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 photoionization 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

<u>Surface</u>: 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.

<u>Subsurface:</u> 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.

		Da	te	
Boring	October 30	, 2003	April 16,	2004
No.	Water Depth	Water	Water Depth	Water
	Below PVC	Elevation	Below PVC	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'

Table 1 – Groundwater Elevations

1. AP-606-P was obstructed at 0.71 feet; ice is suspected.

2. Water elevations are MLLW

7. Engineering Analysis

<u>Slope Stability Analysis</u> – 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.

<u>Well Flow Test</u> – 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

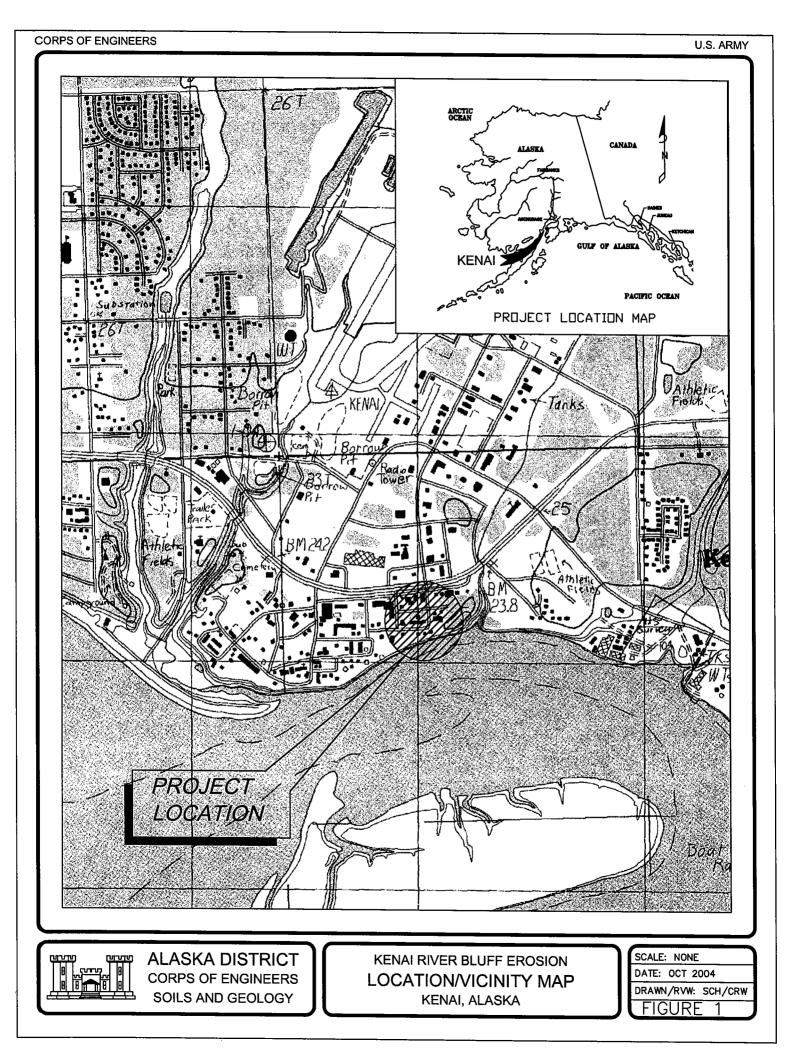
Although the Kenai River bluff is receding, the collected soil data, laboratory testing, and analysis indicate the slope is stable and massive slope failures are not contributing factors. The computed factor of safety for the sand/clay layer is 1.3 and for the clay layer alone, where the sand layer was 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.

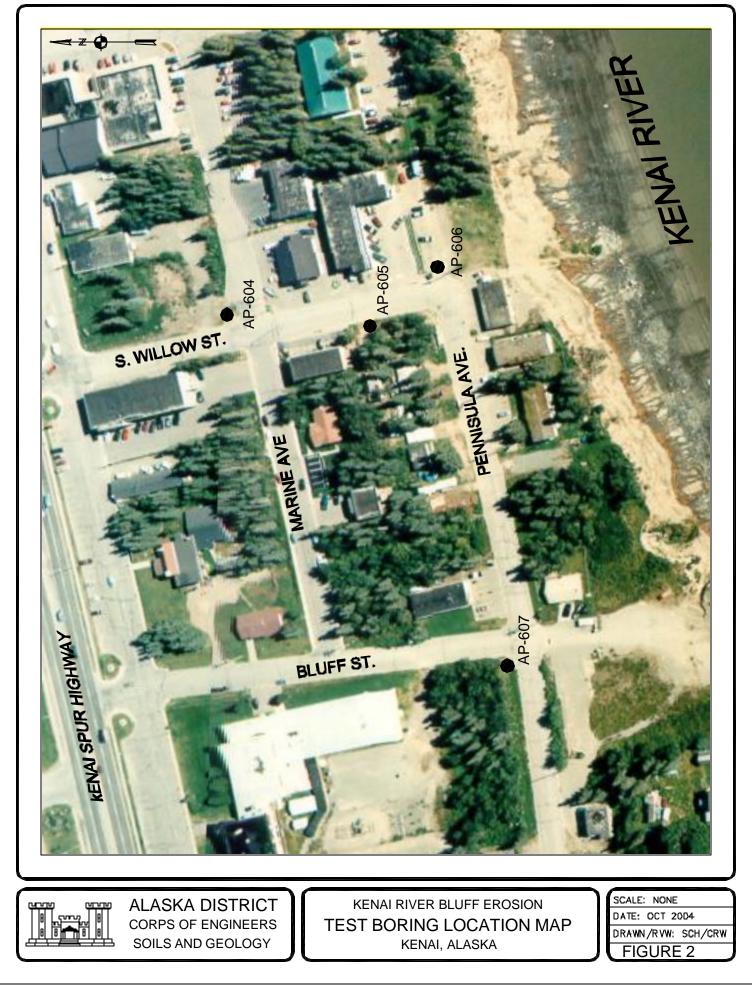


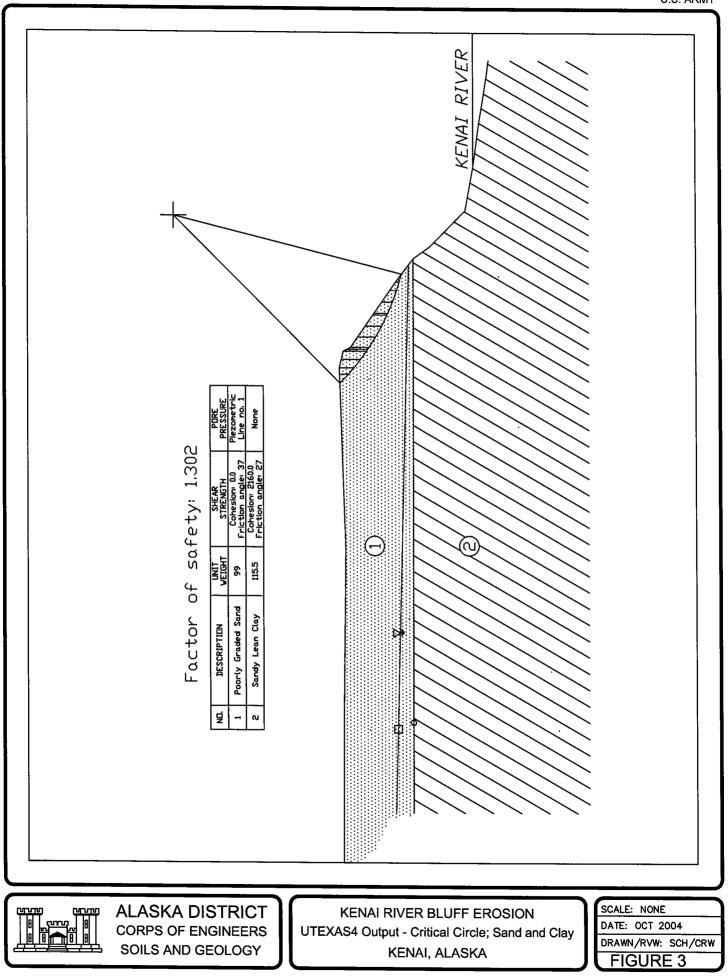
Undercutting of existing structure by receding bluff.

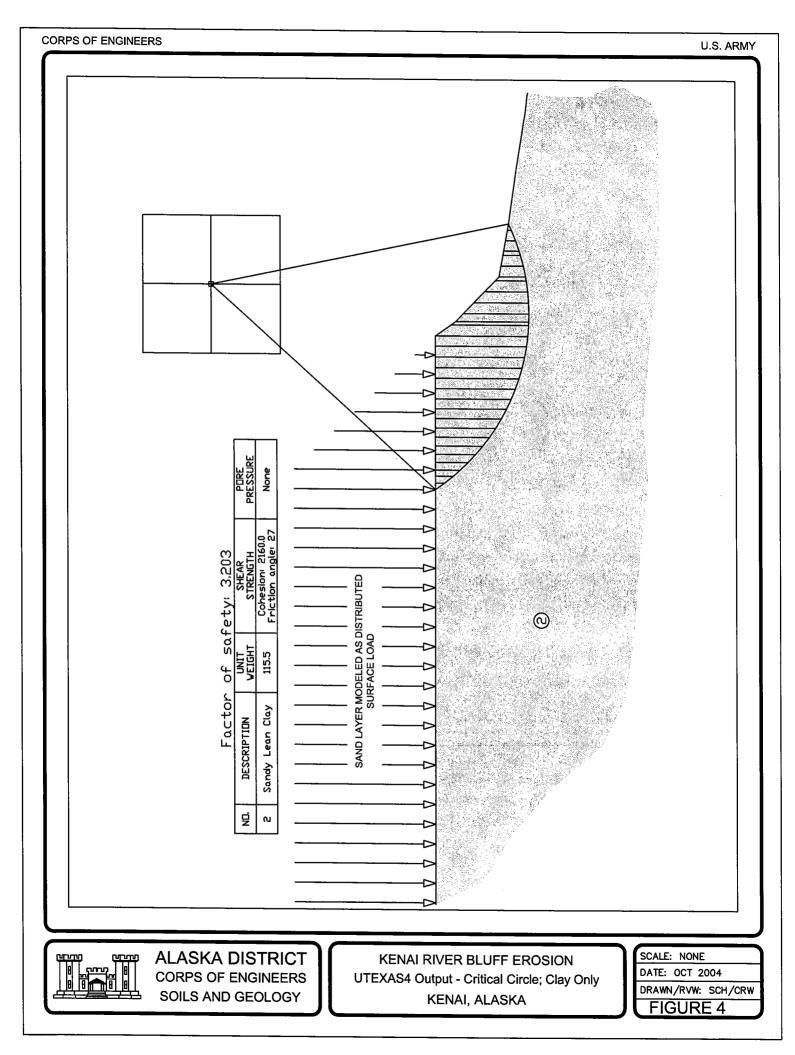
Attachments:

- 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









APPENDIX A

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EXPLORATION LOGS

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			AS	5 T T T	음 Grab	୍ଚି SP	Poorly graded SAN	D with Grovel	9%	%Sand	%Fines		PID	% W	<u> </u>			
- 2	• • •	_•			Grab	0.	- I CONY GIAGEU SAIN	D WILL GLAVEL				0.75			Sand, FILL	oist, roun 	ided gra	vel, fine to me
-		2			23	SP	Poorly graded SAN	D							Brown, me	oist, fine	sand	
- 4					4			,										
- 6		3			2 3 1	SP	Poorly graded SAN	D				0.25	-/ 0.0		Brown, me	oist, fine	sand	
- 8					4													
+			2		•			_										
		4			2 1 3	SP	Poorly graded SAN	D				0.25	-/ 0.0		Brown, m	oist, fine	sand	
-12																		
-14													:					
- 16	· · ·	5			2 2 3 4	SP	Poorly graded SAN	D	- - -				-/ 1.0		Brown, m	oist, fine	sand	
-					Ă													
- 18																		
-20		6			2 4 6	SP	Poorly graded SAN	D					-/ 1.0		Brown, m	oist, fine	sand	
		<u></u>			6													
- -																		
-24 10/6/		7			4 7	SM	Silty SAND		0	79	21		-/	15	Brown, m	oist, fine	sand	
EXPLORATION LOG KENAL BLUFFS.GPJ ACE ANC.GDT 9/3/04					9								0.0					
이지 이 10 이 10 이 10 이 10 이 10 이 10 이 10 이 10															¥			
04 		8			Ţ	SP	Poorly graded SAN	D with Gravel	17	81	2				Brown	nist med	lium to 4	coarse sand
LUFFS.	. ● .				7 9 15											, meu	ann iv i	sourse saily
ਜ਼ <u> </u> -32 ਲ਼	•																	
₩ 8 8					1	SP	Poorly graded 641											
		9			1 6 9	0	Poorly graded SAN	D WITH GRAVEL	32	66	2				Brown, we	et, round	led grav	el, fine to coa
ଟ୍ରି NP/	For			bsolete		<u>. </u>	<u> </u>		Proje	t: Ke	nai Ri	iver Bl	uff Er	osion	Study			Hole Numbe

:20,1

		<u>`</u>							1.14			<u></u> ,	,	ge del m	مېرىم مەمەرى <u>رە</u>	<u>- 192 - 1</u> 862 a (a. 4 a g	na je vije tajova se ov oskotavatek takene some e
				CORPS	OF E	ISTRICT NGINEERS	Project:			iver E \lask		Erosic	on Stud	ły			Page 2 of 3 Date: 17 Sep 2003
	<u> </u>	<u>, , , , , , , , , , , , , , , , , , , </u>				SERVICES Section	Drilling A						Distric				n Datum: MLLW
							X Oth	N		ghes ning:	Drillir 2	ng ,396,2	25 ft			Top of H	
Hole Num				Permar		200	Location:	E	asti			,415,3				Elevatio	0074
TB-3				AP-60			Operator Pat Ke								Inspector: Steven	Henslee	
Type of H			other .uger H	ole ("	7 Monit	oring Well 🛛 🗶 Pi	 iezometer	Dept	th to		undw 7.9 ft.				Depth Drill	ed:	Total Depth:
Hammer 340 lbs			Split	Spoon I		Size and Type		<u> </u>	-			quipm	ent:		99.5 ft.	Type of S	101.0 ft. Samples:
			_	.5 in.	1 - 1	8 in. HSA Classification				CI ain Si			Autoh	amme	er		Ind Drive
Depth (ft.) Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	ASTM: D 2487 or D 2	488	-	%Gravel	%Sand	%Fines ^ā	Max Size (in.)	PID (ppm)	% Water	Surface: D	-	on and Remarks lot
	10a 10b) 10c <i>)</i>			4 8 15	CL GP CL	Lean CLAY with Sa <u>Poorly graded GRA</u> Lean CLAY with Sa	VEL						-/ 1.0			st, rounded	ines, very stiff I gravel, coarse sand, 1.5
	(11a) (11b) (11c <i>)</i> (12			7 17 24 7 13 16	CL SP CL CL	Lean CLAY with Sa Poorly graded SAN Lean CLAY with Sa Lean CLAY with Sa	ID	5					-/ 1.0		<u>Stiff</u> Dark gray Dark, gray stiff	<u>, moist, me</u> 7, moist, fin	e sand, plastic fines, very dium sand e sand, plastic fines, very e sand, plastic fines, very
-52					SP	Poorly graded SAN									Estimated	by drill ac	tion
-56	13			6 13 16	CL	Lean CLAY with Sa	Ind						-/ 0.0		stiff, mart	led with cl	e sand, plastic fines, very ean gray medium sand to inches thick
-60 -62	14			9 13 38	CL	Lean CLAY with Sa	nd		0	23	77		-/ 0.0	17	Dark gray LL=29, Pl	, moist, fin =15	e sand, plastic fines.
-64 -66 -68	15			7 11 15	CL	Lean CLAY with Sa	Ind						-/ 0.0		Dark gray	, moist, fin	e sand, plastic fines
-70	16			4 8 12	CL	Lean CLAY with Sa	Ind						-/ 0.0		Dark gray	, moist, fin	e sand, plastic fines
NPA Form May 94 P			osolete					Pro	ojec	t: Kei	nai Ri	ver Bl	uff Er	osion	Study		Hole Number: AP-606-P

				D	CORPS	OF E		Project:	Kenai Kenai			Erosic	on Stu	dy	<u></u>		Page 3 of 3 Date: 17 Sep 2003
	Sc	oils	ar				S SERVICES Section	Drilling Ag		ughes			Distric	ct	· · · ·	Elevatio	on Datum: MLLW
							I LOG	Location:	No	rthing:	2	,396,2				Top of H	iole and the
	e Nur 3-3	mber,	Field	:	Perman AP-60			Operator:				,415,3	οο π. ———		Inspector:	Elevatio	n:
Тур	e of	Hole:		other		ло-г-		Pat Kel	Depth	to Gro	oundv	vater:			Steven Depth Dril	Henslee Hed:	Total Depth:
	Test nmer	Pit Weig		Auger I	Hole		itoring Well X Pi	ezometer		Υ····-	7.9 ft				99.5 ft.		101.0 ft.
3	40 lbs	,			2.5 in.		8 in. HSA			C	ME-7	quipm 5 with	ient: Autoh	amm	er	Type of S Grab a	Samples: and Drive
) (ft.)	оgу	e	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	9	Classification ASTM: D 2487 or D 24	488		Grain S	Т	Max Size (in.)	(mq	5			on and Remarks
Depth (ft.)	Lithology	Sample	Froze	Frost TM 5-	Blow	Symbol			%Gravel	%Sand	%Fines	Max Si	PID (ppm)	% Water	Surface: D	irt parking	lot
74 76		17			4 9 11	CL	Lean CLAY with Sa	nd	- 1	26	73		-/ 0.0	17	Dark gray stiff	, moist, fine	e sand, plastic fines, very
-78 - -80		18			5	CL	Lean CLAY with Sa	nd							Dark grav	fine cand	plastic fines, 1.25-inch
- 82					5 9 12								0.0		thick sear	n of fine gra	ay sand in sample
- 84 86		19			5 13 21	SP- SM	Poorly graded SAN	D with Silt					-/ 0.0		Dark gray fines	r, moist, fine	e to medium sand, NP
90 		20			3 7 17	SP- SM	Poorly graded SAN	D with Silt	0	89	11		-/ 0.0	20	Dark gray fines	, moist, fine	e to medium sand, NP
92 94 		21			7 12 12	SP-	Pooriy graded SAN	D with Silt					-/ 1.0		Dark gray	r, moist, me	dium sand, NP fines
96 98 					12												
-100		22			6 17	SP- SM	Poorly graded SAN	D with Silt					-/ 0.0		Dark gray fines	, moist, find	e to medium sand, NP
-102 - -104															Groundw an elevati	ion of 60.8 f	ntered While Drilling: at
- 106 -					: : :				-						Survey da NAD83. E	atum is Alas Elevation da	ska State Plane, Zone 4, atum MLLW.
-108 -																	
		m 19- Prev. E		bsolete	e				Proje	ect: Ke	nai R	iver Bl	uff Er	osion	Study	<u>.</u>	Hole Number: AP-606-P

	مرت الم 1000	ر السلي السلي					DISTRICT	Project:	Kenai I Kenai,			Erosio	n Stud	dy			age 1 of 3
-4	C C	مالد م	on on	5_ E	NGINE	ERIN(SERVICES	Drilling A	gency:			aska	Distric	 t			ate: 18 Sep 2003 n Datum: MLLW
							Section	X Oth	ner Hu	ghes	Drillir			~ 			
				JR			LOG	Location:	Nort East	hing: ing:		,396,20 ,414,82				Top of H Elevatio	
TE	3-4		Field:		Perman AP-60			Operator Pat Ke							Inspector: Steven	Henslee	
	be of Test		□ □ A	other uger H	lole 🗆] Moni	toring Well 🔀 Pi	 ezometer	Depth to		undw 7.9 ft.				Depth Dril 100.0 ft		Total Depth: 101.5 ft.
Har 3	nmer 40 lbs	Weig			Spoon I .5 in.	.D:	Size and Type of 8 in. HSA	of Bit:				quipm 5 with /		amme	r	Type of S Grab a	amples: nd Drive
			4083	iss. 2-5	nıt		Classification ASTM: D 2487 or D 24	188	G	rain S	ize	(in.)	-			Descriptio	on and Remarks
Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	_		%Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Surface: S	econd grov	th willows and spruce
- 2		1		F2	Grab	SM	Silty SAND with Gra	avel				2	-/ 0.0		Brown, m sand, nor	oist, rounde plastic (NP	ed gravel, fine to medium) fines
		-								1							
- 6		2		NFS	4335	SP	Poorly graded SAN	D				0.25	-/ 1.0		Brown, m	oist, fine sa	nd
- 8					3 5												
-																	
-12																	
- 14																	
- 16		3		NFS	3 3 4 5	SP	Poorly graded SAN	D				1.25	-/ 0.0		Brown, m	oist, round	ed gravel, fine sand
- 					5												
-20													:				
-22		• :					;										
-24					_												
-26		4a 4b _4c_			5 4 4	SP SM SP	Poorly graded SAN Silty SAND Poorly graded SAN		0	65	35		-/ 0.0	23	Brown, m	ioist, fine sa ioist, fine sa ioist, fine sa	and, NP fines
-28															V.	iviay inte Si	ang
-30 		5			4 7 6	SP	Poorly graded SAN	D	7	92	1				Brown, w	et, medium	to coarse sand
-32	2 				6												
- 26 - 26 - 26 - 26 - 30 - 30 - 30 - 30 - 30 - 30 - 30 - 30		6			2	GP	Poorly graded GRA	VEL with		48	2				Twelve in Dark oray		aving sand ded gravel, fine to coars
NP		rm 19- Prev		osolete		1	Sand		Proje	ct: Ke	nai Ri	iver Bl	uff Er	osion	sand Study		Hole Number:
Livid	, ,,	. 104.			, 			<u>. </u>									AP-607-P

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			L E	CORPS	S OF E Erin	DISTRICT ENGINEERS G SERVICES	Project: Drilling Age	Kenai F Kenai,	Alask	a			-		Da	age 2 of 3 ate: 18 Sep 2
S	olls	an	d G	Seolo	рgy	Section	X Othe	•	ا ghes		laska ng	Distric	t		Elevation	Datum: MLLW
E	EXI		OR	ATI	ON	LOG	Location:		hing:	2	,396,2 ,414,8				Top of Ho Elevation	ole
Hole Nu TB-4	mber,	Field:		Permar AP-6			Operator: Pat Kelle	ey						Inspector: Steven	Henslee	
Type of			other uger H	lole [] Mon	itoring Well 🛛 🕱 Pi	[Depth to		undw 7.9 ft.				Depth Drill 100.0 ft.		Total Depth: 101.5 ft.
Hamme 340 lbs	r Weig s	jht:	1	Spoon .5 in.	l.D:	Size and Type of 8 in. HSA	of Bit:				quipm 5 with		amme		Type of Sa Grab ar	amples:
		1083	လို့လု	 		Classification		G	rain Si		<u> </u>			/		n and Remarks
Depth (ft.) Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5		Symbol	ASTM: D 2487 or D 24	88	%Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Surface: S		h willows and sp
-42 -44 -46 -46 -48 -50 -52 -54	7			5 15 18 3	CL	Lean CLAY with Sar						-1 0.0		stiff		sand, plastic fine
56 58 60 62 64 64 64	9a			3 6 10 2	CL	Lean CLAY with Sa						-/		plastic fin	es, very stiff	sand, plastic fine
	9b			268	SP	Poorly graded SAN	- 					1.0		\ <u>stiff</u> Dark gray	r, moist, fine - — — — — —	to medium sand
	A			6 11 14	CL	Lean CLAY with Sau	nd	1						Dark gray stiff, 1.25-	, moist, fine	

					CORPS	S OF E		Project:	Kenai I Kenai,			Erosic		<u></u> Jy		Pa	age 3 of 3 ate: 18 Sep 2003
	Sc	oils	an				s services Section	Drilling A		ghes			Distric	rt		<u>_</u>	Datum: MLLW
							LOG	Location:	Nor	hing:	2	,396,2 ,414,8				Top of Ho Elevation	ple an c #
Hole TB		mber,	Field:		Perman AP-60			Operator Pat Ke	:						Inspector: Steven	Hensiee	·
	e of l Test			other luger H] Mon	toring Well 🛛 🕅 Pi	iezometer	Depth to		undw 7.9 ft.				Depth Dril 100.0 ft	led:	Total Depth: 101.5 ft.
Han 34	nmer I Ibs	Weig	ht:		t Spoon I 2.5 in.	.D:	Size and Type of 8 in. HSA	of Bit:				quipm 5 with	ient: Autoh	amme	l	Type of Sa Grab an	amples:
(ft.)	λf		D 4083	lass. 22-5	ount		Classification ASTM: D 2487 or D 24	488		rain Si		· · ·					n and Remarks
Depth (ft.)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol			%Gravel	%Sand	%Fines	Max Size (in.)	PID (ppm)	% Water	Surface: S	econd growt	h willows and spruce
- 76 - 78 - 78 - 80 - 82 - 82 - 88 - 88 - 88 - 90 - 90 - 92 - 94 - 94 - 98 - 98 - 100		112a (12b) (13) (14)			5 6 9 5 12 25 3 9 12 3 4 16	CL SP CL SP SP	Lean CLAY with Sa Lean CLAY with Sa Poorly graded SAN Lean CLAY with Sa Poorly graded SAN Poorly graded SAN	nd D 	0	98	2		-/ 1.0 -/ 1.0	20	Dark gray Dark gray Dark gray	/, moist, fine /, moist, fine /, moist, fine	sand, plastic fines sand, plastic fines to medium sand to medium sand
- -102		15			.33	CL	Lean CLAY	<u></u>	0	8	92		-/ 0.0	27	soft	r, moist, fine f Hole 101.5	sand, plastic fines, very ft.
- -104 - -106 - - -108 -															Groundw an elevati PID = (Co Survey da	ater Encount ion of 61.6 ft. Id/Hot) Photo	tered While Drilling: at o lonization Detector ka State Plane, Zone 4
		m 19- Prev. I		solete)	<u> </u>			Proje	ct: Ke	nai Ri	ver Bl	uff Ero	osion	Study		Hole Number: AP-607-P

APPENDIX B

LABATORY ANALYSIS DATA SHEETS



October 24, 2003 W.O. A30510

1

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.

Mr. Steve Henslee, P.E. and Mr. Greg Carpenter, Ph.D, P.E. U.S. Army Corps of Engineers October 24, 2003 Page 2

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 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

Attachments: As stated

A30510.Corps.CC.DLA.102403.mas

Reviewed by. Alaska /Testlab

David L. Andersen, P.E. General Manager

T E S T L A B Project: Kenai River Bluff Erosion Study	DIST. ASTM D422
	W.O. A30510
TB-1, Sample #2, 2.5'-3'	Lab No. 2421
Moisture $= 3.0\%$	Received: 10/1/03
Engineering Classification: Poorly Graded SAND, SP	Reported: 10/23/03
Frost Classification: Not Measured	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
1. 3. 1 [*]	= <u>0</u>
-# \/8 2- 7	
#111 4	1 1/2 1 1/2 1 000%
	-
	No. 4 92%
	Total Wt. = 1144g
	No. 8
50%	No. 10 88%
SSB	No. 16
40%	No. 20 82%
30%	No. 30
	No. 40 59%
20%	
#10	No. 60 22%
	No. 80
	No. 100 8%
	No. 200 4.9%
100 I 0.0 I 0.01 0.01	Total Wt. of Fine Fraction = 363.6g
© Alaska Testlab, 1999	0.02 mm

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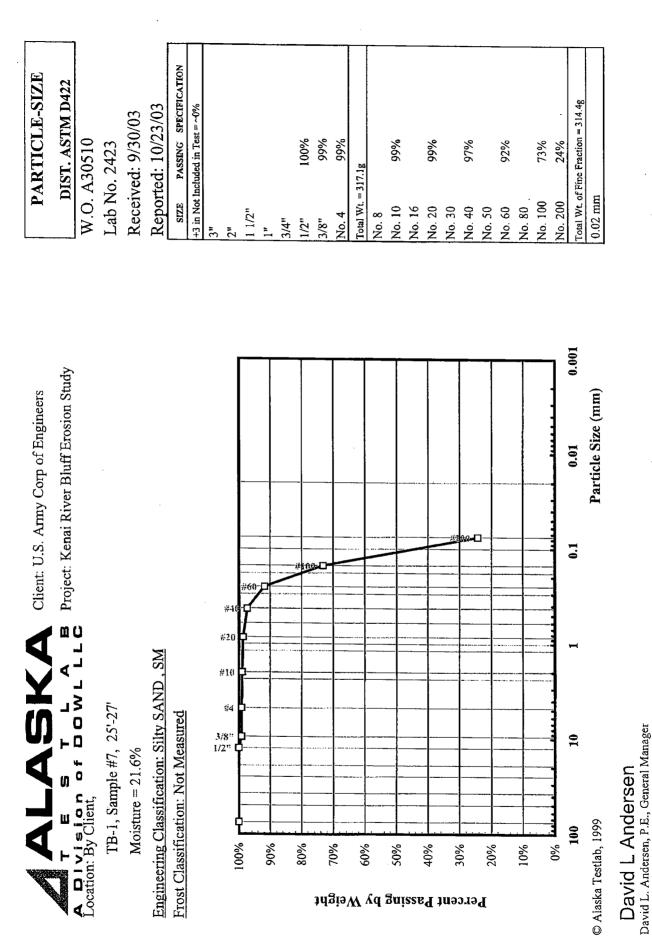
4040 B Street Anchorage Alaska 99503 • 907/562-2000 • 907/563-3953

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Alaska Testlab

Ø 018/021



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Alaska Testlab

Ø 021/021

STLLAB Project: Kenai River Bluff Erosion Study of DOWLLLC	DIST. ASTM D422 W.O. A30510
TB-1 Sample #10, 40'-41.5'	Lab No. 2424
Liquid Limit = 30.8 , Plasticity Index = 15.5	Received: 9/30/03
Engineering Classification: CLAY with Sand, CL	Reported: 11/26/03
	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = ~0% 3"
#2 #10 #4	2"
	1 1/2"
	1"
-#280	3/4"
	1/2" 3/8"
	No. 4 100%
	Vt. = 0g
	No. 10 98% No. 16
	No. 40 92%
	No. 60 88%
	No. 100 82%
	No. 200 78%
TAID	Total Wt. of Fine Fraction = 86.4g
Darticla Siza (mm)	0.02 mm

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12/02/2003 13:21 FAX 9075614862

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Client: U.S. Army Corp of Engineers FARIICLE-SIZE	Project: Kenai River Bluff Erosion Study D422	W.O. A30510	Lab No. 2426	Received: 9/30/03		SIZE PASSING SPECIFICATION	+3 in Not Included in Test = -0%	3"	2"	1 1/2"	=	3/4"	1/2" 100%	No. 4 99%	Total Wt. = 990g	No. 8	No. 10 97%		No. 20 90%	No. 30	No. 40 37%	No. 50	11 ま No. 60 6%	20	08.9N	No. 80
		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							80%	3i9 [/]	60%		50% F F F F F F F F F F F F F F F F F F F	SSE	4 9%	30%		20%				

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Alaska Testlab

Ø 003/021

T E S T L A B Project: Kenai River Bluff Erosion Study	DIST. ASTM D422
Location: By Client,	W.O. A30510
TB-2, Sample #5, 15'-16.5'	Lab No. 2427
Moisture = 5.0%	Received: 9/30/03
Engineering Classification: Poorly Graded SAND , SP	Reported: 10/23/03
Frost Classification: Not Measured	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
	3"
	2"
1 1 1 1	1 1/2"
f	1" 100%
	3/4" 99%
80%	1/2" 99%
	No. 4 96%
	Total Wt. = 1485g
	No. 8
50%	No. 10 94%
	No. 16
40%	No. 20 92%
	No. 30
	No. 40 78%
20%	No. 50
	No. 60 35%
	No. 80
	No. 100 9%
	No. 200 3.6%
100 10 1 0.1 0.01 0.001	Total Wt. of Fine Fraction = 312.5g
© Alaska Testlah 1999	0.02 mm

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

12/02/2003 13:22 FAX 9075614862

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Alaska Testlab

Ø 008/021

	-
T L A B Project: Kenai River Bluff Erosion Study	
By Client, TB-2. Sample #8. 30'-31.5'	UICUCA. W. W. AJUSU Lab No. 2428
	Received: 9/30/03
Engineering Classification: Poorly Graded SAND with Gravel, SP	Reported: 10/23/03
Frost Classification: NFS MOA	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
	3"
	2"
	3/4"
	1/2"
	3/8"
	No. 4
	Total Wt. = 1094g
	No. 8
	No. 10
	No. 16
	No. 20
	N0. 50 N0. 40
	No. 50
	No. 60
	No. 80
-/1	No. 100
10 1 0.1 0.01	0.001 1001 10000 10000 1000 1000 1000 1000 1000 10
Particle Size (mm)	0.02 mm

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E S T L A B Project: Kenai River Bluff Erosion Study	DIST. ASTM D422
נ 2 2	W.O. A30510
TB-2, Sample #10, 37.5'-38.5'	Lab No. 2429
Moisture = 16.5	Received: 9/30/03
Engineering Classification: CLAY with Sand, CL	Reported: 11/26/03
Frost Classification: F4	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
.)/ 1/2/	3.
	2"
F	1 1/2"
	3/4"
	1/2" 100%
	4
	Total Wt. = 389.8g
	No. 8
	No. 10 95%
	No. 16
	No. 20 94%
	No. 30
	No. 40 93%
	No. 50
	No. 60 91%
100 10 1 0.1 0.01 0.001	No. 200 82% Trial WL of Fine Fraction = 374.6%
© Alaska Testlab. 1999 Particle Size (mm)	0.02 mm

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W.O. A30 Lab No. 2' Received: Reported: <u>srzk</u> Fas 3' 1 1/2" 1 1/2" 3/8" No. 40 No. 10 No. 20 No. 20	A AT A AAT
e #7, 24.5'-26' e #7, 24.5'-26' i Measured t Measured	-

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E S T L B Project: Kenai River Bluff Erosion Study M.O. A 3-3, Sample #8, 29.5-31' 3-3, Sample #8, 29.5-31' W.O. A W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study W.O. A 3-3, Sample #8, 29.5-31' Broject: Kenai River Bluff Erosion Study Reporte Internation: NFS MOA Internation: NFS MOA Reporte Internation: NFS MOA Internation: Internation: NFS MOA Internation: Inter	River Bluff Erosion Study W.O. A30 Lab No. 2- Received: Reported: size Pas 3" 11/2" 12" 12" 12" 12" 12" 12" 12" 12" 12" 1
W.O. A Lab No Receive Receive <u>Reporte</u> 31 11/2" 31/4" 31/4" 11/2" 31/4" 11/2" 31/4" 11/2" 1/2"	W.O. A Lab No Receive Receive <u>size</u> 3.4" 11/2" 3.4" 1/2" 3.4" 1/2" 3.4" No. 4 No. 10 No. 10 No. 16 No. 16
Lab No Receive Reporte 3.7 1 1/2" 3.4" 1/2" 3.4" No. 4 No. 8 No. 8	Lab No Receive Reporte 3" 11/2" 3/4" 1/2" 3/4" 1/2" 3/8" No. 4 No. 10 No. 10 No. 10 No. 10 No. 10 No. 10 No. 16
Receive Reporte 3." 3.4" 1.1/2" 3.4" 1.1/2" 3.4" 1.1/2" 3.4" No.4 No. 8	Receive Reporte 31 31 31 31 31 31 31 31 31 31 31 31 32 32 33 34 1
Reporte	Reporte 3" 3" 3" 3" 3" 1 1 1 1 1 3.4" 1
stree street	. = 10
	+3 in Not Included in 3" 3" 1 1/2" 1 1/2" 96 1/1" 96 1/2" 94 1/2" 94 1/2" 94 1/2" 96 1/2" 96 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/2" 94 1/4" 83 1/4" 83 1/4" 83 1/4" 10 1/4" 10 1/4" 10 1/4" 10 1/4" 10 1/4" 10 1/4" 10 1/4" 10
100% 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 11/2" 10/6 11/2" 11/2" 11/2" 10/6 10/6 11/2" 11/2" 10/6 11/2" 10/6 11/2" 10/6 11/2" 10/6 11/2" 10/6 11/2" 10/6 10/	
100% 0 1/2" 90% 0 1/2" 90% 0 1/2" 3/4" 70% 0 2/2" 50% 0 2/2" 50% 0 2/2" 70% 0	.= 1082g
90% 90% 90% 90% 90% 90% 90% 90% 90% 90%	
2006 80% 80% 91/2" 3/4" 3/4" 3/8" 3/8" No. 4 No. 8 No. 8 No. 8 No. 8	.= 1082g
80% 80% 1/2" 3/8" 3/8" 3/8" 3/8" 3/8" 3/8" 3/8" 3/8	. = 1082 <i>g</i>
70% 51% 51% 51% 51% 51% 51% 51% 51% 51% 51	. = 1082 <u>6</u>
/0% 60% 60% 700 100 100 100 100 100 100 100 100 100	. = 1082 g
	. = 1082g
20	
40% 100 20	No. 20 53%
30% - No. 30	No. 30
	No. 40 18%
	No. 60 5%
52001	
-11	
00 10 1 0.1 0.01 0.001	0.01 0.001 0.001 Total Wt. of Fine F
© Alaska Testlab, 1999 0.02 mm	

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E S T L A B Project: Kenai River Bluff Erosion Study	DIST. ASTM D422
Location: By Client,	W.O. A30510
TB-3, Sample #9, 34.5'-36'	Lab No. 2432
Moisture = 11.1%	Received: 9/30/03
Engineering Classification: Poorly Graded SAND with Gravel, SP	Reported: 10/23/03
Frost Classification: NFS MOA	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
3	3"
- - - - - - - - - - - - - - - - - - -	
	2 "
	1" 97%
	`
80%	
	No. 4 68%
	Total Wt. = $1251g$
#10	No. 8
	No. 10 52%
	No. 16
	No. 20 36%
	No. 30
	No. 40 18%
	No. 50
	No. 60 7%
	No. 80
	No. 200 2.3%
100 I 01 0°1 0°1 0°1 0°1 0°1	Total Wt. of Fine Fraction = 315.6g
© Alaska Testlab, 1999	0.02 mm

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	F T L A Project: Kenai River Bluff Ecosion Study DI e#14 59.5-61' = 29, Plasticity Index = 15 W.O. A = 29, Plasticity Index = 15 Reported to the stand CL Receive to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 15 Reported to the stand CL con: CLAY with Sand CL 20, Plasticity Index = 16 Receive to the stand Sand CL con: CLAY with Sand CL 20, Plasticity Index = 16 Receive to the stand Sand CL con: CLAY with Sand CL 20, Plasticity Index = 16 Receive to the stand Sand Sand Sand Sand Sand Sand Sand S	Client: U.S. Army Corp of Engineers PARTICLE-SIZE	
w.O. A work of the first of th	Barticle Size (mm) $1 - 0.01$ $0 - 0.01$ 0		
Sample #14 59.5-61' Limit = 29, Plasticity Index = 15 Sification: CLAY with Sand, CL on: F4 On: F4 Data from the from	Sample #14 59.5-61' Limit = 29, Plasticity Index = 15 Sification: CLAY with Sand, CL on: F4 00: F4 Particle Size (mm) Particle Size (mm) Particle Size (mm) Plasticity Index = 15 Reporte Reporte Reporte Reporte Reporte Reporte Reporte Reporte Reporte Reporte Reporte Reporte Plasticity Index = 15 Reporte Plasticity Index = 13 Reporte Repo	W.O. A3051	of DOWL L
Limit = 29, Plasticity Index = 15 sift fraction: CLAY with Sand, Cl on: F4 on: F4 P P P P P P P P P P	Limit = 29, Plasticity Index = 15 sift fraction: CLAY with Sand, CL on: F4 p p p p p p p p p p	Lab No. 243	TB-3, Sample #14 59.5'-61'
sinflication: CLAY with Sand, CL On: F4 Sinflication: CLAY with Sand, CL Sinflication: CLAY with Sand, CL On: F4 Sinflication: CLAY with Sand, CL Sinflication: Sinfli	isification: CLAY with Sand, CL On: F4 On: F4 Similar of the sand, CL On: F4 Similar of the sand, CL On: F4 Similar of the sand, CL	Received: 9/	Liquid Limit = 29 , Plasticity Index = 15
001. E4 011. E4 012. E4 012. E4 012. E4 013. E4 014. E4 015. E4 014. E4 015. E4 015	001. E4 011. E4 01.	Reported: 11	
10 10 10 10 10 10 10 10 10 10	10 1 0.1 0.01 0.001 1.1 0.1 0	SIZE PASSIN	Frost Classification: F4
10 1 0.0 1 0	10 1 0.01 0.01 Particle Size (mu)	+3 in Not Included in	
10 1 0.01 0.01 0.01 10 1 0.1 0.01 0.01	10 1 0.01 0.01 0.01 10 1 0.01 0.01 0.01	<u></u>	#2) #11
10 1 0.01 0.01	10 1 0.01		
10 1 0.01	10 1 0.01		
10 1 0.01 0.01	10 1 0.01	i	
I0 1 0.01 0.01 Particle Size (mm)	10 1 0.1 0.01 Particle Size (mm)		80%
10 1 0.01 0.01	I0 I 0.01 0.01		
10 1 0.01 0.01 Particle Size (mm) 0.01 0.01 0.001	10 1 0.01 0.01 Particle Size (mm) 0.01 0.01 0.01	4	
10 1 0.01	IO 1 0.01 0.001 Particle Size (mm)	Total Wt. = 0g	
10 1 0.01 0.01	I0 1 0.01 0.001 Particle Size (mm)	No. 8	
10 1 0.01 0.001 Particle Size (mn)	10 1 0.01 0.01 Particle Size (mm) 0.01 0.01 0.001		
I0 I 0.1 0.01 Particle Size (mm)	I0 I 0.01 0.001		
10 1 0.01 0.001 Particle Size (mm)	10 1 0.01 0.001 Particle Size (mm)		
I0 1 0.01 0.001 Particle Size (mm)	10 1 0.01 0.001 Particle Size (mm)		
10 1 0.01 0.001 Particle Size (mm)	10 1 0.01 0.001 Particle Size (mm)		
10 1 0.01 0.001 Particle Size (mm)	I0 I 0.01 0.001 Particle Size (mm) Particle Size (mm) Particle Size (mm)		
IO I 0.1 0.01 0.001 Particle Size (mm) 0.001 0.001 0.001 0.001	10 1 0.1 0.01 0.001 Particle Size (mm) Particle Size (mm) Particle Size (mm) Particle Size (mm)		10%
10 1 0.1 0.01 0.001 10 11 11 11 11 11 11 11 11 11 11 11	10 1 0.1 0.01 0.001 10 Particle Size (mm)	_	
10 1 0.1 0.01 0.001 Particle Size (mm)	10 1 0.1 0.01 0.001 Particle Size (mm)		0% Letter 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1
Particle Size (mm)	Particle Size (mm)	0.01 0.001	
		<u></u>	🕽 Alaska Testlab, 1999

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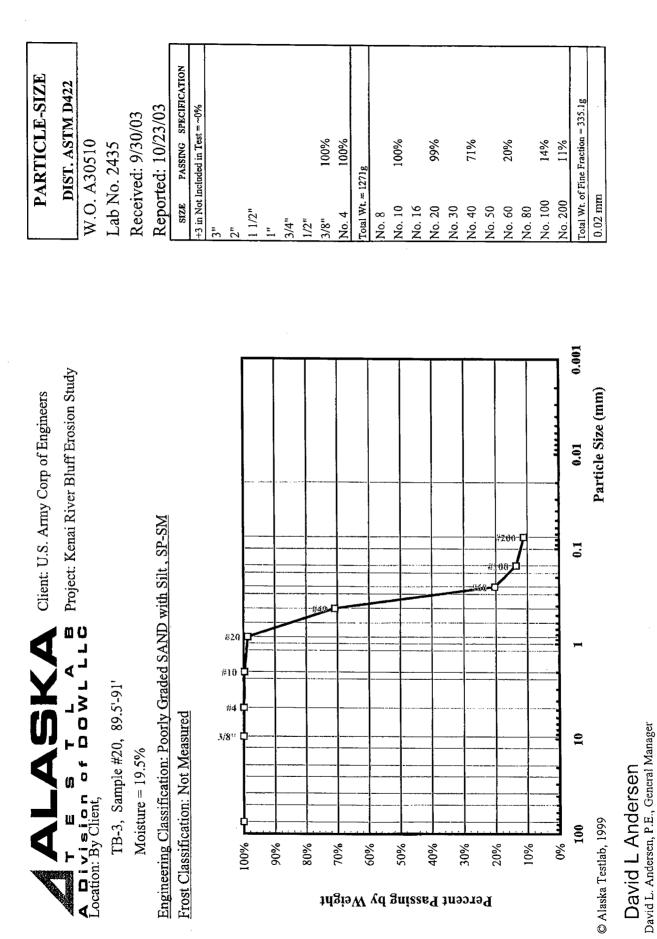
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u U	DIST. ASTM D422
Location: By Client,	W.O. A30510
TB-3, Sample #17, 74.5'-76'	Lab No. 2434
Moisture = 17.2%	Received: 9/30/03
Engineering Classification: CLAY with Sand, CL	Reported: 11/26/03
Frost Classification: F4	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = ~0%
37	3"
# #2 #10 #4	2"
	1 1/2"
/=i	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. 200 73%
	1 0 (21 W (. 01 FING FIZCTION = 394.18
Particle Size (mm)	0.02 mm

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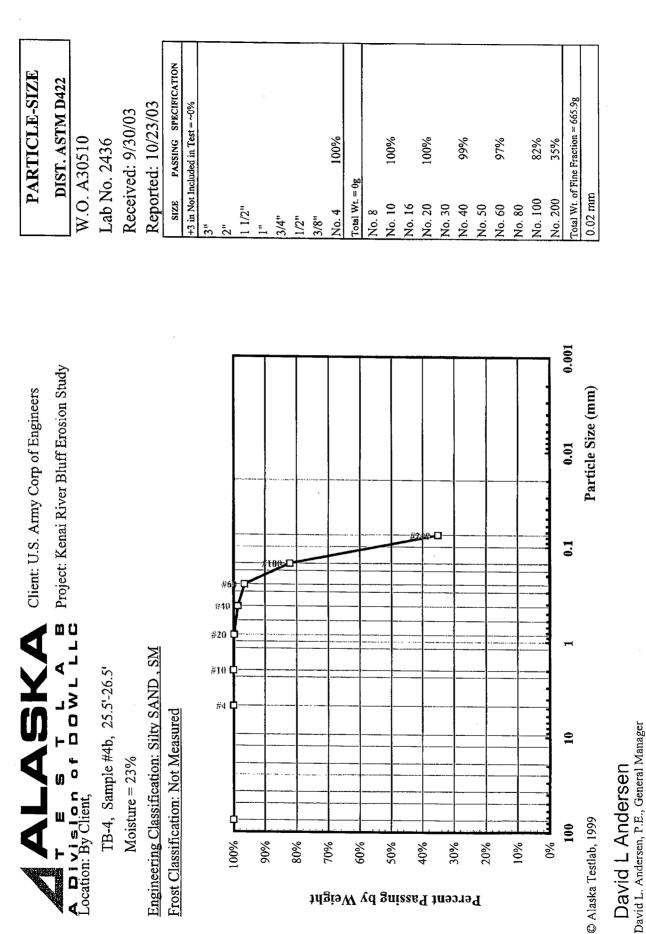
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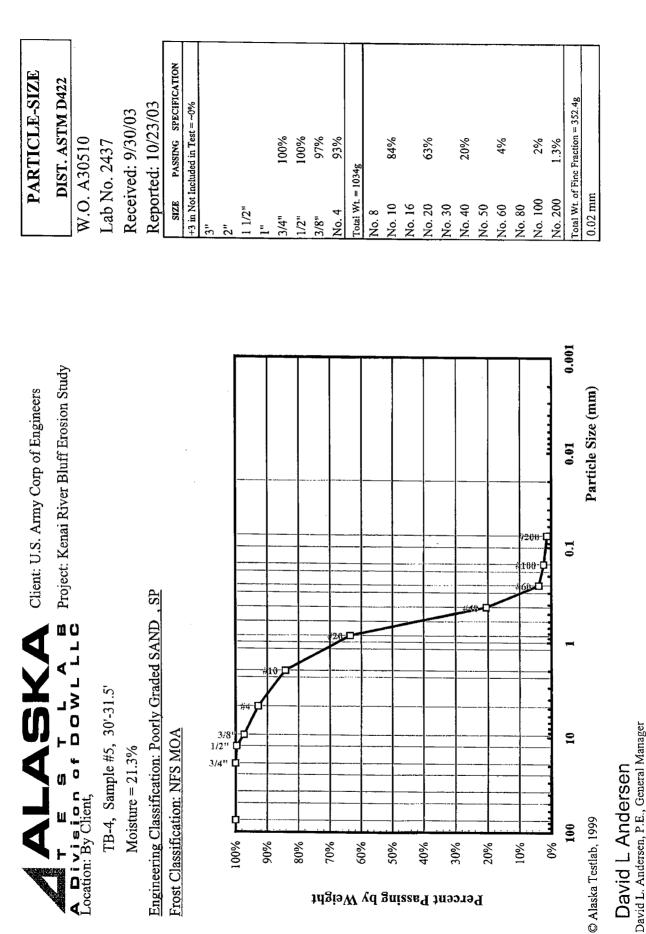
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	DIST. ASTM D422
Location: By Client,	W.O. A30510
TB-4, Sample #6, 35'-	Lab No. 2438
Moisture = 14.5%	Received: 9/30/03
Engineering Classification: Poorly Graded GRAVEL with Sand, GP	Reported: 10/23/03
Frost Classification: NFS MOA	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = $\sim 0\%$
1 1/2	3"
	2"
	1 1/2" 100%
	1" 98%
	3/4" 93%
	1/2" 83%
	3/8" 73%
3i9	No. 4 50%
	Total Wt. = 1374g
	No. 8
20%	No. 10 35%
ISSE	No. 16
4 10%	No. 20 24%
	No. 30
	No. 40 14%
20%	No. 50
	No. 60 6%
	No. 80
	No. 200 1.8%
TA'A Y'A T AT	Total Wt. of Fine Fraction = 338.7g
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Client: U.S. Army Corp of Engineers	PARTICLE-SIZE
T E S T L A B Project: Kenai River Bluff Erosion Study	DIST. ASTM D422
Location: By Client,	W.O. A30510
TB-4, Sample #14, 95'-96.5'	Lab No. 2439
Moisture = 19.9%, Non Plastic	Received: 9/30/03
Engineering Classification: Poorly Graded SAND , SP	Reported: 10/23/03
Frost Classification: NFS MOA	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = ~0%
#2 #1 #4	3"
FF	1 1/2"
	1"
	3/4"
80%	1/2"
	No. 4 100%
	Total Wt. $= 0g$
	No. 8
50%	No. 10 97%
	No. 16
4 J/w	No. 20 96%
30%	No. 30
GELC	No. 40 83%
	No. 50
	No. 60 15%
	No. 80
	No. 200 1.7%
	Total Wt. of Fine Fraction = 327.2g
© Alaska Testlah 1999 Particle Size (mm)	0.02 mm

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

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י עס	DIST. ASTM D422
	W.O. A30510
TB-4, Sample #15, 100'-101.5'	Lab No. 2440
Moisture = 26.5%	Received: 9/30/03
Engineering Classification: CLAY, CL	Reported: 11/26/03
Frost Classification: F4	SIZE PASSING SPECIFICATION
	+3 in Not Included in Test = ~0%
#11 46 #44 #10 #4	3" 2"
	2 1/2"
* 7	
	3/4"
80%	1/2"
	3/8"
10%	No. 4 100%
	Total Wt. = 0g
	No. 8
50%	No. 10 100%
40%	No. 20 100%
30%	
	No. 40 99%
20%	No. 50 No. 60 90%
0% 100 10 1 0.1 0.01 0.001	No. 200 92% Total Wt. of Fine Fraction = 332.4e
© Alaska Testlah 1999 Particle Size (mm)	0.02 mm

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