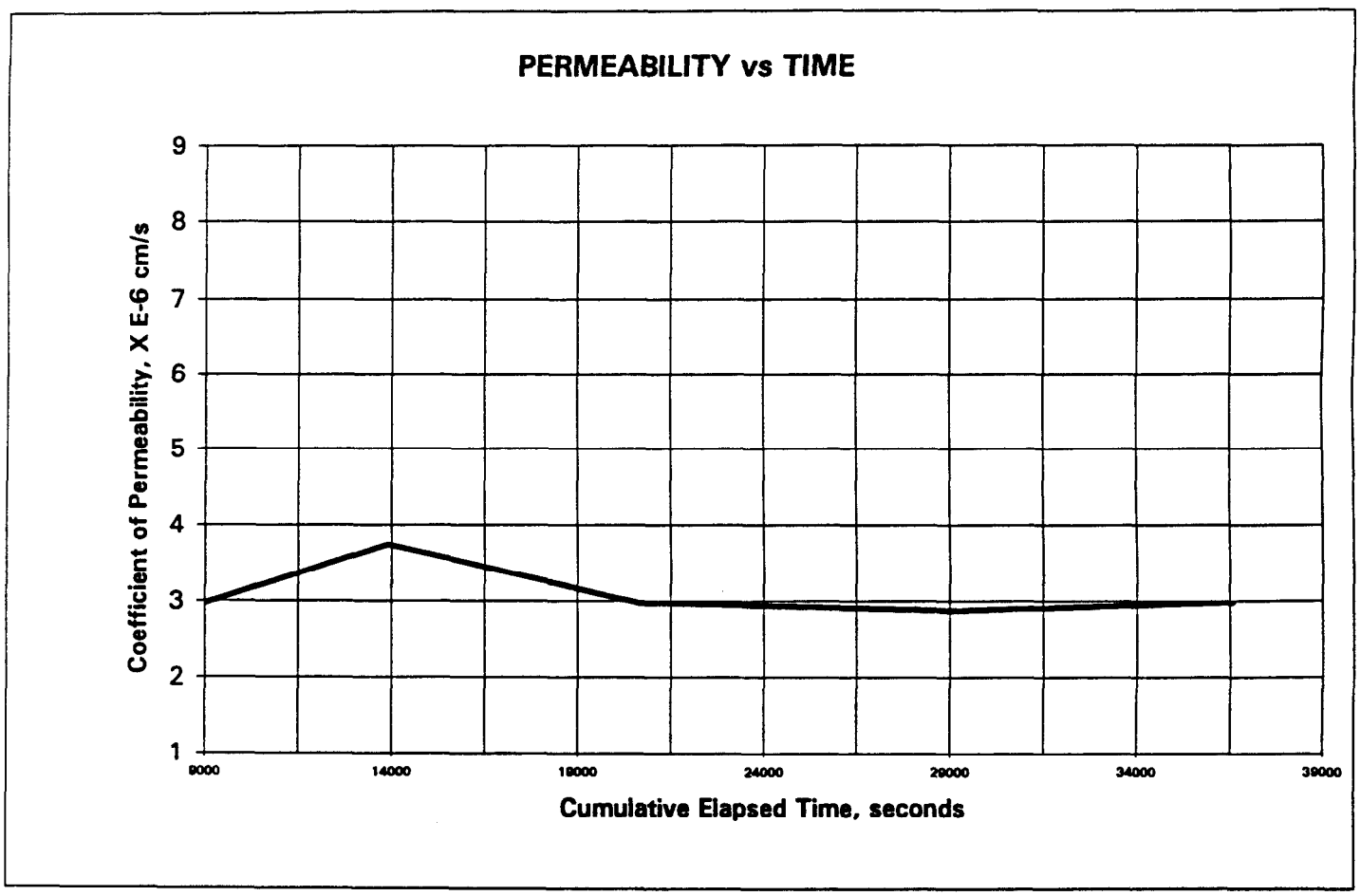
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K413G00
IT LAB SAMPLE NO. ETDC-8003

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	8.40	
Wet weight of specimen, g.	700.9	702.59
Specimen cross-sect. area, cm^2	45.2749	
Water content, %	33.4	33.7
Wet unit weight, pcf	115.1	
Dry unit weight, pcf	86.3	
Estimated degree of saturation, %	96.5	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	16.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Five tests performed	

Coefficient of Permeability, cm/s 3.1E-06



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

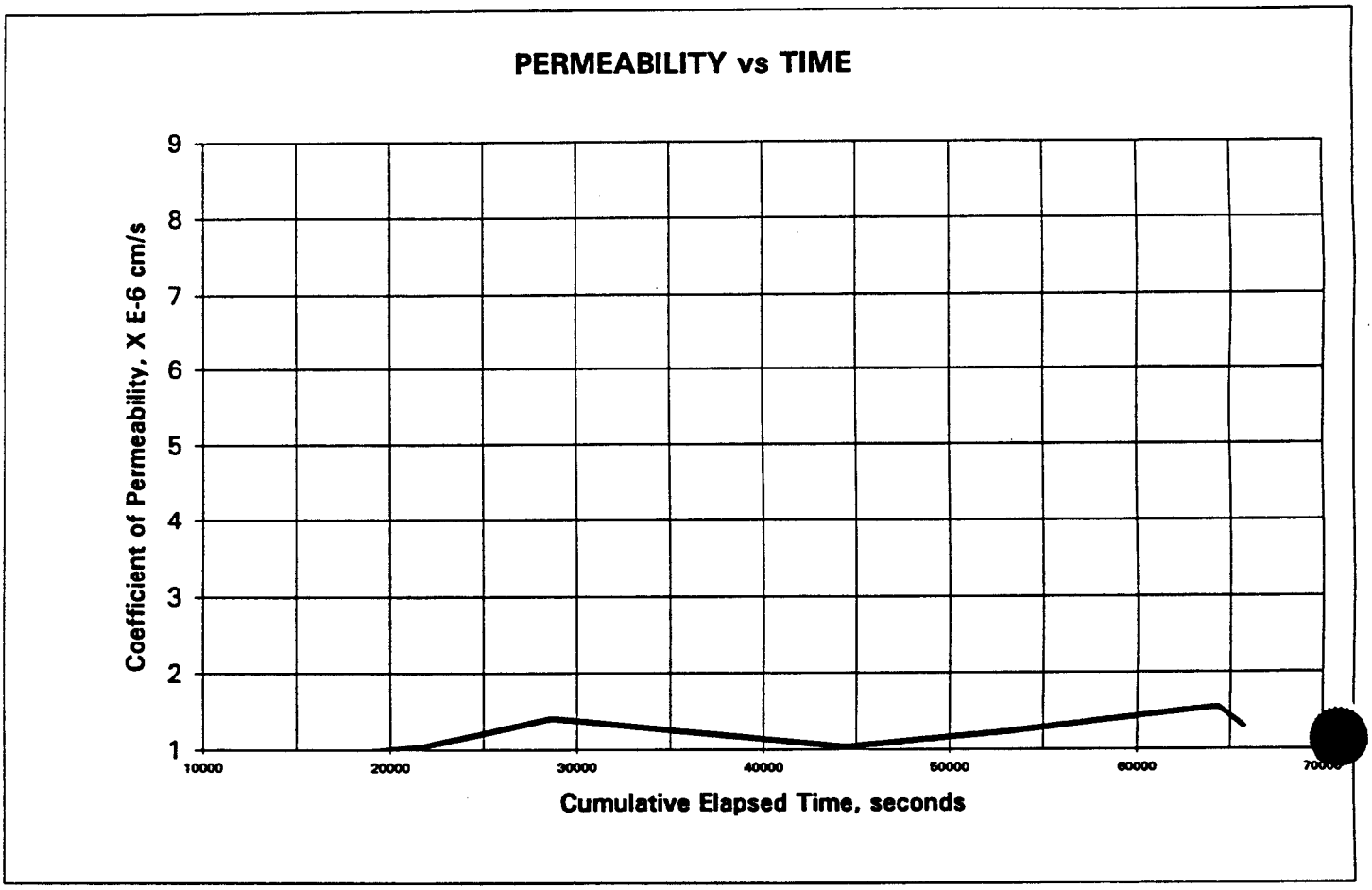
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K423G00
IT LAB SAMPLE NO. ETDC-8004

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	7.22	
Wet weight of specimen, g.	603.42	604.37
Specimen cross-sect. area, cm^2	45.3759	
Water content, %	29.8	30.0
Wet unit weight, pcf	115.0	
Dry unit weight, pcf	88.6	
Estimated degree of saturation, %	91.1	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	29.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Six tests performed	

Coefficient of Permeability, cm/s 1.3E-06



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

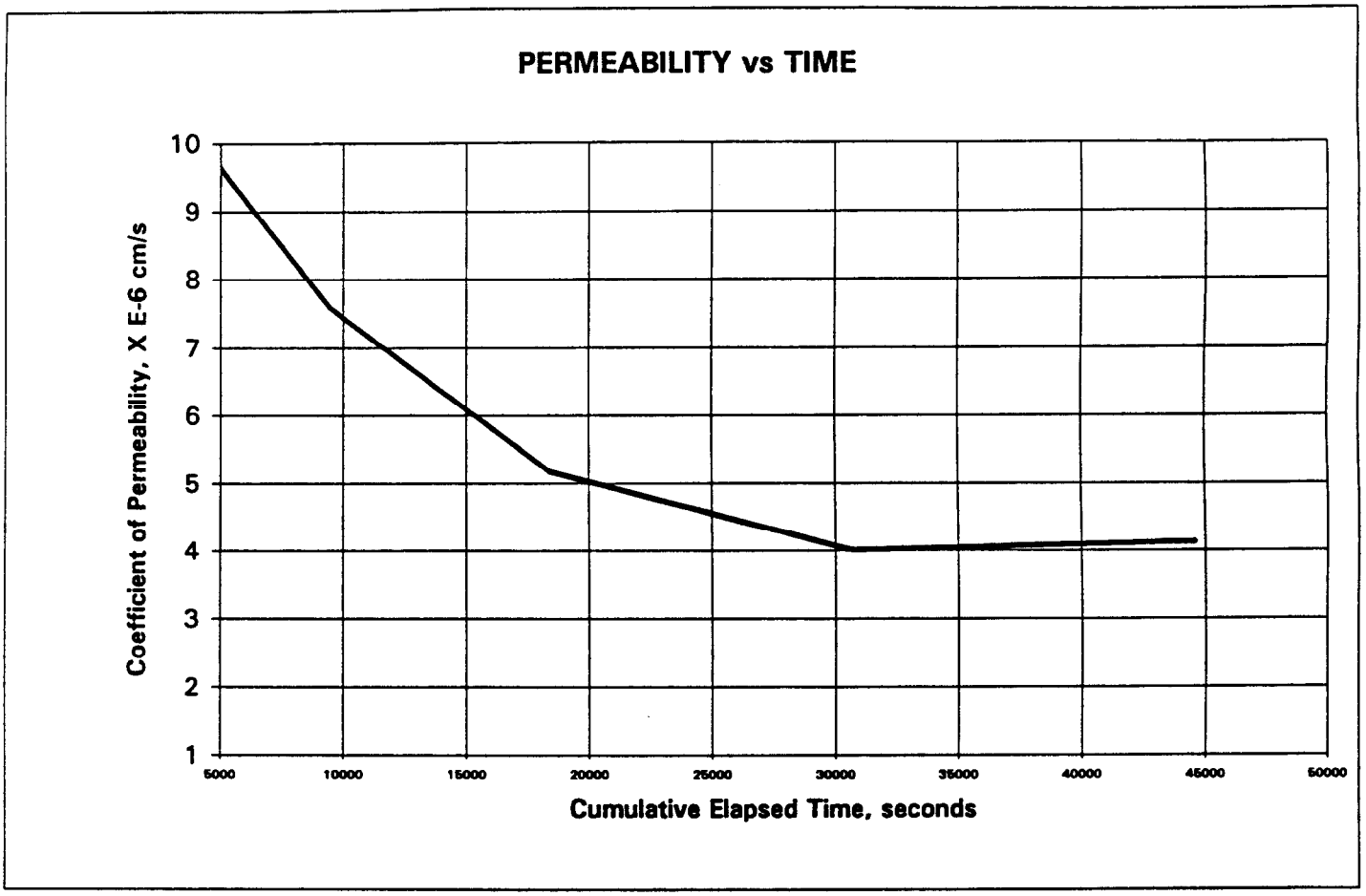
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K433G00
IT LAB SAMPLE NO. ETDC-8005

	INITIAL	FINAL
Specimen diameter, cm	7.63	
Specimen length, cm	10.47	
Wet weight of specimen, g.	846.82	849.01
Specimen cross-sect. area, cm^2	45.7558	
Water content, %	33.7	34.0
Wet unit weight, pcf	110.3	
Dry unit weight, pcf	82.5	
Estimated degree of saturation, %	88.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	6.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Six tests performed	

Coefficient of Permeability, cm/s 4.2E-06



Paul Lear
IT Corporation
April 19, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

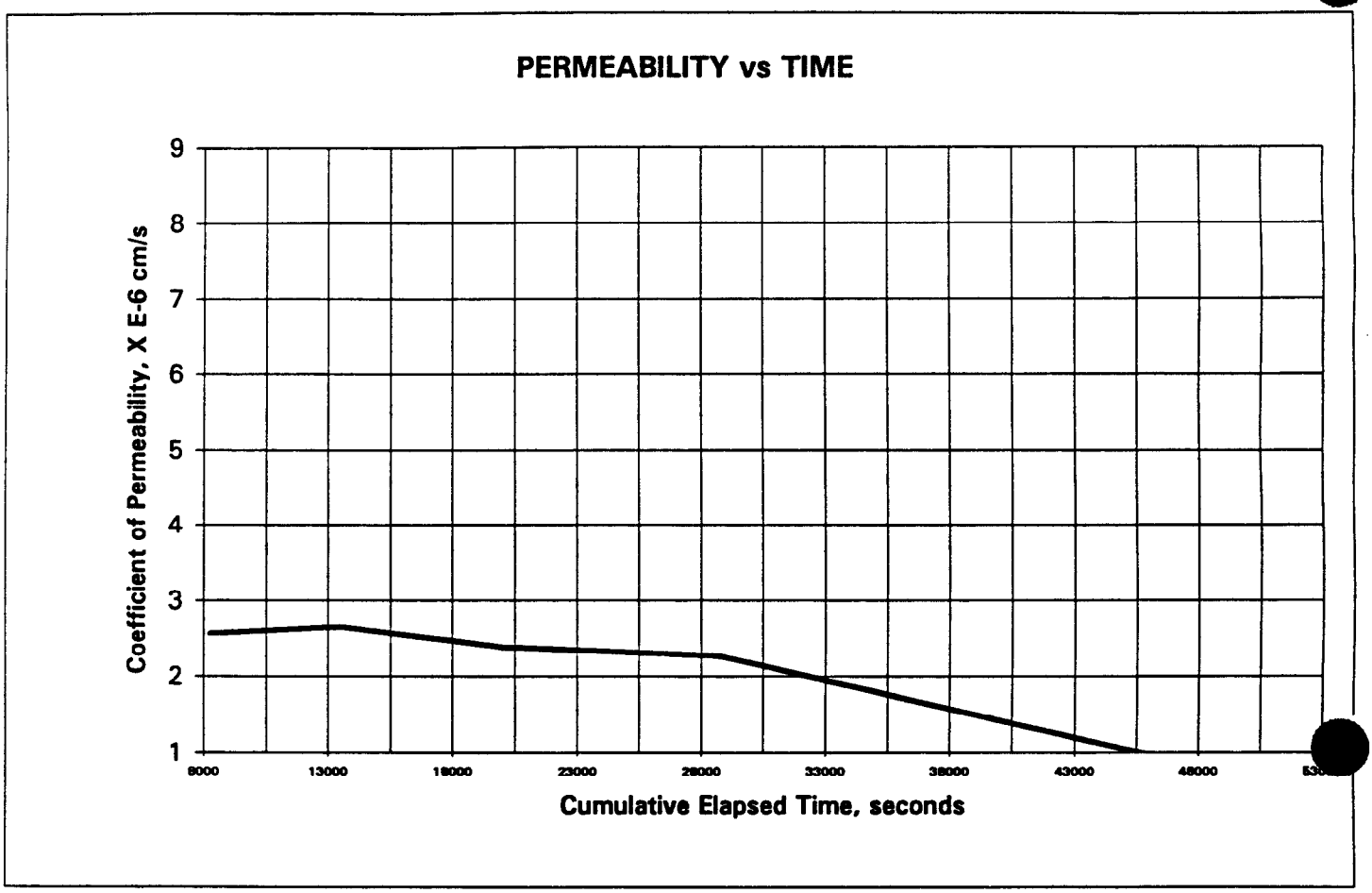
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. K443G00
IT LAB SAMPLE NO. ETDC-8006

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	10.54	
Wet weight of specimen, g.	853.04	855.42
Specimen cross-sect. area, cm^2	45.3507	
Water content, %	35.6	36.0
Wet unit weight, pcf	111.4	
Dry unit weight, pcf	82.1	
Estimated degree of saturation, %	93.1	
Estimated spec. gravity of solids	2.6500	

Initial conditions are post-soak, pre-test

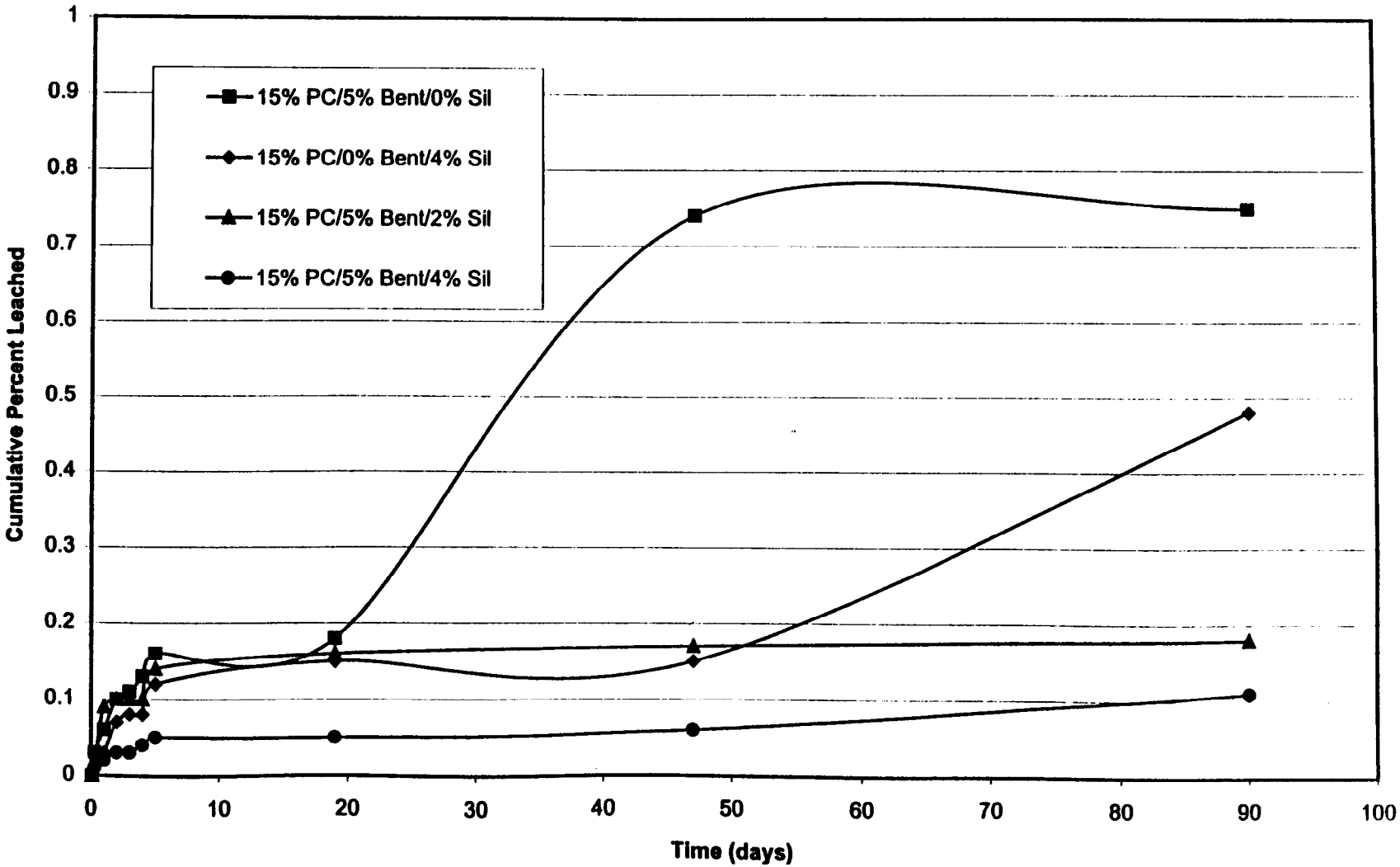
Hydraulic gradient	20.0
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	11/25/99
Sample set up	3/23/99
Five tests performed	

Coefficient of Permeability, cm/s 2.5E-06

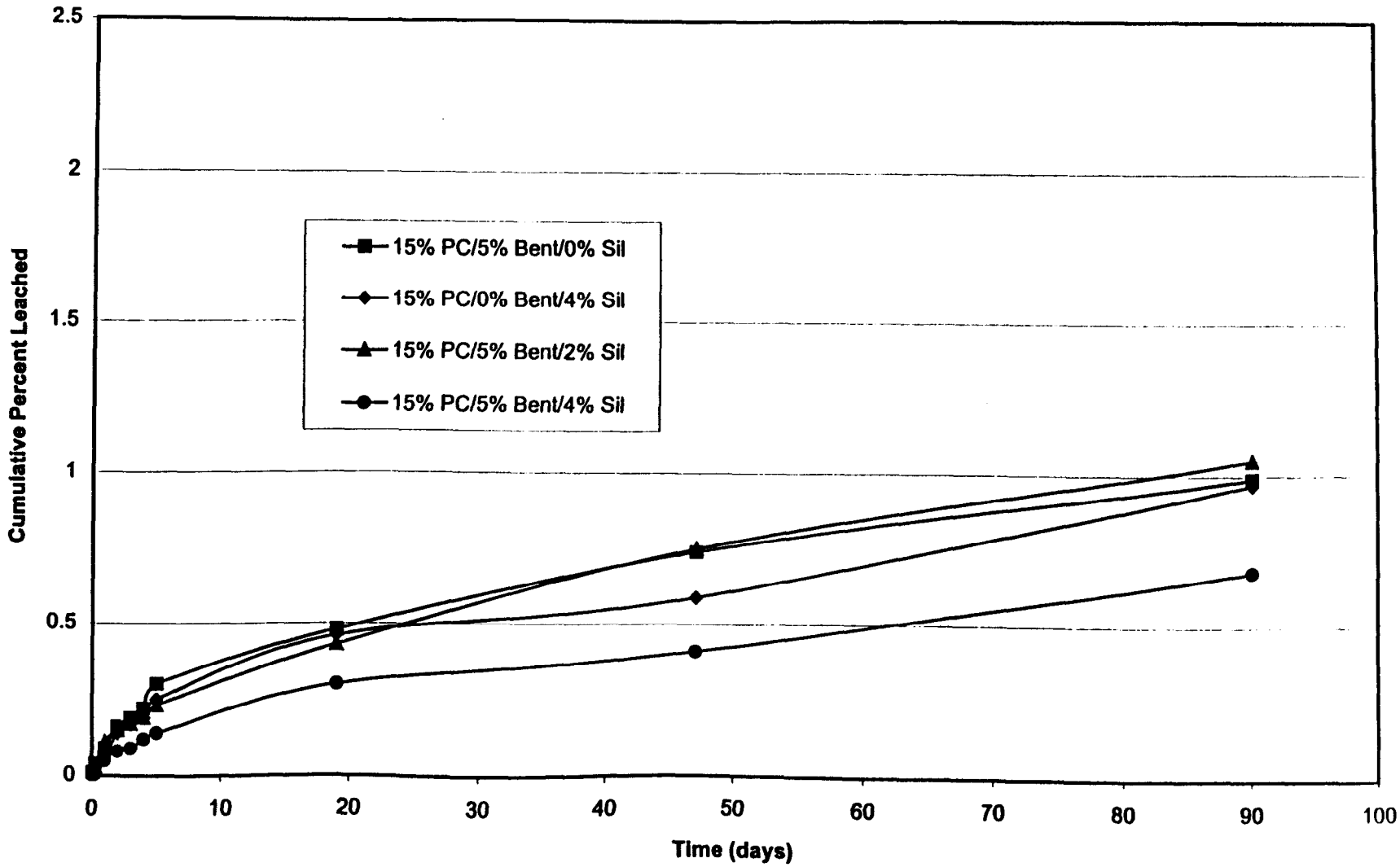


K Series
Leach Index

Gross Alpha Leaching for the Coarse Fraction from KRSB Soil



Gross Beta Leaching for the Coarse Fraction from the KSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K312

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	21.1	Sample Weight (g):	395.89
Initial Contaminant Level (pCi):	8353.279		
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	0.1	0.1800	0.000022	6.253E-14	13.20
7	18000	14835	1.38	2.4840	0.000297	1.570E-11	10.80
24	61200	51231	1.19	2.1420	0.000256	3.488E-12	11.46
48	86400	125894	2.02	3.6360	0.000435	1.239E-11	10.91
72	86400	213818	0.408	0.7344	0.000088	8.587E-13	12.07
96	86400	300849	1	1.8000	0.000215	7.258E-12	11.14
120	86400	387596	1.34	2.4120	0.000289	1.679E-11	10.77
456	1209600	939462	0.898	1.6164	0.000194	9.325E-14	13.03
1128	2419200	2716550	25.9	46.6200	0.005581	5.608E-11	10.25
2160	3715200	5768861	0.665	1.1970	0.000143	3.329E-14	13.48

Average Leach Index: 11.71

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K312

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	704	Sample Weight (g):	395.89
Initial Contaminant Level (pCi):	278706.56		
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	18.8	33.8400	0.000121	1.985E-12	11.70
7	18000	14835	38.7	69.6600	0.000250	1.109E-11	10.95
24	61200	51231	83.1	149.5800	0.000537	1.528E-11	10.82
48	86400	125894	112	201.6000	0.000723	3.422E-11	10.47
72	86400	213818	38.4	69.1200	0.000248	6.833E-12	11.17
96	86400	300849	45.4	81.7200	0.000293	1.344E-11	10.87
120	86400	387596	130	234.0000	0.000840	1.420E-10	9.85
456	1209600	939462	274	493.2000	0.001770	7.799E-12	11.11
1128	2419200	2716550	405	729.0000	0.002616	1.232E-11	10.91
2160	3715200	5768861	392	705.6000	0.002532	1.039E-11	10.98

Average Leach Index: 10.88

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K322

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	21.1	Sample Weight (g):	392.15
Initial Contaminant Level (pCi):	8274.365		
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	0.1	0.1800	0.000022	6.373E-14	13.20
7	18000	14835	0.382	0.6876	0.000083	1.226E-12	11.91
24	61200	51231	0.948	1.7064	0.000206	2.256E-12	11.65
48	86400	125894	1.81	3.2580	0.000394	1.014E-11	10.99
72	86400	213818	0.262	0.4716	0.000057	3.609E-13	12.44
96	86400	300849	0.212	0.3816	0.000046	3.325E-13	12.48
120	86400	387596	1.84	3.3120	0.000400	3.226E-11	10.49
456	1209600	939462	1.35	2.4300	0.000294	2.148E-13	12.67
1128	2419200	2716550	0.238	0.4284	0.000052	4.826E-15	14.32
2160	3715200	5768861	15	27.0000	0.003263	1.726E-11	10.76

Average Leach Index: 12.09

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K322

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	704	Sample Weight (g):	392.15
Initial Contaminant Level (pCi):	276073.6		
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	30.4200	0.000110	1.635E-12	11.79
7	18000	14835	23.1	41.5800	0.000151	4.028E-12	11.39
24	61200	51231	55	99.0000	0.000359	6.822E-12	11.17
48	86400	125894	124	223.2000	0.000808	4.275E-11	10.37
72	86400	213818	37.6	67.6800	0.000245	6.677E-12	11.18
96	86400	300849	33.5	60.3000	0.000218	7.457E-12	11.13
120	86400	387596	86.2	155.1600	0.000562	6.361E-11	10.20
456	1209600	939462	332	597.6000	0.002165	1.167E-11	10.93
1128	2419200	2716550	199	358.2000	0.001297	3.031E-12	11.52
2160	3715200	5768861	575	1035.0000	0.003749	2.278E-11	10.64

Average Leach Index: 11.03

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K332

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	21.1	Sample Weight (g):	382.58
Initial Contaminant Level (pCi):	8072.438		
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	0.1	0.1800	0.000022	6.696E-14	13.17
7	18000	14835	0.962	1.7316	0.000215	8.171E-12	11.09
24	61200	51231	3.05	5.4900	0.000680	2.454E-11	10.61
48	86400	125894	0.175	0.3150	0.000039	9.960E-14	13.00
72	86400	213818	0.1	0.1800	0.000022	5.524E-14	13.26
96	86400	300849	0.1	0.1800	0.000022	7.772E-14	13.11
120	86400	387596	1.69	3.0420	0.000377	2.860E-11	10.54
456	1209600	939462	0.832	1.4976	0.000186	8.571E-14	13.07
1128	2419200	2716550	0.52	0.9360	0.000116	2.420E-14	13.62
2160	3715200	5768861	0.341	0.6138	0.000076	9.372E-15	14.03

Average Leach Index: 12.55

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K332

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 704

Sample Weight (g): 382.58

Initial Contaminant Level (pCi): 269336.32

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	10.1	18.1800	0.000067	6.136E-13	12.21
7	18000	14835	40.9	73.6200	0.000273	1.327E-11	10.88
24	61200	51231	116	208.8000	0.000775	3.188E-11	10.50
48	86400	125894	61.1	109.9800	0.000408	1.091E-11	10.96
72	86400	213818	30.5	54.9000	0.000204	4.616E-12	11.34
96	86400	300849	25.2	45.3600	0.000168	4.433E-12	11.35
120	86400	387596	61	109.8000	0.000408	3.347E-11	10.48
456	1209600	939462	292	525.6000	0.001951	9.484E-12	11.02
1128	2419200	2716550	483	869.4000	0.003228	1.876E-11	10.73
2160	3715200	5768861	446	802.8000	0.002981	1.440E-11	10.84

Average Leach Index: 11.03

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K342

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	21.1	Sample Weight (g):	383.07
Initial Contaminant Level (pCi):	8082.777		
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	0.1	0.1800	0.000022	6.679E-14	13.18
7	18000	14835	0.254	0.4572	0.000057	5.682E-13	12.25
24	61200	51231	0.572	1.0296	0.000127	8.608E-13	12.07
48	86400	125894	0.393	0.7074	0.000088	5.010E-13	12.30
72	86400	213818	0.161	0.2898	0.000036	1.428E-13	12.85
96	86400	300849	0.1	0.1800	0.000022	7.752E-14	13.11
120	86400	387596	0.546	0.9828	0.000122	2.977E-12	11.53
456	1209600	939462	0.1	0.1800	0.000022	1.235E-15	14.91
1128	2419200	2716550	0.372	0.6696	0.000083	1.236E-14	13.91
2160	3715200	5768861	2.12	3.8160	0.000472	3.613E-13	12.44

Average Leach Index: 12.85

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K342

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 704

Sample Weight (g): 383.07

Initial Contaminant Level (pCi): 269681.28

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

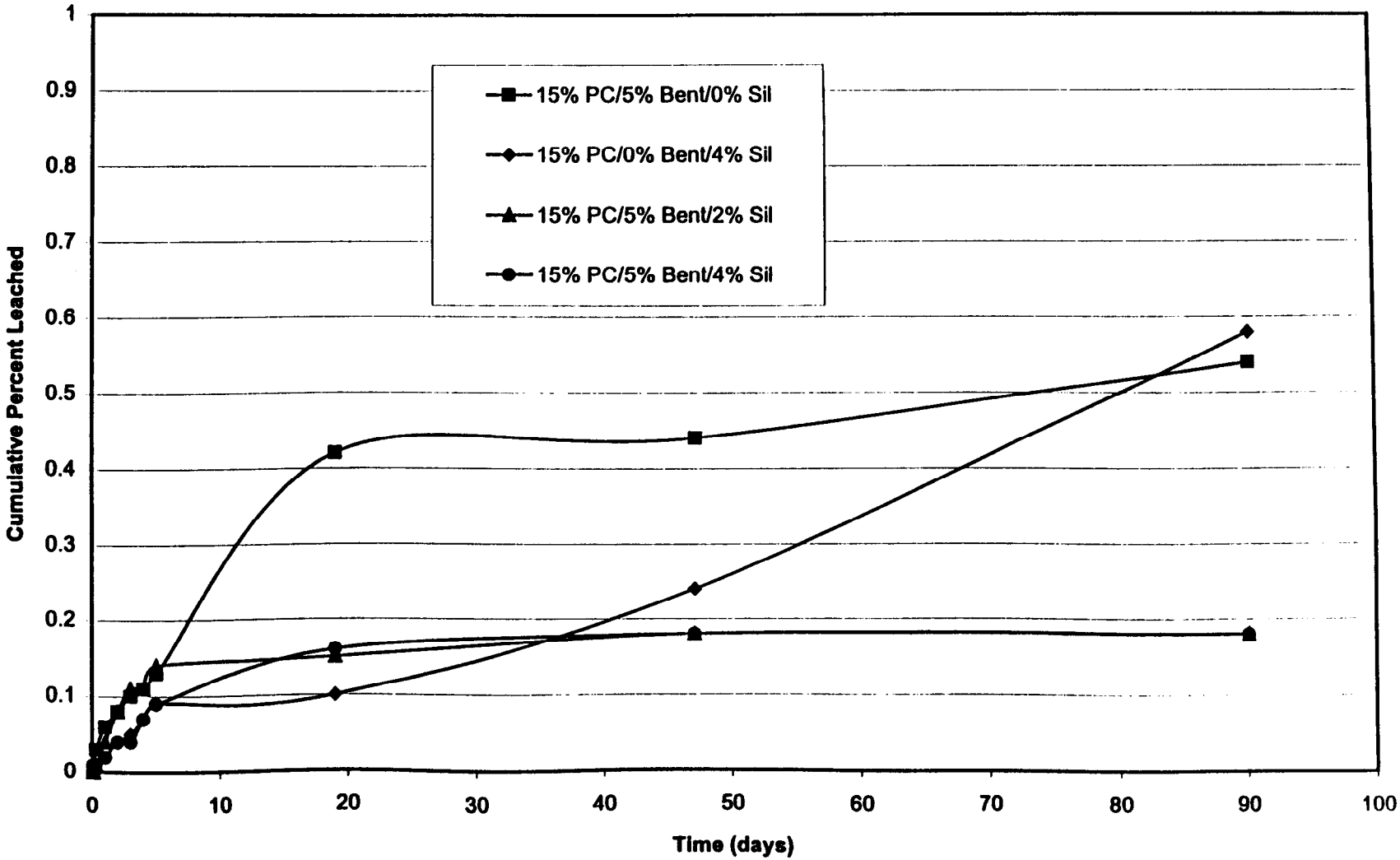
Leachate Volume (mL): 1800

Monolith Volume (cm^3): 196.35

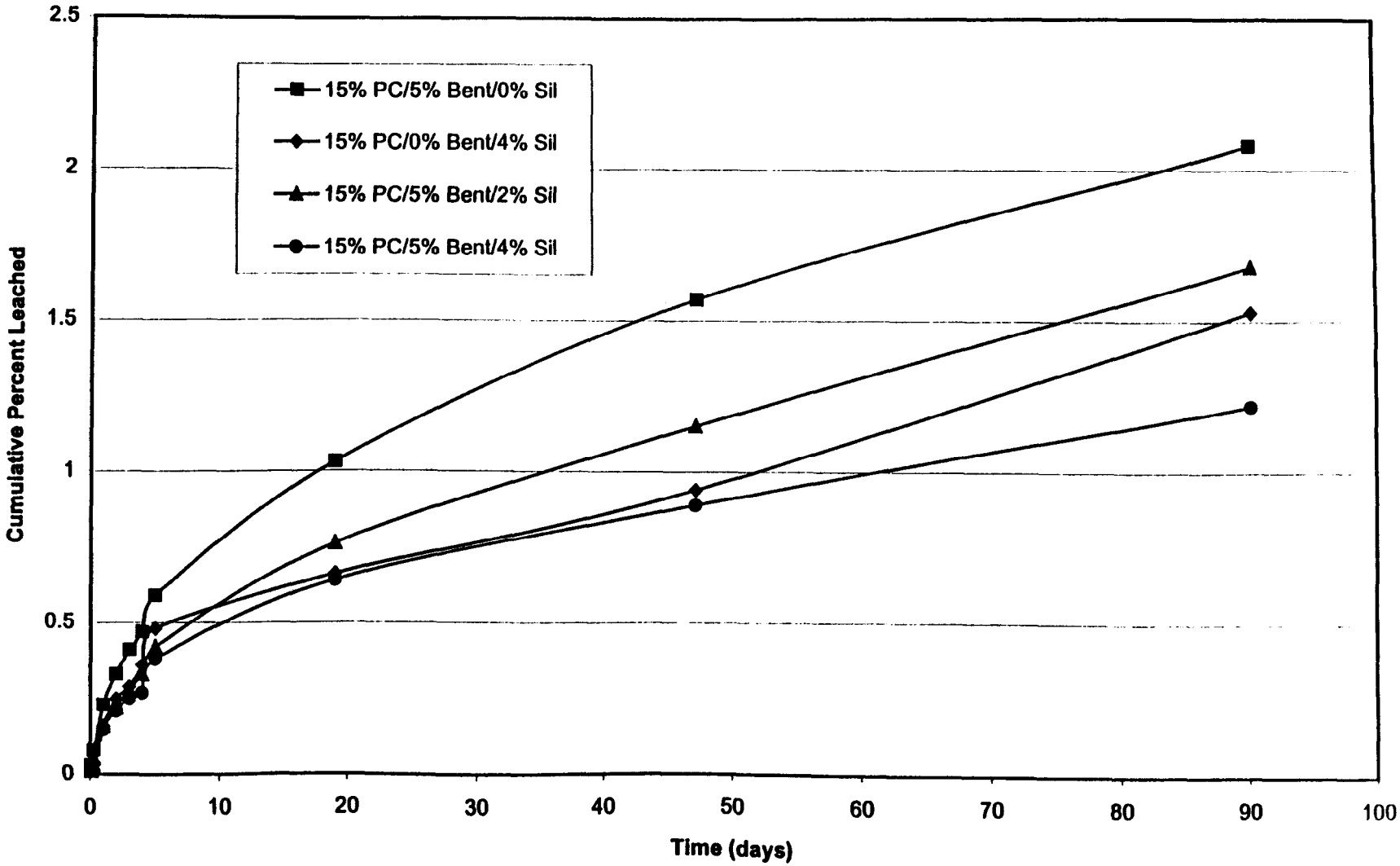
Time (hrs)	Interval Length (s)	Mean Time (s)	Leachate Conc. (pCi/L)	Amount Leached (pCi)	Fraction Leached	Diffusivity Coefficient (cm^2/s)	Leach Index
2	7200	1800	6.17	11.1060	0.000041	2.284E-13	12.64
7	18000	14835	8.8	15.8400	0.000059	6.127E-13	12.21
24	61200	51231	59.1	106.3800	0.000394	8.255E-12	11.08
48	86400	125894	45.8	82.4400	0.000306	6.112E-12	11.21
72	86400	213818	21.2	38.1600	0.000142	2.224E-12	11.65
96	86400	300849	38.8	69.8400	0.000259	1.048E-11	10.98
120	86400	387596	23.4	42.1200	0.000156	4.912E-12	11.31
456	1209600	939462	245	441.0000	0.001635	6.659E-12	11.18
1128	2419200	2716550	165	297.0000	0.001101	2.183E-12	11.66
2160	3715200	5768861	412	741.6000	0.002750	1.226E-11	10.91

Average Leach Index: 11.48

Gross Alpha Leaching for the Fine Fraction from KRSB Soil



Gross Beta Leaching for the Fine Fraction from the KSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K412

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	12.9	Sample Weight (g):	376.13
Initial Contaminant Level (pCi):	4852.077		
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	0.1	0.1800	0.000037	1.853E-13	12.73
7	18000	14835	0.596	1.0728	0.000221	8.681E-12	11.06
24	61200	51231	1.02	1.8360	0.000378	7.596E-12	11.12
48	86400	125894	0.341	0.6138	0.000127	1.047E-12	11.98
72	86400	213818	0.532	0.9576	0.000197	4.327E-12	11.36
96	86400	300849	0.476	0.8568	0.000177	4.874E-12	11.31
120	86400	387596	0.501	0.9018	0.000186	6.956E-12	11.16
456	1209600	939462	7.74	13.9320	0.002871	2.053E-11	10.69
1128	2419200	2716550	0.576	1.0368	0.000214	8.220E-14	13.09
2160	3715200	5768861	2.59	4.6620	0.000961	1.497E-12	11.82

Average Leach Index: 11.63

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K412

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 293

Sample Weight (g): 376.13

Initial Contaminant Level (pCi): 110206.09

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	16.2	29.1600	0.000265	9.428E-12	11.03
7	18000	14835	30	54.0000	0.000490	4.264E-11	10.37
24	61200	51231	92.2	165.9600	0.001506	1.203E-10	9.92
48	86400	125894	66.7	120.0600	0.001089	7.763E-11	10.11
72	86400	213818	43.2	77.7600	0.000706	5.531E-11	10.26
96	86400	300849	42.3	76.1400	0.000691	7.461E-11	10.13
120	86400	387596	67.7	121.8600	0.001106	2.462E-10	9.61
456	1209600	939462	272	489.6000	0.004443	4.915E-11	10.31
1128	2419200	2716550	330	594.0000	0.005390	5.230E-11	10.28
2160	3715200	5768861	308	554.4000	0.005031	4.102E-11	10.39

Average Leach Index: 10.24

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K422

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	12.9	Sample Weight (g):	386.11
Initial Contaminant Level (pCi):	4980.819		
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	0.26	0.4680	0.000094	1.189E-12	11.92
7	18000	14835	0.1	0.1800	0.000036	2.319E-13	12.63
24	61200	51231	0.1	0.1800	0.000036	6.928E-14	13.16
48	86400	125894	0.739	1.3302	0.000267	4.665E-12	11.33
72	86400	213818	0.2	0.3600	0.000072	5.803E-13	12.24
96	86400	300849	0.46	0.8280	0.000166	4.320E-12	11.36
120	86400	387596	0.501	0.9018	0.000181	6.601E-12	11.18
456	1209600	939462	0.277	0.4986	0.000100	2.496E-14	13.60
1128	2419200	2716550	4.05	7.2900	0.001464	3.857E-12	11.41
2160	3715200	5768861	9.31	16.7580	0.003365	1.835E-11	10.74

Average Leach Index: 11.96

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K422

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	293	Sample Weight (g):	386.11
Initial Contaminant Level (pCi):	113130.23		
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	10.1	18.1800	0.000161	3.478E-12	11.46
7	18000	14835	14.1	25.3800	0.000224	8.938E-12	11.05
24	61200	51231	79.1	142.3800	0.001259	8.403E-11	10.08
48	86400	125894	54.6	98.2800	0.000869	4.936E-11	10.31
72	86400	213818	27.5	49.5000	0.000438	2.127E-11	10.67
96	86400	300849	38.2	68.7600	0.000608	5.774E-11	10.24
120	86400	387596	78.6	141.4800	0.001251	3.150E-10	9.50
456	1209600	939462	112	201.6000	0.001782	7.908E-12	11.10
1128	2419200	2716550	179	322.2000	0.002848	1.460E-11	10.84
2160	3715200	5768861	368	662.4000	0.005855	5.557E-11	10.26

Average Leach Index: 10.55

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K432

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	12.9	Sample Weight (g):	366.14
Initial Contaminant Level (pCi):	4723.206		
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	0.1	0.1800	0.000038	1.956E-13	12.71
7	18000	14835	0.1	0.1800	0.000038	2.579E-13	12.59
24	61200	51231	0.783	1.4094	0.000298	4.724E-12	11.33
48	86400	125894	1.18	2.1240	0.000450	1.323E-11	10.88
72	86400	213818	0.624	1.1232	0.000238	6.282E-12	11.20
96	86400	300849	0.1	0.1800	0.000038	2.270E-13	12.64
120	86400	387596	0.712	1.2816	0.000271	1.483E-11	10.83
456	1209600	939462	0.386	0.6948	0.000147	5.389E-14	13.27
1128	2419200	2716550	0.701	1.2618	0.000267	1.285E-13	12.89
2160	3715200	5768861	0.1	0.1800	0.000038	2.354E-15	14.63

Average Leach Index: 12.30

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K432

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	293	Sample Weight (g):	366.14
Initial Contaminant Level (pCi):	107279.02		
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	6.85	12.3300	0.000115	1.779E-12	11.75
7	18000	14835	24.1	43.3800	0.000404	2.904E-11	10.54
24	61200	51231	66.6	119.8800	0.001117	6.625E-11	10.18
48	86400	125894	31.4	56.5200	0.000527	1.816E-11	10.74
72	86400	213818	38.2	68.7600	0.000641	4.564E-11	10.34
96	86400	300849	27.4	49.3200	0.000460	3.304E-11	10.48
120	86400	387596	56	100.8000	0.000940	1.778E-10	9.75
456	1209600	939462	201	361.8000	0.003373	2.832E-11	10.55
1128	2419200	2716550	234	421.2000	0.003926	2.775E-11	10.56
2160	3715200	5768861	317	570.6000	0.005319	4.586E-11	10.34

Average Leach Index: 10.52

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K442

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	12.9	Sample Weight (g):	371.24
Initial Contaminant Level (pCi):	4788.996		
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	0.205	0.3690	0.000077	7.995E-13	12.10
7	18000	14835	0.1	0.1800	0.000038	2.509E-13	12.60
24	61200	51231	0.1	0.1800	0.000038	7.495E-14	13.13
48	86400	125894	0.601	1.0818	0.000226	3.338E-12	11.48
72	86400	213818	0.145	0.2610	0.000054	3.300E-13	12.48
96	86400	300849	0.595	1.0710	0.000224	7.818E-12	11.11
120	86400	387596	0.637	1.1466	0.000239	1.154E-11	10.94
456	1209600	939462	1.86	3.3480	0.000699	1.217E-12	11.91
1128	2419200	2716550	0.468	0.8424	0.000176	5.570E-14	13.25
2160	3715200	5768861	0.1	0.1800	0.000038	2.290E-15	14.64

Average Leach Index: 12.36

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: K442

Analyst: PRL

Date: 15-Apr-99

Contaminant: Gross Beta

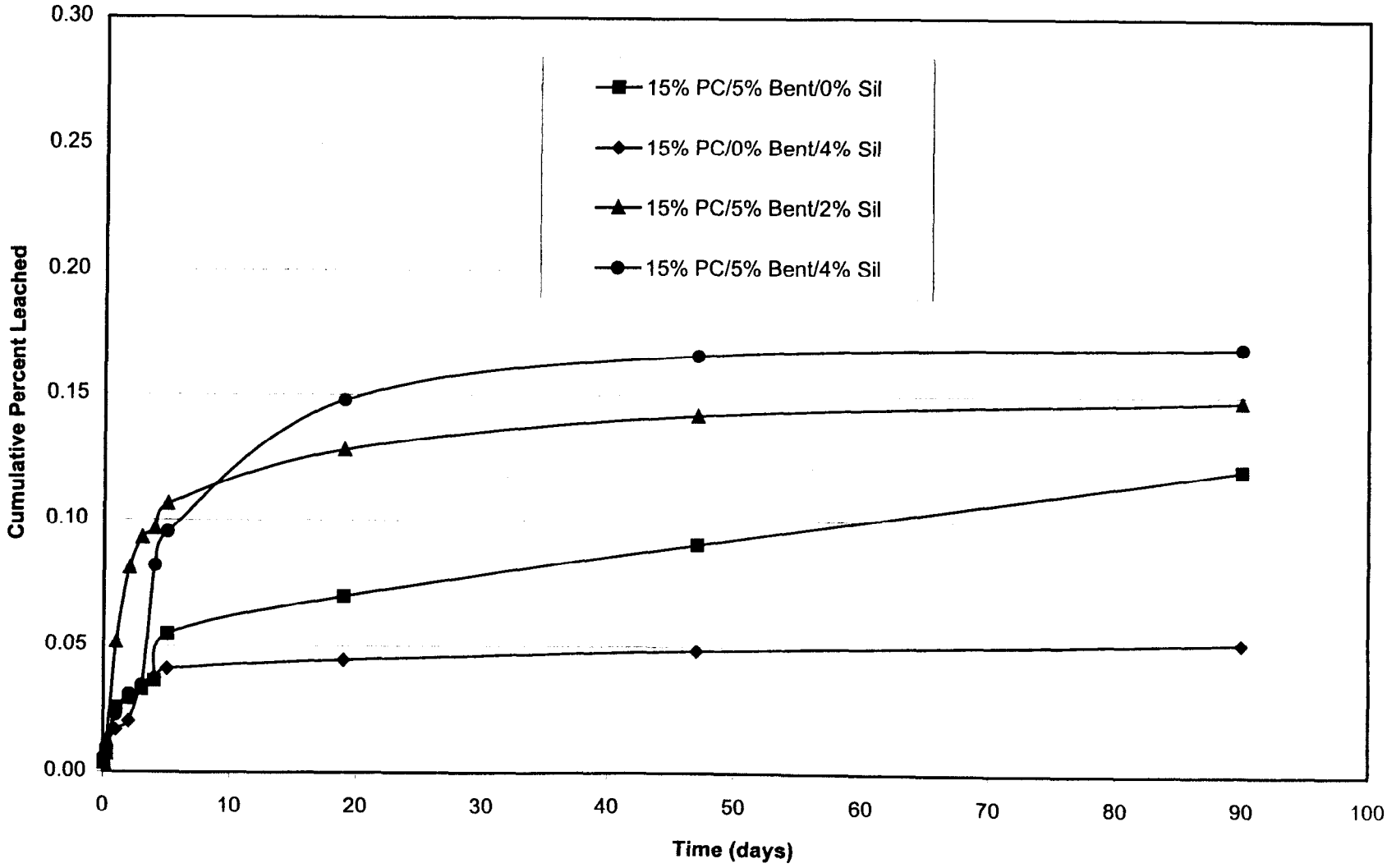
Initial Contaminant Conc. (pCi/g):	293	Sample Weight (g):	371.24
Initial Contaminant Level (pCi):	108773.32		
Monolith Height (cm):	10	Monolith Diameter (cm):	5
Monolith Surface Area (cm^2):	176.72	Leachate Volume (mL):	1800
Monolith Volume (cm^3):	196.35		

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	6.68	12.0240	0.000111	1.646E-12	11.78
7	18000	14835	0.218	0.3924	0.000004	2.311E-15	14.64
24	61200	51231	83	149.4000	0.001373	1.001E-10	10.00
48	86400	125894	37.1	66.7800	0.000614	2.465E-11	10.61
72	86400	213818	21.6	38.8800	0.000357	1.419E-11	10.85
96	86400	300849	14	25.2000	0.000232	8.390E-12	11.08
120	86400	387596	66.7	120.0600	0.001104	2.453E-10	9.61
456	1209600	939462	155	279.0000	0.002565	1.638E-11	10.79
1128	2419200	2716550	155	279.0000	0.002565	1.184E-11	10.93
2160	3715200	5768861	195	351.0000	0.003227	1.688E-11	10.77

Average Leach Index: 11.10

L Series
Leach Index

Gross Alpha Leaching for the Coarse Fraction from LRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L312

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.4	Sample Weight (g):	377.43
Initial Contaminant Level (pCi):	5057.562		
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	0.1	0.1800	0.000036	1.706E-13	12.77
7	18000	14835	0.1	0.1800	0.000036	2.249E-13	12.65
24	61200	51231	0.516	0.9288	0.000184	1.789E-12	11.75
48	86400	125894	0.1	0.1800	0.000036	8.285E-14	13.08
72	86400	213818	0.1	0.1800	0.000036	1.407E-13	12.85
96	86400	300849	0.1	0.1800	0.000036	1.980E-13	12.70
120	86400	387596	0.519	0.9342	0.000185	6.871E-12	11.16
456	1209600	939462	0.425	0.7650	0.000151	5.698E-14	13.24
1128	2419200	2716550	0.582	1.0476	0.000207	7.724E-14	13.11
2160	3715200	5768861	0.844	1.5192	0.000300	1.463E-13	12.83

Average Leach Index: 12.62

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L322

Analyst: PRL Date: 15-Apr-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.4	Sample Weight (g):	386.8
Initial Contaminant Level (pCi):	5183.12		
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	0.189	0.3402	0.000066	5.802E-13	12.24
7	18000	14835	0.1	0.1800	0.000035	2.142E-13	12.67
24	61200	51231	0.194	0.3492	0.000067	2.408E-13	12.62
48	86400	125894	0.1	0.1800	0.000035	7.889E-14	13.10
72	86400	213818	0.397	0.7146	0.000138	2.112E-12	11.68
96	86400	300849	0.1	0.1800	0.000035	1.885E-13	12.72
120	86400	387596	0.1	0.1800	0.000035	2.429E-13	12.61
456	1209600	939462	0.1	0.1800	0.000035	3.003E-15	14.52
1128	2419200	2716550	0.111	0.1998	0.000039	2.675E-15	14.57
2160	3715200	5768861	0.1	0.1800	0.000035	1.955E-15	14.71

Average Leach Index: 13.14

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L332

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.4	Sample Weight (g):	370
Initial Contaminant Level (pCi):	4958		
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	0.1	0.1800	0.000036	1.775E-13	12.75
7	18000	14835	0.242	0.4356	0.000088	1.371E-12	11.86
24	61200	51231	1.07	1.9260	0.000388	8.006E-12	11.10
48	86400	125894	0.812	1.4616	0.000295	5.684E-12	11.25
72	86400	213818	0.332	0.5976	0.000121	1.614E-12	11.79
96	86400	300849	0.1	0.1800	0.000036	2.060E-13	12.69
120	86400	387596	0.269	0.4842	0.000098	1.921E-12	11.72
456	1209600	939462	0.594	1.0692	0.000216	1.158E-13	12.94
1128	2419200	2716550	0.386	0.6948	0.000140	3.535E-14	13.45
2160	3715200	5768861	0.163	0.2934	0.000059	5.677E-15	14.25

Average Leach Index: 12.38

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L342

Analyst: PRL

Date: 25-May-99

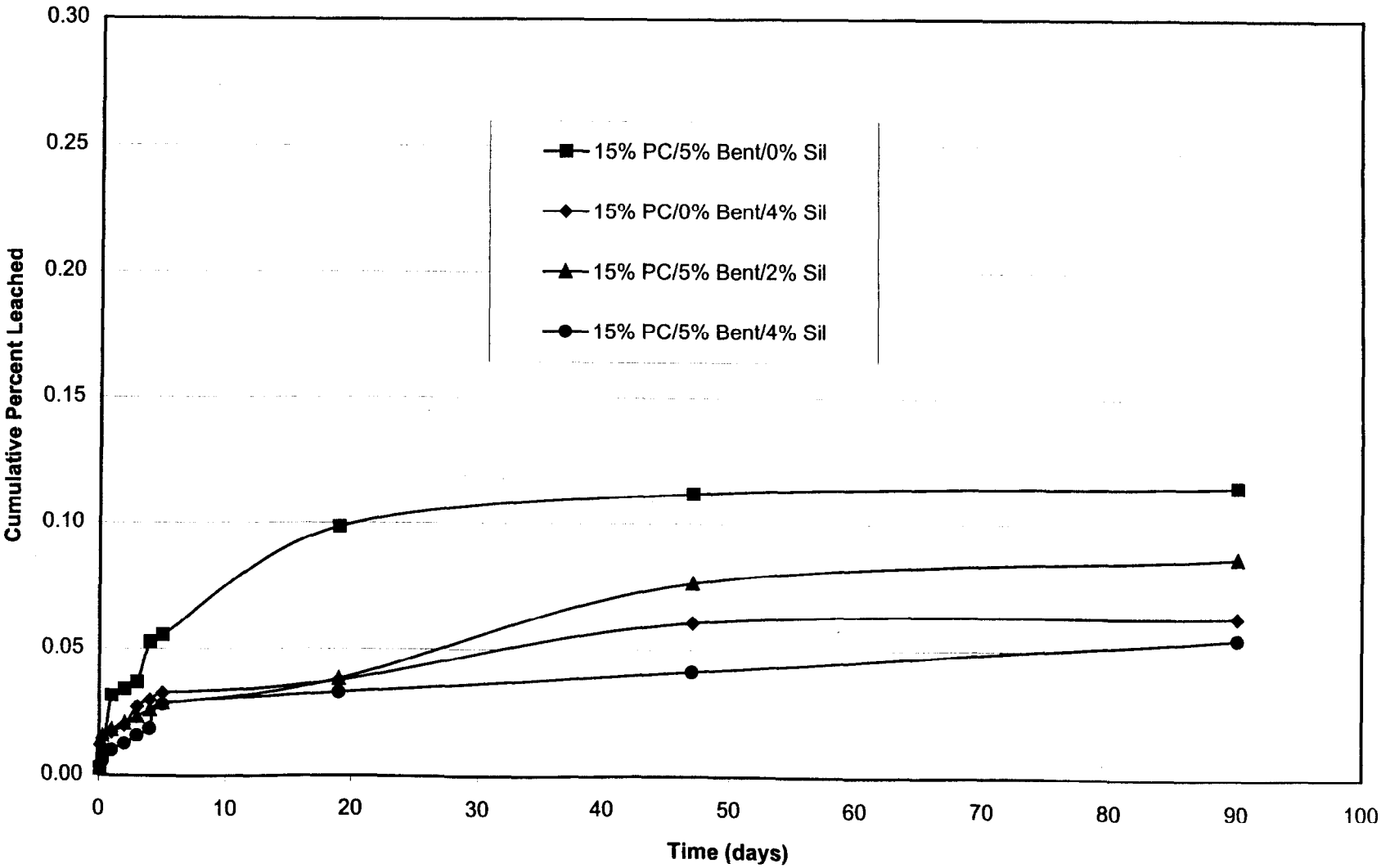
Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.4	Sample Weight (g):	373.98
Initial Contaminant Level (pCi):	5011.332		
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	0.1	0.1800	0.000036	1.737E-13	12.76
7	18000	14835	0.1	0.1800	0.000036	2.291E-13	12.64
24	61200	51231	0.433	0.7794	0.000156	1.283E-12	11.89
48	86400	125894	0.223	0.4014	0.000080	4.197E-13	12.38
72	86400	213818	0.1	0.1800	0.000036	1.433E-13	12.84
96	86400	300849	1.32	2.3760	0.000474	3.514E-11	10.45
120	86400	387596	0.373	0.6714	0.000134	3.615E-12	11.44
456	1209600	939462	1.46	2.6280	0.000524	6.849E-13	12.16
1128	2419200	2716550	0.501	0.9018	0.000180	5.830E-14	13.23
2160	3715200	5768861	0.1	0.1800	0.000036	2.091E-15	14.68

Average Leach Index: 12.45

Gross Alpha Leaching for the Fine Fraction from LRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L412

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	376.21
Initial Contaminant Level (pCi):	6734.159		
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	0.1	0.1800	0.000027	9.622E-14	13.02
7	18000	14835	0.178	0.3204	0.000048	4.020E-13	12.40
24	61200	51231	0.9	1.6200	0.000241	3.070E-12	11.51
48	86400	125894	0.1	0.1800	0.000027	4.673E-14	13.33
72	86400	213818	0.1	0.1800	0.000027	7.937E-14	13.10
96	86400	300849	0.593	1.0674	0.000159	3.927E-12	11.41
120	86400	387596	0.1	0.1800	0.000027	1.439E-13	12.84
456	1209600	939462	1.61	2.8980	0.000430	4.612E-13	12.34
1128	2419200	2716550	0.506	0.9108	0.000135	3.293E-14	13.48
2160	3715200	5768861	0.123	0.2214	0.000033	1.752E-15	14.76
					Average Leach Index:		12.82

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L422

Analyst: PRL Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	371.15
Initial Contaminant Level (pCi):	6643.585		
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	0.433	0.7794	0.000117	1.853E-12	11.73
7	18000	14835	0.1	0.1800	0.000027	1.304E-13	12.88
24	61200	51231	0.1	0.1800	0.000027	3.894E-14	13.41
48	86400	125894	0.1	0.1800	0.000027	4.802E-14	13.32
72	86400	213818	0.268	0.4824	0.000073	5.857E-13	12.23
96	86400	300849	0.1	0.1800	0.000027	1.147E-13	12.94
120	86400	387596	0.1	0.1800	0.000027	1.478E-13	12.83
456	1209600	939462	0.185	0.3330	0.000050	6.257E-15	14.20
1128	2419200	2716550	0.852	1.5336	0.000231	9.593E-14	13.02
2160	3715200	5768861	0.1	0.1800	0.000027	1.190E-15	14.92

Average Leach Index: 13.15

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L432

Analyst: PRL Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	386.89
Initial Contaminant Level (pCi):	6925.331		
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	0.1	0.1800	0.000026	9.098E-14	13.04
7	18000	14835	0.493	0.8874	0.000128	2.916E-12	11.54
24	61200	51231	0.1	0.1800	0.000026	3.584E-14	13.45
48	86400	125894	0.1	0.1800	0.000026	4.419E-14	13.35
72	86400	213818	0.1	0.1800	0.000026	7.505E-14	13.12
96	86400	300849	0.1	0.1800	0.000026	1.056E-13	12.98
120	86400	387596	0.1	0.1800	0.000026	1.360E-13	12.87
456	1209600	939462	0.371	0.6678	0.000096	2.316E-14	13.64
1128	2419200	2716550	1.47	2.6460	0.000382	2.628E-13	12.58
2160	3715200	5768861	0.407	0.7326	0.000106	1.814E-14	13.74

Average Leach Index: 13.03

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: L442

Analyst: PRL Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	365.69
Initial Contaminant Level (pCi):	6545.851		
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	0.1	0.1800	0.000027	1.018E-13	12.99
7	18000	14835	0.1	0.1800	0.000027	1.343E-13	12.87
24	61200	51231	0.156	0.2808	0.000043	9.762E-14	13.01
48	86400	125894	0.1	0.1800	0.000027	4.946E-14	13.31
72	86400	213818	0.116	0.2088	0.000032	1.130E-13	12.95
96	86400	300849	0.1	0.1800	0.000027	1.182E-13	12.93
120	86400	387596	0.348	0.6264	0.000096	1.844E-12	11.73
456	1209600	939462	0.176	0.3168	0.000048	5.833E-15	14.23
1128	2419200	2716550	0.302	0.5436	0.000083	1.242E-14	13.91
2160	3715200	5768861	0.495	0.8910	0.000136	3.003E-14	13.52

Average Leach Index: 13.15

L Series
Index Test Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

MOISTURE CONTENT

PROJECT NAME
SAIC - Savannah River

PROJECT NUMBER
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	MOISTURE, % ASTM D 2216	MOISTURE , % SW846	SOLIDS, % SW846
ETDC-8009	L100Q00	14.7	12.8	87.2
ETDC-8010	L200Q00	15.1	13.1	86.9
ETDC-8011	L300Q00	15.1	13.1	86.9
ETDC-8012	L400Q00	15.9	13.7	86.3
ETDC-8013	L700Q00	14.6	12.8	87.2
ETDC-8014	L800Q00	14.9	12.9	87.1

ASTM D 2216 results are based on dry sample weight.
SW846 results are based on wet sample weight.
Solids content is determined by subtracting the SW846 moisture (%) from 100.

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SPECIFIC GRAVITY
ASTM D 854

PROJECT NAME:
SAIC - Savannah River

PROJECT NUMBER:
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	SPECIFIC GRAVITY
ETDC-8009	L100Q00	2.6370
ETDC-8010	L200Q00	2.6255
ETDC-8011	L300Q00	2.6279
ETDC-8012	L400Q00	2.6335
ETDC-8013	L700Q00	2.6289
ETDC-8014	L800Q00	2.6336

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME:
SAIC - Savannah River

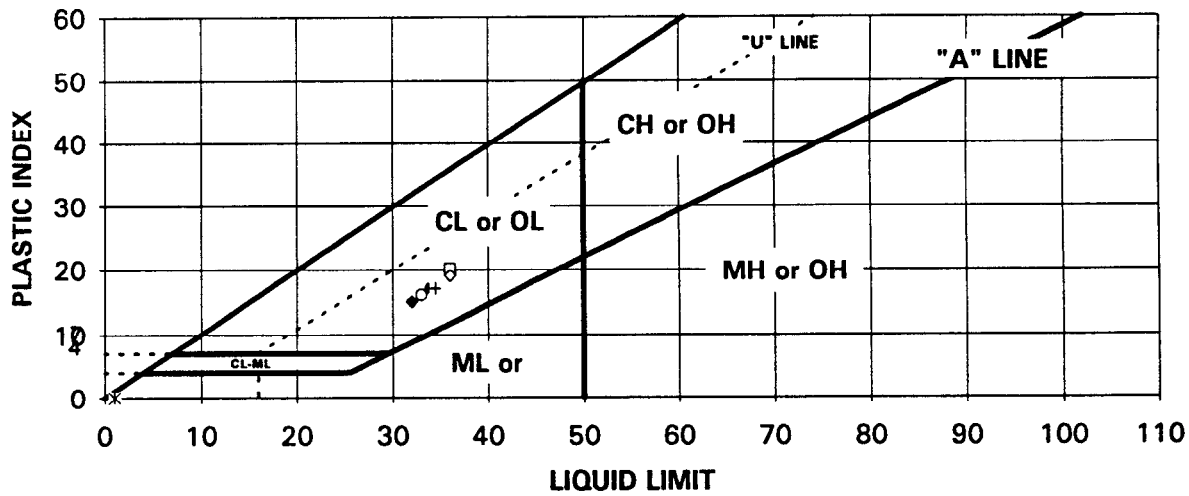
PROJECT NO.
777304.00010500

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
ETDC-8009 •	L100Q00	34	17	17	CL
ETDC-8010 ⬩	L200Q00	32	17	15	CL
ETDC-8011 □	L300Q00	36	16	20	CL
ETDC-8012 ◊	L400Q00	36	17	19	CL
ETDC-8013 +	L700Q00	34	17	17	CL
ETDC-8014 ○	L800Q00	33	17	16	CL
■					
x					
△					
*					

*NP = Nonplastic

PLASTICITY CHART



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SOIL CLASSIFICATION ASTM D 2487

PROJECT NAME: SAIC - Savannah River **PROJECT NO:** 777304.00010500

	ETDC NUMBER:	CLIENT NUMBER:	GROUP SYMBOL:	CLASSIFICATION-GROUP NAME:
SAMPLE 1:	ETDC-8009	L100Q00	SC	CLAYEY SAND
SAMPLE 2:	ETDC-8010	L200Q00	SC	CLAYEY SAND
SAMPLE 3:	ETDC-8011	L300Q00	SC	CLAYEY SAND
SAMPLE 4:	ETDC-8012	L400Q00	SC	CLAYEY SAND
SAMPLE 5:	ETDC-8013	L700Q00	SC	CLAYEY SAND
SAMPLE 6:	ETDC-8014	L800Q00	SC	CLAYEY SAND
SAMPLE 7:				
SAMPLE 8:				
SAMPLE 9:				
SAMPLE 10:				

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SOIL CLASSIFICATION ASTM D 2487

PROJECT NAME: SAIC - Savannah River **PROJECT NO:** 777304.00010500

	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
ETDC NUMBER:	ETDC-8009	ETDC-8010	ETDC-8011	ETDC-8012	ETDC-8013
CLIENT NUMBER:	L100Q00	L200Q00	L300Q00	L400Q00	L700Q00
(COARSE-GRAVELS, SANDS) % RETAINED ON # 200 SIEVE:	65.8	68.0	72.6	66.2	66.0
(FINE-SILTS, CLAYS) % PASSING # 200 SIEVE:	34.2	32.0	27.4	33.8	34.0
% GRAVEL:	0.8	0.2	0.4	0.4	0.5
% SAND:	64.9	67.7	72.2	65.8	65.5
D60 IN MM (DIAMETER AT 60% PASSING):	0.24774	0.34188	0.50697	0.27507	0.26483
D30 IN MM (DIAMETER AT 30% PASSING):	0.01251	0.05091	0.11525	0.02056	0.02527
D10 IN MM (DIAMETER AT 10% PASSING):	0.00056	0.00061	0.00067	0.00055	0.00061
Cc:	442.49	557.38	761.37	500.55	436.39
Cu:	1.13	12.36	39.35	2.80	3.97
LIQUID LIMIT:	34	32	36	36	34
PLASTIC INDEX:	17	15	20	19	17
ATTERBERG CLASSIFICATION*:	CL	CL	CL	CL	CL

	SAMPLE 6	SAMPLE 7	SAMPLE 8	SAMPLE 9	SAMPLE 10
ETDC NUMBER:	ETDC-8014				
CLIENT NUMBER:	L800Q00				
(COARSE-GRAVELS, SANDS) % RETAINED ON # 200 SIEVE:	65.4				
(FINE-SILTS, CLAYS) % PASSING # 200 SIEVE:	34.6				
% GRAVEL:	0.7				
% SAND:	64.8				
D60 IN MM (DIAMETER AT 60% PASSING):	0.26137				
D30 IN MM (DIAMETER AT 30% PASSING):	0.02933				
D10 IN MM (DIAMETER AT 10% PASSING):	0.00058				
Cc:	448.40				
Cu:	5.65				
LIQUID LIMIT:	33				
PLASTIC INDEX:	16				
ATTERBERG CLASSIFICATION*:	CL				

*FINES< #40 SIEVE (0.425 mm)

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L100Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8009
Specific Gravity =	2.6370	Moisture Content =	14.7%
		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	99.2%
	#4	4.750	99.2%
	#10	2.000	98.3%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	93.5%
	#40	0.425	78.3%
	#60	0.250	60.4%
	#100	0.149	43.5%
	#140	0.106	37.4%
	#200	0.075	34.2%

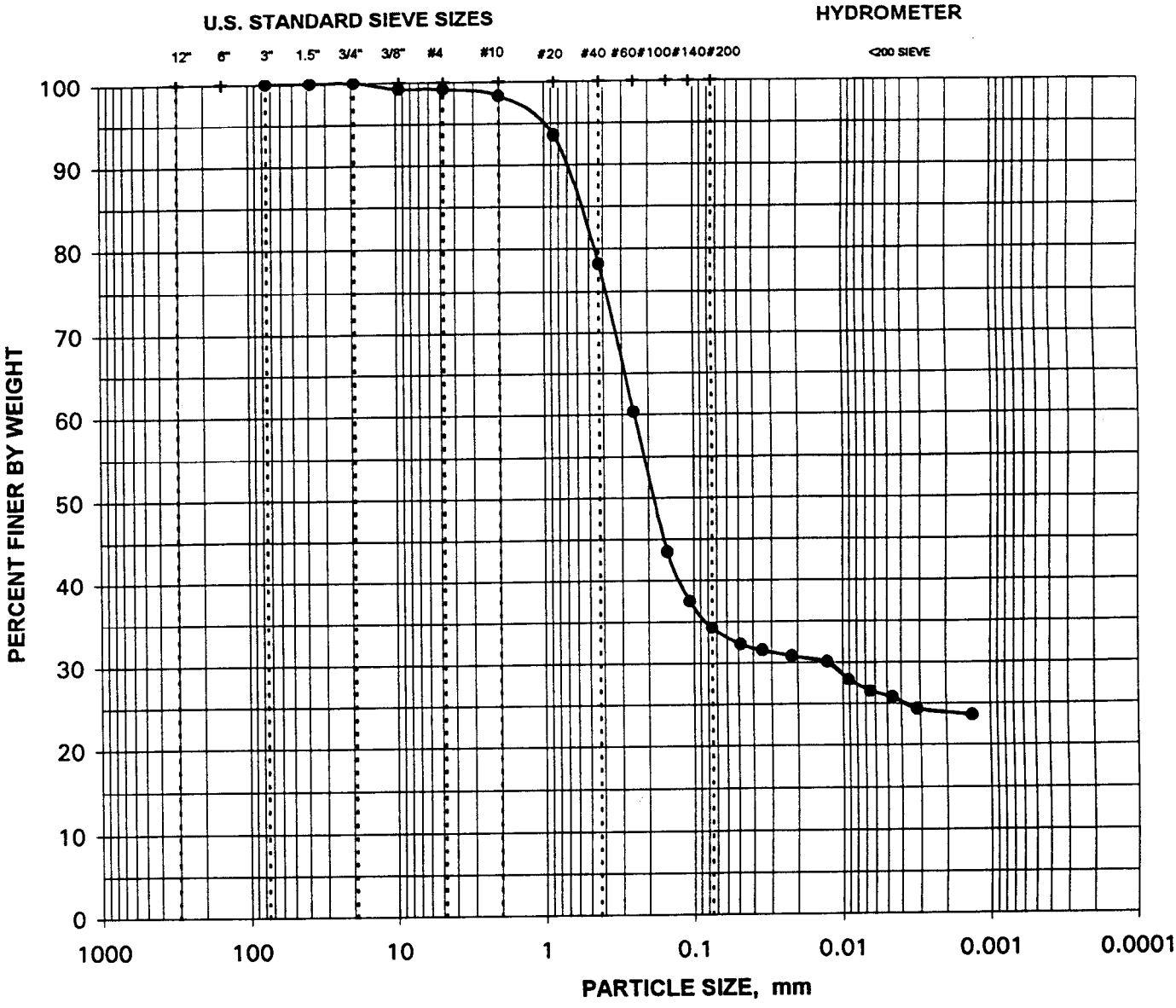
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER	0.06785	33.6%
	0.04819	32.2%
	0.03422	31.5%
	0.02174	30.8%
	0.01260	30.1%
	0.00899	27.9%
	0.00641	26.5%
	0.00455	25.8%
	0.00313	24.3%
	0.00132	23.6%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L100Q00

IT LAB SAMPLE NO.: ETDC-8009

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L200Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8010
Specific Gravity =	2.6255	Moisture Content =	15.1%
		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	100.0%
	#4	4.750	99.8%
	#10	2.000	98.8%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	91.5%
	#40	0.425	69.0%
	#60	0.250	50.1%
	#100	0.149	38.8%
	#140	0.106	34.5%
	#200	0.075	32.0%

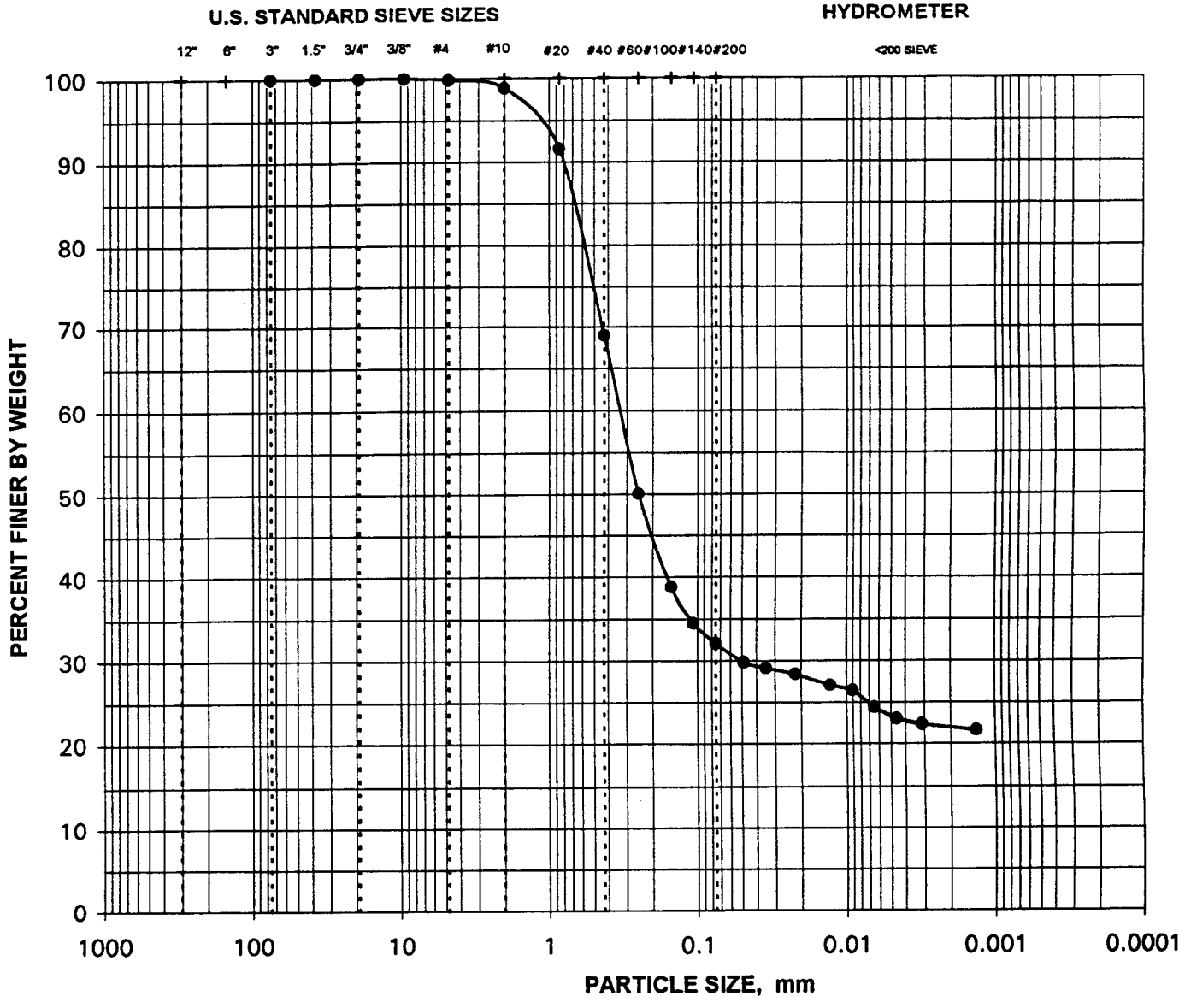
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER	0.06815	30.5%
	0.04840	29.8%
	0.03437	29.1%
	0.02183	28.4%
	0.01268	27.1%
	0.00899	26.4%
	0.00643	24.4%
	0.00456	23.0%
	0.00310	22.3%
	0.00133	21.7%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L200Q00

IT LAB SAMPLE NO.: ETDC-8010

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L300Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8011
Specific Gravity =	2.6279	Moisture Content =	15.1%
		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	100.0%
	#4	4.750	99.6%
	#10	2.000	98.5%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	83.4%
	#40	0.425	54.4%
	#60	0.250	40.7%
	#100	0.149	32.6%
	#140	0.106	29.3%
	#200	0.075	27.4%

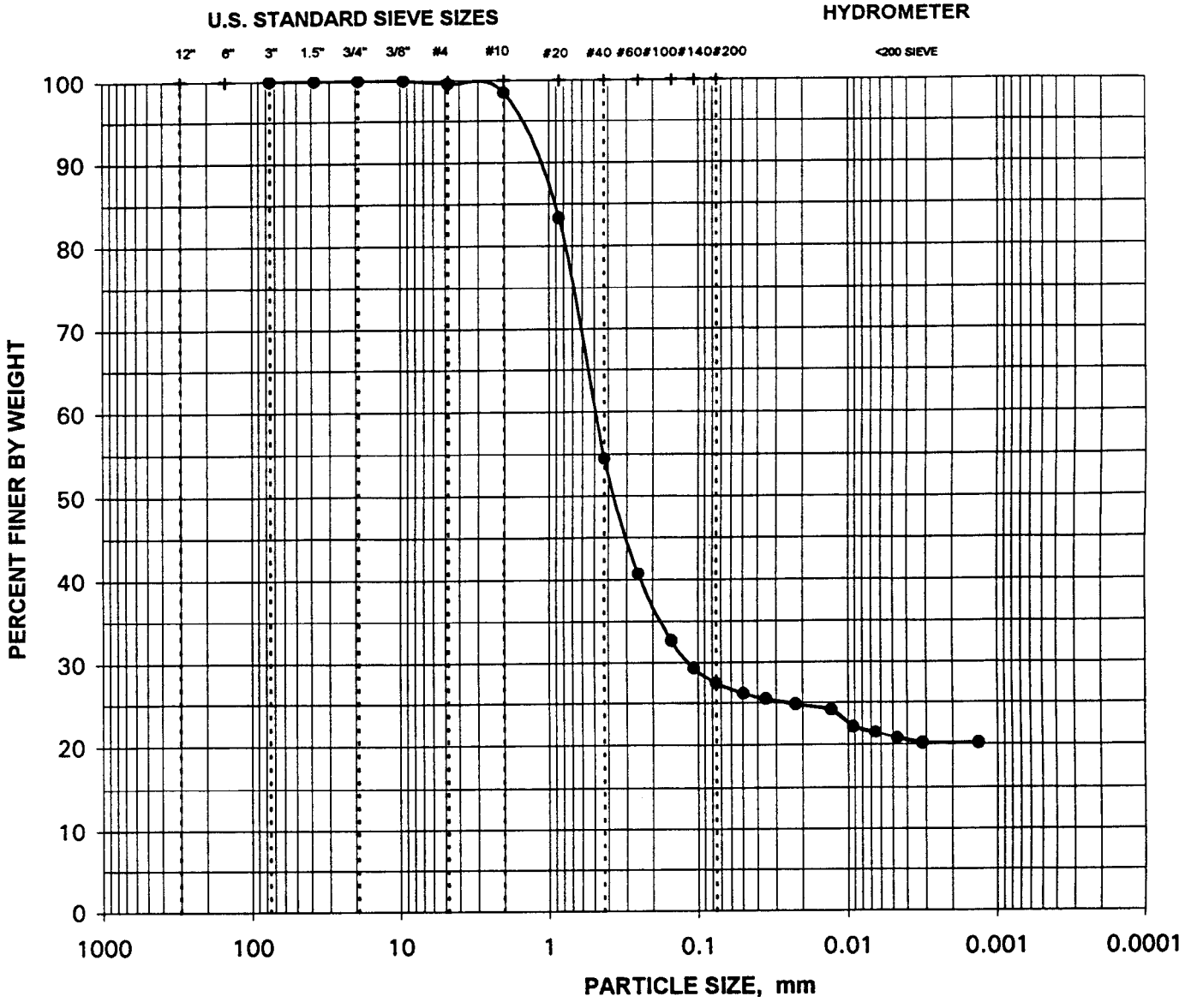
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04922	26.2%
	0.03495	25.5%
	0.02220	24.8%
	0.01287	24.1%
	0.00917	22.1%
	0.00651	21.5%
	0.00462	20.8%
	0.00314	20.1%
	0.00134	20.1%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L300Q00

IT LAB SAMPLE NO.: ETDC-8011

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns CLAY <2 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L400Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8012
Specific Gravity =	2.6335	Moisture Content =	15.9%
		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	99.6%
	#10	2.000	98.3%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	91.3%
	#40	0.425	75.1%
	#60	0.250	57.5%
	#100	0.149	41.9%
	#140	0.106	36.7%
	#200	0.075	33.8%

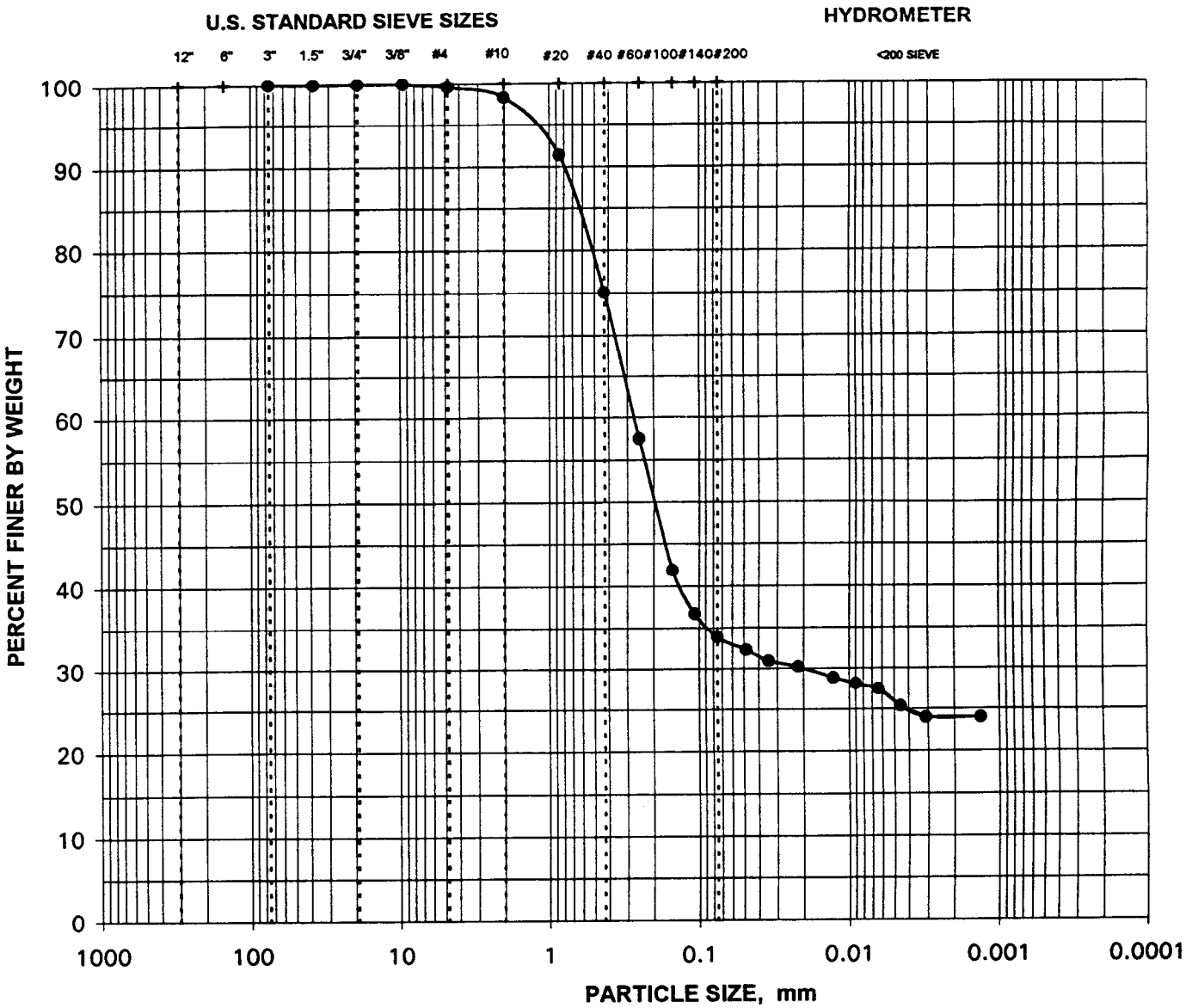
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04798	32.2%
	0.03407	30.9%
	0.02164	30.2%
	0.01260	28.8%
	0.00895	28.1%
	0.00634	27.4%
	0.00453	25.4%
	0.00307	24.0%
	0.00132	24.0%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L400Q00

IT LAB SAMPLE NO.: ETDC-8012

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L700Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8013
Specific Gravity =	2.6289	Moisture Content =	14.7%
		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	100.0%
	#4	4.750	99.5%
	#10	2.000	98.6%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	92.2%
	#40	0.425	76.2%
	#60	0.250	58.5%
	#100	0.149	42.4%
	#140	0.106	36.9%
	#200	0.075	34.0%

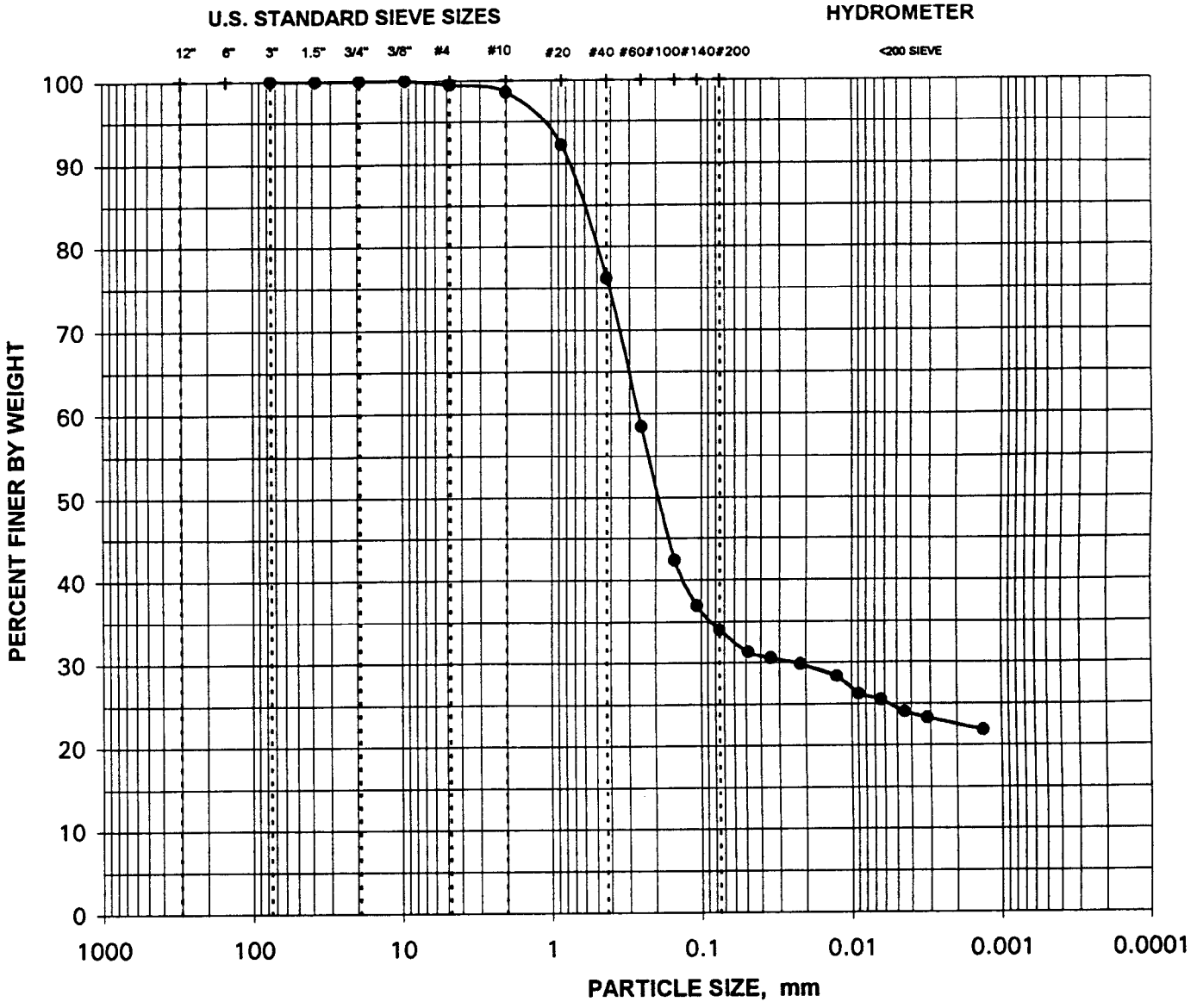
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04799	31.2%
	0.03408	30.5%
	0.02164	29.8%
	0.01240	28.3%
	0.00887	26.2%
	0.00630	25.4%
	0.00442	24.0%
	0.00311	23.2%
	0.00132	21.8%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L700Q00

IT LAB SAMPLE NO.: ETDC-8013

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	L800Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8014
Specific Gravity =	2.6336	Moisture Content =	14.9%
		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	99.5%
	#4	4.750	99.3%
	#10	2.000	98.4%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	93.0%
	#40	0.425	76.9%
	#60	0.250	58.8%
	#100	0.149	43.0%
	#140	0.106	37.5%
	#200	0.075	34.6%

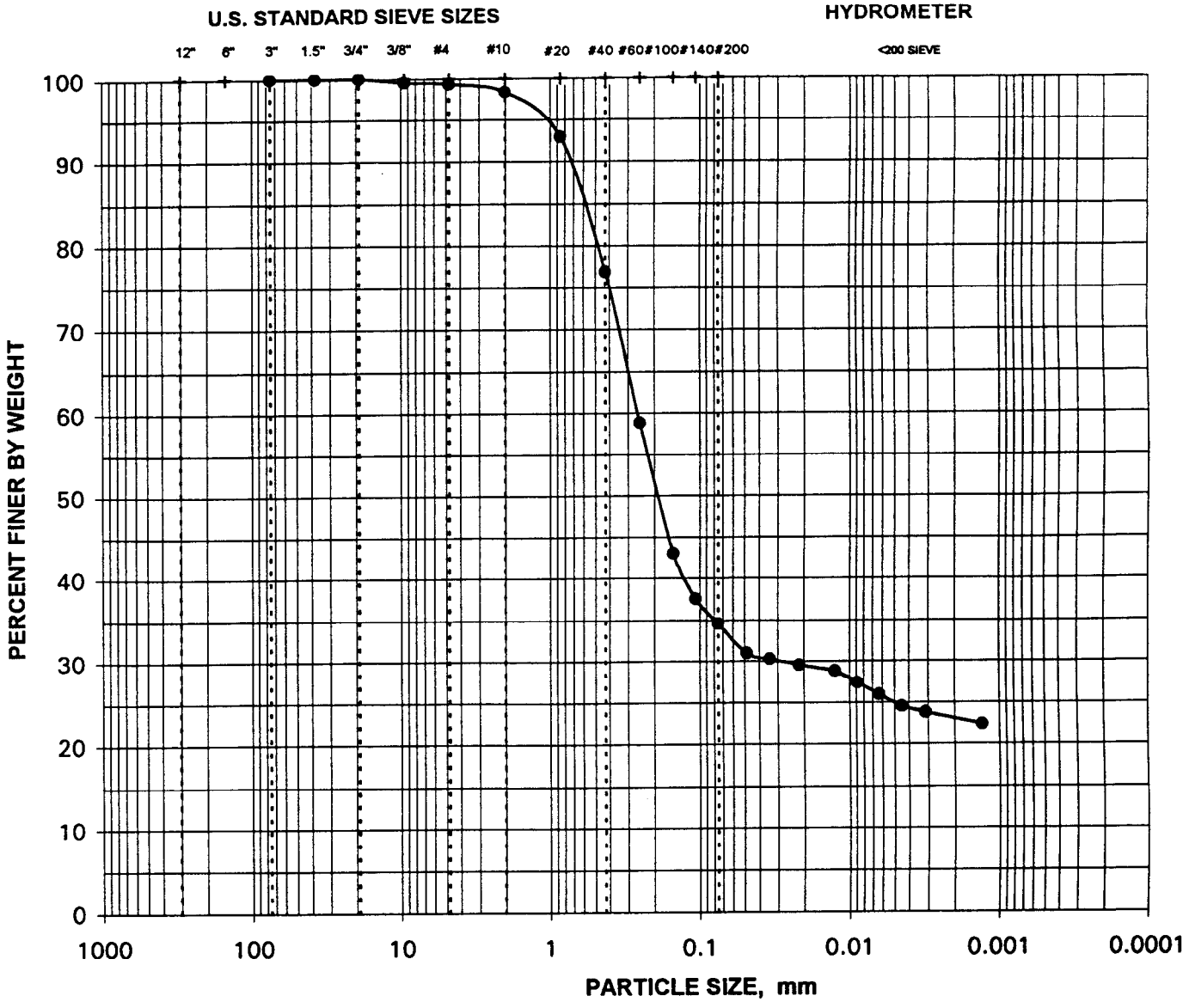
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04799	31.0%
	0.03367	30.3%
	0.02138	29.5%
	0.01237	28.8%
	0.00880	27.4%
	0.00628	25.9%
	0.00445	24.5%
	0.00310	23.8%
	0.00130	22.3%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: L800Q00

IT LAB SAMPLE NO.: ETDC-8014

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns CLAY <2 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	

L Series
28 Day UCS Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

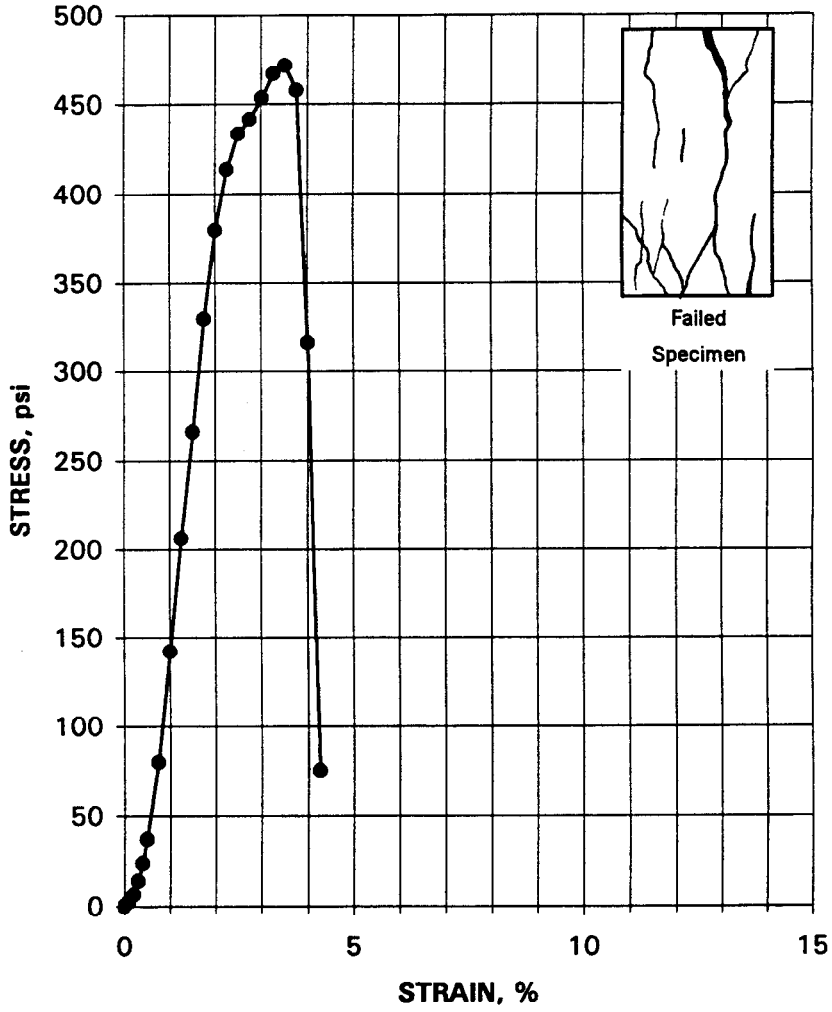
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	L312F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8063

Specimen Mold Date		Specimen Height, in.	3.9783
Specimen Test Date	1/20/99	Specimen Diameter, in.	2.0152
		Specimen Weight, g.	376.72
STRESS AT FAILURE, psi	**471.3**	Moisture Content, %	29.3
STRAIN AT FAILURE, %	**3.5**	Wet Unit Weight, pcf.	113.1
		Dry Unit Weight, pcf.	87.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	6.3
0.30	13.8
0.40	23.7
0.50	37.1
0.75	80.0
1.01	141.5
1.26	205.9
1.51	265.9
1.76	329.9
2.01	379.7
2.26	413.7
2.51	433.1
2.76	441.4
3.02	453.4
3.27	466.8
3.52	471.3
3.77	457.4
4.02	316.0
4.27	75.3



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

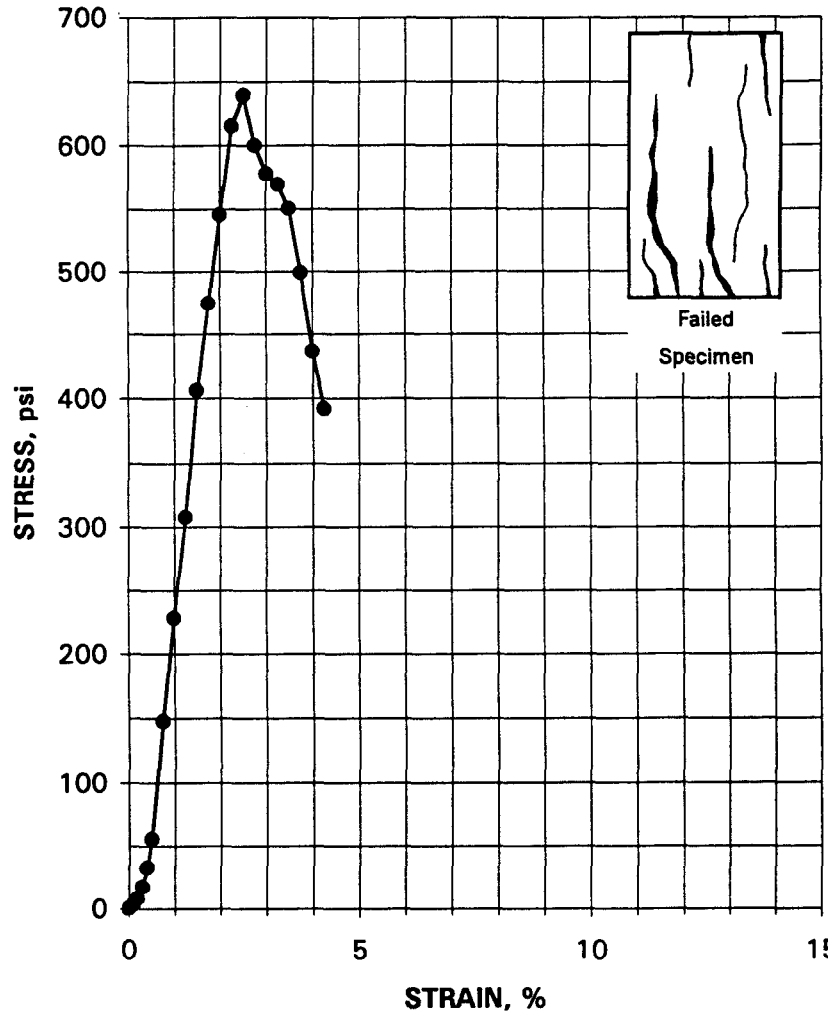
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	L322F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8064

Specimen Mold Date		Specimen Height, in.	3.9915
Specimen Test Date	1/20/99	Specimen Diameter, in.	2.0082
		Specimen Weight, g.	390.43
STRESS AT FAILURE, psi	**639.6**	Moisture Content, %	27.1
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	117.7
		Dry Unit Weight, pcf.	92.6
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.8
0.20	8.2
0.30	17.6
0.40	33.0
0.50	55.6
0.75	147.6
1.00	228.2
1.25	307.4
1.50	406.5
1.75	474.9
2.00	545.8
2.25	615.1
2.51	639.6
2.76	600.2
3.01	578.2
3.26	569.3
3.51	550.8
3.76	499.2
4.01	436.7
4.26	392.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

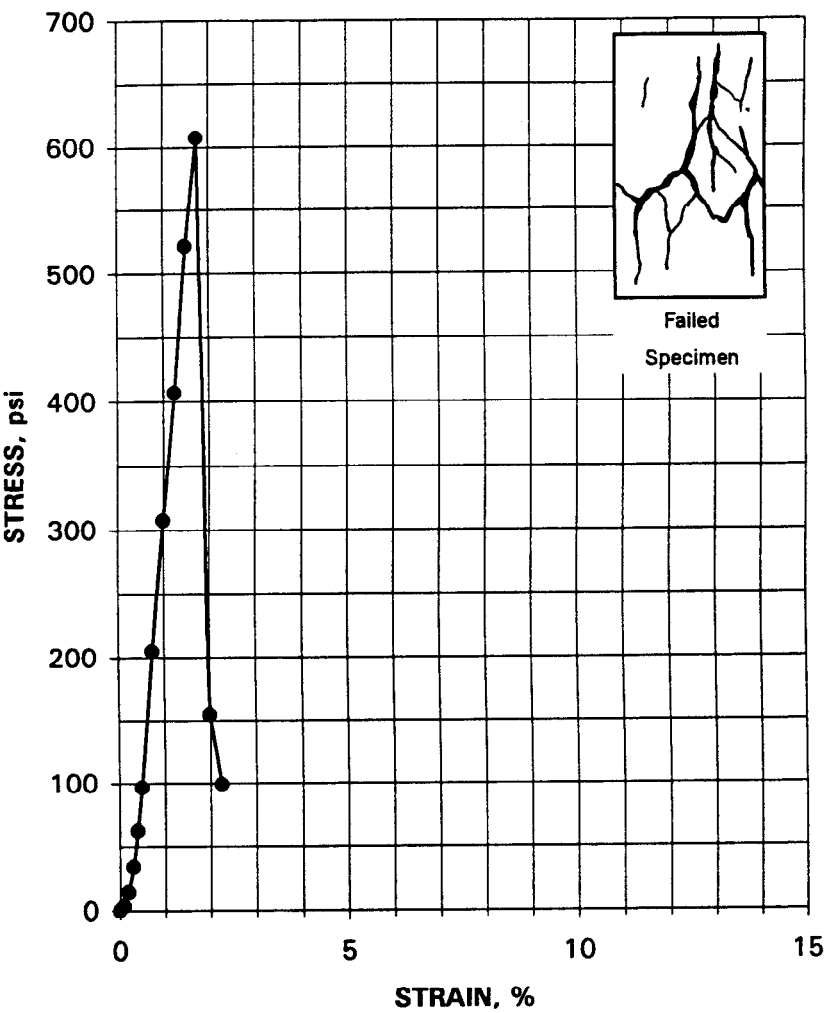
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	L332F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8065

Specimen Mold Date		Specimen Height, in.	4.0012
Specimen Test Date	1/20/99	Specimen Diameter, in.	2.0017
		Specimen Weight, g.	369.41
STRESS AT FAILURE, psi	**607.6**	Moisture Content, %	33.3
STRAIN AT FAILURE, %	**1.7**	Wet Unit Weight, pcf.	111.8
		Dry Unit Weight, pcf.	83.9
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	14.0
0.30	33.6
0.40	62.0
0.50	96.4
0.75	205.0
1.00	307.4
1.25	407.0
1.50	521.5
1.75	607.6
2.00	154.5
2.25	99.1



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

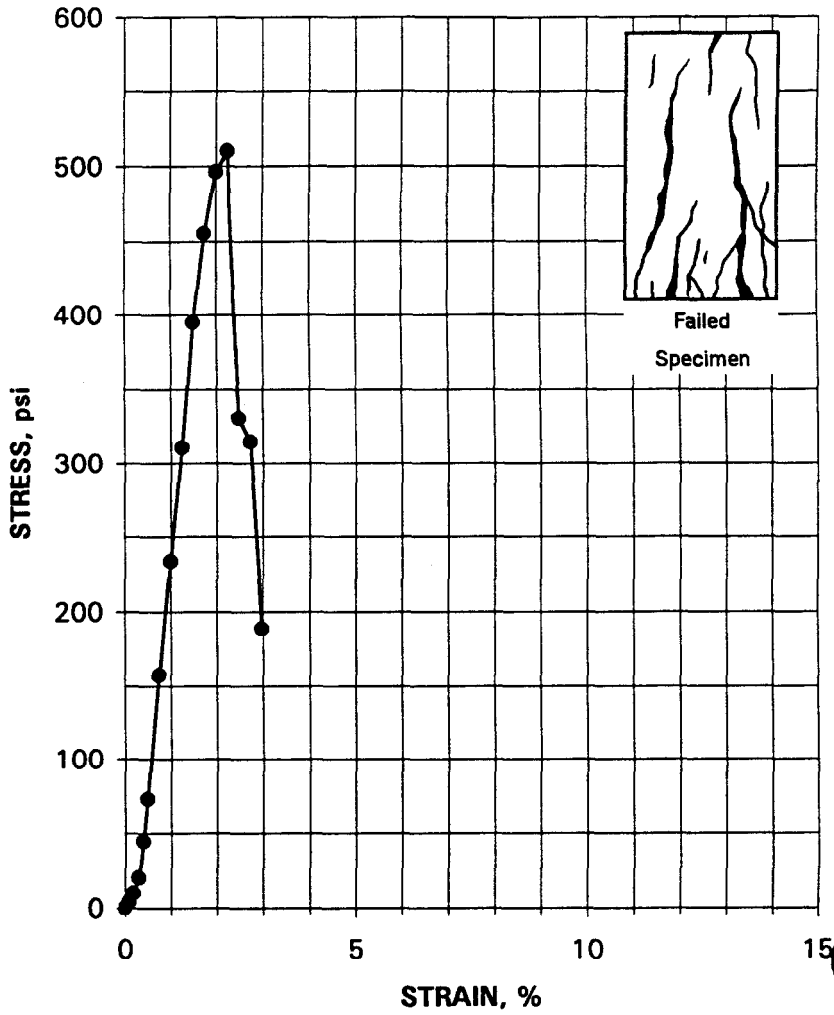
Client Sample No. L342F00
IT Lab Specimen No. ETDC-8066

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **509.6**
STRAIN AT FAILURE, % **2.2**

Specimen Height, in.	4.0193
Specimen Diameter, in.	2.0052
Specimen Weight, g.	373.56
Moisture Content, %	32.0
Wet Unit Weight, pcf.	112.1
Dry Unit Weight, pcf.	84.9
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.1
0.20	10.4
0.30	20.5
0.40	44.5
0.50	73.1
0.75	157.2
1.00	233.9
1.24	310.5
1.49	394.9
1.74	455.2
1.99	496.0
2.24	509.6
2.49	330.1
2.74	314.5
2.99	188.9



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

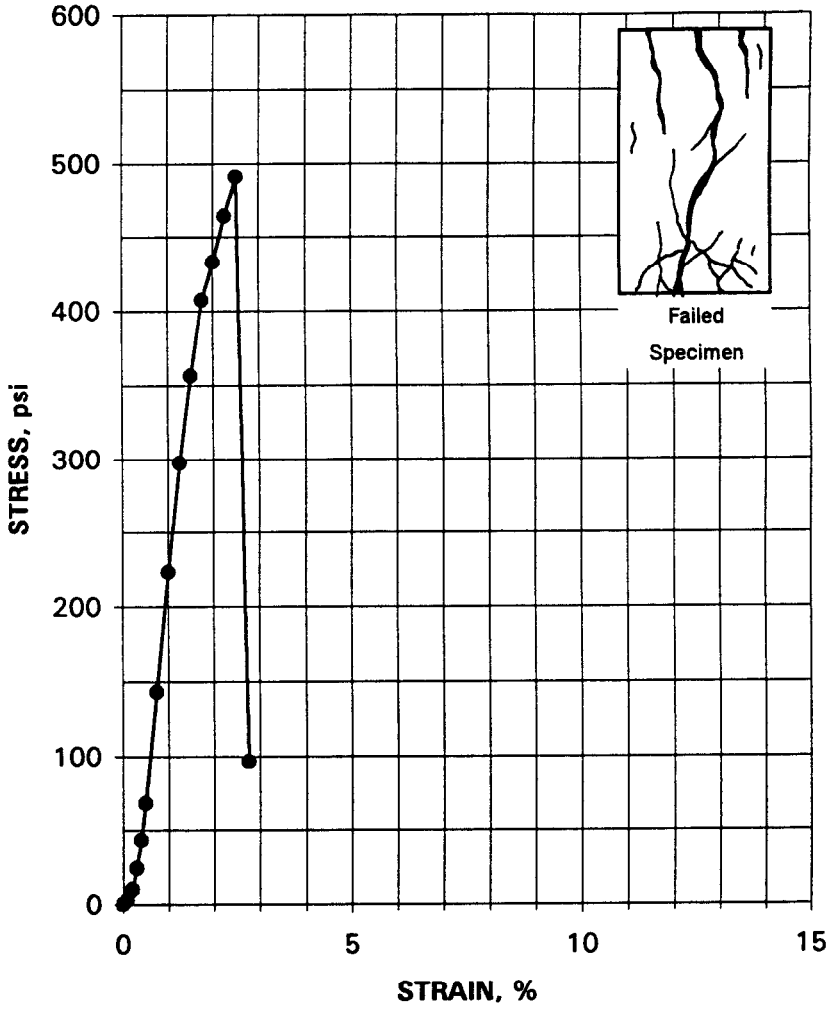
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	L412F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8067

Specimen Mold Date		Specimen Height, in.	3.9780
Specimen Test Date	1/20/99	Specimen Diameter, in.	1.9975
		Specimen Weight, g.	371.62
STRESS AT FAILURE, psi	**490.6**	Moisture Content, %	29.9
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	113.6
		Dry Unit Weight, pcf.	87.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.2
0.20	9.9
0.30	24.2
0.40	43.2
0.50	67.9
0.75	143.1
1.01	223.7
1.26	297.1
1.51	356.4
1.76	407.2
2.01	433.1
2.26	463.8
2.51	490.6
2.77	96.2



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

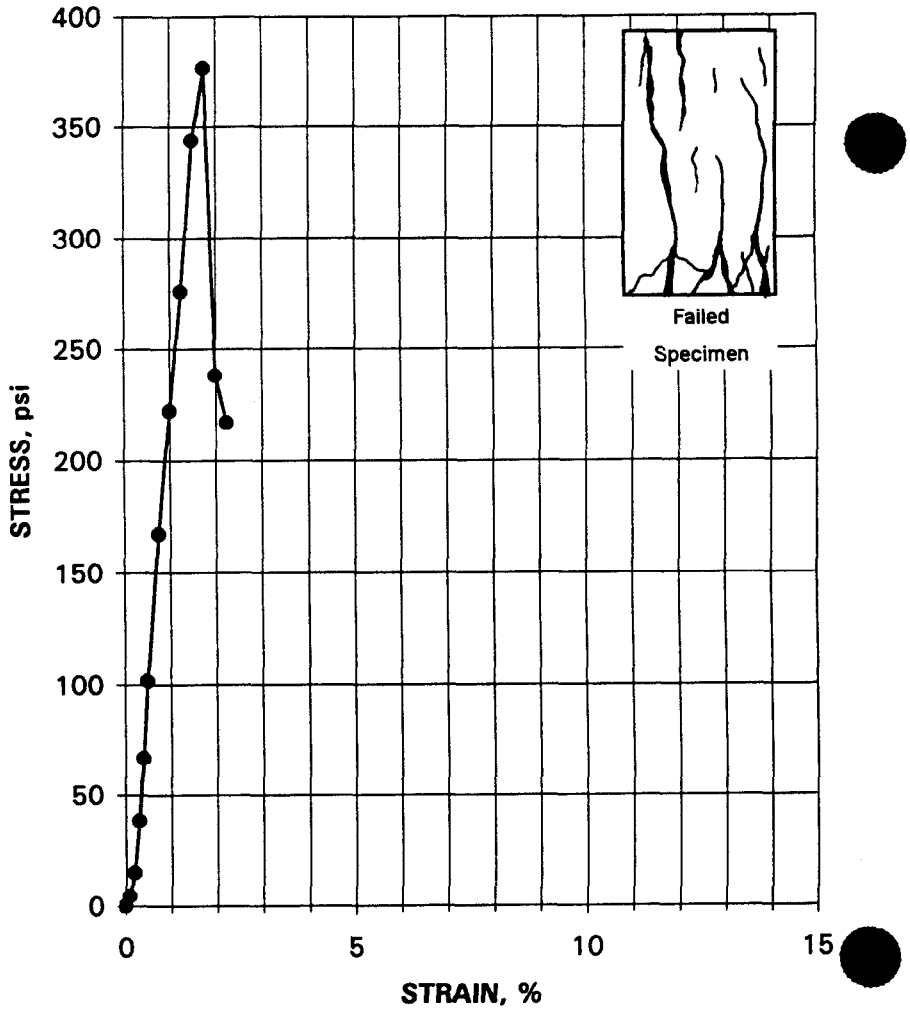
Client Sample No. L422F00
IT Lab Specimen No. ETDC-8068

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **376.6**
STRAIN AT FAILURE, % **1.7**

Specimen Height, in.	4.0208
Specimen Diameter, in.	2.0000
Specimen Weight, g.	390.02
Moisture Content, %	27.6
Wet Unit Weight, pcf.	117.6
Dry Unit Weight, pcf.	92.2
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.5
0.20	14.9
0.30	38.4
0.40	66.9
0.50	101.7
0.75	167.1
0.99	222.5
1.24	275.7
1.49	343.7
1.74	376.6
1.99	238.0
2.24	217.2



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

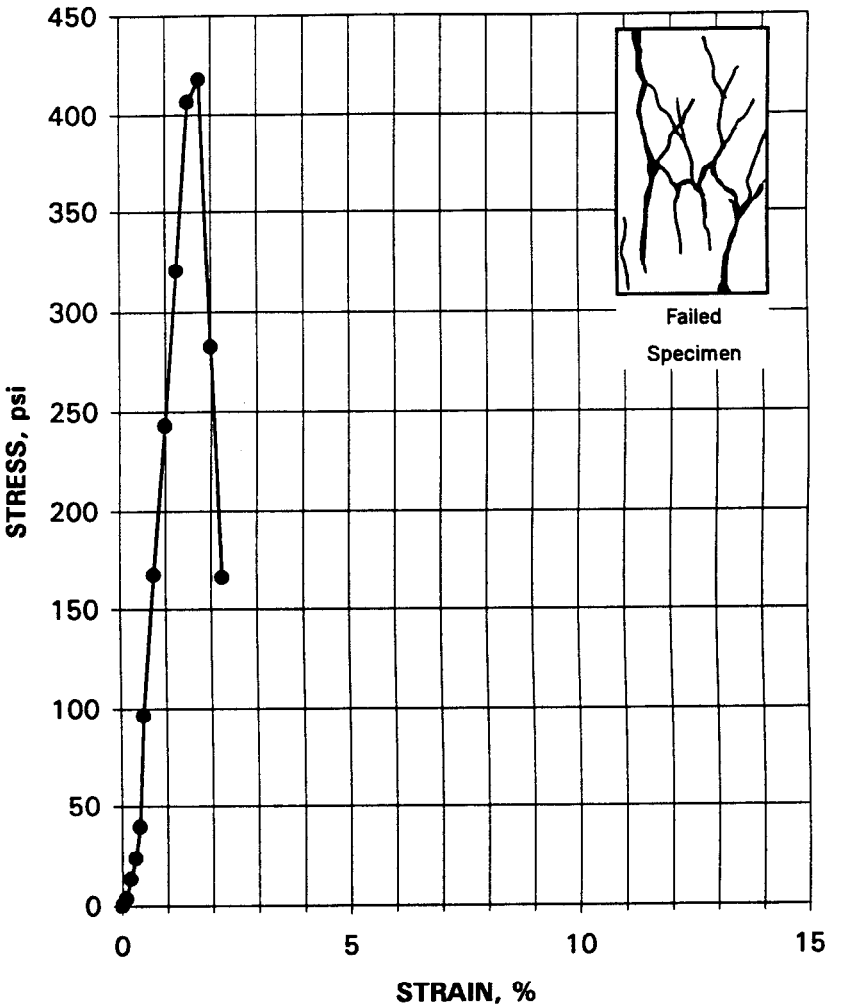
Client Sample No. L432F00
IT Lab Specimen No. ETDC-8069

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **417.5**
STRAIN AT FAILURE, % **1.7**

Specimen Height, in.	4.0105
Specimen Diameter, in.	2.0008
Specimen Weight, g.	366.60
Moisture Content, %	34.0
Wet Unit Weight, pcf.	110.8
Dry Unit Weight, pcf.	82.7
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	13.0
0.30	23.5
0.40	39.6
0.50	96.5
0.75	167.6
1.00	243.1
1.25	320.7
1.50	406.3
1.75	417.5
1.99	282.4
2.24	166.3



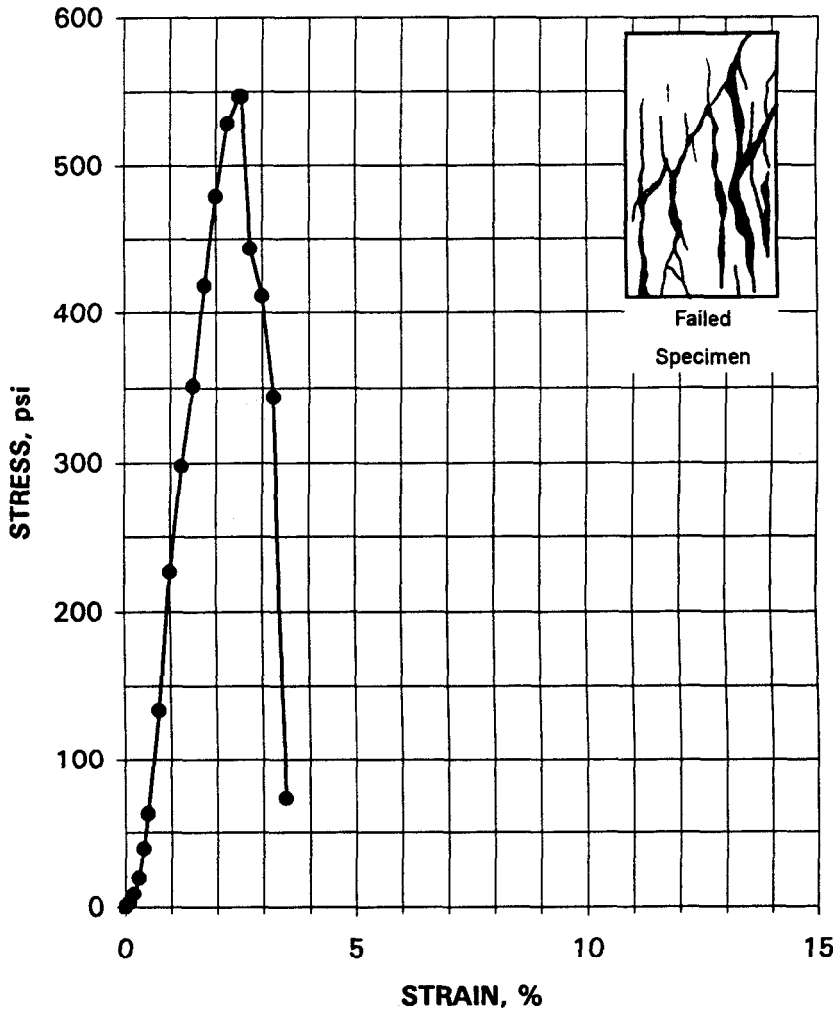
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	L442F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8070

Specimen Mold Date		Specimen Height, in.	4.0038
Specimen Test Date	1/20/99	Specimen Diameter, in.	2.0038
		Specimen Weight, g.	371.01
STRESS AT FAILURE, psi	**546.6**	Moisture Content, %	32.7
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	112.0
		Dry Unit Weight, pcf.	84.3
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.2
0.20	8.9
0.30	19.6
0.40	38.8
0.50	62.8
0.75	132.8
1.00	226.3
1.25	297.8
1.50	351.1
1.75	418.4
2.00	478.3
2.25	527.6
2.50	546.3
2.55	546.6
2.75	443.5
3.00	411.6
3.25	343.9
3.50	73.1



L Series
90 Day Immersion UCS Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

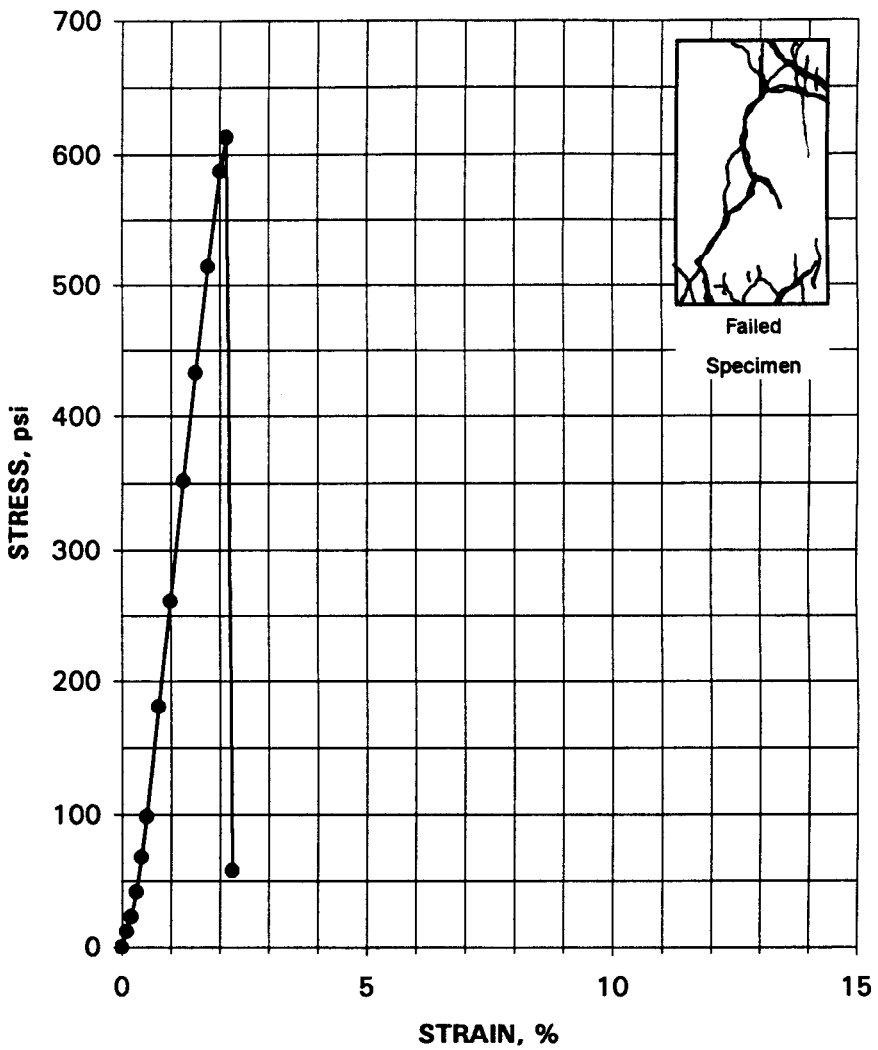
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L313F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8039

Specimen Mold Date	12/21/98	Specimen Height, in.	3.9778
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0077
		Specimen Weight, g.	380.46
STRESS AT FAILURE, psi	**613.0**	Moisture Content, %	31.6
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	115.1
		Dry Unit Weight, pcf.	87.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	11.7
0.20	22.7
0.30	41.9
0.40	68.0
0.50	98.4
0.75	180.6
1.01	261.1
1.26	351.5
1.51	433.4
1.76	513.9
2.01	587.5
2.14	613.0
2.26	57.7



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

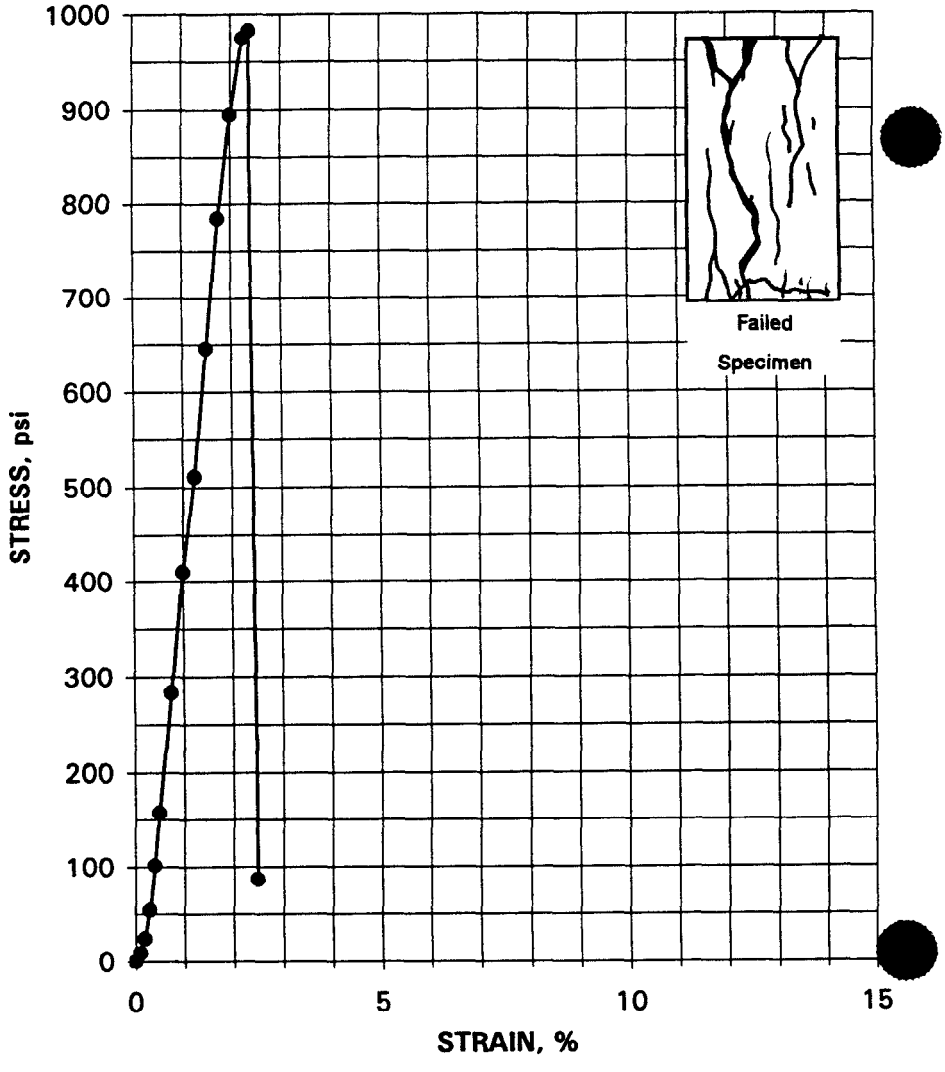
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L323F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8040

Specimen Mold Date	12/21/98	Specimen Height, in.	4.0147
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0087
		Specimen Weight, g.	393.80
STRESS AT FAILURE, psi	**982.5**	Moisture Content, %	28.4
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	117.9
		Dry Unit Weight, pcf.	91.9
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	8.8
0.20	24.3
0.30	54.1
0.40	101.5
0.50	157.3
0.75	282.8
1.00	409.6
1.25	511.1
1.49	645.3
1.74	784.5
1.99	894.7
2.24	974.2
2.37	982.5
2.49	86.8



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

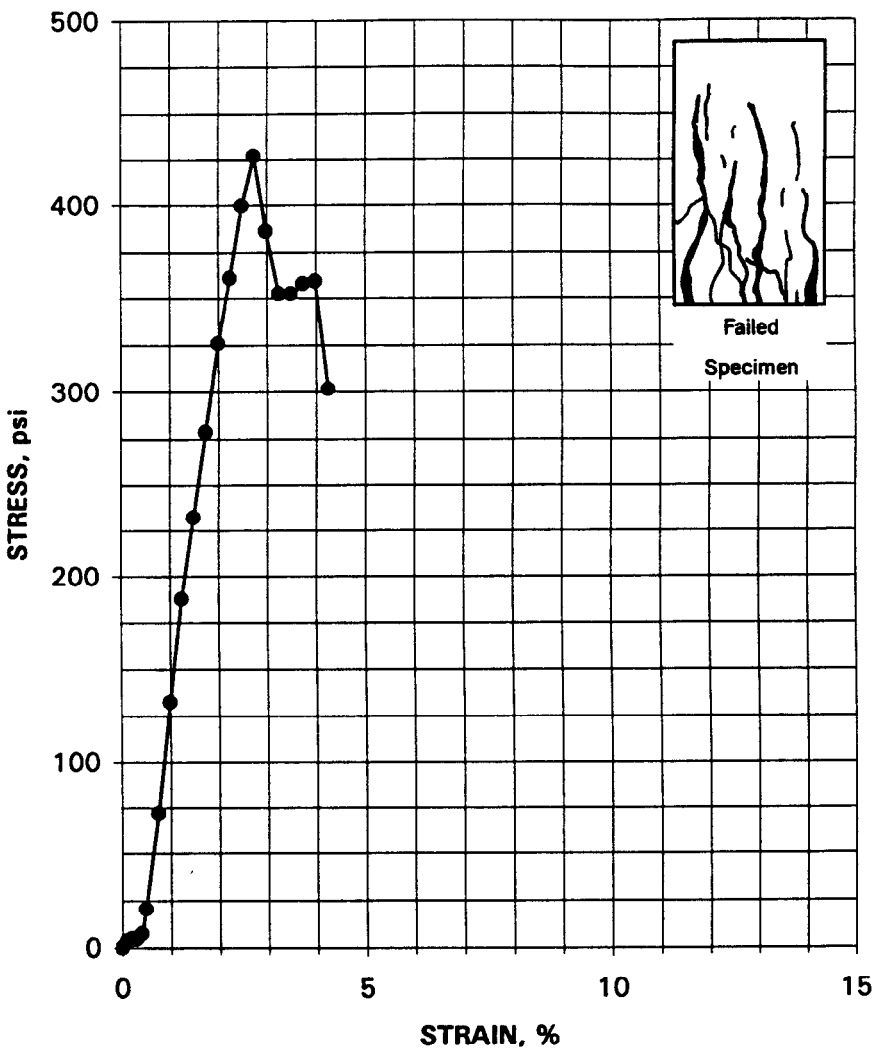
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L333F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8041

Specimen Mold Date	12/21/98	Specimen Height, in.	4.0092
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0095
		Specimen Weight, g.	372.80
STRESS AT FAILURE, psi	**426.9**	Moisture Content, %	37.0
STRAIN AT FAILURE, %	**2.7**	Wet Unit Weight, pcf.	111.7
		Dry Unit Weight, pcf.	81.6
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	4.7
0.30	4.7
0.40	7.5
0.50	20.7
0.75	72.0
1.00	132.4
1.25	187.4
1.50	232.0
1.75	278.8
2.00	326.0
2.24	360.9
2.49	399.7
2.74	426.9
2.99	386.0
3.24	352.4
3.49	352.4
3.74	357.5
3.99	359.0
4.24	301.9



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

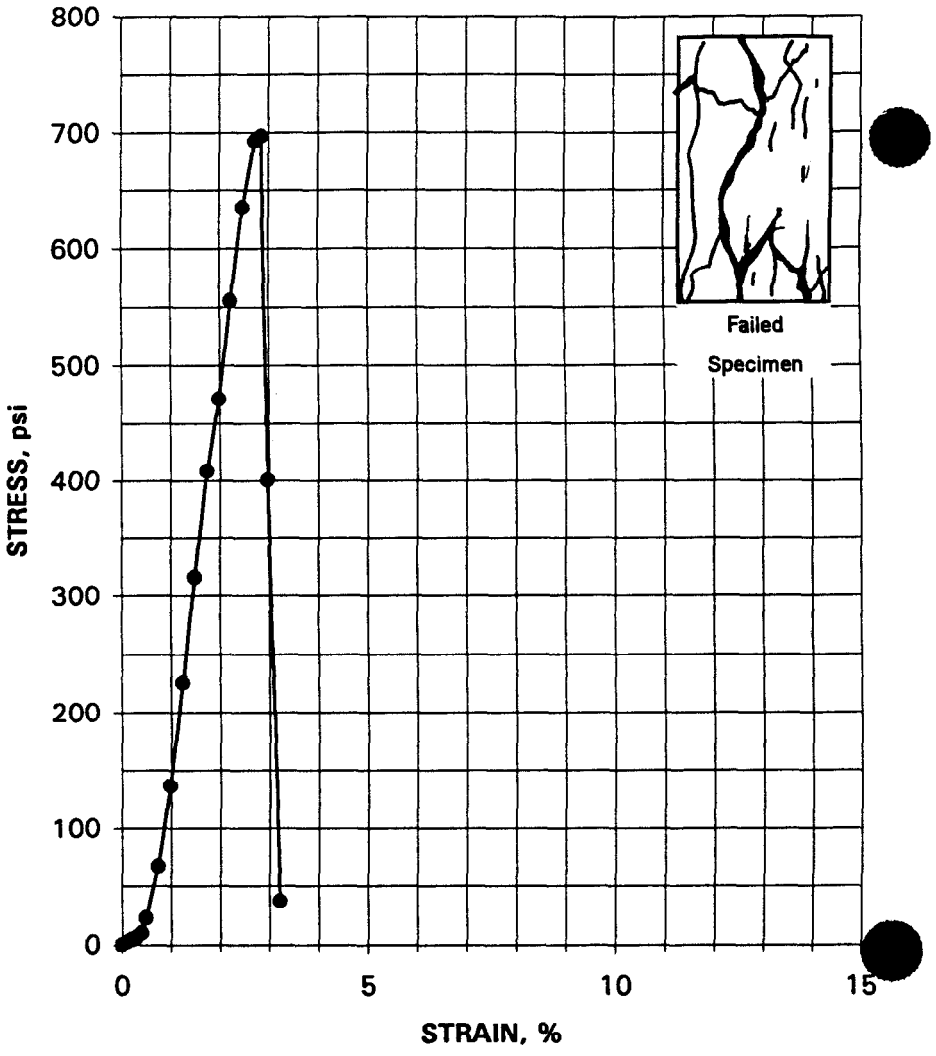
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L343F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8042

Specimen Mold Date	12/21/98	Specimen Height, in.	4.0307
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0115
		Specimen Weight, g.	379.61
STRESS AT FAILURE, psi	**697.0**	Moisture Content, %	33.7
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	112.9
		Dry Unit Weight, pcf.	84.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.2
0.20	4.4
0.30	6.3
0.40	9.7
0.50	22.5
0.74	66.5
0.99	136.2
1.24	225.6
1.49	316.2
1.74	408.2
1.98	470.7
2.23	555.3
2.48	634.9
2.73	692.4
2.85	697.0
2.98	400.6
3.23	36.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

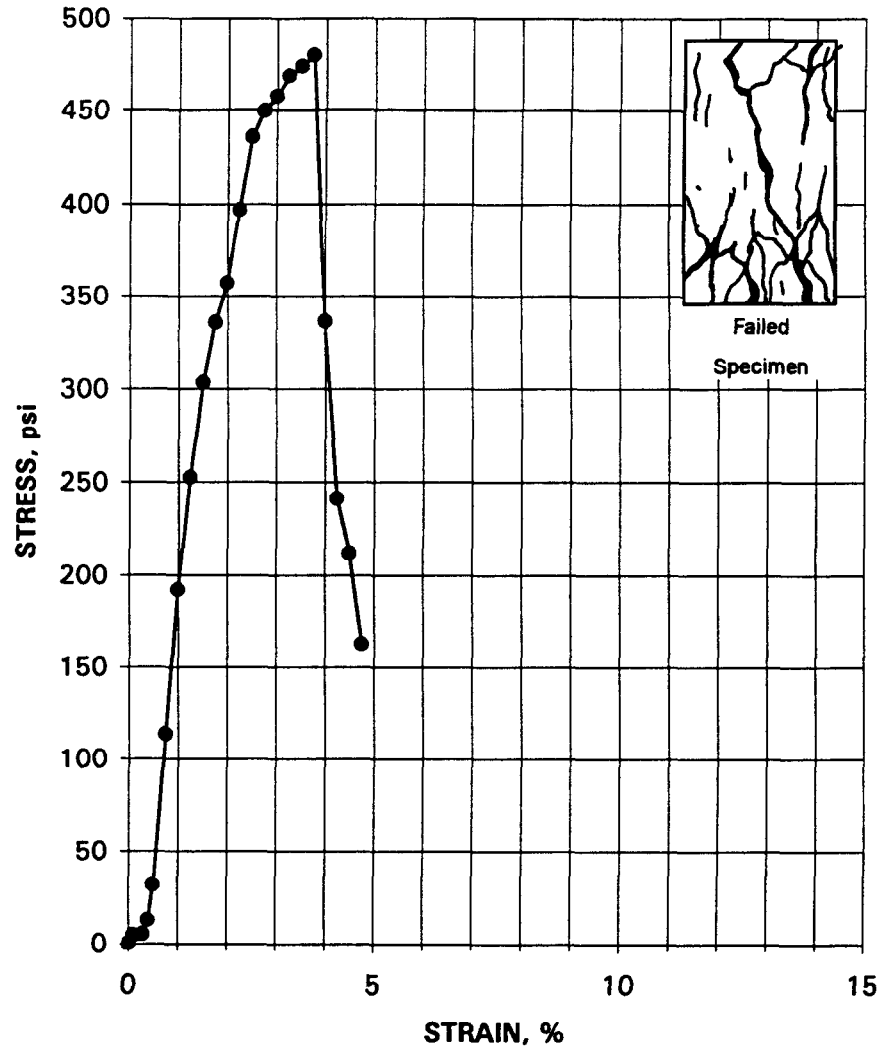
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L413F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8043

Specimen Mold Date	12/21/98	Specimen Height, in.	3.9975
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0055
		Specimen Weight, g.	385.16
STRESS AT FAILURE, psi	**479.9**	Moisture Content, %	32.4
STRAIN AT FAILURE, %	**3.8**	Wet Unit Weight, pcf.	116.2
		Dry Unit Weight, pcf.	87.7
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.4
0.30	5.0
0.40	12.6
0.50	31.8
0.75	113.4
1.00	192.1
1.25	252.3
1.50	303.4
1.75	335.9
2.00	357.4
2.25	396.7
2.50	435.8
2.75	449.5
3.00	457.5
3.25	468.3
3.50	473.5
3.75	479.9
4.00	336.4
4.25	241.0
4.50	211.9
4.75	162.2



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

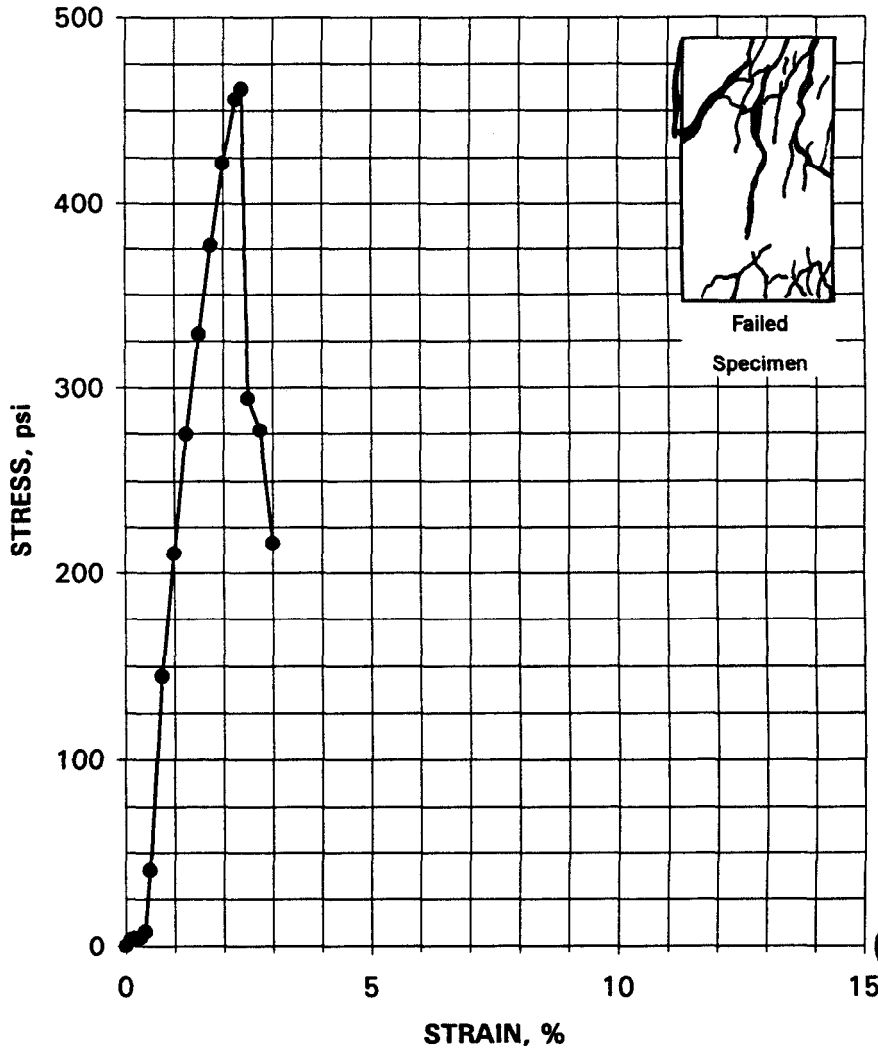
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L423F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8044

Specimen Mold Date	12/21/98	Specimen Height, in.	3.9962
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0070
		Specimen Weight, g.	388.11
STRESS AT FAILURE, psi	**461.6**	Moisture Content, %	29.0
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	117.0
		Dry Unit Weight, pcf.	90.7
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	4.1
0.30	4.4
0.40	7.9
0.50	40.9
0.75	144.6
1.00	210.6
1.25	274.7
1.50	328.8
1.75	376.4
2.00	421.9
2.25	455.7
2.38	461.6
2.50	294.3
2.75	276.7
3.00	216.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

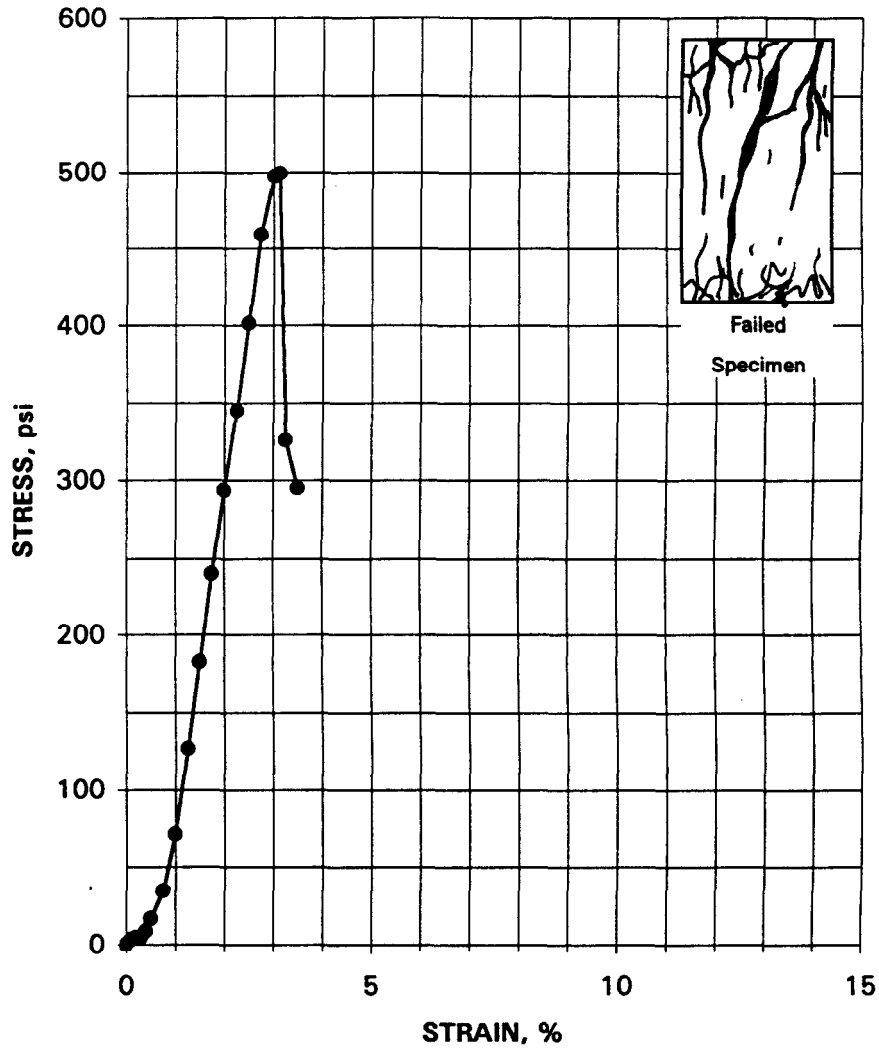
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L433F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8045

Specimen Mold Date	12/21/98	Specimen Height, in.	3.9880
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0040
		Specimen Weight, g.	367.92
STRESS AT FAILURE, psi	**499.3**	Moisture Content, %	36.9
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	111.4
		Dry Unit Weight, pcf.	81.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.2
0.20	4.4
0.30	4.4
0.40	8.5
0.50	16.4
0.75	34.3
1.00	70.6
1.25	126.8
1.50	182.7
1.76	239.5
2.01	293.6
2.26	344.9
2.51	401.2
2.76	458.7
3.01	496.9
3.13	499.3
3.26	325.4
3.51	295.2



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

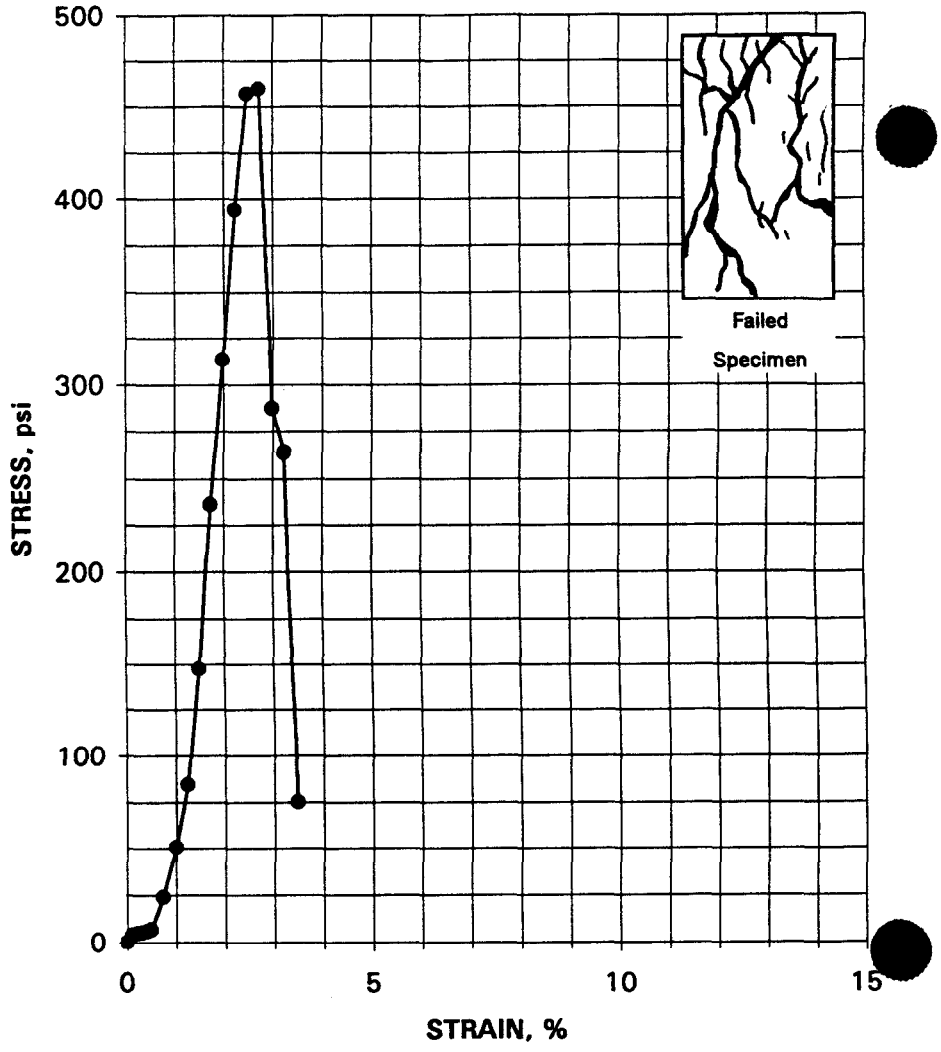
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	L443F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8046

Specimen Mold Date	12/21/98	Specimen Height, in.	4.0240
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0073
		Specimen Weight, g.	375.02
STRESS AT FAILURE, psi	**459.8**	Moisture Content, %	34.6
STRAIN AT FAILURE, %	**2.7**	Wet Unit Weight, pcf.	112.2
		Dry Unit Weight, pcf.	83.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	4.7
0.30	5.0
0.40	6.0
0.50	6.9
0.75	23.8
0.99	50.7
1.24	84.6
1.49	147.5
1.74	236.0
1.99	313.4
2.24	393.9
2.49	457.0
2.73	459.8
2.98	287.9
3.23	264.2
3.48	75.3



L Series
28 Day Expansion / Shrinkage Results

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures ASTM D 3877

28-Day Cure

Geo Lab Sample No.	Knoxville Lab Sample No.	Expansion, %	Expansion Result	Shrinkage, %
ETDC-8087	L312K00	-0.059%	No expansion	0.22%
ETDC-8088	L322K00	-0.120%	No expansion	0.75%
ETDC-8089	L332K00	-0.110%	No expansion	4.13%
ETDC-8090	L342K00	-0.070%	No expansion	1.12%
ETDC-8091	L412K00	-0.050%	No expansion	2.32%
ETDC-8092	L422K00	-0.100%	No expansion	Insuff. Sample
ETDC-8093	L432K00	-0.440%	No expansion	1.98%
ETDC-8094	L442K00	-0.040%	No expansion	1.07%

L Series
28 Day Permeability Results

Paul Lear
IT Corporation
May 28, 1999 *corrected*
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

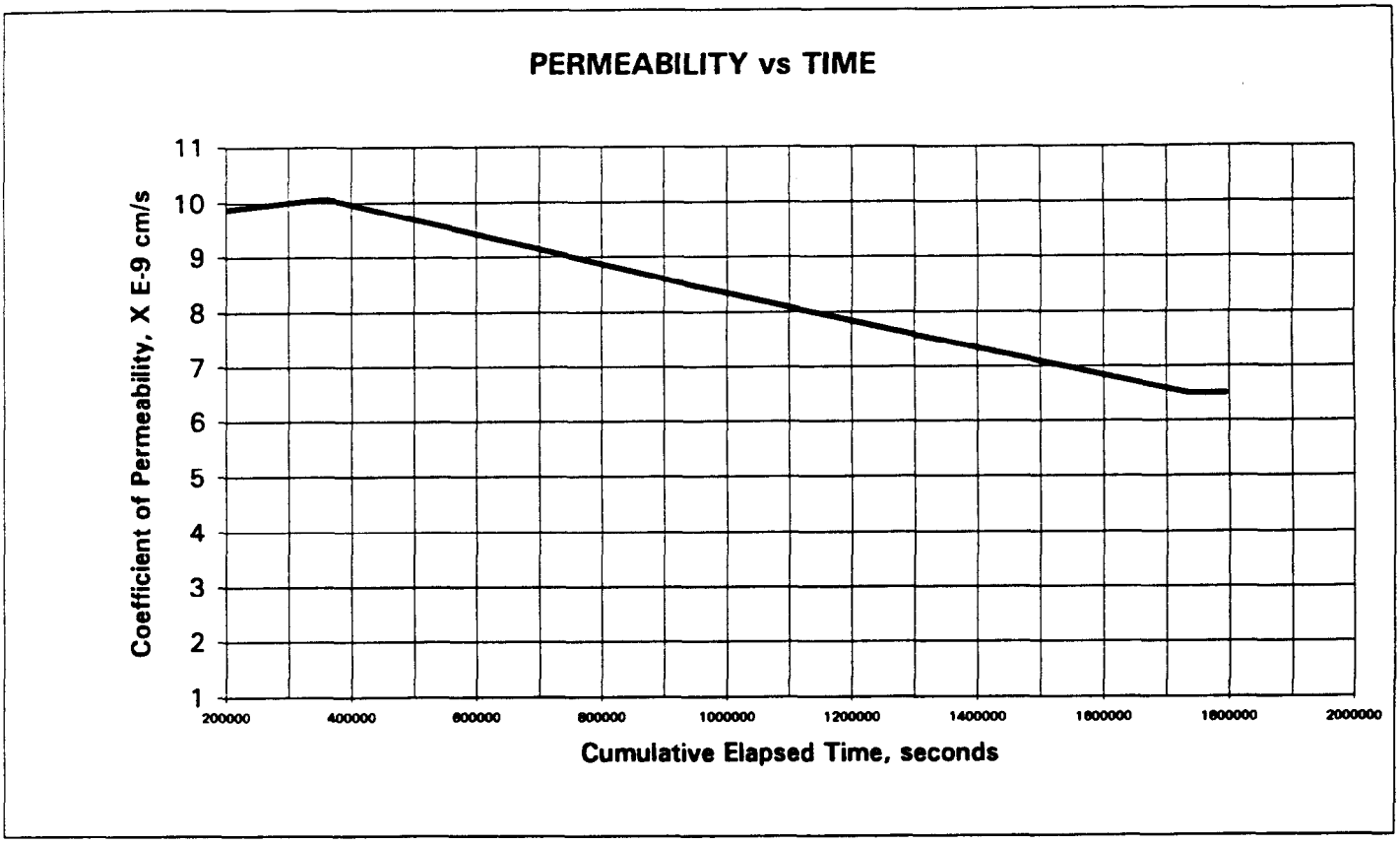
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. L312G00
IT LAB SAMPLE NO. ETDC-8111

	INITIAL	FINAL
Specimen diameter, cm	5.06	
Specimen length, cm	10.10	
Wet weight of specimen, g.	374.4	381.38
Specimen cross-sect. area, cm^2	20.1267	
Water content, %	29.7	32.1
Wet unit weight, pcf	115.0	
Dry unit weight, pcf	88.6	
Estimated degree of saturation, %	90.8	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Five tests performed	

Coefficient of Permeability, cm/s 8.7E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

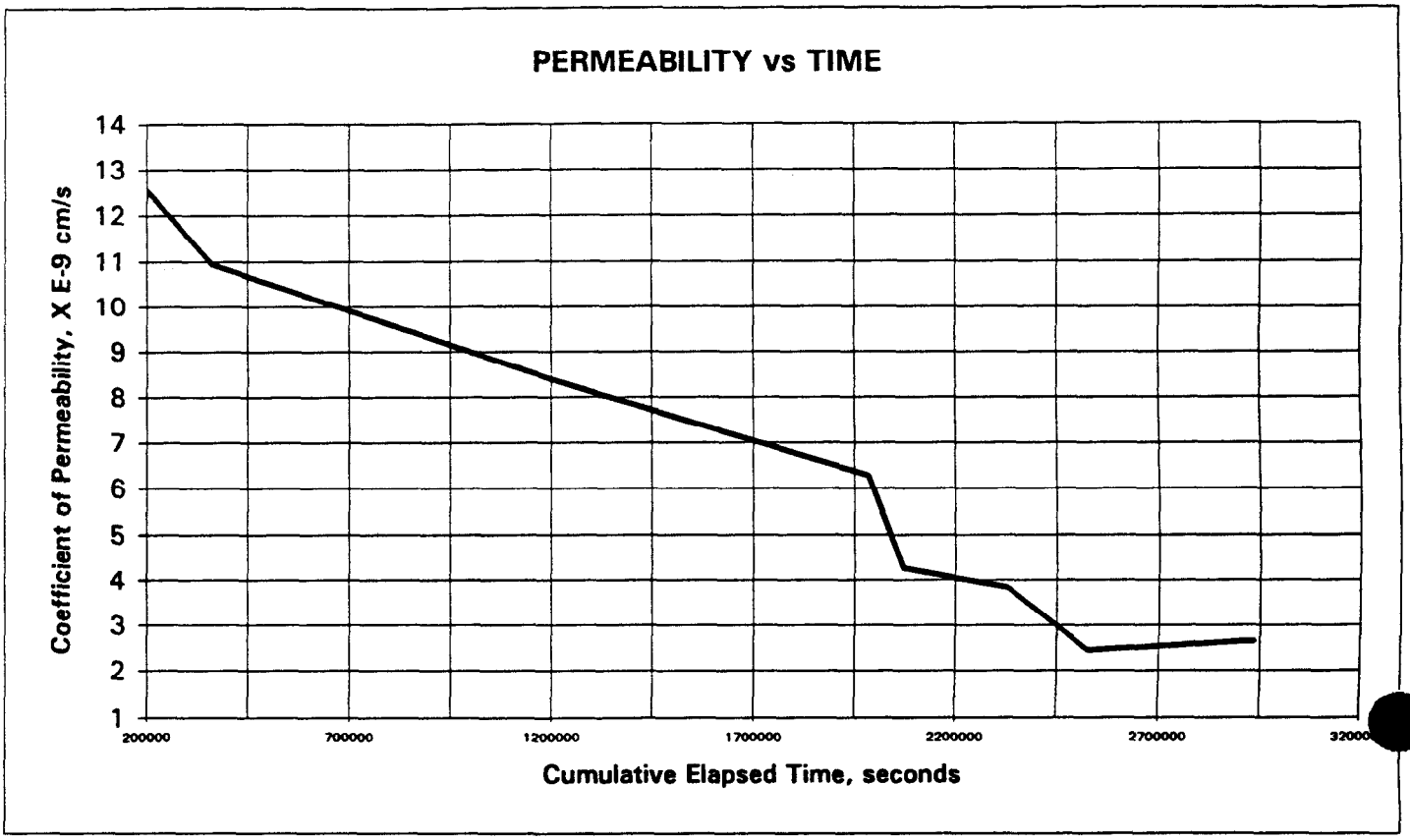
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. L322G00
IT LAB SAMPLE NO. ETDC-8112

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.17	
Wet weight of specimen, g.	388.66	393.06
Specimen cross-sect. area, cm^2	20.5122	
Water content, %	27.5	28.9
Wet unit weight, pcf	116.3	
Dry unit weight, pcf	91.2	
Estimated degree of saturation, %	89.5	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Eight tests performed	

Coefficient of Permeability, cm/s	3.3E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

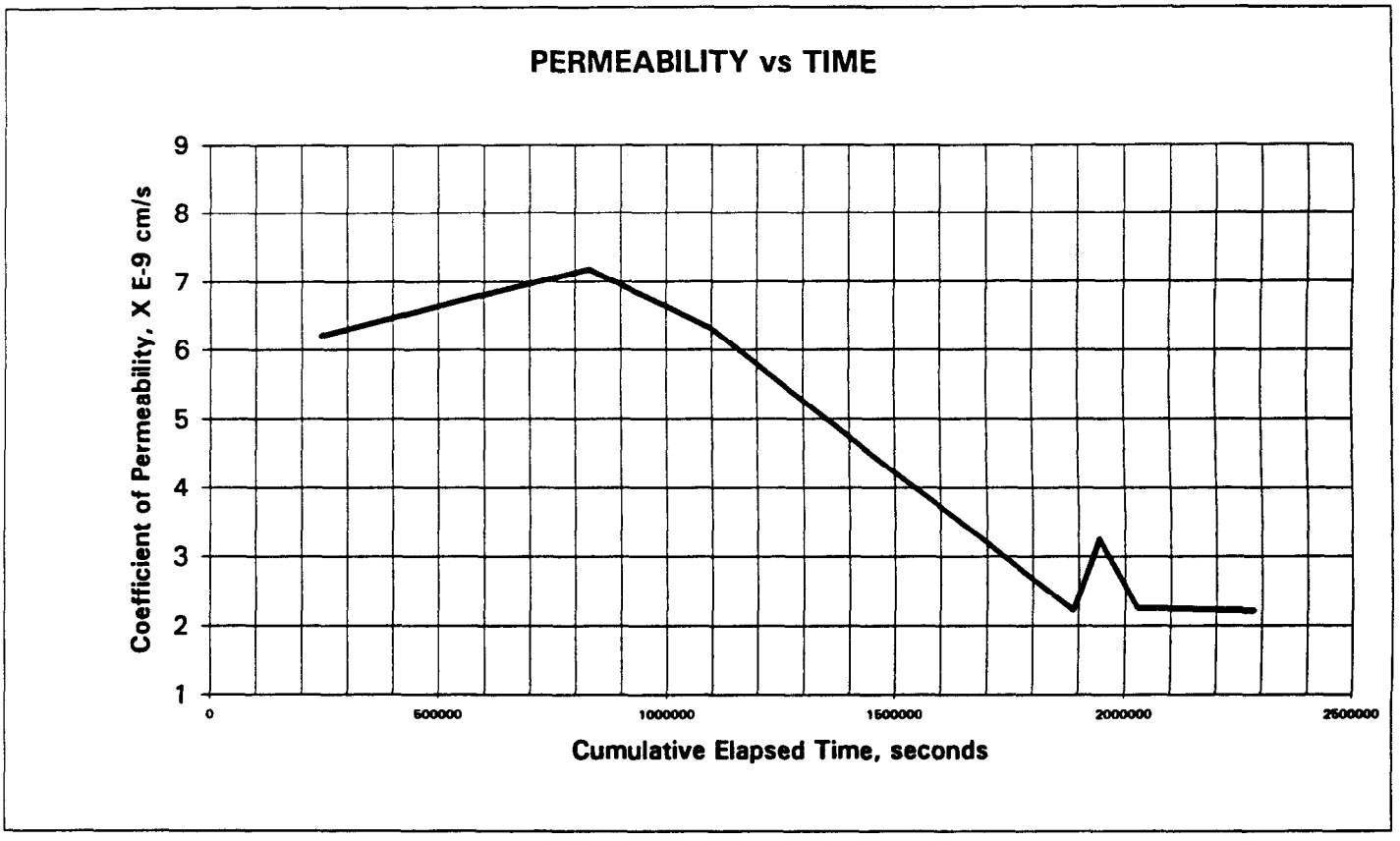
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L332G00
IT LAB SAMPLE NO. ETDC-8113

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.16	
Wet weight of specimen, g.	365.24	371.5
Specimen cross-sect. area, cm^2	20.4274	
Water content, %	35.5	37.8
Wet unit weight, pcf	109.9	
Dry unit weight, pcf	81.1	
Estimated degree of saturation, %	90.5	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	34.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	10.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Seven tests performed	

Coefficient of Permeability, cm/s	2.5E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

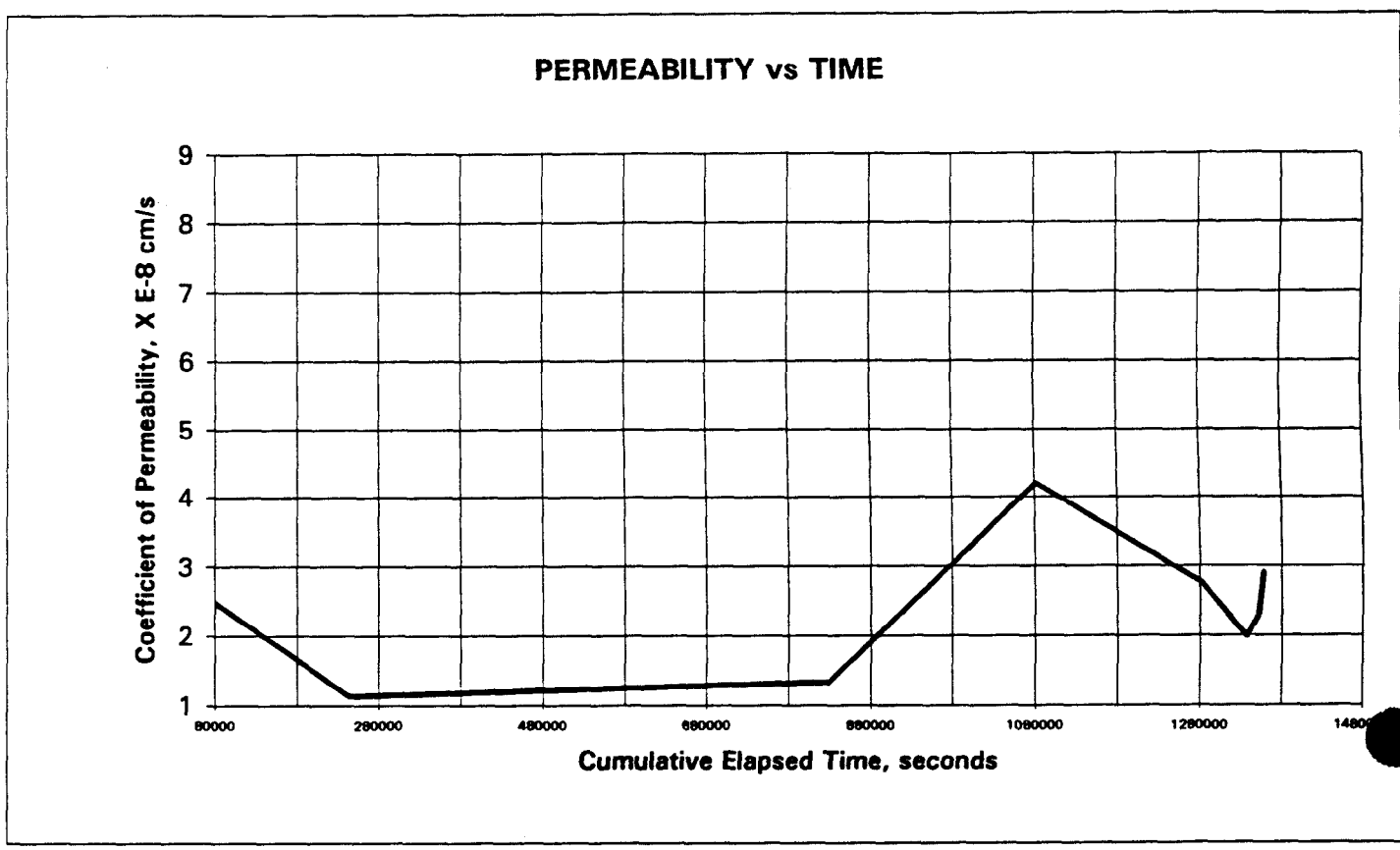
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. L342G00
IT LAB SAMPLE NO. ETDC-8114

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.17	
Wet weight of specimen, g.	374.72	377.56
Specimen cross-sect. area, cm^2	20.2615	
Water content, %	33.6	34.6
Wet unit weight, pcf	113.5	
Dry unit weight, pcf	85.0	
Estimated degree of saturation, %	94.1	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	34.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Eight tests performed	

Coefficient of Permeability, cm/s 2.5E-08



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

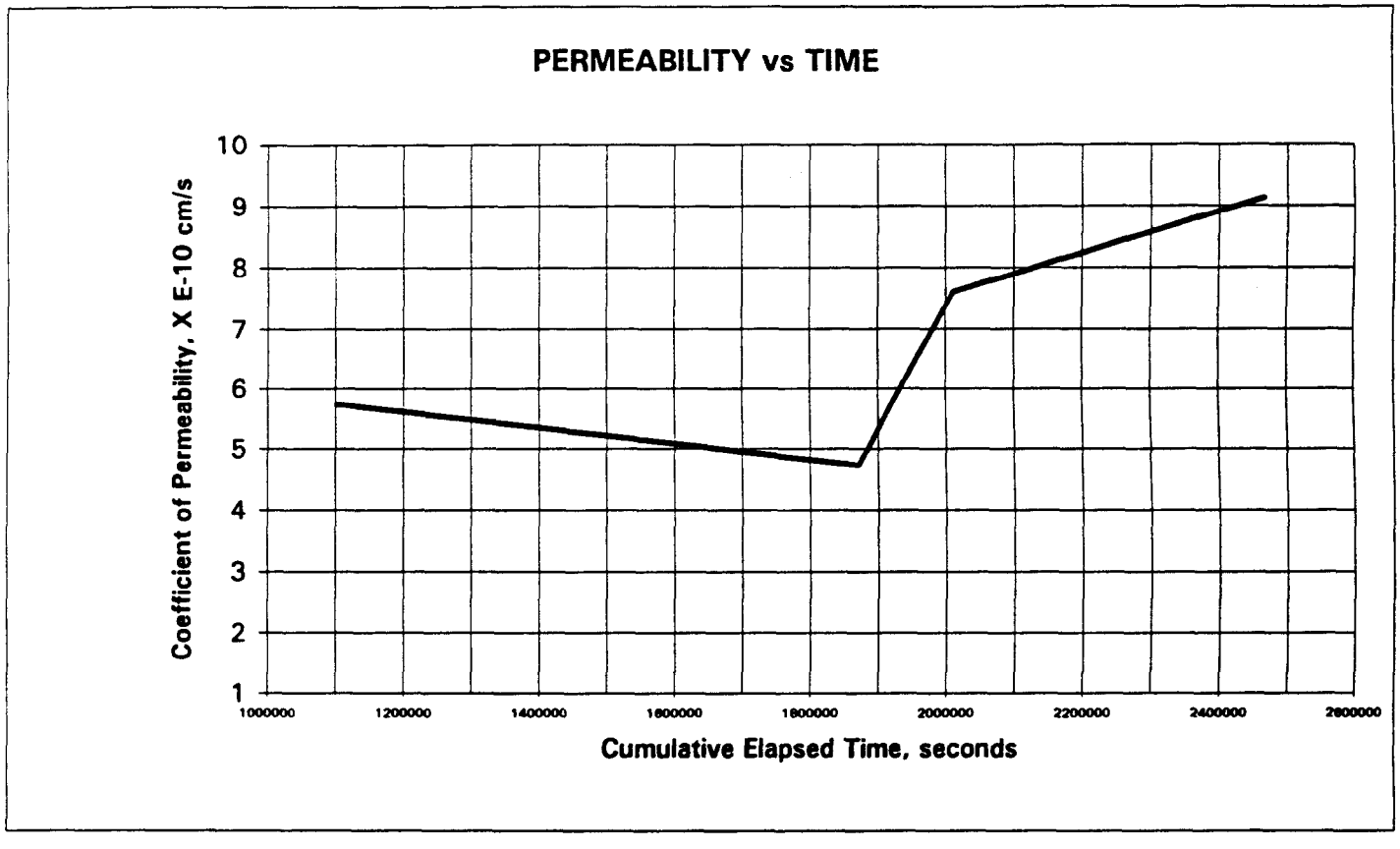
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L412G00
IT LAB SAMPLE NO. ETDC-8115

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.11	
Wet weight of specimen, g.	375.03	380.79
Specimen cross-sect. area, cm^2	20.2751	
Water content, %	30.3	32.3
Wet unit weight, pcf	114.3	
Dry unit weight, pcf	87.7	
Estimated degree of saturation, %	90.6	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	34.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Six tests performed	

Coefficient of Permeability, cm/s 6.8E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

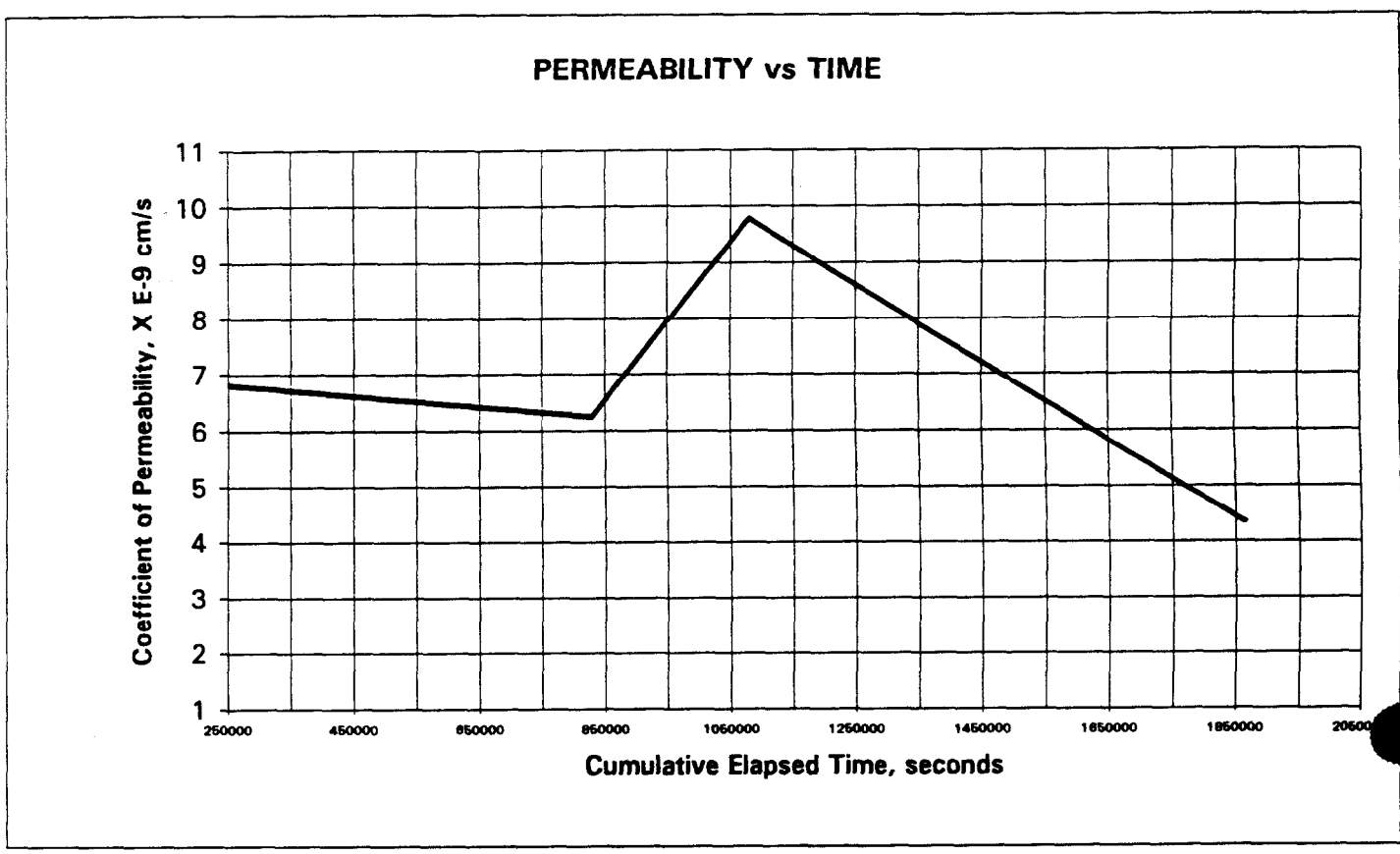
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. L422G00
IT LAB SAMPLE NO. ETDC-8116

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.16	
Wet weight of specimen, g.	390.91	393.61
Specimen cross-sect. area, cm^2	20.2953	
Water content, %	27.3	28.2
Wet unit weight, pcf	118.3	
Dry unit weight, pcf	93.0	
Estimated degree of saturation, %	92.7	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	34.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Five tests performed	

Coefficient of Permeability, cm/s 7.3E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

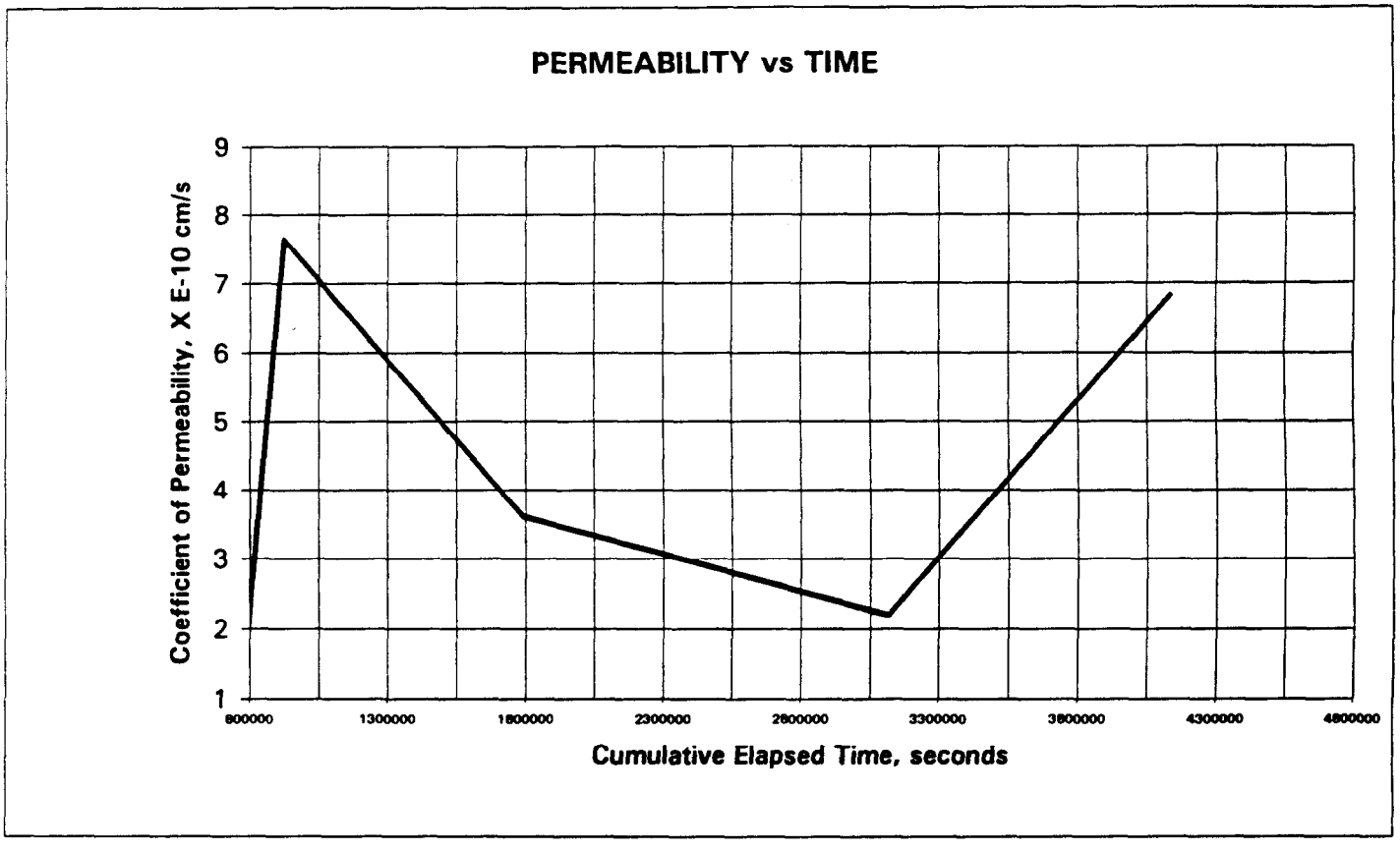
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	L432G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8117

	INITIAL	FINAL		
Specimen diameter, cm	5.08			
Specimen length, cm	10.16		Hydraulic gradient	41.6
Wet weight of specimen, g.	363.49	368.8	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	20.2548		Max. consolidation stress, psi	9.0
Water content, %	35.4	37.3	Total backpressure, psi	3.0
Wet unit weight, pcf	110.3		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	81.5		Sample molded	12/21/98
Estimated degree of saturation, %	90.9		Sample set up	1/21/99
Estimated spec. gravity of solids	2.65		Eight tests performed	

Coefficient of Permeability, cm/s 5.1E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

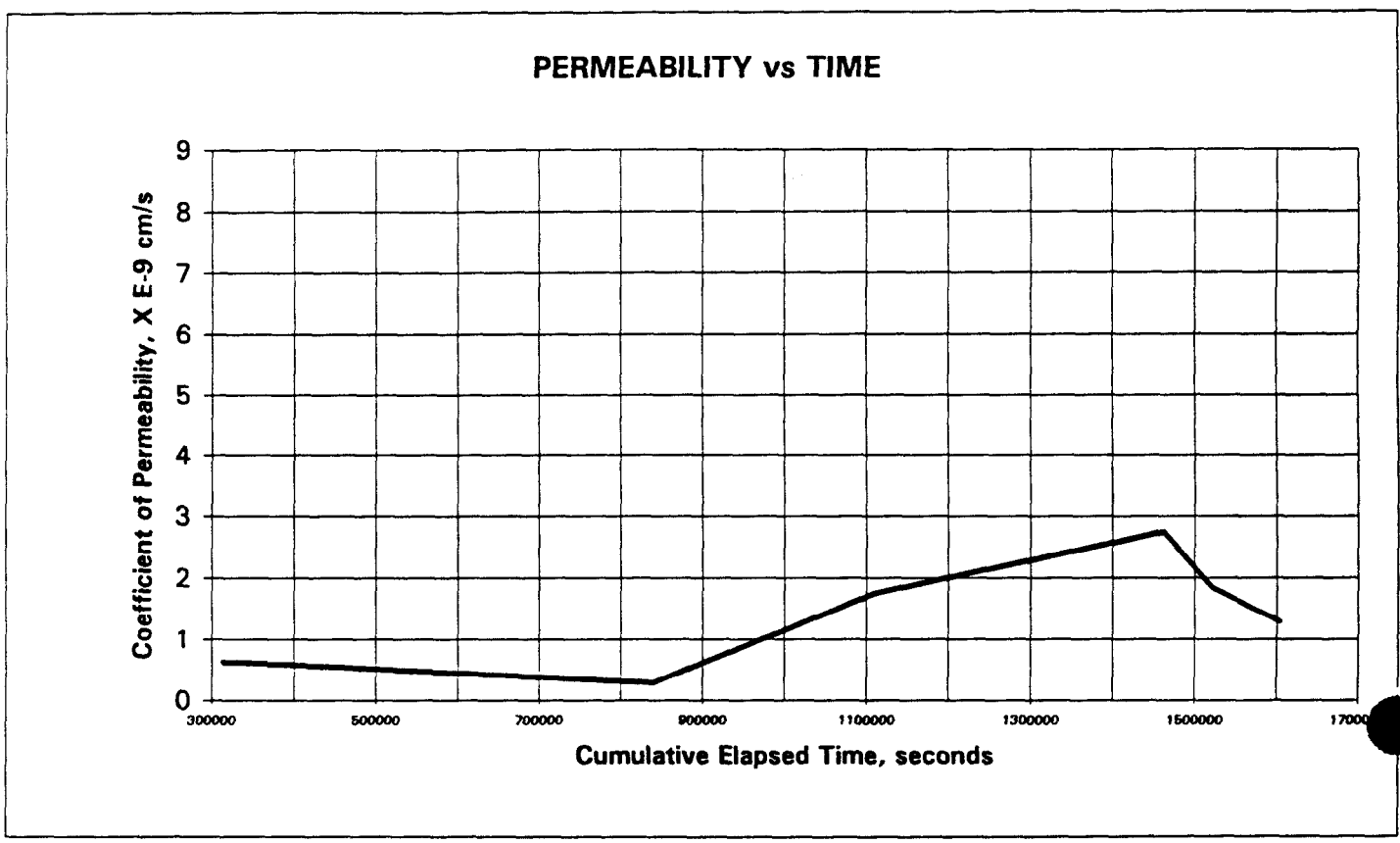
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L442G00
IT LAB SAMPLE NO. ETDC-8118

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.15	
Wet weight of specimen, g.	378.38	381.73
Specimen cross-sect. area, cm^2	20.3224	
Water content, %	31.9	33.1
Wet unit weight, pcf	114.6	
Dry unit weight, pcf	86.8	
Estimated degree of saturation, %	93.5	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/21/98
Sample set up	1/21/99
Six tests performed	

Coefficient of Permeability, cm/s 1.9E-09



L Series
90 Immersion Permeability Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

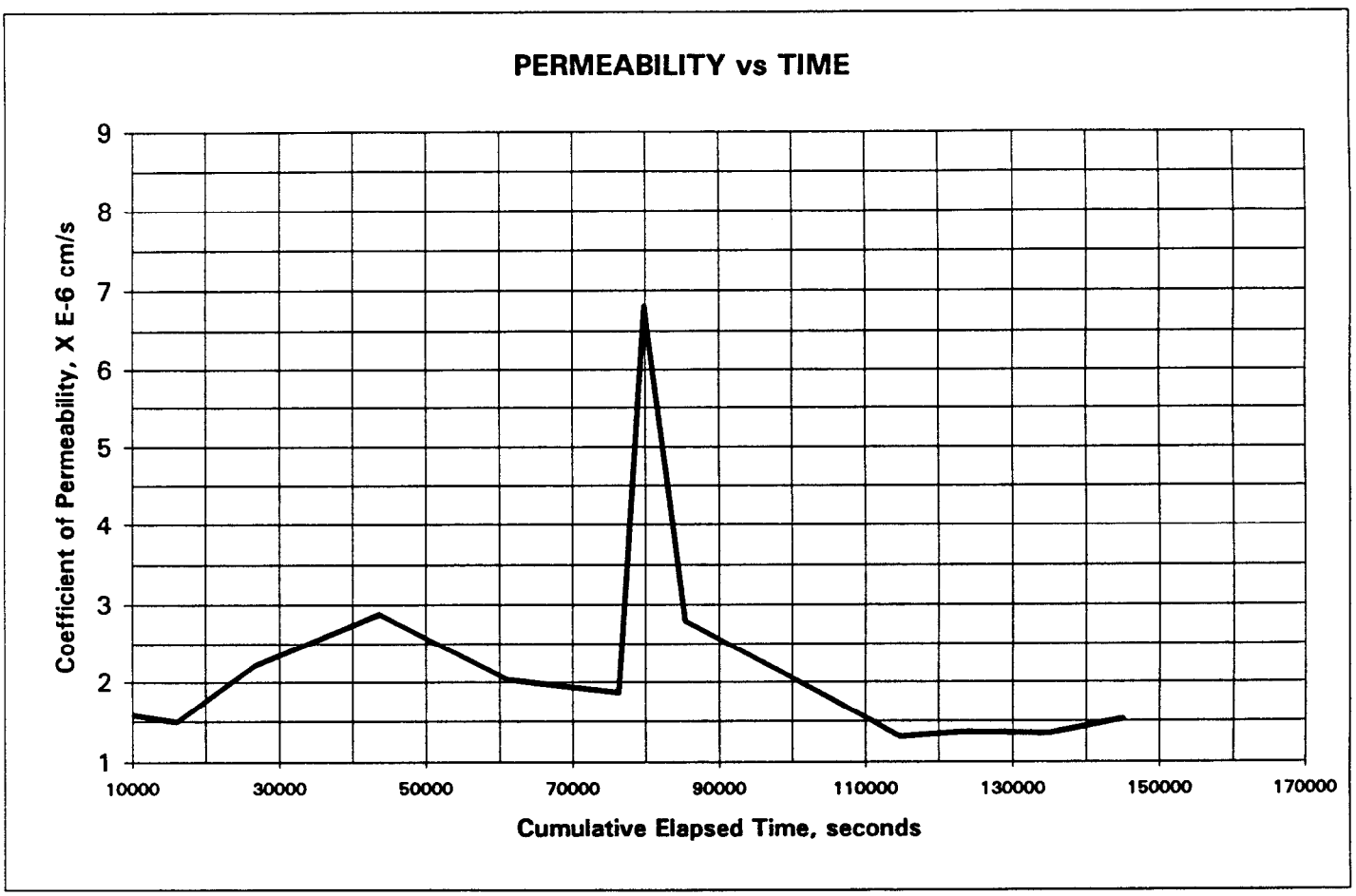
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L313G00
IT LAB SAMPLE NO. ETDC-8135

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	7.65	
Wet weight of specimen, g.	641.44	646.09
Specimen cross-sect. area, cm^2	45.1437	
Water content, %	27.5	28.4
Wet unit weight, pcf	116.0	
Dry unit weight, pcf	91.0	
Estimated degree of saturation, %	88.9	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	18.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Twelve tests performed	

Coefficient of Permeability, cm/s 1.4E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

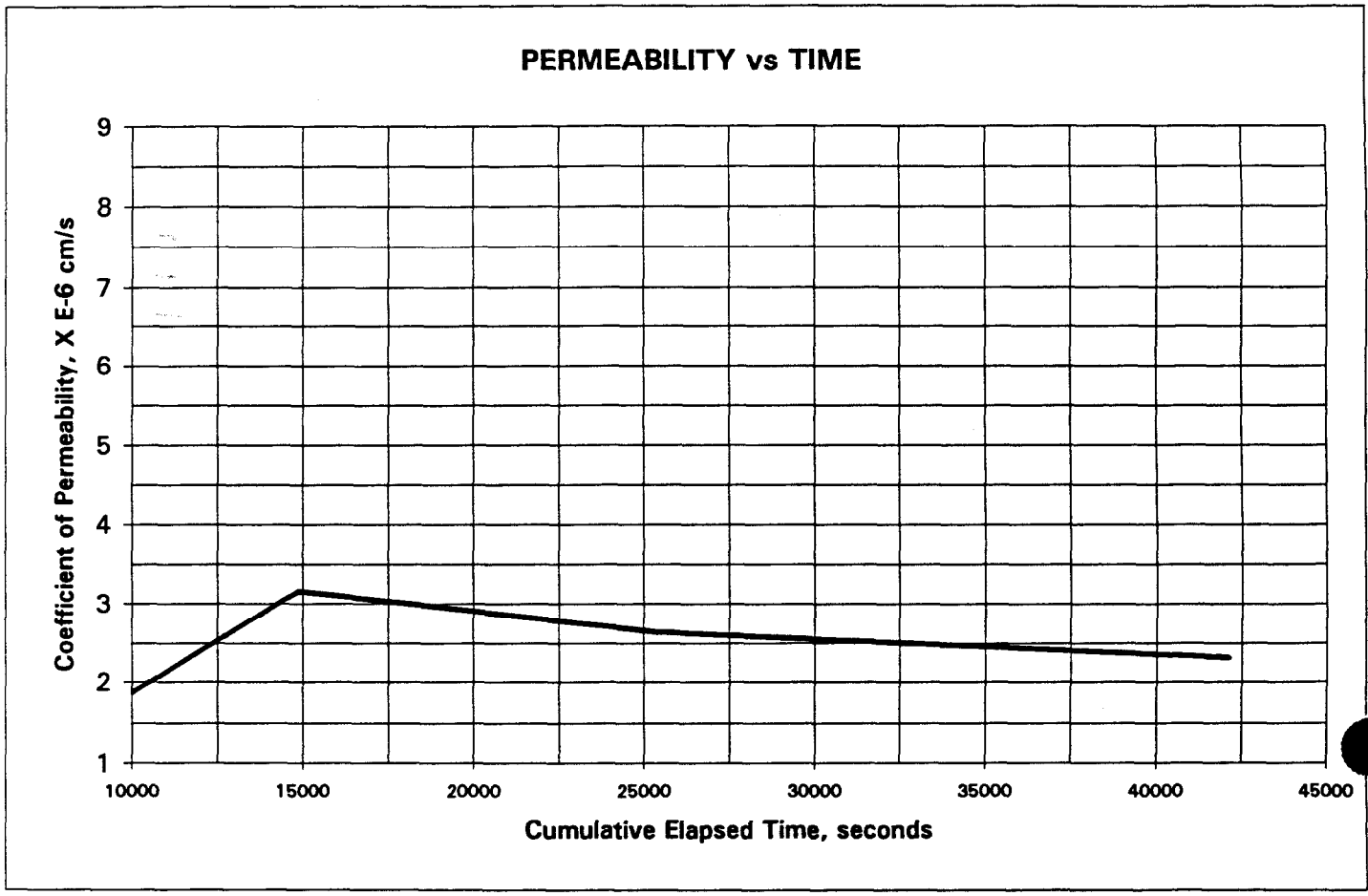
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L323G00
IT LAB SAMPLE NO. ETDC-8136

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	6.59	
Wet weight of specimen, g.	562.39	563.61
Specimen cross-sect. area, cm^2	45.3052	
Water content, %	28.5	28.8
Wet unit weight, pcf	117.6	
Dry unit weight, pcf	91.5	
Estimated degree of saturation, %	93.6	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	21.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Six tests performed	

Coefficient of Permeability, cm/s 2.6E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

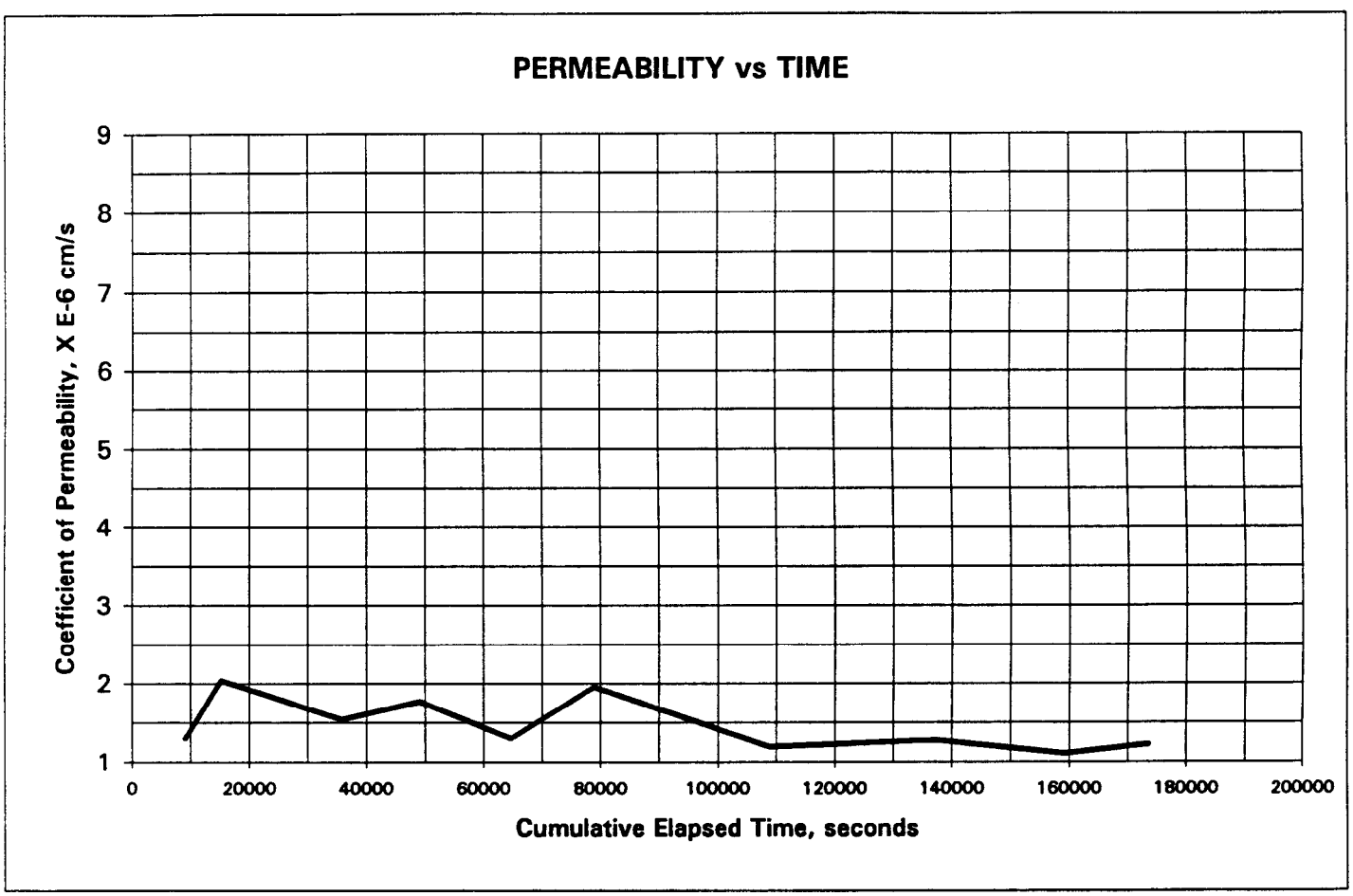
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L333G00
IT LAB SAMPLE NO. ETDC-8137

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	9.43	
Wet weight of specimen, g.	774.62	778.4
Specimen cross-sect. area, cm^2	45.2093	
Water content, %	31.5	32.1
Wet unit weight, pcf	113.5	
Dry unit weight, pcf	86.3	
Estimated degree of saturation, %	91.0	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	14.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Ten tests performed	

Coefficient of Permeability, cm/s 1.2E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

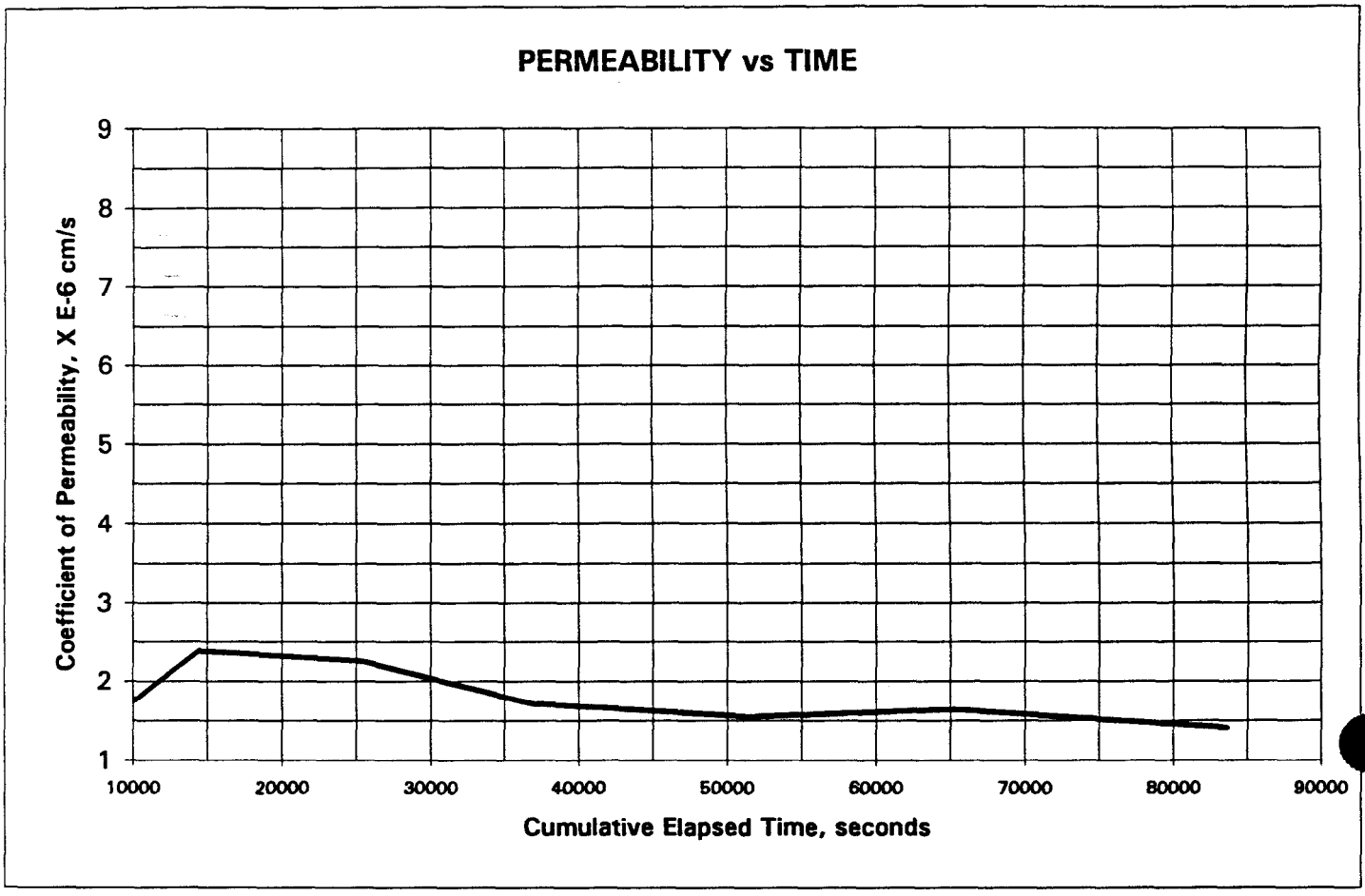
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L343G00
IT LAB SAMPLE NO. ETDC-8138

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	9.41	
Wet weight of specimen, g.	776.08	778.25
Specimen cross-sect. area, cm^2	45.3456	
Water content, %	32.4	32.8
Wet unit weight, pcf	113.5	
Dry unit weight, pcf	85.7	
Estimated degree of saturation, %	92.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	29.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Seven tests performed	

Coefficient of Permeability, cm/s 1.6E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

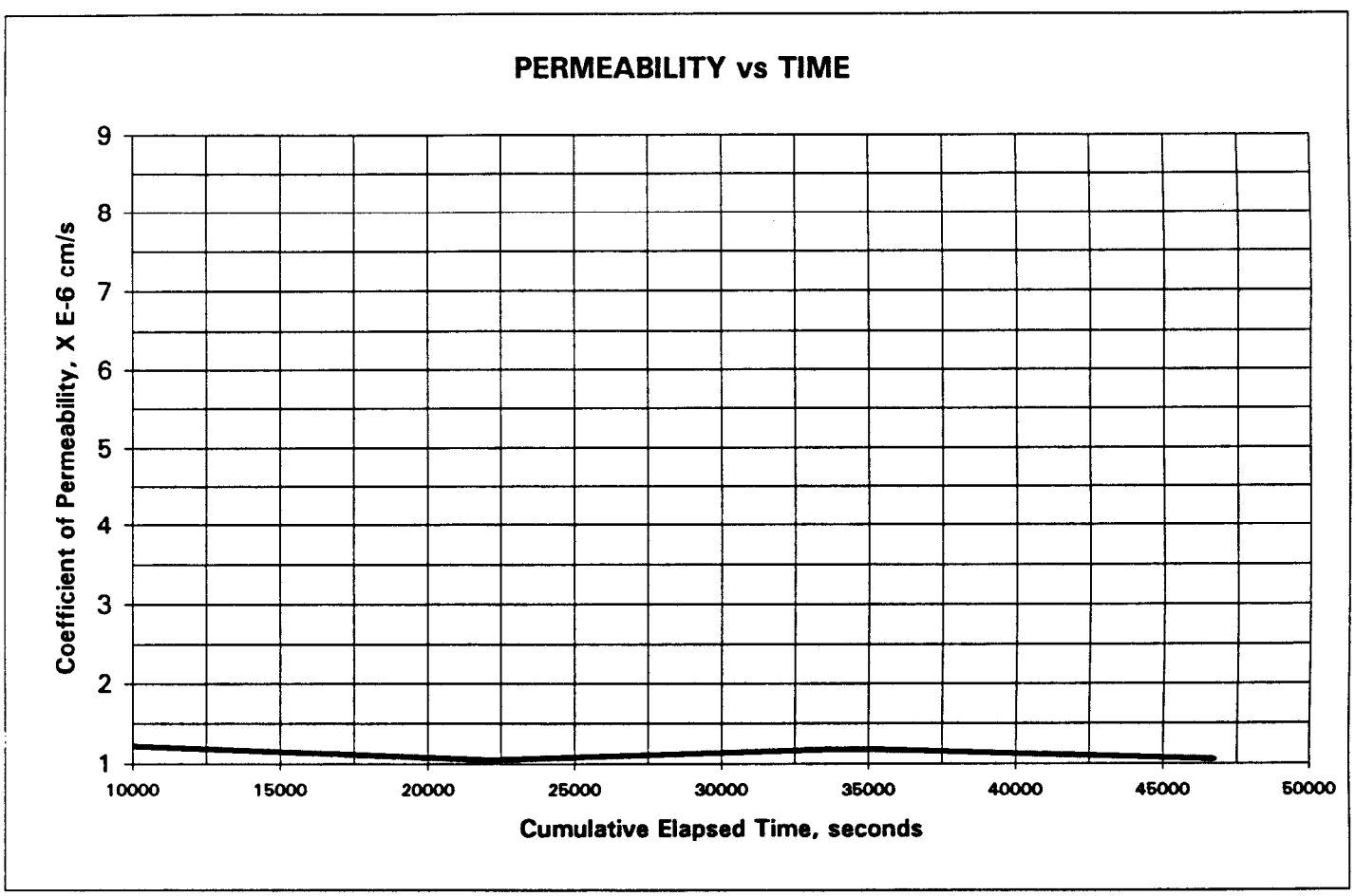
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L413G00
IT LAB SAMPLE NO. ETDC-8139

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	7.46	
Wet weight of specimen, g.	625.4	628.71
Specimen cross-sect. area, cm^2	45.1286	
Water content, %	28.6	29.3
Wet unit weight, pcf	115.9	
Dry unit weight, pcf	90.1	
Estimated degree of saturation, %	90.7	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	18.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Seven tests performed	

Coefficient of Permeability, cm/s 1.1E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

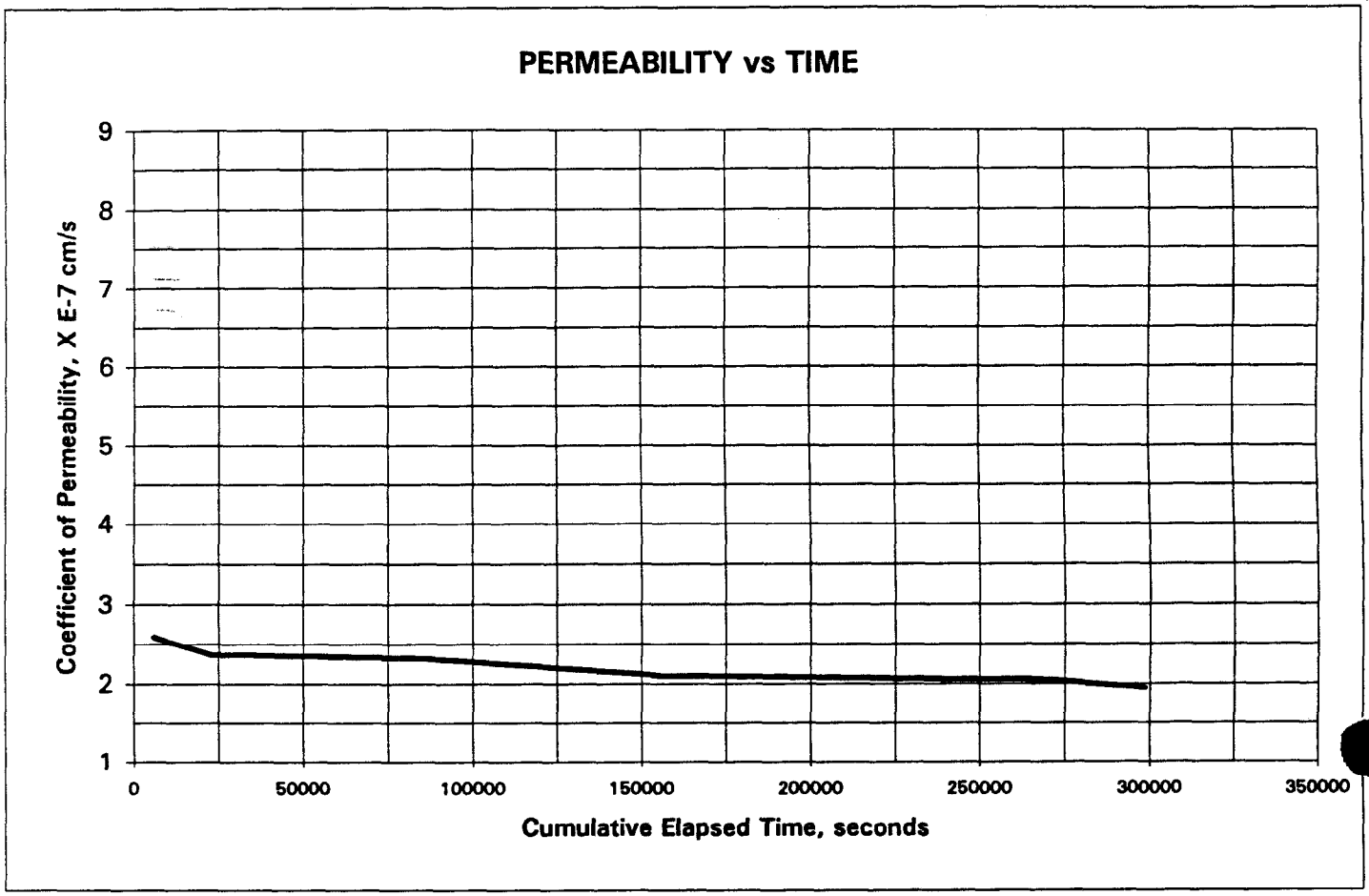
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L423G00
IT LAB SAMPLE NO. ETDC-8140

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	5.83	
Wet weight of specimen, g.	492.83	495.23
Specimen cross-sect. area, cm^2	45.3507	
Water content, %	25.5	26.1
Wet unit weight, pcf	116.3	
Dry unit weight, pcf	92.7	
Estimated degree of saturation, %	86.1	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	24.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Seven tests performed	

Coefficient of Permeability, cm/s 2.0E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

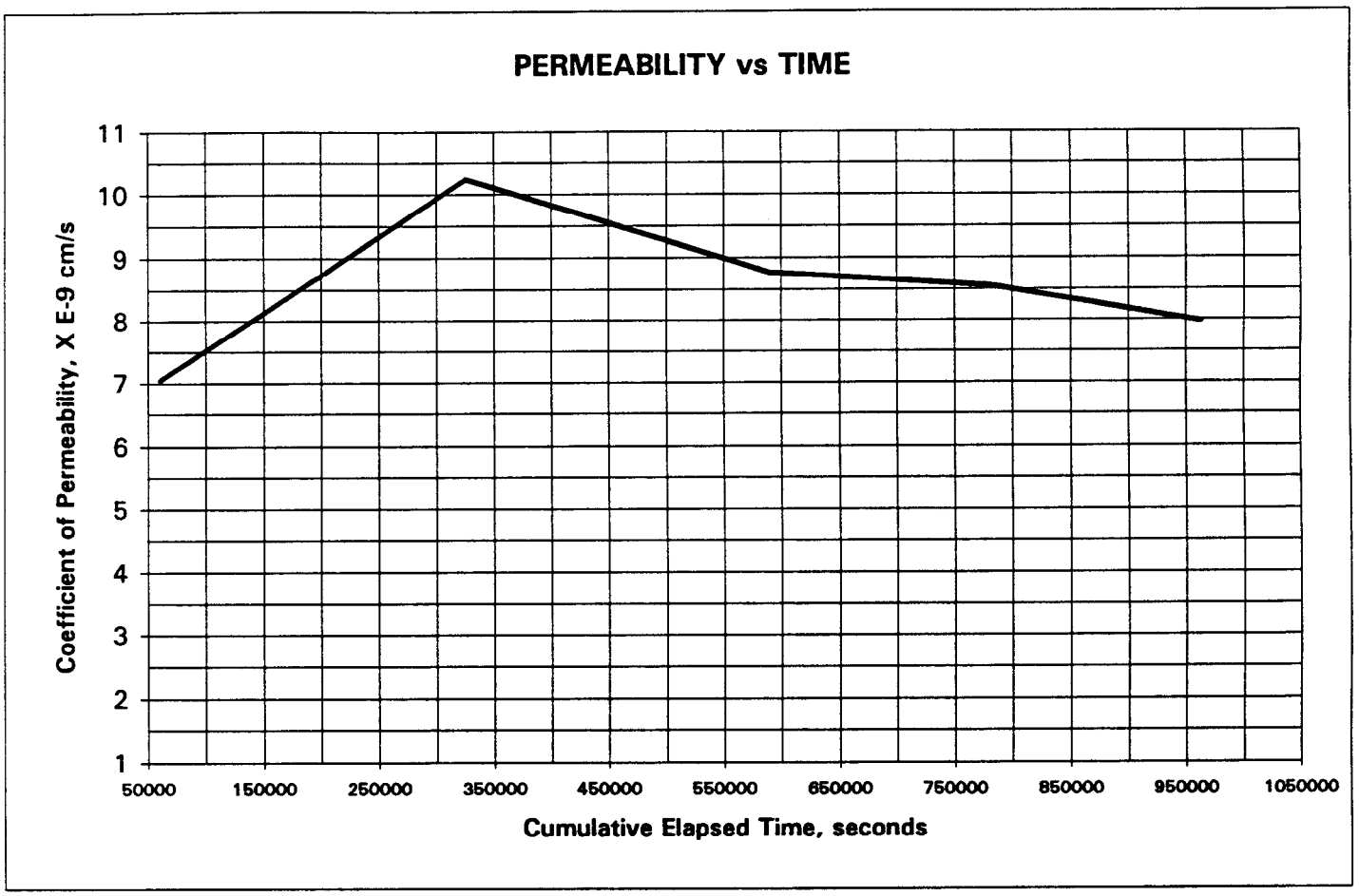
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L433G00
IT LAB SAMPLE NO. ETDC-8141

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	8.90	
Wet weight of specimen, g.	719.74	723.16
Specimen cross-sect. area, cm^2	45.4164	
Water content, %	33.7	34.3
Wet unit weight, pcf	111.1	
Dry unit weight, pcf	83.1	
Estimated degree of saturation, %	90.1	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	15.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Five tests performed	

Coefficient of Permeability, cm/s 8.9E-09



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

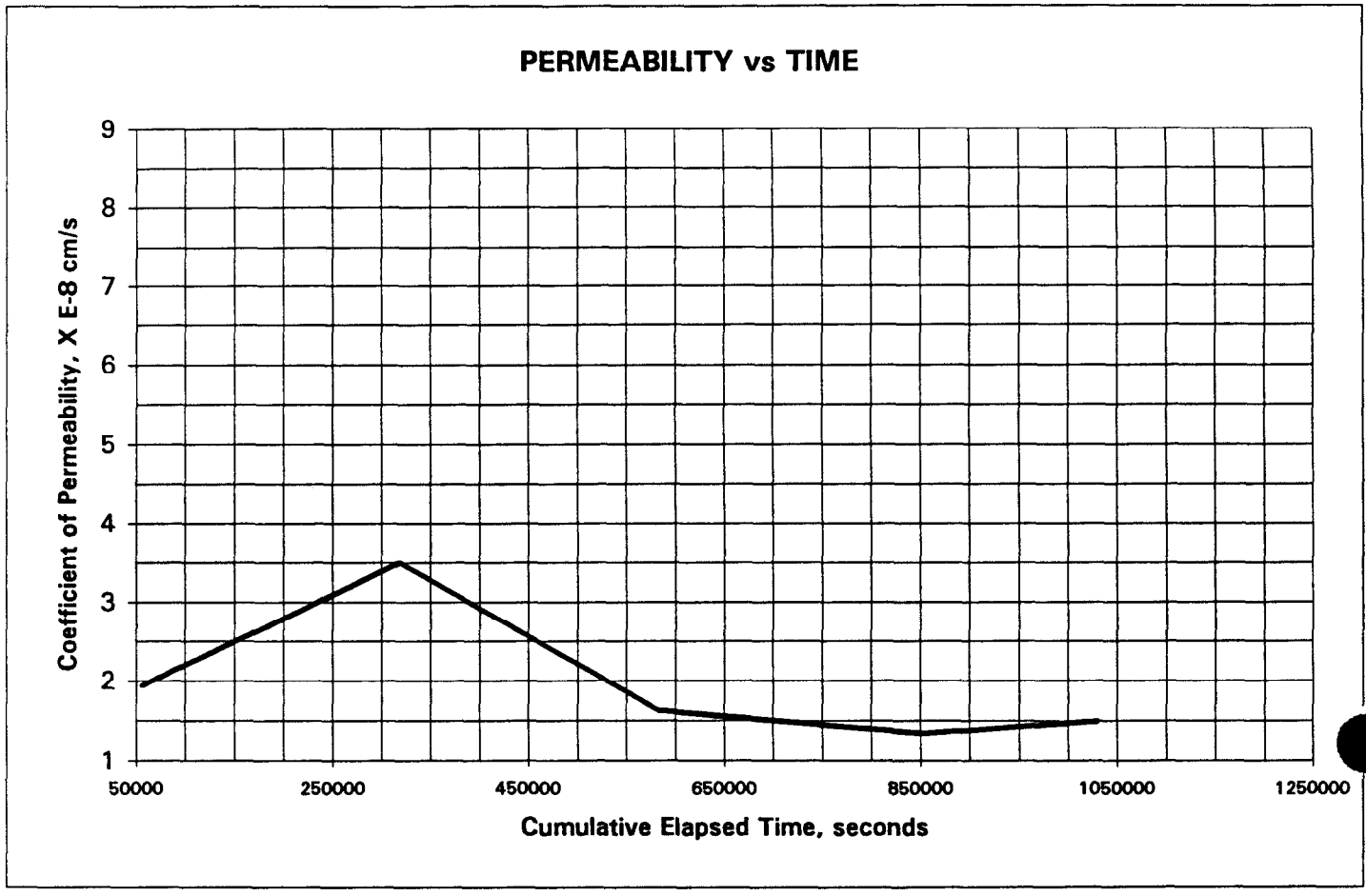
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. L443G00
IT LAB SAMPLE NO. ETDC-8142

	INITIAL	FINAL
Specimen diameter, cm	7.62	
Specimen length, cm	9.70	
Wet weight of specimen, g.	795.92	798.4
Specimen cross-sect. area, cm^2	45.5885	
Water content, %	30.1	30.5
Wet unit weight, pcf	112.4	
Dry unit weight, pcf	86.3	
Estimated degree of saturation, %	87.2	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	14.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Five tests performed	
Four consecutive tests +/-25% not achieved.	

Coefficient of Permeability, cm/s 1.5E-08



P Series
Leach Index

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P412

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	1340	Sample Weight (g):	372.64
Initial Contaminant Level (pCi):	499337.6		
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	100	180.0000	0.000360	1.750E-11	10.76
7	18000	14835	179	322.2000	0.000645	7.394E-11	10.13
24	61200	51231	150	270.0000	0.000541	1.551E-11	10.81
48	86400	125894	166	298.8000	0.000598	2.342E-11	10.63
72	86400	213818	156	280.8000	0.000562	3.513E-11	10.45
96	86400	300849	161	289.8000	0.000580	5.265E-11	10.28
120	86400	387596	75.1	135.1800	0.000271	1.476E-11	10.83
456	1209600	939462	795	1431.0000	0.002866	2.045E-11	10.69
1128	2419200	2716550	1170	2106.0000	0.004218	3.202E-11	10.49
2160	3715200	5768861	731	1315.8000	0.002635	1.126E-11	10.95

Average Leach Index: 10.60

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P422

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 1340

Sample Weight (g): 376.25

Initial Contaminant Level (pCi): 504175

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	126	226.8000	0.000450	2.725E-11	10.56
7	18000	14835	98.7	177.6600	0.000352	2.205E-11	10.66
24	61200	51231	68.4	123.1200	0.000244	3.164E-12	11.50
48	86400	125894	82.3	148.1400	0.000294	5.647E-12	11.25
72	86400	213818	84.1	151.3800	0.000300	1.002E-11	11.00
96	86400	300849	114	205.2000	0.000407	2.589E-11	10.59
120	86400	387596	62.3	112.1400	0.000222	9.963E-12	11.00
456	1209600	939462	819	1474.2000	0.002924	2.129E-11	10.67
1128	2419200	2716550	2380	4284.0000	0.008497	1.300E-10	9.89
2160	3715200	5768861	271	487.8000	0.000968	1.517E-12	11.82

Average Leach Index: 10.89

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P432

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	1340	Sample Weight (g):	356.98
Initial Contaminant Level (pCi):	478353.2		
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	115	207.0000	0.000433	2.522E-11	10.60
7	18000	14835	170	306.0000	0.000640	7.267E-11	10.14
24	61200	51231	141	253.8000	0.000531	1.493E-11	10.83
48	86400	125894	88.4	159.1200	0.000333	7.238E-12	11.14
72	86400	213818	188	338.4000	0.000707	5.560E-11	10.25
96	86400	300849	103	185.4000	0.000388	2.348E-11	10.63
120	86400	387596	61.6	110.8800	0.000232	1.082E-11	10.97
456	1209600	939462	892	1605.6000	0.003357	2.806E-11	10.55
1128	2419200	2716550	995	1791.0000	0.003744	2.524E-11	10.60
2160	3715200	5768861	1270	2286.0000	0.004779	3.702E-11	10.43

Average Leach Index: 10.61

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P442

Analyst: PRL

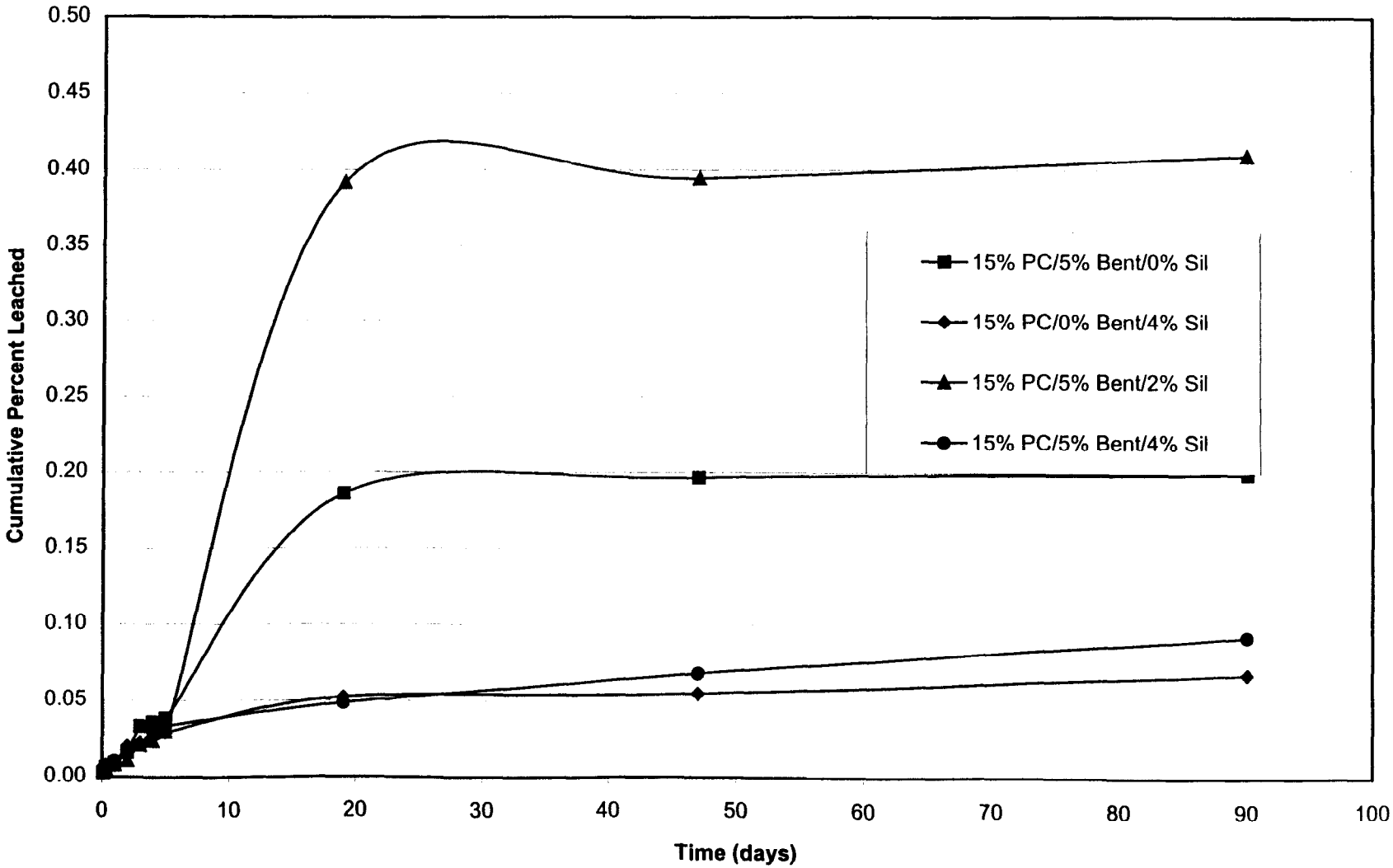
Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	1340	Sample Weight (g):	364.46
Initial Contaminant Level (pCi):	488376.4		
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	75.9	136.6200	0.000280	1.054E-11	10.98
7	18000	14835	23.1	41.5800	0.000085	1.287E-12	11.89
24	61200	51231	123	221.4000	0.000453	1.090E-11	10.96
48	86400	125894	79.9	143.8200	0.000294	5.672E-12	11.25
72	86400	213818	171	307.8000	0.000630	4.413E-11	10.36
96	86400	300849	31.2	56.1600	0.000115	2.067E-12	11.68
120	86400	387596	52	93.6000	0.000192	7.397E-12	11.13
456	1209600	939462	799	1438.2000	0.002945	2.160E-11	10.67
1128	2419200	2716550	890	1602.0000	0.003280	1.937E-11	10.71
2160	3715200	5768861	1310	2358.0000	0.004828	3.779E-11	10.42
					Average Leach Index:		11.00

Gross Alpha Leaching for the Bulk Fraction #1 from PRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P512

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	381.45
Initial Contaminant Level (pCi):	6827.955		
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	0.1	0.1800	0.000026	9.359E-14	13.03
7	18000	14835	0.145	0.2610	0.000038	2.595E-13	12.59
24	61200	51231	0.1	0.1800	0.000026	3.687E-14	13.43
48	86400	125894	0.265	0.4770	0.000070	3.192E-13	12.50
72	86400	213818	0.645	1.1610	0.000170	3.212E-12	11.49
96	86400	300849	0.1	0.1800	0.000026	1.086E-13	12.96
120	86400	387596	0.1	0.1800	0.000026	1.400E-13	12.85
456	1209600	939462	5.59	10.0620	0.001474	5.408E-12	11.27
1128	2419200	2716550	0.408	0.7344	0.000108	2.083E-14	13.68
2160	3715200	5768861	0.1	0.1800	0.000026	1.127E-15	14.95
					Average Leach Index:		12.88

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P522

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	388.98
Initial Contaminant Level (pCi):	6962.742		
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	0.1	0.1800	0.000026	9.000E-14	13.05
7	18000	14835	0.1	0.1800	0.000026	1.187E-13	12.93
24	61200	51231	0.1	0.1800	0.000026	3.545E-14	13.45
48	86400	125894	0.471	0.8478	0.000122	9.698E-13	12.01
72	86400	213818	0.1	0.1800	0.000026	7.424E-14	13.13
96	86400	300849	0.1	0.1800	0.000026	1.045E-13	12.98
120	86400	387596	0.156	0.2808	0.000040	3.275E-13	12.48
456	1209600	939462	0.892	1.6056	0.000231	1.324E-13	12.88
1128	2419200	2716550	0.1	0.1800	0.000026	1.203E-15	14.92
2160	3715200	5768861	0.507	0.9126	0.000131	2.785E-14	13.56

Average Leach Index: 13.14

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P532

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g): 17.9

Initial Contaminant Level (pCi): 6614.229

Monolith Height (cm): 10

Monolith Surface Area (cm^2): 176.72

Monolith Volume (cm^3): 196.35

Sample Weight (g): 369.51

Monolith Diameter (cm): 5

Leachate Volume (mL): 1800

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	0.1	0.1800	0.000027	9.974E-14	13.00
7	18000	14835	0.1	0.1800	0.000027	1.315E-13	12.88
24	61200	51231	0.1	0.1800	0.000027	3.929E-14	13.41
48	86400	125894	0.1	0.1800	0.000027	4.844E-14	13.31
72	86400	213818	0.364	0.6552	0.000099	1.090E-12	11.96
96	86400	300849	0.1	0.1800	0.000027	1.158E-13	12.94
120	86400	387596	0.227	0.4086	0.000062	7.685E-13	12.11
456	1209600	939462	13.3	23.9400	0.003619	3.263E-11	10.49
1128	2419200	2716550	0.1	0.1800	0.000027	1.333E-15	14.88
2160	3715200	5768861	0.552	0.9936	0.000150	3.658E-14	13.44

Average Leach Index: 12.84

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P542

Analyst: PRL

Date: 25-May-99

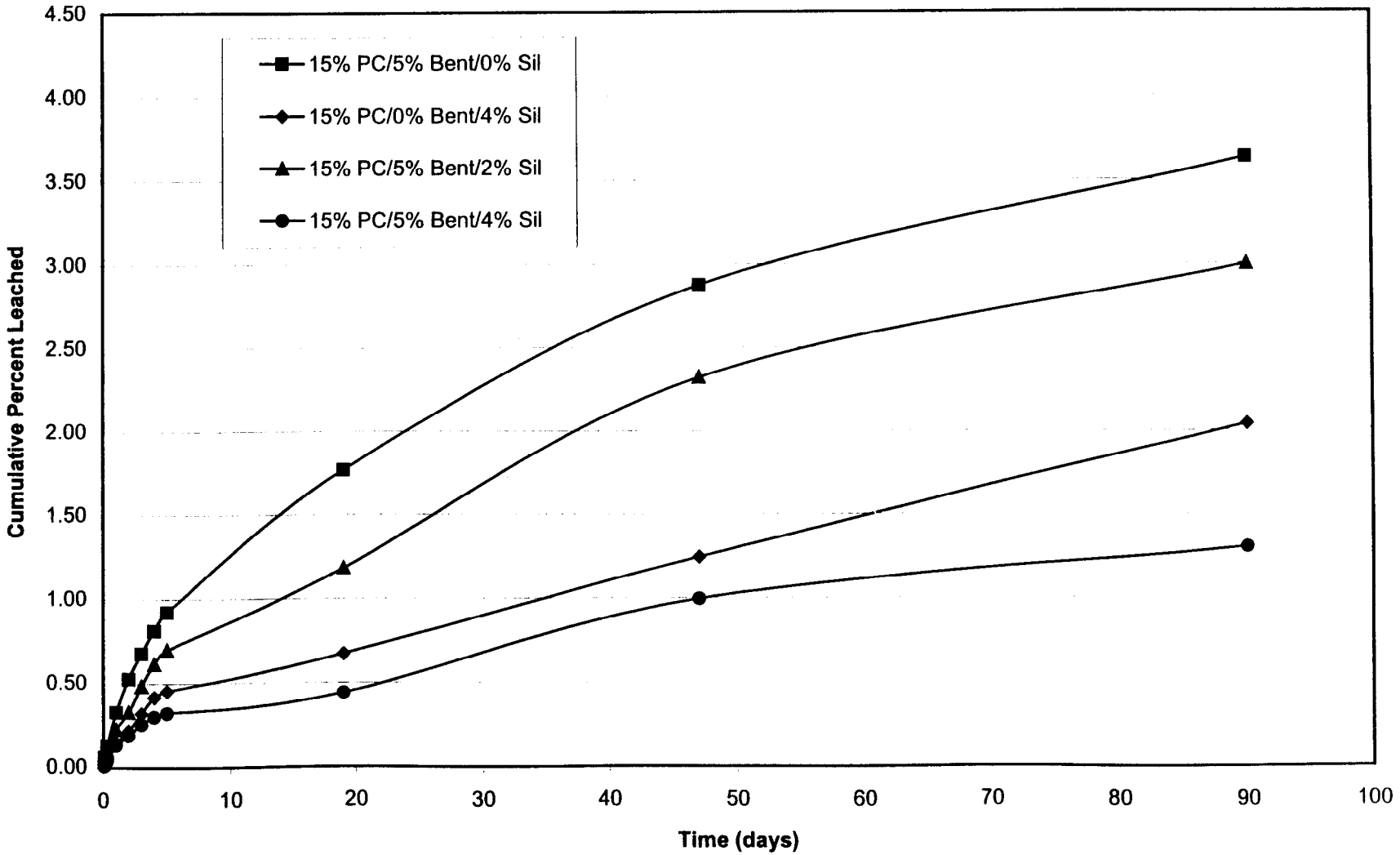
Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	17.9	Sample Weight (g):	374.21
Initial Contaminant Level (pCi):	6698.359		
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	0.188	0.3384	0.000051	3.437E-13	12.46
7	18000	14835	0.1	0.1800	0.000027	1.282E-13	12.89
24	61200	51231	0.1	0.1800	0.000027	3.831E-14	13.42
48	86400	125894	0.262	0.4716	0.000070	3.242E-13	12.49
72	86400	213818	0.126	0.2268	0.000034	1.274E-13	12.89
96	86400	300849	0.367	0.6606	0.000099	1.520E-12	11.82
120	86400	387596	0.1	0.1800	0.000027	1.454E-13	12.84
456	1209600	939462	0.551	0.9918	0.000148	5.460E-14	13.26
1128	2419200	2716550	0.735	1.3230	0.000198	7.023E-14	13.15
2160	3715200	5768861	0.904	1.6272	0.000243	9.566E-14	13.02

Average Leach Index: 12.82

Gross Beta Leaching for the Bulk Fraction #1 from the PSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P512

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 338

Sample Weight (g): 381.45

Initial Contaminant Level (pCi): 128930.1

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	43.8	78.8400	0.000611	5.036E-11	10.30
7	18000	14835	49.5	89.1000	0.000691	8.481E-11	10.07
24	61200	51231	141	253.8000	0.001969	2.056E-10	9.69
48	86400	125894	143	257.4000	0.001996	2.607E-10	9.58
72	86400	213818	107	192.6000	0.001494	2.479E-10	9.61
96	86400	300849	96.6	173.8800	0.001349	2.843E-10	9.55
120	86400	387596	79	142.2000	0.001103	2.450E-10	9.61
456	1209600	939462	605	1089.0000	0.008446	1.777E-10	9.75
1128	2419200	2716550	793	1427.4000	0.011071	2.207E-10	9.66
2160	3715200	5768861	545	981.0000	0.007609	9.385E-11	10.03

Average Leach Index: 9.78

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P522

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 338

Initial Contaminant Level (pCi): 131475.24

Monolith Height (cm): 10

Monolith Surface Area (cm^2): 176.72

Monolith Volume (cm^3): 196.35

Sample Weight (g): 388.98

Monolith Diameter (cm): 5

Leachate Volume (mL): 1800

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	14.9	26.8200	0.000204	5.604E-12	11.25
7	18000	14835	36.4	65.5200	0.000498	4.410E-11	10.36
24	61200	51231	56.3	101.3400	0.000771	3.152E-11	10.50
48	86400	125894	50.8	91.4400	0.000695	3.164E-11	10.50
72	86400	213818	75.4	135.7200	0.001032	1.184E-10	9.93
96	86400	300849	71.1	127.9800	0.000973	1.481E-10	9.83
120	86400	387596	26	46.8000	0.000356	2.552E-11	10.59
456	1209600	939462	160	288.0000	0.002191	1.195E-11	10.92
1128	2419200	2716550	417	750.6000	0.005709	5.868E-11	10.23
2160	3715200	5768861	581	1045.8000	0.007954	1.026E-10	9.99

Average Leach Index: 10.41

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P532

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g): 338

Sample Weight (g): 369.51

Initial Contaminant Level (pCi): 124894.38

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	24.3	43.7400	0.000350	1.652E-11	10.78
7	18000	14835	37.1	66.7800	0.000535	5.077E-11	10.29
24	61200	51231	95.1	171.1800	0.001371	9.966E-11	10.00
48	86400	125894	70.6	127.0800	0.001017	6.772E-11	10.17
72	86400	213818	108	194.4000	0.001557	2.691E-10	9.57
96	86400	300849	90.5	162.9000	0.001304	2.659E-10	9.58
120	86400	387596	58.2	104.7600	0.000839	1.417E-10	9.85
456	1209600	939462	336	604.8000	0.004842	5.840E-11	10.23
1128	2419200	2716550	790	1422.0000	0.011386	2.334E-10	9.63
2160	3715200	5768861	468	842.4000	0.006745	7.375E-11	10.13

Average Leach Index: 10.02

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P542

Analyst: PRL

Date: 25-May-99

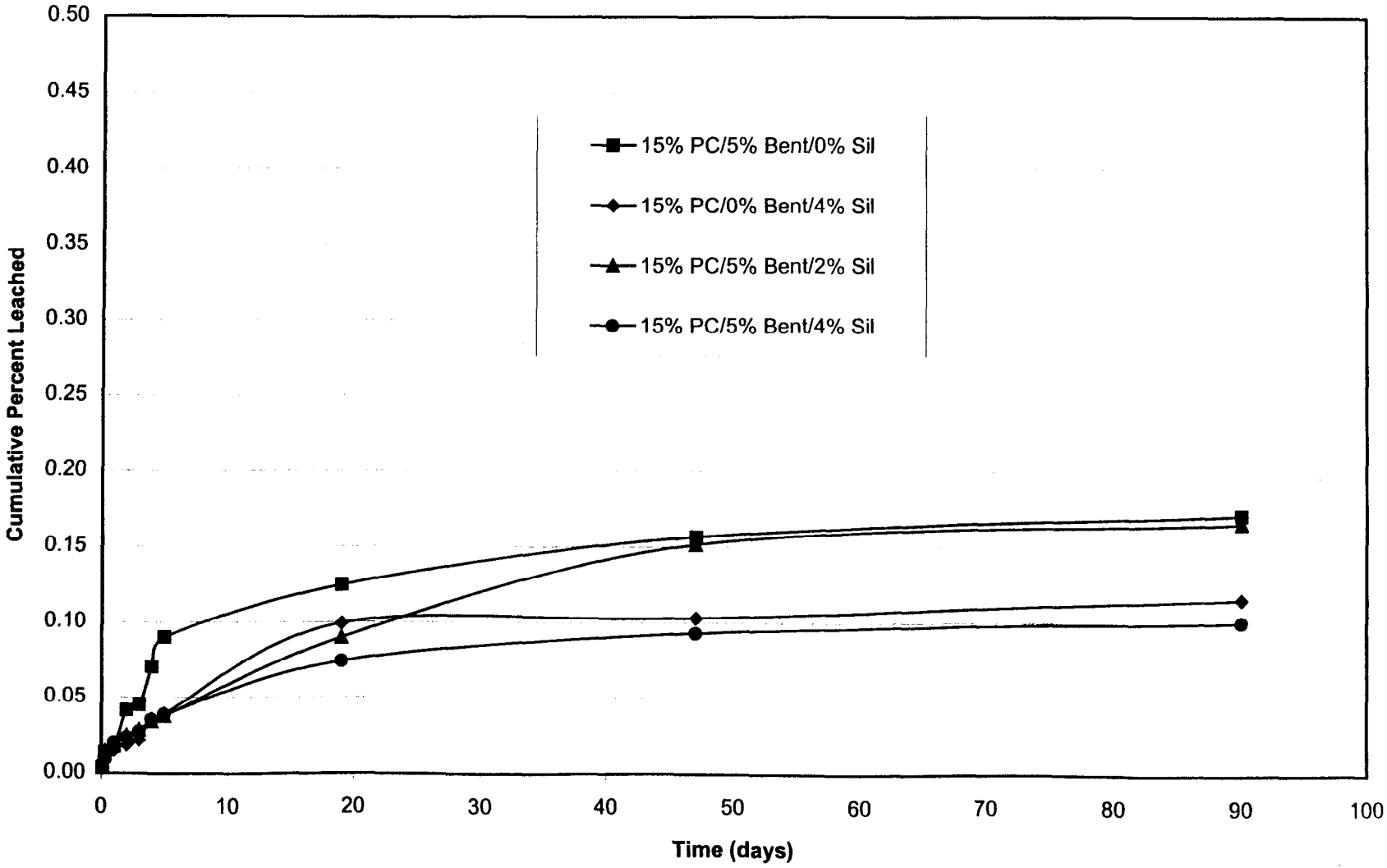
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	338	Sample Weight (g):	374.21
Initial Contaminant Level (pCi):	126482.98		
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	7.04	12.6720	0.000100	1.352E-12	11.87
7	18000	14835	20.7	37.2600	0.000295	1.541E-11	10.81
24	61200	51231	63.6	114.4800	0.000905	4.346E-11	10.36
48	86400	125894	41.8	75.2400	0.000595	2.315E-11	10.64
72	86400	213818	46.9	84.4200	0.000667	4.949E-11	10.31
96	86400	300849	30	54.0000	0.000427	2.849E-11	10.55
120	86400	387596	15.9	28.6200	0.000226	1.031E-11	10.99
456	1209600	939462	82.4	148.3200	0.001173	3.424E-12	11.47
1128	2419200	2716550	389	700.2000	0.005536	5.517E-11	10.26
2160	3715200	5768861	216	388.8000	0.003074	1.532E-11	10.81

Average Leach Index: 10.81

Gross Alpha Leaching for the Bulk Fraction #2 from PRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P612

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	382.1
Initial Contaminant Level (pCi):	5158.35		
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	0.1	0.1800	0.000035	1.640E-13	12.79
7	18000	14835	0.292	0.5256	0.000102	1.844E-12	11.73
24	61200	51231	0.1	0.1800	0.000035	6.460E-14	13.19
48	86400	125894	0.695	1.2510	0.000243	3.847E-12	11.41
72	86400	213818	0.1	0.1800	0.000035	1.353E-13	12.87
96	86400	300849	0.73	1.3140	0.000255	1.014E-11	10.99
120	86400	387596	0.561	1.0098	0.000196	7.717E-12	11.11
456	1209600	939462	0.983	1.7694	0.000343	2.930E-13	12.53
1128	2419200	2716550	0.93	1.6740	0.000325	1.896E-13	12.72
2160	3715200	5768861	0.416	0.7488	0.000145	3.416E-14	13.47

Average Leach Index: 12.28

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P622

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	392.54
Initial Contaminant Level (pCi):	5299.29		
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	0.1	0.1800	0.000034	1.554E-13	12.81
7	18000	14835	0.147	0.2646	0.000050	4.427E-13	12.35
24	61200	51231	0.197	0.3546	0.000067	2.375E-13	12.62
48	86400	125894	0.1	0.1800	0.000034	7.547E-14	13.12
72	86400	213818	0.1	0.1800	0.000034	1.282E-13	12.89
96	86400	300849	0.414	0.7452	0.000141	3.091E-12	11.51
120	86400	387596	0.1	0.1800	0.000034	2.323E-13	12.63
456	1209600	939462	1.76	3.1680	0.000598	8.900E-13	12.05
1128	2419200	2716550	0.116	0.2088	0.000039	2.795E-15	14.55
2160	3715200	5768861	0.371	0.6678	0.000126	2.574E-14	13.59

Average Leach Index: 12.81

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P632

Analyst: PRL Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	13.5	Sample Weight (g):	367.59
Initial Contaminant Level (pCi):	4962.465		
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	0.1	0.1800	0.000036	1.772E-13	12.75
7	18000	14835	0.299	0.5382	0.000108	2.089E-12	11.68
24	61200	51231	0.1	0.1800	0.000036	6.980E-14	13.16
48	86400	125894	0.187	0.3366	0.000068	3.009E-13	12.52
72	86400	213818	0.1	0.1800	0.000036	1.462E-13	12.84
96	86400	300849	0.154	0.2772	0.000056	4.877E-13	12.31
120	86400	387596	0.1	0.1800	0.000036	2.650E-13	12.58
456	1209600	939462	1.43	2.5740	0.000519	6.700E-13	12.17
1128	2419200	2716550	1.71	3.0780	0.000620	6.926E-13	12.16
2160	3715200	5768861	0.388	0.6984	0.000141	3.211E-14	13.49

Average Leach Index: 12.57

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P642

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g): 13.5

Sample Weight (g): 374.5

Initial Contaminant Level (pCi): 5055.75

Monolith Height (cm): 10

Monolith Diameter (cm): 5

Monolith Surface Area (cm^2): 176.72

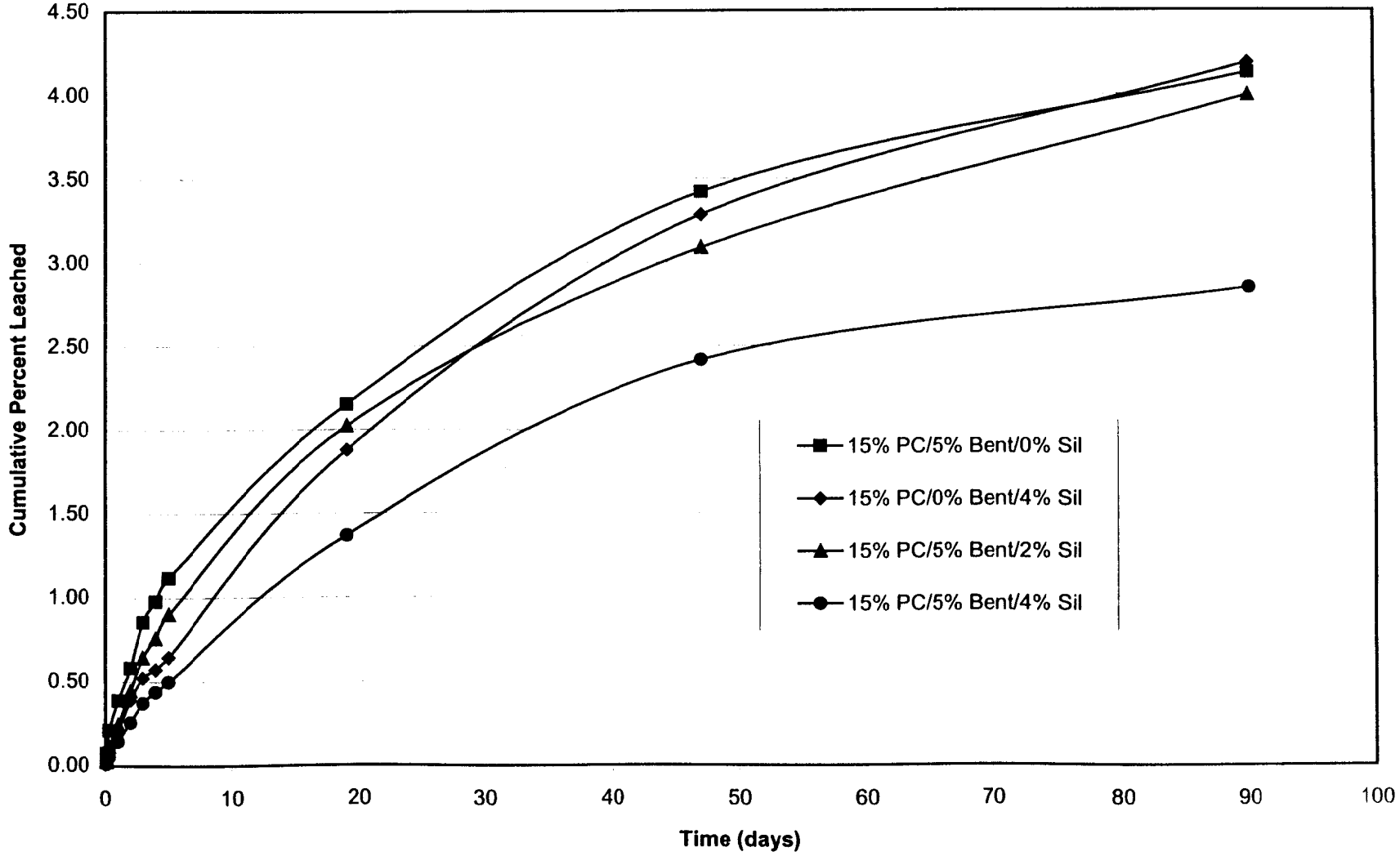
Leachate Volume (mL): 1800

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	0.158	0.2844	0.000056	4.261E-13	12.37
7	18000	14835	0.1	0.1800	0.000036	2.251E-13	12.65
24	61200	51231	0.311	0.5598	0.000111	6.504E-13	12.19
48	86400	125894	0.1	0.1800	0.000036	8.291E-14	13.08
72	86400	213818	0.1	0.1800	0.000036	1.408E-13	12.85
96	86400	300849	0.223	0.4014	0.000079	9.853E-13	12.01
120	86400	387596	0.1	0.1800	0.000036	2.553E-13	12.59
456	1209600	939462	0.989	1.7802	0.000352	3.088E-13	12.51
1128	2419200	2716550	0.533	0.9594	0.000190	6.483E-14	13.19
2160	3715200	5768861	0.208	0.3744	0.000074	8.890E-15	14.05

Average Leach Index: 12.75

Gross Beta Leaching for the Bulk Fraction #2 from the PSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P612

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	183	Sample Weight (g):	382.1
Initial Contaminant Level (pCi):	69924.3		
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	28.7	51.6600	0.000739	7.351E-11	10.13
7	18000	14835	53.1	95.5800	0.001367	3.318E-10	9.48
24	61200	51231	69	124.2000	0.001776	1.674E-10	9.78
48	86400	125894	75	135.0000	0.001931	2.438E-10	9.61
72	86400	213818	106	190.8000	0.002729	8.271E-10	9.08
96	86400	300849	47.8	86.0400	0.001230	2.367E-10	9.63
120	86400	387596	54.7	98.4600	0.001408	3.993E-10	9.40
456	1209600	939462	401	721.8000	0.010323	2.654E-10	9.58
1128	2419200	2716550	493	887.4000	0.012691	2.899E-10	9.54
2160	3715200	5768861	275	495.0000	0.007079	8.124E-11	10.09

Average Leach Index: 9.63

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P622

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	183	Sample Weight (g):	392.54
Initial Contaminant Level (pCi):	71834.82		
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	12.9	23.2200	0.000323	1.407E-11	10.85
7	18000	14835	29.8	53.6400	0.000747	9.902E-11	10.00
24	61200	51231	40.5	72.9000	0.001015	5.464E-11	10.26
48	86400	125894	72.9	131.2200	0.001827	2.183E-10	9.66
72	86400	213818	52.3	94.1400	0.001311	1.908E-10	9.72
96	86400	300849	19.9	35.8200	0.000499	3.887E-11	10.41
120	86400	387596	29.2	52.5600	0.000732	1.078E-10	9.97
456	1209600	939462	492	885.6000	0.012328	3.785E-10	9.42
1128	2419200	2716550	561	1009.8000	0.014057	3.557E-10	9.45
2160	3715200	5768861	361	649.8000	0.009046	1.326E-10	9.88

Average Leach Index: 9.96

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P632

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	183	Sample Weight (g):	367.59
Initial Contaminant Level (pCi):	67268.97		
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	9.5	17.1000	0.000254	8.702E-12	11.06
7	18000	14835	33.6	60.4800	0.000899	1.435E-10	9.84
24	61200	51231	48.8	87.8400	0.001306	9.046E-11	10.04
48	86400	125894	74.8	134.6400	0.002002	2.620E-10	9.58
72	86400	213818	73.4	132.1200	0.001964	4.285E-10	9.37
96	86400	300849	42.3	76.1400	0.001132	2.003E-10	9.70
120	86400	387596	53.9	97.0200	0.001442	4.189E-10	9.38
456	1209600	939462	419	754.2000	0.011212	3.130E-10	9.50
1128	2419200	2716550	398	716.4000	0.010650	2.042E-10	9.69
2160	3715200	5768861	339	610.2000	0.009071	1.334E-10	9.87

Average Leach Index: 9.80

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P642

Analyst: PRL

Date: 25-May-99

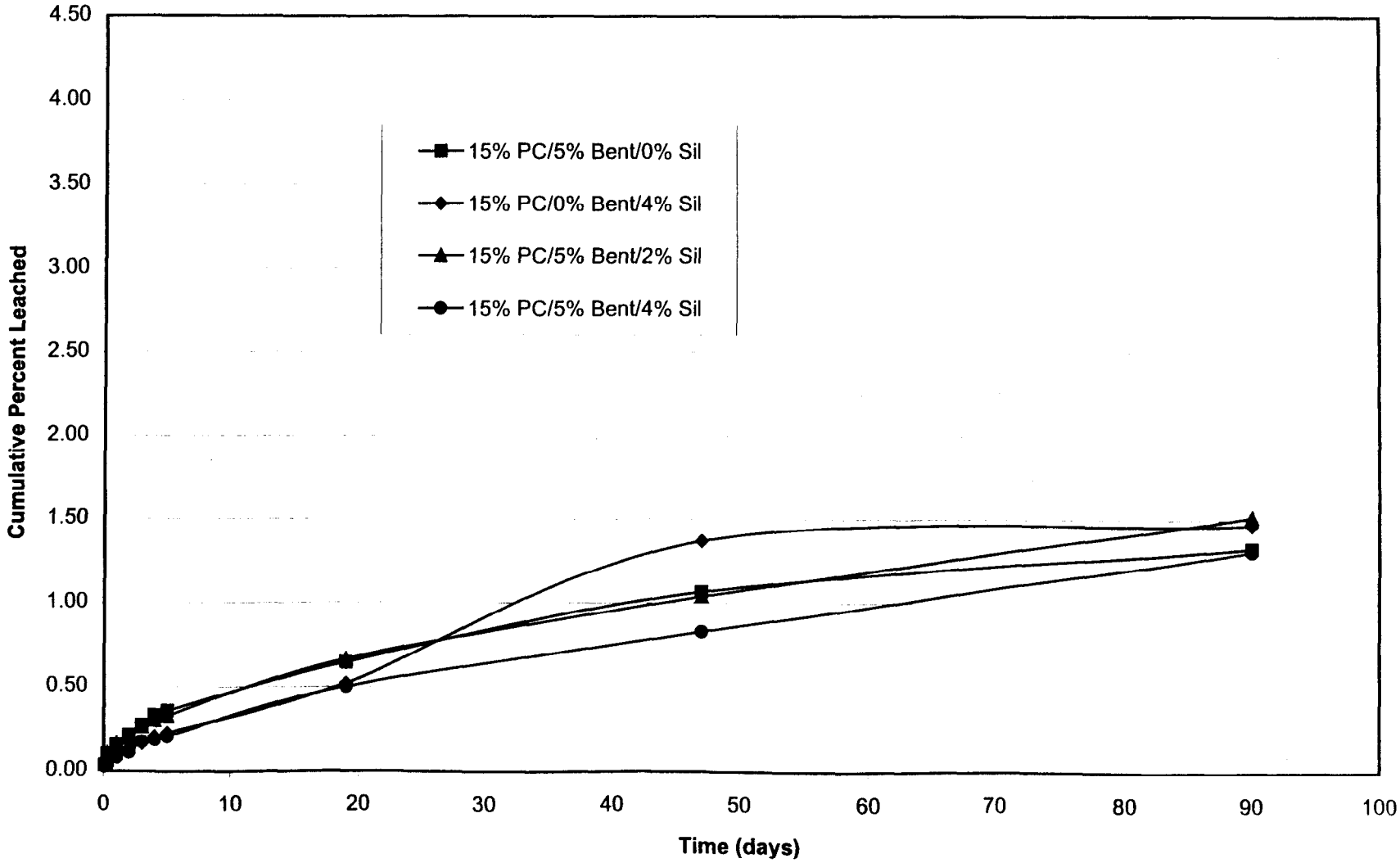
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	183	Sample Weight (g):	374.5
Initial Contaminant Level (pCi):	68533.5		
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	4.52	8.1360	0.000119	1.898E-12	11.72
7	18000	14835	15.5	27.9000	0.000407	2.943E-11	10.53
24	61200	51231	35	63.0000	0.000919	4.483E-11	10.35
48	86400	125894	43.3	77.9400	0.001137	8.460E-11	10.07
72	86400	213818	43.2	77.7600	0.001135	1.430E-10	9.84
96	86400	300849	25.6	46.0800	0.000672	7.067E-11	10.15
120	86400	387596	22.9	41.2200	0.000601	7.285E-11	10.14
456	1209600	939462	331	595.8000	0.008694	1.882E-10	9.73
1128	2419200	2716550	398	716.4000	0.010453	1.967E-10	9.71
2160	3715200	5768861	164	295.2000	0.004307	3.008E-11	10.52

Average Leach Index: 10.28

Gross Beta Leaching for the Fine Fraction from the PSRB Soil



P Series
Index Test Results

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P432

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g): 32.3

Initial Contaminant Level (pCi): 11530.454

Monolith Height (cm): 10

Monolith Surface Area (cm^2): 176.72

Monolith Volume (cm^3): 196.35

Sample Weight (g): 356.98

Monolith Diameter (cm): 5

Leachate Volume (mL): 1800

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	0.1	0.1800	0.000016	3.282E-14	13.48
7	18000	14835	1.44	2.5920	0.000225	8.974E-12	11.05
24	61200	51231	1.3	2.3400	0.000203	2.185E-12	11.66
48	86400	125894	0.1	0.1800	0.000016	1.594E-14	13.80
72	86400	213818	0.595	1.0710	0.000093	9.584E-13	12.02
96	86400	300849	0.1	0.1800	0.000016	3.809E-14	13.42
120	86400	387596	0.1	0.1800	0.000016	4.908E-14	13.31
456	1209600	939462	7.86	14.1480	0.001227	3.749E-12	11.43
1128	2419200	2716550	0.1	0.1800	0.000016	4.387E-16	15.36
2160	3715200	5768861	0.503	0.9054	0.000079	9.995E-15	14.00

Average Leach Index: 12.95

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P442

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	23.2	Sample Weight (g):	364.46
Initial Contaminant Level (pCi):	8455.472		
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	0.1	0.1800	0.000021	6.103E-14	13.21
7	18000	14835	0.181	0.3258	0.000039	2.637E-13	12.58
24	61200	51231	0.1	0.1800	0.000021	2.404E-14	13.62
48	86400	125894	0.227	0.4086	0.000048	1.527E-13	12.82
72	86400	213818	5.45	9.8100	0.001160	1.495E-10	9.83
96	86400	300849	0.204	0.3672	0.000043	2.948E-13	12.53
120	86400	387596	0.1	0.1800	0.000021	9.126E-14	13.04
456	1209600	939462	8.84	15.9120	0.001882	8.819E-12	11.05
1128	2419200	2716550	0.169	0.3042	0.000036	2.330E-15	14.63
2160	3715200	5768861	0.1	0.1800	0.000021	7.346E-16	15.13

Average Leach Index: 12.84

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P422

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g): 32.3

Sample Weight (g): 376.25

Initial Contaminant Level (pCi): 12152.875

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	0.1	0.1800	0.000015	2.954E-14	13.53
7	18000	14835	1.2	2.1600	0.000178	5.610E-12	11.25
24	61200	51231	0.1	0.1800	0.000015	1.164E-14	13.93
48	86400	125894	2.02	3.6360	0.000299	5.855E-12	11.23
72	86400	213818	0.34	0.6120	0.000050	2.817E-13	12.55
96	86400	300849	0.1	0.1800	0.000015	3.429E-14	13.46
120	86400	387596	0.1	0.1800	0.000015	4.418E-14	13.35
456	1209600	939462	8.37	15.0660	0.001240	3.827E-12	11.42
1128	2419200	2716550	0.436	0.7848	0.000065	7.508E-15	14.12
2160	3715200	5768861	0.1	0.1800	0.000015	3.556E-16	15.45

Average Leach Index: 13.03

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P412

Analyst: PRL

Date: 25-May-99

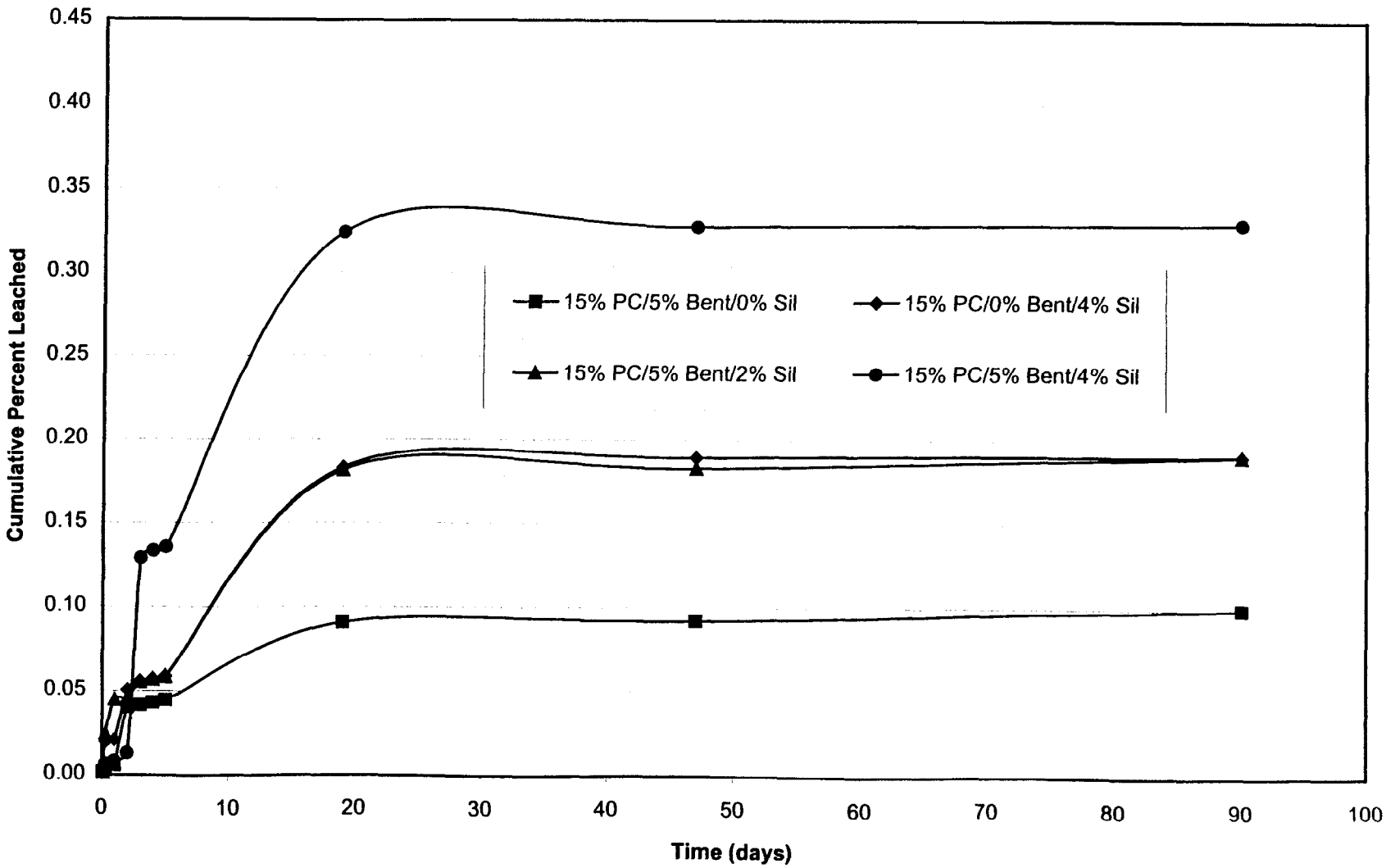
Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	32.3	Sample Weight (g):	372.64
Initial Contaminant Level (pCi):	12036.272		
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	0.1	0.1800	0.000015	3.012E-14	13.52
7	18000	14835	0.1	0.1800	0.000015	3.972E-14	13.40
24	61200	51231	0.184	0.3312	0.000028	4.017E-14	13.40
48	86400	125894	2.28	4.1040	0.000341	7.605E-12	11.12
72	86400	213818	0.1	0.1800	0.000015	2.485E-14	13.60
96	86400	300849	0.1	0.1800	0.000015	3.496E-14	13.46
120	86400	387596	0.1	0.1800	0.000015	4.504E-14	13.35
456	1209600	939462	3.08	5.5440	0.000461	5.284E-13	12.28
1128	2419200	2716550	0.1	0.1800	0.000015	4.026E-16	15.40
2160	3715200	5768861	0.514	0.9252	0.000077	9.578E-15	14.02

Average Leach Index: 13.35

Gross Alpha Leaching for the Fine Fraction from PRSB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P342

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	239	Sample Weight (g):	378.69
Initial Contaminant Level (pCi):	90506.91		
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	5.67	10.2060	0.000113	1.712E-12	11.77
7	18000	14835	10.2	18.3600	0.000203	7.308E-12	11.14
24	61200	51231	19.5	35.1000	0.000388	7.979E-12	11.10
48	86400	125894	20.1	36.1800	0.000400	1.045E-11	10.98
72	86400	213818	19.2	34.5600	0.000382	1.620E-11	10.79
96	86400	300849	15.9	28.6200	0.000316	1.563E-11	10.81
120	86400	387596	15.5	27.9000	0.000308	1.914E-11	10.72
456	1209600	939462	73	131.4000	0.001452	5.249E-12	11.28
1128	2419200	2716550	94.3	169.7400	0.001875	6.332E-12	11.20
2160	3715200	5768861	184	331.2000	0.003659	2.171E-11	10.66

Average Leach Index: 11.04

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P322

Analyst: PRL Date: 25-May-99

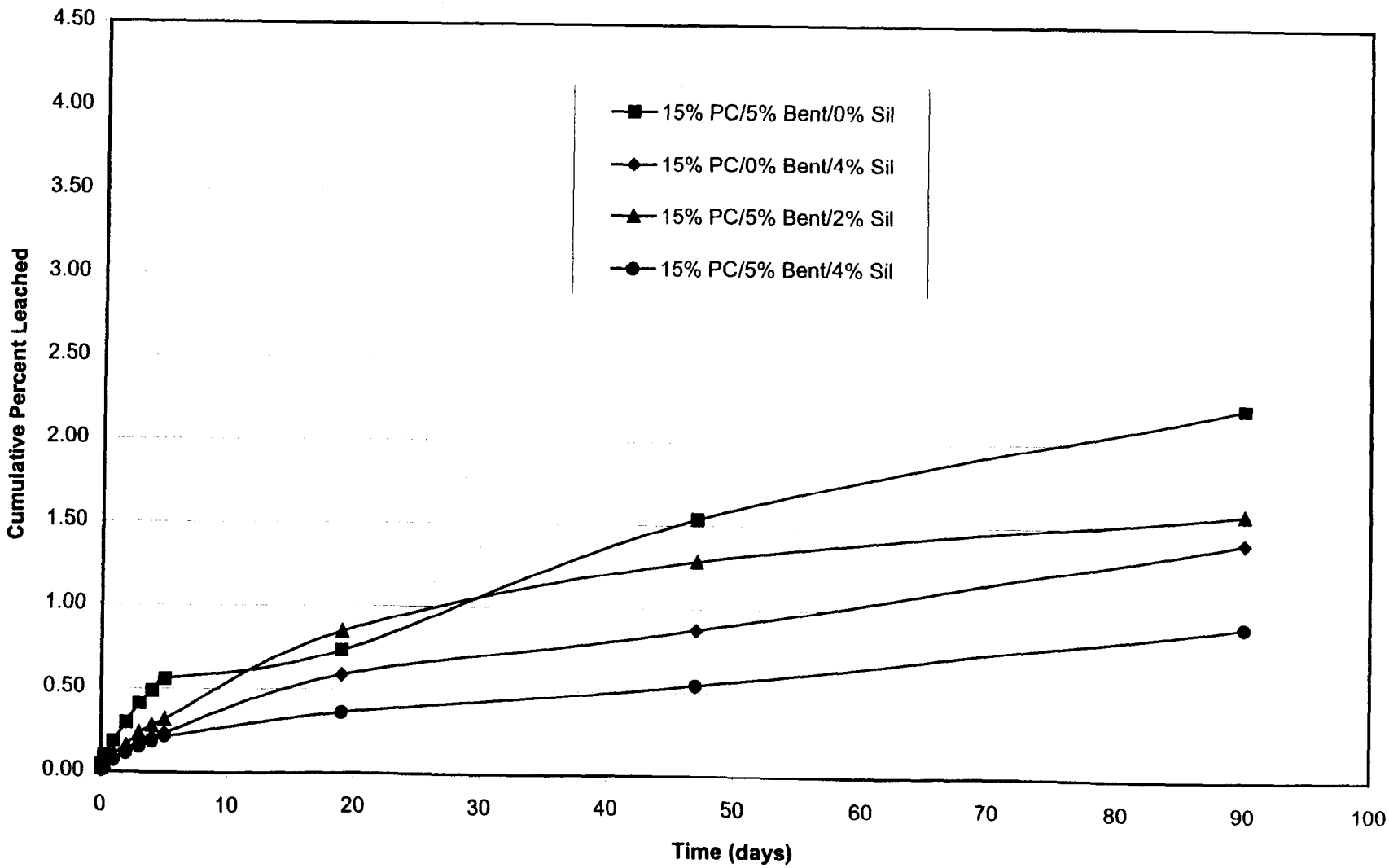
Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	239	Sample Weight (g):	394.9
Initial Contaminant Level (pCi):	94381.1		
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	6.66	11.9880	0.000127	2.173E-12	11.66
7	18000	14835	14.2	25.5600	0.000271	1.302E-11	10.89
24	61200	51231	20.4	36.7200	0.000389	8.030E-12	11.10
48	86400	125894	20.4	36.7200	0.000389	9.901E-12	11.00
72	86400	213818	34.9	62.8200	0.000666	4.922E-11	10.31
96	86400	300849	11.6	20.8800	0.000221	7.650E-12	11.12
120	86400	387596	14.9	26.8200	0.000284	1.626E-11	10.79
456	1209600	939462	183	329.4000	0.003490	3.033E-11	10.52
1128	2419200	2716550	150	270.0000	0.002861	1.473E-11	10.83
2160	3715200	5768861	284	511.2000	0.005416	4.756E-11	10.32

Average Leach Index: 10.85

Gross Beta Leaching for the Coarse Fraction from the PSRB Soil



American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P332

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	239	Sample Weight (g):	379.56
Initial Contaminant Level (pCi):	90714.84		
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	11	19.8000	0.000218	6.416E-12	11.19
7	18000	14835	15.8	28.4400	0.000314	1.745E-11	10.76
24	61200	51231	25.7	46.2600	0.000510	1.380E-11	10.86
48	86400	125894	25.7	46.2600	0.000510	1.701E-11	10.77
72	86400	213818	39	70.2000	0.000774	6.653E-11	10.18
96	86400	300849	23.1	41.5800	0.000458	3.284E-11	10.48
120	86400	387596	17.3	31.1400	0.000343	2.373E-11	10.62
456	1209600	939462	267	480.6000	0.005298	6.990E-11	10.16
1128	2419200	2716550	223	401.4000	0.004425	3.525E-11	10.45
2160	3715200	5768861	151	271.8000	0.002996	1.455E-11	10.84

Average Leach Index: 10.63

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P312

Analyst: PRL Date: 25-May-99

Contaminant: Gross Beta

Initial Contaminant Conc. (pCi/g):	239	Sample Weight (g):	380.26
Initial Contaminant Level (pCi):	90882.14		
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	19.2	34.5600	0.000380	1.947E-11	10.71
7	18000	14835	28.2	50.7600	0.000559	5.540E-11	10.26
24	61200	51231	43.9	79.0200	0.000869	4.011E-11	10.40
48	86400	125894	56.5	101.7000	0.001119	8.191E-11	10.09
72	86400	213818	58	104.4000	0.001149	1.466E-10	9.83
96	86400	300849	39.1	70.3800	0.000774	9.374E-11	10.03
120	86400	387596	35.4	63.7200	0.000701	9.899E-11	10.00
456	1209600	939462	88	158.4000	0.001743	7.565E-12	11.12
1128	2419200	2716550	407	732.6000	0.008061	1.170E-10	9.93
2160	3715200	5768861	346	622.8000	0.006853	7.613E-11	10.12

Average Leach Index: 10.25

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P342

Analyst: PRL Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	19	Sample Weight (g):	378.69
Initial Contaminant Level (pCi):	7195.11		
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	0.1	0.1800	0.000025	8.428E-14	13.07
7	18000	14835	0.418	0.7524	0.000105	1.942E-12	11.71
24	61200	51231	0.1	0.1800	0.000025	3.320E-14	13.48
48	86400	125894	1.75	3.1500	0.000438	1.254E-11	10.90
72	86400	213818	0.1	0.1800	0.000025	6.953E-14	13.16
96	86400	300849	0.1	0.1800	0.000025	9.783E-14	13.01
120	86400	387596	1.23	2.2140	0.000308	1.907E-11	10.72
456	1209600	939462	0.794	1.4292	0.000199	9.826E-14	13.01
1128	2419200	2716550	0.68	1.2240	0.000170	5.210E-14	13.28
2160	3715200	5768861	0.1	0.1800	0.000025	1.015E-15	14.99

Average Leach Index: 12.73

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P332

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	19	Sample Weight (g):	379.56
Initial Contaminant Level (pCi):	7211.64		
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	0.1	0.1800	0.000025	8.390E-14	13.08
7	18000	14835	0.475	0.8550	0.000119	2.496E-12	11.60
24	61200	51231	0.1	0.1800	0.000025	3.305E-14	13.48
48	86400	125894	0.1	0.1800	0.000025	4.075E-14	13.39
72	86400	213818	0.1	0.1800	0.000025	6.921E-14	13.16
96	86400	300849	0.1	0.1800	0.000025	9.738E-14	13.01
120	86400	387596	0.1	0.1800	0.000025	1.255E-13	12.90
456	1209600	939462	0.141	0.2538	0.000035	3.084E-15	14.51
1128	2419200	2716550	0.1	0.1800	0.000025	1.122E-15	14.95
2160	3715200	5768861	0.1	0.1800	0.000025	1.010E-15	15.00

Average Leach Index: 13.51

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P322

Analyst: PRL

Date: 25-May-99

Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	19	Sample Weight (g):	394.9
Initial Contaminant Level (pCi):	7503.1		
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	0.215	0.3870	0.000052	3.583E-13	12.45
7	18000	14835	0.1	0.1800	0.000024	1.022E-13	12.99
24	61200	51231	0.346	0.6228	0.000083	3.655E-13	12.44
48	86400	125894	0.237	0.4266	0.000057	2.114E-13	12.67
72	86400	213818	0.1	0.1800	0.000024	6.394E-14	13.19
96	86400	300849	0.1	0.1800	0.000024	8.996E-14	13.05
120	86400	387596	0.1	0.1800	0.000024	1.159E-13	12.94
456	1209600	939462	0.793	1.4274	0.000190	9.013E-14	13.05
1128	2419200	2716550	0.398	0.7164	0.000095	1.641E-14	13.78
2160	3715200	5768861	0.1	0.1800	0.000024	9.329E-16	15.03

Average Leach Index: 13.16

American Nuclear Society - 16.1 Static Leach Test

Project: SRS Reactor Seepage Basin Stabilization

Sample Description: P312

Analyst: PRL

Date: 25-May-99

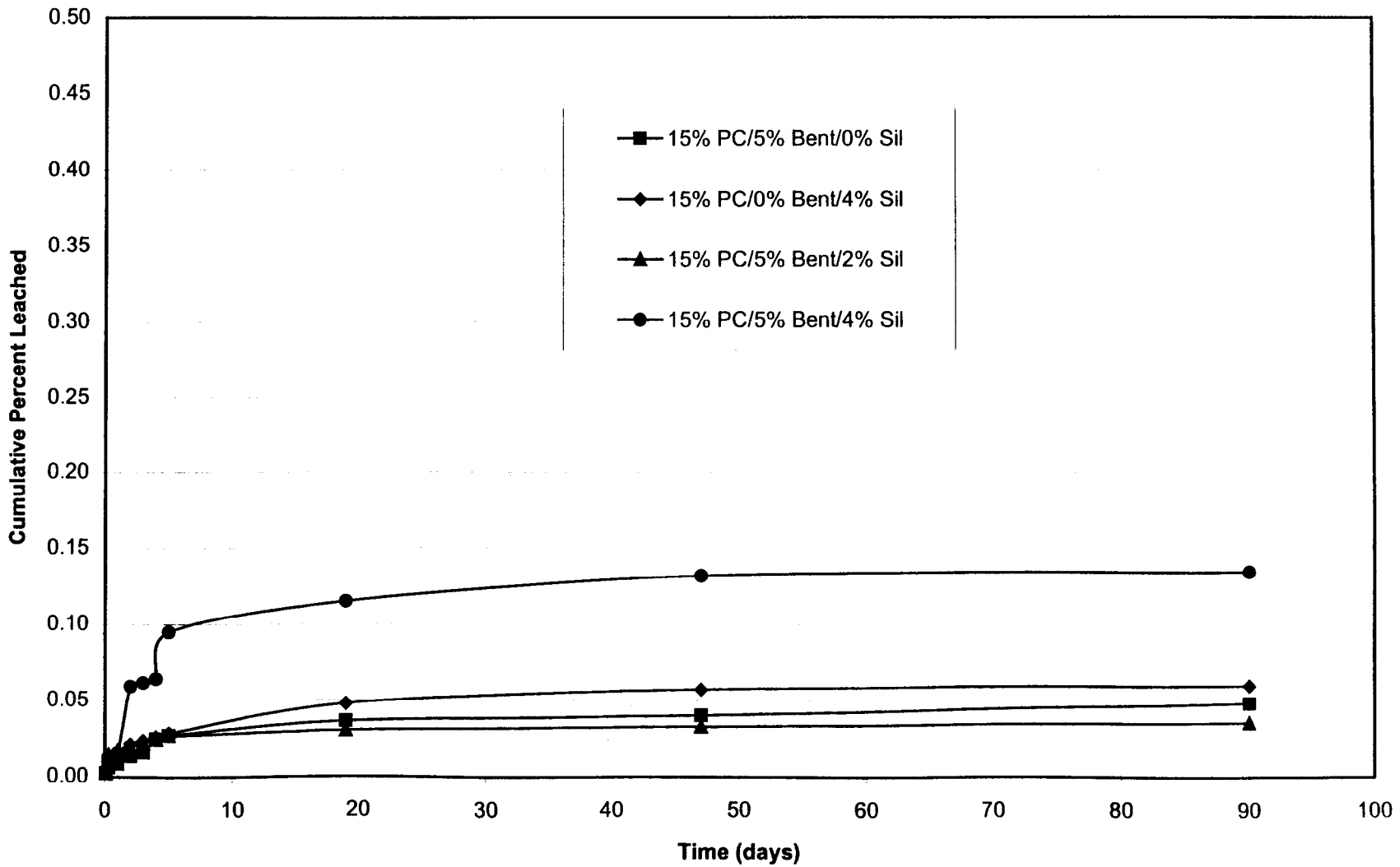
Contaminant: Gross Alpha

Initial Contaminant Conc. (pCi/g):	19	Sample Weight (g):	380.26
Initial Contaminant Level (pCi):	7224.94		
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	0.1	0.1800	0.000025	8.359E-14	13.08
7	18000	14835	0.147	0.2646	0.000037	2.382E-13	12.62
24	61200	51231	0.1	0.1800	0.000025	3.293E-14	13.48
48	86400	125894	0.2	0.3600	0.000050	1.624E-13	12.79
72	86400	213818	0.1	0.1800	0.000025	6.895E-14	13.16
96	86400	300849	0.354	0.6372	0.000088	1.216E-12	11.92
120	86400	387596	0.1	0.1800	0.000025	1.250E-13	12.90
456	1209600	939462	0.359	0.6462	0.000089	1.992E-14	13.70
1128	2419200	2716550	0.159	0.2862	0.000040	2.825E-15	14.55
2160	3715200	5768861	0.309	0.5562	0.000077	9.607E-15	14.02

Average Leach Index: 13.22

Gross Alpha Leaching for the Coarse Fraction from PRSB Soil



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

MOISTURE CONTENT

PROJECT NAME
SAIC - Savannah River

PROJECT NUMBER
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	MOISTURE, % ASTM D 2216	MOISTURE , % SW846	SOLIDS, % SW846
ETDC-8015	P100Q00	13.1	11.6	88.4
ETDC-8016	P200Q00	14.9	13.0	87.0
ETDC-8017	P300Q00	14.9	13.0	87.0
ETDC-8018	P400Q00	19.6	16.4	83.6
ETDC-8019	P500Q00	14.9	13.0	87.0
ETDC-8020	P600Q00	13.1	11.6	88.4
ETDC-8021	P700Q00	14.9	13.0	87.0
ETDC-8022	P800Q00	15.9	13.7	86.3

ASTM D 2216 results are based on dry sample weight.
SW846 results are based on wet sample weight.
Solids content is determined by subtracting the SW846 moisture (%) from 100.

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SPECIFIC GRAVITY
ASTM D 854

PROJECT NAME:
SAIC - Savannah River

PROJECT NUMBER:
777304.00010500

IT LAB SAMPLE NO.	CLIENT SAMPLE NO.	SPECIFIC GRAVITY
ETDC-8015	P100Q00	2.6407
ETDC-8016	P200Q00	2.6446
ETDC-8017	P300Q00	2.6429
ETDC-8018	P400Q00	2.6374
ETDC-8019	P500Q00	2.6428
ETDC-8020	P600Q00	2.6408
ETDC-8021	P700Q00	2.6435
ETDC-8022	P800Q00	2.6428

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME:
SAIC - Savannah River

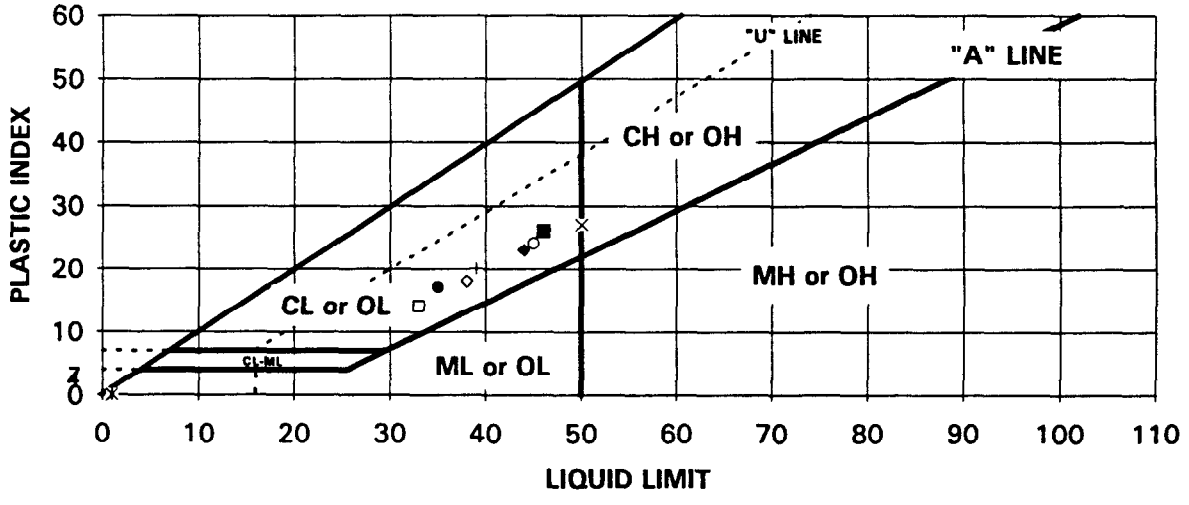
PROJECT NO.
777304.00010500

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
ETDC-8015 •	P100Q00	35	18	17	CL
ETDC-8016 ♦	P200Q00	44	21	23	CL
ETDC-8017 □	P300Q00	33	19	14	CL
ETDC-8018 ◊	P400Q00	38	20	18	CL
ETDC-8019 +	P500Q00	39	19	20	CL
ETDC-8020 ○	P600Q00	45	21	24	CL
ETDC-8021 ■	P700Q00	46	20	26	CL
ETDC-8022 ×	P800Q00	50	23	27	CH
△					
*					

*NP=Nonplastic

PLASTICITY CHART



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SOIL CLASSIFICATION ASTM D 2487

PROJECT NAME: SAIC - Savannah River **PROJECT NO:** 777304.00010500

	ETDC NUMBER:	CLIENT NUMBER:	GROUP SYMBOL:	CLASSIFICATION-GROUP NAME:
SAMPLE 1:	ETDC-8015	P100Q00	SC	CLAYEY SAND
SAMPLE 2:	ETDC-8016	P200Q00	SC	CLAYEY SAND
SAMPLE 3:	ETDC-8017	P300Q00	SC	CLAYEY SAND
SAMPLE 4:	ETDC-8018	P400Q00	SC	CLAYEY SAND
SAMPLE 5:	ETDC-8019	P500Q00	SC	CLAYEY SAND
SAMPLE 6:	ETDC-8020	P600Q00	SC	CLAYEY SAND
SAMPLE 7:	ETDC-8021	P700Q00	SC	CLAYEY SAND
SAMPLE 8:	ETDC-8022	P800Q00	SC	CLAYEY SAND
SAMPLE 9:				
SAMPLE 10:				

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SOIL CLASSIFICATION ASTM D 2487

PROJECT NAME: SAIC - Savannah River **PROJECT NO:** 777304.00010500

	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
ETDC NUMBER:	ETDC-8015	ETDC-8016	ETDC-8017	ETDC-8018	ETDC-8019
CLIENT NUMBER:	P100Q00	P200Q00	P300Q00	P400Q00	P500Q00
(COARSE-GRAVELS, SANDS) % RETAINED ON # 200 SIEVE:	71.6	70.0	69.5	65.2	68.3
(FINE-SILTS, CLAYS) % PASSING # 200 SIEVE:	28.4	30.0	30.5	34.8	31.7
% GRAVEL:	3.8	1.2	0.9	1.6	1.4
% SAND:	67.7	68.8	68.6	63.6	66.8
D60 IN MM (DIAMETER AT 60% PASSING):	0.40685	0.41277	0.33018	0.29156	0.27654
D30 IN MM (DIAMETER AT 30% PASSING):	0.10171	0.07460	0.06911	0.00983	0.05882
D10 IN MM (DIAMETER AT 10% PASSING):	0.00078	0.00063	0.00068	0.00054	0.00060
Cc:	520.88	658.01	486.53	539.69	457.48
Cu:	32.56	21.49	21.32	0.61	20.70
LIQUID LIMIT:	35	44	33	38	39
PLASTIC INDEX:	17	23	14	18	20
ATTERBERG CLASSIFICATION*:	CL	CL	CL	CL	CL

	SAMPLE 6	SAMPLE 7	SAMPLE 8	SAMPLE 9	SAMPLE 10
ETDC NUMBER:	ETDC-8020	ETDC-8021	ETDC-8022		
CLIENT NUMBER:	P600Q00	P700Q00	P800Q00		
(COARSE-GRAVELS, SANDS) % RETAINED ON # 200 SIEVE:	74.2	69.4	68.2		
(FINE-SILTS, CLAYS) % PASSING # 200 SIEVE:	25.8	30.6	31.8		
% GRAVEL:	5.1	3.7	0.9		
% SAND:	69.1	65.7	67.3		
D60 IN MM (DIAMETER AT 60% PASSING):	0.57715	0.41961	0.44716		
D30 IN MM (DIAMETER AT 30% PASSING):	0.15436	0.05435	0.05921		
D10 IN MM (DIAMETER AT 10% PASSING):	0.00072	0.00063	0.00183		
Cc:	796.41	669.95	244.88		
Cu:	56.97	11.24	4.29		
LIQUID LIMIT:	45	46	50		
PLASTIC INDEX:	24	26	27		
ATTERBERG CLASSIFICATION*:	CL	CL	CH		

*FINES< #40 SIEVE (0.425 mm)

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P100Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8015

Specific Gravity = 2.6407

Moisture Content = 13.1%
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	97.1%
	#4	4.750	96.2%
	#10	2.000	94.4%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.7%
	#40	0.425	61.8%
	#60	0.250	44.0%
	#100	0.149	33.7%
	#140	0.106	30.3%
	#200	0.075	28.4%

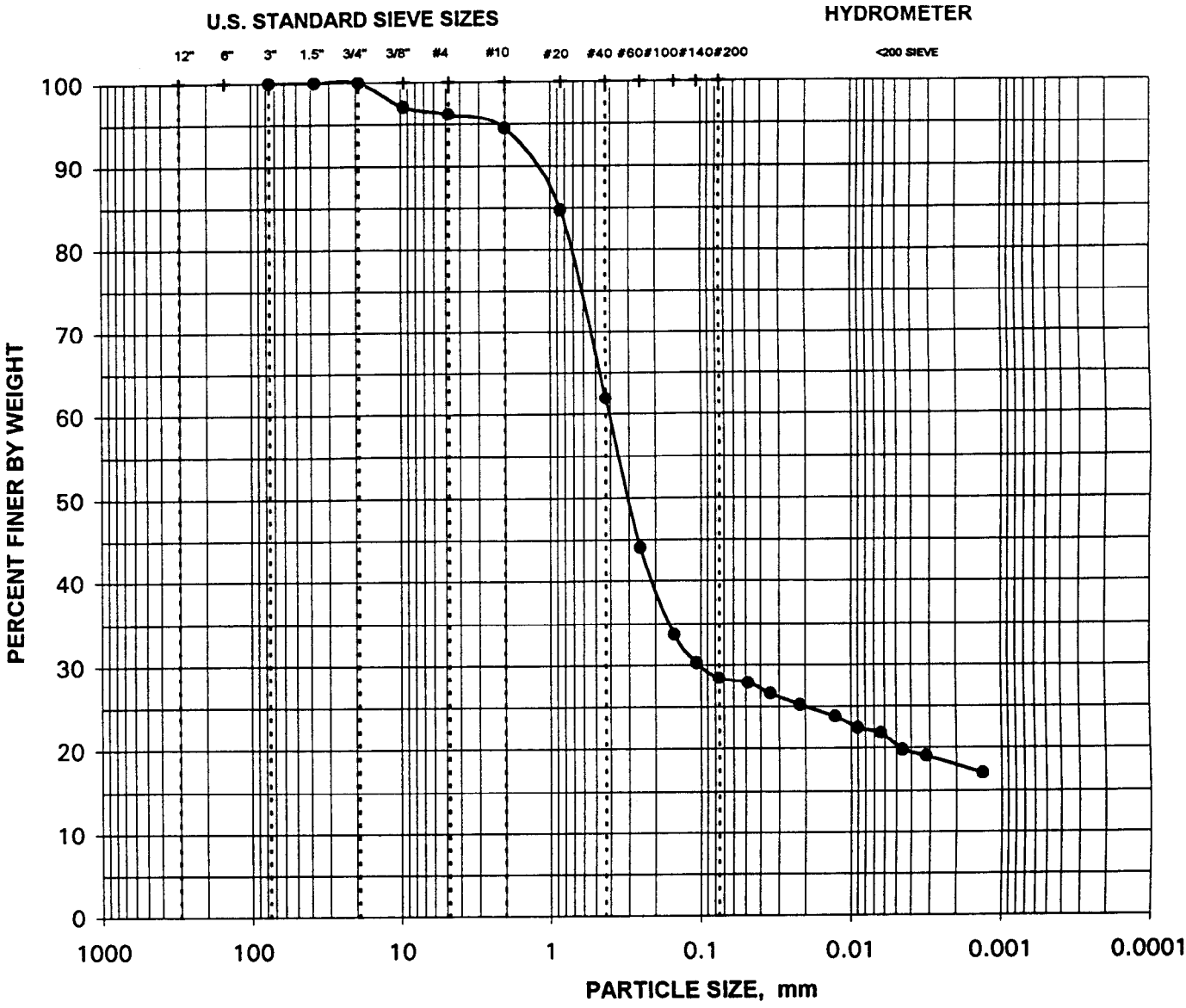
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04781	27.9%
	0.03395	26.5%
	0.02165	25.1%
	0.01260	23.8%
	0.00895	22.4%
	0.00630	21.7%
	0.00453	19.7%
	0.00315	19.0%
	0.00133	17.0%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P100Q00

IT LAB SAMPLE NO.: ETDC-8015

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P200Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8016
Specific Gravity =	2.6446	Moisture Content =	14.9%
		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	98.8%
	#10	2.000	95.7%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.7%
	#40	0.425	61.0%
	#60	0.250	46.1%
	#100	0.149	35.1%
	#140	0.106	31.6%
	#200	0.075	30.0%

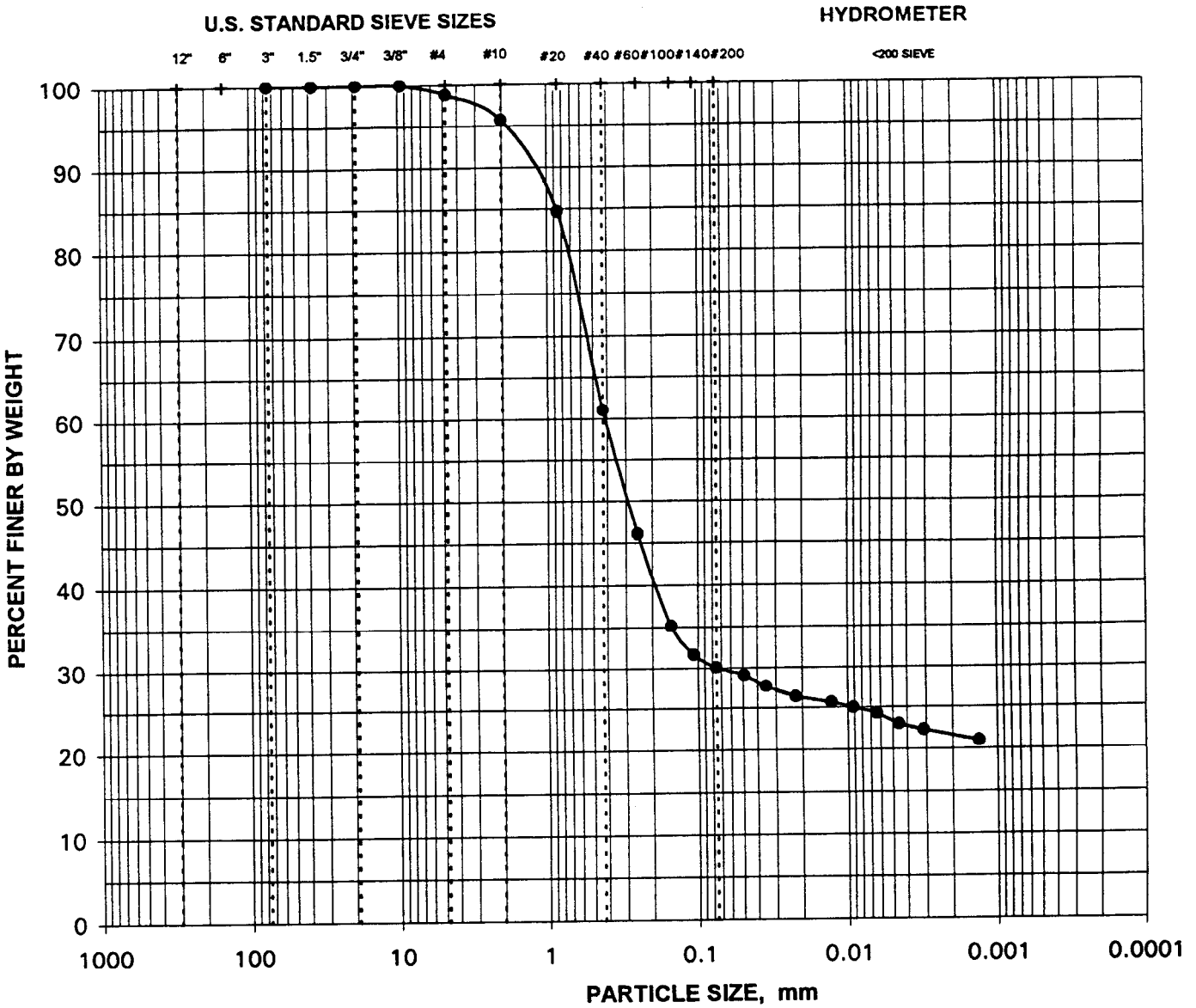
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04861	29.1%
	0.03466	27.7%
	0.02201	26.4%
	0.01276	25.7%
	0.00906	25.0%
	0.00635	24.3%
	0.00452	23.0%
	0.00310	22.3%
	0.00131	20.9%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P200Q00

IT LAB SAMPLE NO.: ETDC-8016

BOULDERS	COBBLES	GRAVEL		SAND			SILT 2 - 75 microns CLAY <2 microns
		COARSE	FINE	COARSE	MEDIUM	FINE	

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P300Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8017

Specific Gravity = 2.6429

Moisture Content = 14.9%
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	99.1%
	#10	2.000	98.2%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	91.9%
	#40	0.425	70.3%
	#60	0.250	51.3%
	#100	0.149	37.5%
	#140	0.106	32.9%
	#200	0.075	30.5%

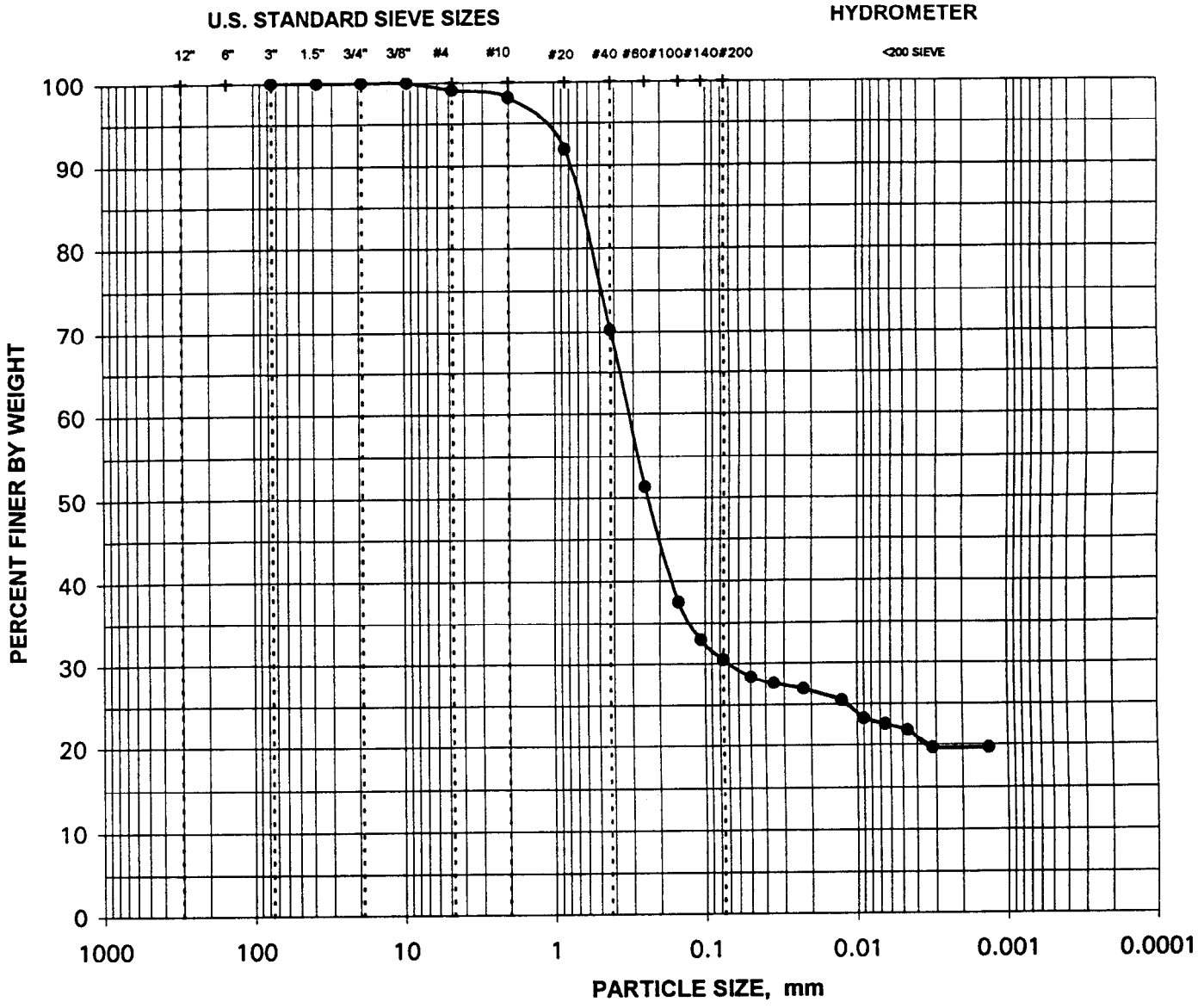
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04922	28.3%
	0.03495	27.6%
	0.02220	26.8%
	0.01251	25.4%
	0.00892	23.2%
	0.00645	22.5%
	0.00458	21.8%
	0.00315	19.6%
	0.00133	19.6%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P300Q00

IT LAB SAMPLE NO.: ETDC-8017

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P400Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8018
Specific Gravity =	2.6374	Moisture Content =	19.6%
		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	99.2%
	#4	4.750	98.4%
	#10	2.000	97.2%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	90.0%
	#40	0.425	71.4%
	#60	0.250	56.4%
	#100	0.149	41.6%
	#140	0.106	36.8%
	#200	0.075	34.8%

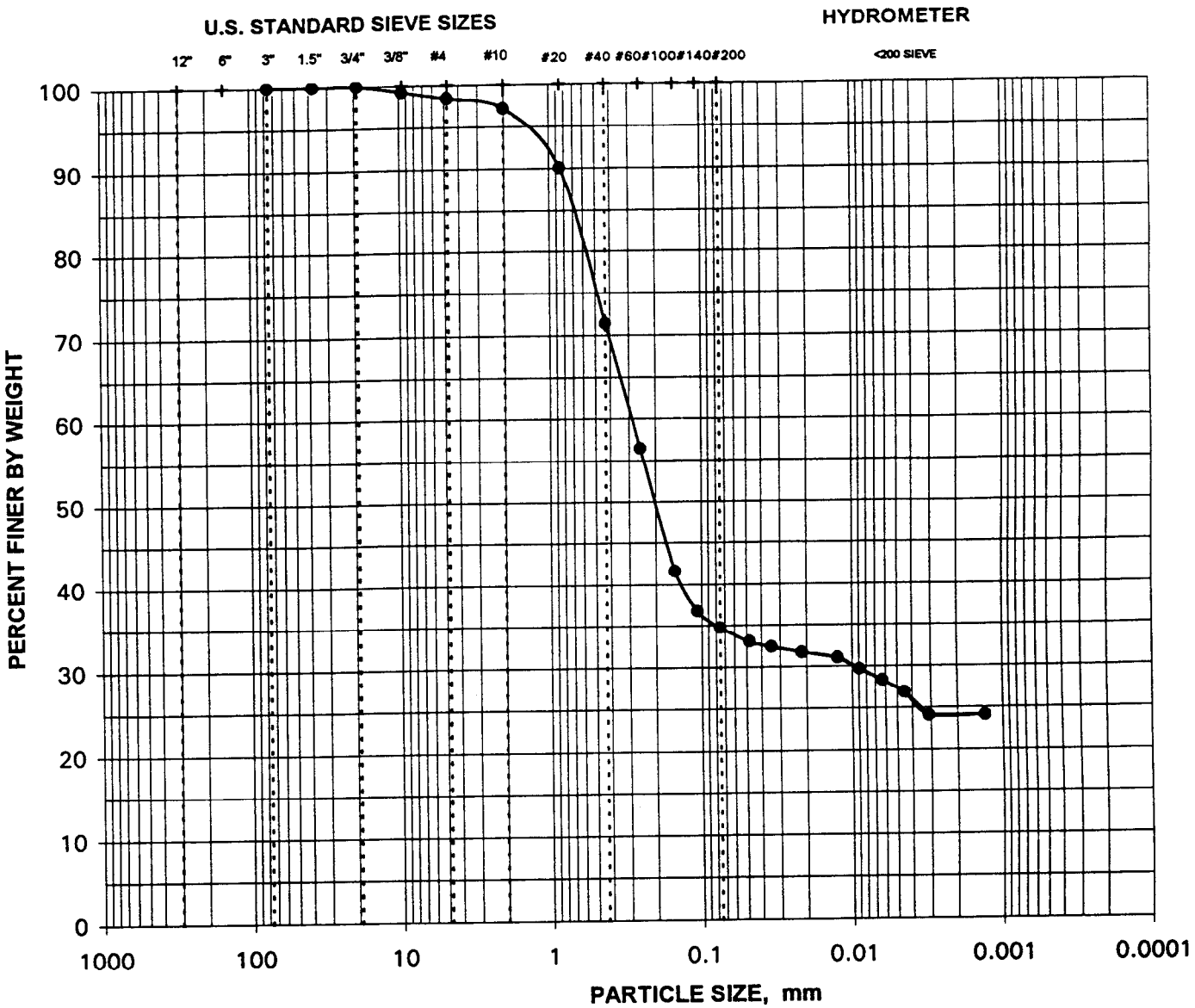
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04777	33.1%
	0.03393	32.4%
	0.02150	31.7%
	0.01244	31.0%
	0.00887	29.6%
	0.00625	28.3%
	0.00444	26.9%
	0.00309	24.1%
	0.00130	24.1%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P400Q00

IT LAB SAMPLE NO.: ETDC-8018

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P500Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8019
Specific Gravity =	2.6428	Moisture Content =	14.9%
		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	99.2%
	#4	4.750	98.6%
	#10	2.000	97.3%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	91.6%
	#40	0.425	75.0%
	#60	0.250	57.3%
	#100	0.149	39.0%
	#140	0.106	33.8%
	#200	0.075	31.7%

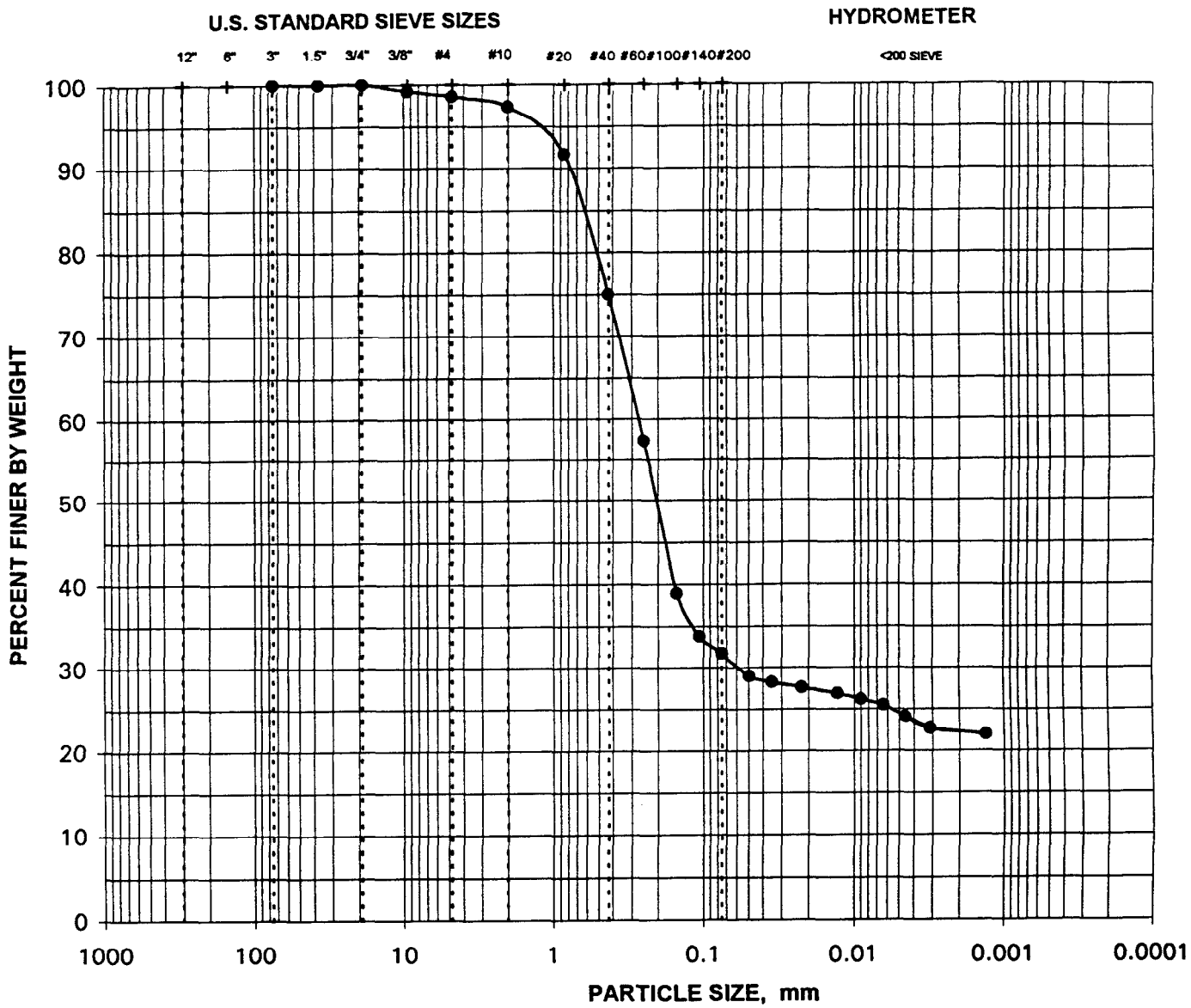
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04902	29.0%
	0.03473	28.3%
	0.02201	27.6%
	0.01276	26.8%
	0.00895	26.1%
	0.00635	25.4%
	0.00452	24.0%
	0.00311	22.6%
	0.00132	21.9%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P500Q00

IT LAB SAMPLE NO.: ETDC-8019

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P600Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8020
Specific Gravity =	2.6408	Moisture Content =	13.1%
		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	97.4%
	0.375"	9.500	96.4%
	#4	4.750	94.9%
	#10	2.000	90.8%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	76.8%
	#40	0.425	50.6%
	#60	0.250	37.5%
	#100	0.149	29.6%
	#140	0.106	27.1%
	#200	0.075	25.8%

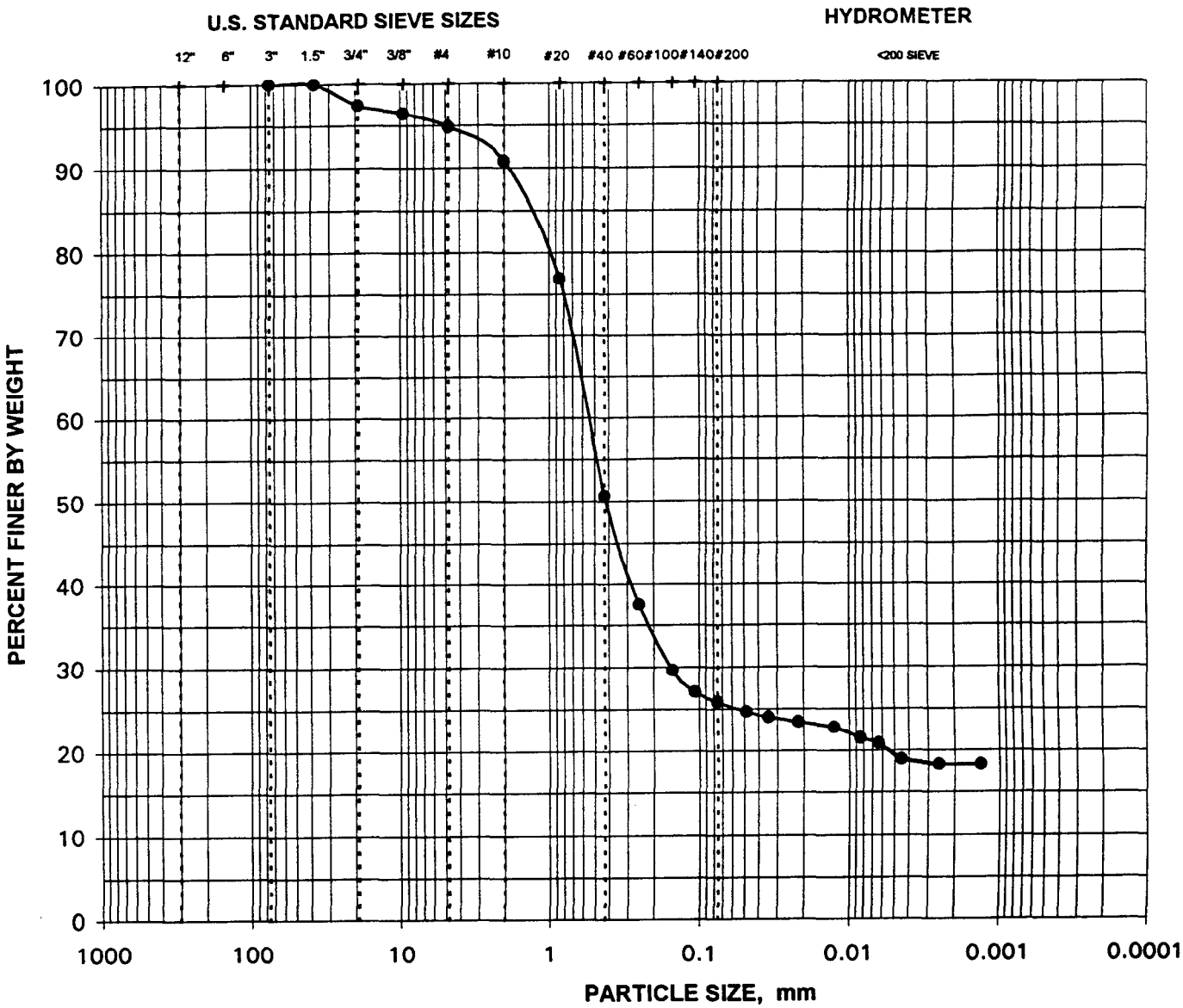
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04801	24.6%
	0.03409	24.0%
	0.02165	23.4%
	0.01255	22.7%
	0.00839	21.5%
	0.00633	20.9%
	0.00447	19.0%
	0.00252	18.3%
	0.00133	18.3%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P600Q00

IT LAB SAMPLE NO.: ETDC-8020

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P700Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8021

Specific Gravity = 2.6435

Moisture Content = 14.9%
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	97.3%
#4	4.750	96.3%
#10	2.000	93.7%

FINE

Sieve No.	Diameter mm	Percent Finer
#20	0.850	82.8%
#40	0.425	60.5%
#60	0.250	45.7%
#100	0.149	35.5%
#140	0.106	32.2%
#200	0.075	30.6%

HYDROMETER ANALYSIS

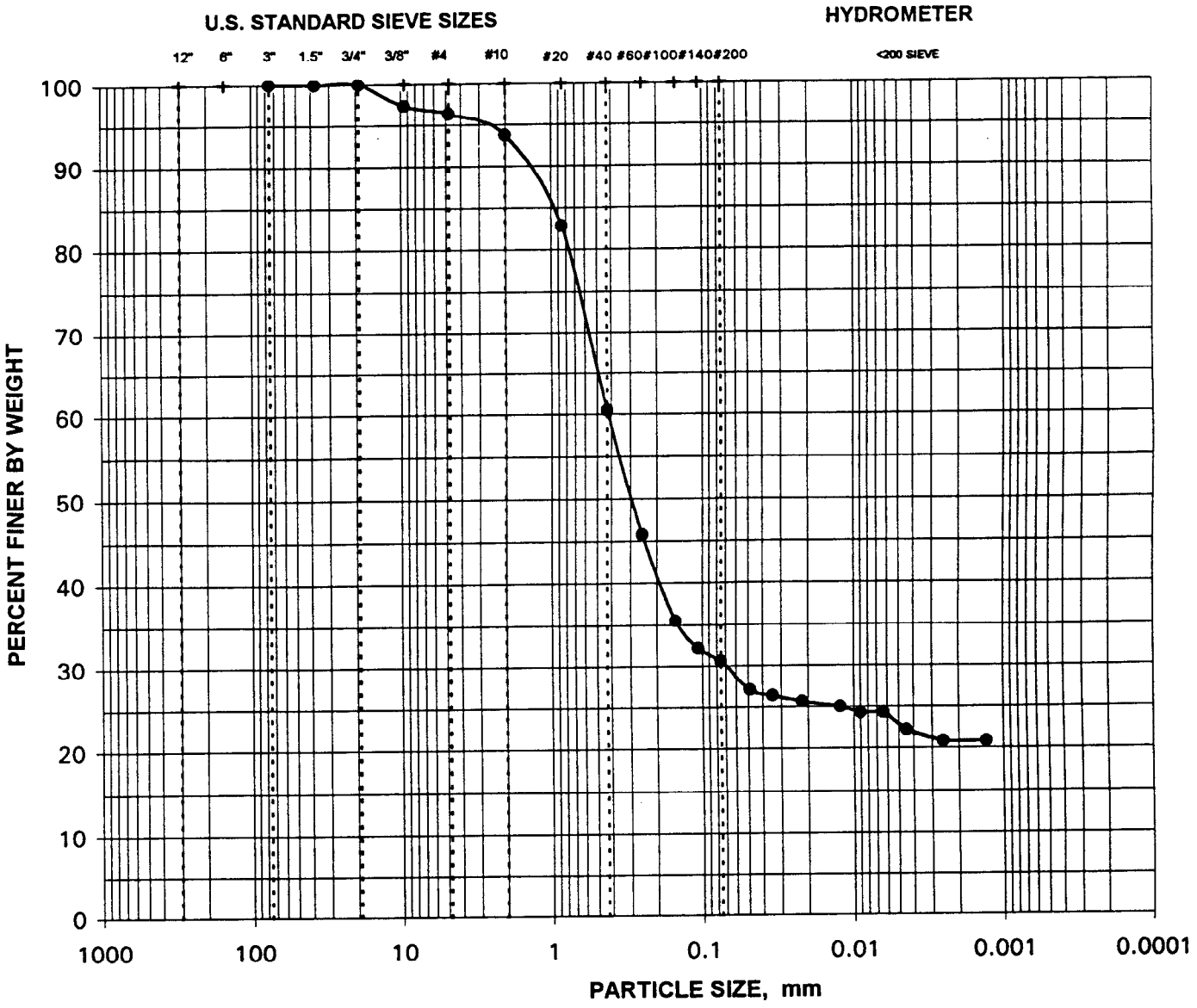
HYDROMETER

Diameter mm	Percent Finer
0.04801	27.0%
0.03409	26.3%
0.02165	25.6%
0.01215	25.0%
0.00891	24.3%
0.00630	24.3%
0.00444	22.2%
0.00253	20.8%
0.00130	20.8%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P700Q00

IT LAB SAMPLE NO.: ETDC-8021

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name	SAIC - Savannah River	Client Sample No.	P800Q00
Project No.	777304.00010500	IT Lab Sample No.	ETDC-8022
Specific Gravity =	2.6428	Moisture Content =	15.9%
		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	99.7%
	#4	4.750	99.1%
	#10	2.000	96.0%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	82.7%
	#40	0.425	58.8%
	#60	0.250	45.2%
	#100	0.149	36.1%
	#140	0.106	33.2%
	#200	0.075	31.8%

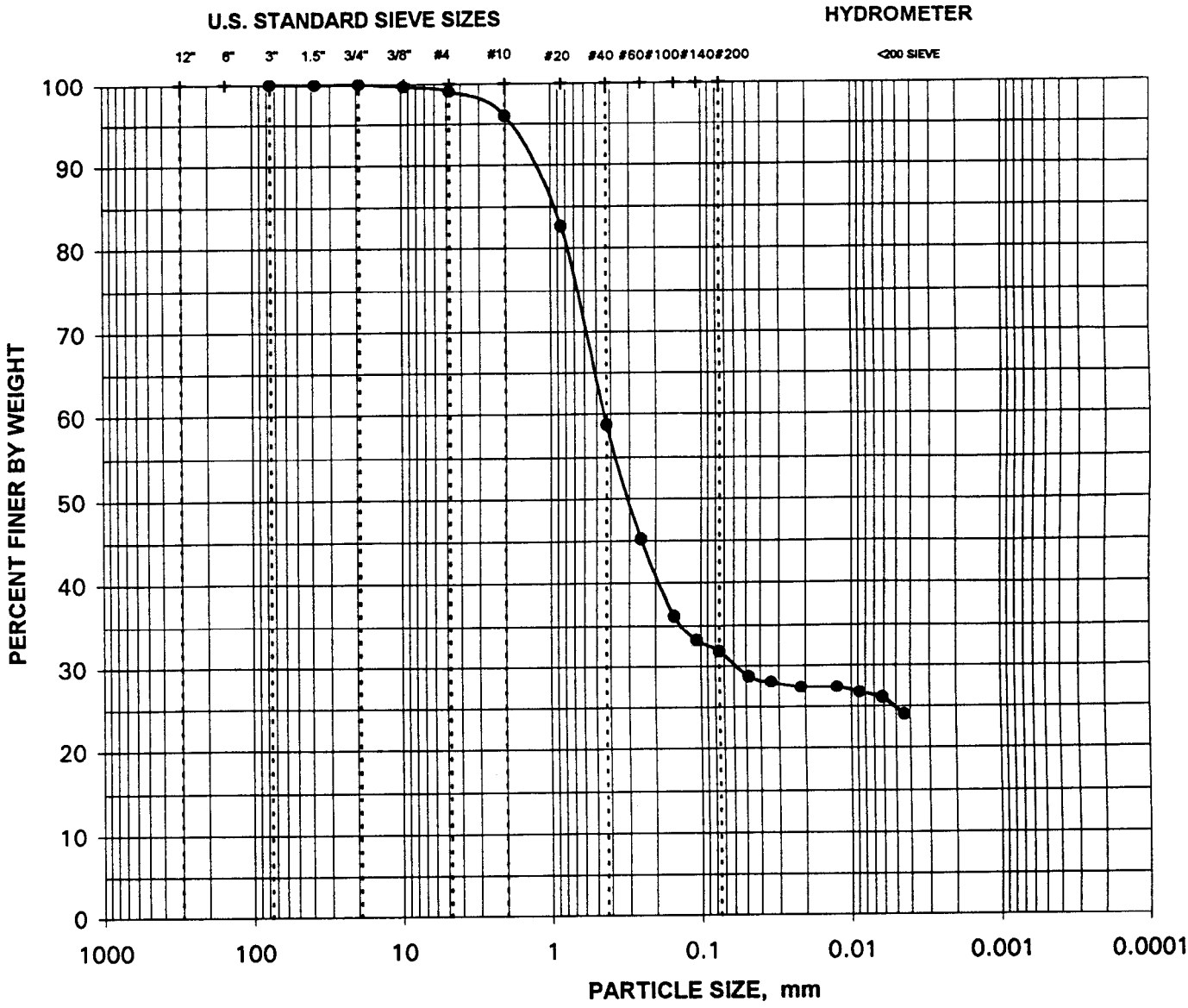
HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER	0.06647	30.0%
	0.04741	28.7%
	0.03367	28.0%
	0.02138	27.3%
	0.01234	27.3%
	0.00875	26.7%
	0.00612	26.0%
	0.00438	24.0%
	0.00131	22.0%

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

SAIC - Savannah River



CLIENT SAMPLE NO.: P800Q00

IT LAB SAMPLE NO.: ETDC-8022

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	

SILT 2 - 75 microns

CLAY <2 microns

P Series
28 Day UCS Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

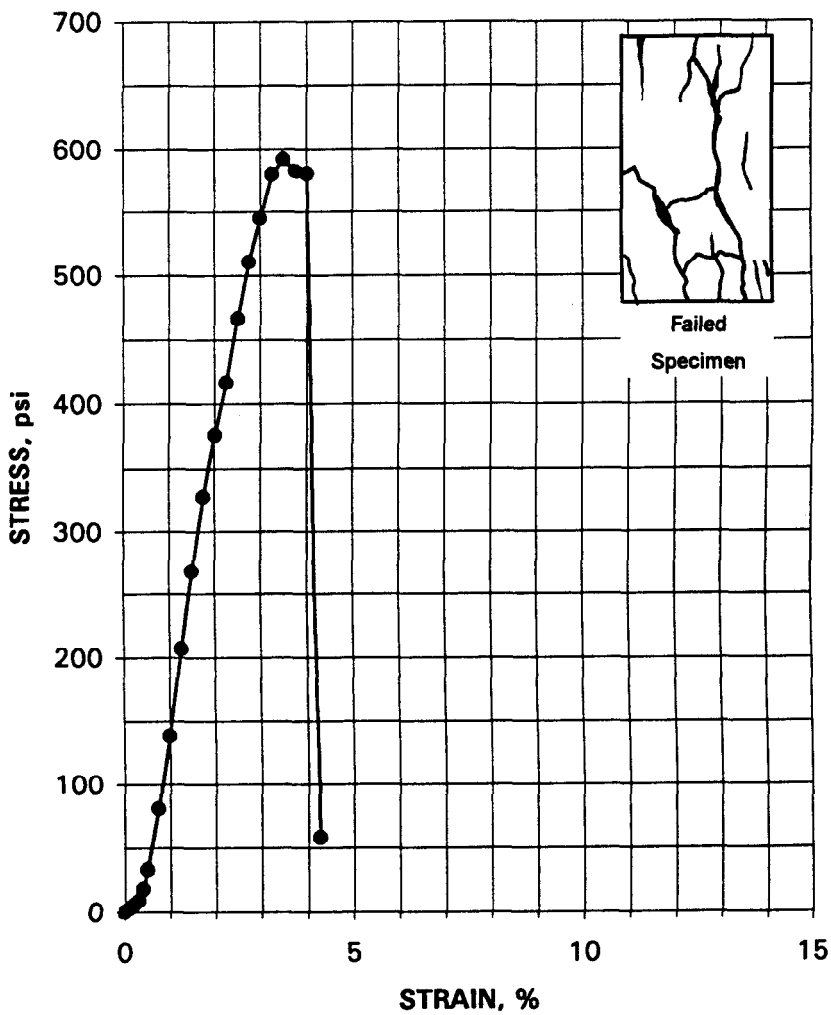
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P312F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8047

Specimen Mold Date	12/22/98	Specimen Height, in.	3.9842
Specimen Test Date	1/19/99	Specimen Diameter, in.	1.9962
		Specimen Weight, g.	381.63
STRESS AT FAILURE, psi	**592.3**	Moisture Content, %	27.8
STRAIN AT FAILURE, %	**3.5**	Wet Unit Weight, pcf.	116.6
		Dry Unit Weight, pcf.	91.2
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.6
0.20	5.4
0.30	9.2
0.40	17.8
0.50	32.7
0.75	81.2
1.00	138.6
1.25	206.7
1.51	268.1
1.76	327.7
2.01	376.4
2.26	416.6
2.51	466.6
2.76	510.5
3.01	544.5
3.26	580.2
3.51	592.3
3.76	582.7
4.02	580.6
4.27	58.1



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

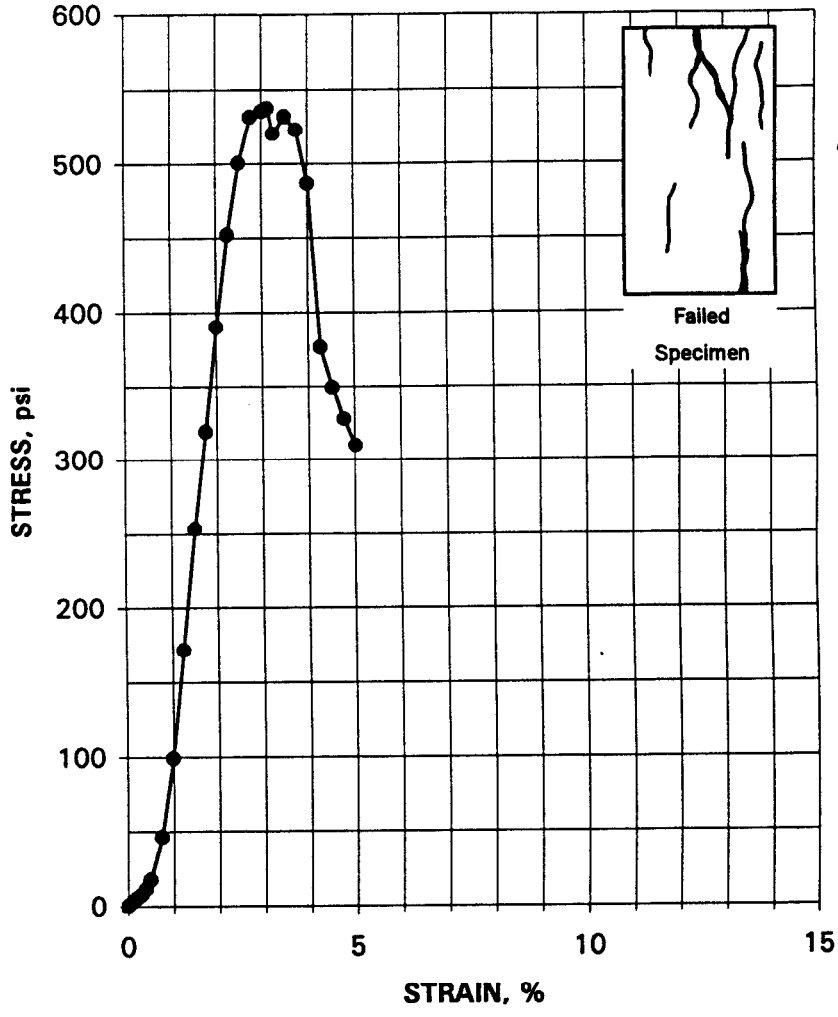
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
27-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P322F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8048

Specimen Mold Date	12/22/98	Specimen Height, in.	3.9803
Specimen Test Date	1/19/99	Specimen Diameter, in.	2.0047
		Specimen Weight, g.	390.38
STRESS AT FAILURE, psi	**537.3**	Moisture Content, %	26.3
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	118.4
		Dry Unit Weight, pcf.	93.7
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	5.1
0.30	7.6
0.40	11.4
0.50	17.7
0.75	46.2
1.00	99.1
1.26	171.8
1.51	253.1
1.76	319.0
2.01	389.9
2.26	452.1
2.51	500.7
2.76	531.4
3.01	535.3
3.14	537.3
3.27	520.4
3.52	531.9
3.77	522.9
4.02	486.9
4.27	376.4
4.52	349.1
4.77	327.4
5.02	309.6



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

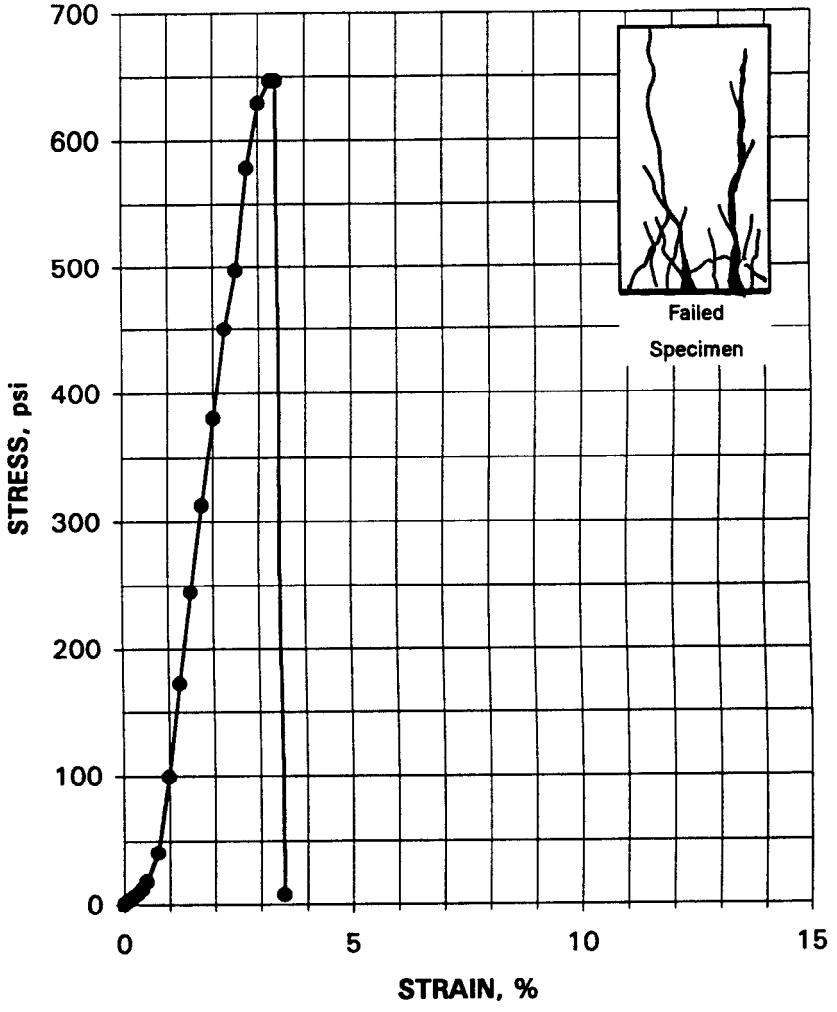
Client Sample No. P332F00
IT Lab Specimen No. ETDC-8049

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **646.8**
STRAIN AT FAILURE, % **3.4**

Specimen Height, in.	3.9855
Specimen Diameter, in.	2.0142
Specimen Weight, g.	380.08
Moisture Content, %	28.5
Wet Unit Weight, pcf.	114.0
Dry Unit Weight, pcf.	88.7
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.8
0.20	5.6
0.30	8.4
0.40	12.2
0.50	18.1
0.75	40.5
1.00	98.8
1.25	171.7
1.51	244.2
1.76	312.7
2.01	380.7
2.26	450.3
2.51	496.9
2.76	578.6
3.01	629.2
3.26	646.4
3.39	646.8
3.51	7.6



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

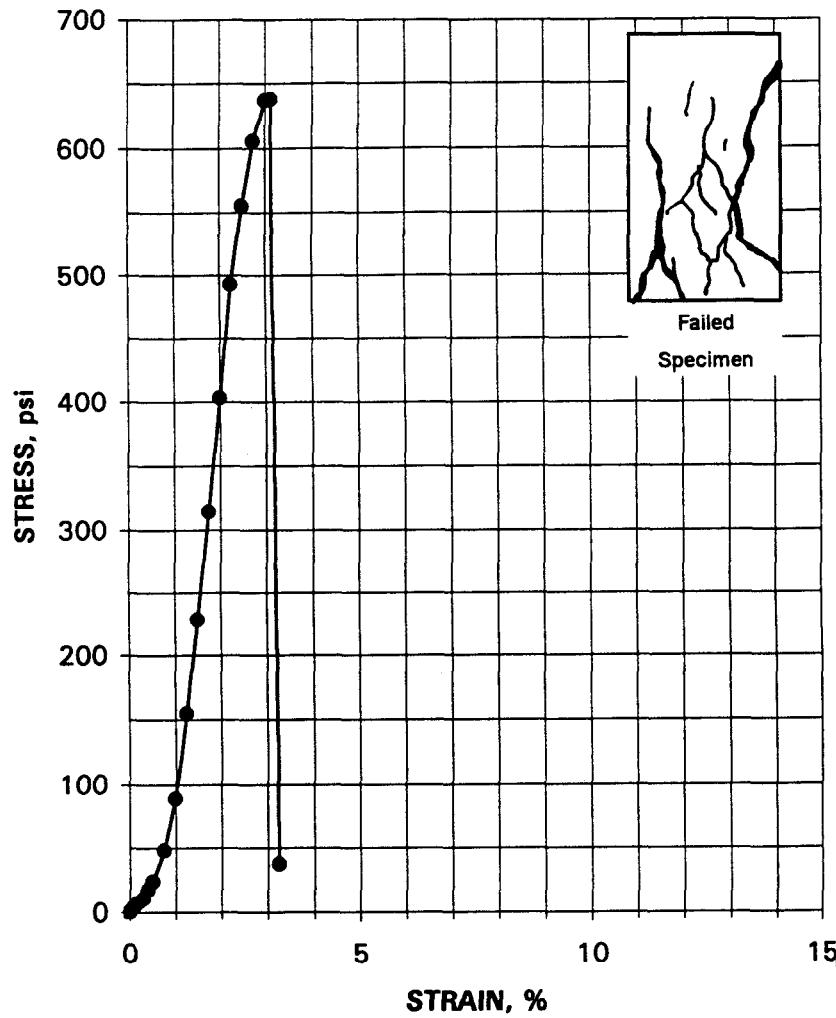
Client Sample No. P342F00
IT Lab Specimen No. ETDC-8050

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **638.1**
STRAIN AT FAILURE, % **3.1**

Specimen Height, in.	4.0008
Specimen Diameter, in.	2.0052
Specimen Weight, g.	374.81
Moisture Content, %	32.3
Wet Unit Weight, pcf.	113.0
Dry Unit Weight, pcf.	85.5
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	7.3
0.30	10.7
0.40	17.7
0.50	23.9
0.75	48.1
1.00	89.0
1.25	154.2
1.50	228.3
1.75	314.2
2.00	403.1
2.25	493.1
2.50	555.1
2.75	605.5
3.00	637.1
3.12	638.1
3.25	37.7



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

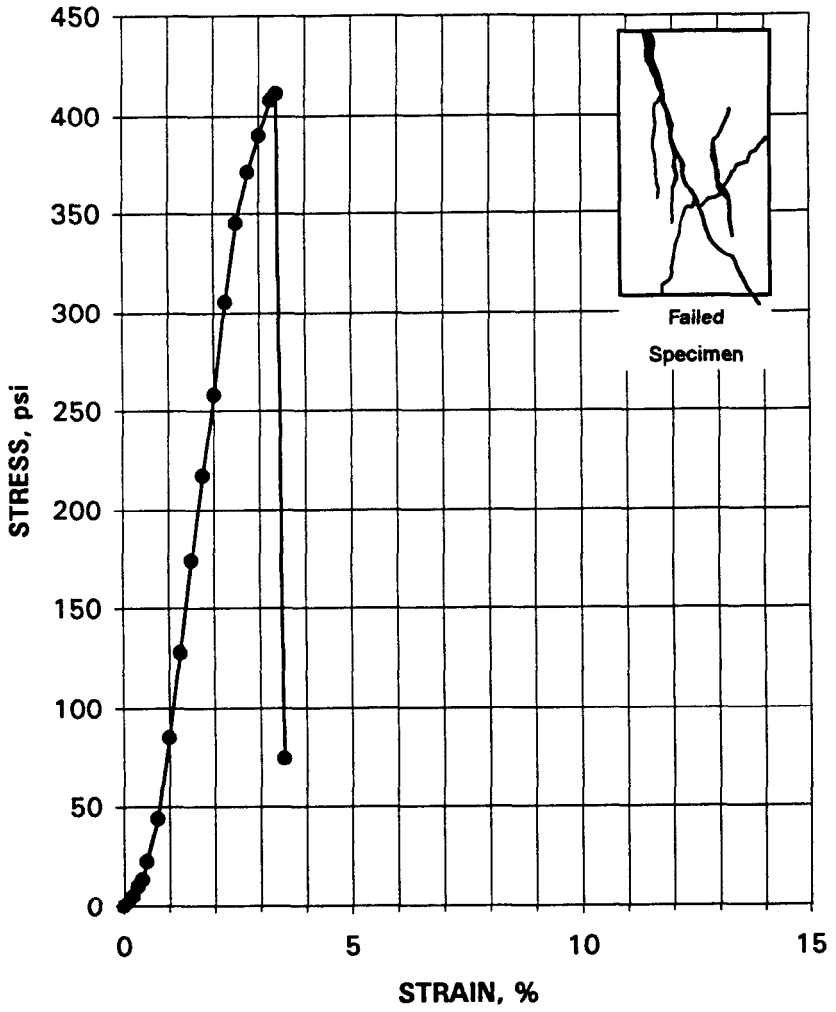
Project Name SAIC - Savannah River
Project No. 777304.00010500

Client Sample No. P412F00
IT Lab Specimen No. ETDC-8051

Specimen Mold Date	12/22/98
Specimen Test Date	1/19/99
STRESS AT FAILURE, psi	**411.1**
STRAIN AT FAILURE, %	**3.4**

Specimen Height, in.	3.9792
Specimen Diameter, in.	1.9987
Specimen Weight, g.	372.17
Moisture Content, %	31.8
Wet Unit Weight, pcf.	113.6
Dry Unit Weight, pcf.	86.2
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.2
0.20	5.1
0.30	10.2
0.40	13.7
0.50	22.5
0.75	44.0
1.01	85.2
1.26	127.5
1.51	174.2
1.76	217.0
2.01	257.7
2.26	305.3
2.51	345.2
2.76	371.0
3.02	389.5
3.27	407.9
3.39	411.1
3.52	74.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

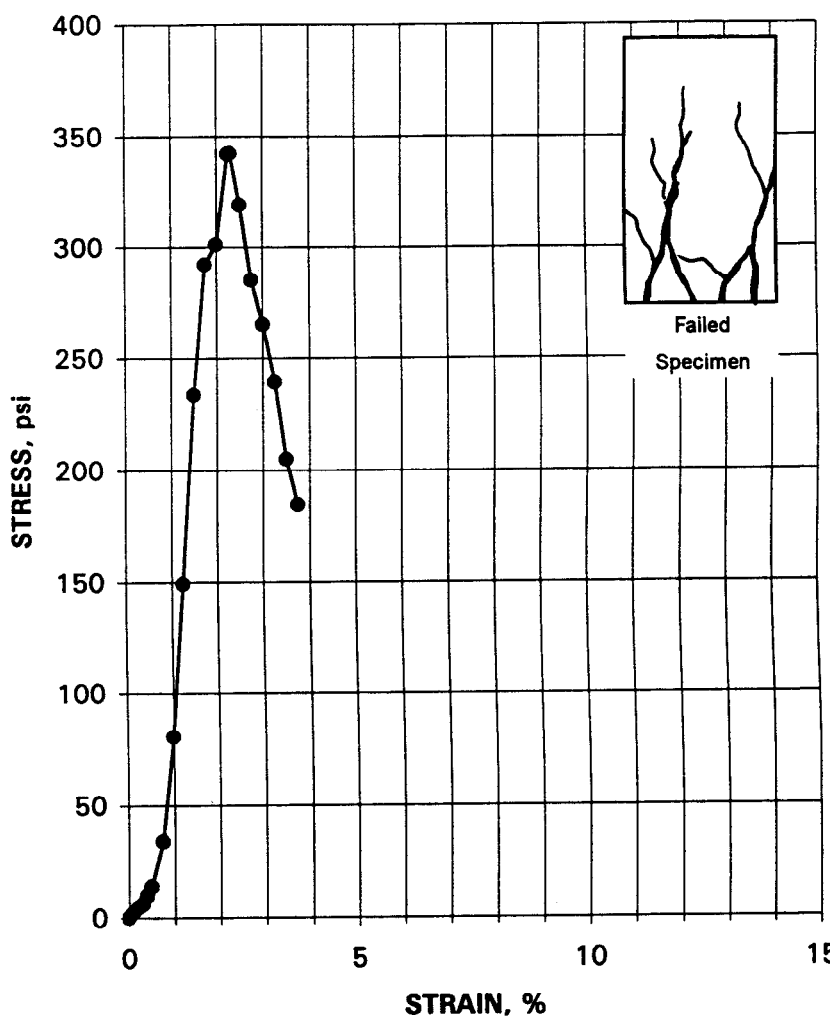
Client Sample No. P422F00
IT Lab Specimen No. ETDC-8052

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **342.4**
STRAIN AT FAILURE, % **2.3**

Specimen Height, in.	3.9953
Specimen Diameter, in.	2.0072
Specimen Weight, g.	382.76
Moisture Content, %	30.4
Wet Unit Weight, pcf.	115.4
Dry Unit Weight, pcf.	88.5
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.2
0.20	4.4
0.30	6.0
0.40	9.8
0.50	13.8
0.75	33.9
1.00	80.1
1.25	149.2
1.50	233.8
1.75	292.2
2.00	301.4
2.25	342.0
2.30	342.4
2.50	319.2
2.75	284.9
3.00	265.2
3.25	239.4
3.50	204.6
3.75	184.3



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

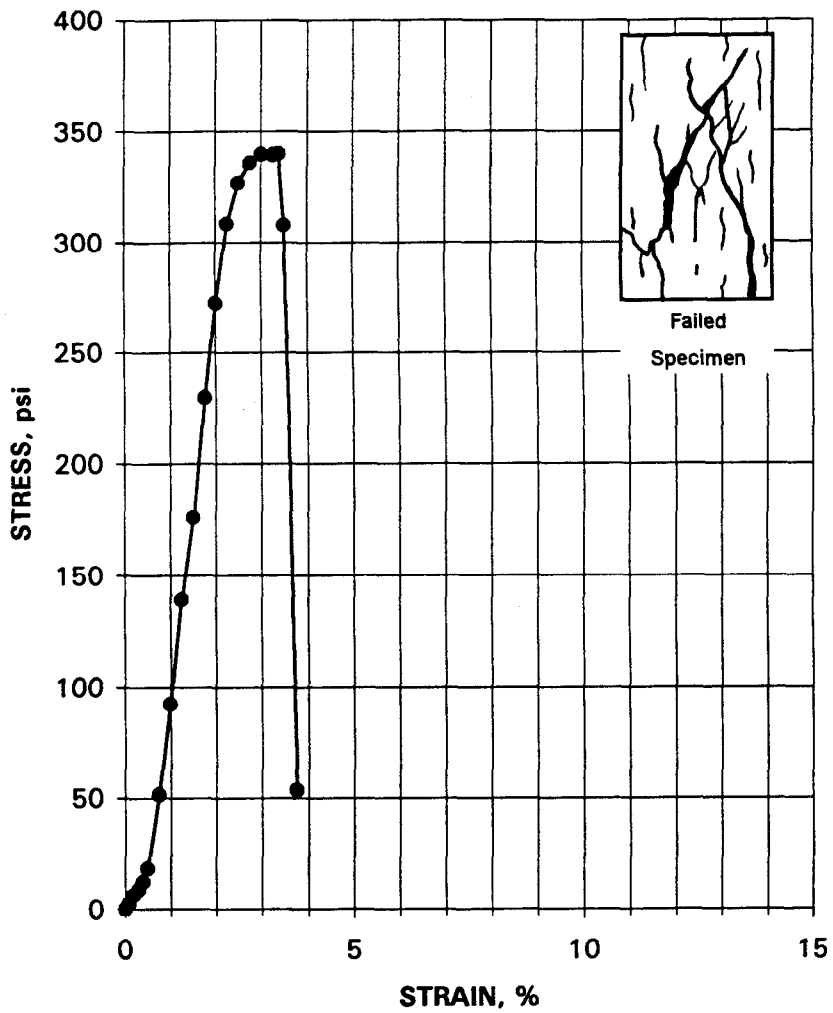
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P432F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8053

Specimen Mold Date		Specimen Height, in.	3.9855
Specimen Test Date	1/19/99	Specimen Diameter, in.	2.0038
		Specimen Weight, g.	361.96
STRESS AT FAILURE, psi	**340.1**	Moisture Content, %	37.5
STRAIN AT FAILURE, %	**3.4**	Wet Unit Weight, pcf.	109.7
		Dry Unit Weight, pcf.	79.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.9
0.20	6.6
0.30	9.2
0.40	12.6
0.50	18.6
0.75	51.3
1.00	92.3
1.25	139.0
1.51	175.8
1.76	229.3
2.01	272.5
2.26	308.4
2.51	326.8
2.76	335.8
3.01	339.8
3.26	339.6
3.39	340.1
3.51	307.8
3.76	53.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

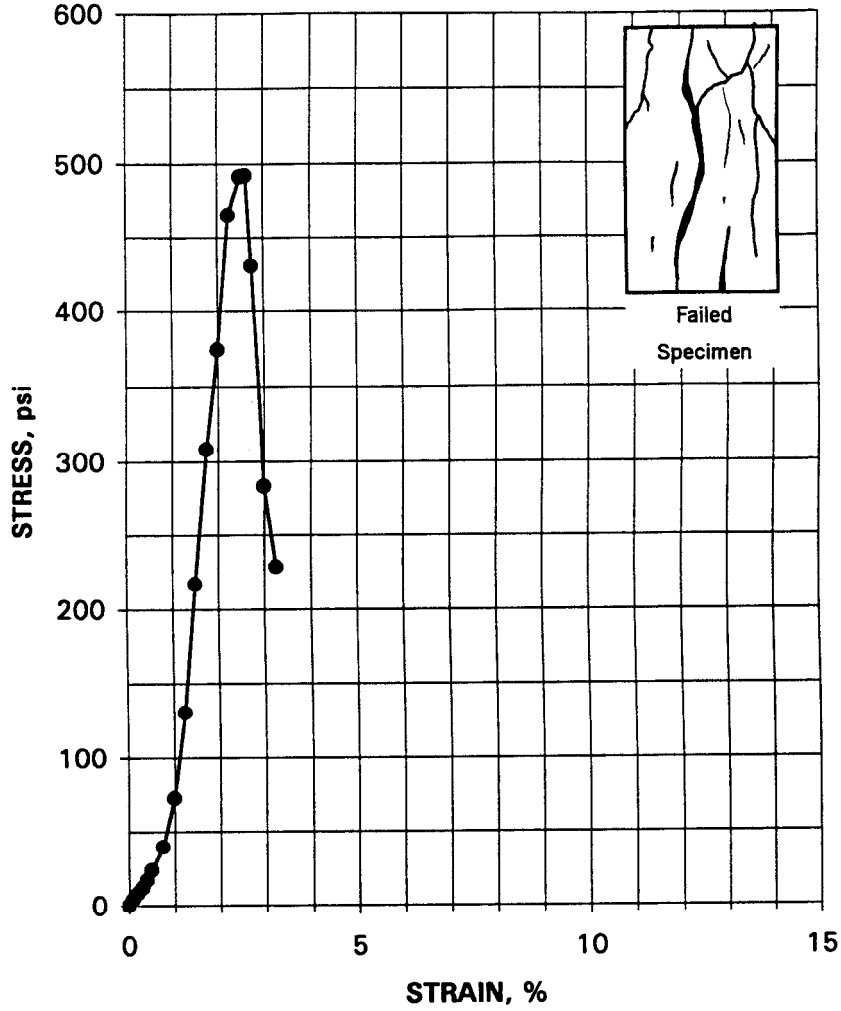
Client Sample No. P442F00
IT Lab Specimen No. ETDC-8054

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **492.2**
STRAIN AT FAILURE, % **2.6**

Specimen Height, in.	3.9987
Specimen Diameter, in.	2.0082
Specimen Weight, g.	364.40
Moisture Content, %	36.0
Wet Unit Weight, pcf.	109.6
Dry Unit Weight, pcf.	80.6
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.1
0.20	8.2
0.30	12.0
0.40	17.0
0.50	23.9
0.75	39.8
1.00	72.5
1.25	130.0
1.50	216.8
1.75	308.0
2.00	374.1
2.25	465.1
2.50	491.3
2.63	492.2
2.75	430.5
3.00	283.0
3.25	228.2



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

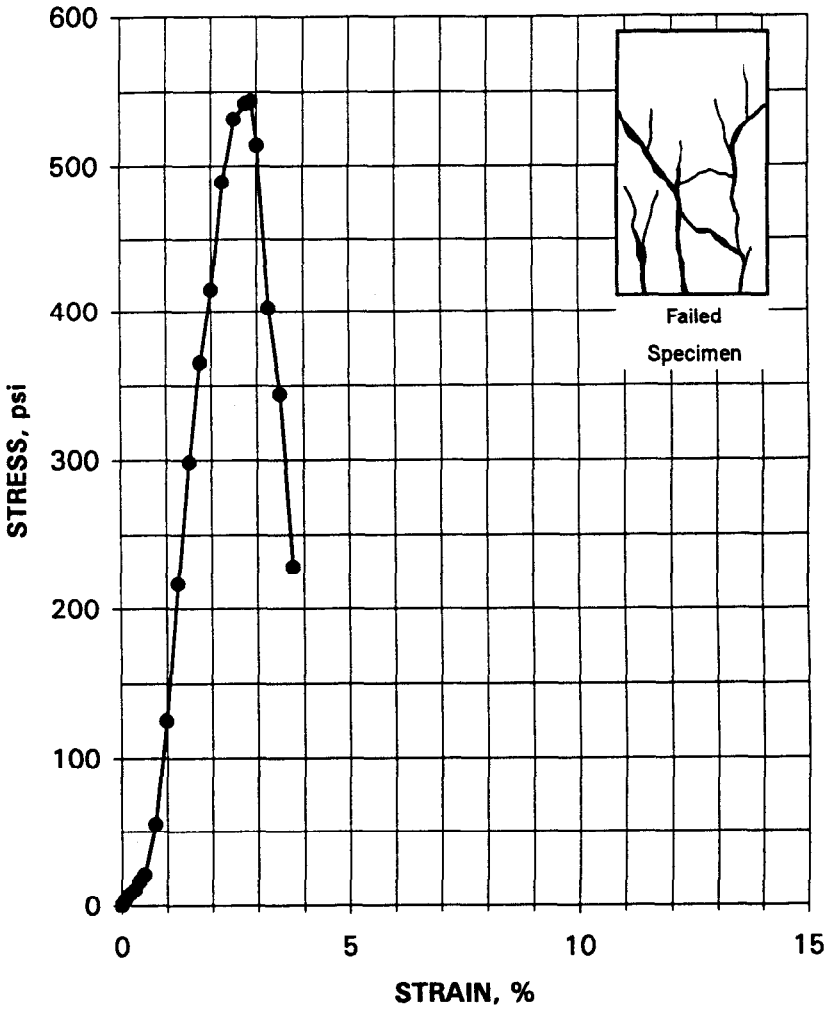
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P512F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8055

Specimen Mold Date		Specimen Height, in.	3.9838
Specimen Test Date	1/19/99	Specimen Diameter, in.	2.0007
		Specimen Weight, g.	377.87
STRESS AT FAILURE, psi	**543.4**	Moisture Content, %	29.1
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	115.0
		Dry Unit Weight, pcf.	89.1
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.1
0.20	7.6
0.30	10.8
0.40	16.5
0.50	20.6
0.75	54.9
1.00	124.7
1.26	216.7
1.51	298.0
1.76	365.6
2.01	414.6
2.26	488.8
2.51	531.2
2.76	541.9
2.89	543.4
3.01	513.7
3.26	402.2
3.51	344.1
3.77	228.1



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

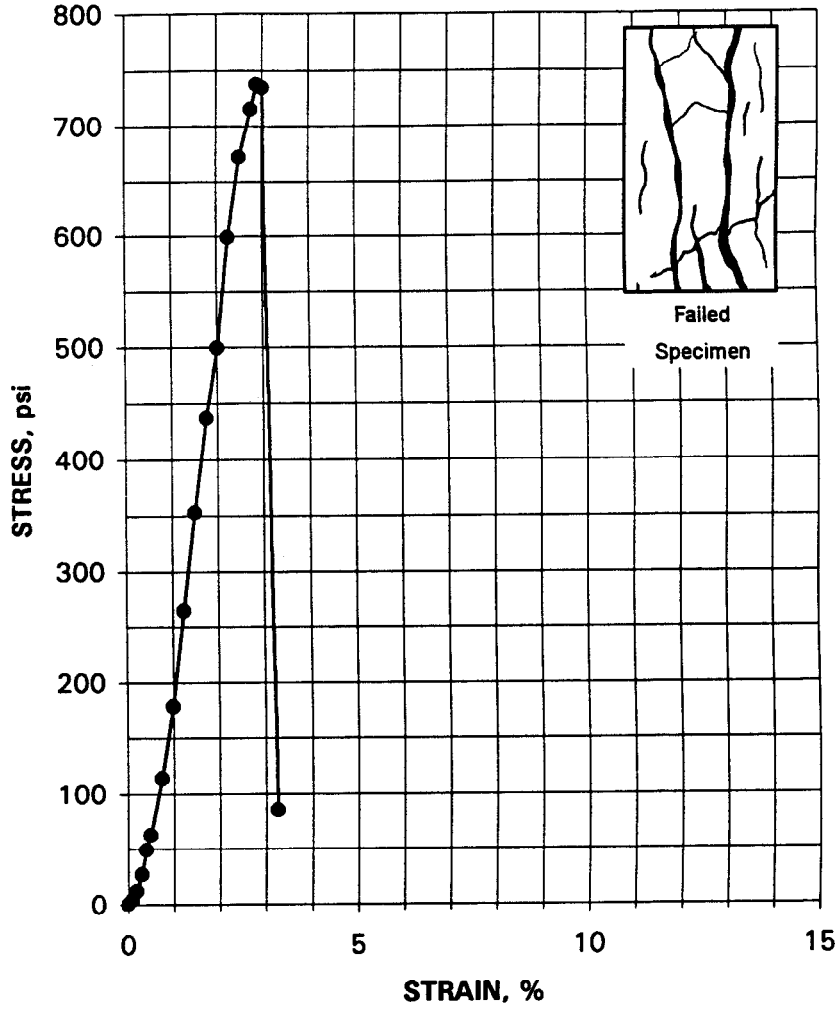
Client Sample No. P522F00
IT Lab Specimen No. ETDC-8056

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **737.1**
STRAIN AT FAILURE, % **2.9**

Specimen Height, in.	3.9907
Specimen Diameter, in.	1.9982
Specimen Weight, g.	393.76
Moisture Content, %	26.5
Wet Unit Weight, pcf.	119.9
Dry Unit Weight, pcf.	94.8
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	11.8
0.30	26.7
0.40	48.9
0.50	62.8
0.75	114.3
1.00	179.0
1.25	264.2
1.50	353.0
1.75	437.1
2.00	499.4
2.26	598.8
2.51	672.2
2.76	714.8
2.88	737.1
3.01	734.6
3.26	85.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

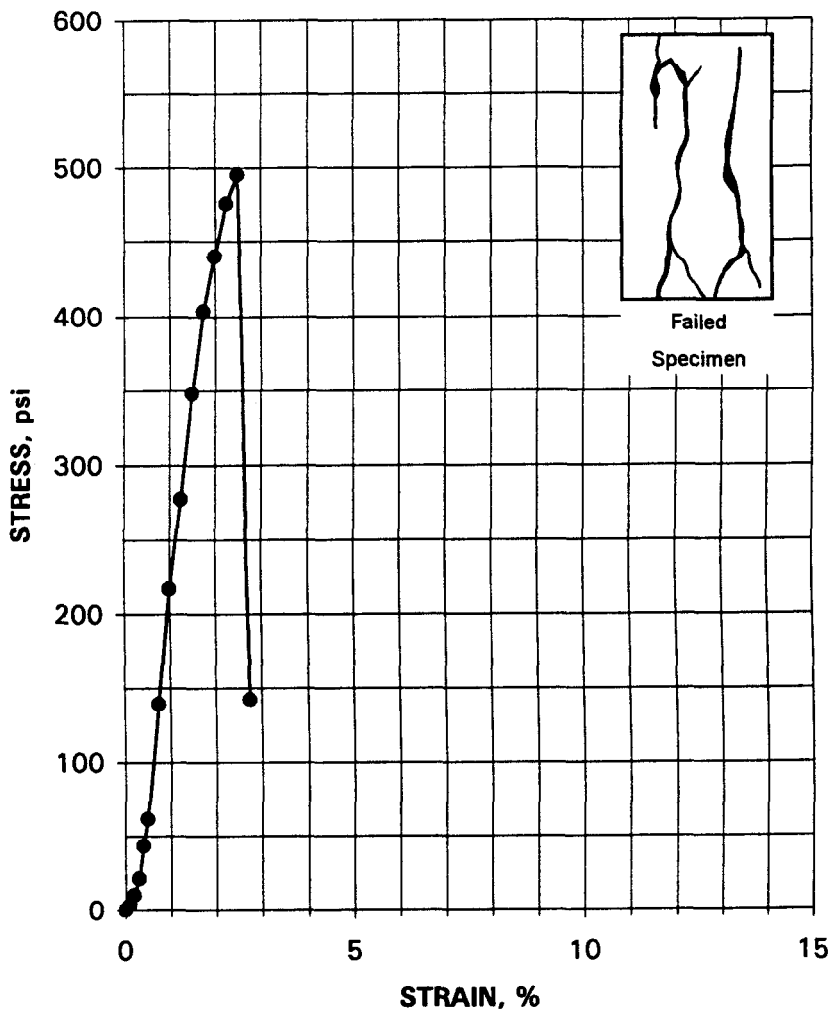
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P532F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8057

Specimen Mold Date		Specimen Height, in.	3.9998
Specimen Test Date	1/19/99	Specimen Diameter, in.	1.9997
		Specimen Weight, g.	396.27
STRESS AT FAILURE, psi	**495.2**	Moisture Content, %	32.8
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	120.2
		Dry Unit Weight, pcf.	90.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	10.2
0.30	21.3
0.40	43.1
0.50	61.8
0.75	139.4
1.00	216.6
1.25	277.3
1.50	347.8
1.75	403.6
2.00	440.0
2.25	475.0
2.50	495.2
2.75	142.1



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

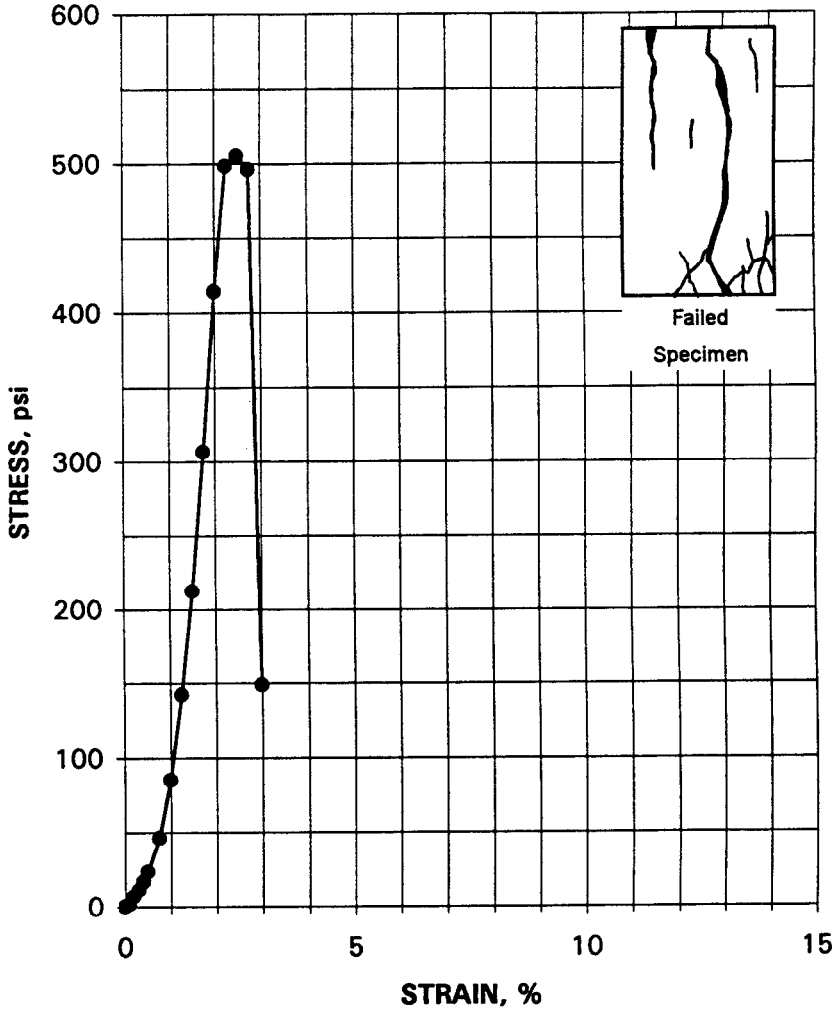
Client Sample No. P542F00
IT Lab Specimen No. ETDC-8058

Specimen Mold Date
Specimen Test Date 1/19/99

STRESS AT FAILURE, psi **504.8**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0148
Specimen Diameter, in.	1.9980
Specimen Weight, g.	372.48
Moisture Content, %	32.2
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	85.3
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	1.6
0.20	6.7
0.30	11.1
0.40	16.8
0.50	23.5
0.75	46.2
1.00	85.3
1.25	142.1
1.49	212.4
1.74	306.2
1.99	414.2
2.24	498.3
2.49	504.8
2.74	496.0
2.99	148.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

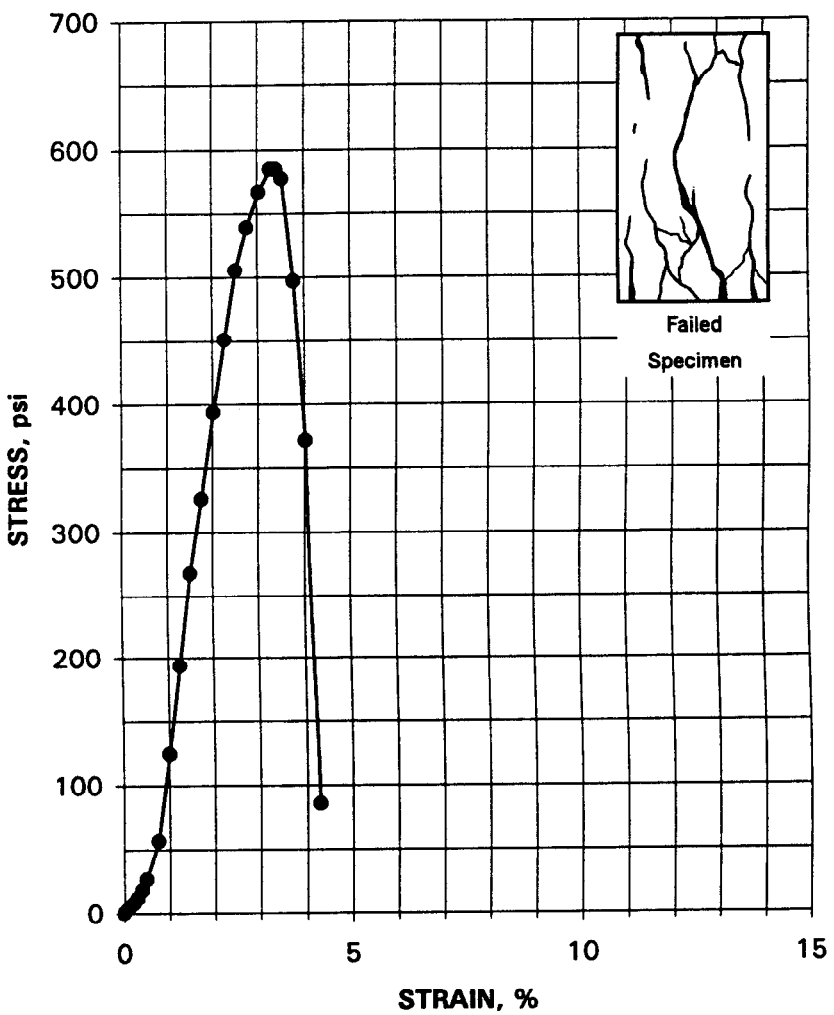
Client Sample No. P612F00
IT Lab Specimen No. ETDC-8059

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **585.3**
STRAIN AT FAILURE, % **3.4**

Specimen Height, in.	3.9608
Specimen Diameter, in.	1.9980
Specimen Weight, g.	377.70
Moisture Content, %	28.9
Wet Unit Weight, pcf.	115.9
Dry Unit Weight, pcf.	89.9
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.8
0.20	7.6
0.30	12.1
0.40	18.1
0.50	26.7
0.76	56.3
1.01	124.1
1.26	193.4
1.51	267.9
1.77	325.8
2.02	393.7
2.27	451.0
2.52	505.5
2.78	539.2
3.03	567.2
3.28	584.9
3.41	585.3
3.53	577.5
3.79	497.1
4.04	371.9
4.29	85.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

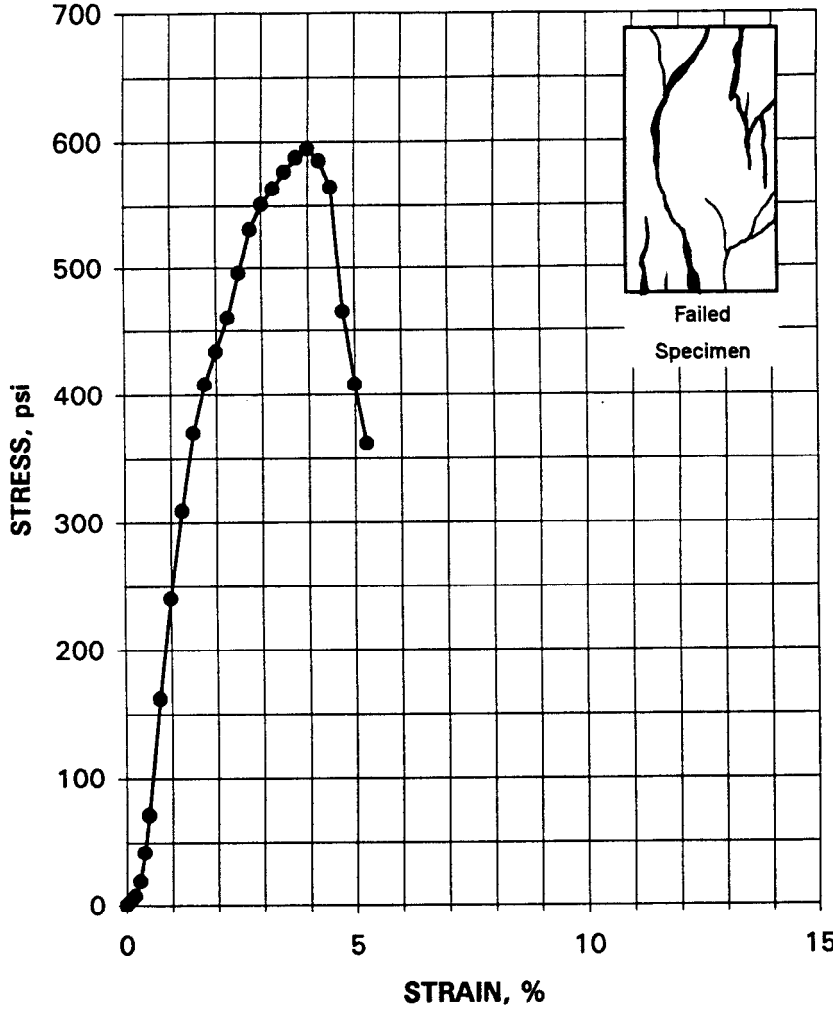
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name	SAIC - Savannah River	Client Sample No.	P622F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8060

Specimen Mold Date		Specimen Height, in.	3.9947
Specimen Test Date	1/20/99	Specimen Diameter, in.	2.0065
		Specimen Weight, g.	390.34
STRESS AT FAILURE, psi	**594.4**	Moisture Content, %	26.1
STRAIN AT FAILURE, %	**4.0**	Wet Unit Weight, pcf.	117.7
		Dry Unit Weight, pcf.	93.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	7.6
0.30	18.9
0.40	41.6
0.50	71.1
0.75	161.6
1.00	239.8
1.25	309.5
1.50	370.4
1.75	408.0
2.00	433.6
2.25	460.0
2.50	495.8
2.75	531.1
3.00	551.2
3.25	563.6
3.50	576.8
3.76	587.7
4.01	594.4
4.26	585.0
4.51	564.7
4.76	465.1
5.01	408.3
5.26	361.6



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

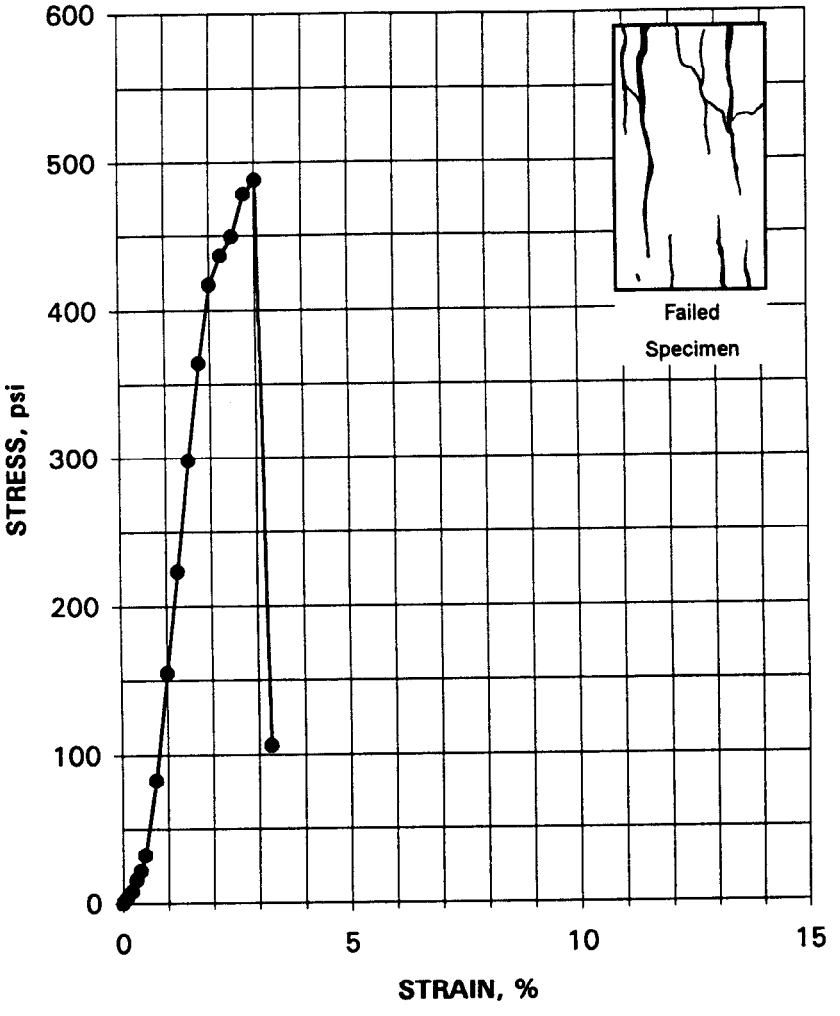
Client Sample No. P632F00
IT Lab Specimen No. ETDC-8061

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **487.7**
STRAIN AT FAILURE, % **3.0**

Specimen Height, in.	3.9770
Specimen Diameter, in.	2.0002
Specimen Weight, g.	368.96
Moisture Content, %	33.3
Wet Unit Weight, pcf.	112.5
Dry Unit Weight, pcf.	84.4
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.5
0.20	7.6
0.30	15.2
0.40	21.2
0.50	32.3
0.75	82.8
1.01	154.7
1.26	223.8
1.51	297.5
1.76	363.9
2.01	416.6
2.26	436.4
2.51	449.2
2.77	478.1
3.02	487.7
3.27	105.6



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project Name SAIC - Savannah River
Project No. 777304.00010500

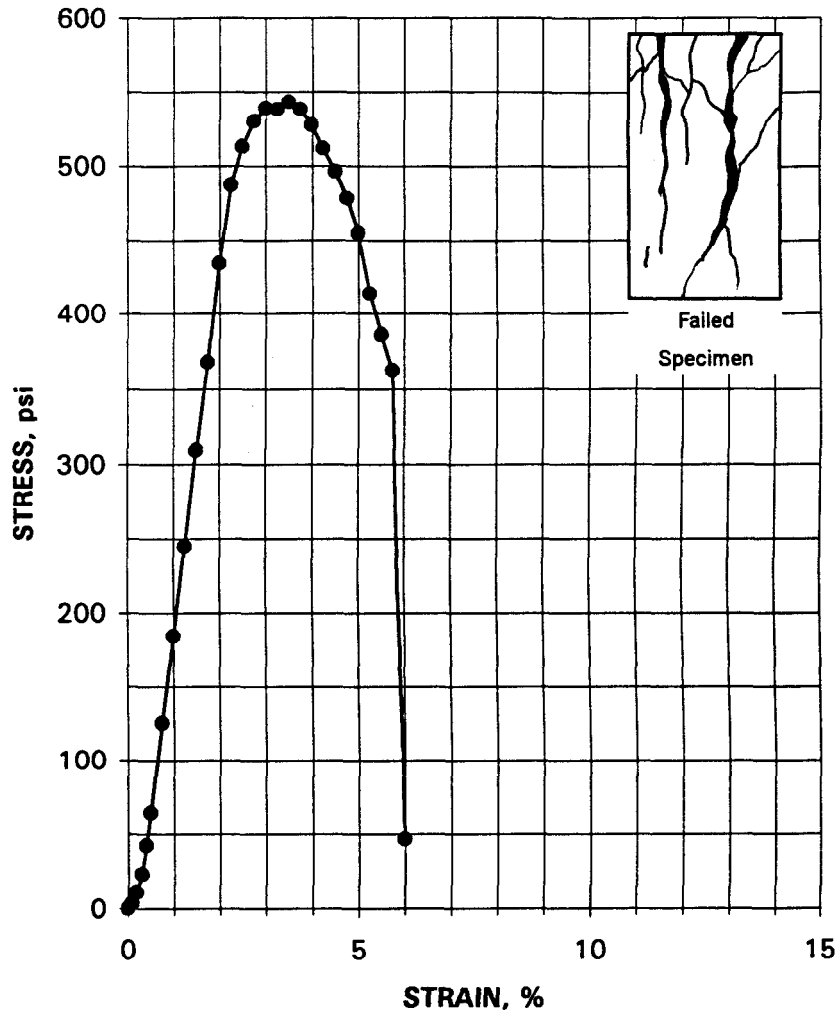
Client Sample No. P642F00
IT Lab Specimen No. ETDC-8062

Specimen Mold Date
Specimen Test Date 1/20/99

STRESS AT FAILURE, psi **543.1**
STRAIN AT FAILURE, % **3.5**

Specimen Height, in.	4.0012
Specimen Diameter, in.	2.0022
Specimen Weight, g.	375.47
Moisture Content, %	31.4
Wet Unit Weight, pcf.	113.6
Dry Unit Weight, pcf.	86.4
Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, *psi*
0.00	0.0
0.10	3.8
0.20	11.1
0.30	23.1
0.40	42.4
0.50	64.8
0.75	124.8
1.00	184.0
1.25	245.0
1.50	309.4
1.75	367.9
2.00	434.2
2.25	487.1
2.50	512.8
2.75	529.7
3.00	538.6
3.25	537.8
3.50	543.1
3.75	538.1
4.00	527.2
4.25	511.2
4.50	495.9
4.75	478.0
5.00	455.0
5.25	413.5
5.50	385.7
5.75	362.2



P Series
90 Day Immersion UCS Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

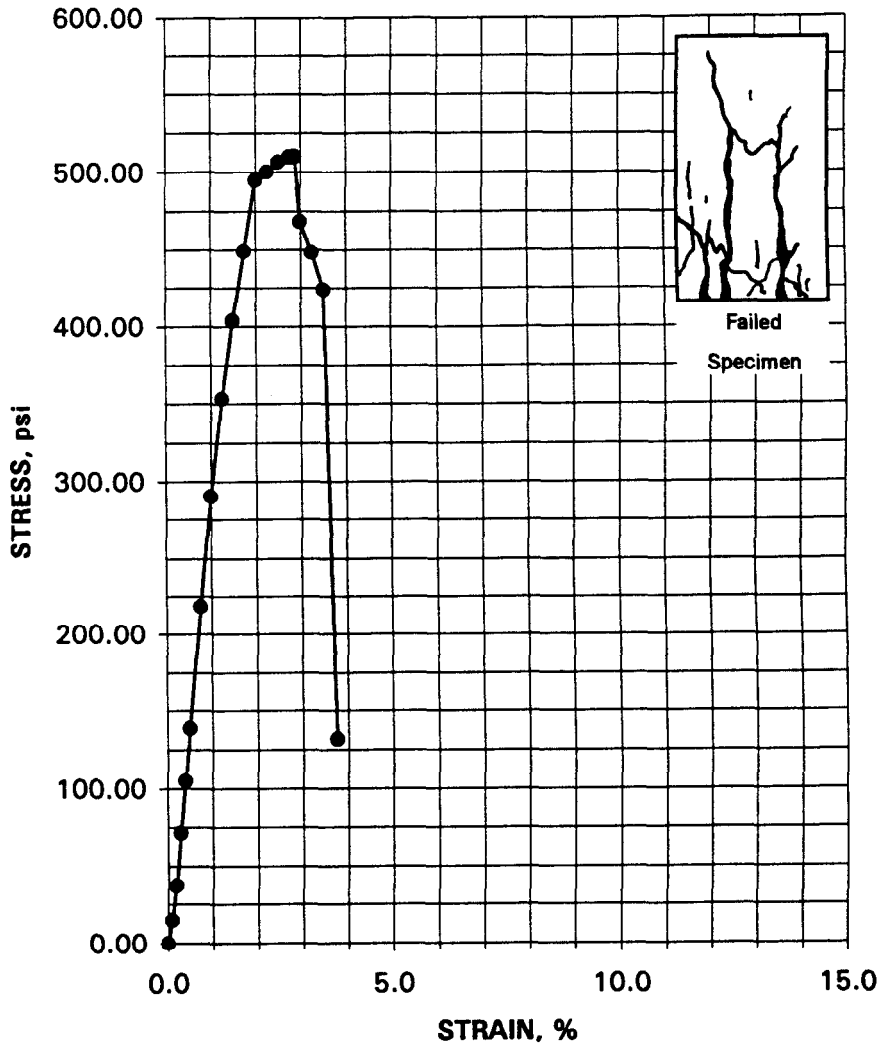
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P313F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8023

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9910
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0038
		Specimen Weight, g.	388.04
STRESS AT FAILURE, psi	**509.7**	Moisture Content, %	30.8
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	117.5
		Dry Unit Weight, pcf.	89.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	14.9
0.20	37.0
0.30	71.1
0.40	104.9
0.50	138.8
0.75	218.4
1.00	289.7
1.25	353.2
1.50	403.5
1.75	448.9
2.00	494.7
2.26	499.9
2.51	506.1
2.76	509.4
2.88	509.7
3.01	468.4
3.26	448.2
3.51	423.8
3.76	131.8



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

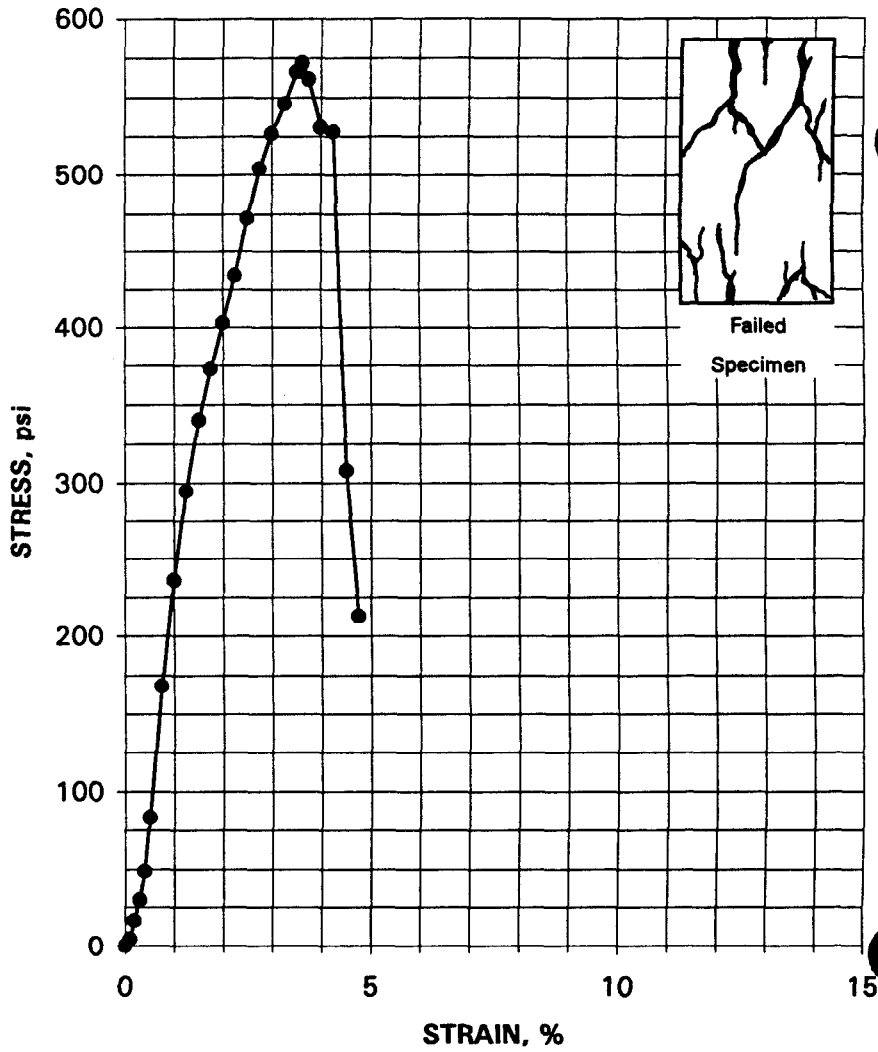
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P323F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8024

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9953
Specimen Test Date	4/19/99	Specimen Diameter, in.	2.0077
		Specimen Weight, g.	395.20
STRESS AT FAILURE, psi	**571.4**	Moisture Content, %	28.7
STRAIN AT FAILURE, %	**3.6**	Wet Unit Weight, pcf.	119.1
		Dry Unit Weight, pcf.	92.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.7
0.20	16.4
0.30	29.6
0.40	48.5
0.50	83.3
0.75	168.0
1.00	235.5
1.25	294.5
1.50	340.1
1.75	373.0
2.00	402.7
2.25	434.1
2.50	471.8
2.75	504.1
3.00	526.7
3.25	546.1
3.50	566.3
3.63	571.4
3.75	561.5
4.00	531.0
4.25	528.1
4.51	307.7
4.76	212.7



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

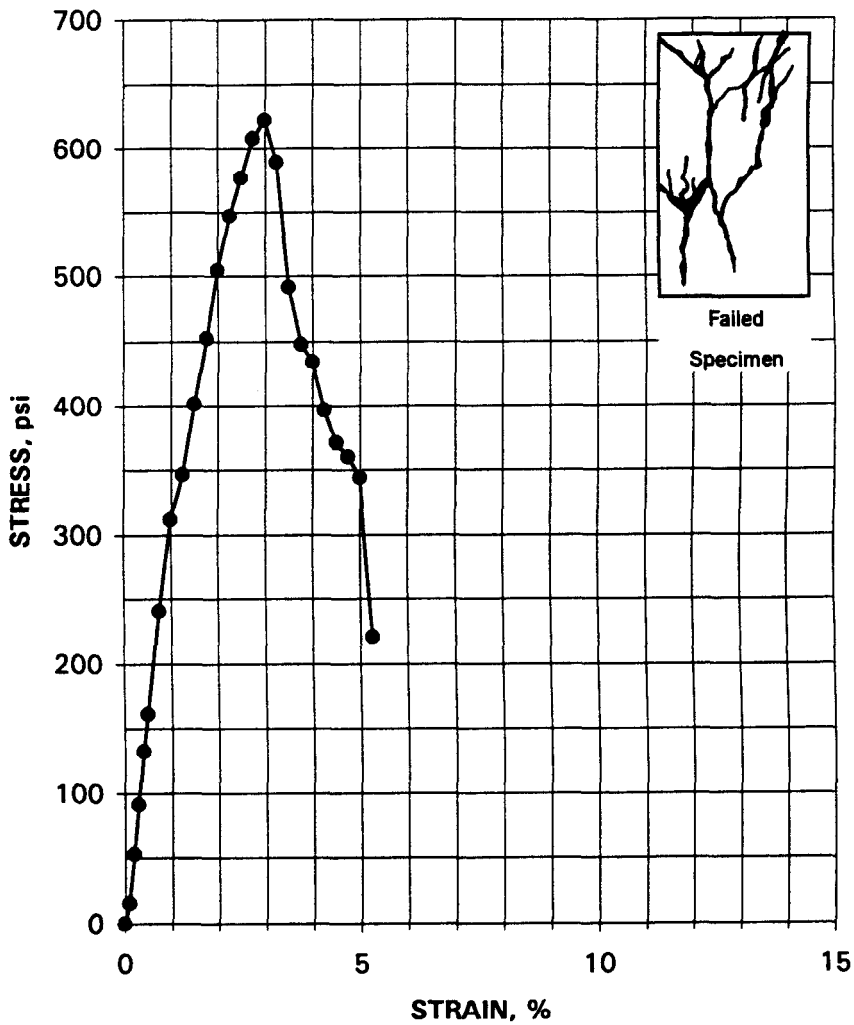
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P333F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8025

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9970
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	384.87
STRESS AT FAILURE, psi	**621.5**	Moisture Content, %	31.0
STRAIN AT FAILURE, %	**3.0**	Wet Unit Weight, pcf.	116.6
		Dry Unit Weight, pcf.	89.0
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	15.2
0.20	53.3
0.30	91.5
0.40	132.3
0.50	161.2
0.75	240.9
1.00	311.7
1.25	346.3
1.50	401.8
1.75	452.2
2.00	504.6
2.25	547.1
2.50	577.0
2.75	607.7
3.00	621.5
3.25	589.2
3.50	491.7
3.75	447.9
4.00	434.9
4.25	396.6
4.50	370.7
4.75	360.1
5.00	344.0
5.25	220.0



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

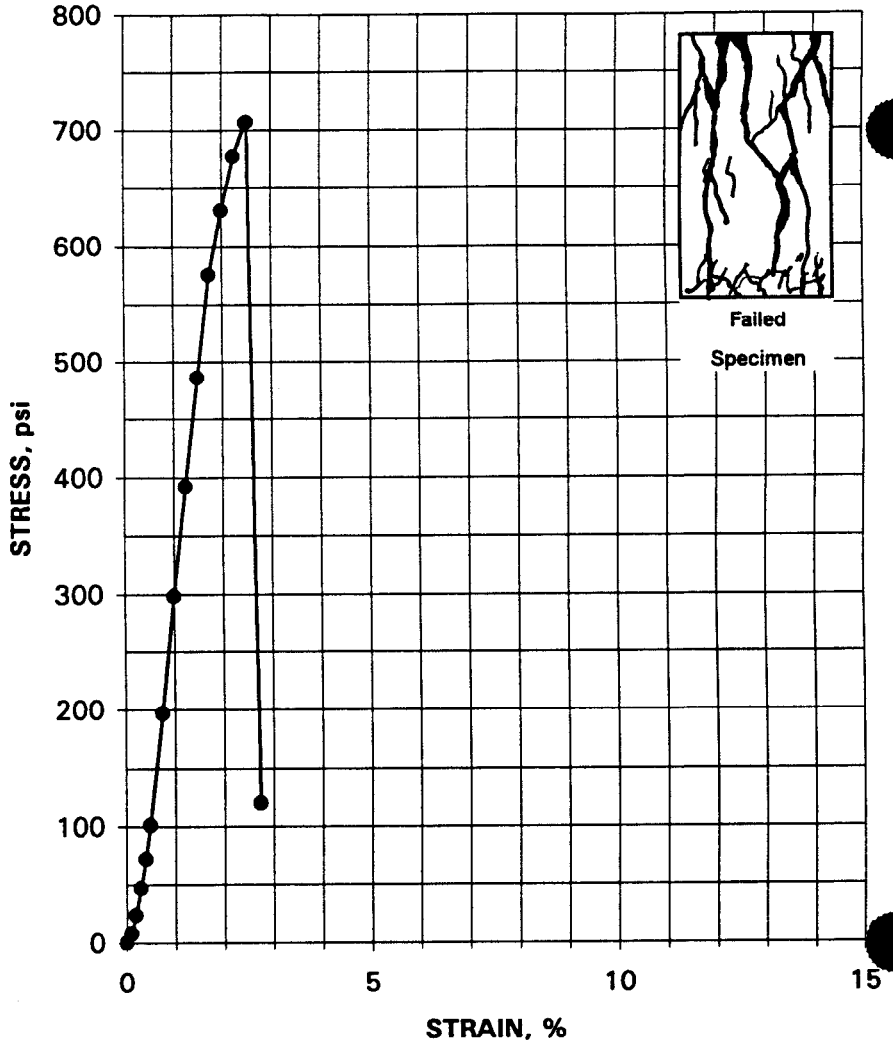
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P343F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8026

Specimen Mold Date	12/22/99	Specimen Height, in.	4.0115
Specimen Test Date	4/19/99	Specimen Diameter, in.	2.0058
		Specimen Weight, g.	379.20
STRESS AT FAILURE, psi	**707.1**	Moisture Content, %	33.4
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	114.0
		Dry Unit Weight, pcf.	85.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	7.6
0.20	23.1
0.30	46.4
0.40	71.6
0.50	101.1
0.75	196.6
1.00	298.3
1.25	392.5
1.50	485.4
1.74	574.9
1.99	630.5
2.24	677.5
2.49	706.9
2.52	707.1
2.74	119.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

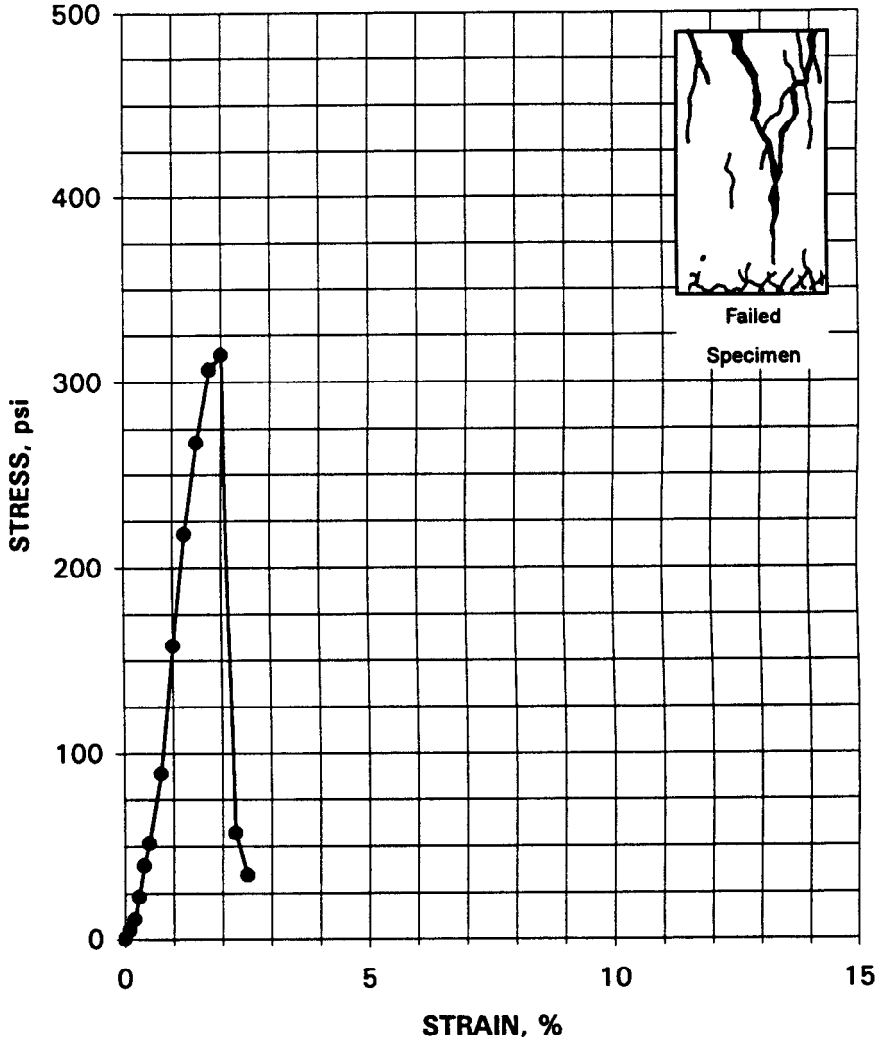
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P413F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8027

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9708
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0007
		Specimen Weight, g.	377.96
STRESS AT FAILURE, psi	**314.2**	Moisture Content, %	35.0
STRAIN AT FAILURE, %	**2.0**	Wet Unit Weight, pcf.	115.4
		Dry Unit Weight, pcf.	85.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	4.8
0.20	10.5
0.30	22.8
0.40	39.9
0.50	51.9
0.76	89.0
1.01	157.8
1.26	218.0
1.51	267.2
1.76	306.6
2.01	314.2
2.27	57.2
2.52	34.7



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

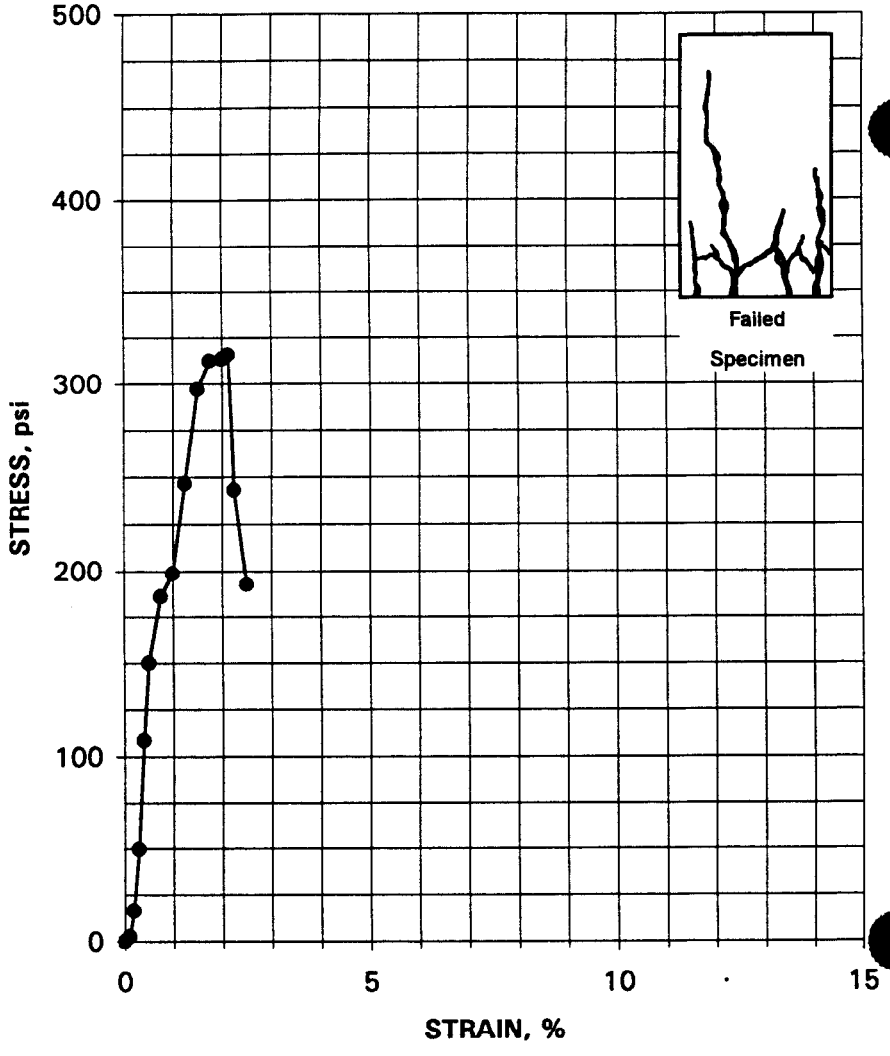
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P423F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8028

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9963
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0092
		Specimen Weight, g.	385.26
STRESS AT FAILURE, psi	**315.8**	Moisture Content, %	32.2
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	115.9
		Dry Unit Weight, pcf.	87.6
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.8
0.20	16.1
0.30	49.7
0.40	108.7
0.50	150.0
0.75	185.9
1.00	198.6
1.25	246.7
1.50	297.0
1.75	312.4
2.00	313.4
2.13	315.8
2.25	243.3
2.50	192.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

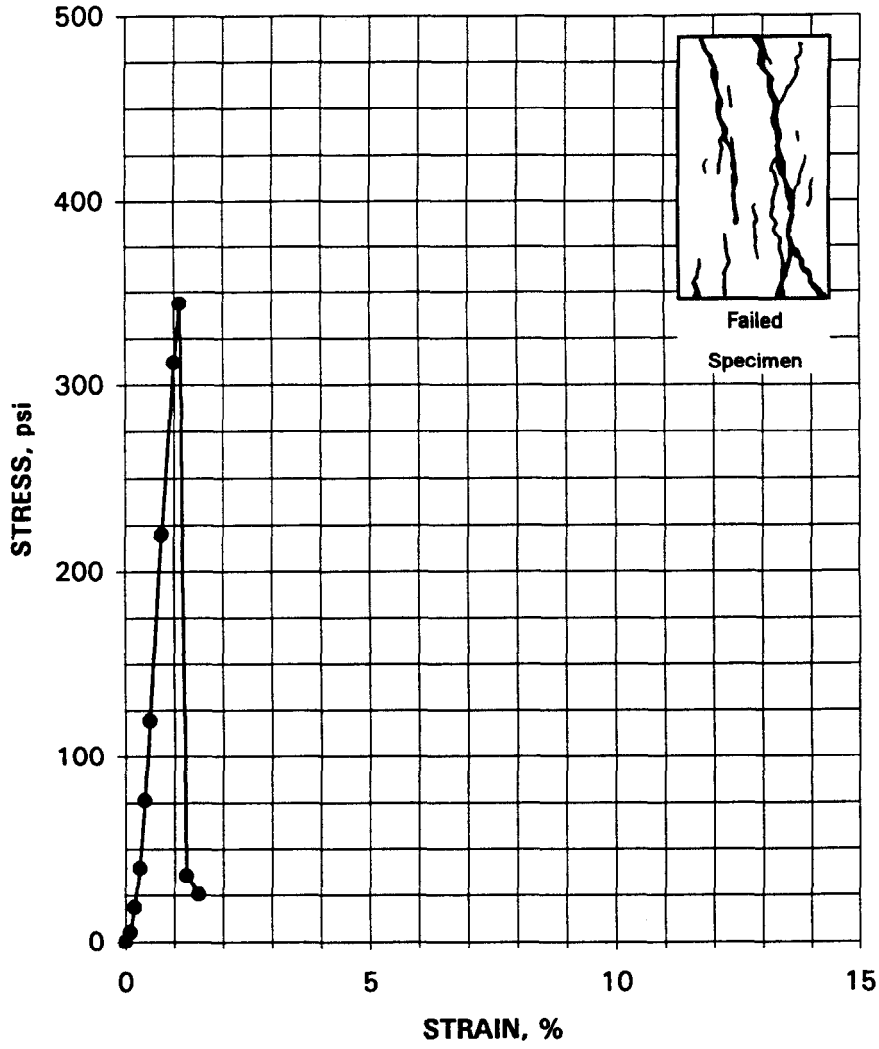
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P433F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8029

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9997
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0007
		Specimen Weight, g.	368.01
STRESS AT FAILURE, psi	**343.8**	Moisture Content, %	38.8
STRAIN AT FAILURE, %	**1.1**	Wet Unit Weight, pcf.	111.5
		Dry Unit Weight, pcf.	80.4
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	5.1
0.20	18.4
0.30	39.6
0.40	76.4
0.50	119.3
0.75	220.1
1.00	312.1
1.13	343.8
1.25	35.5
1.50	25.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

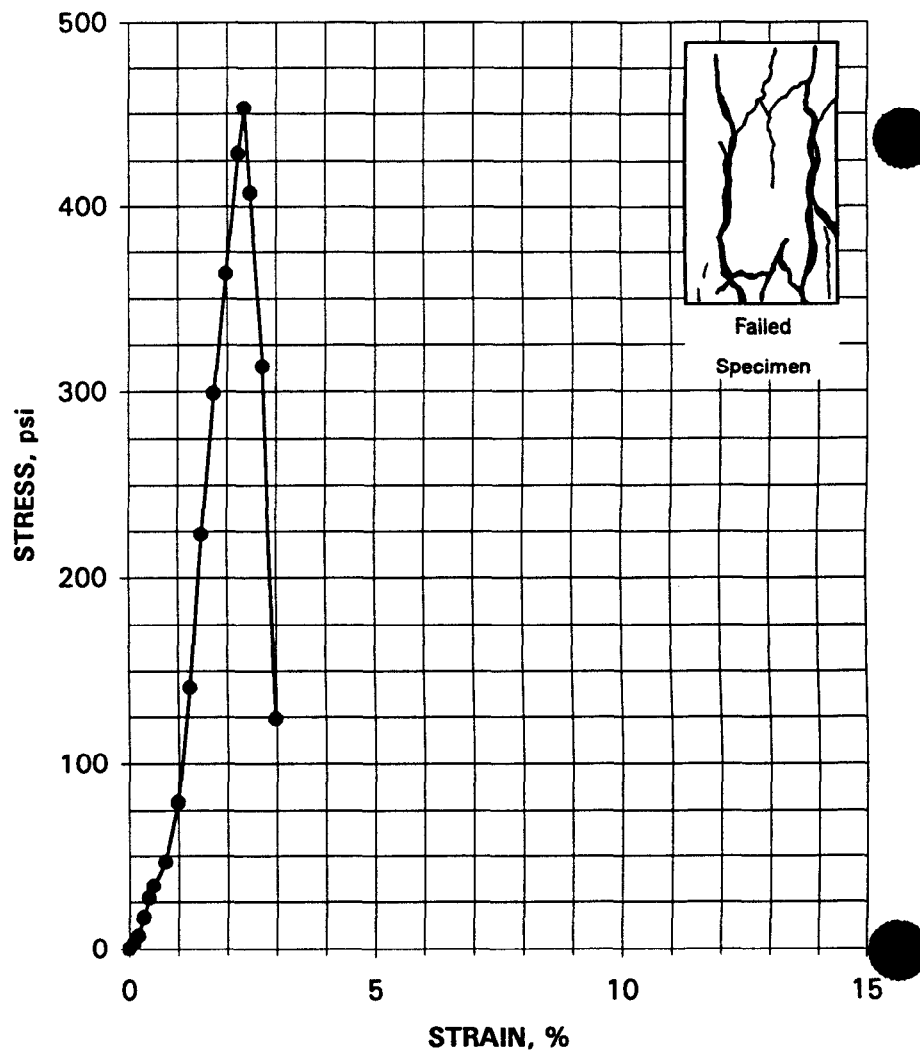
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P443F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8030

Specimen Mold Date	12/22/99	Specimen Height, in.	4.0257
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0100
		Specimen Weight, g.	371.64
STRESS AT FAILURE, psi	**453.0**	Moisture Content, %	36.9
STRAIN AT FAILURE, %	**2.4**	Wet Unit Weight, pcf.	110.9
		Dry Unit Weight, pcf.	81.0
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	3.1
0.20	7.2
0.30	17.0
0.40	27.0
0.50	33.6
0.75	46.6
0.99	79.3
1.24	140.7
1.49	223.5
1.74	298.8
1.99	363.6
2.24	428.6
2.36	453.0
2.48	407.5
2.73	313.3
2.98	123.8



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

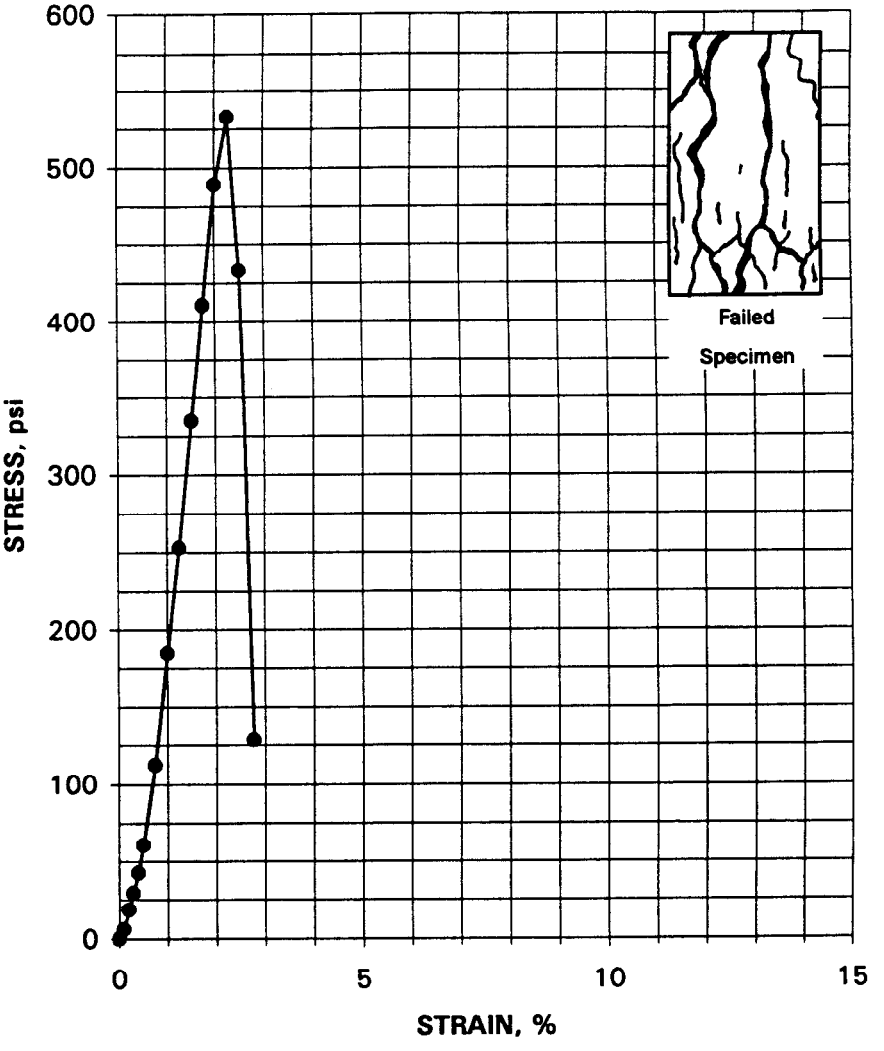
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P513F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8031

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9633
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0052
		Specimen Weight, g.	381.43
STRESS AT FAILURE, psi	**532.9**	Moisture Content, %	30.8
STRAIN AT FAILURE, %	**2.3**	Wet Unit Weight, pcf.	116.1
		Dry Unit Weight, pcf.	88.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	6.0
0.20	18.3
0.30	29.0
0.40	42.6
0.50	60.5
0.76	112.5
1.01	184.6
1.26	252.6
1.51	334.6
1.77	410.6
2.02	488.7
2.27	532.9
2.52	432.8
2.78	128.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

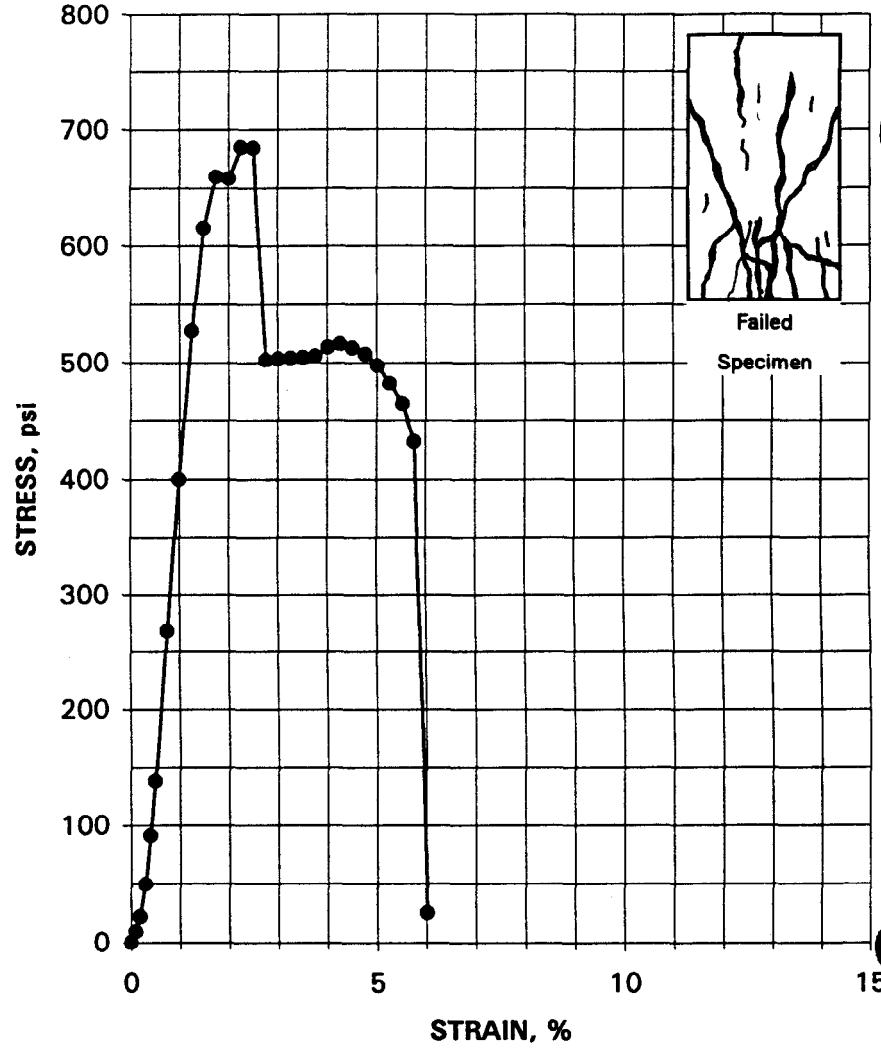
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P523F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8032

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9793
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0062
		Specimen Weight, g.	393.78
STRESS AT FAILURE, psi	**685.2**	Moisture Content, %	28.5
STRAIN AT FAILURE, %	**2.3**	Wet Unit Weight, pcf.	119.3
		Dry Unit Weight, pcf.	92.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	9.2
0.20	22.1
0.30	49.2
0.40	91.1
0.50	138.2
0.75	267.2
1.01	399.6
1.26	527.0
1.51	615.4
1.76	660.1
2.01	658.1
2.26	685.2
2.51	684.7
2.76	502.6
3.02	503.5
3.27	504.0
3.52	504.8
3.77	506.0
4.02	513.4
4.27	516.0
4.52	512.6
4.77	507.3
5.03	497.3
5.28	481.9
5.53	464.7
5.78	431.6



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

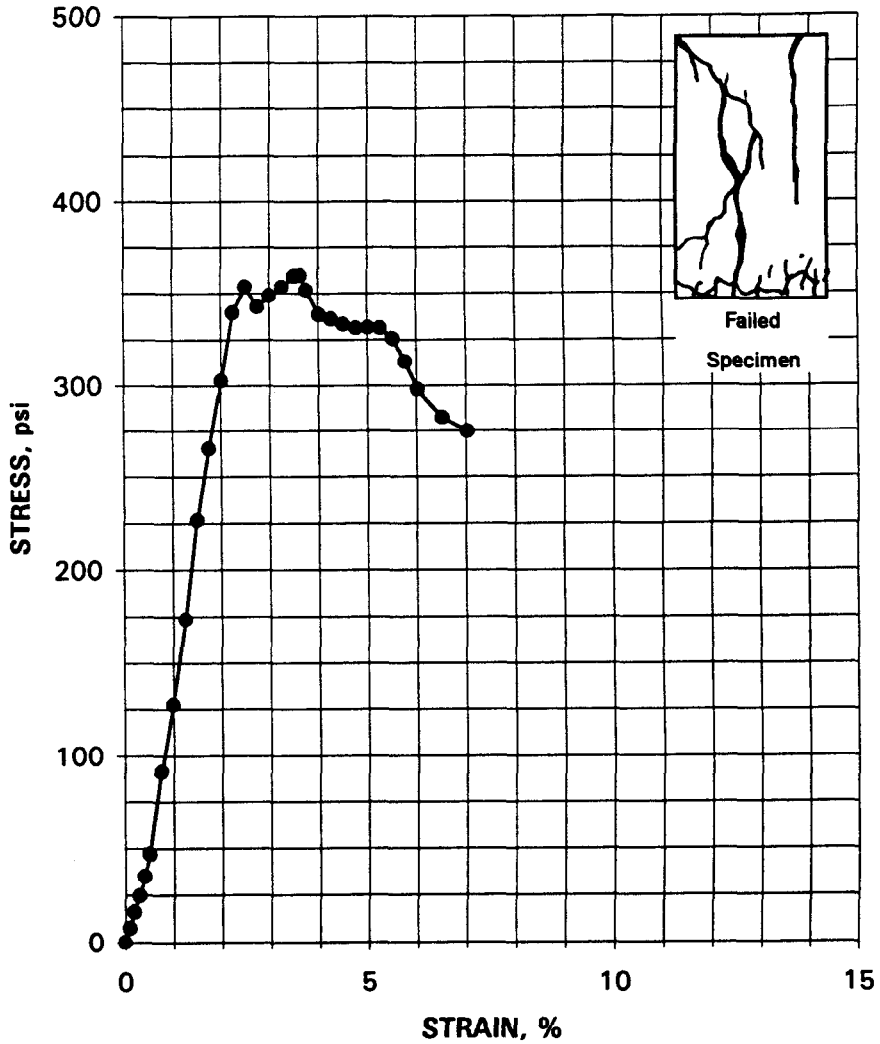
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P533F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8033

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9788
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0027
		Specimen Weight, g.	371.50
STRESS AT FAILURE, psi	**359.7**	Moisture Content, %	36.0
STRAIN AT FAILURE, %	**3.6**	Wet Unit Weight, pcf.	112.9
		Dry Unit Weight, pcf.	83.1
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	7.6
0.20	16.2
0.30	24.7
0.40	35.1
0.50	47.1
0.75	91.4
1.01	127.3
1.26	173.4
1.51	227.0
1.76	265.4
2.01	302.7
2.26	339.4
2.51	353.4
2.76	342.6
3.02	348.5
3.27	353.5
3.52	359.3
3.64	359.7
3.77	351.6
4.02	338.5
4.27	335.8
4.52	333.1
4.78	331.0
5.03	331.4
5.28	331.1
5.53	325.4



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

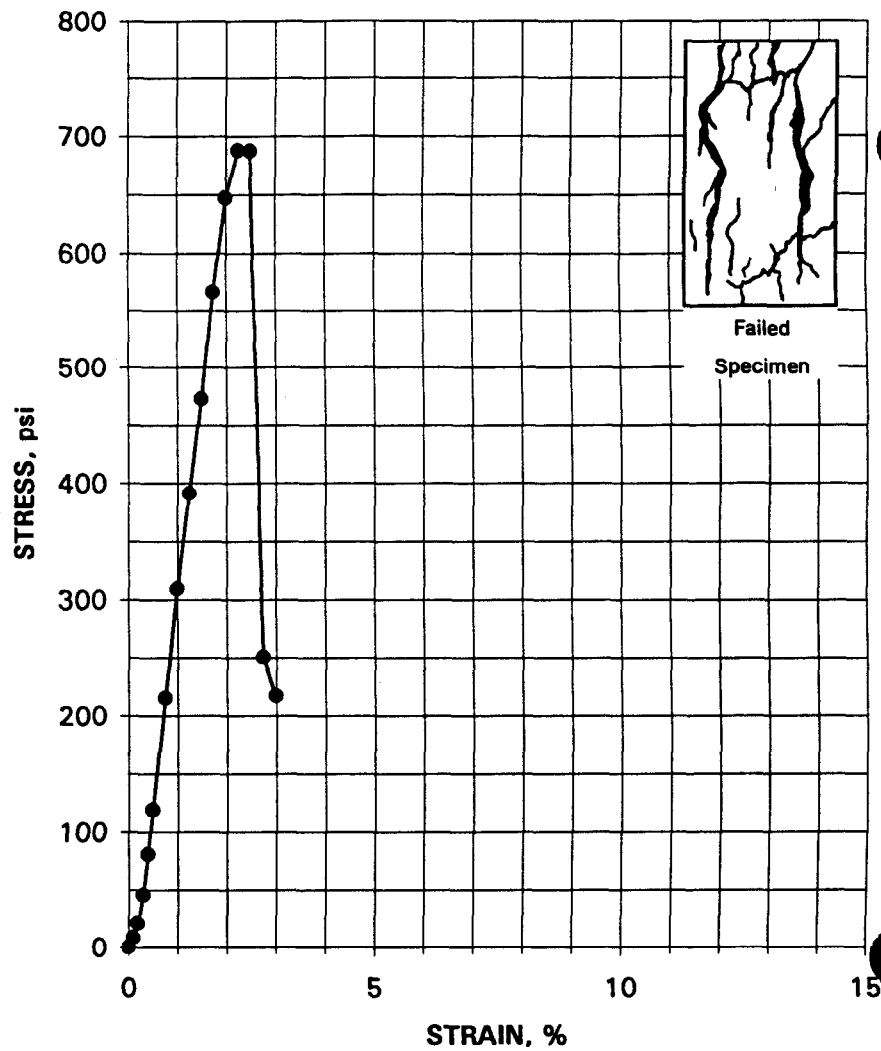
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P543F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8034

Specimen Mold Date	12/22/99	Specimen Height, in.	4.0087
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0025
		Specimen Weight, g.	378.66
STRESS AT FAILURE, psi	**687.8**	Moisture Content, %	33.5
STRAIN AT FAILURE, %	**2.2**	Wet Unit Weight, pcf.	114.3
		Dry Unit Weight, pcf.	85.6
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	8.9
0.20	21.5
0.30	45.3
0.40	81.0
0.50	119.1
0.75	214.9
1.00	309.6
1.25	391.0
1.50	472.3
1.75	566.9
2.00	647.3
2.25	687.8
2.49	687.3
2.74	250.7
2.99	217.5



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

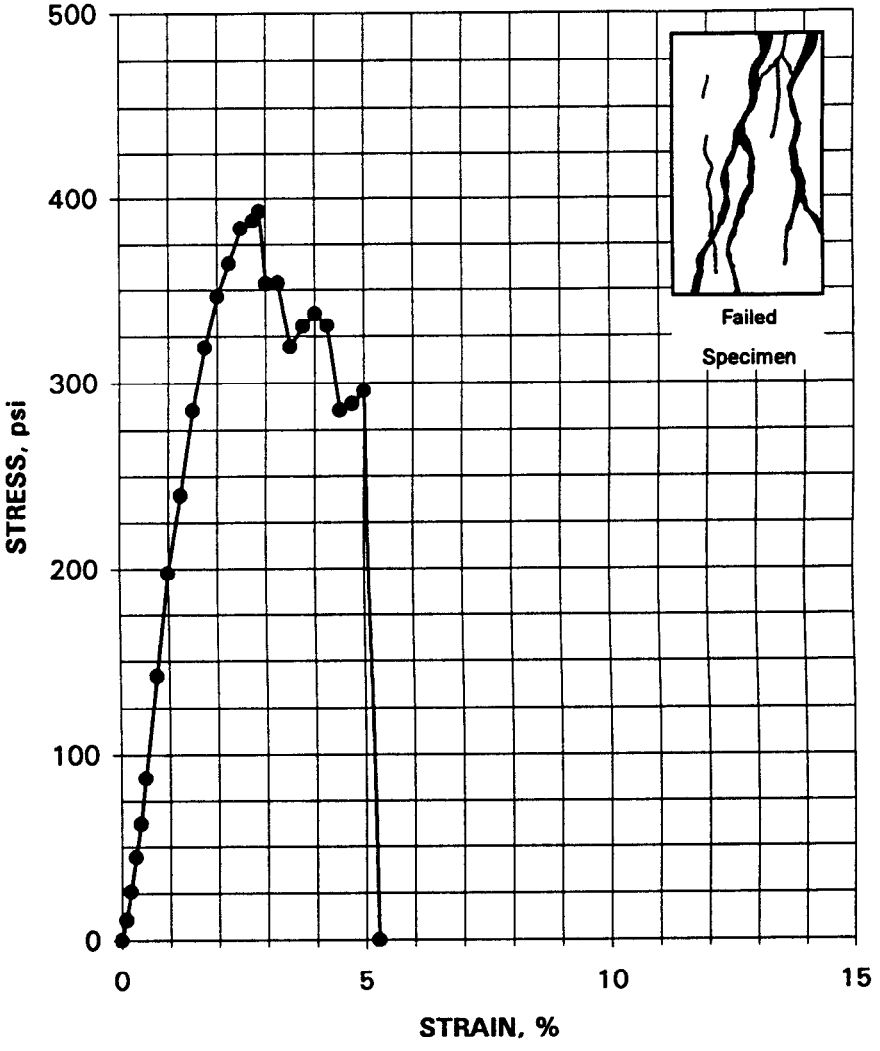
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P613F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8035

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9862
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0008
		Specimen Weight, g.	388.93
STRESS AT FAILURE, psi	**392.6**	Moisture Content, %	29.8
STRAIN AT FAILURE, %	**2.9**	Wet Unit Weight, pcf.	118.2
		Dry Unit Weight, pcf.	91.1
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	10.5
0.20	26.0
0.30	44.7
0.40	62.7
0.50	87.3
0.75	142.0
1.00	197.4
1.25	239.6
1.51	285.4
1.76	319.0
2.01	346.3
2.26	363.7
2.51	383.6
2.76	387.5
2.88	392.6
3.01	353.2
3.26	353.5
3.51	319.1
3.76	330.3
4.01	337.0
4.26	330.7
4.52	285.5
4.77	288.6
5.02	295.7
5.27	0.0



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

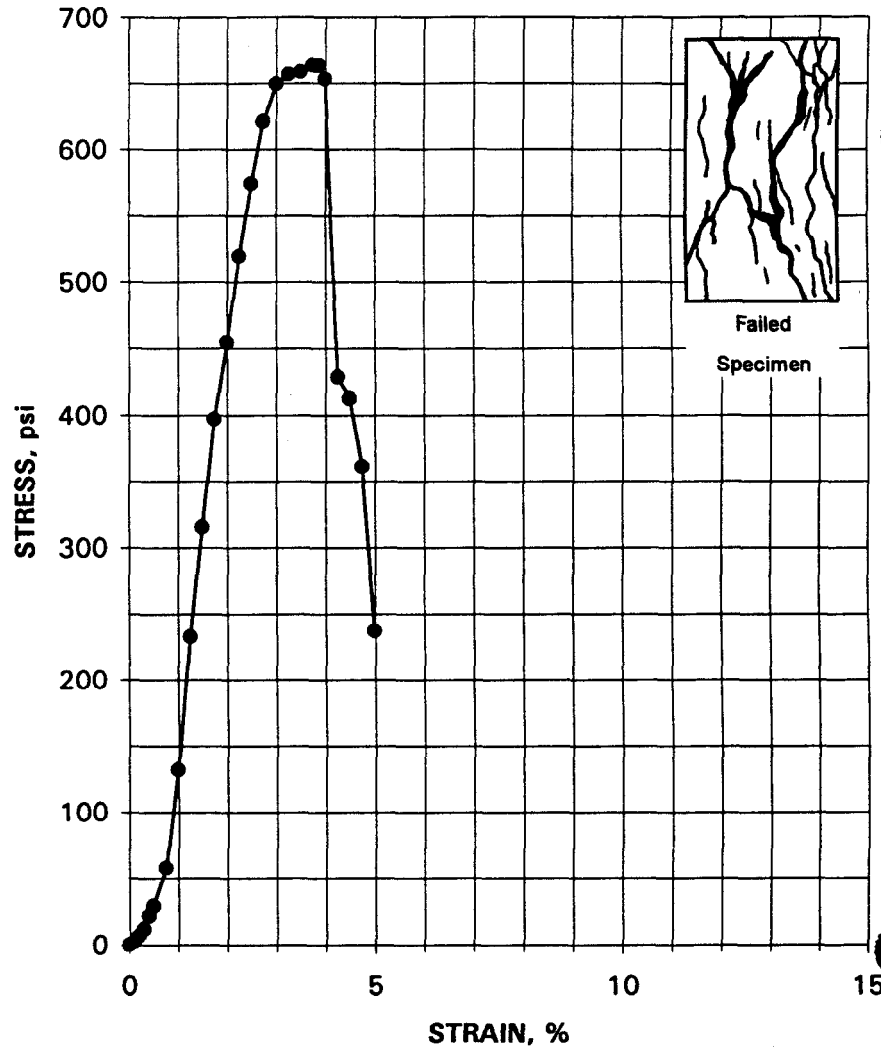
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P623F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8036

Specimen Mold Date	12/22/99	Specimen Height, in.	4.0077
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0075
		Specimen Weight, g.	395.09
STRESS AT FAILURE, psi	**663.6**	Moisture Content, %	27.9
STRAIN AT FAILURE, %	**3.9**	Wet Unit Weight, pcf.	118.7
		Dry Unit Weight, pcf.	92.8
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	2.5
0.20	6.6
0.30	12.0
0.40	21.7
0.50	28.9
0.75	57.7
1.00	131.7
1.25	232.7
1.50	315.3
1.75	397.0
2.00	454.2
2.25	518.9
2.50	573.6
2.74	620.7
2.99	649.4
3.24	656.6
3.49	658.9
3.74	663.6
3.87	663.6
3.99	653.7
4.24	428.1
4.49	412.2
4.74	361.1
4.99	237.1



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

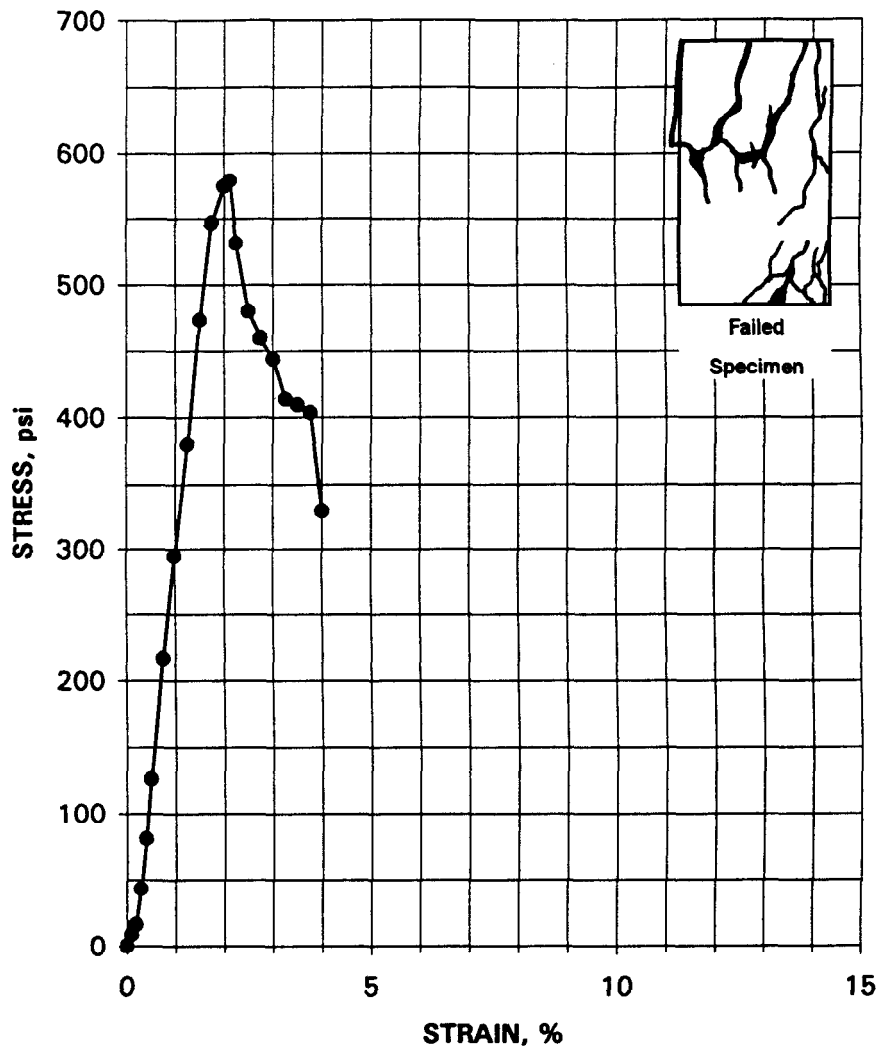
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P633F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8037

Specimen Mold Date	12/22/99	Specimen Height, in.	3.9877
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0075
		Specimen Weight, g.	371.86
STRESS AT FAILURE, psi	**578.8**	Moisture Content, %	35.7
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	112.3
		Dry Unit Weight, pcf.	82.7
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	8.8
0.20	16.4
0.30	43.5
0.40	80.9
0.50	125.7
0.75	216.0
1.00	294.3
1.25	379.4
1.50	473.0
1.76	546.6
2.01	574.6
2.13	578.8
2.26	531.5
2.51	479.9
2.76	459.6
3.01	444.0
3.26	413.8
3.51	409.4
3.76	403.5
4.01	329.0



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

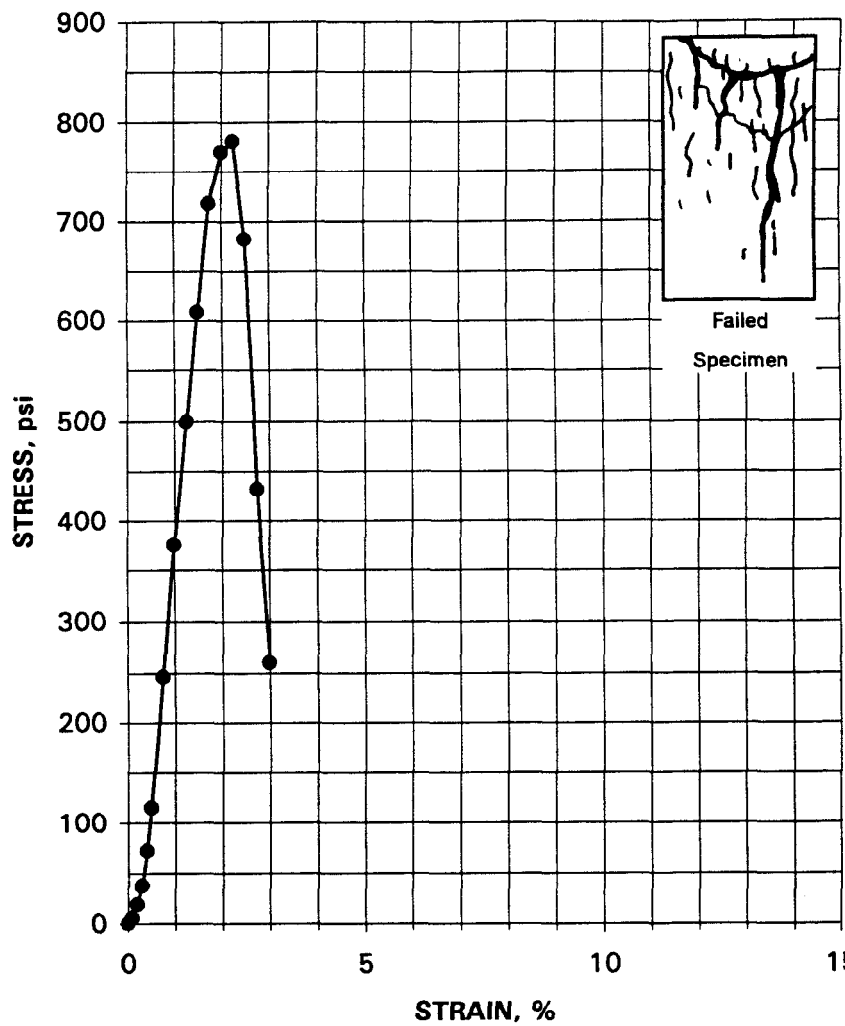
IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE, 90-DAY SATURATION

Project Name	SAIC/SAVANNAH RIVER	Client Sample No.	P634F00
Project No.	777304.00010500	IT Lab Specimen No.	ETDC-8038

Specimen Mold Date	12/22/99	Specimen Height, in.	4.0042
Specimen Test Date	4/20/99	Specimen Diameter, in.	2.0065
		Specimen Weight, g.	378.35
STRESS AT FAILURE, psi	**780.9**	Moisture Content, %	33.1
STRAIN AT FAILURE, %	**2.2**	Wet Unit Weight, pcf.	113.9
		Dry Unit Weight, pcf.	85.5
		Rate of Strain, in./min.	0.0400

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0.0
0.10	6.0
0.20	19.3
0.30	37.5
0.40	72.1
0.50	115.5
0.75	246.1
1.00	375.7
1.25	499.7
1.50	608.4
1.75	717.8
2.00	769.3
2.25	780.9
2.50	681.8
2.75	432.1
3.00	259.8



P Series
28 Day Expansion / Shrinkage Results

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures ASTM D 3877

28-Day Cure

Geo Lab Sample No.	Knoxville Lab Sample No.	Expansion, %	Expansion Result	Shrinkage, %
ETDC-8071	P312K00	-0.004%	No expansion	Insuff. Sample
ETDC-8072	P322K00	-0.308%	No expansion	0.99%
ETDC-8073	P332K00	-0.091%	No expansion	2.72%
ETDC-8074	P342K00	-0.205%	No expansion	0.55%
ETDC-8075	P412K00	-0.212%	No expansion	5.54%
ETDC-8076	P422K00	-0.091%	No expansion	0.53%
ETDC-8077	P432K00	-0.192%	No expansion	5.33%
ETDC-8078	P442K00	-0.212%	No expansion	1.14%
ETDC-8079	P512K00	-0.175%	No expansion	0.28%
ETDC-8080	P522K00	-0.223%	No expansion	1.38%
ETDC-8081	P532K00	-0.025%	No expansion	4.52%
ETDC-8082	P542K00	-0.103%	No expansion	0.81%
ETDC-8083	P612K00	-0.089%	No expansion	5.48%
ETDC-8084	P622K00	-0.111%	No expansion	0.73%
ETDC-8085	P632K00	-0.081%	No expansion	7.18%
ETDC-8086	P642K00	-0.040%	No expansion	0.02%

P Series
28 Day Permeability Results

Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

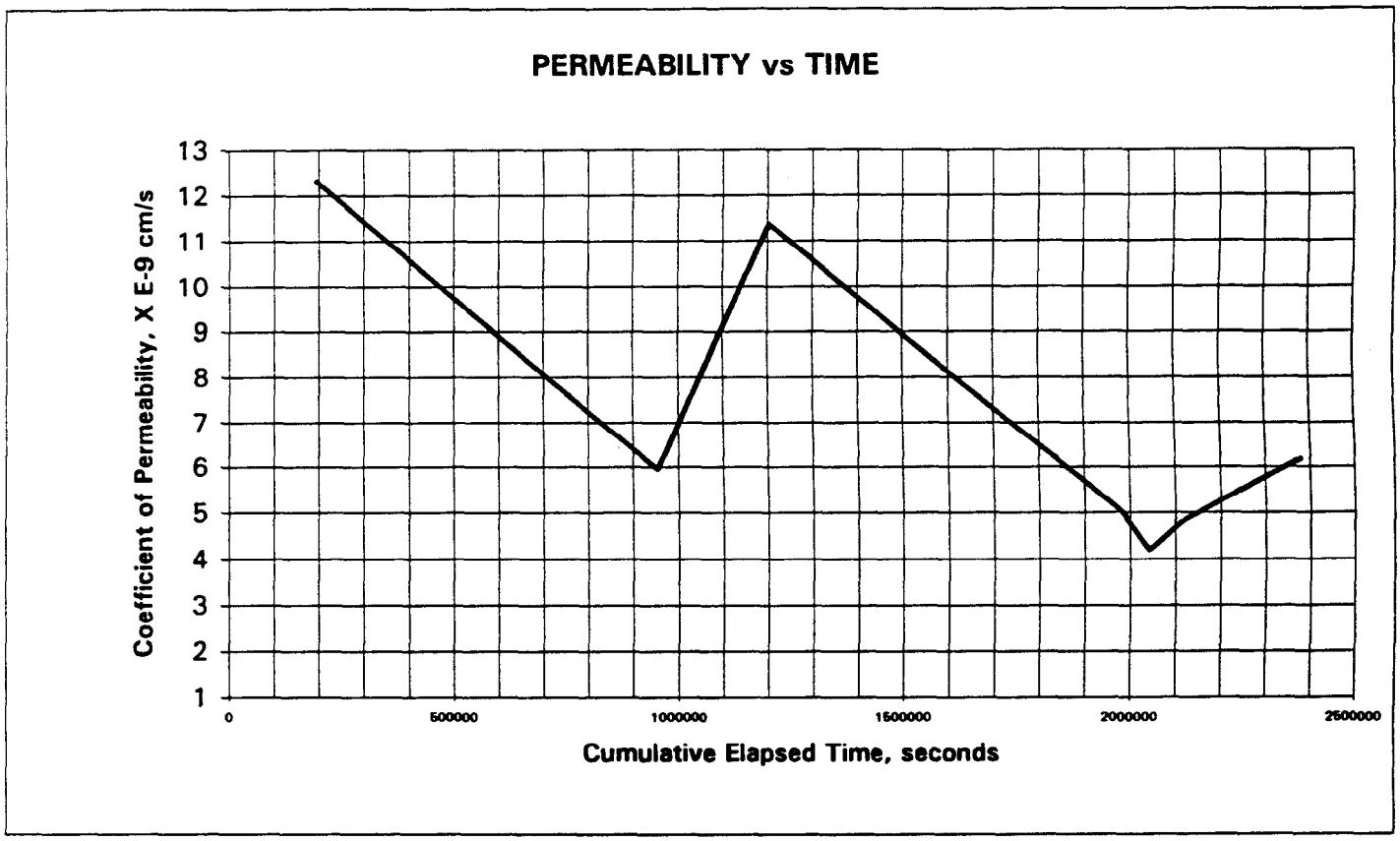
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. P312G00
IT LAB SAMPLE NO. ETDC-8095

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.07	
Wet weight of specimen, g.	378.31	386.16
Specimen cross-sect. area, cm^2	20.3291	
Water content, %	29.9	32.6
Wet unit weight, pcf	115.3	
Dry unit weight, pcf	88.8	
Estimated degree of saturation, %	91.8	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Seven tests performed	

Coefficient of Permeability, cm/s	5.0E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

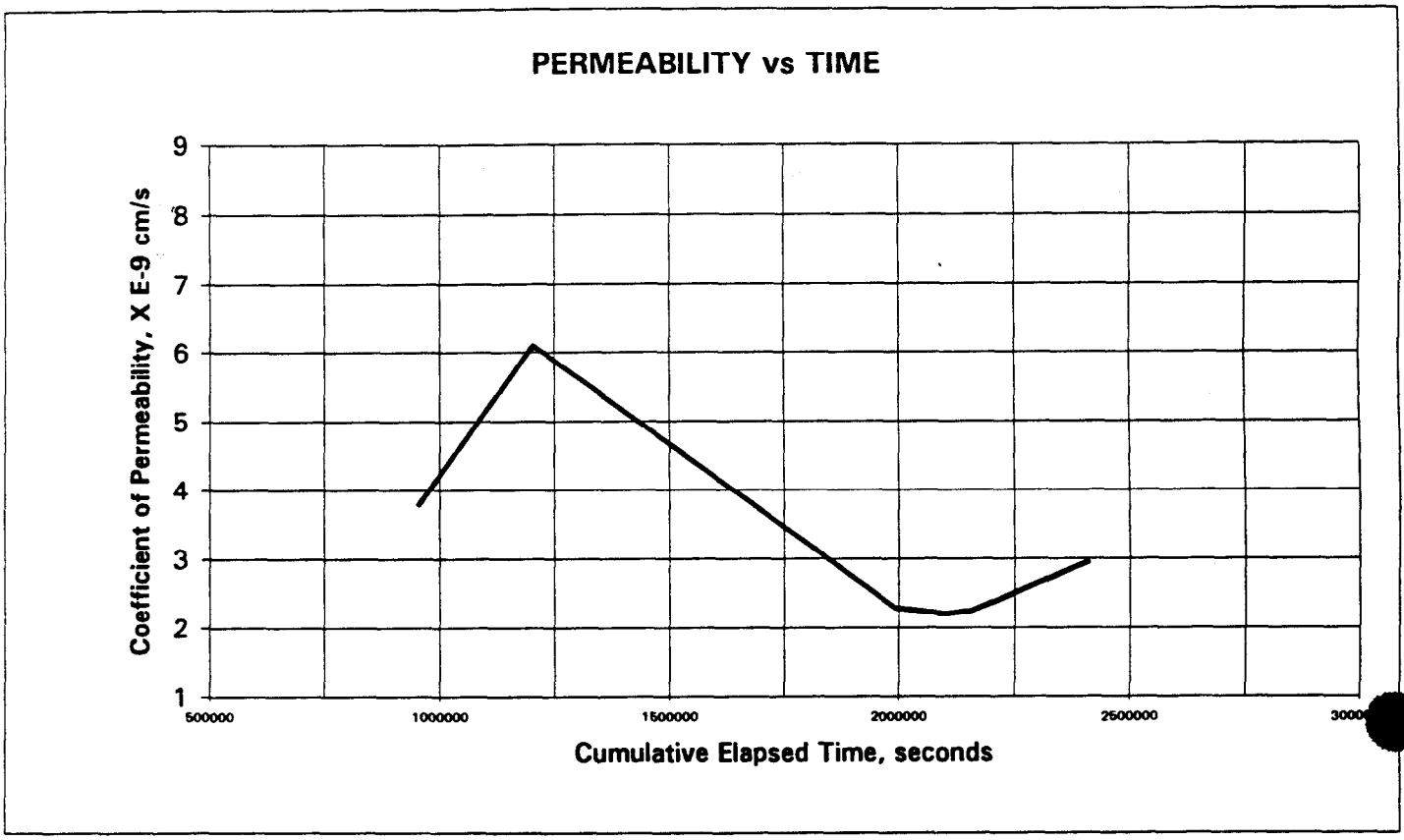
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. P322G00
IT LAB SAMPLE NO. ETDC-8096

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.12	
Wet weight of specimen, g.	391.92	396.32
Specimen cross-sect. area, cm^2	20.3630	
Water content, %	27.3	28.8
Wet unit weight, pcf	118.7	
Dry unit weight, pcf	93.2	
Estimated degree of saturation, %	93.5	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	27.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Six tests performed	

Coefficient of Permeability, cm/s 2.4E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

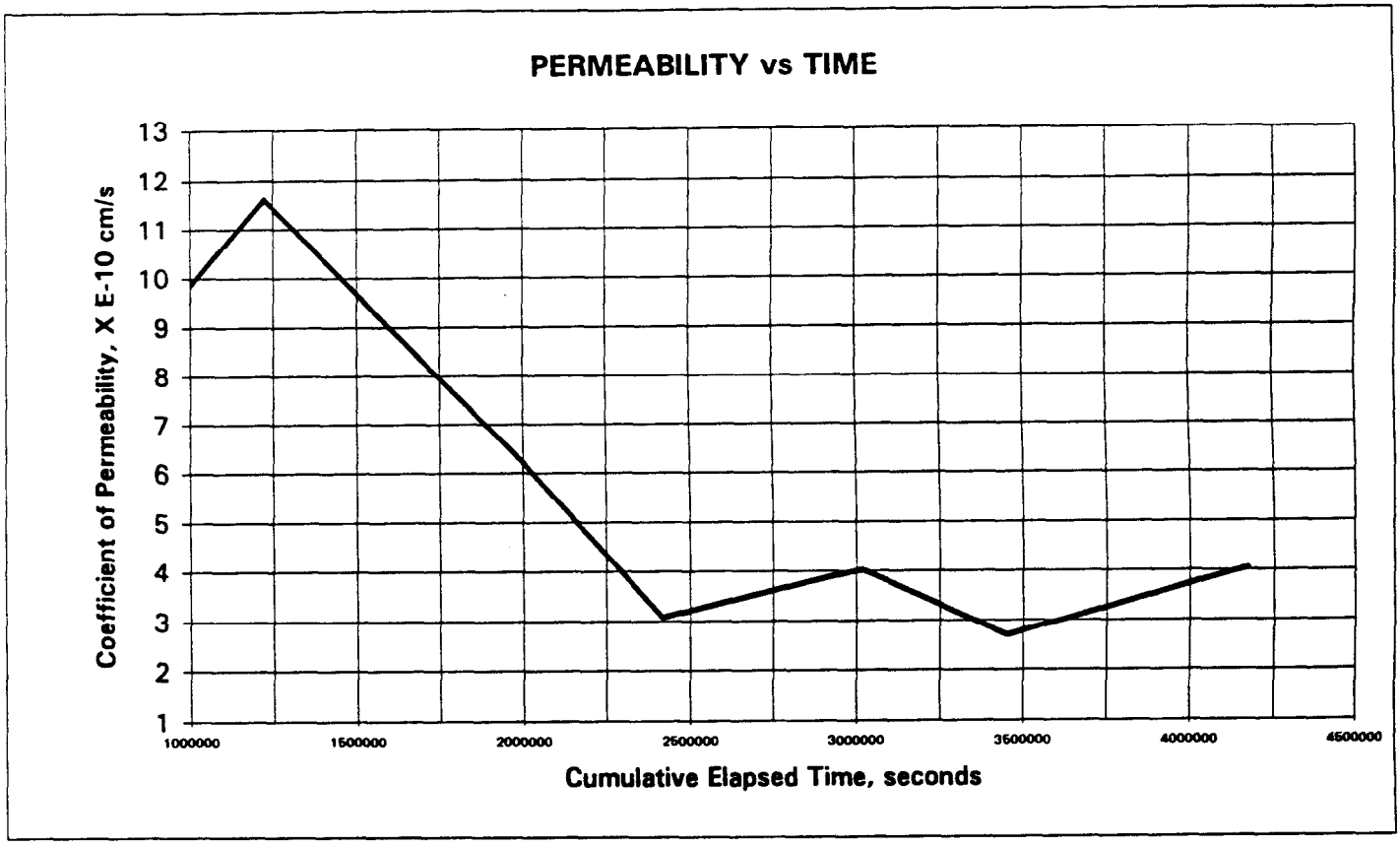
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. P332G00
IT LAB SAMPLE NO. ETDC-8097

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.17	
Wet weight of specimen, g.	382.45	388.8
Specimen cross-sect. area, cm^2	20.3867	
Water content, %	28.7	30.9
Wet unit weight, pcf	115.2	
Dry unit weight, pcf	89.5	
Estimated degree of saturation, %	89.7	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Seven tests performed	

Coefficient of Permeability, cm/s 3.5E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

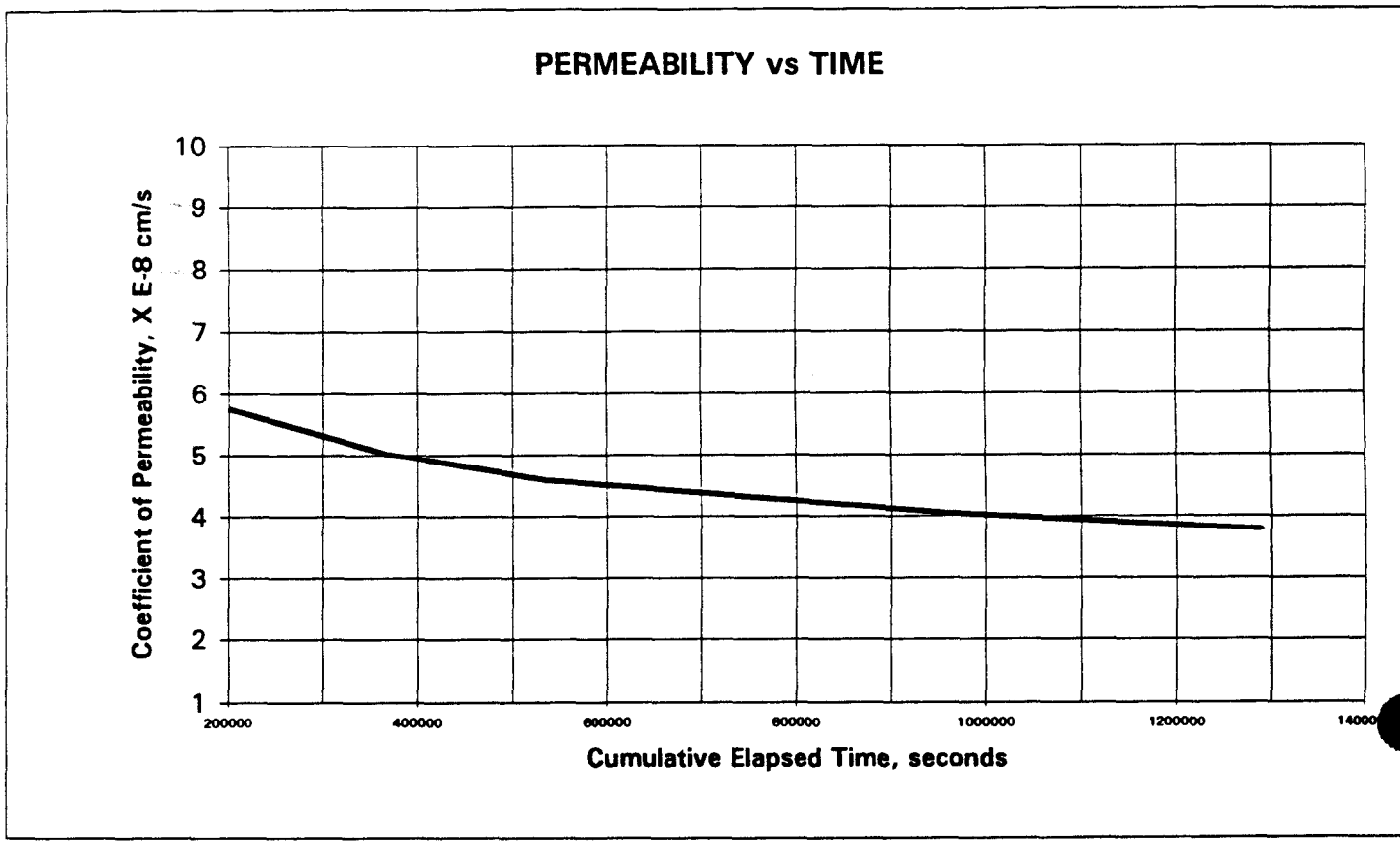
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P342G00
IT LAB SAMPLE NO. ETDC-8098

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.23	
Wet weight of specimen, g.	377.12	379.76
Specimen cross-sect. area, cm^2	20.3969	
Water content, %	33.9	34.9
Wet unit weight, pcf	112.9	
Dry unit weight, pcf	84.3	
Estimated degree of saturation, %	93.3	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	27.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	2.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Five tests performed	

Coefficient of Permeability, cm/s 4.4E-08



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

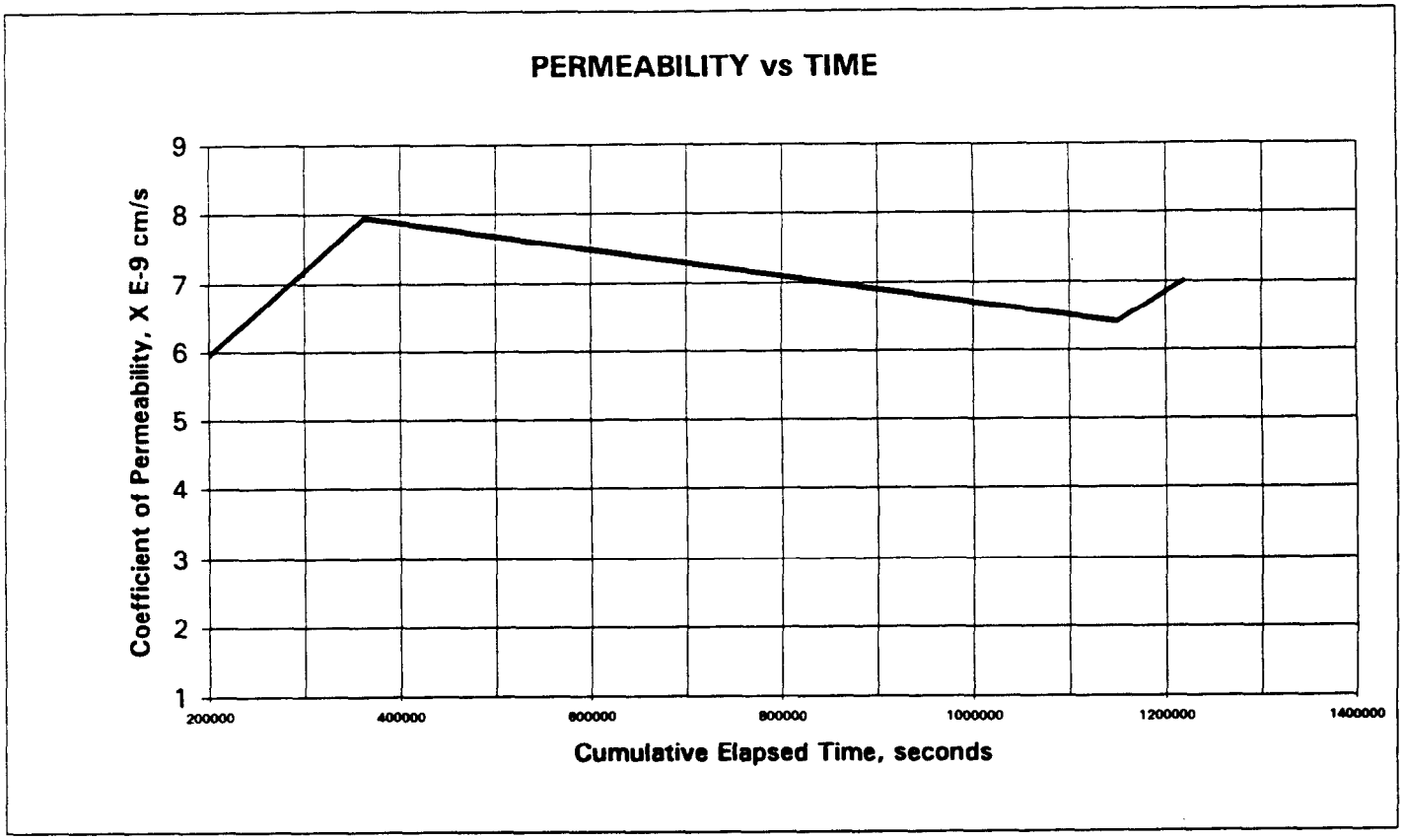
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P412G00
IT LAB SAMPLE NO. ETDC-8099

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.07	
Wet weight of specimen, g.	368.86	377.31
Specimen cross-sect. area, cm^2	20.3698	
Water content, %	33.2	36.2
Wet unit weight, pcf	112.2	
Dry unit weight, pcf	84.2	
Estimated degree of saturation, %	91.3	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	27.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Four tests performed	

Coefficient of Permeability, cm/s 6.8E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

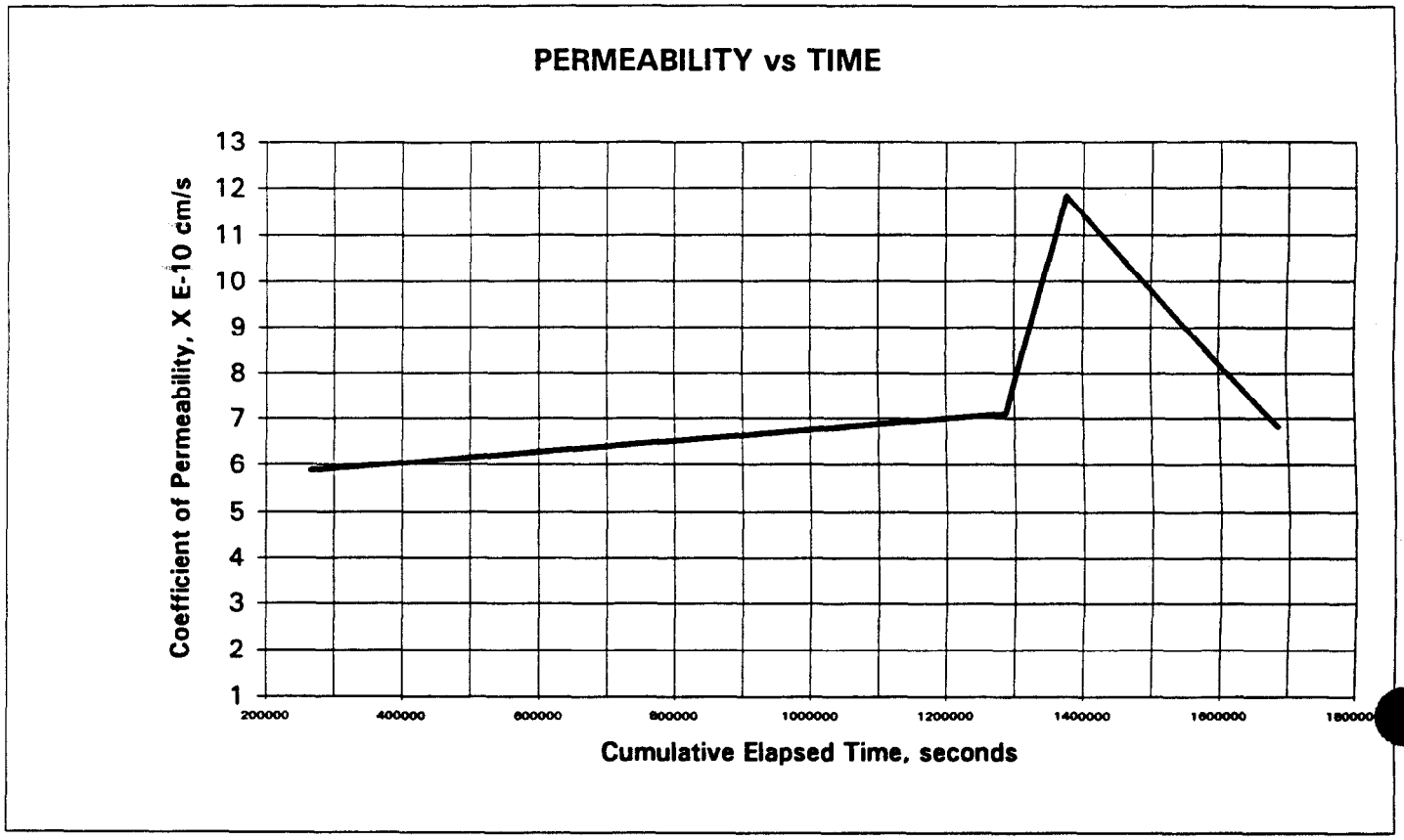
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P422G00
IT LAB SAMPLE NO. ETDC-8100

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.12	
Wet weight of specimen, g.	378.41	384.26
Specimen cross-sect. area, cm^2	20.3596	
Water content, %	30.6	32.7
Wet unit weight, pcf	114.6	
Dry unit weight, pcf	87.7	
Estimated degree of saturation, %	91.7	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	34.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Four tests performed	

Coefficient of Permeability, cm/s 7.9E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

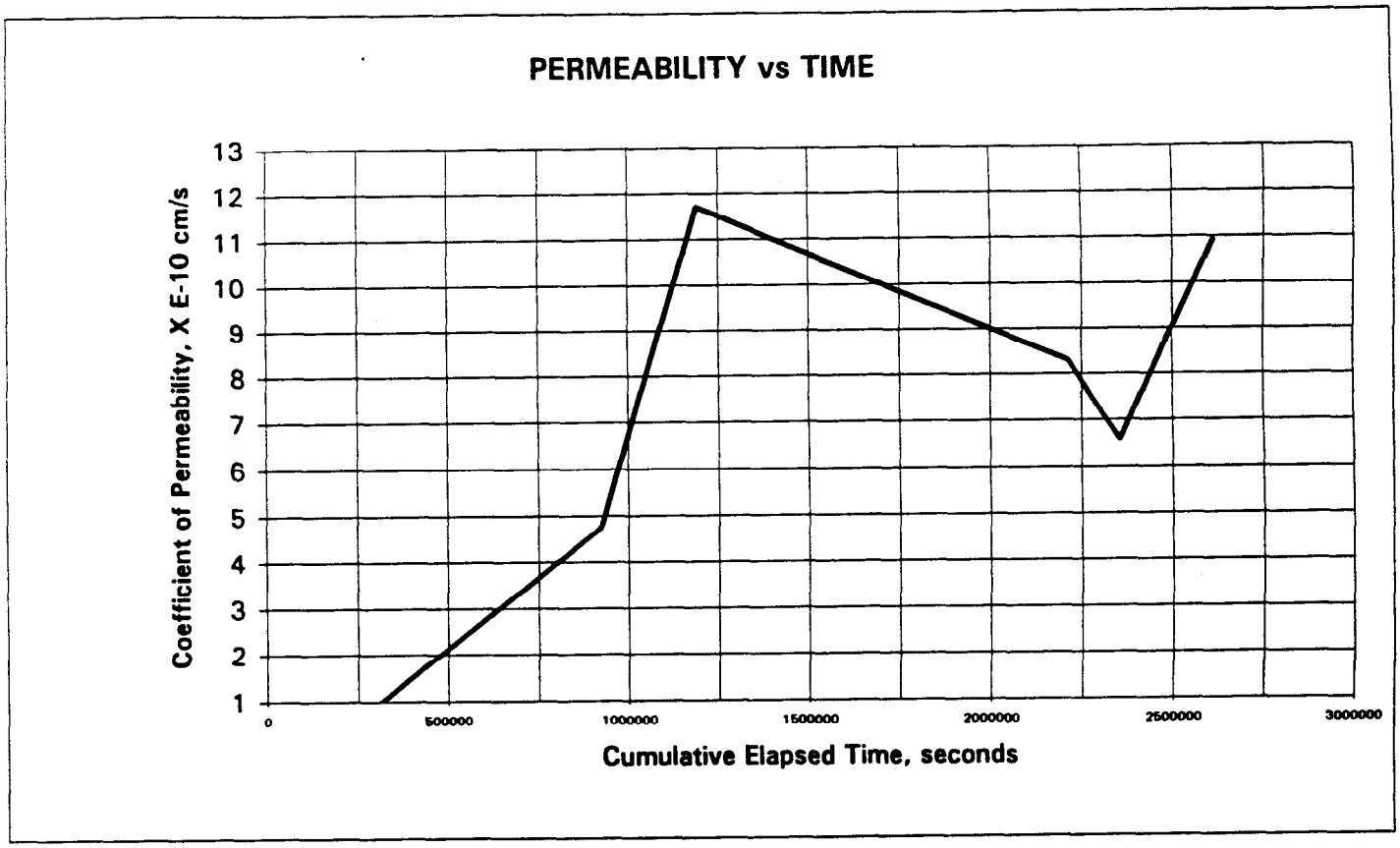
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. P432G00
IT LAB SAMPLE NO. ETDC-8101

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.13	
Wet weight of specimen, g.	357.63	364.96
Specimen cross-sect. area, cm^2	20.3055	
Water content, %	37.9	40.7
Wet unit weight, pcf	108.5	
Dry unit weight, pcf	78.7	
Estimated degree of saturation, %	91.0	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	27.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	10.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Six tests performed	

Coefficient of Permeability, cm/s 9.4E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

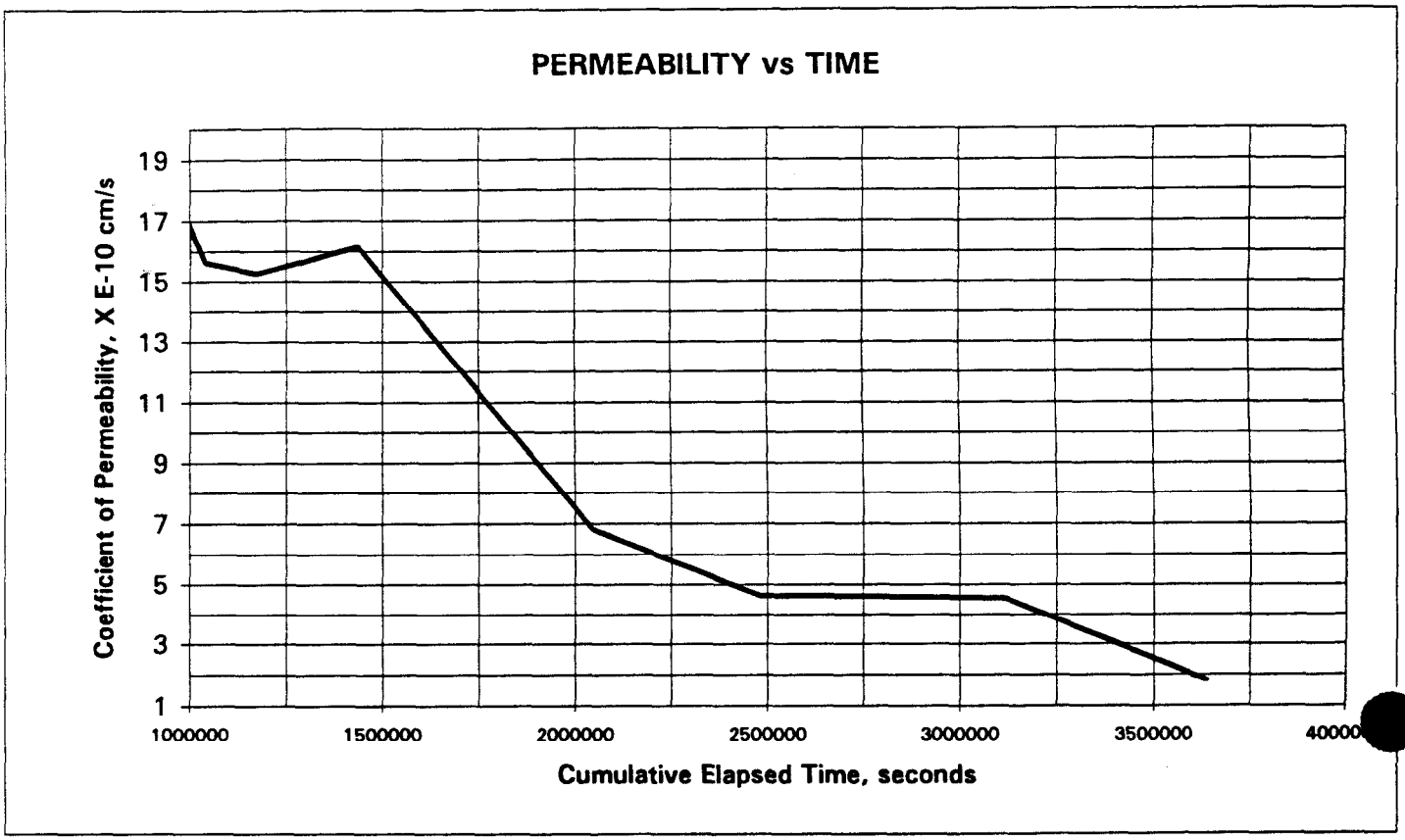
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P442G00
IT LAB SAMPLE NO. ETDC-8102

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.17	
Wet weight of specimen, g.	373.54	373.54
Specimen cross-sect. area, cm^2	20.4138	
Water content, %		38.0
Wet unit weight, pcf	112.4	
Dry unit weight, pcf		
Estimated degree of saturation, %		
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	20.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Eight tests performed	

Coefficient of Permeability, cm/s 8.0E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

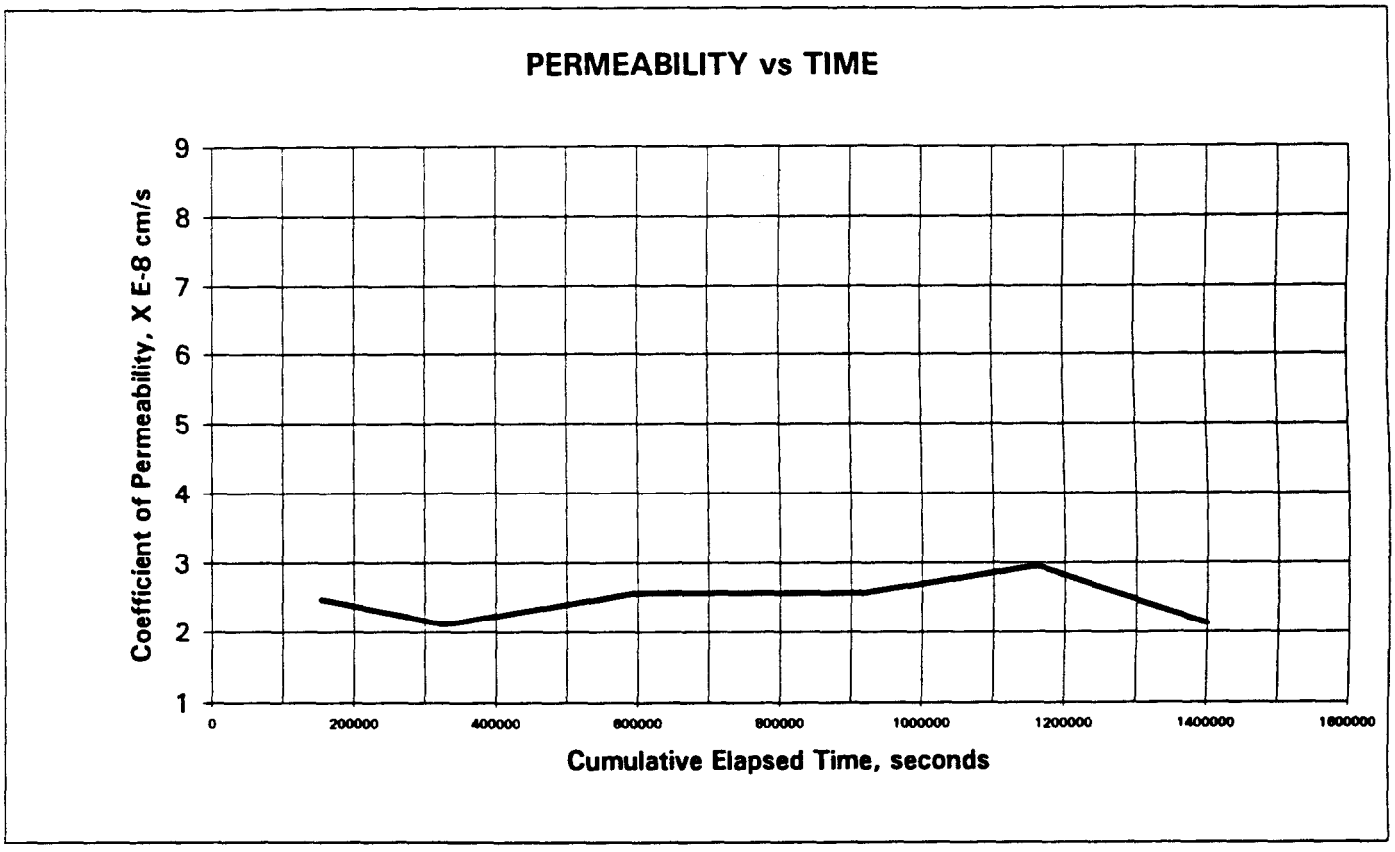
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P512G00
IT LAB SAMPLE NO. ETDC-8103

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.18	
Wet weight of specimen, g.	381.59	389.01
Specimen cross-sect. area, cm^2	20.3122	
Water content, %	29.1	31.6
Wet unit weight, pcf	115.2	
Dry unit weight, pcf	89.3	
Estimated degree of saturation, %	90.2	
Estimated spec. gravity of solids	2.6500	

Hydraulic gradient	27.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Six tests performed	

Coefficient of Permeability, cm/s 2.6E-08



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

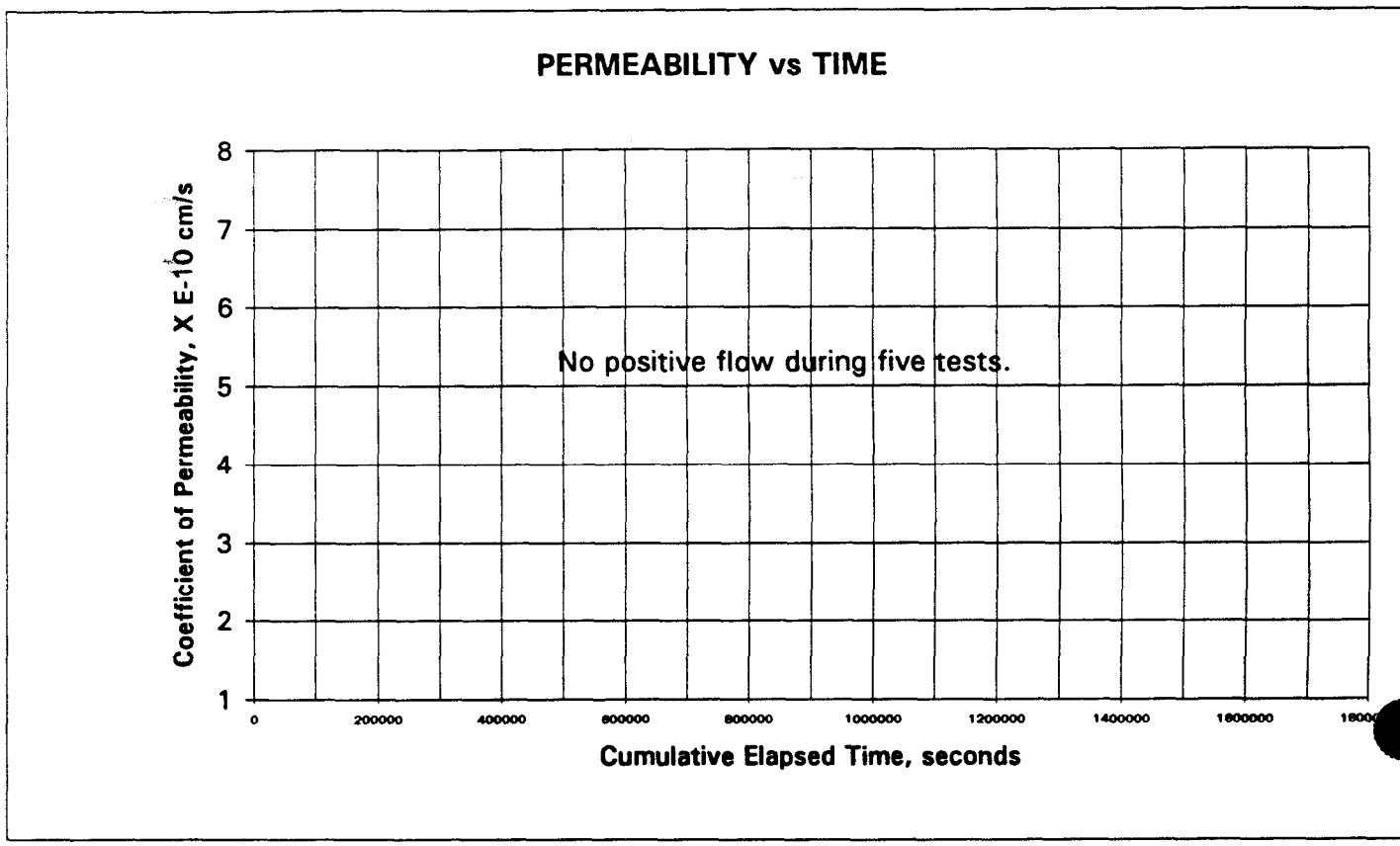
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P522G00
IT LAB SAMPLE NO. ETDC-8104

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.10	
Wet weight of specimen, g.	391.74	
Specimen cross-sect. area, cm^2	20.3935	
Water content, %	26.6	
Wet unit weight, pcf	118.7	
Dry unit weight, pcf	93.8	
Estimated degree of saturation, %	92.1	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Seven tests performed	

Coefficient of Permeability, cm/s	7.1E-10



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

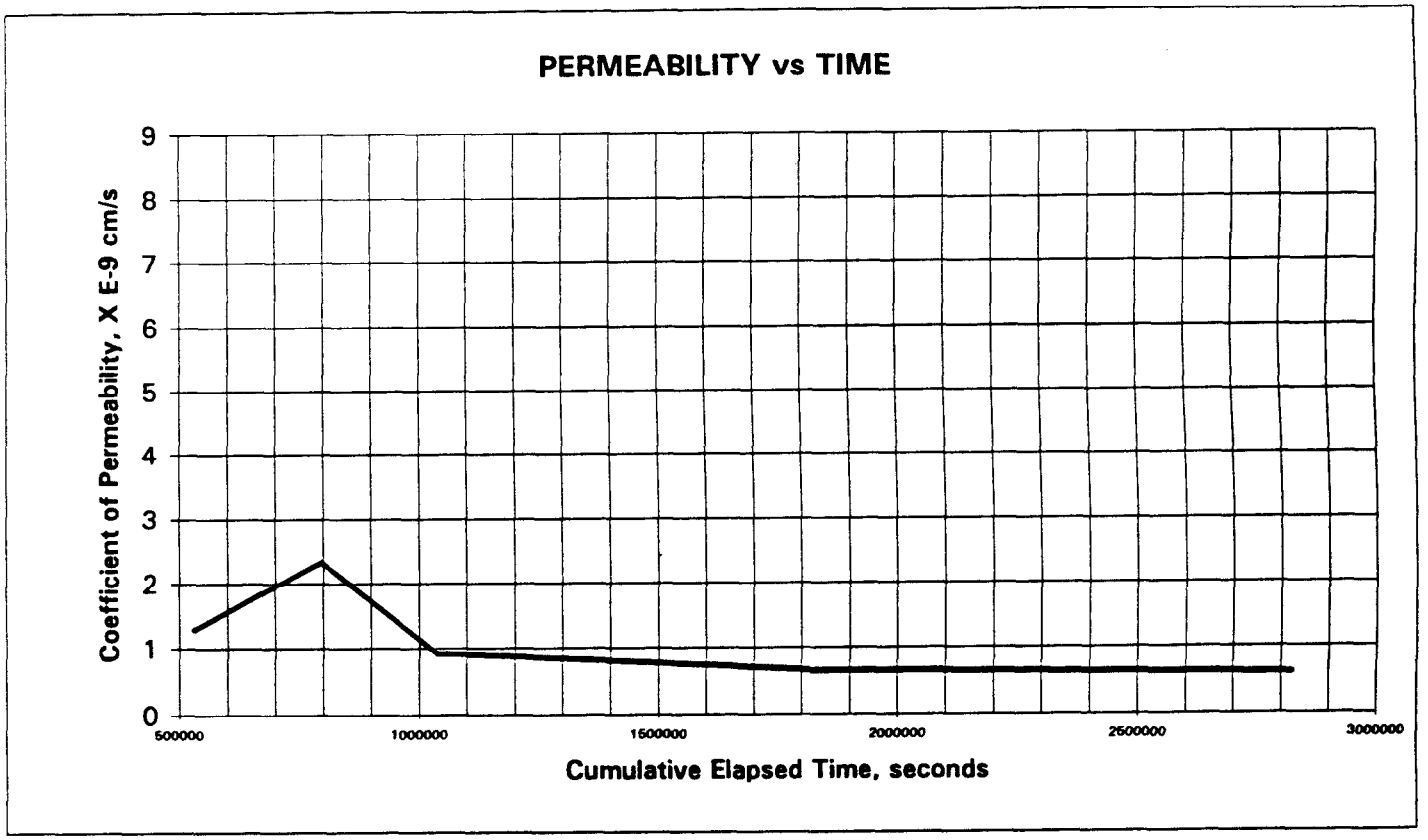
CLIENT SAMPLE NO. P532G00
IT LAB SAMPLE NO. ETDC-8105

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.05	
Wet weight of specimen, g.	364.11	370.7
Specimen cross-sect. area, cm^2	20.2717	
Water content, %	34.6	37.0
Wet unit weight, pcf	111.6	
Dry unit weight, pcf	82.9	
Estimated degree of saturation, %	92.0	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	28.0
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Five tests performed	

Coefficient of Permeability, cm/s 1.1E-09

Results based on influent volume. No effluent observed from sample.



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

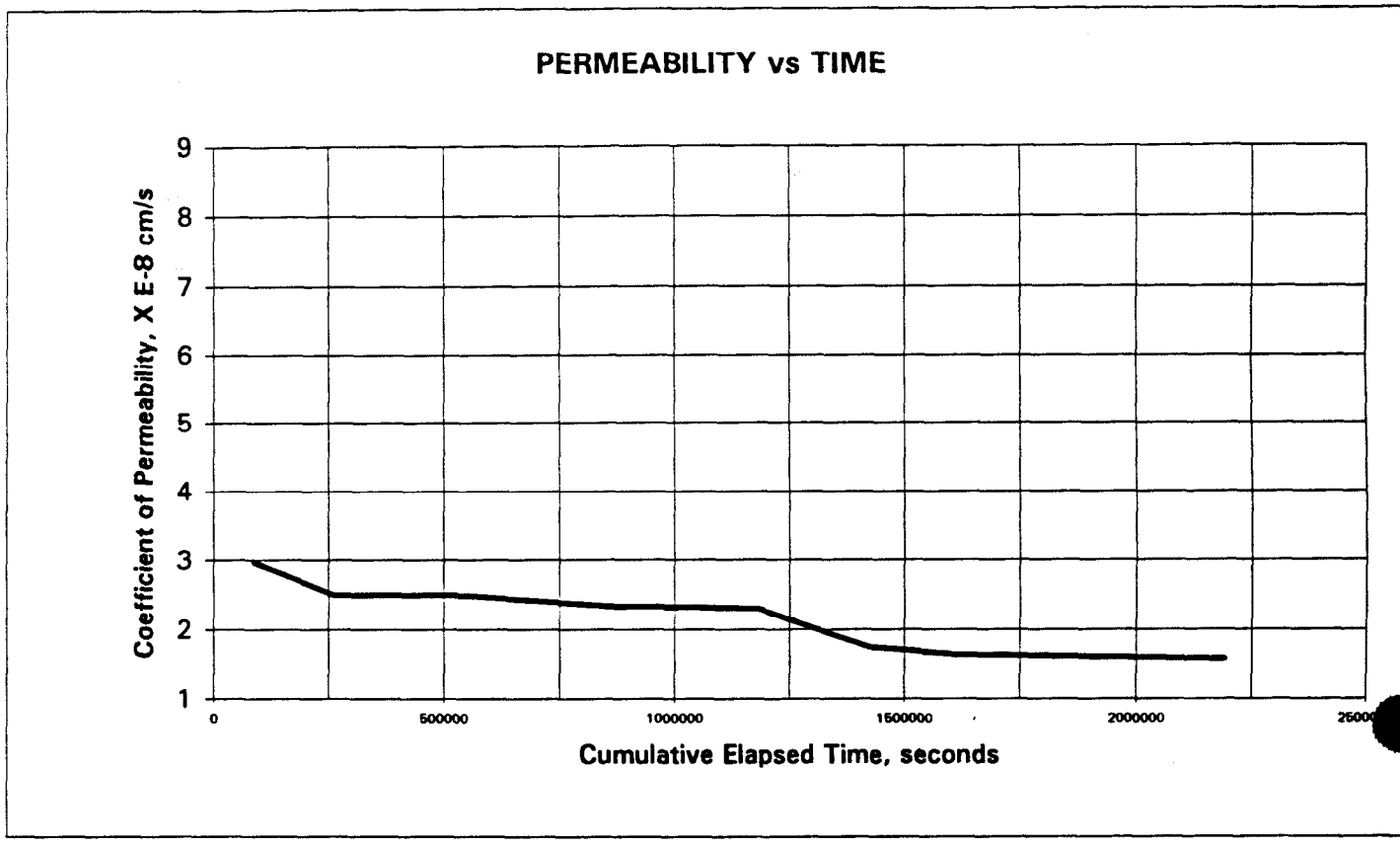
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500

CLIENT SAMPLE NO. P542G00
IT LAB SAMPLE NO. ETDC-8106

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.15	
Wet weight of specimen, g.		379.1
Specimen cross-sect. area, cm^2	20.3122	
Water content, %		35.0
Wet unit weight, pcf		
Dry unit weight, pcf		
Estimated degree of saturation, %		
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	8.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Eight tests performed	

Coefficient of Permeability, cm/s	1.8E-08



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

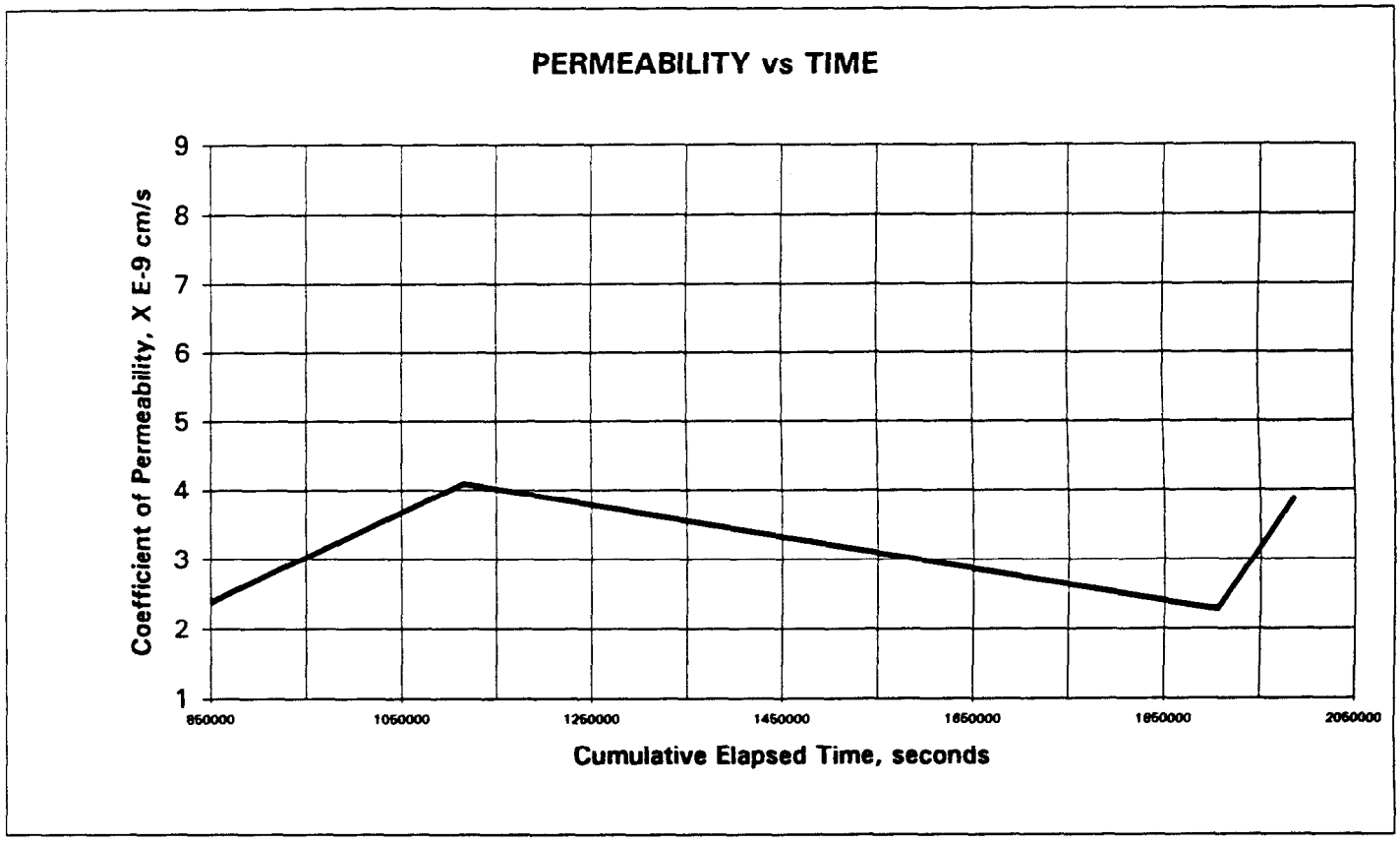
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P612G00
IT LAB SAMPLE NO. ETDC-8107

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.08	
Wet weight of specimen, g.	373.1	380.15
Specimen cross-sect. area, cm^2	20.3698	
Water content, %	29.3	31.7
Wet unit weight, pcf	113.4	
Dry unit weight, pcf	87.7	
Estimated degree of saturation, %	87.6	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	34.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	3.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Four tests performed	

Coefficient of Permeability, cm/s 3.2E-09



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

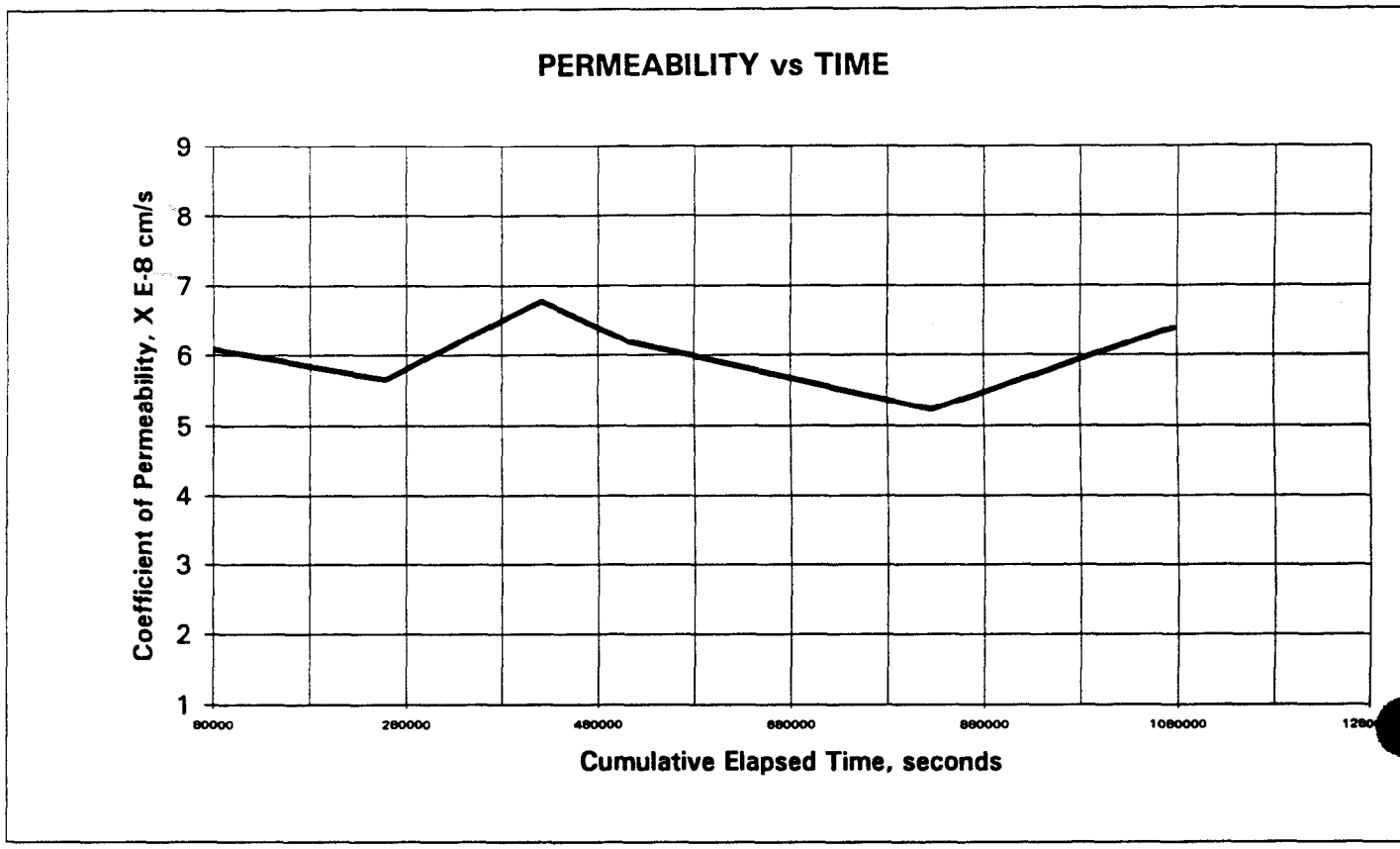
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P622G00
IT LAB SAMPLE NO. ETDC-8108

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.13	
Wet weight of specimen, g.	388.27	391.91
Specimen cross-sect. area, cm^2	20.3055	
Water content, %	27.1	28.3
Wet unit weight, pcf	117.9	
Dry unit weight, pcf	92.8	
Estimated degree of saturation, %	91.6	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Six tests performed	

Coefficient of Permeability, cm/s 6.2E-08



Paul Lear
IT Corporation
May 28, 1999 corrected
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

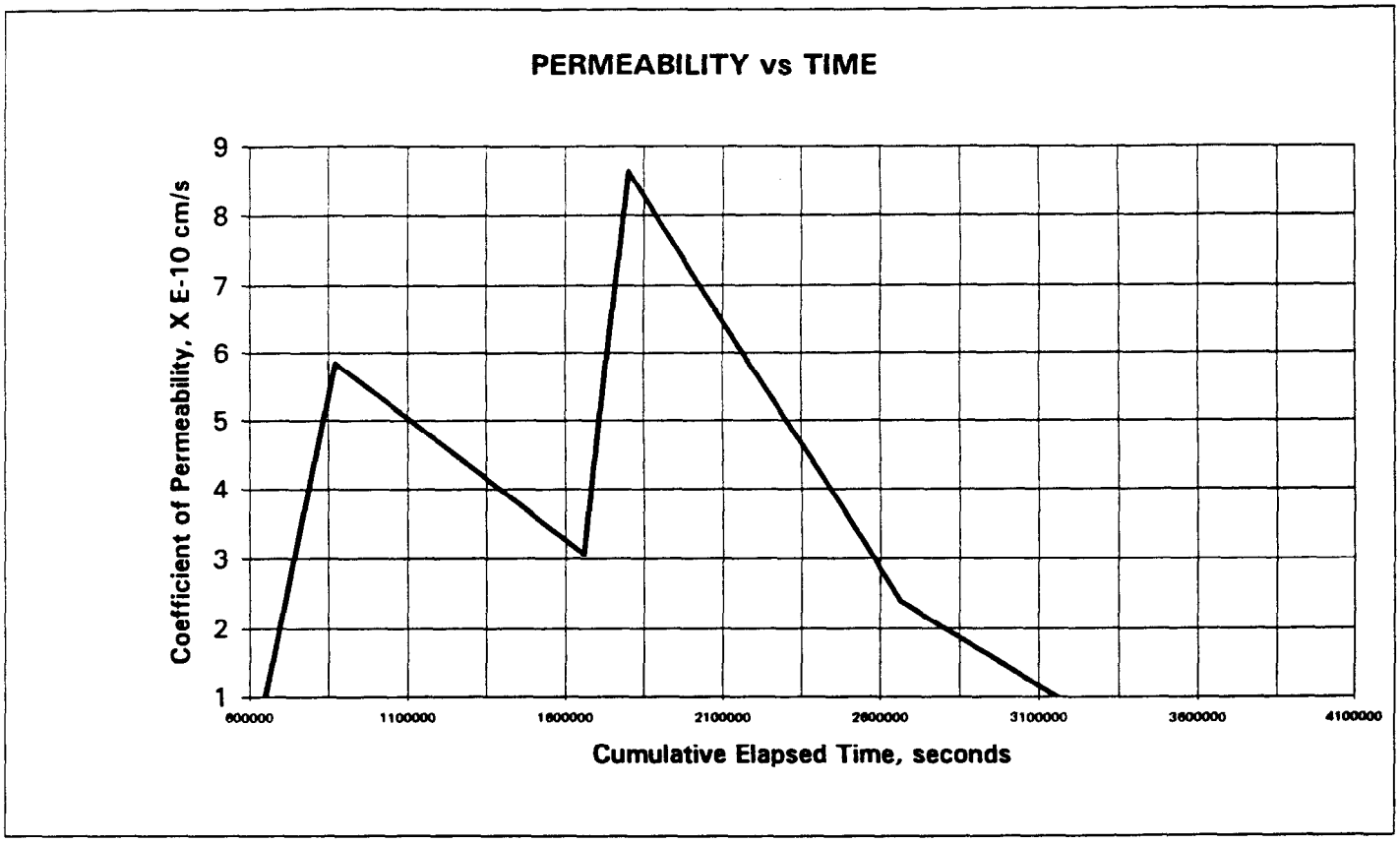
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P632G00
IT LAB SAMPLE NO. ETDC-8109

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.08	
Wet weight of specimen, g.	367.52	373.97
Specimen cross-sect. area, cm^2	20.2987	
Water content, %	34.0	36.3
Wet unit weight, pcf	112.1	
Dry unit weight, pcf	83.7	
Estimated degree of saturation, %	92.2	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	9.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/21/99
Six tests performed	

Coefficient of Permeability, cm/s 5.0E-10



IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

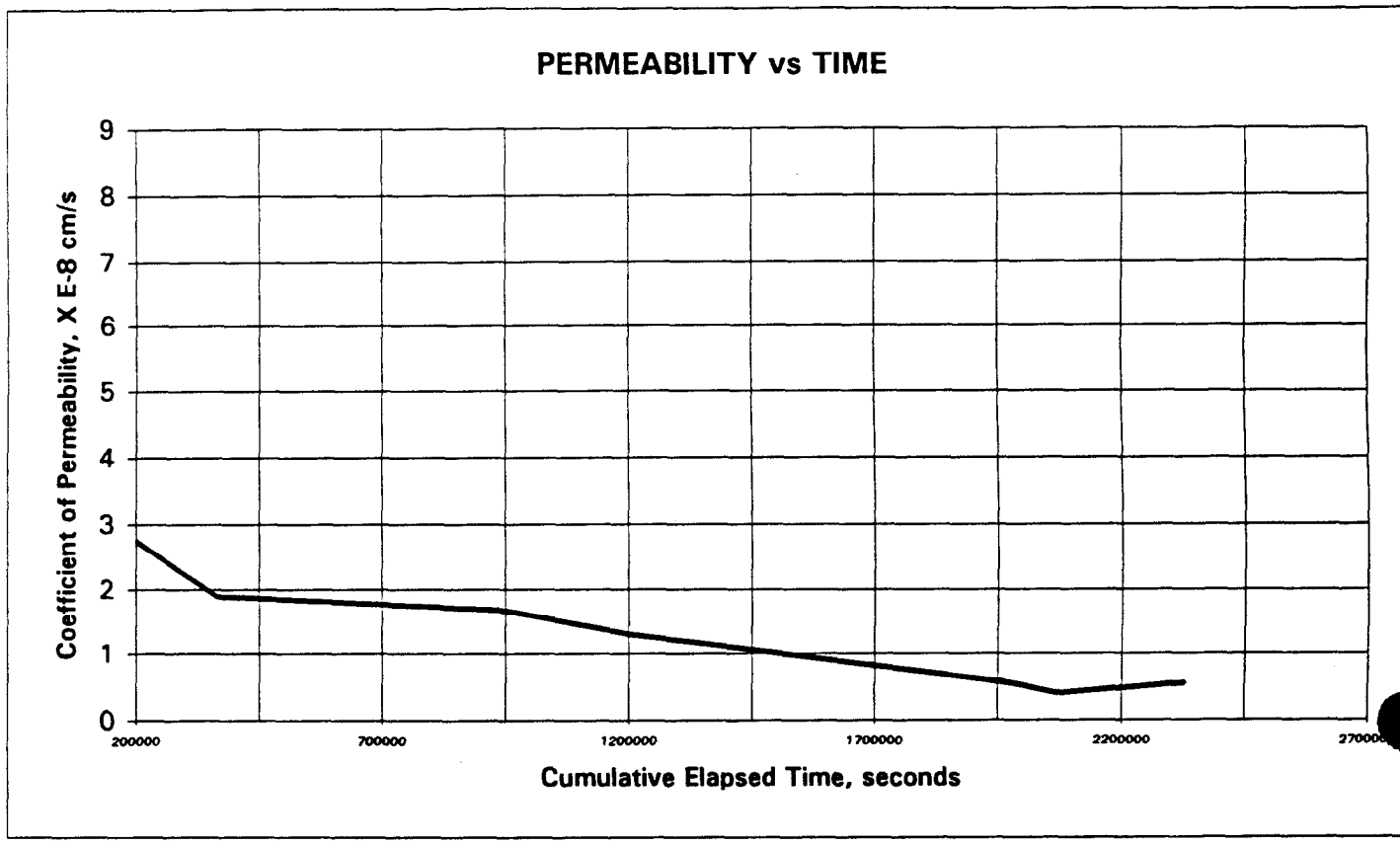
28-DAY HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P642G00
IT LAB SAMPLE NO. ETDC-8110

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.11	
Wet weight of specimen, g.	374.02	378.23
Specimen cross-sect. area, cm^2	20.3291	
Water content, %	33.1	34.6
Wet unit weight, pcf	113.6	
Dry unit weight, pcf	85.3	
Estimated degree of saturation, %	93.4	
Estimated spec. gravity of solids	2.65	

Hydraulic gradient	27.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	4.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	1/20/99
Seven tests performed	

Coefficient of Permeability, cm/s	1.9E-08



P Series
90 Immersion Permeability Results

Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

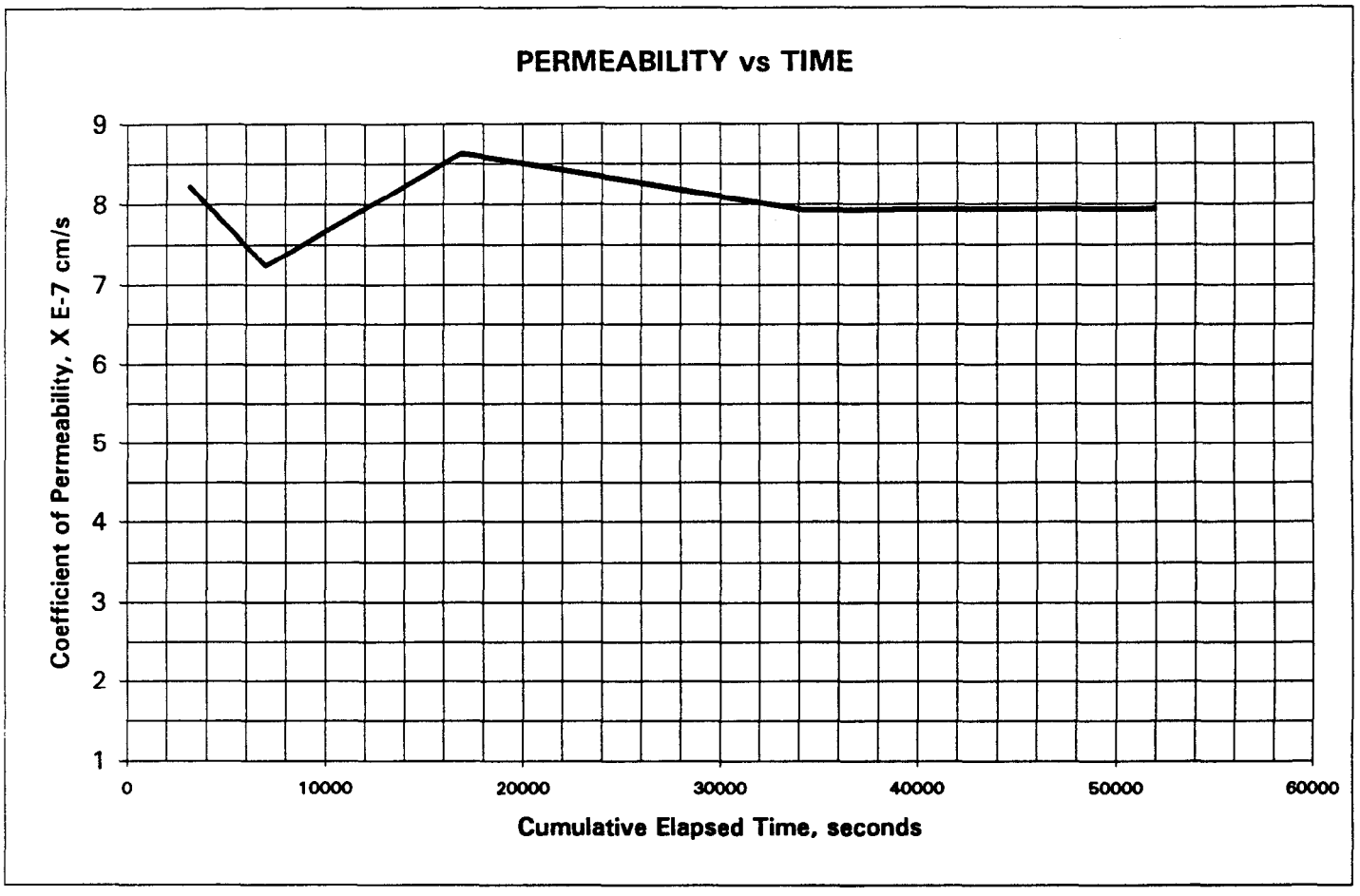
PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P313G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8119

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	7.25	
Wet weight of specimen, g.	611.2	615.03
Specimen cross-sect. area, cm^2	45.2093	
Water content, %	30.2	31.0
Wet unit weight, pcf	116.4	
Dry unit weight, pcf	89.4	
Estimated degree of saturation, %	94.2	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	38.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/18/99
Five tests performed	

Coefficient of Permeability, cm/s 7.9E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

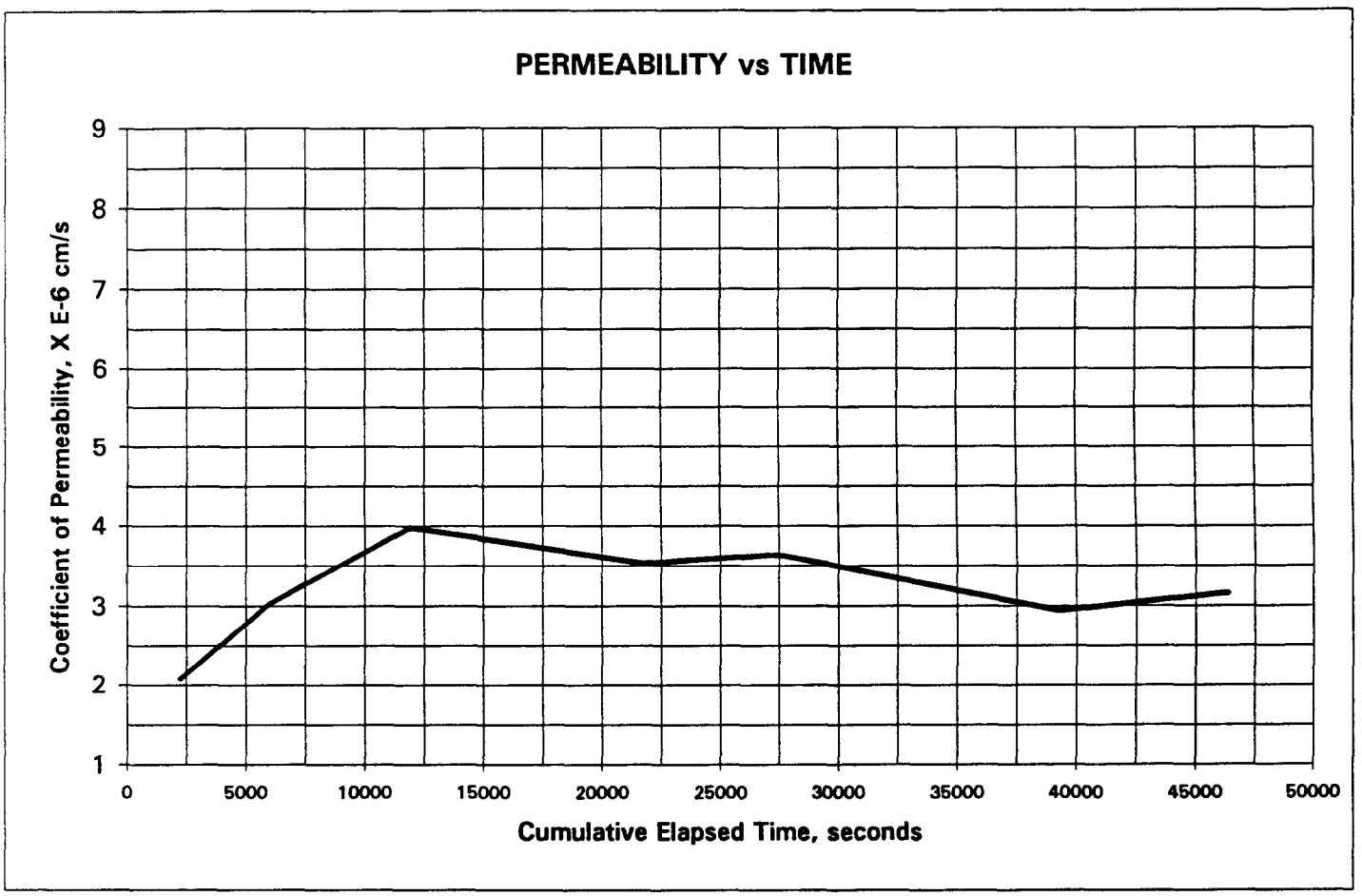
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P323G00
IT LAB SAMPLE NO. ETDC-8120

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	6.32	
Wet weight of specimen, g.	538.06	538.02
Specimen cross-sect. area, cm^2	45.1589	
Water content, %	23.8	23.8
Wet unit weight, pcf	117.7	
Dry unit weight, pcf	95.0	
Estimated degree of saturation, %	85.2	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	44.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/18/99
Seven tests performed	

Coefficient of Permeability, cm/s 3.3E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

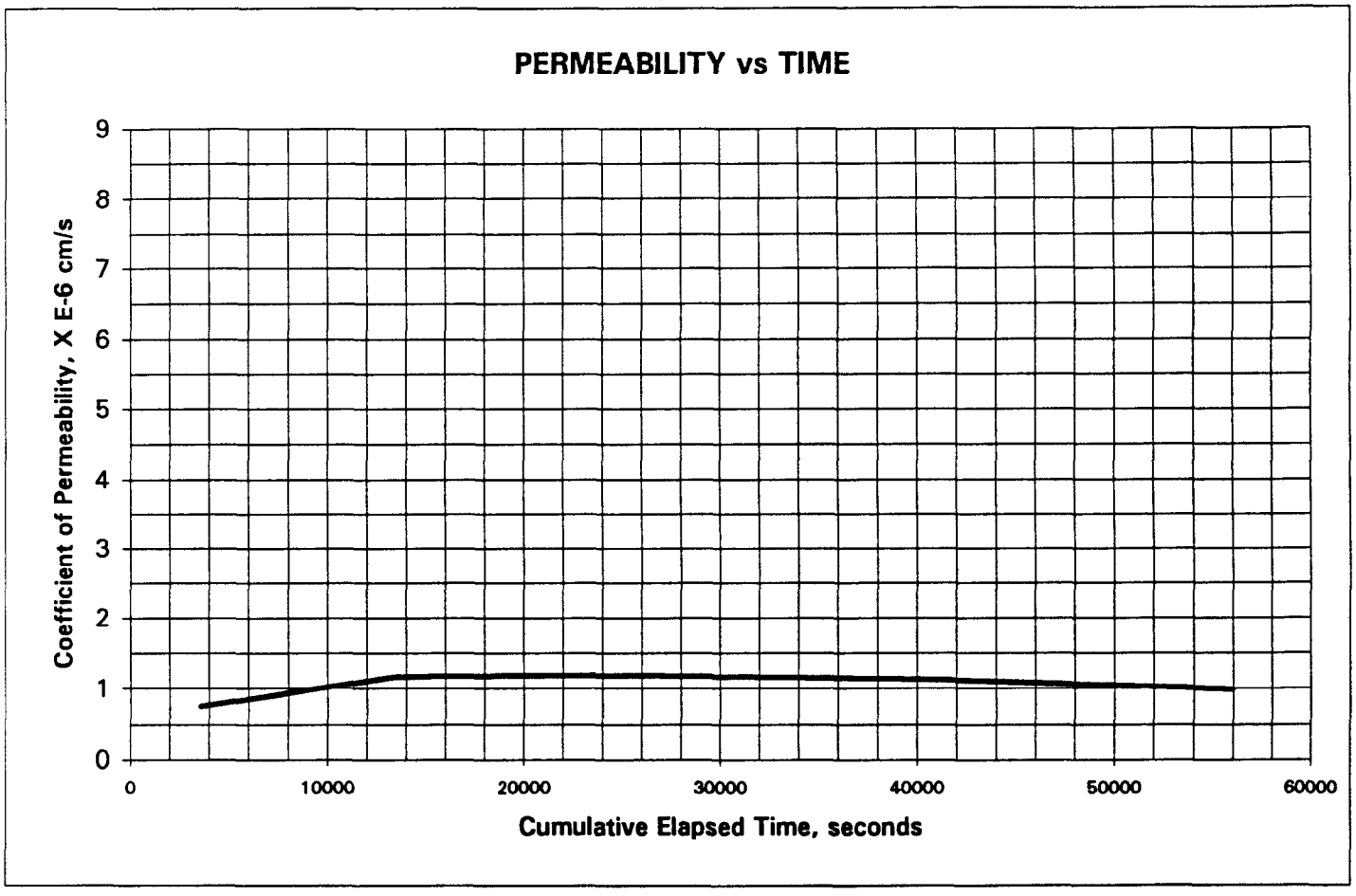
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P333G00
IT LAB SAMPLE NO. ETDC-8121

	INITIAL	FINAL
Specimen diameter, cm	7.56	
Specimen length, cm	7.88	
Wet weight of specimen, g.	665.14	667.6
Specimen cross-sect. area, cm^2	44.8468	
Water content, %	27.9	28.4
Wet unit weight, pcf	117.5	
Dry unit weight, pcf	91.9	
Estimated degree of saturation, %	92.4	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	35.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Five tests performed	

Coefficient of Permeability, cm/s 1.1E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

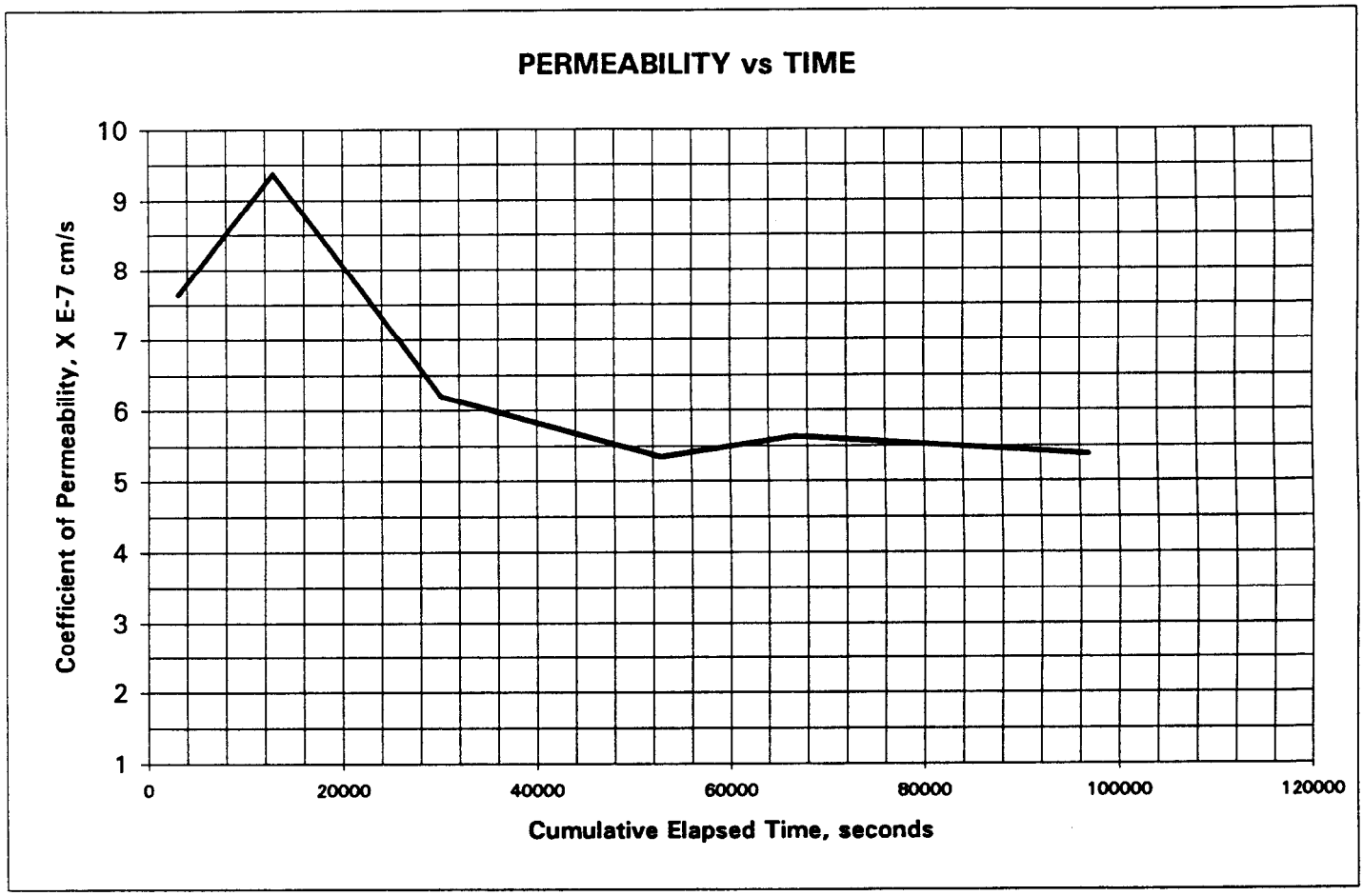
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P343G00
IT LAB SAMPLE NO. ETDC-8122

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	8.88	
Wet weight of specimen, g.	729.9	731.47
Specimen cross-sect. area, cm^2	45.4113	
Water content, %	30.4	30.7
Wet unit weight, pcf	113.0	
Dry unit weight, pcf	86.7	
Estimated degree of saturation, %	88.6	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	31.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Six tests performed	

Coefficient of Permeability, cm/s 5.6E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

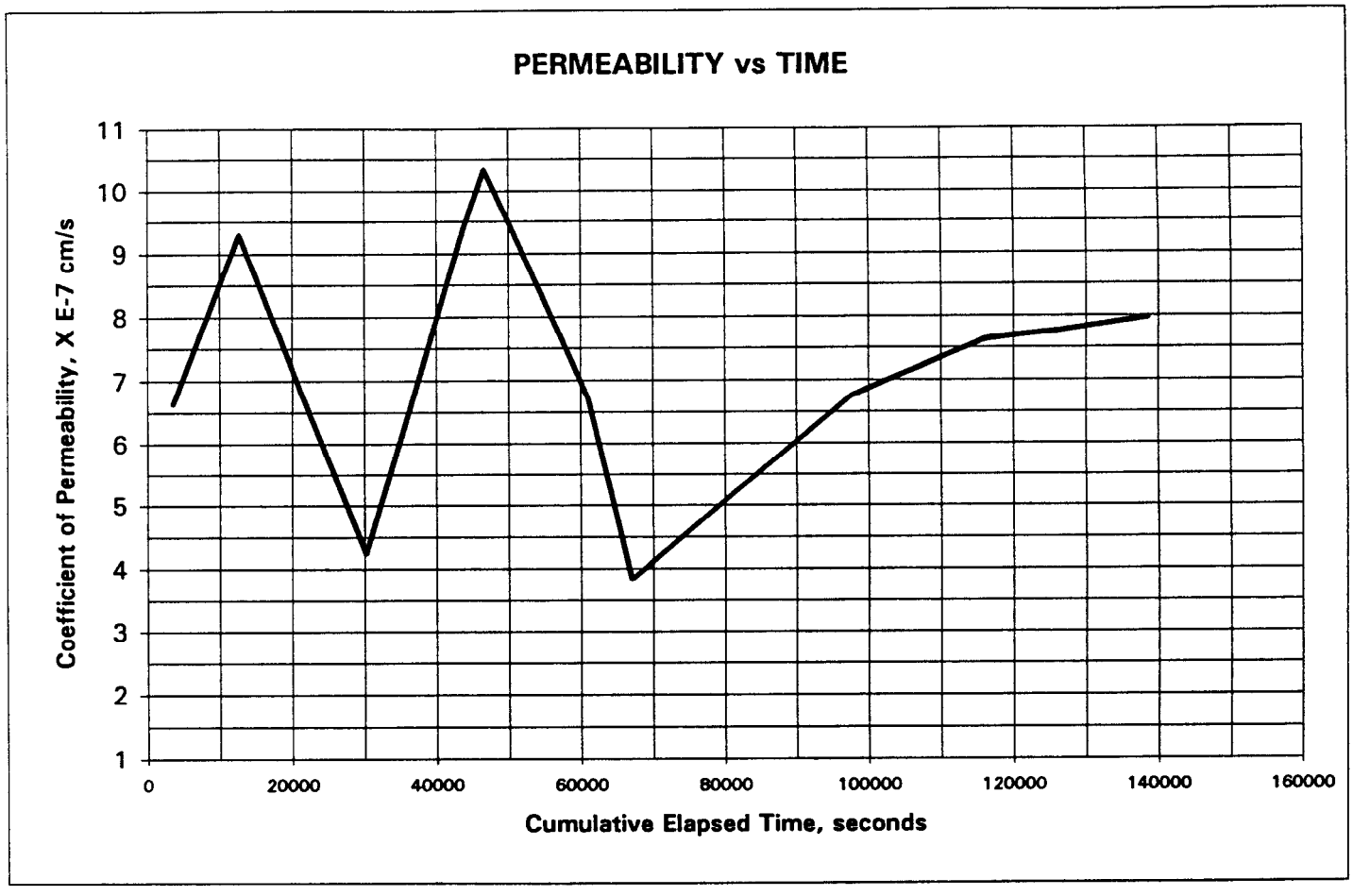
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P413G00
IT LAB SAMPLE NO. ETDC-8123

	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	8.64	
Wet weight of specimen, g.	754.34	756.8
Specimen cross-sect. area, cm^2	45.3002	
Water content, %	30.8	31.2
Wet unit weight, pcf	120.4	
Dry unit weight, pcf	92.0	
Estimated degree of saturation, %	102.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	32.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Eleven tests performed	

Coefficient of Permeability, cm/s 7.5E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P423G00
IT LAB SAMPLE NO. ETDC-8124

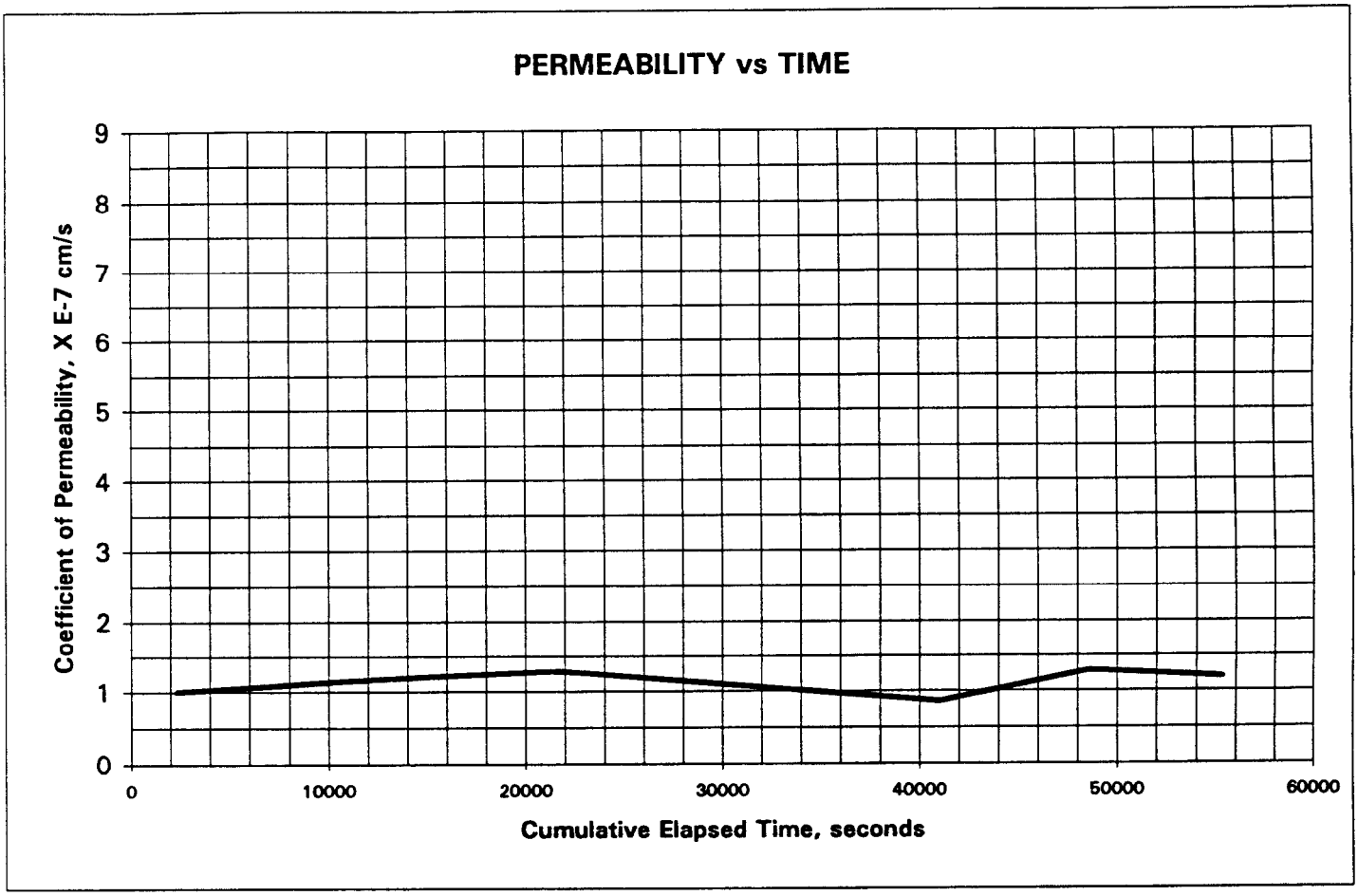
	INITIAL	FINAL
Specimen diameter, cm	7.59	
Specimen length, cm	7.69	
Wet weight of specimen, g.	642.14	643.28
Specimen cross-sect. area, cm^2	45.2901	
Water content, %	27.5	27.7
Wet unit weight, pcf	115.0	
Dry unit weight, pcf	90.2	
Estimated degree of saturation, %	87.4	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	36.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99

Six tests performed. Test #4 was 0.07 cm/s below of QC range of +/-25%.

Coefficient of Permeability, cm/s 1.2E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

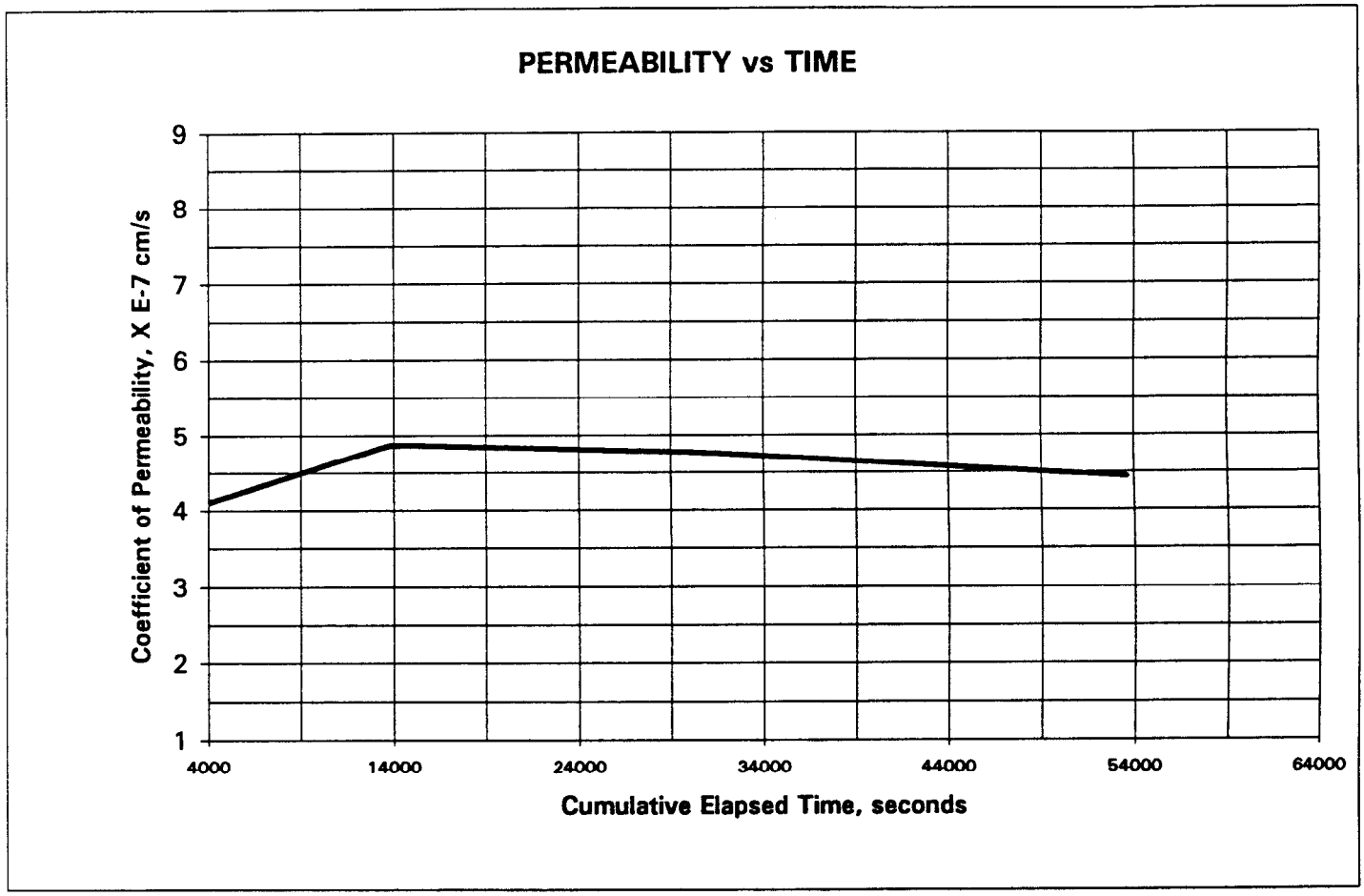
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P433G00
IT LAB SAMPLE NO. ETDC-8125

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	9.28	
Wet weight of specimen, g.	748.08	750.66
Specimen cross-sect. area, cm^2	45.3658	
Water content, %	40.3	40.8
Wet unit weight, pcf	110.9	
Dry unit weight, pcf	79.0	
Estimated degree of saturation, %	97.8	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	30.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Four tests performed	

Coefficient of Permeability, cm/s 4.5E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

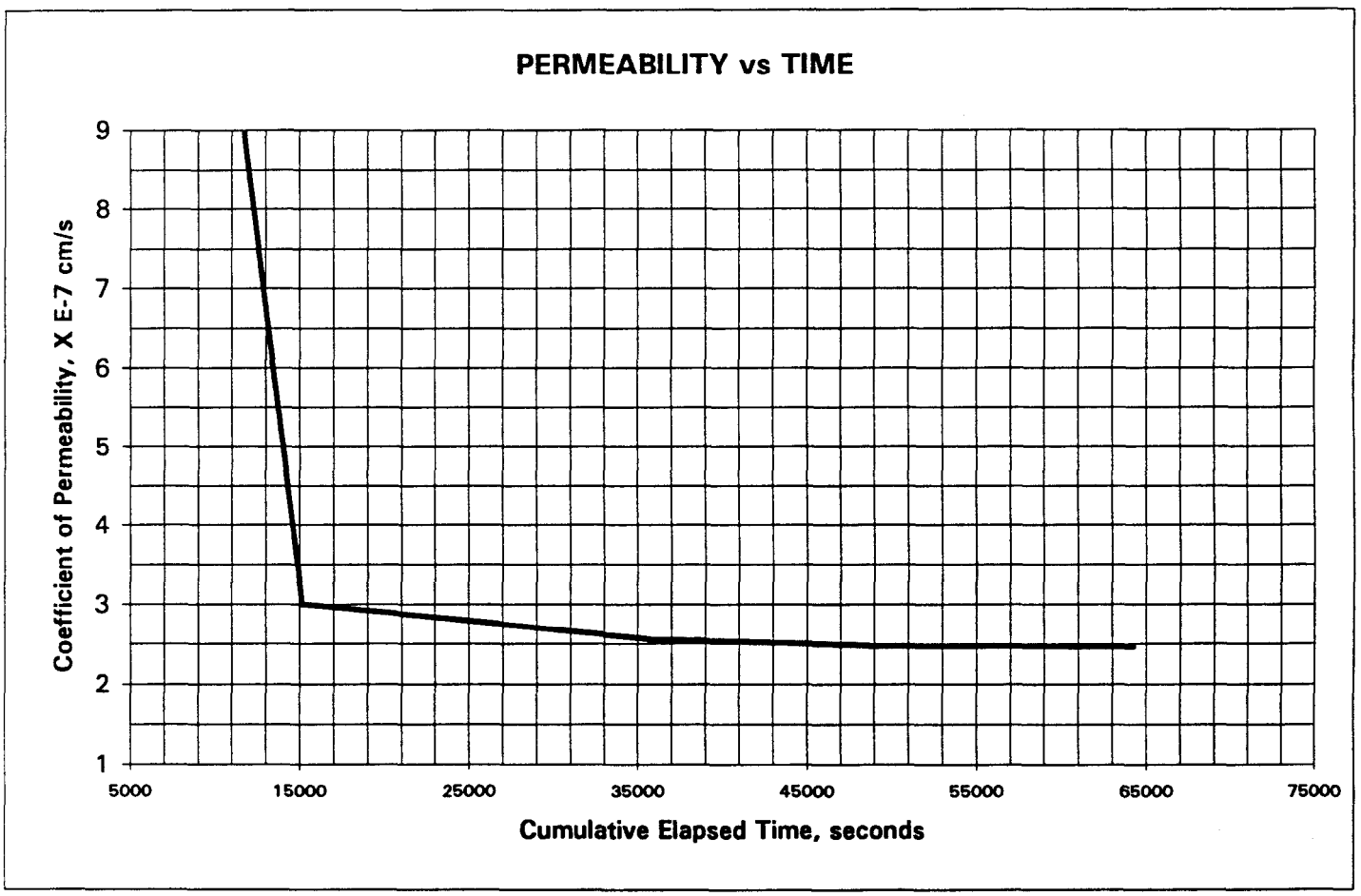
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P443G00
IT LAB SAMPLE NO. ETDC-8126

	INITIAL	FINAL
Specimen diameter, cm	7.60	
Specimen length, cm	9.89	
Wet weight of specimen, g.	799.96	799.59
Specimen cross-sect. area, cm^2	45.3962	
Water content, %	38.3	38.2
Wet unit weight, pcf	111.2	
Dry unit weight, pcf	80.4	
Estimated degree of saturation, %	96.0	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	14.2
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	7.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Six tests performed	

Coefficient of Permeability, cm/s 2.6E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

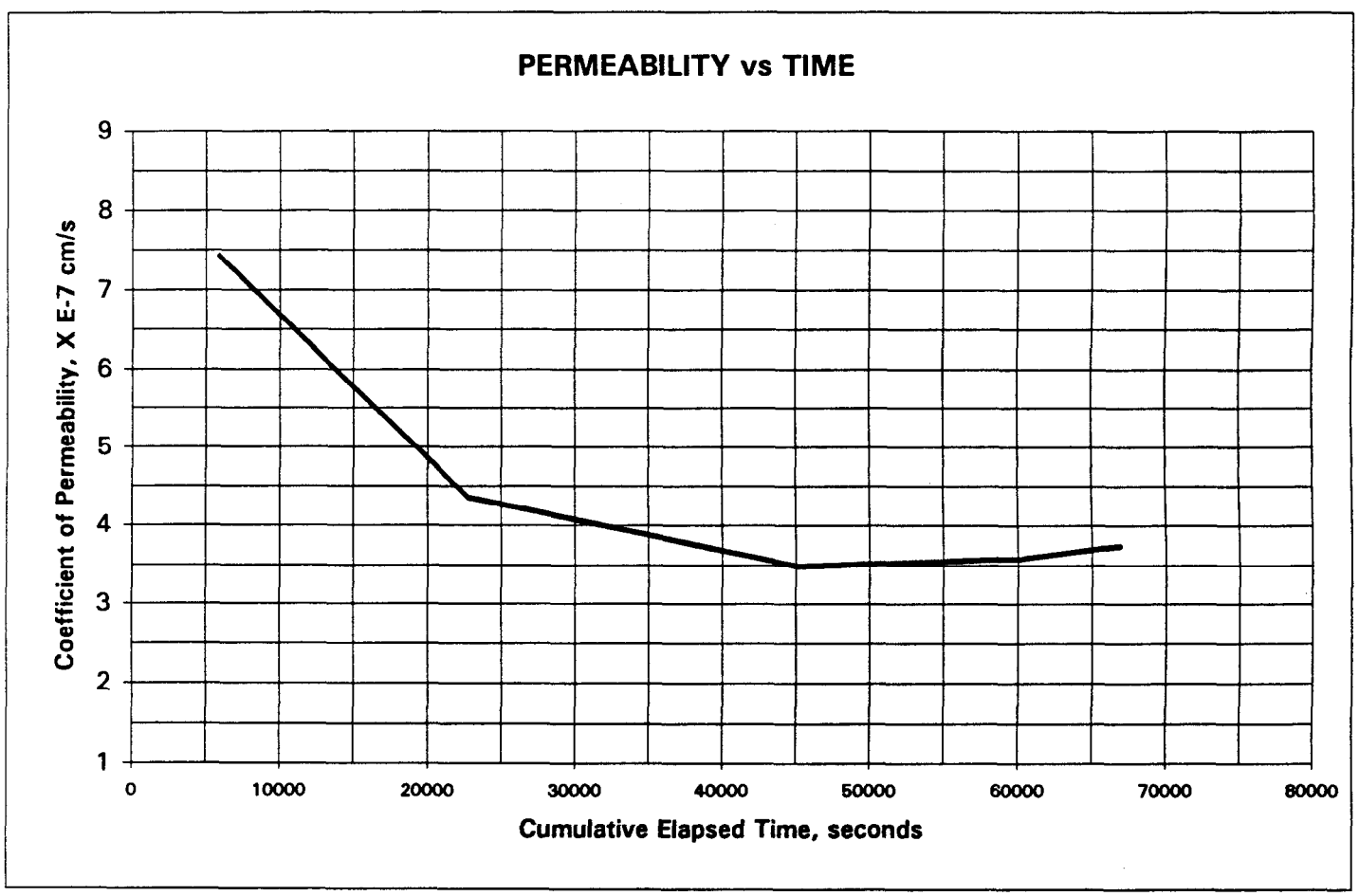
90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P513G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8127

	INITIAL	FINAL		
Specimen diameter, cm	7.58			
Specimen length, cm	8.23		Hydraulic gradient	17.1
Wet weight of specimen, g.	697.28	700.48	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.0933		Max. consolidation stress, psi	4.0
Water content, %	29.1	29.6	Total backpressure, psi	6.0
Wet unit weight, pcf	117.2		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	90.9		Sample molded	12/22/98
Estimated degree of saturation, %	93.8		Sample set up	4/19/99
Estimated spec. gravity of solids	2.65		Five tests performed	

Initial conditions are post-soak, pre-test

Coefficient of Permeability, cm/s	3.8E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

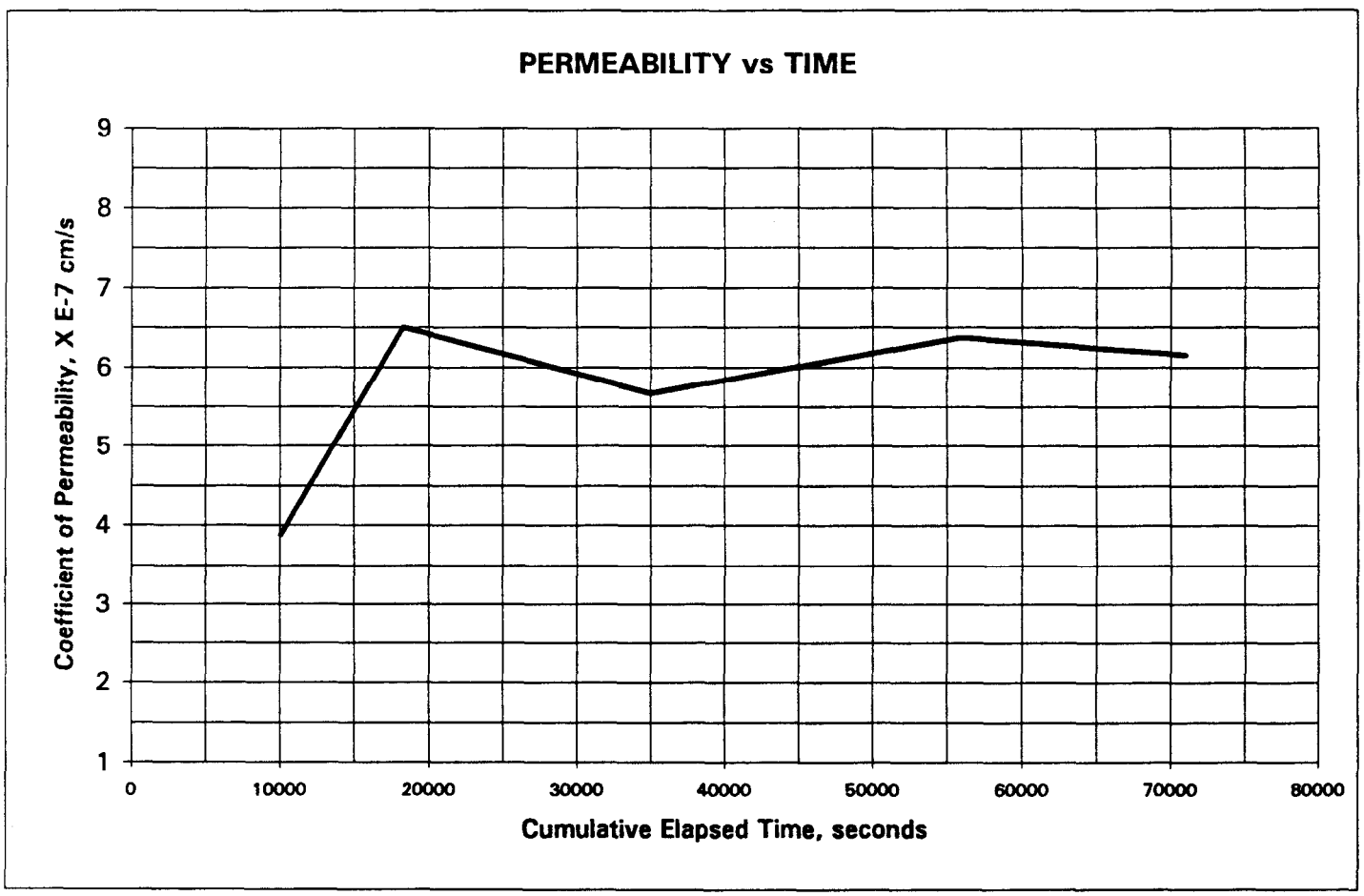
90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P523G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8128

	INITIAL	FINAL		
Specimen diameter, cm	7.58			
Specimen length, cm	6.79		Hydraulic gradient	41.5
Wet weight of specimen, g.	566.64	567.81	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.1538		Max. consolidation stress, psi	4.0
Water content, %	23.3	23.6	Total backpressure, psi	6.0
Wet unit weight, pcf	115.4		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	93.6		Sample molded	12/22/98
Estimated degree of saturation, %	80.4		Sample set up	4/18/99
Estimated spec. gravity of solids	2.65		Five tests performed	

Initial conditions are post-soak, pre-test

Coefficient of Permeability, cm/s	6.2E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

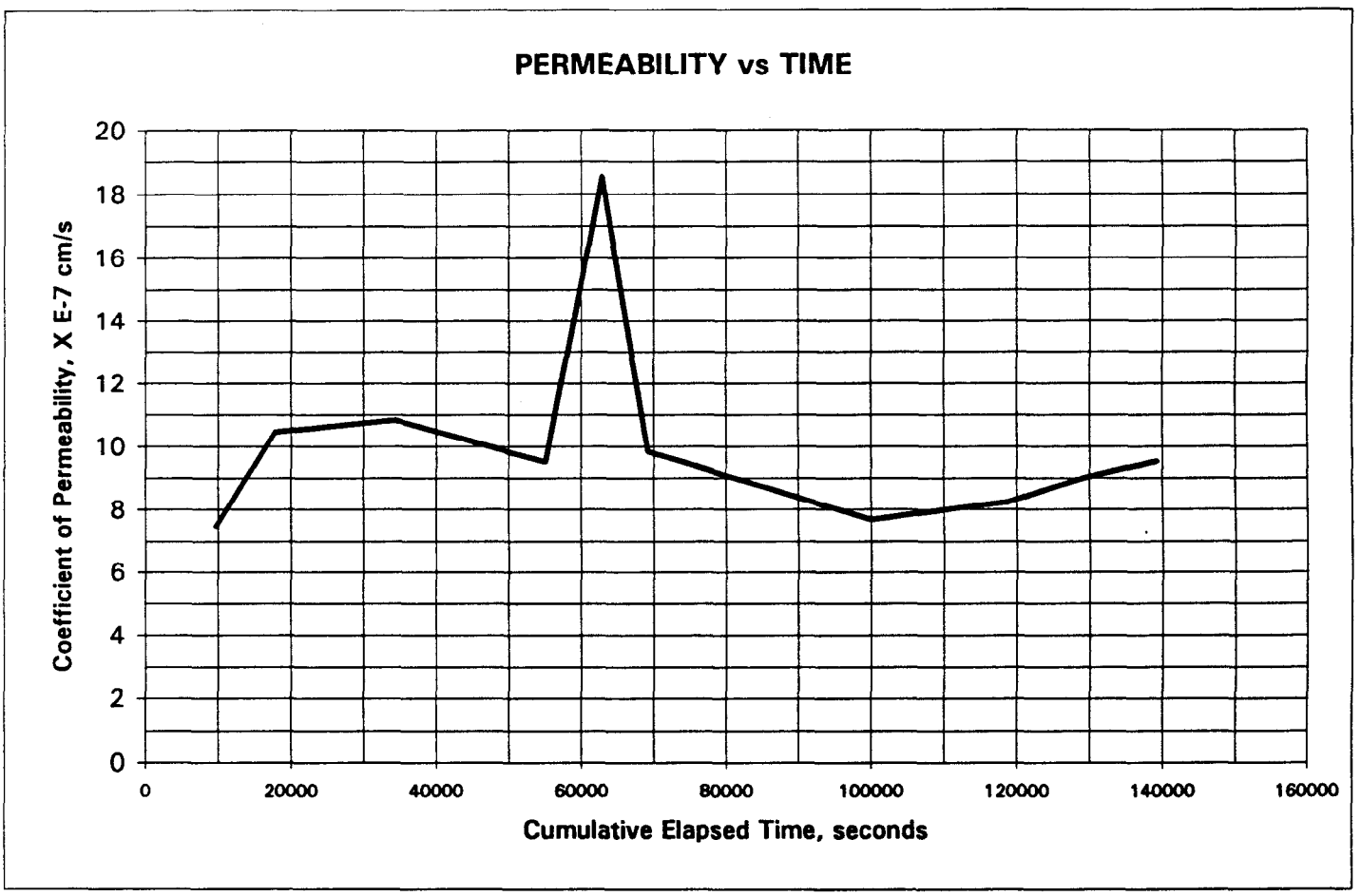
PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P533G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8129

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	9.25	
Wet weight of specimen, g.	755.12	759.11
Specimen cross-sect. area, cm^2	45.0782	
Water content, %	31.8	32.5
Wet unit weight, pcf	113.0	
Dry unit weight, pcf	85.8	
Estimated degree of saturation, %	90.7	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	30.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Ten tests performed	

Coefficient of Permeability, cm/s	8.6E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

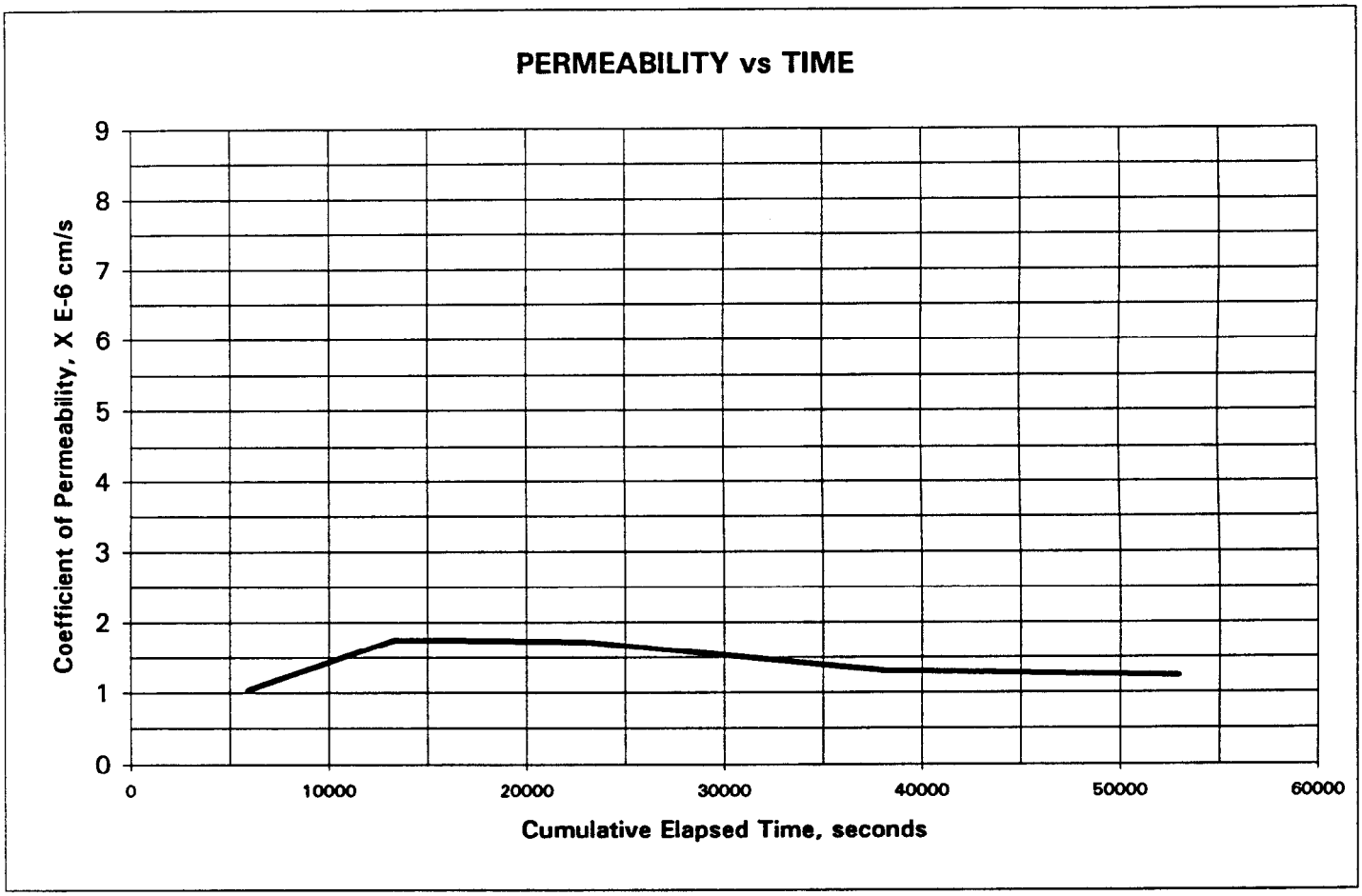
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P543G00
IT LAB SAMPLE NO. ETDC-8130

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	9.42	
Wet weight of specimen, g.	777.52	779.15
Specimen cross-sect. area, cm^2	45.1286	
Water content, %	30.2	30.5
Wet unit weight, pcf	114.2	
Dry unit weight, pcf	87.7	
Estimated degree of saturation, %	90.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	29.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Six tests performed	

Coefficient of Permeability, cm/s 1.4E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

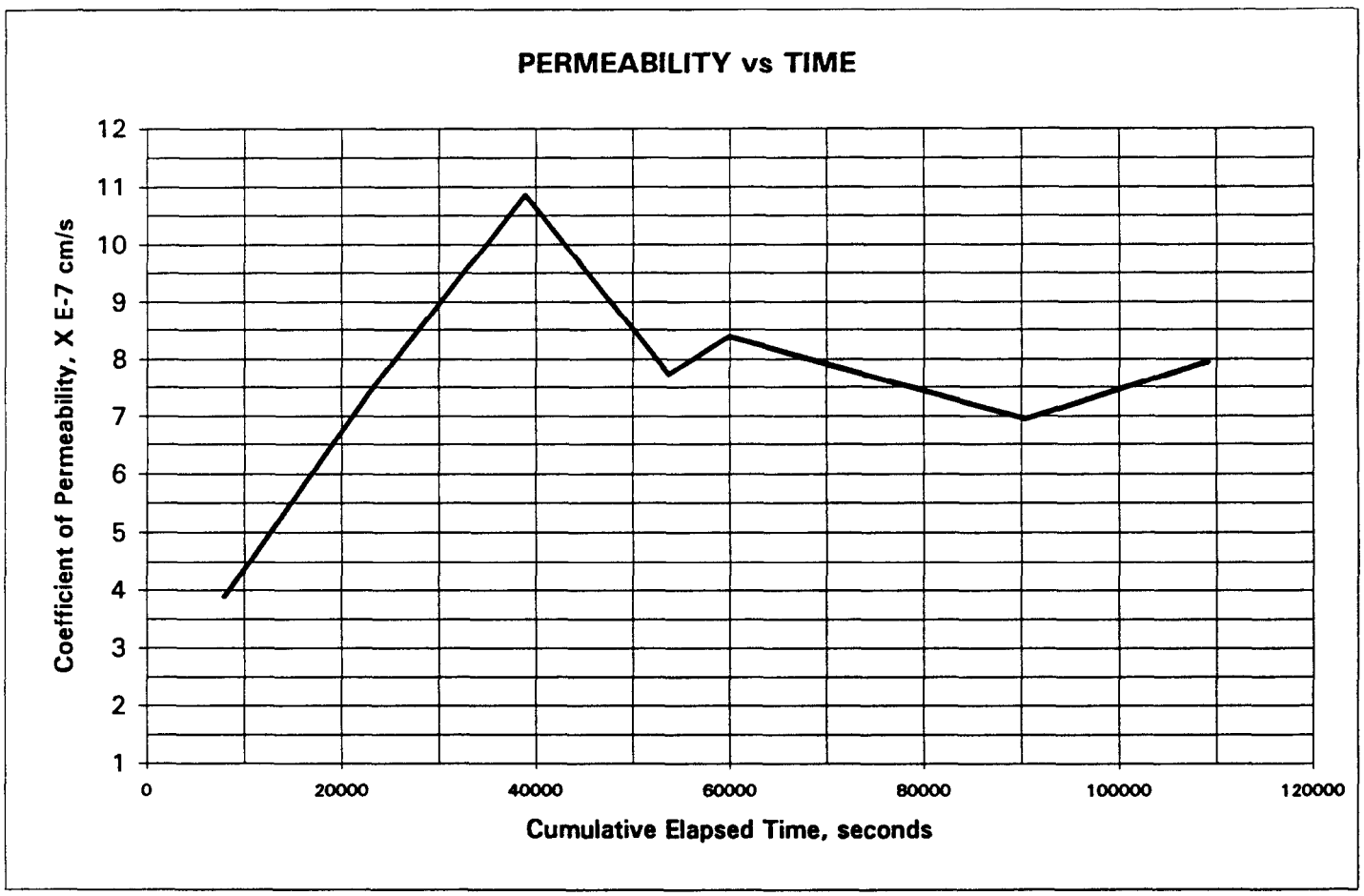
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P613G00
IT LAB SAMPLE NO. ETDC-8131

	INITIAL	FINAL
Specimen diameter, cm	7.58	
Specimen length, cm	8.03	
Wet weight of specimen, g.	680.88	684.83
Specimen cross-sect. area, cm^2	45.0681	
Water content, %	27.3	28.1
Wet unit weight, pcf	117.5	
Dry unit weight, pcf	92.3	
Estimated degree of saturation, %	91.4	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	35.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Seven tests performed	

Coefficient of Permeability, cm/s 7.8E-07



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

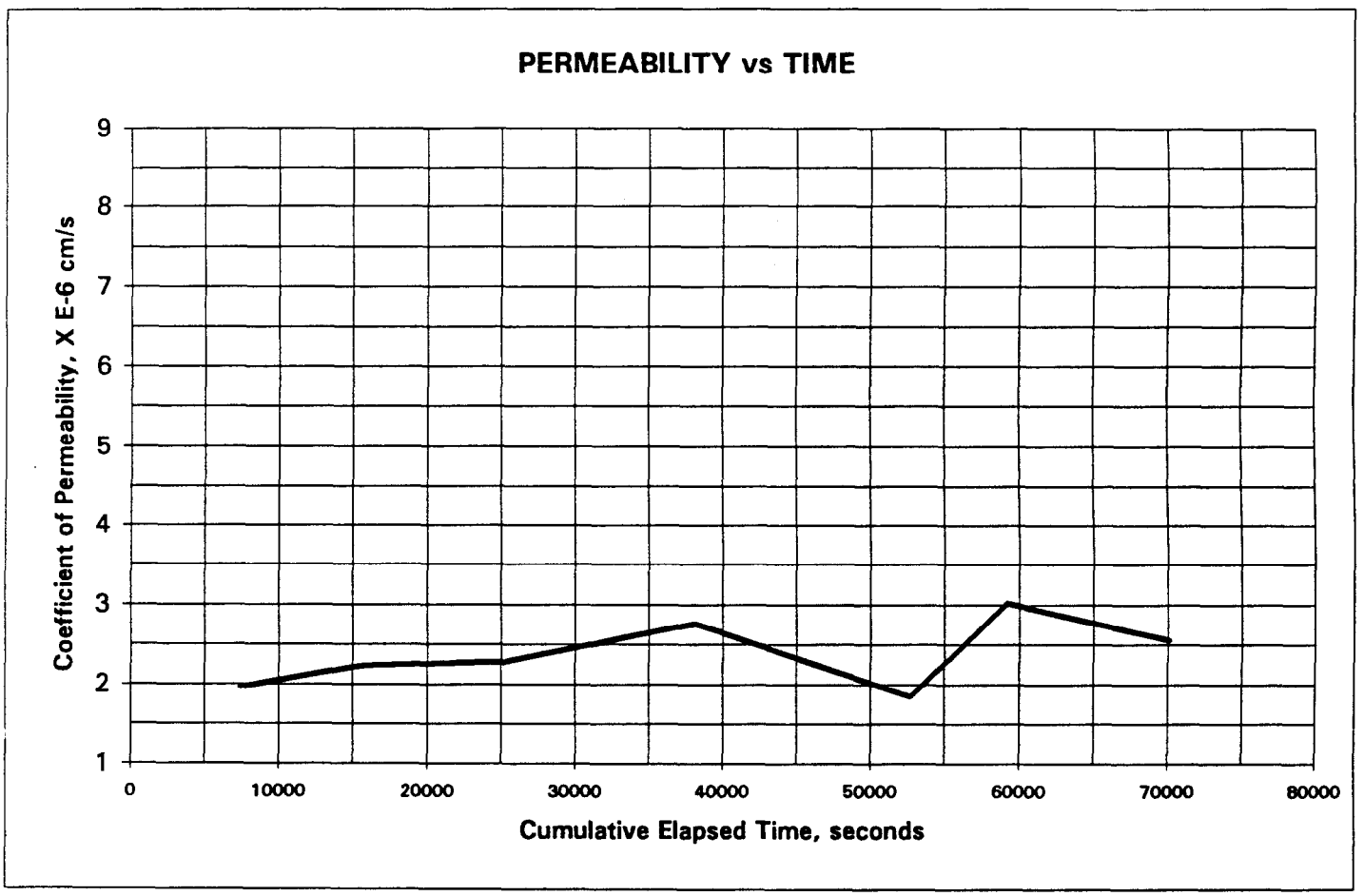
90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P623G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8132

	INITIAL	FINAL		
Specimen diameter, cm	7.57			
Specimen length, cm	6.44		Hydraulic gradient	21.9
Wet weight of specimen, g.	549.91	551.55	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	44.9977		Max. consolidation stress, psi	3.0
Water content, %	24.9	25.3	Total backpressure, psi	7.0
Wet unit weight, pcf	118.5		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	94.8		Sample molded	12/22/98
Estimated degree of saturation, %	88.7		Sample set up	4/19/99
Estimated spec. gravity of solids	2.65		Seven tests performed	

Initial conditions are post-soak, pre-test

Coefficient of Permeability, cm/s	2.3E-06



Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

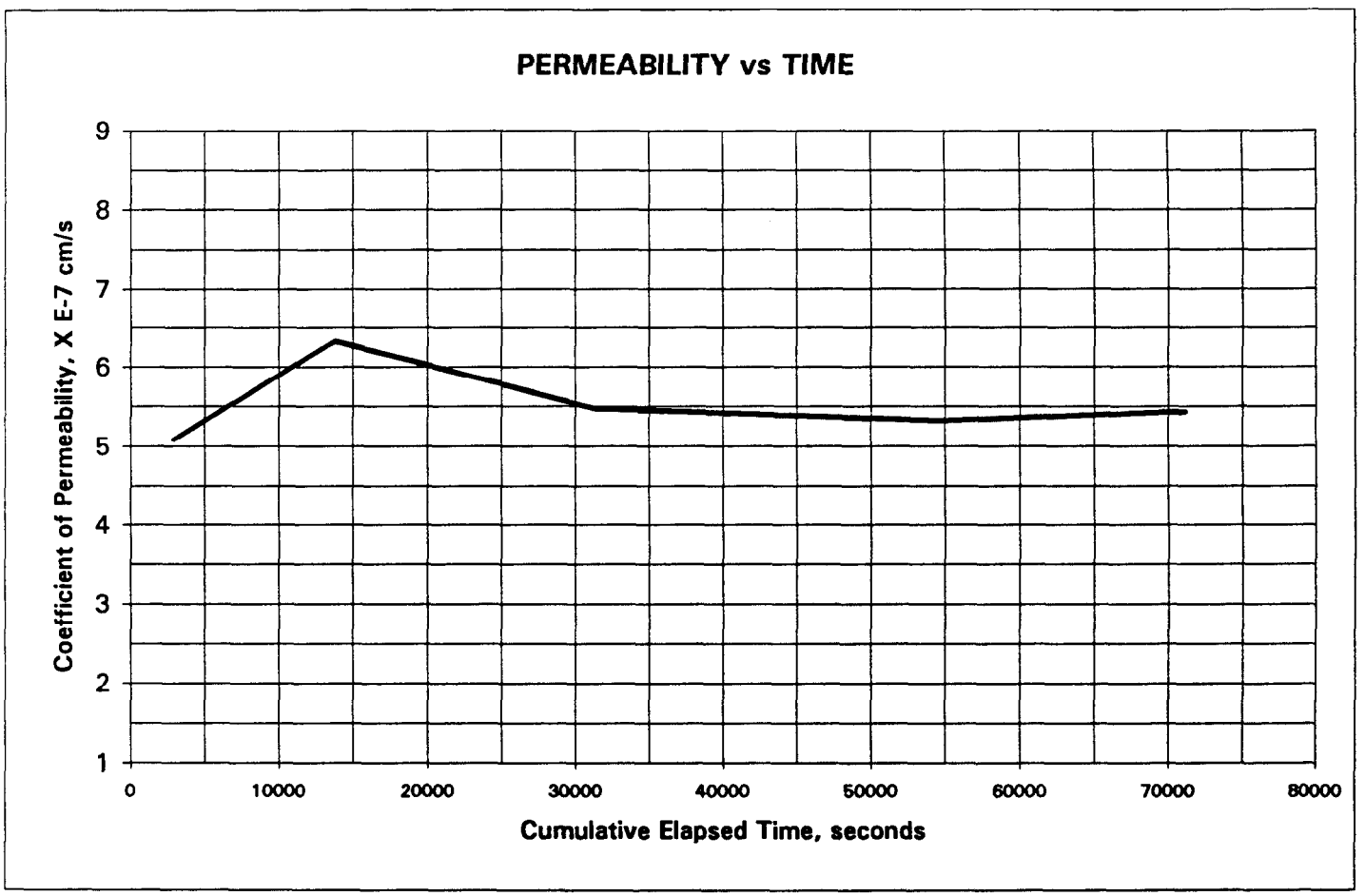
PROJECT NAME: SAIC / Savannah River
PROJECT NO. 777304.00010500
CLIENT SAMPLE NO. P633G00
IT LAB SAMPLE NO. ETDC-8133

	INITIAL	FINAL
Specimen diameter, cm	7.57	
Specimen length, cm	9.45	
Wet weight of specimen, g.	771.28	774.37
Specimen cross-sect. area, cm^2	44.9624	
Water content, %	33.3	33.9
Wet unit weight, pcf	113.3	
Dry unit weight, pcf	85.0	
Estimated degree of saturation, %	93.3	
Estimated spec. gravity of solids	2.65	

Initial conditions are post-soak, pre-test

Hydraulic gradient	29.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water
Sample molded	12/22/98
Sample set up	4/19/99
Five tests performed	

Coefficient of Permeability, cm/s 5.6E-07



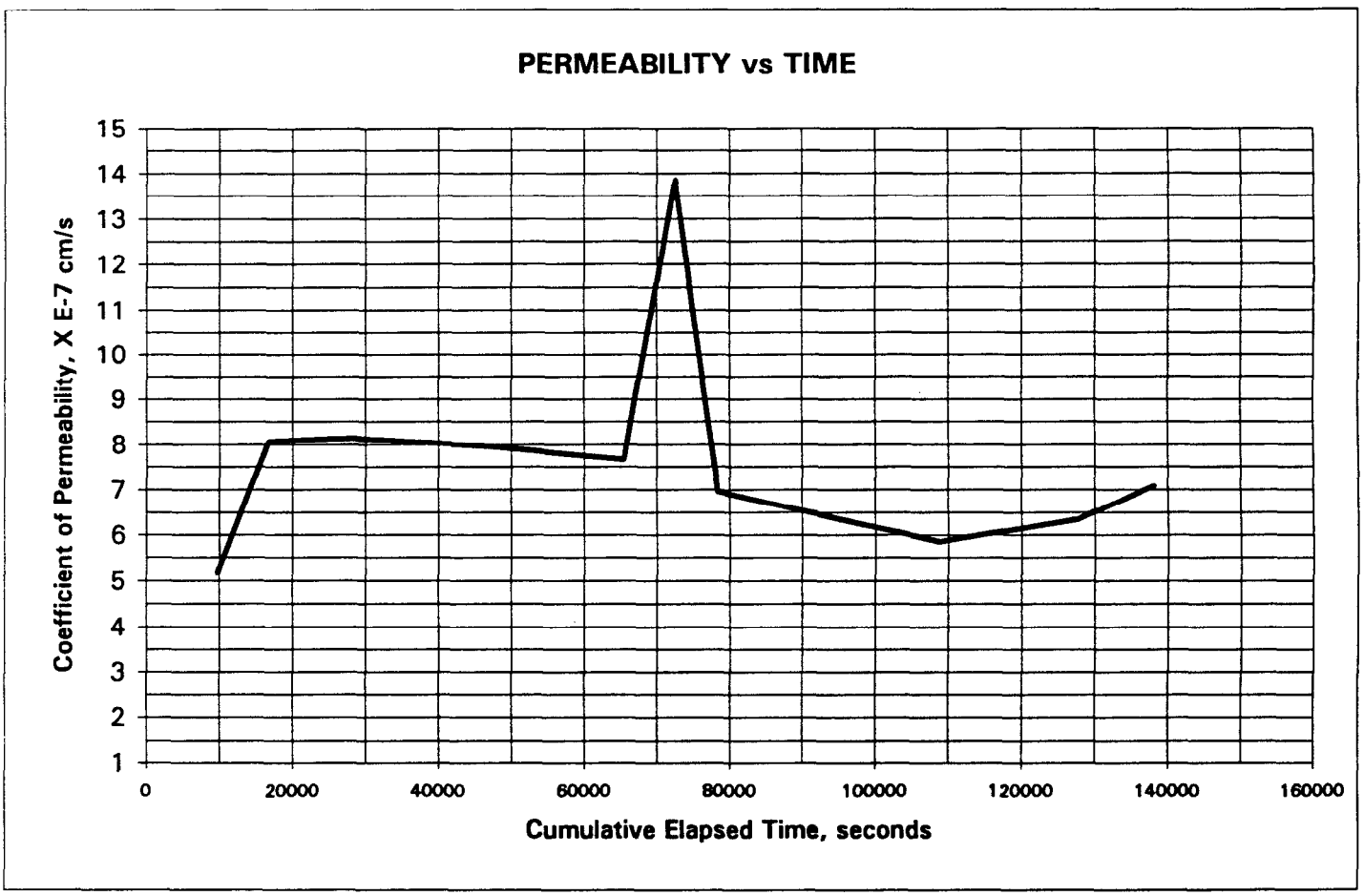
Paul Lear
IT Corporation
May 28, 1999
IT Project ID: SAIC Savannah River Site
IT Project No.: 777304.00010500

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(423) 482-6497

90-DAY SATURATED HYDRAULIC CONDUCTIVITY / PERMEABILITY ASTM D 5084

PROJECT NAME:	SAIC / Savannah River	CLIENT SAMPLE NO.	P643G00
PROJECT NO.	777304.00010500	IT LAB SAMPLE NO.	ETDC-8134

	INITIAL	FINAL		
Specimen diameter, cm	7.60			
Specimen length, cm	8.94		Hydraulic gradient	31.5
Wet weight of specimen, g.	737.2	739.25	Min. consolidation stress, psi	2.0
Specimen cross-sect. area, cm^2	45.3103		Max. consolidation stress, psi	4.0
Water content, %	31.0	31.4	Total backpressure, psi	6.0
Wet unit weight, pcf	113.6		Permeant Fluid	Deaired DI Water
Dry unit weight, pcf	86.7		Sample molded	12/22/98
Estimated degree of saturation, %	90.5		Sample set up	4/19/99
Estimated spec. gravity of solids	2.65		Eleven tests performed	

Initial conditions are post-soak, pre-test

Coefficient of Permeability, cm/s 6.6E-07