APPENDIX D

GEOTECHNICAL INVESTIGATION
KENAI BLUFF EROSION
TECHNICAL REPORT
KENAI, ALASKA

Geotechnical Findings Report
Kenai River Bluff Erosion Project
Slope Stability Analysis
Kenai, Alaska

October 2004

1. Introduction

The results of a geotechnical investigation performed for the Kenai River Bluff Erosion project in Kenai, Alaska are presented in this report.

The purpose of the investigation was to determine if slope stability was contributing to the recession of a steep bluff along the north shore of the Kenai River adjacent to the City of Kenai. In addition to the stability investigation, a well flow test was incorporated to collect data for to estimate soil permeability.

This report presents a summary of the findings based on site observations and the results of a field exploration, laboratory testing program, and engineering computations.

2. Project Description and Location

The City of Kenai has proposed constructing a revetment and bike trail along the north bank of the Kenai River near its mouth at Cook Inlet. The details of the proposal are described in a report by Peratrovich, Nottingham and Drage (PN&D). According to the report, the primary intent of the project is to protect a one-mile reach of riverbank, along the toe of a steep bluff, from erosion by water currents, rain, wind, and waves. Photograph 1 is typical of the erosion that is taking place.

The site of the exploration is shown on the Location and Vicinity Map, Figure 1.

3. Field Exploration

The subsurface exploration for the project was conducted from 15 to 18 September 2003. A total of four test borings were drilled. One was drilled to 37.5 feet and three to 100 feet. The borings have been designated AP-604-P, AP-605-MW, AP-606-P and AP-607-P. The shallower boring, AP-605-MW, was finished as a monitor well using 2-inch diameter PVC casing. In the deeper borings, one-inch diameter PVC casing, slotted with a hack saw, was installed to facilitate future groundwater measurements.

Photograph 1 – Kenai River Bluff Erosion; looking west

Hughes Drilling, under contract with the U.S. Army Corps of Engineers – Alaska District (USACE-AD), drilled the test borings using a truck mounted CME 75 drill rig. The drill rig was fitted with an 8-inch outside diameter, continuous flight, hollow-stem auger. An engineer with the Corps supervised the drilling and logged the test borings in accordance with ASTM D-2488, "Description and Identification of Soils (Visual – Manual Procedure). Collected samples were screened with a photo-ionization detector (PID) to scan for volatile organic compounds (VOC's).

The test boring locations were determined using standard survey techniques. McLane Surveying, under contract with USACE-AD, performed the survey. Horizontal coordinates are based on NAD83, Alaska State Plane, Zone 4. Elevations are based on Mean Lower Low Water. Boring locations are shown on the Boring Location Map, Figure 2.

Generally, grab samples were procured from the surface and split-spoon samples were taken below the surface at 2.5 feet, five feet, and at 5-foot intervals, thereafter.

The split-spoon samples were collected using a 2.5-inch inside diameter split spoon driven with a 340-pound auto-hammer falling 30 inches. The sampler was typically driven to 18 inches ahead of the auger. The number of blows required to drive each 6-inch increment is recorded on the exploration logs. The blow count is an indication of the relative density or consistency of the soil.

4. Laboratory Testing and Soil Classification

A laboratory testing program was established to classify and determine physical and engineering properties of the encountered soils. These tests and classifications were performed in accordance with the latest version of the following methods:

- ASTM D 422, "Standard Test Method for Particle Size Analysis of Soils."
- ASTM D 2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."
- ASTM D 2487, "Standard Practice for Classification of Soils for Engineering Purposes (Uniform Soil Classification System)."
- ASTM D 4318, "Determining the Plastic Limit and Plasticity Index of Soils."
- ASTM D 4767, "Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils."
- Multi-Stage Consolidated-Drained Triaxial Compression Test

The soil descriptions and classifications contained in this report and presented on the exploration logs are the project engineer's interpretation of the field logs and the results of the laboratory testing program. The stratification lines represent approximate boundaries between soil types; the transitions are often gradual or not discernible by drill action. The exploration logs are enclosed as Appendix A, the grain size distribution curves and other laboratory test results are enclosed as Appendix B.

5. Regional Geology

The City of Kenai is located on the Nikishka Lowland geomorphological subdivision of the Kenai Lowland. This region is characterized by a modified morainal topography, which is separated by an interlacing pattern of swamps and muskegs developed in abandoned drainage channels and broad depressions. The topography and surficial deposits of the region are primarily the products of repeated Pleistocene glaciations, which advanced from ice centers in the surrounding mountain ranges. Near the City of Kenai, the Naptowne glacial moraines are fronted by a broad coastal plain consisting of terraced and channeled sand and gravel deposits, which terminate as steep sea bluffs above a series of raised tidal flats. (Tippetts-Abbett-McCarthy-Stratton (TAMS), 1982.)

The topography in the area of the Kenai River mouth consists of a bluff approximately 70 feet high on the north side of the river opposite a low lying wetland and tide flat area with a dendridic drainage pattern. The topography indicates the river valley has historically experienced much

higher flows. Two drainage channels west of the City of Kenai, which extend from the south and southwest end of the airport to their confluence behind the dunes at the mouth of the river, could be remnant drainage channels associated with the historical higher flows.

According to Dick Reger, retired geologist with the Alaska Division of Geological and Geophysical Surveys, the bluff at the mouth of the River is composed of three distinct material layers; an organic mat top layer that is approximately two feet thick, a layer of fine sand to sand and gravel with erratics that is approximately 35 feet thick, and a lower marine deposit layer that can vary from 35 to 45 feet thick. This layering is readily visible in the bluff face.

6. Site Conditions

Surface: The site is within an established residential neighborhood with paved streets, curb and gutters, and overhead and underground utilities. The topography of the area is relatively flat with little vertical relief. Vegetation consists of manicured yards and mature trees. The neighborhood is located on a steep bluff paralleling the Kenai River along an east-west alignment. The bluff is very steep, over 45 degrees in some areas. There is very little vegetation on the slope.

Subsurface: The test borings indicate the surficial soils are comprised of brown, moist, poorly graded fine sand (SP). A single instance of brown, moist, silty sand (SM) was also encountered. In general, the frost classification of these soils is non-frost susceptible (NFS). Blow counts indicate the sand is in a very loose to medium dense state. These surficial sandy soils extend to an average depth of 38 feet. Photograph 2 shows a typical soil sample collected within the surficial sand layer.

The soils underlying the surficial sands consist predominately of an impermeable layer of dark gray, moist, sandy lean clay (CL). Interlayed with the clay are seams of brown, moist, poorly graded sand (SP) from a few inches to several feet thick. These sand seams are loose and very permeable. Photograph 3 shows a representative seam of sand within the clay. Blow counts indicate the sandy lean clay is stiff to very stiff.

Poorly graded sand (SP) and poorly graded sand with silt (SP-SM) were encountered below the clay layer at depths of 75 to 86 feet.

Groundwater was encountered from 27 to 30 feet below the ground surface in the four borings. Although, groundwater may be present in the sand seams, its presence could not be determined conclusively. Ground water elevations measured while drilling and subsequently are tabulated below.

Table 1 – Groundwater Elevations

Boring No.	Date			
	October 30, 2003		April 16, 2004	
	Water Depth Below PVC	Water Elevation	Water Depth Below PVC	Water Elevation
AP-604-P	26.68'	62.94'	27.23'	62.39'
AP-605-MW	29.15'	60.57'	29.46'	60.26'
AP-606-P	31.12'	57.23	Obstructed	na
AP-607-P	27.62'	61.24	27.91'	60.95'

1. AP-606-P was obstructed at 0.71 feet; ice is suspected.
2. Water elevations are MLLW

7. Engineering Analysis

Slope Stability Analysis – The Corps' slope analysis software, UTEXAS4, was used to perform the slope stability analysis. The UTEXAS program has been the Corp's primary slope stability software since the late 1980's. The software performs an auto-search for the critical surface and is capable of performing static and dynamic analyses.

Photograph 2 –Surficial Sand

Laboratory determined soil parameters were used in the analysis and are tabulated below. These parameters are assumed to be isotropic and constant within the soil layers. The laboratory analyses are attached as Appendix B.

Photograph 3 – Small 2-inch sand seam within lean sandy clay

Soil Type	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg)
Poorly graded Sand (SP)	99	0	37
Sandy Lean Clay (CL)	116	2,196	27

Water measurements taken on April 16, 2004 were used as the seasonal high groundwater elevation for modeling the groundwater profile within the surficial sand layer.

The ground profile was taken from a 2003 cross sectioning effort undertaken by McLane Surveying of Kenai, Alaska. Section 3, which closely coincides with the alignment of AP's 604-P, 605-MW, and 606-P was used in the analysis.

Well Flow Test – Well flow test for collecting information to be used for estimating the permeability of the surficial sand layer was also performed. Because the screened section extended above the water elevation, it was only possible to obtain water level recovery rates after pumping. Since the scope was limited to the collection of data no calculations or interpretations of the data are presented.

The well was pumped at six gallons per minute; the maximum rate of the Grundfos pump and the recovery was recorded over time. Due to the very permeable nature of the sand, the maximum capable draw down of the

pump was no more than 1.23 feet. This combination of very permeable soil and limited draw down allowed the collection of only three recovery measurements. The recovery rates for the various draw-down levels are tabulated below.

Water Level Below Top of PVC	Draw Down (ft)	Recovery (seconds)
29.15	0	na
29.35	.2	0*
29.8	.65	1
30.0	0.85	4
30.38	1.23	6

* Recovery was too quick to record accurately.

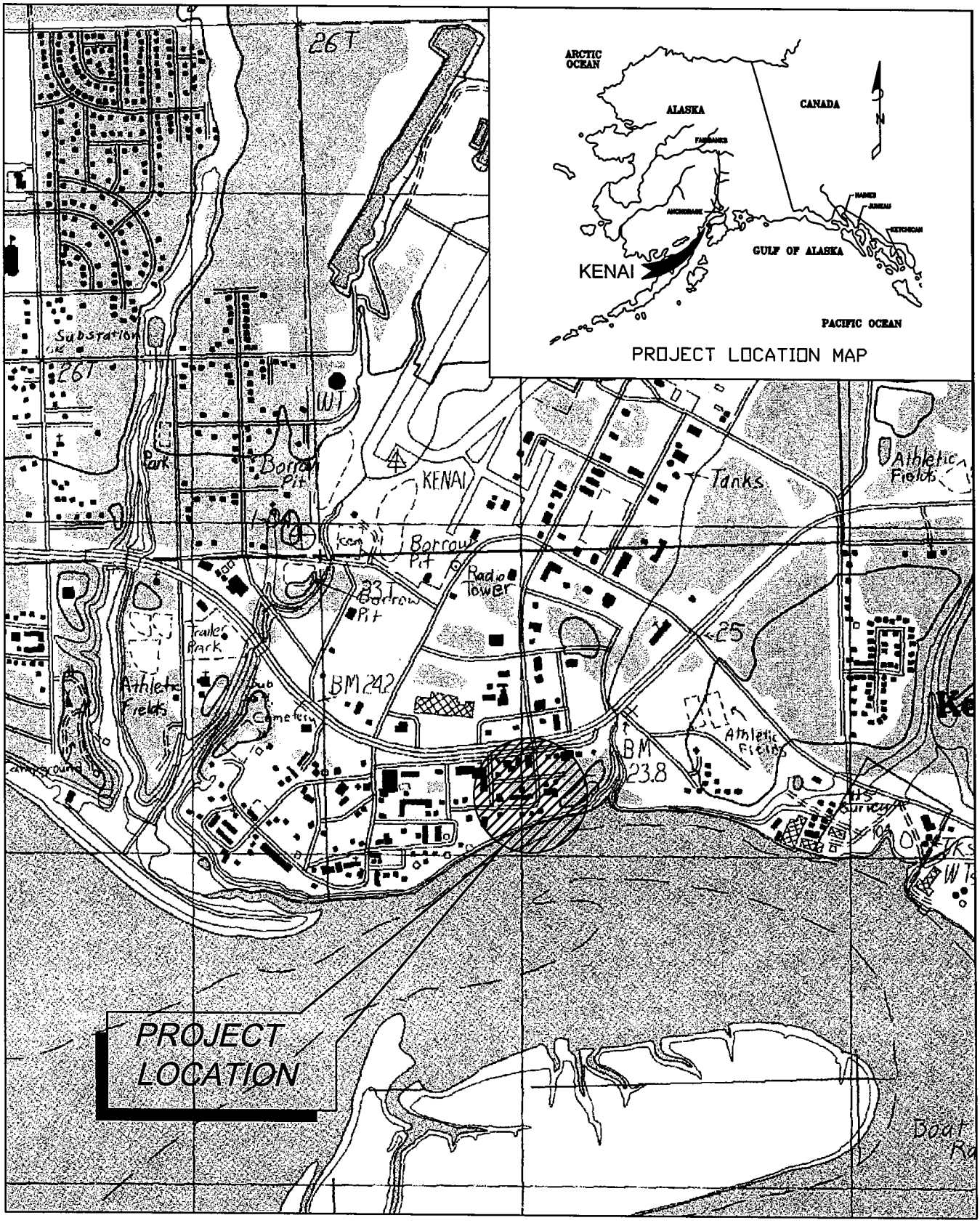
8. Conclusions

Although the Kenai River bluff is receding, the collected soil data, laboratory testing, and analysis indicate the slope is stable and massive slope failures are not contributing factors. The computed factor of safety for the sand/clay layer is 1.3 and for the clay layer alone, where the sand layer was modeled as a surcharge, is 3.2. Both the sand and clay slope faces, however, are susceptible to surface raveling, sloughing, and wind and water erosion. The critical surfaces for the sand/clay layers and the clay layer are presented in Figures 3 and 4, respectively.

Undercutting of existing structure by receding bluff.

Attachments:

1. Figure 1 – Location/Vicinity Map
2. Figure 2 – Test Boring Location Map
3. Figure 3 – UTEXAS4 Output - Critical Circle; Sand and Clay
4. Figure 4 – UTEXAS4 Output - Critical Circle; Clay Only
5. Appendix A – Exploration Logs
6. Appendix B – Laboratory Analysis Data Sheets



ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

KENAI RIVER BLUFF EROSION
LOCATION/VICINITY MAP
KENAI, ALASKA

SCALE: NONE
DATE: OCT 2004
DRAWN/RVW: SCH/CRW
FIGURE 1

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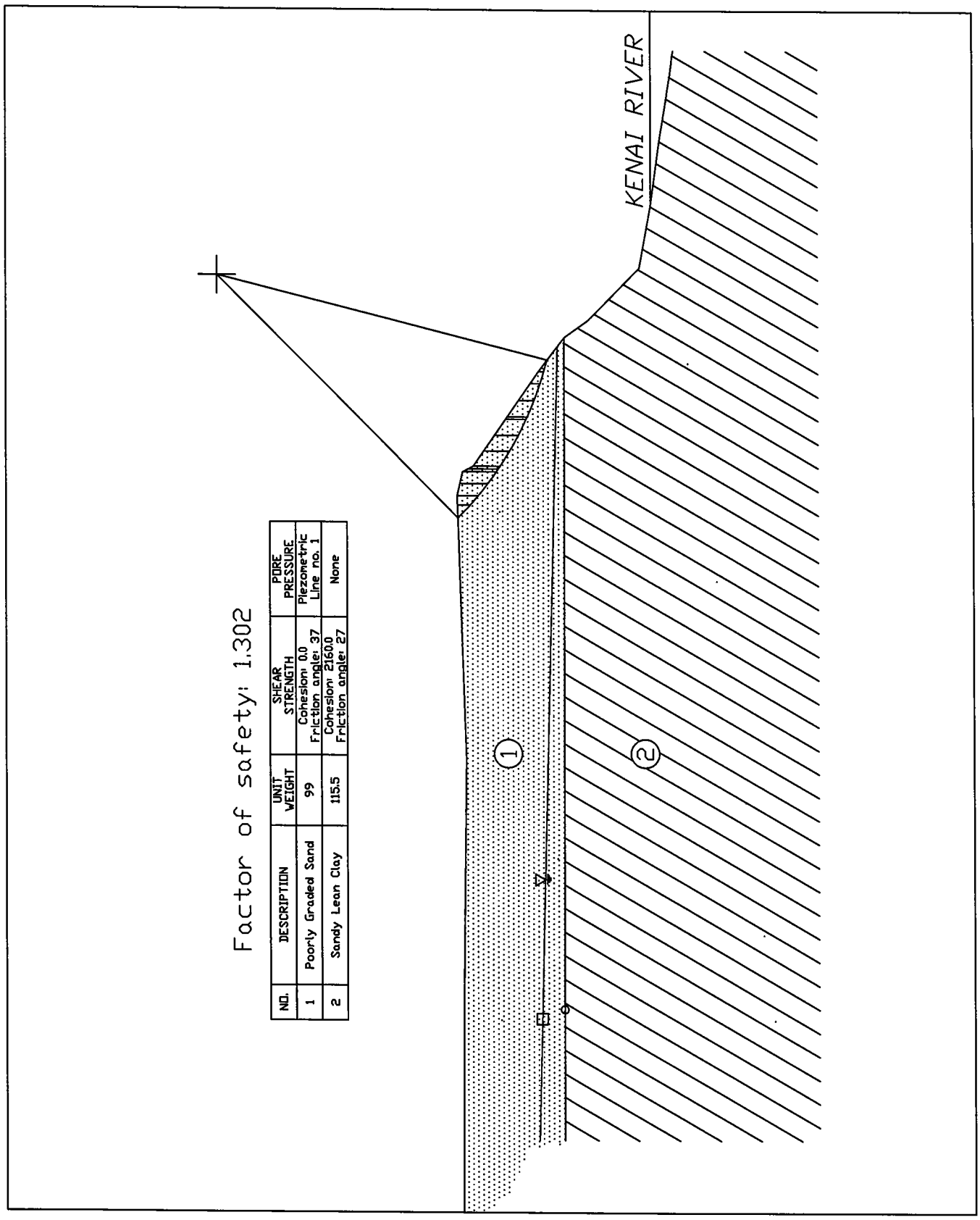
KENAI RIVER BLUFF EROSION

TEST BORING LOCATION MAP

KENAI, ALASKA

SCALE: NONE
DATE: OCT 2004
DRAWN/RVW: SCH/CRW
FIGURE 2



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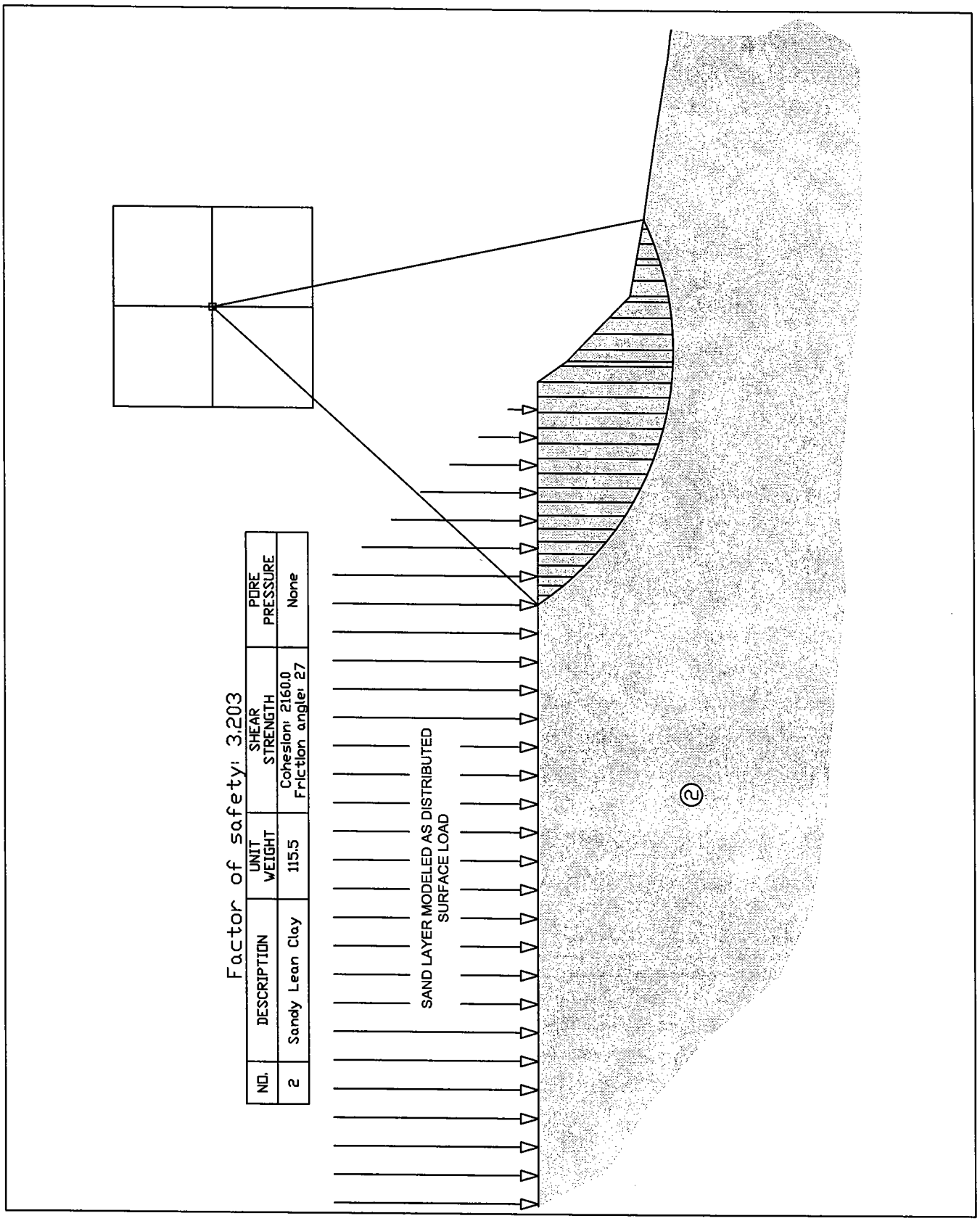
KENAI RIVER BLUFF EROSION
UTEXAS4 Output - Critical Circle; Sand and Clay
KENAI, ALASKA

SCALE: NONE
DATE: OCT 2004
DRAWN/RVW: SCH/CRW
FIGURE 3



ALASKA DISTRICT
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KENAI RIVER BLUFF EROSION
UTEXAS4 Output - Critical Circle; Clay Only
KENAI, ALASKA

SCALE: NONE
DATE: OCT 2004
DRAWN/RVW: SCH/CRW
FIGURE 4

APPENDIX A

EXPLORATION LOGS

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 15 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,502 ft. Easting: 1,415,363 ft.

Top of Hole Elevation: 90.0 ft.

Hole Number, Field: TB-1

Permanent: AP-604-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.0 ft. WD

Depth Drilled: 100.0 ft.

Total Depth: 101.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Second growth willows
0		1		NFS	Grab	SP	Poorly graded SAND					-/ 0.0		Brown, moist, fine to medium sand
2														
4		2		NFS	1 1 2 1	SP	Poorly graded SAND	8	87	5		-/ 0.0	3	Brown, moist, fine to medium sand
6		3		NFS	1 1 1 1	SP	Poorly graded SAND					-/ 0.0		Brown, moist, fine to medium sand
8														
10		4		NFS	2 3 3 5	SP	Poorly graded SAND	4	93	3		-/ 0.0	5	Gray, moist, fine to medium sand
12														
14														
16		5		NFS	2 5 7 9	SP	Poorly graded SAND					-/ 0.0		Gray, moist, fine to medium sand
18														
20		6			3 4 3 5	SP	Poorly graded SAND					-/ 0.0		Gray, moist, fine to medium sand
22														
24														
26		7a			3 5	SP	Poorly graded SAND							
		7b			5	SM	Silty SAND	1	75	24			22	Dark gray, moist, fine sand, nonplastic (NP) fines
		7c			9	SP	Poorly graded SAND							
28														
30		8			7 11 15	SP	Poorly graded SAND							Gray, wet, medium sand
32														
34														
36		9			5 8	SP	Poorly graded SAND							Gray, wet, fine to medium sand

EXPLORATION LOG KENAI_BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 15 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,502 ft. Easting: 1,415,363 ft.

Top of Hole Elevation: 90.0 ft.

Hole Number, Field: TB-1

Permanent: AP-604-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.0 ft. WD

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Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Second growth willows
38					13									
40		10			6 11 14	CL	Lean CLAY with Sand	0	22	78				Dark gray, moist, fine sand, plastic fines. LL=30.8, PI=15.5
42														
44														
46		11			7 7 10	CL	Lean CLAY with Sand							Dark gray, moist, rounded gravel, fine sand, plastic fines, very stiff
48														
50		12			6 8 13	CL	Lean CLAY with Sand							Dark gray, moist, plastic fines, very stiff
52														
54														
56		13			8 20 12	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines, very stiff
58														
60		14			5 9 8	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines, very stiff
62														
64														
66		15			4 9 12	CL	Lean CLAY with Sand	7	18	75	0.25		15	Dark gray, moist, fine sand, plastic fines, very stiff
68														
70		16			4 6 9	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines, very stiff
72														

EXPLORATION LOG KENAI_BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 15 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,502 ft. Easting: 1,415,363 ft.

Top of Hole Elevation: 90.0 ft.

Hole Number, Field: TB-1

Permanent: AP-604-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.0 ft. WD

Depth Drilled: 100.0 ft.

Total Depth: 101.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
74						CL	Lean CLAY with Sand							Surface: Second growth willows
76		17			6 14 21	SP- SM	Poorly graded SAND with Silt							Dark gray, moist, fine sand, plastic fines, very stiff Gray, wet, fine to medium sand
78														
80		18			10 14 18	SP- SM	Poorly graded SAND with Silt	1	92	7				Gray, wet, medium sand
82														
84														
86														
88														
90		19a			4 12 11	SP- SM CL	Poorly graded SAND with Silt Lean CLAY with Sand							Gray, wet, medium sand Dark gray, moist, fine sand, plastic fines
92		19b												
94														
96														
98														
100					7 15 18	SP	Poorly graded SAND							Gray, wet, fine to medium sand
102														Bottom of Hole 101.5 ft. Groundwater Encountered While Drilling: at an elevation of 63.0 ft. PID = (Cold/Hot) Photo Ionization Detector
104														
106														Survey datum is Alaska State Plane, Zone 4, NAD83. Elevation datum MLLW.
108														

EXPLORATION LOG KENAI_BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 16 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,309 ft. Easting: 1,415,302 ft.

Top of Hole Elevation: 89.8 ft.

Hole Number, Field: TB-2

Permanent: AP-605-MW

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☒ Monitoring Well ☐ Piezometer

Depth to Groundwater: 29.9 ft. WD

Depth Drilled: 37.5 ft.

Total Depth: 38.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
		1a			Grab	ML	SILT					-/		Surface: Lawn
		1b				SP	Poorly graded SAND				1	1.0		Brown, moist, nonplastic (NP) fines, organics (sixty percent by volume)
2														Brown, moist, rounded gravel, fine to medium sand
		2			2 2 4 6	SP	Poorly graded SAND				0.5	-/ 1.0		Brown, moist, fine to medium sand
6		3			2 3 4 5	SP	Poorly graded SAND					-/ 1.0		Brown, moist, fine to medium sand
10		4			5 4 6	SP	Poorly graded SAND				0.75	-/ 0.0		Gray, moist, fine to medium sand
16		5			2 6 7	SP	Poorly graded SAND	4	92	4	0.75	-/ 1.0	5	Gray, moist, fine to medium sand
20		6			3 3 5	SP	Poorly graded SAND					-/ 1.0		Brown, moist, fine to medium sand
26		7			3 4 8	SP	Poorly graded SAND					-/ 1.0		Brown, moist, fine to medium sand, localized evidence of mottling, one small area (one inch thick) of 30% silt
30		8			2 6 10	SP	Poorly graded SAND with Gravel	24	74	2	1			Brown, wet, rounded gravel, fine to coarse sand
36		9			2 3	SP	Poorly graded SAND							Twelve inches of heaving sand Gray, wet, fine to medium sand

EXPLORATION LOG KENAI BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 16 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,309 ft. Easting: 1,415,302 ft.

Top of Hole Elevation: 89.8 ft.

Hole Number, Field: TB-2

Permanent: AP-605-MW

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☒ Monitoring Well ☐ Piezometer

Depth to Groundwater: 29.9 ft. WD

Depth Drilled: 37.5 ft.

Total Depth: 38.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
					4									Surface: Lawn
38		10			3 7	CL	Lean CLAY with Sand	4	14	82			17	Dark gray, moist, fine sand, plastic fines, very stiff
40														Bottom of Hole 38.5 ft.
42														Groundwater Encountered While Drilling: at an elevation of 59.9 ft.
44														PID = (Cold/Hot) Photo Ionization Detector
46														Survey datum is Alaska State Plane, Zone 4, NAD83. Elevation datum MLLW.
48														
50														
52														
54														
56														
58														
60														
62														
64														
66														
68														
70														
72														

EXPLORATION LOG KENAI BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 17 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,225 ft. Easting: 1,415,366 ft.

Top of Hole Elevation: 88.7 ft.

Hole Number, Field: TB-3

Permanent: AP-606-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 99.5 ft.

Total Depth: 101.0 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Dirt parking lot
0		1			Grab	SP	Poorly graded SAND with Gravel				0.75			Brown, moist, rounded gravel, fine to medium sand, FILL
2					2 3 4 4	SP	Poorly graded SAND							Brown, moist, fine sand
4		2												
6		3			2 3 1 4	SP	Poorly graded SAND				0.25	-/ 0.0		Brown, moist, fine sand
8														
10		4			2 1 3	SP	Poorly graded SAND				0.25	-/ 0.0		Brown, moist, fine sand
12														
14														
16		5			2 2 3 4	SP	Poorly graded SAND					-/ 1.0		Brown, moist, fine sand
18														
20		6			2 4 6	SP	Poorly graded SAND					-/ 1.0		Brown, moist, fine sand
22														
24														
26		7			4 7 9	SM	Silty SAND	0	79	21		-/ 0.0	15	Brown, moist, fine sand
28														
30		8			7 9 15	SP	Poorly graded SAND with Gravel	17	81	2				Brown, moist, medium to coarse sand
32														
34														
36		9			1 6 9	SP	Poorly graded SAND with Gravel	32	66	2				Brown, wet, rounded gravel, fine to coarse sand

EXPLORATION LOG KENAI_BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 17 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,225 ft. Easting: 1,415,366 ft.

Top of Hole Elevation: 88.7 ft.

Hole Number, Field: TB-3

Permanent: AP-606-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 99.5 ft.

Total Depth: 101.0 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Dirt parking lot
38														
40		10a			4 8 15	CL	Lean CLAY with Sand					-/ 1.0		Gray, moist, plastic fines, very stiff
		10b				GP	Poorly graded GRAVEL							Gray, moist, rounded gravel, coarse sand, 1.5 inches thick
42		10c				CL	Lean CLAY with Sand							
44														
		11a			7 17 24	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines, very stiff
46		11b				SP	Poorly graded SAND							Dark gray, moist, medium sand
		11c				CL	Lean CLAY with Sand							Dark, gray, moist, fine sand, plastic fines, very stiff
48														
50		12			7 13 16	CL	Lean CLAY with Sand					-/ 1.0		Dark gray, moist, fine sand, plastic fines, very stiff
52						SP	Poorly graded SAND							Estimated by drill action
54		13			6 13 16	CL	Lean CLAY with Sand					-/ 0.0		Dark gray, moist, fine sand, plastic fines, very stiff, marbled with clean gray medium sand to one and one sixteen inches thick
56														
58														
60		14			9 13 38	CL	Lean CLAY with Sand	0	23	77		-/ 0.0	17	Dark gray, moist, fine sand, plastic fines. LL=29, PI=15
62														
64		15			7 11 15	CL	Lean CLAY with Sand					-/ 0.0		Dark gray, moist, fine sand, plastic fines
66														
68														
70		16			4 8 12	CL	Lean CLAY with Sand					-/ 0.0		Dark gray, moist, fine sand, plastic fines
72														

EXPLORATION LOG KENAI BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 17 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,225 ft. Easting: 1,415,366 ft.

Top of Hole Elevation: 88.7 ft.

Hole Number, Field: TB-3 Permanent: AP-606-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 99.5 ft.

Total Depth: 101.0 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Dirt parking lot
74		17			4 9 11	CL	Lean CLAY with Sand	1	26	73		-/ 0.0	17	Dark gray, moist, fine sand, plastic fines, very stiff
76														
78														
80		18			5 9 12	CL	Lean CLAY with Sand					-/ 0.0		Dark gray, fine sand, plastic fines, 1.25-inch thick seam of fine gray sand in sample
82														
84		19			5 13 21	SP-SM	Poorly graded SAND with Silt					-/ 0.0		Dark gray, moist, fine to medium sand, NP fines
86														
88														
90		20			3 7 17	SP-SM	Poorly graded SAND with Silt	0	89	11		-/ 0.0	20	Dark gray, moist, fine to medium sand, NP fines
92														
94		21			7 12 12	SP-SM	Poorly graded SAND with Silt					-/ 1.0		Dark gray, moist, medium sand, NP fines
96														
98														
100		22			6 17	SP-SM	Poorly graded SAND with Silt					-/ 0.0		Dark gray, moist, fine to medium sand, NP fines
102														Bottom of Hole 101.0 ft. Groundwater Encountered While Drilling: at an elevation of 60.8 ft. PID = (Cold/Hot) Photo Ionization Detector
104														
106														Survey datum is Alaska State Plane, Zone 4, NAD83. Elevation datum MLLW.
108														

EXPLORATION LOG KENAI BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 18 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,206 ft. Easting: 1,414,825 ft.

Top of Hole Elevation: 89.6 ft.

Hole Number, Field: TB-4

Permanent: AP-607-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 100.0 ft.

Total Depth: 101.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Second growth willows and spruce
0–2		1		F2	Grab	SM	Silty SAND with Gravel				2	-/ 0.0		Brown, moist, rounded gravel, fine to medium sand, nonplastic (NP) fines
4–6		2		NFS	4 3 3 5	SP	Poorly graded SAND				0.25	-/ 1.0		Brown, moist, fine sand
14–16		3		NFS	3 3 4 5	SP	Poorly graded SAND				1.25	-/ 0.0		Brown, moist, rounded gravel, fine sand
24–26		4a			5	SP	Poorly graded SAND					-/		Brown, moist, fine sand
		4b			4	SM	Silty SAND	0	65	35		0.0	23	Brown, moist, fine sand, NP fines
		4c			4	SP	Poorly graded SAND							Brown, moist, fine sand
28–30		5			4 7 6	SP	Poorly graded SAND	7	92	1				Brown, wet, medium to coarse sand
34–36		6			2 9	GP	Poorly graded GRAVEL with Sand	50	48	2				Twelve inches of heaving sand Dark gray, wet, rounded gravel, fine to coarse sand

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 18 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,206 ft. Easting: 1,414,825 ft.

Top of Hole Elevation: 89.6 ft.

Hole Number, Field: TB-4

Permanent: AP-607-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 100.0 ft.

Total Depth: 101.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
					13									Surface: Second growth willows and spruce
38														
40														
42														
44														
46		7			5 15 18	CL	Lean CLAY with Sand					-/ 0.0		Dark gray, moist, find sand, plastic fines, very stiff
48														
50														
52														
54														
56		8			3 6 10	CL	Lean CLAY with Sand					-/ 1.0		Dark gray, moist, rounded gravel, fine sand, plastic fines, very stiff
58														
60														
62														
64														
66		9a 9b			2 6 8	CL SP	Lean CLAY with Sand Poorly graded SAND					-/ 1.0		Dark gray, moist, fine sand, plastic fines, very stiff Dark gray, moist, fine to medium sand
68														
70		10			6 11 14	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines, very stiff, 1.25-inch layer of gray fine sand
72														

EXPLORATION LOG KENAI_BLUFFS.GPJ ACE_ANC.GDT 9/3/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Kenai River Bluff Erosion Study
Kenai, Alaska

Date: 18 Sep 2003

Drilling Agency: ☐ Alaska District ☒ Other Hughes Drilling

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 2,396,206 ft. Easting: 1,414,825 ft.

Top of Hole Elevation: 89.6 ft.

Hole Number, Field: TB-4

Permanent: AP-607-P

Operator: Pat Kelley

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 27.9 ft. WD

Depth Drilled: 100.0 ft.

Total Depth: 101.5 ft.

Hammer Weight: 340 lbs

Split Spoon I.D.: 2.5 in.

Size and Type of Bit: 8 in. HSA

Type of Equipment: CME-75 with Autohammer

Type of Samples: Grab and Drive

Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (in.)	PID (ppm)	% Water	Description and Remarks
														Surface: Second growth willows and spruce
74														
76														
78														
80		11			5 6 9	CL	Lean CLAY with Sand					-/ 1.0		Dark gray, moist, fine sand, plastic fines
82														
84														
86		12a			5 12	CL	Lean CLAY with Sand							Dark gray, moist, fine sand, plastic fines
		12b			25	SP	Poorly graded SAND							Dark gray, moist, fine to medium sand
88														
						CL	Lean CLAY with Sand							
90		13			3 9 12	SP	Poorly graded SAND					-/ 1.0		Dark gray, moist, fine to medium sand
92														
94														
96		14			3 4 16	SP	Poorly graded SAND	0	98	2		-/ 1.0	20	Dark gray, moist, fine to medium sand
98														
100		15			.33	CL	Lean CLAY	0	8	92		-/ 0.0	27	Dark gray, moist, fine sand, plastic fines, very soft
102														Bottom of Hole 101.5 ft. Groundwater Encountered While Drilling: at an elevation of 61.6 ft. PID = (Cold/Hot) Photo Ionization Detector Survey datum is Alaska State Plane, Zone 4, NAD83. Elevation datum MLLW.
104														
106														
108														

APPENDIX B

LABATORY ANALYSIS DATA SHEETS

ALASKA
TESTLAB
A Division of DOWL LLC

October 24, 2003
W.O. A30510

Mr. Steve Henslee, P.E. and Mr. Greg Carpenter, Ph.D, P.E.
U.S. Army Corps of Engineers
Alaska Distirct
Soils and Geology Branch
P.O. Box 6898
Elmendorf AFB, Alaska 99506-6898

Project: Kenai River Bluff Erosion Study

Dear Mr. Henslee and Mr. Carpenter:

Alaska Testlab (ATL) has completed the testing you requested for the three "undisturbed" brass liner soil samples, the "undisturbed" plastic liner sand sample, and the sixteen "bag" soil samples that were delivered to us on September 30, 2003. We performed two Multi-Stage Consolidated-Drained Triaxial Compression tests (Multi-Stage CD) in accordance with a modified test method as described in your instructions and three Consolidated-Undrained Triaxial Compression tests (CU) in accordance with ASTM D4767 "Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils." We also performed twenty Particle Size Analysis of Soil according to ASTM D422 "Particle Size Analysis of Soils," sixteen moisture contents according to ASTM D2216 "Standard Test Method of Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," and three Plasticity Index of Soil in accordance with ASTM D4318 "Determining the Plastic Limit and Plasticity Index of Soils." The three samples tested using ASTM D4318 were classified according to ASTM D2487 "Standard Practice for Classification of Soils for Engineering Purposes (Uniform Soil Classification System)." The remaining samples were classified according to ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)."

The two Multi-Stage CD triaxial compression test specimens were approximately 4.3 inches in length and 2.4 inches in diameter. Both samples were taken from TB-3 sample No. 14 at 59.5 feet to 61 feet. The sample was sliced in half and the two halves were tested. We attempted to use the material from TB-1 sample No. 10 at 40 feet to 41.5 feet, but the sample contained a column of sand in the center of the sample. There was only about three inches of the sample that could be used. The test specimens used were saturated by starting with an initially saturated drainage system and a 5-psi confining pressure. The "B" value was calculated for each test specimen to verify a minimum of 95 percent saturation had occurred. The "B" values of 0.99 and 1.00 were achieved for the two samples. The samples were consolidated to the prescribed confining pressures and the pour water was allowed to drain. Upon completion of consolidation the test specimens were compressed at a rate of 0.1 percent strain or 0.0048 inches per minute. Load and deformation readings were taken every 0.25 percent strain. The loading continued until the stress-strain curve started to break-over. The test was then stopped and the next prescribed confining pressure was applied. The sample was then consolidated and the procedure was repeated. During the third stage, the axial load was applied until shear failure occurred. The confining pressures used were 10, 20, and 30 psi for the first sample and 5, 15, and 25 psi for the second sample. The graphs for the deviator stress vs. strain and the mohr circles are attached.

Three CU triaxial compression tests were performed on the sand sample from the plastic liner. The density of the sand was measured prior to removing the sand from its liner. The initial dry density of the sand was 97.7 pcf. Three test specimens were constructed within two pounds of that dry density. The test specimens were approximately 5.0 inches in length and 2.5 inches in diameter. The test specimens were saturated by starting with an initially saturated drainage system and a 5-psi confining pressure. The "B" value was calculated for each test specimen to verify a minimum of 95 percent saturation had occurred. The samples were consolidated to the prescribed confining pressures and the pour water was allowed to drain. Upon completion of consolidation the test specimens were then isolated to prevent the pore water from draining during compression. The specimens were compressed at a rate of 0.1 percent strain or 0.0053 inches per minute. Load, deformation, and pour water pressure readings were taken every 0.25 percent strain. The confining pressures used were 10, 20, and 30 psi. The graphs for the deviator stress vs. strain and the mohr circles are attached.

A summary of the test specimen's densities and moisture contents is provided below:

Confining Pressure (psi)	Type of Test	Test Specimen Location	Dry Density (pcf)	Initial Moisture percent	Final Moisture percent
10, 20, 30	CD	TB-3 No. 14 @59.5'	114.8	16.6	17.2
5, 15, 25	CD	TB-3 No. 14 @59.5'	117.5	16.9	17.5
10	CU	TB-3 No. 7	98.8	14.9	16.5
20	CU	TB-3 No. 7	98.7	14.9	16.4
30	CU	TB-3 No. 7	99.6	14.9	16.5

In addition to the triaxial test results the sieve analysis results are also attached.

If you have any questions regarding the test procedures or results please call me.

Sincerely,
Alaska Testlab

Chris Christensen, EIT
Engineer

Reviewed by,
Alaska Testlab

David L. Andersen, P.E.
General Manager

Attachments: As stated

A30510.Corps.CC.DLA.102403.mas

ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-1, Sample #2, 2.5'-3'

Moisture = 3.0%

Engineering Classification: Poorly Graded SAND , SP

Frost Classification: Not Measured

PARTICLE-SIZE

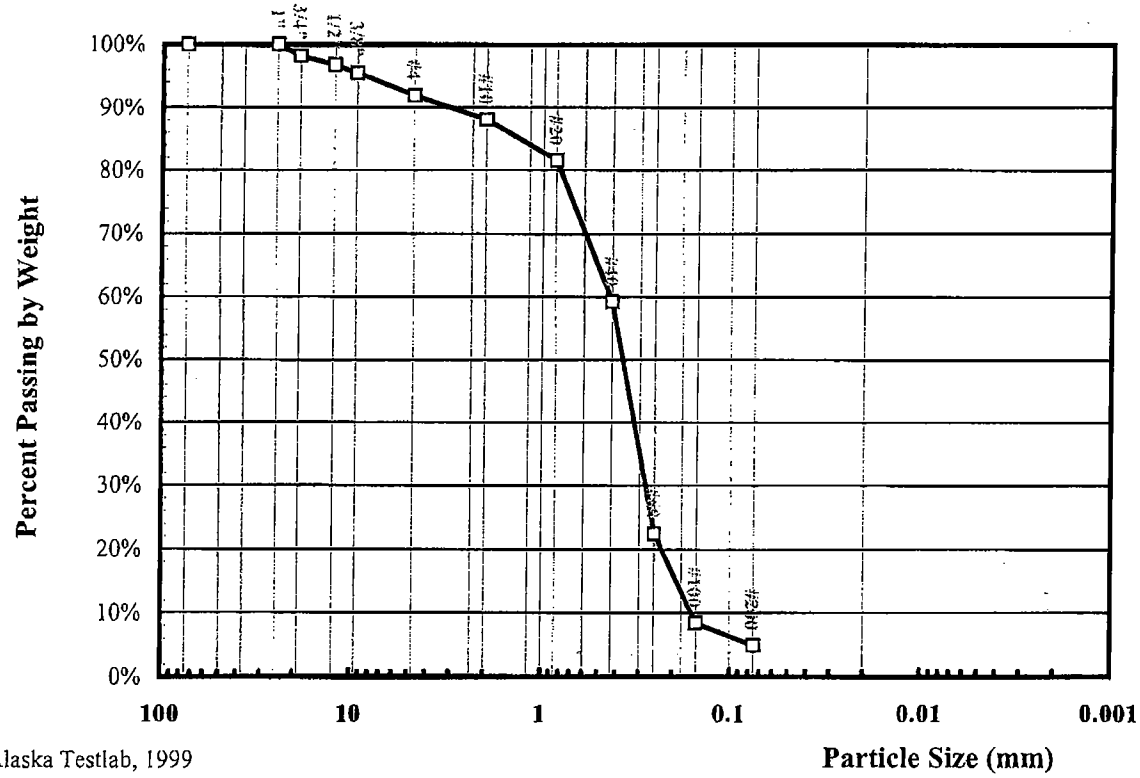
DIST. ASTM D422

W.O. A30510

Lab No. 2421

Received: 10/1/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"	100%	
3/4"	98%	
1/2"	97%	
3/8"	95%	
No. 4	92%	
Total Wt. = 1144g		
No. 8		
No. 10	88%	
No. 16		
No. 20	82%	
No. 30		
No. 40	59%	
No. 50		
No. 60	22%	
No. 80		
No. 100	8%	
No. 200	4.9%	
Total Wt. of Fine Fraction = 363.6g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

4040 B Street Anchorage Alaska 99503 • 907/562-2000 • 907/563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client

TB-1, Sample #4, 10'-12'

Moisture = 4.7%

Engineering Classification: Poorly Graded SAND , SP

Frost Classification: NFS MOA

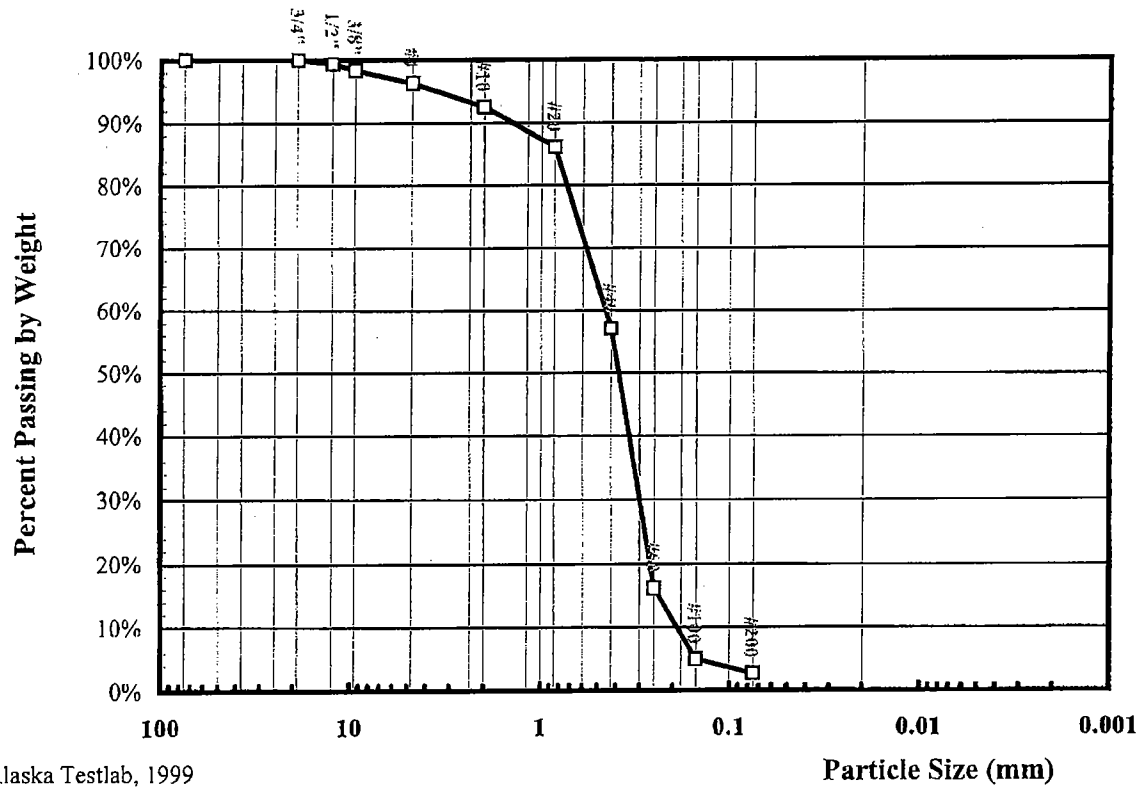
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2422

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"	100%	
1/2"	99%	
3/8"	98%	
No. 4	96%	
Total Wt. = 1269g		
No. 8		
No. 10	93%	
No. 16		
No. 20	86%	
No. 30		
No. 40	57%	
No. 50		
No. 60	16%	
No. 80		
No. 100	5%	
No. 200	2.7%	
Total Wt. of Fine Fraction = 362.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-1, Sample #7, 25'-27'

Moisture = 21.6%

Engineering Classification: Silty SAND , SM

Frost Classification: Not Measured

PARTICLE-SIZE

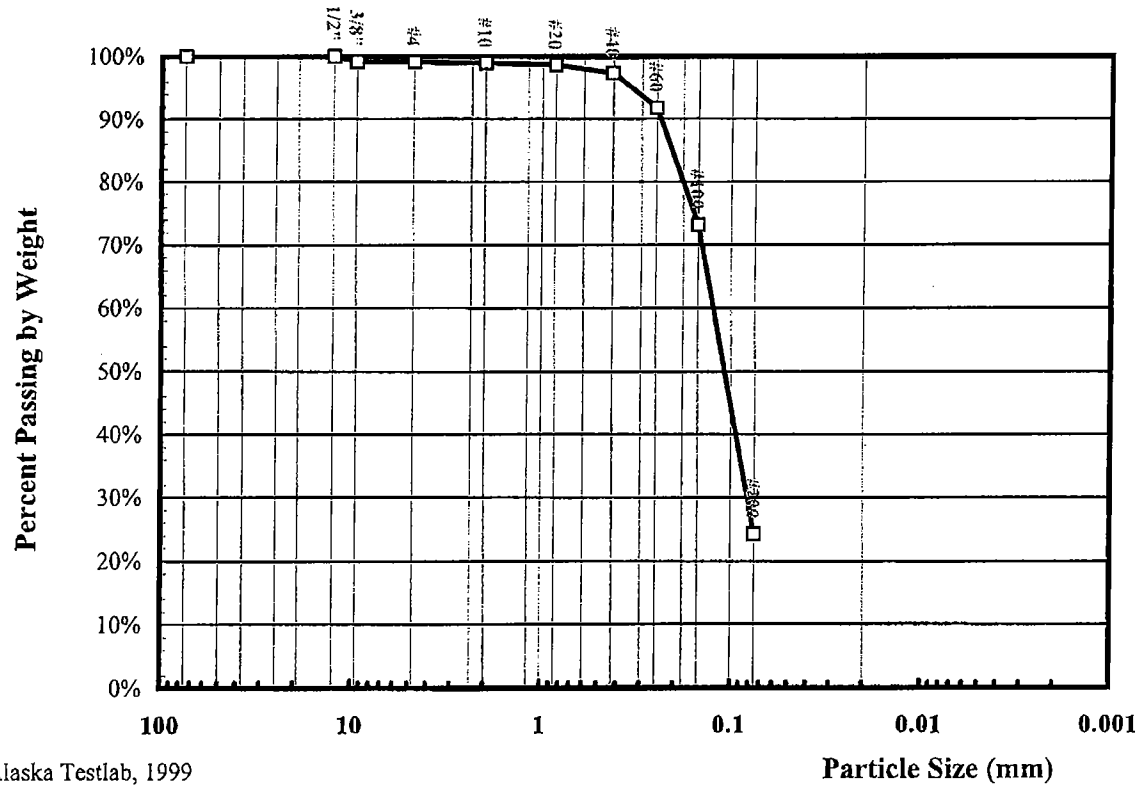
DIST. ASTM D422

W.O. A30510

Lab No. 2423

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"	100%	
3/8"	99%	
No. 4	99%	
Total Wt. = 317.1g		
No. 8		
No. 10	99%	
No. 16		
No. 20	99%	
No. 30		
No. 40	97%	
No. 50		
No. 60	92%	
No. 80		
No. 100	73%	
No. 200	24%	
Total Wt. of Fine Fraction = 314.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-1 Sample #10, 40'-41.5'

Liquid Limit = 30.8, Plasticity Index = 15.5

Engineering Classification: CLAY with Sand, CL

Frost Classification: F4

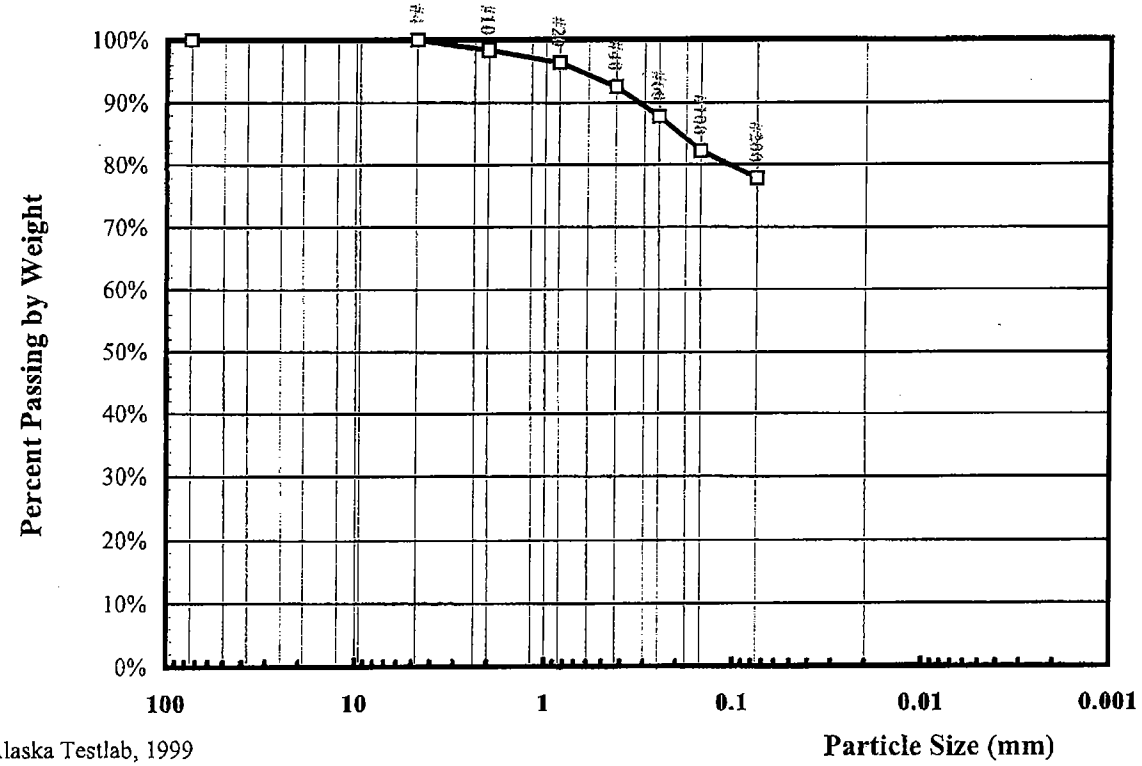
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2424

Received: 9/30/03

Reported: 11/26/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	98%	
No. 16		
No. 20	96%	
No. 30		
No. 40	92%	
No. 50		
No. 60	88%	
No. 80		
No. 100	82%	
No. 200	78%	
Total Wt. of Fine Fraction = 86.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

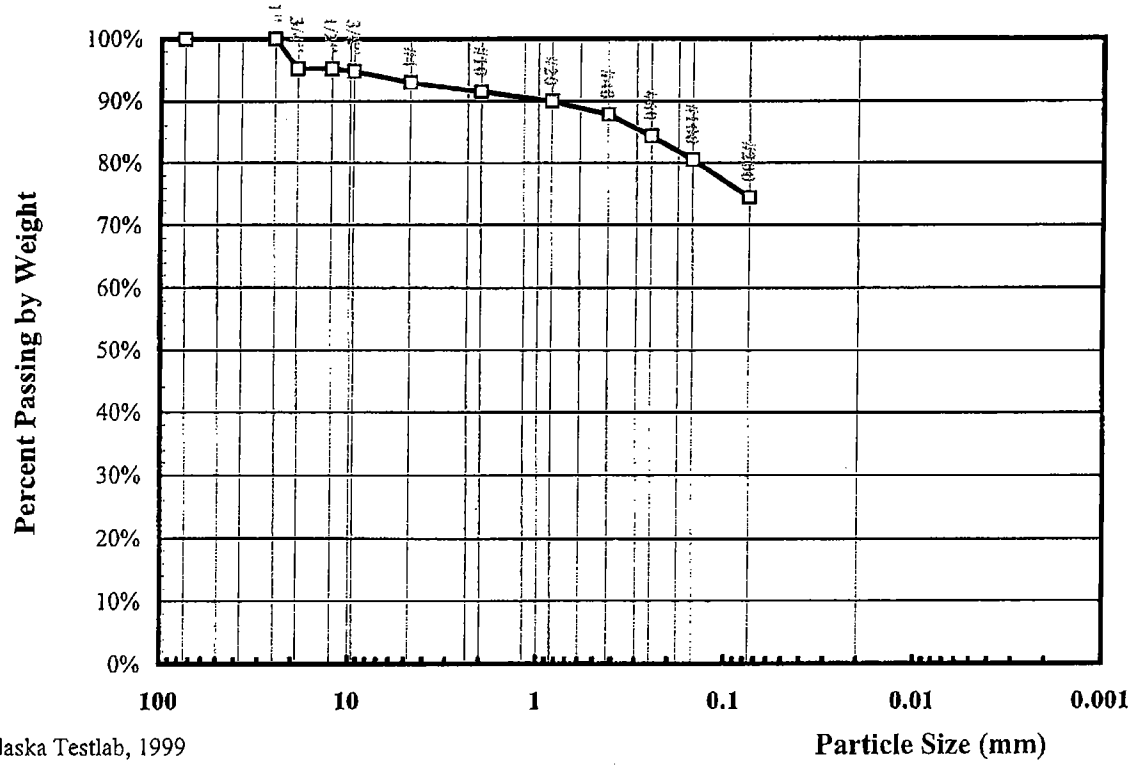
Location: By Client,

TB-1, Sample #15, 65'-66.5'

Moisture = 15.2%

Engineering Classification: CLAY with Sand, CL

Frost Classification: F4



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2425

Received: 9/30/03

Reported: 11/26/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"	100%	
3/4"	95%	
1/2"	95%	
3/8"	95%	
No. 4	93%	
Total Wt. = 482g		
No. 8		
No. 10	91%	
No. 16		
No. 20	90%	
No. 30		
No. 40	88%	
No. 50		
No. 60	84%	
No. 80		
No. 100	80%	
No. 200	75%	
Total Wt. of Fine Fraction = 448.2g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

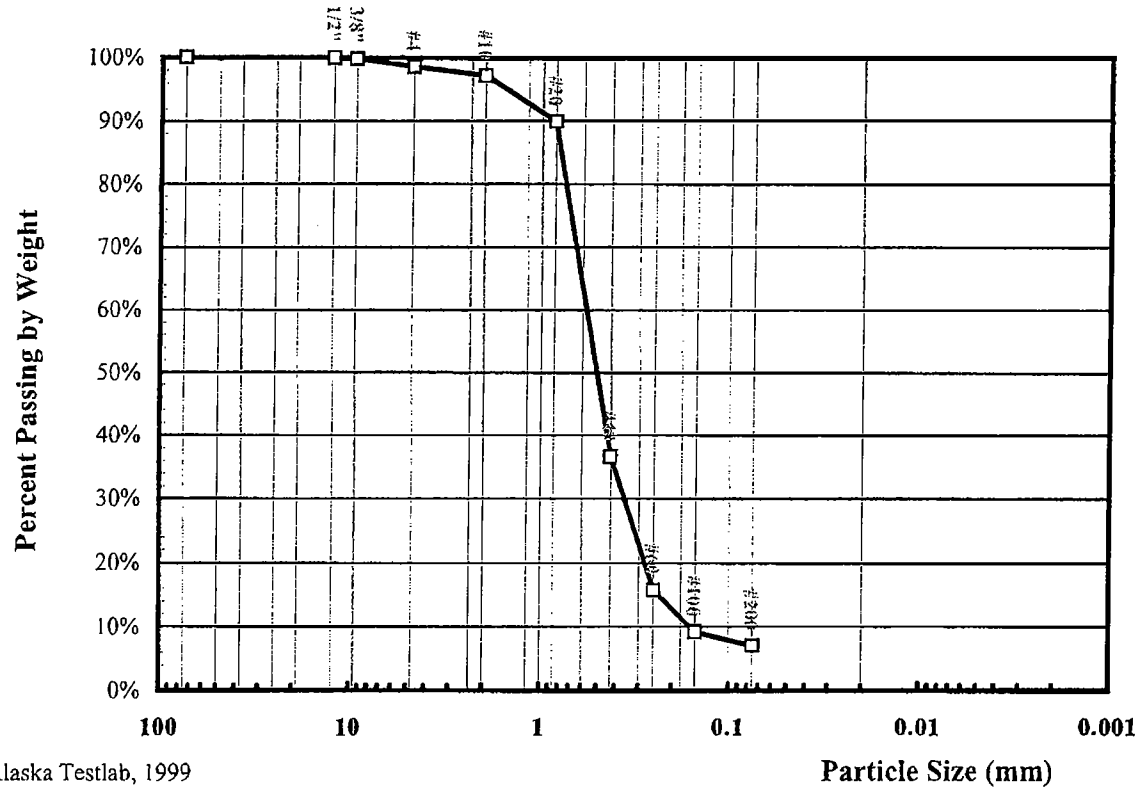
Location: By Client,

TB-1, Sample #18, 80'-81.5'

Moisture = 14.5%

Engineering Classification: Poorly Graded SAND with Silt , SP-SM

Frost Classification: Not Measured



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2426

Received: 9/30/03

Reported: 10/23/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"	100%	
3/8"	100%	
No. 4	99%	
Total Wt. = 990g		
No. 8		
No. 10	97%	
No. 16		
No. 20	90%	
No. 30		
No. 40	37%	
No. 50		
No. 60	16%	
No. 80		
No. 100	9%	
No. 200	7.1%	
Total Wt. of Fine Fraction = 385.5g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

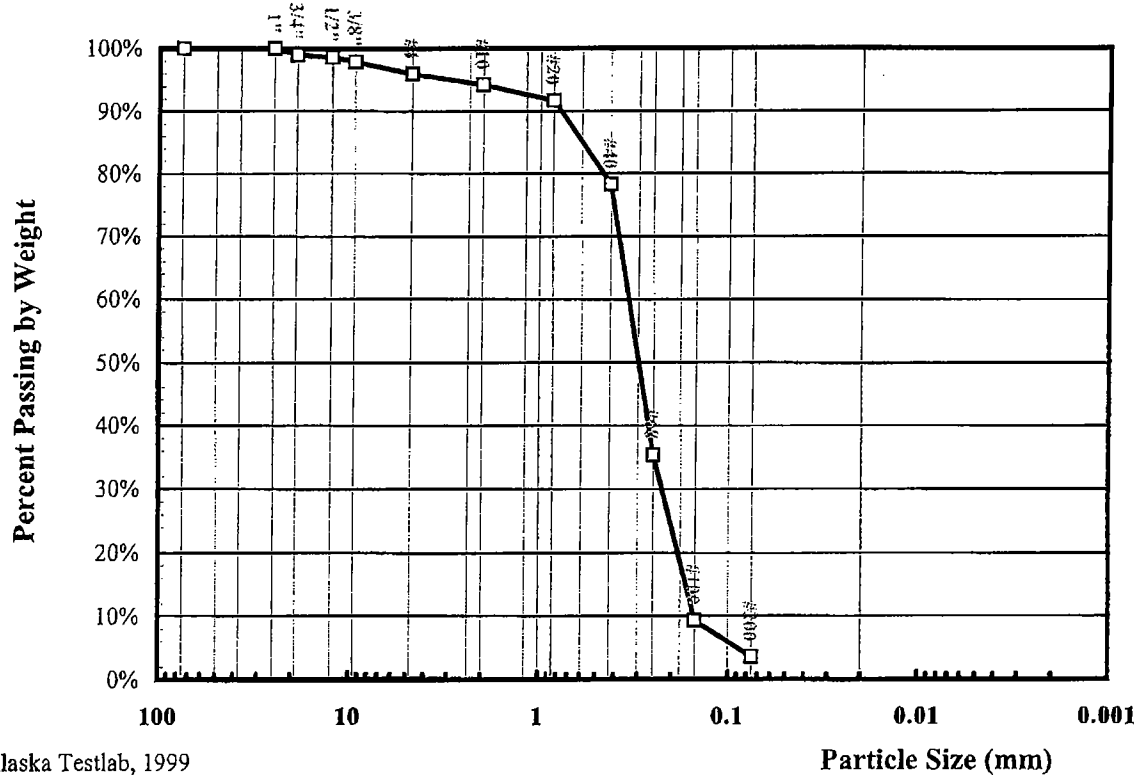
Location: By Client,

TB-2, Sample #5, 15'-16.5'

Moisture = 5.0%

Engineering Classification: Poorly Graded SAND , SP

Frost Classification: Not Measured



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2427

Received: 9/30/03

Reported: 10/23/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"	100%	
3/4"	99%	
1/2"	99%	
3/8"	98%	
No. 4	96%	
Total Wt. = 1485g		
No. 8		
No. 10	94%	
No. 16		
No. 20	92%	
No. 30		
No. 40	78%	
No. 50		
No. 60	35%	
No. 80		
No. 100	9%	
No. 200	3.6%	
Total Wt. of Fine Fraction = 312.5g		
0.02 mm		

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-2, Sample #8, 30'-31.5'

Moisture = 13.7%

Engineering Classification: Poorly Graded SAND with Gravel, SP

Frost Classification: NFS MOA

PARTICLE-SIZE

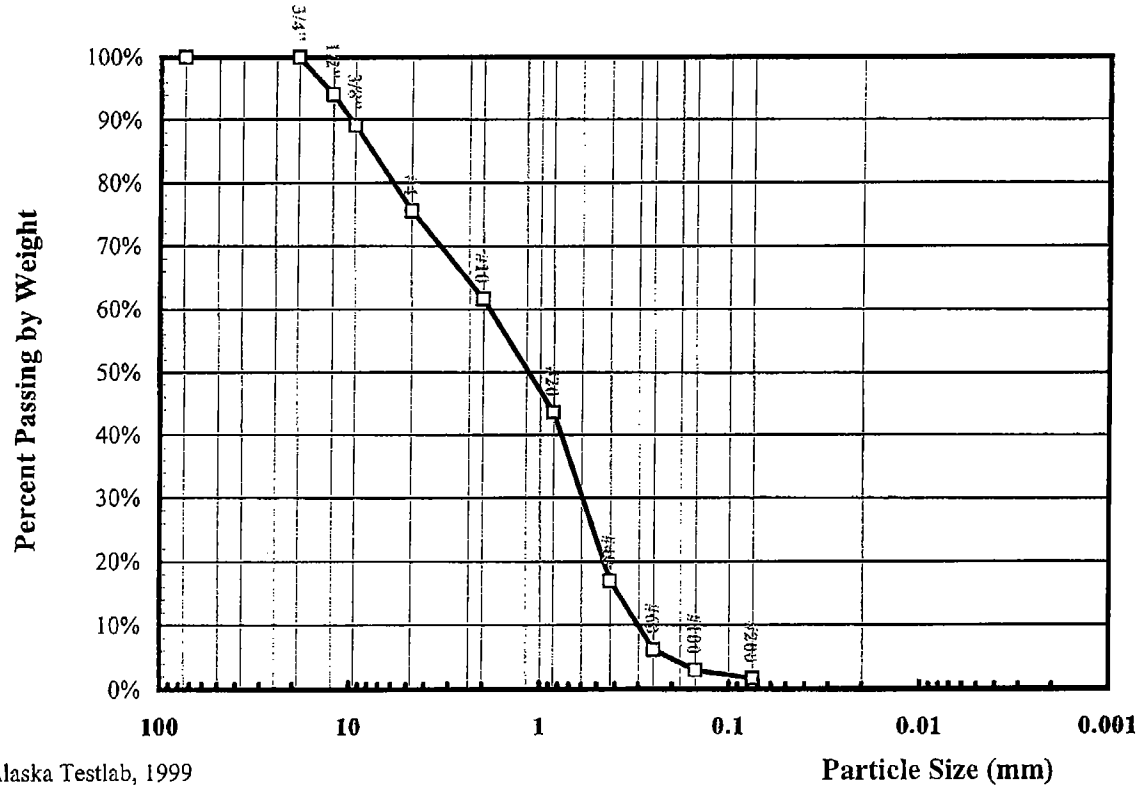
DIST. ASTM D422

W.O. A30510

Lab No. 2428

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"	100%	
1/2"	94%	
3/8"	89%	
No. 4	76%	
Total Wt. = 1094g		
No. 8		
No. 10	62%	
No. 16		
No. 20	44%	
No. 30		
No. 40	17%	
No. 50		
No. 60	6%	
No. 80		
No. 100	3%	
No. 200	1.7%	
Total Wt. of Fine Fraction = 308.4g		
0.02 mm		

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David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-2, Sample #10, 37.5'-38.5'

Moisture = 16.5

Engineering Classification: CLAY with Sand, CL

Frost Classification: F4

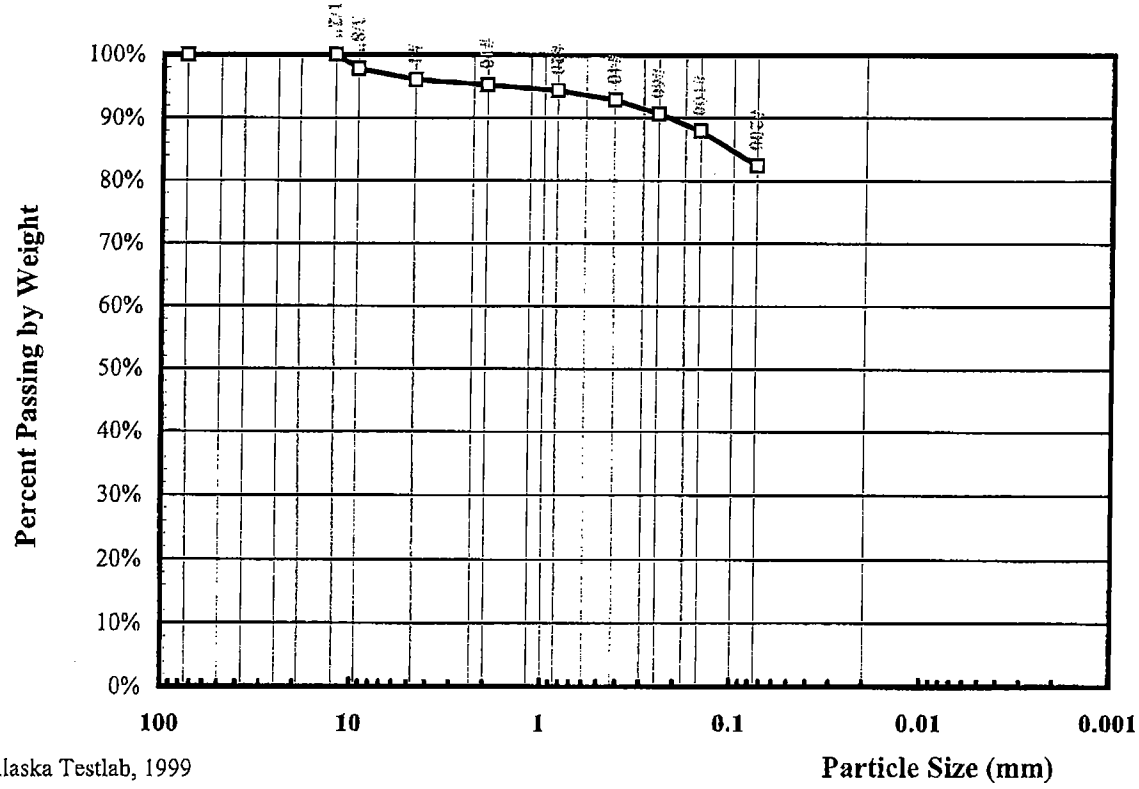
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2429

Received: 9/30/03

Reported: 11/26/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"	100%	
3/8"	98%	
No. 4	96%	
Total Wt. = 389.8g		
No. 8		
No. 10	95%	
No. 16		
No. 20	94%	
No. 30		
No. 40	93%	
No. 50		
No. 60	91%	
No. 80		
No. 100	88%	
No. 200	82%	
Total Wt. of Fine Fraction = 374.6g		
0.02 mm		

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David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

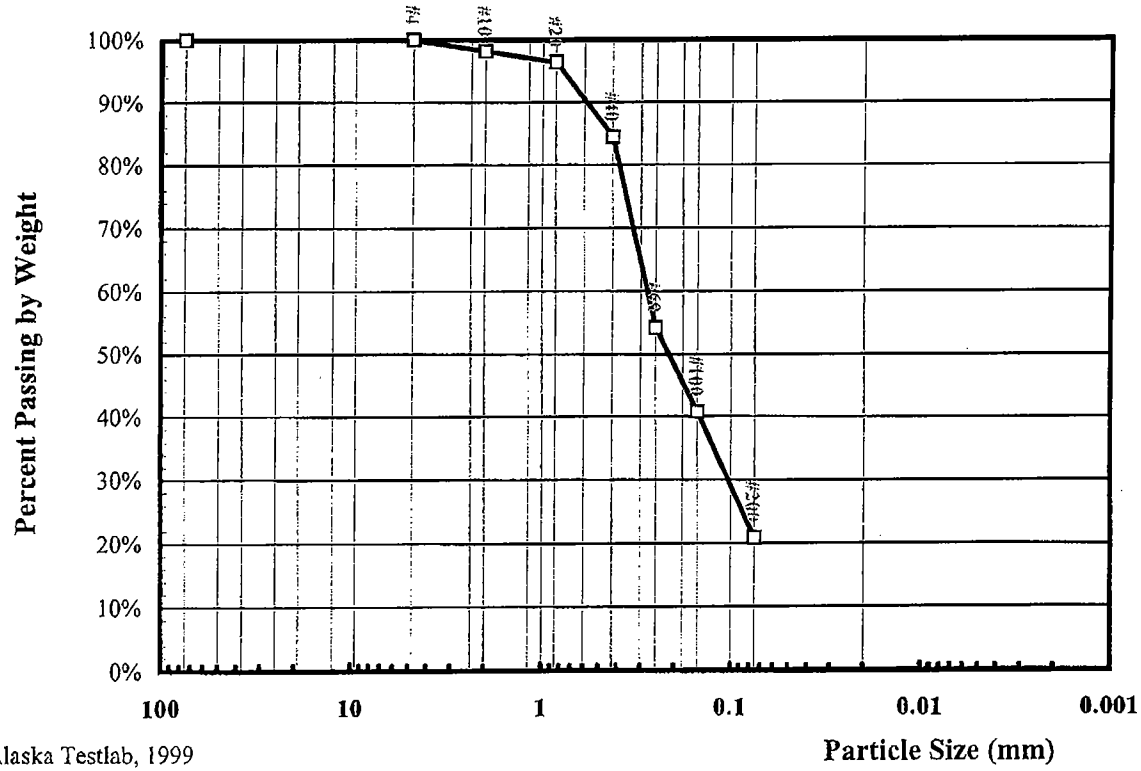
Location: By Client,

TB-3, Sample #7, 24.5'-26'

PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510
Lab No. 2430
Received: 9/30/03
Reported: 10/23/03

Engineering Classification: Silty SAND , SM
Frost Classification: Not Measured



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	98%	
No. 16		
No. 20	96%	
No. 30		
No. 40	84%	
No. 50		
No. 60	54%	
No. 80		
No. 100	41%	
No. 200	21%	
Total Wt. of Fine Fraction = 303.8g		
0.02 mm		

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David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
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Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

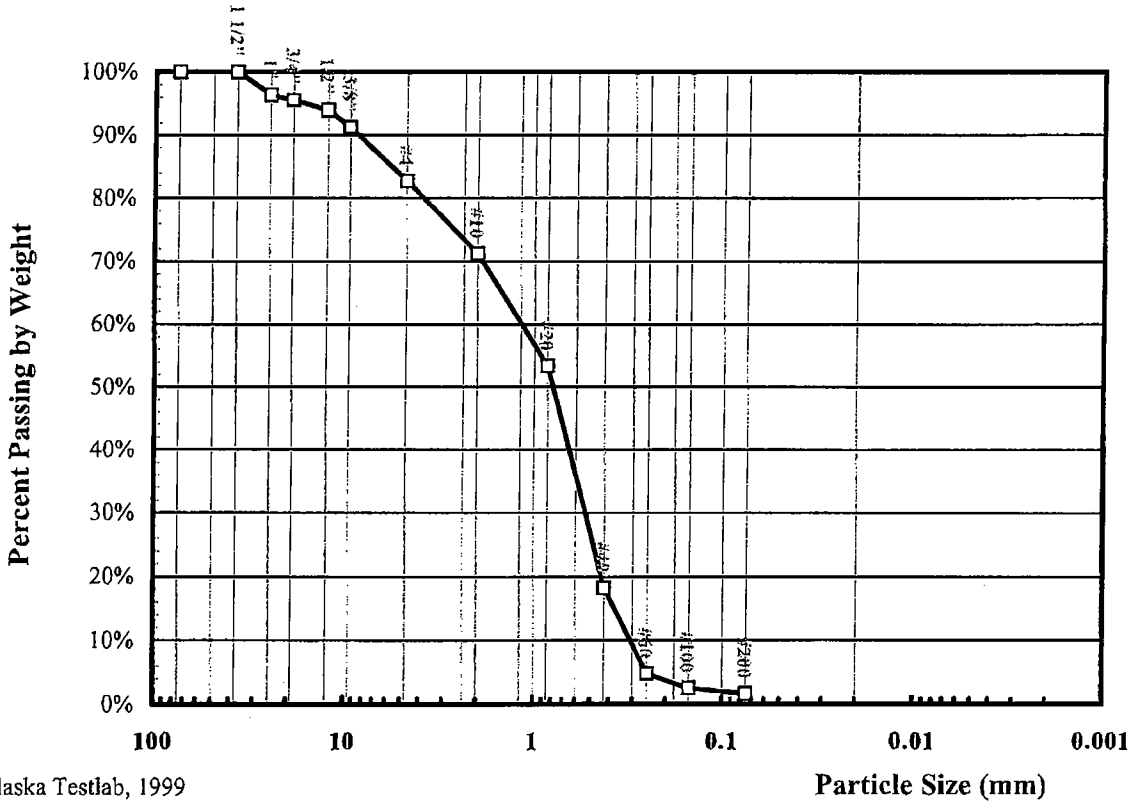
Location: By Client,

TB-3, Sample #8, 29.5'-31'

Moisture = 12.1%

Engineering Classification: Poorly Graded SAND with Gravel, SP

Frost Classification: NFS MOA



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2431

Received: 9/30/03

Reported: 10/23/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"	100%	
1"	96%	
3/4"	96%	
1/2"	94%	
3/8"	91%	
No. 4	83%	
Total Wt. = 1082g		
No. 8		
No. 10	71%	
No. 16		
No. 20	53%	
No. 30		
No. 40	18%	
No. 50		
No. 60	5%	
No. 80		
No. 100	3%	
No. 200	1.7%	
Total Wt. of Fine Fraction = 357.66g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

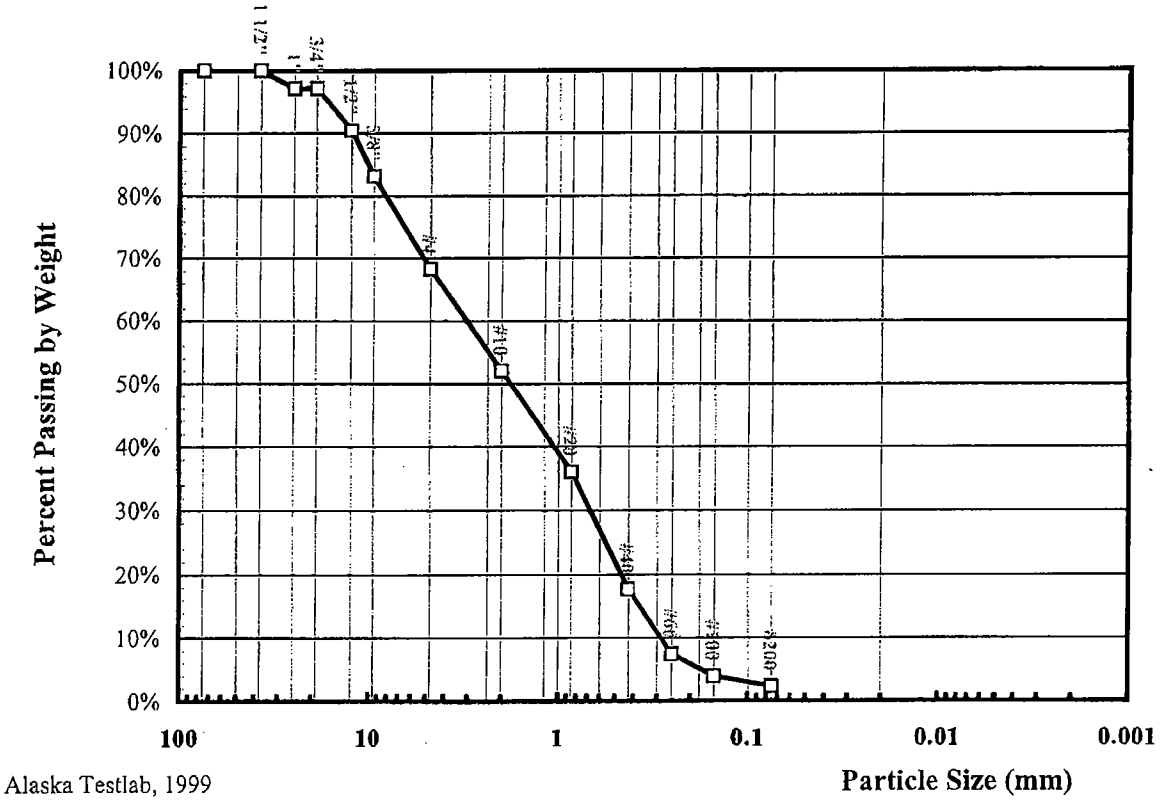
Location: By Client,

TB-3, Sample #9, 34.5'-36'

Moisture = 11.1%

Engineering Classification: Poorly Graded SAND with Gravel, SP

Frost Classification: NFS MOA



PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510
Lab No. 2432
Received: 9/30/03
Reported: 10/23/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"	100%	
1"	97%	
3/4"	97%	
1/2"	90%	
3/8"	83%	
No. 4	68%	
Total Wt. = 1251g		
No. 8		
No. 10	52%	
No. 16		
No. 20	36%	
No. 30		
No. 40	18%	
No. 50		
No. 60	7%	
No. 80		
No. 100	4%	
No. 200	2.3%	
Total Wt. of Fine Fraction = 315.6g		
0.02 mm		

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David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

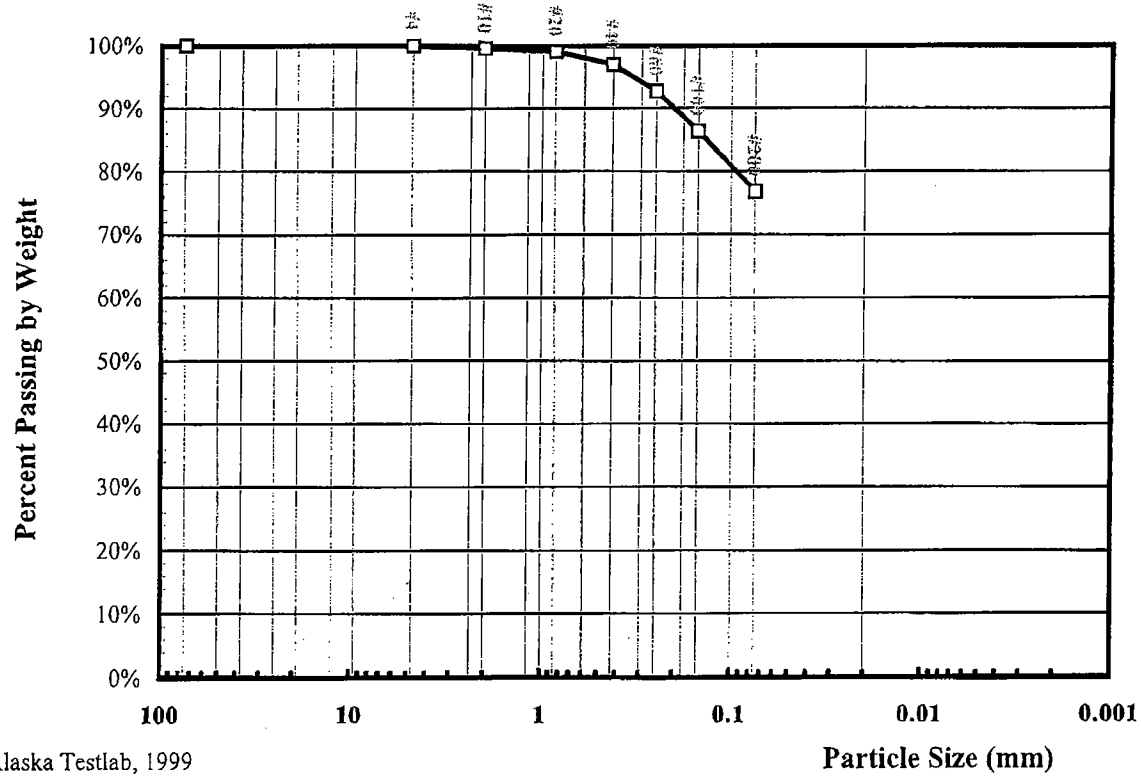
Location: By Client,

TB-3, Sample #14 59.5'-61'

Liquid Limit = 29, Plasticity Index = 15

Engineering Classification: CLAY with Sand, CL

Frost Classification: F4



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2433

Received: 9/30/03

Reported: 11/26/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	100%	
No. 16		
No. 20	99%	
No. 30		
No. 40	97%	
No. 50		
No. 60	93%	
No. 80		
No. 100	86%	
No. 200	77%	
Total Wt. of Fine Fraction = 335.9g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
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Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-3, Sample #17, 74.5'-76'

Moisture = 17.2%

Engineering Classification: CLAY with Sand, CL

Frost Classification: F4

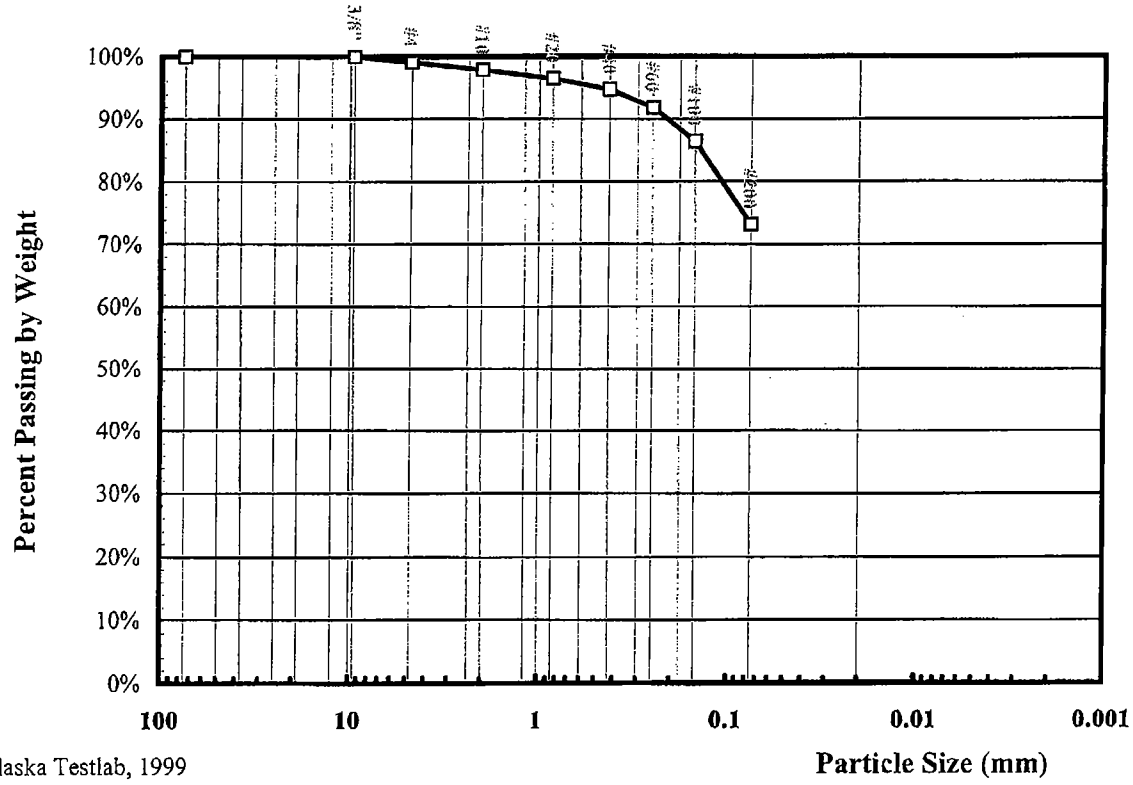
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2434

Received: 9/30/03

Reported: 11/26/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"	100%	
No. 4	99%	
Total Wt. = 397.8g		
No. 8		
No. 10	98%	
No. 16		
No. 20	97%	
No. 30		
No. 40	95%	
No. 50		
No. 60	92%	
No. 80		
No. 100	86%	
No. 200	73%	
Total Wt. of Fine Fraction = 394.1g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

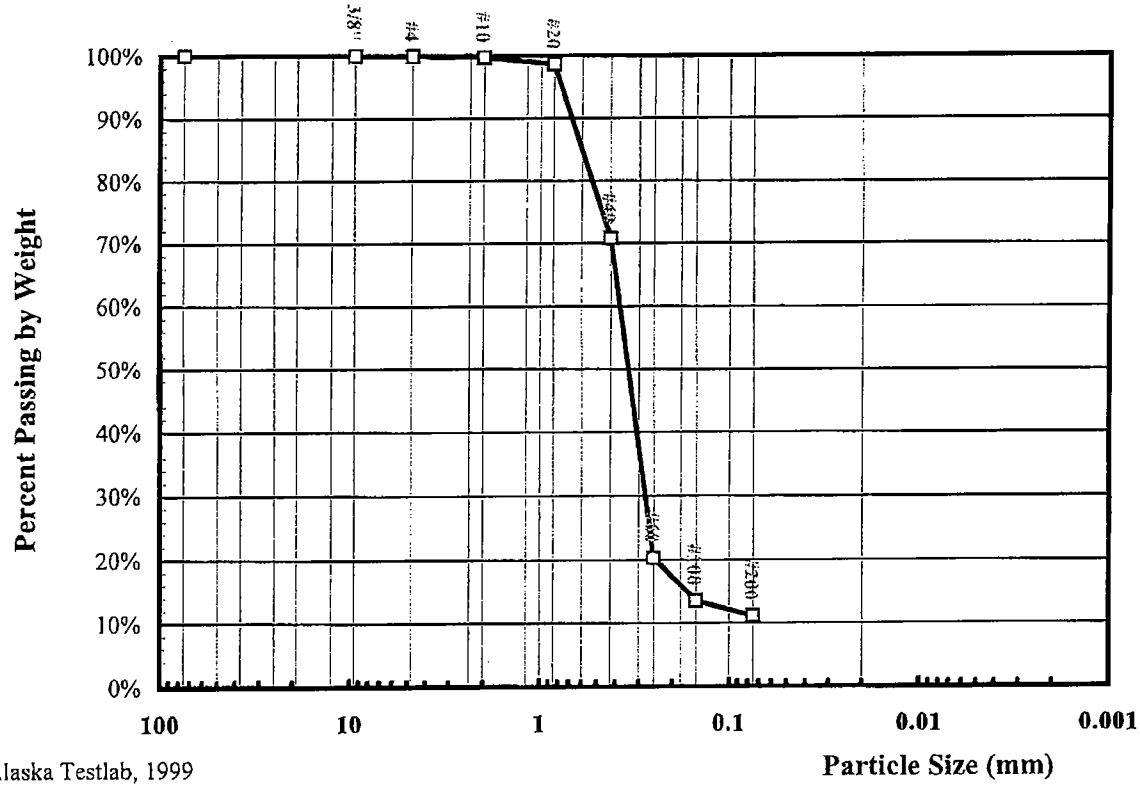
Location: By Client,

TB-3, Sample #20, 89.5'-91'

Moisture = 19.5%

Engineering Classification: Poorly Graded SAND with Silt , SP-SM

Frost Classification: Not Measured



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2435

Received: 9/30/03

Reported: 10/23/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"	100%	
No. 4	100%	
Total Wt. = 1271g		
No. 8		
No. 10	100%	
No. 16		
No. 20	99%	
No. 30		
No. 40	71%	
No. 50		
No. 60	20%	
No. 80		
No. 100	14%	
No. 200	11%	
Total Wt. of Fine Fraction = 335.1g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-4, Sample #4b, 25.5'-26.5'

Moisture = 23%

Engineering Classification: Silty SAND , SM

Frost Classification: Not Measured

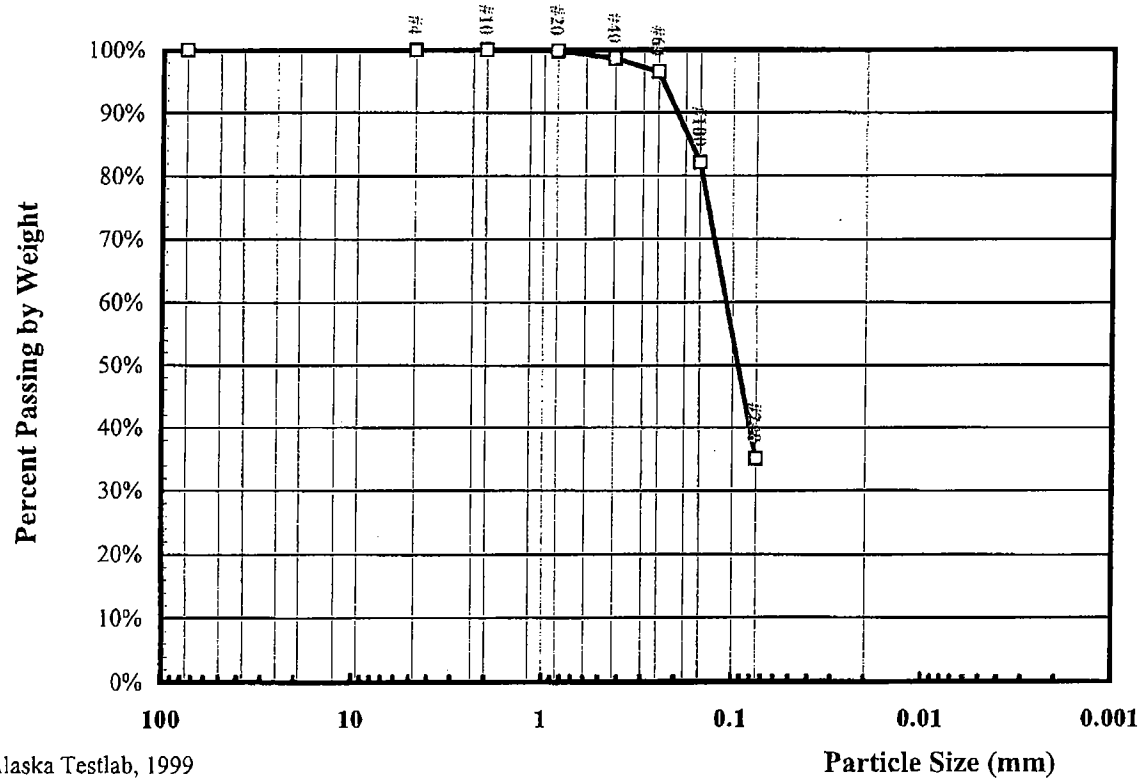
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2436

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	100%	
No. 16		
No. 20	100%	
No. 30		
No. 40	99%	
No. 50		
No. 60	97%	
No. 80		
No. 100	82%	
No. 200	35%	
Total Wt. of Fine Fraction = 665.9g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-4, Sample #5, 30'-31.5'

Moisture = 21.3%

Engineering Classification: Poorly Graded SAND , SP

Frost Classification: NFS MOA

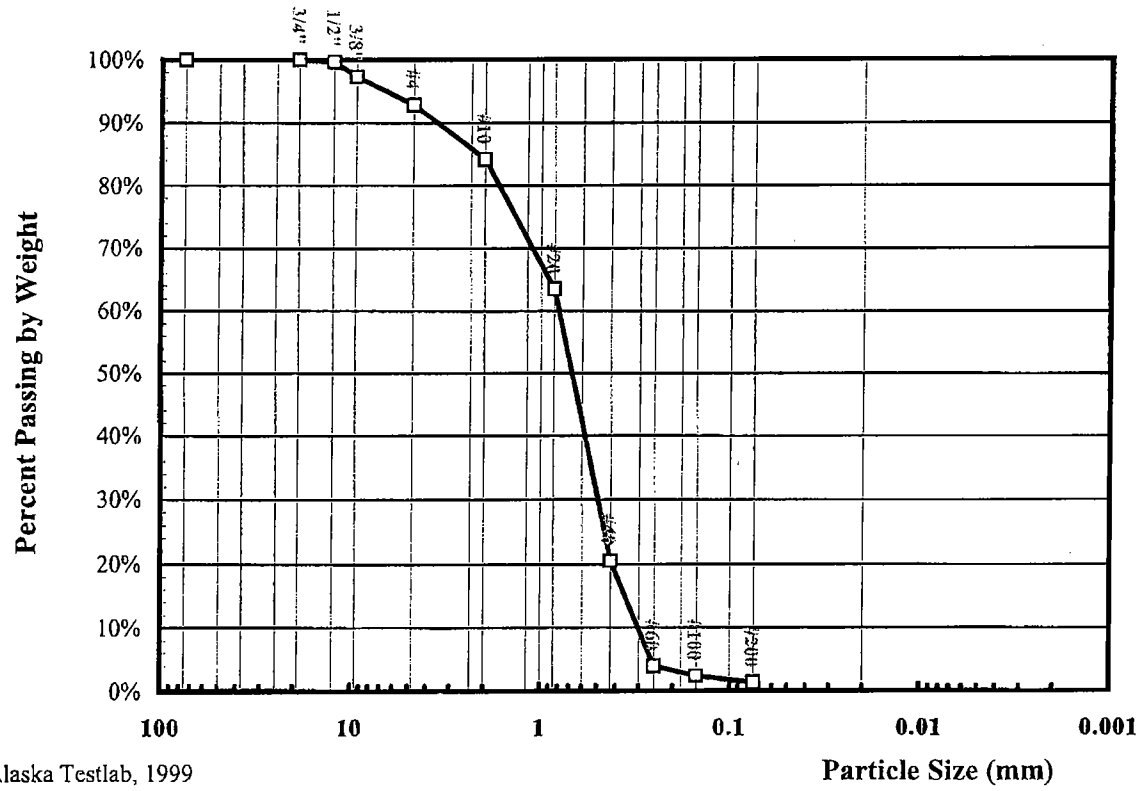
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2437

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"	100%	
1/2"	100%	
3/8"	97%	
No. 4	93%	
Total Wt. = 1034g		
No. 8		
No. 10	84%	
No. 16		
No. 20	63%	
No. 30		
No. 40	20%	
No. 50		
No. 60	4%	
No. 80		
No. 100	2%	
No. 200	1.3%	
Total Wt. of Fine Fraction = 352.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-4, Sample #6, 35'-

Moisture = 14.5%

Engineering Classification: Poorly Graded GRAVEL with Sand, GP

Frost Classification: NFS MOA

PARTICLE-SIZE

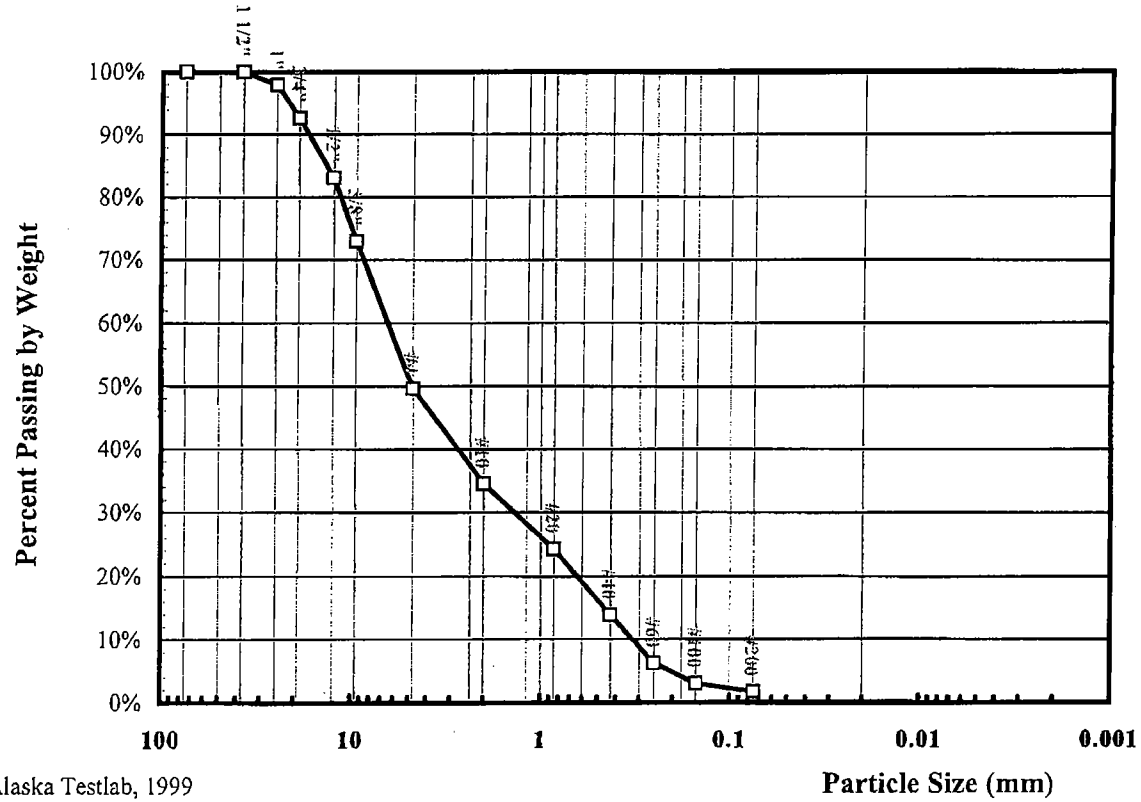
DIST. ASTM D422

W.O. A30510

Lab No. 2438

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"	100%	
1"	98%	
3/4"	93%	
1/2"	83%	
3/8"	73%	
No. 4	50%	
Total Wt. = 1374g		
No. 8		
No. 10	35%	
No. 16		
No. 20	24%	
No. 30		
No. 40	14%	
No. 50		
No. 60	6%	
No. 80		
No. 100	3%	
No. 200	1.8%	
Total Wt. of Fine Fraction = 338.7g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

Location: By Client,

TB-4, Sample #14, 95'-96.5'

Moisture = 19.9%, Non Plastic

Engineering Classification: Poorly Graded SAND , SP

Frost Classification: NFS MOA

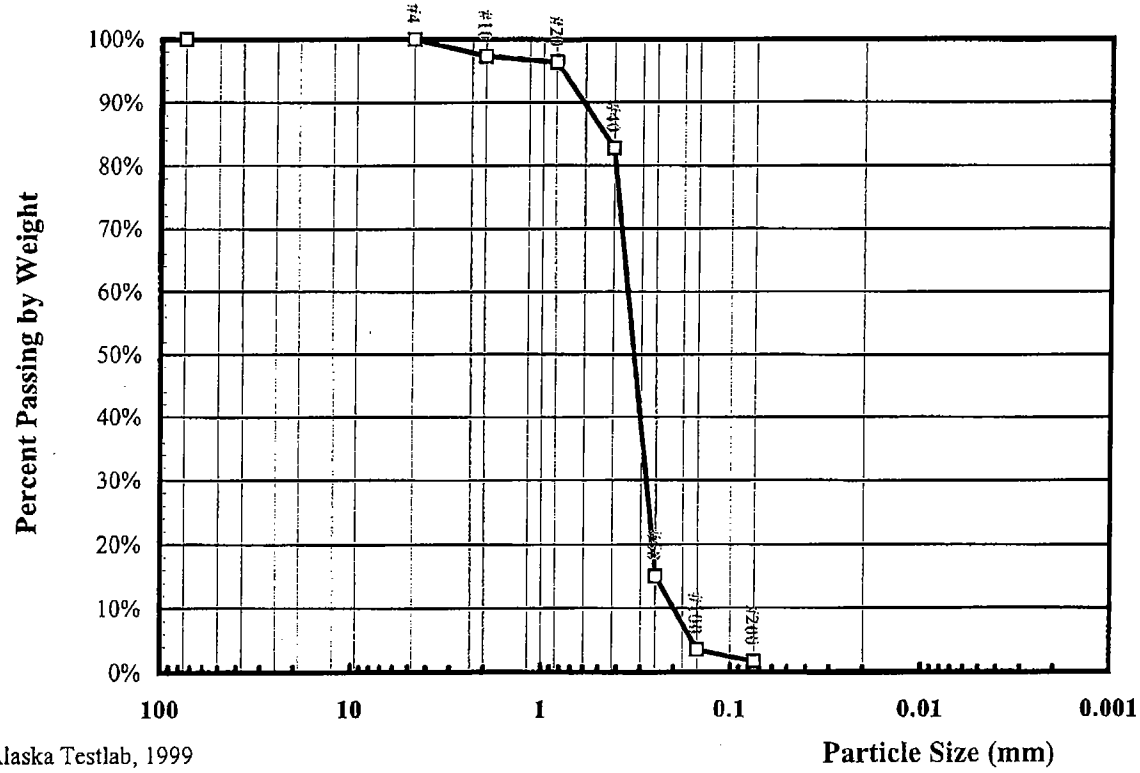
PARTICLE-SIZE
DIST. ASTM D422

W.O. A30510

Lab No. 2439

Received: 9/30/03

Reported: 10/23/03



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	97%	
No. 16		
No. 20	96%	
No. 30		
No. 40	83%	
No. 50		
No. 60	15%	
No. 80		
No. 100	4%	
No. 200	1.7%	
Total Wt. of Fine Fraction = 327.2g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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ALASKA TESTLAB
A Division of DOWL LLC

Client: U.S. Army Corp of Engineers

Project: Kenai River Bluff Erosion Study

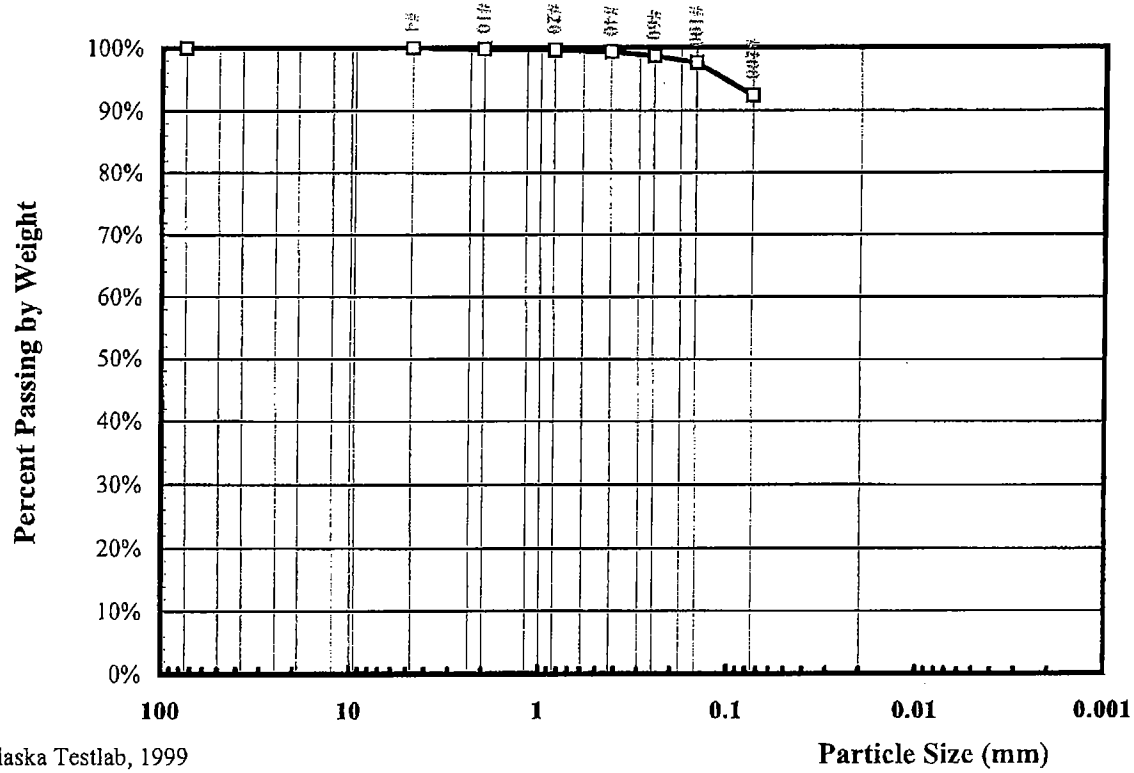
Location: By Client,

TB-4, Sample #15, 100'-101.5'

Moisture = 26.5%

Engineering Classification: CLAY, CL

Frost Classification: F4



PARTICLE-SIZE

DIST. ASTM D422

W.O. A30510

Lab No. 2440

Received: 9/30/03

Reported: 11/26/03

SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
No. 4	100%	
Total Wt. = 0g		
No. 8		
No. 10	100%	
No. 16		
No. 20	100%	
No. 30		
No. 40	99%	
No. 50		
No. 60	99%	
No. 80		
No. 100	98%	
No. 200	92%	
Total Wt. of Fine Fraction = 332.4g		
0.02 mm		

David L Andersen

David L. Andersen, P.E., General Manager

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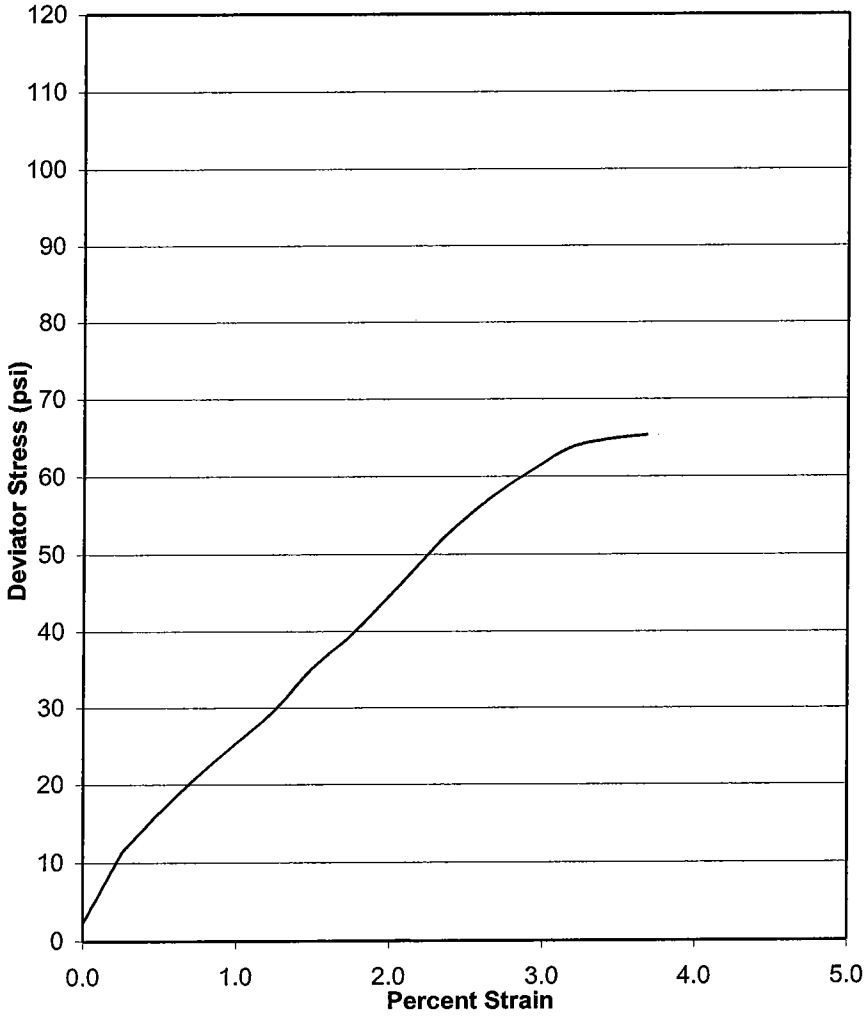
Project :	Kenai River Bluff Erosion Study
Client:	U.S. Army Corp of Engineers
WO #	A30510
Boring #	3 Depth : 59.5' to 61.0'
Sample #	14
Initial Dry Density:	114.8 pcf
Effective Confining Pressure :	10 psi
Initial Moisture Content	16.6 %
Laboratory #	T200318
Date:	10/18/2003

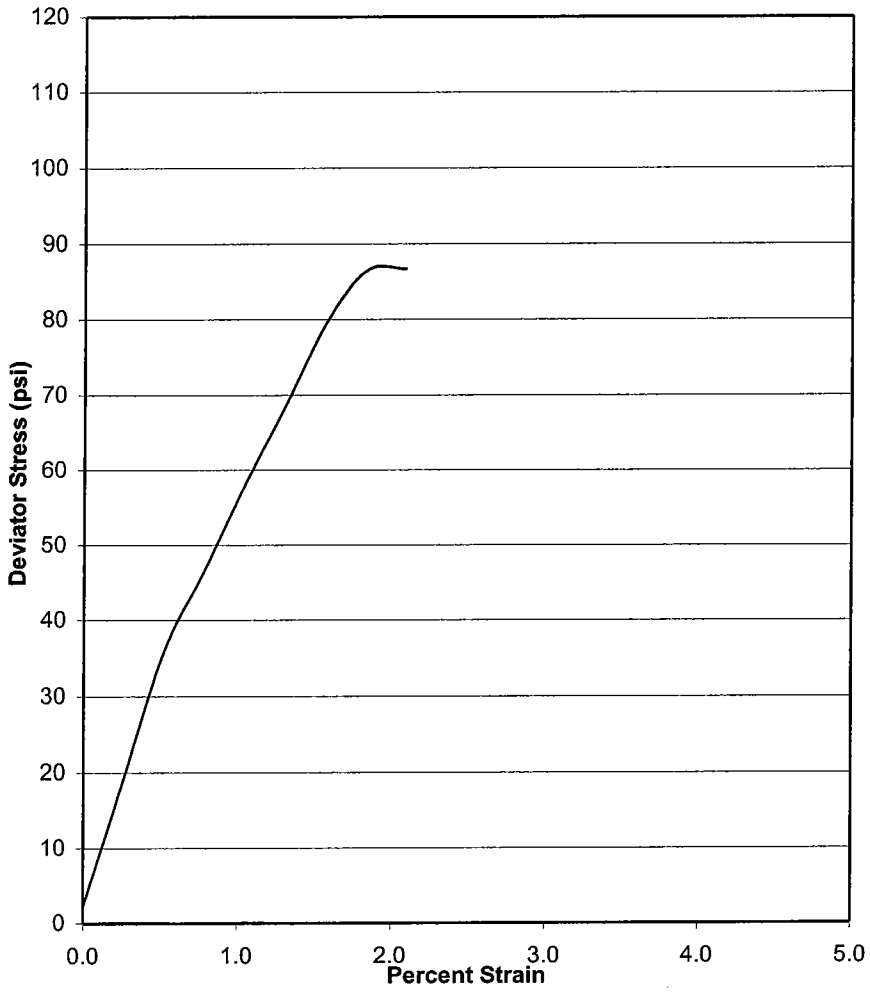


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study
Client:	U.S. Army Corp of Engineers
WO #	A30510
Boring #	3 Depth : 59.5' to 61.0'
Sample #	14
Initial Dry Density:	114.8 pcf
Effective Confining Pressure :	20 psi
Initial Moisture Content	16.6 %
Laboratory #	T200319
Date:	10/18/2003

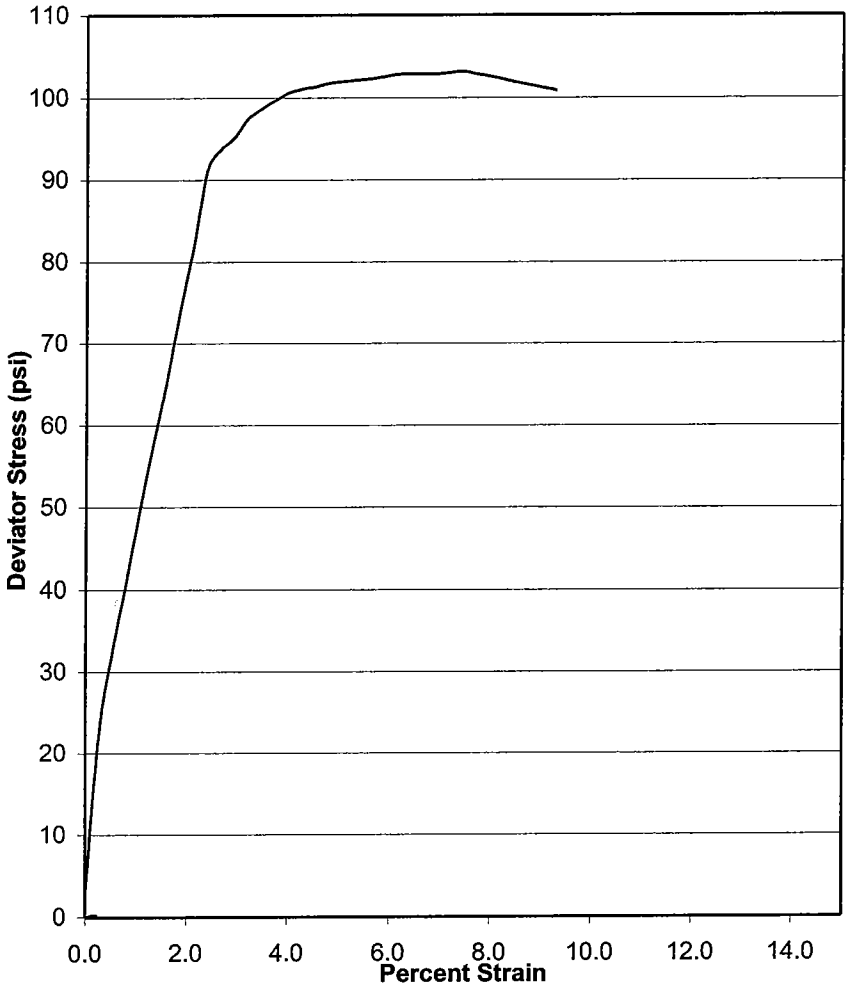


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study
Client:	U.S. Army Corp of Engineers
WO #	A30510
Boring #	3 Depth : 59.5' to 61.0'
Sample #	14
Initial Dry Density:	114.8 pcf
Effective Confining Pressure :	30 psi
Initial Moisture Content	16.6 %
Laboratory #	T200320
Date:	10/18/2003

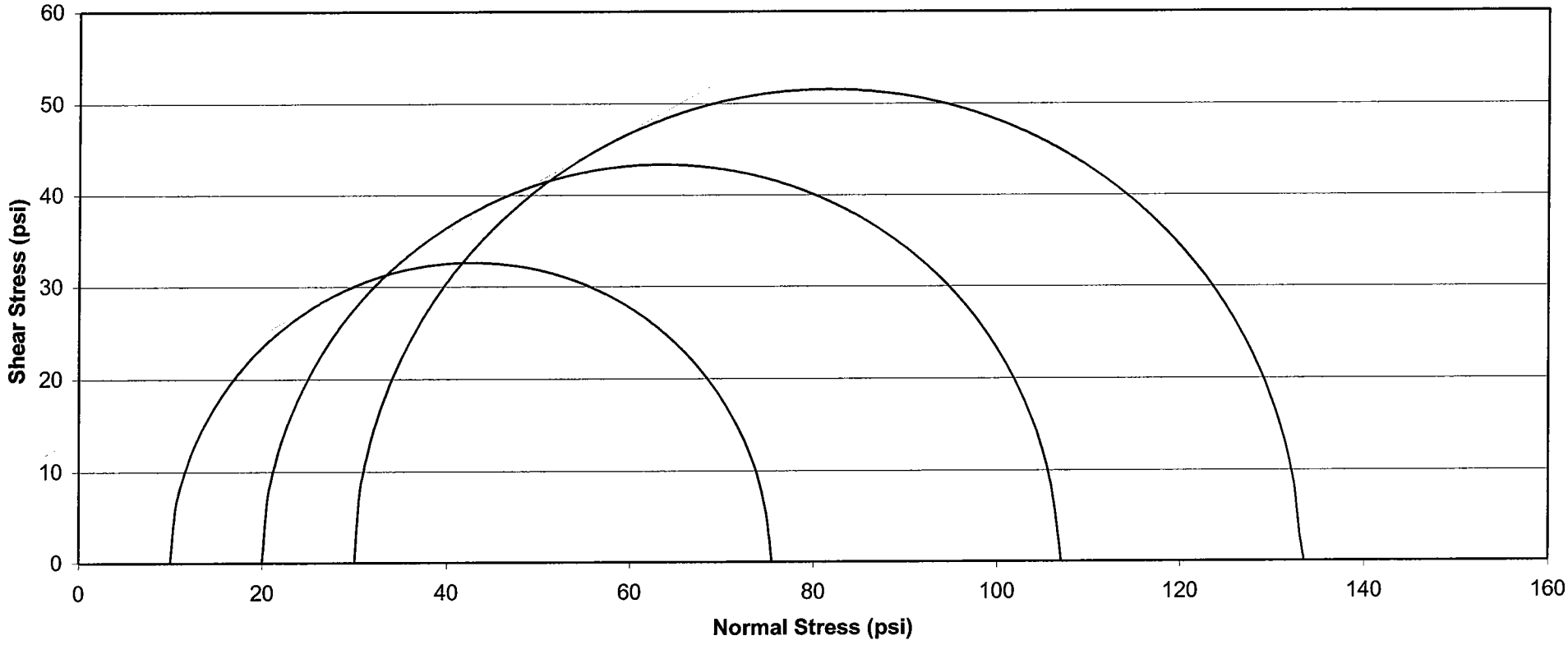


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

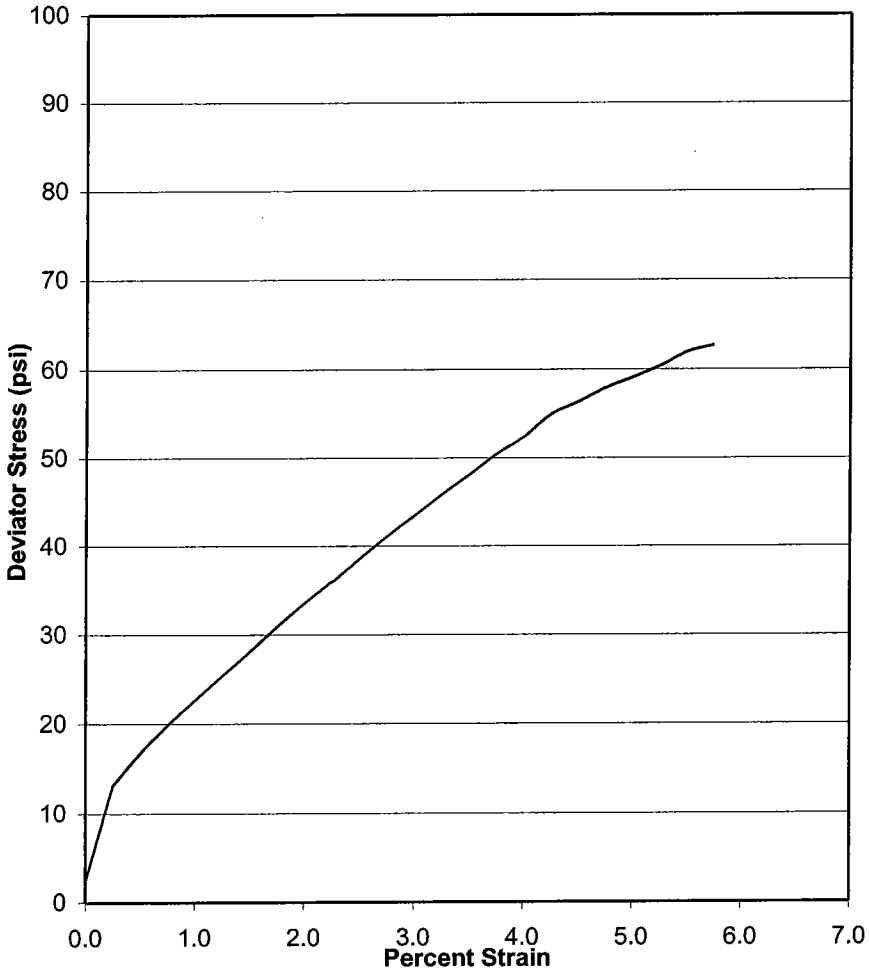
Project :	Kenai River Bluff Erosion Study	Lab #	T200318	σ_3 =	10.0 psi	γ_d =	114.8 pcf
Client:	U.S. Army Corp of Engineers	Lab #	T200319	σ_3 =	20.0 psi		
WO #	A30510	Lab #	T200320	σ_3 =	30.0 psi		
Boring #	3						
Sample #	14						
Depth :	59.5' to 61.0						
Date:	10/18/2003						



	Mohr Diagram - Multi-Stage CD Tests	WO #	A30510
		Figure	

ALASKA
TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study		
Client:	U.S. Army Corp of Engineers		
WO #	A30510		
Boring #	3	Depth :	59.5' to 61.0'
Sample #	14		
Initial Dry Density:	117.5	pcf	
Effective Confining Pressure :	5	psi	
Initial Moisture Content	16.9	%	
Laboratory #	T200321		
Date:	10/19/2003		

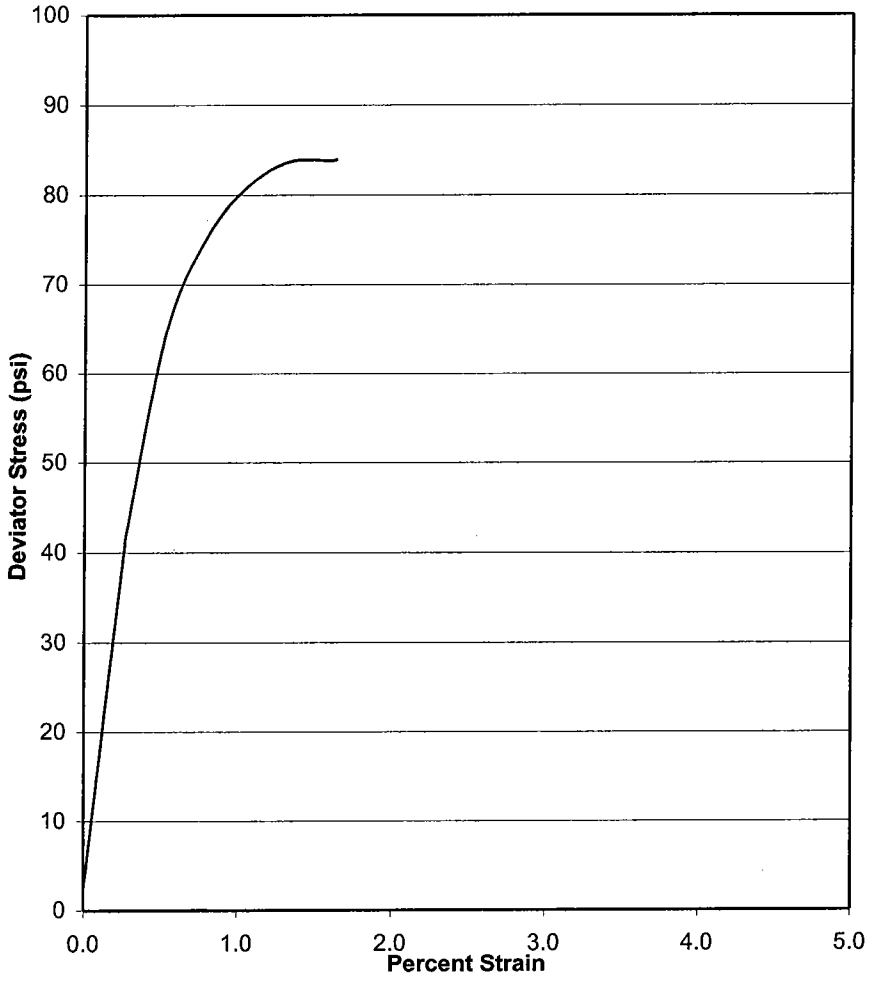


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study
Client:	U.S. Army Corp of Engineers
WO #	A30510
Boring #	3 Depth : 59.5' to 61.0'
Sample #	14
Initial Dry Density:	117.5 pcf
Effective Confining Pressure :	15 psi
Initial Moisture Content	16.9 %
Laboratory #	T200322
Date:	10/19/2003

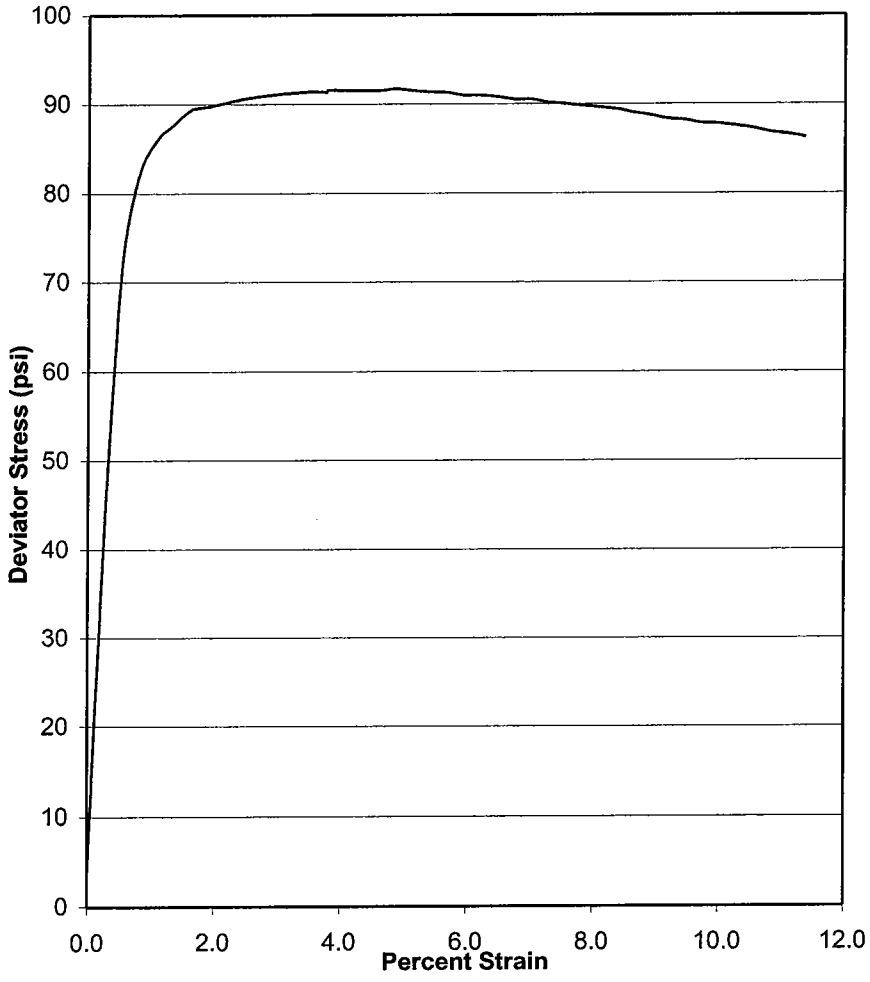


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study
Client:	U.S. Army Corp of Engineers
WO #	A30510
Boring #	3 Depth : 59.5' to 61.0'
Sample #	14
Initial Dry Density:	117.5 pcf
Effective Confining Pressure :	25 psi
Initial Moisture Content	16.9 %
Laboratory #	T200323
Date:	10/19/2003

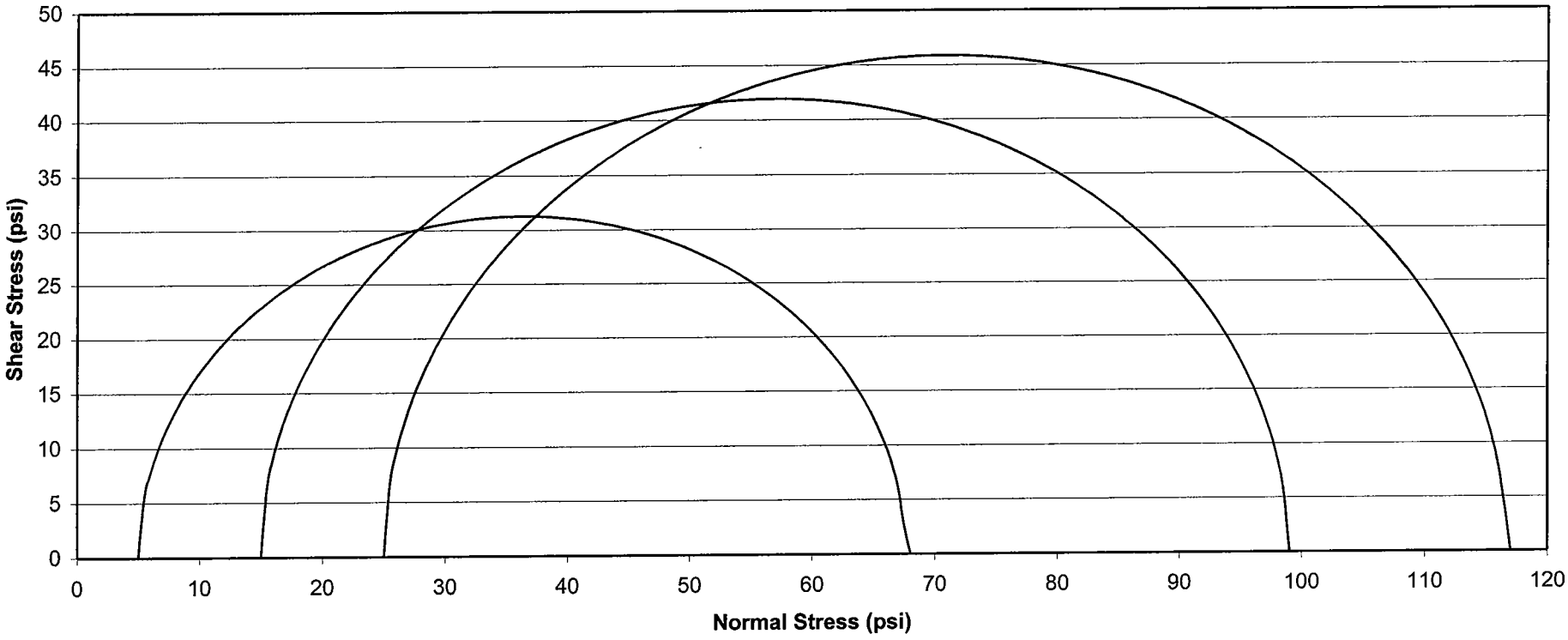


	Multi-Stage Consolidated Drained Tests	WO #	A30510
		Figure	

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

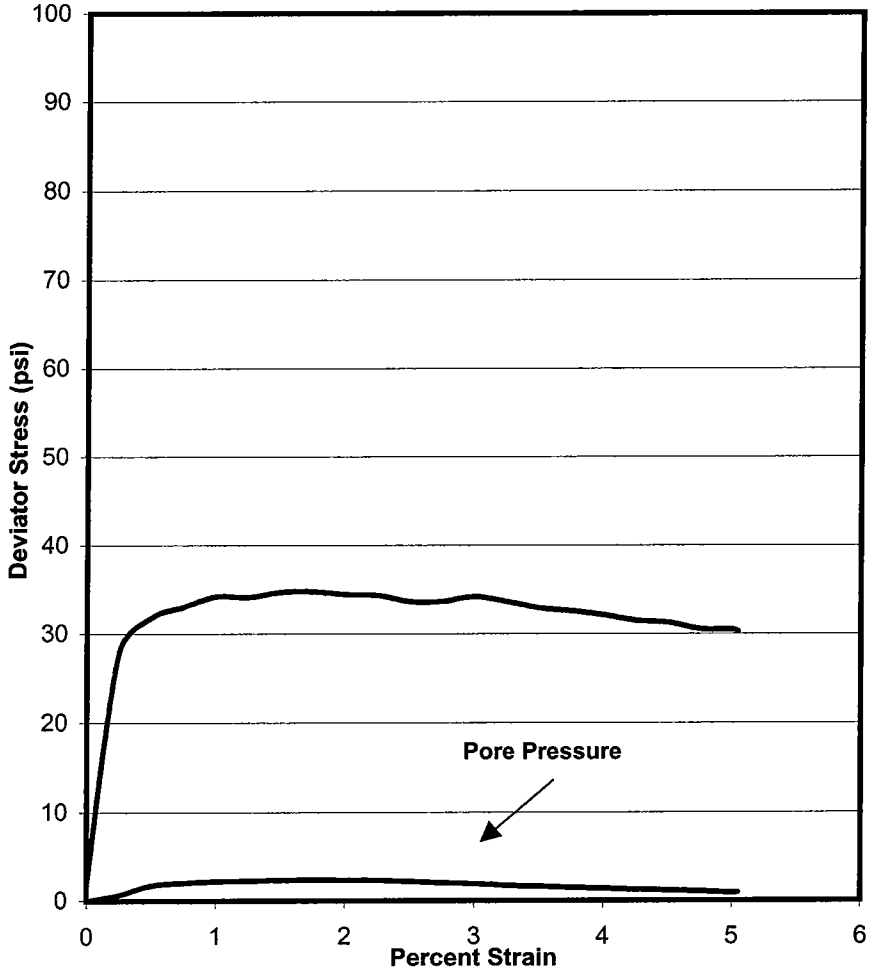
Project :	Kenai River Bluff Erosion Study	Lab #	T200321	σ_3 =	5.0 psi	γ_d =	117.5 pcf
Client:	U.S. Army Corp of Engineers	Lab #	T200322	σ_3 =	15.0 psi		
WO #	A30510	Lab #	T200323	σ_3 =	25.0 psi		
Boring #	3						
Sample #	14						
Depth :	59.5' to 61.0'						
Date:	10/19/2003						



	Mohr Diagram - Multi-Stage CD Tests	WO # Figure	A30510

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study		
Client:	U.S. Army Corp of Engineers		
WO #	A30510		
Boring #	3	Depth :	24.5' to 26.0'
Sample #	7		
Initial Dry Density:		98.8	pcf
Effective Confining Pressure :		10	psi
Initial Moisture Content		14.9	%
Laboratory #	T200324		
Date:	10/19/2003		

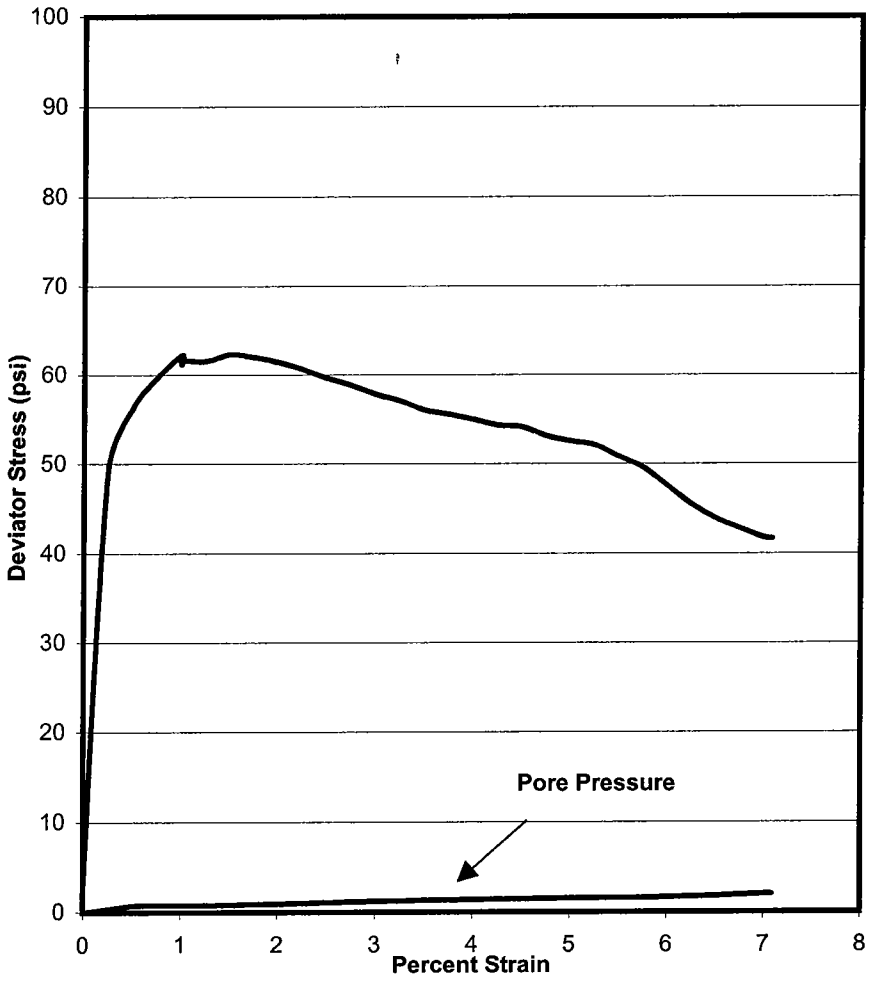


	Consolidated Undrained	WO #	A30510

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study		
Client:	U.S. Army Corp of Engineers		
WO #	A30510		
Boring #	3	Depth :	24.5' to 26.0'
Sample #	7		
Initial Dry Density:		98.7	pcf
Effective Confining Pressure :		20	psi
Initial Moisture Content		14.9	%
Laboratory #	T200325		
Date:	10/22/2003		

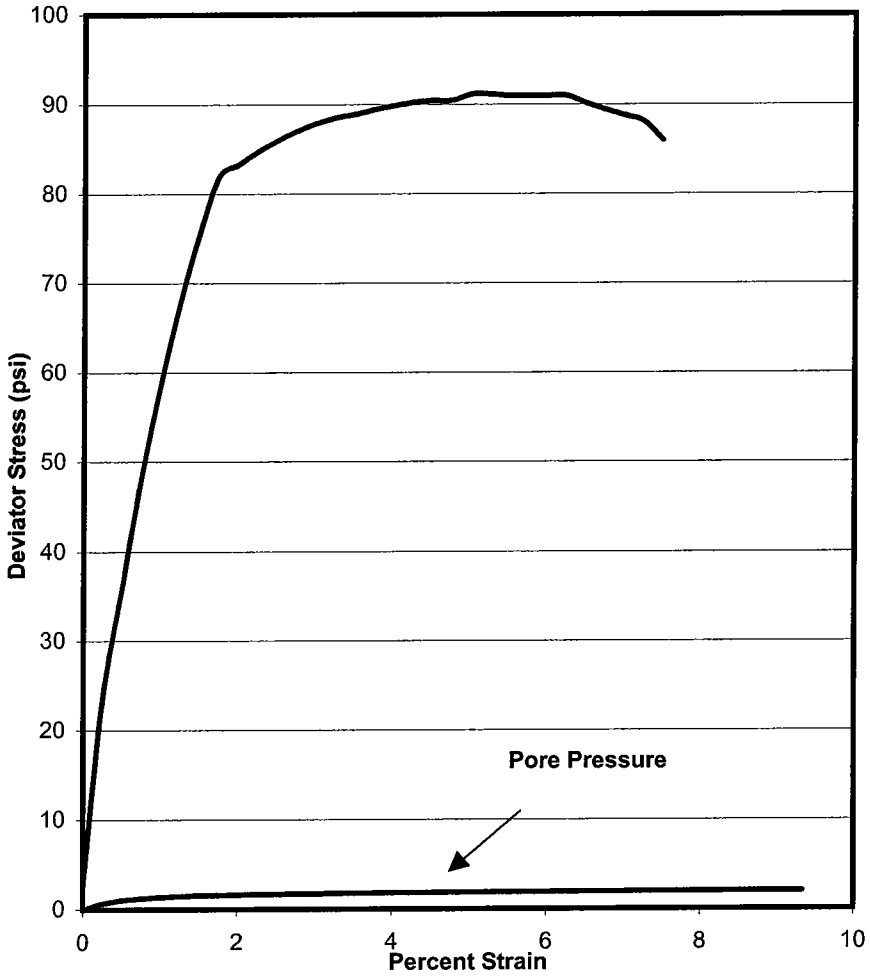


	Consolidated Undrained	WO #	A30510

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study		
Client:	U.S. Army Corp of Engineers		
WO #	A30510		
Boring #	3	Depth :	24.5' to 26.0'
Sample #	7		
Initial Dry Density:		99.6	pcf
Effective Confining Pressure :		30	psi
Initial Moisture Content		14.9	%
Laboratory #	T200326		
Date:	10/21/2003		

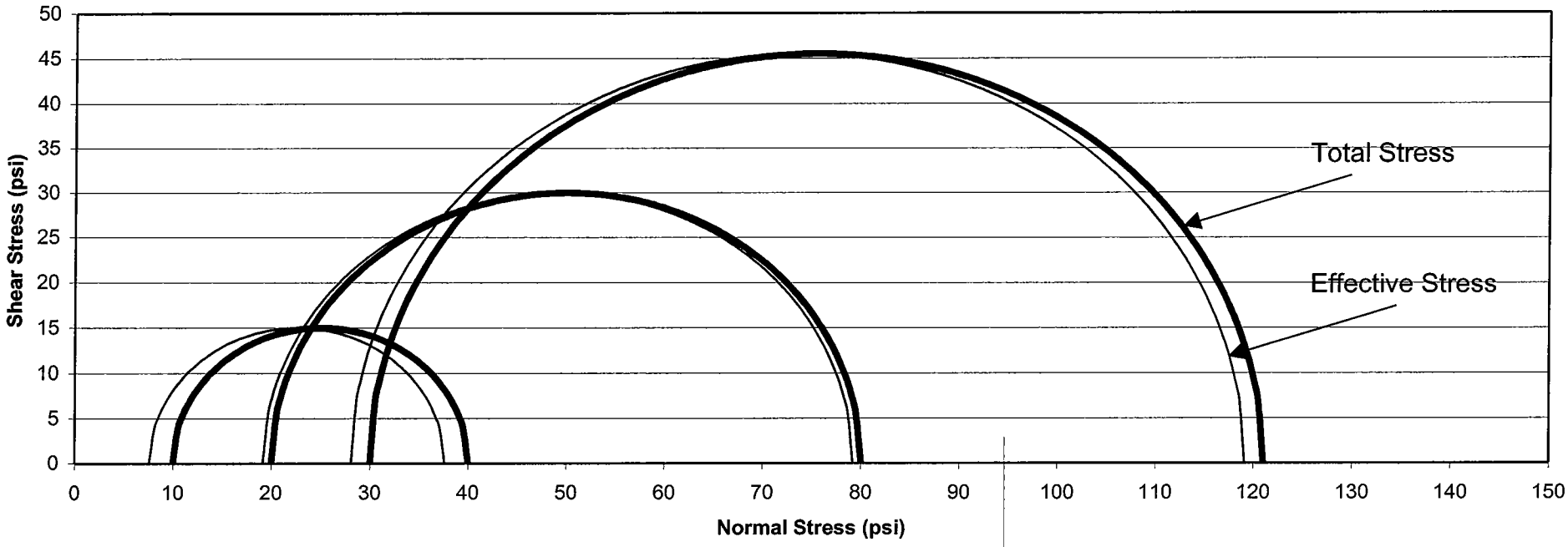


	Consolidated Undrained	WO #	A30510

4040 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

ALASKA TESTLAB
A Division of DOWL LLC

Project :	Kenai River Bluff Erosion Study	Lab #	T200324	σ_3 =	10.0 psi	γ_d =	98.8 pcf
Client:	U.S. Army Corp of Engineers	Lab #	T200325	σ_3 =	20.0 psi	γ_d =	98.7 pcf
WO #	A30510	Lab #	T200326	σ_3 =	30.0 psi	γ_d =	99.6 pcf
Boring #	3						
Sample #	7						
Depth :	24.5' to 26.0'						
Date:	10/19/2003						



	Mohr Diagram - CU Tests	WO #	A30510