SUSITNA HYDROELECTRIC PROJECT

1982 SUPPLEMENT

TO

THE 1980-81 GEOTECHNICAL REPORT

VOLUME 2

APPENDICES

DECEMBER 1982

Prepared by:

ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

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TO

THE 1980-81 GEOTECHNICAL REPORT

VOLUME 2

APPENDICES

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ALASKA POWER AUTHORITY

APPENDIX A
WATANA RELICT CHANNEL/ BORROW SITE D-DRILLING LOGS

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS

BUFFALO, NEW YORK

DRILLING REPORT LEGEND SHEET (EXPLANATION IN ITALICS)

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-27

SITE: Borrow Site D — SHEET NO. 1 OF 13

CONTRACTOR: Denali Drilling Inc.

STARTED 5:30 P.M. September 5 19 82

FINISHED 3:00 P.M. September 17 19 82

METHOD OF DRILLING: SOIL Rotary Casing; 3-7/8 and 2-15/16" Tricone

ROCK NQ Core Barrel with Diamond Bit

CASING DIAM. HW, 4-1/2" O.D. 4" I.D.

CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,231,126; DEPARTURE E 749,709; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2148.8'; GROUND SURFACE 2148.8'; ROCK SURFACE -; BOTTOM OF HOLE 1953.8'; WATER TABLE

ALL DEPTHS VERTICAL FROM TOP OF GROUND

DEPTH (FEET)	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra vegetation and surficial soils						
5	Sand	Brown, gravelly. Little silt. Mostly fine grained with some coarser sand. Coarse, subangular gravel. Medium density. Moist. Temperature 4°C.	1	AS	2-1/2	5.0 to 7.0	5	16 13 7 7

SOIL DESCRIPTION

SAMPLE NUMBER — *SHIPPING CONTAINER (SEE BELOW)* — *SAMPLING METHOD (SEE BELOW)* — *DIAMETER OF SAMPLE (INCHES)* — *SAMPLE DEPTH (FEET)* — *LENGTH OF SAMPLE RECOVERED (INCHES)* — *BLOWS TO DRIVE 3" O.D. SAMPLER 6" W/300# HAMMER. N VALUE IS CALCULATED IN ACCORDANCE WITH ASTM D1586-67*

* SAMPLING METHOD
- A - SPLIT TUBE
- B - THIN WALL TUBE
- C - PISTON SAMPLER
- D - CORE BARREL
- E - AUGER
- F - WASH

SHIPPING CONTAINER
- N - INSERT
- O - TUBE
- P - WATER CONTENT TIN
- Q - GLASS JAR
- R - CLOTH BAG
- S - PLIOFILM BAG
- Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.G. Adams

APPROVED [signature]

DATE 12/6/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE: Borrow Area D — SHEET NO. 1 OF 6

CONTRACTOR: Denali Drilling Co. — STARTED 7:15 A.M. July 13 1982; FINISHED 7:30 A.M. July 19 1982
METHOD OF DRILLING: SOIL Hollow Stem Auger; ROCK — CASING DIAM. — CORE DIAM.

LOCATION: LATITUDE N 3,235,761; DEPARTURE E 750,190; BEARING -; INITIAL DIP 90°; OTHER DIPS None
ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2313.9'; GROUND SURFACE 2313.9'; ROCK SURFACE -; BOTTOM OF HOLE 2229.9'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0–2	Surficial Deposits	Boulders with organics, roots. Peat to 1 ft depth.		No Sampling				
3–4	Sand	Light brown to tan, silty, clayey, non-plastic. Water content approximately 9%, poorly graded. Occasional gravel throughout. (Outwash)	1	AQ	2-1/2	2.5 to 4.0	17	28 23 14
5–6			2	AQ	2-1/2	5.0 to 7.0	18	5 5 5 6
7–9			3	AQ	2-1/2	7.0 to 9.0	17	5 7 6 6

*SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH
SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - POLYFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf
LOGGED BY R.G. Adams
APPROVED [signature]
DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE: Borrow Area D — SHEET NO. 2 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
10–11	Sand	Brown to gray brown, silty, clayey, some gravel. Gravel rounded to subangular.	4	AQ	2-1/2	9.0 to 11.0	14	4 5 6 7
12–13			5	AQ	2-1/2	11.0 to 13.0	9	5 7 10 11
14–15			6	AQ	2-1/2	13.0 to 15.0	12	5 4 7 15
15–16		Cobbles in spoon causing poor recovery.	7	AQ	2-1/2	15.0 to 17.0	3	14 14 15 22
17–18			8	AQ	2-1/2	17.0 to 19.0	15	9 12 12 17
18–20			9	AQ	2-1/2	19.0 to 21.0	18	9 13 19 11
20–22	Silt	Gray brown, with many cobbles and boulders, dense. Coarse fraction subangular to subrounded. Moisture content approximately 10%.	10	AQ	2-1/2	21.0 to 23.0	11	7 9 12 17
23–25			11	AQ	2-1/2	23.0 to 25.0	15	20 15 50 50/.1

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE Borrow Area D — SHEET NO. 3 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Silt (cont)	Boulder zone 25 to 29 ft. One boulder approximately 3 ft in diameter.						
26					No Sampling Due to Boulders			
27								
28								
29								
30			12	A	2-1/2	29.0 to 31.0	0	22 38 30 38
31								
32		Cobbles and boulders jamming sampling spoon, therefcre, poor recovery.						
33			13	AQ	2-1/2	32.0 to 34.0	3	23 17 19 16
34								
35	Clay	Gray with trace sand and other fine gravel. Stiff to very stiff, some mottling, water content approximately 30%. Temperature approximately 7°C.	14	AQ	2-1/2	34.0 to 35.5	14	3 9
36			15	AQ	2-1/2	35.5 to 37.0	24	7 10 11
37		Ice Lenses At:						
38		35.5 ft - 2 inches 36.5 ft - 3-1/2 inches 37.0 ft - 3 inches 39.5 ft - 1 inch	16	AQ	2-1/2	37.0 to 39.0	24	6 4 4 6
39								
40			17	AQ	2-1/2	39.0 to 41.0	24	4 4 5 8
41								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE Borrow Area D — SHEET NO. 4 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Clay	Gray, stiff, moist to wet, plastic. Contains thin tan interlaminations. Moisture content 33%.	18	AQ	2-1/2	41.0 to 43.0	18	3 5 8 9
42								
43		(Lacustrine)						
44			19	AQ	2-1/2	43.0 to 45.0	8	3 5 6 8
45								
46			20	AQ	2-1/2	45.0 to 47.0	21	4 6 9 11
47		Trace fine sand in thin interlaminations.						
48			21	AQ	2-1/2	47.0 to 49.0	24	3 6 6 8
49								
50		Frozen at 50 ft, temperature -2°C.	22	AQ	2-1/2	49.0 to 51.0	24	3 4 6 7
51								
52			23	AQ	2-1/2	51.0 to 53.0	24	3 7 6 13
53								
54			24	AQ	2-1/2	53.0 to 55.0	24	4 5 6 9
55								
56		Becomes varved, pronounced laminations.	25	AQ	2-1/2	55.0 to 57.0	24	7 8 8 10
57								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE Borrow Area D — SHEET NO. 5 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
57	Clay (cont)	Gray, stiff, laminated with thin layers of fine sand, moist, water content 28%.	26	AQ	2-1/2	57.0 to 59.0	24	6 7 8 11
58								
59			27	AQ	2-1/2	59.0 to 61.0	24	3 7 11 21
60								
61			28	AQ	2-1/2	61.0 to 63.0	24	5 8 11 18
62								
63			29	AQ	2-1/2	63.0 to 65.0	24	6 9 16 19
64								
65			30	AQ	2-1/2	65.0 to 67.0	24	8 12 12 24
66								
67			31	AQ	2-1/2	67.0 to 69.0	24	8 12 16 24
68		Gray, stiff, mottled with increased gravel content.						
69			32	AQ	2-1/2	69.0 to 70.4	16	7 15 50/.4
70								
71								
72	Gravel	Gray-brown, alternating layers of sand, gravel, and	33	AQ	2-1/2	72.0 to	15	10 41
73								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-15
SITE Borrow Area D — SHEET NO. 6 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
73	Gravel (cont)	cobbles, subrounded to sub-angular.	33	(continued)		73.5		50/.3
74			34	AQ	2-1/2	74.0-74.5	0	3
75			35	AQ	2-1/2	74.5 to 76.0	9	5 7 17
76								
77								
78			36	A	2-1/2	76.0	0	Refusal
79		Refusal encountered due to numerous cobbles. No samples obtained.						
80								
81								
82			37	A	2-1/2	81.0	0	Refusal
83								
84		Bottom of Hole 84 Ft. (Not Bedrock)						
85								
86								
87								
88								
89								

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-16 (A&B)
SITE: Borrow Site D — SHEET NO. 1 OF 13

CONTRACTOR: Denali Drilling Inc. — STARTED 2:45 P.M. July 15 1982 — FINISHED 3:30 P.M. July 27 1982

METHOD OF DRILLING: SOIL Hollow Stem Auger (to 22 ft) Rotary Casing and 3-7/8" Tricone — CASING DIAM. HW 4" I.D.
ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. 4-1/2" O.D.

LOCATION: LATITUDE N 3,233,517; DEPARTURE E 751,997; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2271.3'; GROUND SURFACE 2271.3'; ROCK SURFACE 2100.8'; BOTTOM OF HOLE 2078.3'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial	Boulders and organic silts.						
1								
2								
3	Sand	Tan, loose to medium, well graded, moist. Cobbles and gravel throughout. Moisture content approximately 12%. Temperature approximately 5°C.	1	AS	2-1/2	3.0 to 5.0	13	3 5 9 8
4								
5			2	AS	2-1/2	5.0 to 7.0	16	4 3 5 5
6								
7			3	AS	2-1/2	7.0 to 7.7	4	10 50/2
8								
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf
LOGGED BY R.C. Powell
APPROVED J. Powell
DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-16 (A&B)
SITE: Borrow Site D — SHEET NO. 2 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Tan, fine to coarse with gravel and cobbles throughout. Coarse fraction subangular to subrounded.	4	AS	2-1/2	9.0 to 11.0	17	3 5 8 8
10								
11			5	AS	2-1/2	11.0 to 13.0	17	6 8 11 15
12								
13			6	AS	2-1/2	13.0-13.5	6	9/6
14								
15		Frequent refusal due to numerous cobbles.	7	AS	2-1/2	15.0 15.7	7	13 20/1
16								
17		Temperature 9°C	8	AS	2-1/2	17.0-17.2	2	21/2
18								
19		Temperature 9°C.	9	AS	2-1/2	19.0-19.7	4	19 27/2
20								
21								
22			10	AS	2-1/2	21.8 to 23.0	7	21 50 32/2
23		Temperature 11°C.						
24								
25			11	AS	2-1/2	24.0 to 25.4	3	35 43 53/5

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CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 3 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand (cont)	Tan, fine to medium with angular and subangular gravel. Moisture content approximately 11%. Temperature 11-15°C. 4 inch gravel layer at 26 ft.	11	(continued)				
26			12	AS	2-1/2	26.2 to 28.2	18	18 31 31 49
27								
28			13	AS	2-1/2	28.2-28.6	3	57/5
29	Clay	Gray, silty with gravel throughout. Gravel subangular to subrounded. Some gravel striated. Clay matrix stiff, temperature 11°C. Moisture content approximately 13%.	14	AS	2-1/2	29.0 to 31.0	18	17 29 35 41
30								
31			15	AS	2-1/2	31.0 to 31.9	15	43 50/5
32								
33			16	AS	2-1/2	33.0-33.4	2	55/5
34								
35			17	AS	2-1/2	34.0 to 36.0	18	30 24 45 62
36								
37		Boulders and cobbles throughout. Clay matrix very stiff.	18	AS	2-1/2	36.0 to 38.0	24	15 31 47 82
38			19	BS	3	38.0-38.2	2	N/A
39		Temperature 7°C.	20	AS	2-1/2	38.2-39.2	12	26 84
40								
41			21	AS	2-1/2	40.0 to 42.0	24	5 38

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CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 4 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Clay (cont)	Gray, silty with subangular gravel throughout. Very stiff, temperature 0°C.	21	(continued)				55 89
42			22	AS	2-1/2	42.0 to 43.5	22	37 33 95
43								
44	Sand	Tan, with alternating layers of gravel and cobbles 6 to 10 inches thick. Temperature 3°C, moisture content approximately 13%.						
45			23	AS	2-1/2	44.0 to 45.6	24	20 28 83 50/1
46								
47			24	AS	2-1/2	46.0 to 47.9	22	15 34 46 50/1
48								
49		Gravel portion subrounded to subangular. Stratification of fine and coarse sands.	25	AS	2-1/2	48.0 to 49.5	2	26 38 61
50			26	AS	2-1/2	49.5 to 50.8	2	35 41 70/3
51			27	AS	2-1/2	51.0-51.3	2	40/4
52								
53			28	AS	2-1/2	52.0-52.7	5	20 50/2
54		Gravel layer 54.2 to 54.9.	29	AS	2-1/2	54.0 to 55.7	22	22 33 58 50/2
55								
56			30	AS	2-1/2	56.0-56.8	6	35 50/3
57								

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CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 5 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
58	Sand (cont)	Tan with alternating gravel layers, wet.						
59			31	AS	2-1/2	58.0 to 59.8	15	16 32 41 50/4
60	Sand	Tan, fine to medium, silty, laminated, wet to saturated. Occasional gravel, dense.						
61			32	AS	2-1/2	60.0 to 61.3	8	38 37 60/4
62			33	AS	2-1/2	61.5 to 62.8	5	18 50 55/3
63								
64			34	AS	2-1/2	63.0 to 65.0	7	41 63 72 61
65		Silty, sandy clay layer 65 to 67 ft, laminated, very stiff.						
66			35	AS	2-1/2	65.0 to 67.0	17	9 16 22 21
67	Sand	Gray brown, fine to coarse with subrounded to subangular gravel throughout. Temperature approximately 2°C, moisture content approximately 18%.						
68			36	AS	2-1/2	67.0 to 69.0	18	9 22 31 42
69								
70			37	AS	2-1/2	69.0 to 71.0	24	7 24 45 61
71								
72			38	AS	2-1/2	71.0 to 73.0	17	2 15 16 31
73								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 6 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
73	Sand (cont)	Gray brown, fine to coarse, silty with gravel throughout. Moisture content approximately 5%.	39	A	2-1/2	73.0 to 75.0		10 32 41 49
74								
75			40	AS	2-1/2	75.0 to 77.0		8 25 23 26
76								
77								
78	Sand	Greenish gray, silty, clayey with numerous cobbles, boulders. Coarse fraction subangular. Very dense to hard. Moisture content approximately 12%.						
79								
80			41	AS	2-1/2	80.0 to 81.5		28 28 75/.5
81								
82			42	AS	2-1/2	81.7-82.0		50/.3
83								
84		Numerous cobbles and boulders.	43	AS	2-1/2	83.0 to 84.3		57 53 90/.3
85								
86			44	AS	2-1/2	85.0 to 85.7		40 50/.2
87			45	AS	2-1/2	86.0-87.0		26 70/.5
88			46	AS	2-1/2	87.0-87.5		68/.5
89								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-16 (A&B)
SITE Borrow Site D — SHEET NO. 7 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
90	Sand (cont)	Greenish-gray, silty, very dense to hard. Numerous cobbles and boulders throughout. Moisture content approximately 8%.	47	AS	2-1/2	89.0-89.3	3	50/.3
91								
92			48	AS	2-1/2	91.3 to 92.0	5	47 50/.2
93								
94			49	AS	2-1/2	94.0 to 94.7	3	30 50/.2
95		Difficult sampling due to numerous cobbles.						
96			50	AS	2-1/2	96.0-96.4	2	50/.4
97								
98			51	AS	2-1/2	98.0-98.5	2	65/.5
99								
100		Clayey, silty, 100 to 102 ft.						
101			52	AS	2-1/2	100.3 to 101.6	7	25 69 80/4
102								
103			53	AS	2-1/2	102.0 to 102.8	2	40 80/4
104		Silty.						
105			54	AS	2-1/2	104.0-104.8	2	48 50/3

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-16 (A&B)
SITE Borrow Site D — SHEET NO. 8 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
105	Sand (cont)	Gray, silty, gravelly. Very dense to hard. Moist.						
106		106.5-109.5 Gravelly.						
107			55	AS	2-1/2	106.5 to 107.2	[illegible]	46 50/[illegible]
108								
109			56	AS	2-1/2	108.0 to 108.7	[illegible]	31 65/3
110								
111								
112	Clay	Dark gray, silty with some fine to coarse sand, gravel to 2 inches. Very stiff. Moisture content 22%.	57	AS	2-1/2	112.0-112.6	[illegible]	33 50/1
113								
114								
115								
116								
117		Thinly laminated clay. Temperature 11°C.	58	AS	2-1/2	116.0 to 118.0	[illegible]	11 14 18 26
118								
119		Silty. Occasional over-consolidated clay pieces.	59	AS	2-1/2	118.0 to 120.0	[illegible]	10 13 20 25
120		Temperature 9°C.	60	AS	3	120.0-121.6	[illegible]	N/A

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55 AH-D-16
PROJECT Susitna Hydrorlectric Project — HOLE NO. (A&B)
SITE Borrow Site D — SHEET NO. 9 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Clay (cont)	Light to dark gray clay. Silty. Thin to medium laminations present in some zones. Very stiff. Moisture content 31%. Temperature 10°C at 124.	60	(continued)				
122								
123								
124			61	AS	2-1/2	124.0 to 126.0	24	10 15 19 32
125								
126								
127		Lamination more pronounced. Medium to thin in thickness.						
128			62	AS	2-1/2	128.0 to 130.0	19	10 15 25 38
129								
130								
131								
132			63	AS	2-1/2	132.0 to 133.5	18	10 13 23
133								
134								
135								
136		Temperature 9°C.	64	AS	2-1/2	136.0 to 137.5	18	9 13 23
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55 AH-D-16
PROJECT Susitna Hydroelectric Project — HOLE NO. (A&B)
SITE Borrow Site D — SHEET NO. 10 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Clay (cont)	Light to dark gray clay. Silty, laminated (medium to thin). 2-inch piece of overconsolidated clay present in sample. Very stiff. Moisture content 32%.	64	(continued)				
138								
139								
140			65	AS	2-1/2	140.0 to 141.5	18	10 16 19
141								
142		Laminations range from thin to medium in thickness.						
143								
144			66	AS	2-1/2	144.0 to 145.5	18	10 14 22
145								
146		Silty, medium laminated. Moisture content 28%.						
147								
148	Silt	Dark gray silt. Fine to coarse sands and gravels present. Denst to very dense. Moisture content 19%. Gravel is subrounded to angular.	67	AS	2-1/2	148.0 to 149.2	14	8 76 50/2
149								
150								
151			68	AS	2-1/2	151.0 to 152.0	10	24 88
152		Clayey, trace fine to coarse sand. Faint laminations.						
153								

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CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 11 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
153	Silt (cont)	Gray silt. Clayey. Some to trace of sand (fine to coarse grained, trace subrounded to subangular gravel. Moisture content 15%.	69	AS	2-1/2	153.0 to 154.4	17	24 29 60/5
154								
155			70	AS	2-1/2	155.0 to 156.0	12	22 65
156								
157	Clay	Olive gray clay. Silty. Little fine to coarse sand; trace fine gravel. Very stiff to hard. Mottled. Gravel to 2 inches in size.	71	AS	2-1/2	157.0 to 158.5	18	20 21 65
158								
159			72	AS	2-1/2	159.0 to 160.9	19	16 24 47 50/5
160								
161								
162								
163		Gravel to 1 inch; subangular to angular.	73	AS	2-1/2	163.0 to 164.1	10	12 21 50/1
164								
165								
166								
167	Silt	Olive gray silt, clayey. Trace fine to medium grained sand. Occasional layers of dark yellow to orange over consolidated clay.	74	AS	2-1/2	167.0 to 168.4	17	11 25 50/5
168								
169								

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CLIENT ALASKA POWER AUTHORITY
PROJECT Susitna Hydroelectric Project
SITE Borrow Site D

JOB NO. P5700.55
HOLE NO. AH-D-16 (A&B)
SHEET NO. 12 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
169	Silt (cont)	Clayey with trace sand.						
170								
171	Bedrock/ Quartz Diorite		75	A	2-1/2	171.0-171.1	[illegible]	40/1
172								
173		Quartz diorite. Weathered, fractured. Light gray, medium to coarse grained. 10 to 15% quartz. RQD 10%.						
174								
175			76	DY	1-7/8	174.0 to 179.0	60	-
176		Fresh to slightly weathered at end of run.						
177								
178								
179		Weathered, fractured.						
180		RQD 0%.						
181		Decomposed zone; sandy.	77	DY	1-7/8	179.0 to 183.3	57	-
182	Mafic Dike	Dike material very fractured and highly weathered.						
183	Argillite	Dark gray, fine-grained, fractured. RQD 0%. Ironing staining on some fractures.	78	DY	1-7/8	183.3 to 188.3	60	-
184								
185								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-16 (A&B)
SITE Borrow Site D — SHEET NO. 13 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
185	Argillite (cont)	Full recovery this run.	78	(continued)				
186								
187		Less weathered.						
188								
189		Dark gray, fractured, recrystallized. Less fracturing in this run. Iron staining present on some fractures. Slightly weathered.	79	DY	1-7/8	188.3 to 193.0	57	-
190								
191								
192								
193		Bottom of Hole 193 ft						
194		* Piezometer installed in hole at 150 ft.						
195								
196								
197								
198								
199								
200								

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CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-17

SITE: Borrow Site D — SHEET NO. 1 OF 15

CONTRACTOR: Denali Drilling Inc. — STARTED 4:30 P.M. July 19 19 82; FINISHED 11:30 A.M. August 1 19 82

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone to 198.0'; 2-15/16" Tricone — CASING DIAM. HW, 4" I.D. 4-1/2" O.D.
ROCK NQ Core Barrel From 198.0' to 217' — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,237,891; DEPARTURE E 752,193; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2383.1'; GROUND SURFACE 2383.1'; ROCK SURFACE 2165.1'; BOTTOM OF HOLE 2153.1'; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0–1	Surficial Deposits	Boulders, cobbles, organics. Roots. Fiberous.		No Sampling				
1–3	Silt	Brown to tan, sandy, gravelly, trace clay. Sand is fine to coarse grained. Gravel subrounded to angular to 2 inches. Unsorted.	1	AS	2-1/2	2.0 to 4.0	14	3 3 4 4
4–6	Sand	Light brown to tan, silty. Fine to coarse grained. Well graded. Moist. Medium consistency.	2	AS	2-1/2	4.0 to 6.0	16	8 11 9 9
6–8		Gravelly, silty. Gravel is subrounded to subangular and fine to medium grained. Moist.	3	AS	2-1/2	6.0 to 8.0	15	6 7 6 10
8–9	Silt	Brown to tan, sandy, gravelly. Well graded. Stiff.	4	AS	2-1/2	8.0-10.0	15	10 9

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.G. Adams

APPROVED

DATE 1/7/82

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CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-17

SITE: Borrow Site D — SHEET NO. 2 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9–10	Silt (cont)	Brown to tan, sandy, gravelly. Sand fine to coarse grained. Fine subangular gravel. Well graded. Moist. Very stiff.	4	(continued)				12 16
10–11			5	AS	2-1/2	10.0 to 12.0	1'	12 20 24 34
12–13		Brown, gravelly, sandy. Very stiff to hard.	6	AS	2-1/2	12.0 to 13.9	1'	19 35 32 50/.4
14–15		Poorly graded.	7	AS	2-1/2	14.0 to 15.3	4"	16 38 50/.3
16–17		Brown, gravelly, sandy. Sand fine to coarse grained. Gravel medium grained, angular to subrounded. Poorly graded. Very stiff to hard. Moist.	8	AS	2-1/2	16.0 to 17.3	1'	16 34 50/.3
18–19			9	AS	2-1/2	18.0 to 18.8	11"	26 50/.3
20–21		Rock fragments present in sample.	10	AS	2-1/2	20.0-20.6	6"	24 50/.1
22–23		Brown to gray, gravelly, sandy. Sand medium to coarse grained. Gravel fine to coarse grained (subrounded to subangular). Poorly graded. Hard. Moist.	11	AS	2-1/2	22.0 to 22.7	7"	18 50/.2
24–25			12	AS	2-1/2	24.0 to 26.0	16"	18 29

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 3 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Silt (cont)	Brown to gray, gravelly, sandy. Medium grained gravel subrounded to angular. Sand medium to coarse grained. Poorly graded. Hard. Moist.	12	(continued)				
26			13	AS	2-1/2	26.0 to	16	37 33 42 44
27								
28		Trace clay. Gravel is subrounded to subangular.	14	AS	2-1/2	28.0 to 29.3	8	33 45 50/.3
29								
30			15	AS	2-1/2	30.0 to 30.7	7	14 50/.2
31								
32		Gravel subrounded to angular.						
33		Brown, hard, moist. Poorly graded.	16	AS	2-1/2	32.0 to 33.3	16	31 47 50/.3
34		Boulder from 34.8 ft to 36.8 ft.						
35			17	AS	2-1/2	34.0 to 34.7	8	20 50/.3
36								
37								
38	Sand	Gray brown, silty, gravelly. Trace clay. Gravel mostly angular. Some cobble fragments at 40.0 ft. Very hard.						
39								
40								
41			18	AS	2-1/2	40.0 to 41.0	12	63 90/.5

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 4 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Gray-brown, gravelly. Some silt. Trace clay. Sand fine to coarse grained. Cobble fragments. Very hard. Boulder 42.9 ft to 45.3 ft.						
42			19	AS	2-1/2	42.0 to 42.9	5	31 80/.4
43								
44								
45		Gravel angular to subangular. Very hard. Cobble fragments present throughout.	20	AS	2-1/2	45.3-45.7	5	100/.4
46								
47								
48		48.0-53.0 ft Occasional cobbles. Gravel content increased.	21	AS	2-1/2	48.0-48.4	5	50/.4
49								
50								
51								
52								
53		Tan-gray, silty, gravelly. Trace clay. Fine to coarse grained. Gravel fine to coarse grained and angular to subangular. Occasional cobbles. Very hard.	22	AS	2-1/2	53.0-53.7	18	30 50/.2
54								
55								
56								
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 5 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
57	Sand (cont)	Tan-gray, gravelly, silty. Trace clay. Fine to coarse grained. Gravel fine to coarse grained (angular to subangular). Occasional cobbles. Very dense.						
58			23	A	2-1/2	58.0-58.1	0	50/.1
59								
60			24	AS	2-1/2	60.0-60.8	10	35 50/.3
61								
62		Boulders and cobbles.						
63								
64								
65			25	A	2-1/2	65.1-65.5	0	50/.4
66								
67		Rocks in hole causing no recovery in samples.						
68								
69								
70			26	A	2-1/2	70.0-70.2	0	50/.2
71								
72			27	A	2-1/2	72.0 to 73.3	0	22 48 50/.3
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 6 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
73	Sand (cont)	Tan-gray, gravelly, silty. Trace clay. Both sand and gravel fine to coarse grained. Very dense. Numerous cobbles.	27	(continued)				
74								
75			28	A	2-1/2	75.0-75.3	0	50/.3
76	Sand	Gray-brown. Fine grained. Laminated with thin layers of clay and silt. Trace medium grained gravel. Medium dense to dense. Moist.						
77			29	AS	2-1/2	77.0 to 77.8	14	14 50/.3
78								
79								
80		Fine to coarse grained. Well graded. Trace gravel.	30	AS	2-1/2	80.0 to 81.7	22	25 35 45 50/.2
81		81.0-81.7 ft Clayey, poorly graded. Gray-black. Moist.						
82								
83								
84		Gray, clayey, gravelly. Fine to coarse grained. Gravel is subangular to subrounded and fine to medium grained. Poorly graded. Moist to wet. Dense.						
85			31	AS	2-1/2	85.0 to 86.9	21	11 17 32 50/.4
86								
87								
88			32	AS	2-1/2	87.0 to 89.0	24	30 32 29 34
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17

SITE Borrow Site D — SHEET NO. 7 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Sand	Gray with brown areas, silty, clayey, gravelly. Poorly graded, unsorted. Moist. 90.0 ft change to dark gray color.	33	AS	2-1/2	89.0 to 90.6	19	17 25 49 50/.1
90								
91		Cobbles encountered.	34	A	2-1/2	91.0-91.4	0	50/.4
92								
93								
94		Dark gray, clayey. Trace gravel. Fine to coarse grained. Poorly graded. Dense. Moist.	35	AS	2-1/2	94.0 to 95.2	13	13 50 50/.2
95								
96	Sand and Clay	Gray, gravelly. Sand fine to coarse grained. Trace silt. Poorly graded. Moist.	36	AS	2-1/2	96.0 to 97.9	23	15 26 32 50/.4
97								
98	Sand	Gray, clayey, gravelly. Trace silt. Fine angular to subrounded gravel. Poorly graded. Dense. Moist.	37	AS	2-1/2	98.0 to 99.7	19	19 27 50 50/.2
99								
100			38	A	2-1/2	100.0 to 101.3	0	19 46 50/.3
101								
102			39	AS	2-1/2	102.0 to 102.8	7	44 50/.3
103	Cobbles and Boulders	Cobbles and boulders. No sampling due to coarseness of material.						
104								
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17

SITE Borrow Site D — SHEET NO. 8 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Cobbles and Boulders (cont)	Cobbles and boulders. No sampling due to coarseness of material.						
106								
107	Gravel	Gray, cobbly. Cobbles are small to large. Gravel ranges 1 to 2 inches and is subangular to subrounded. Very dense, coarse material. Sampling unproductive. Tri-coned to 120 ft.	39A	DS	1-7/8	107.0 to 110.0	23	-
108								
109								
110								
111								
112								
113								
114								
115								
116								
117								
118								
119								
120	Clay	Light gray. Laminated thinly with silt. Trace sand.	40	AS	2-1/2	120.0 to 120.7	6	21 50/.2
121								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 9 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Clay (cont)	Light gray. Laminated thinly with silt. Trace fine grained sand. Firm. Slightly plastic. Moist.						
122			41	AS	2-1/2	122.0 to 122.8	9	31 50/.3
123								
124		Dry to slightly moist.	42	A	2-1/2	124.0-124.5	0	75/.5
125	Gravel and Cobbles	Cobble and gravel. Zone is very dense. No sampling to 136.0 ft.						
126								
127								
128								
129								
130								
131								
132								
133								
134								
135								
136	Sand	Gray, silty, clayey, gravelly. Poorly graded. Moist to wet.	43	AS	2-1/2	136.0-136.4	5	50/.4
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 10 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Sand (cont)	Gray, silty, clayey, gravelly. Fine to medium grained. Gravel angular to 1-1/2 inches. Dense. Poorly graded. Moist to wet.						
138			44	A	2-1/2	138.0-138.4	0	82/.4
139								
140	Sand	Brown, trace silt. Fine to medium grained. Soft. Well graded. Moist.	45	AS	2-1/2	140.0 to 140.8	9	45 85/.3
141								
142								
143		Cobble zone. Triconed to less dense material.	45	A	2-1/2	142.0-142.9	0	47 85/.4
144								
145								
146								
147	Sand	Brown, gravelly, silty. Fine to coarse grained. Gravel (subangular to subrounded) to 1/2 inch. Poorly graded. Medium consistency. Wet.	47	AS	2-1/2	147.0-147.8	2	57 50/.3
148								
149								
150								
151								
152		1-1/2 inch Gravel pieces causing sample recovery problems.	48	A	2- 2	151.0 to 152.2	0	48 76 50/.2
153								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 11 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
153	Sand (cont)	Brown, gravelly, silty. Fine to coarse grained. Gravel angular to 1-1/2 inch. Poorly graded. Wet. Dense.						
154								
155			49	A	2-1/2	155.0-155.2	0	50/.2
156								
157								
158								
159								
160	Cobbles and Gravel	No sampling due to coarseness and density of material.						
161								
162								
163								
164	Sand	Gray, clayey. Trace of silt and gravel. Dense. Moist. Poorly graded.	50	AS	2-1/2	164.0-164.5	6	78/.5
165								
166								
167		Very cobbly.						
168								
169								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 12 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
169	Clay and Silt	Gray, gravelly (to 2 inch subrounded). Slightly sandy. Hard. Moist.	51	AS	2-1/2	169.0-169.3	3	[illegible]
170								
171								
172	Cobbles and Boulders	Very difficult drilling. No sampling due to coarseness and density of material. Triconed hole ahead to material change.						
173								
174								
175			52	A	2-1/2	175.0-175.5	0	[illegible]
176								
177								
178								
179								
180								
181								
182								
183								
184								
185								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 13 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
185	Clay	Gray and light gray. Laminated with 1/4 inch layers of silt. Trace to some sand. Some gravel. Dry to slightly moist. Hard.	53	AS	2-1/2	185.0 to 186.8	17	12 24 43 50/.3
186								
187								
188	Cobbles and Boulders	Very difficult drilling.						
189								
190								
191		Dark gray, coarse gravel and cobbles. Gravel ranges from 1/2 inch. Very hard. Cored through rock 191.0-191.6 ft.	54	DS	1-7/8	191.0-191.6	7	-
192								
193								
194								
195								
196								
197								
198		Cobbles and boulders.						
199								
200								
201								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 14 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
201	Cobbles and Boulders	Very rocky. Difficult drilling. No sampling due to coarseness and density of material.						
202								
203								
204								
205								
206								
207		207.0 - 210.0 Boulder						
208								
209								
210								
211		Hole advanced with 2-15/16 inch roller bit.						
212								
213								
214								
215								
216		Same material.						
217								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-17
SITE Borrow Site D — SHEET NO. 15 OF 15

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
217	Cobbles & Boulders (cont)		55	D	1-7/8	217.0 to 220.0	36	RQD 93%
218	Bedrock Diorite	Gray, 20-30% Mafics (biotite and hornblende). Medium grained plagioclose feldspar. No visible quartz. Fresh to slightly weathered. Very hard.						
219								
220			56	D	1-7/8	220.0 to 225.0	60	RQD 22%
221								
222		222.0 - 224.7 Fracture/ shear zone. Vertical joints. Trace slickensides. Some iron oxide staining on joint surfaces.						
223								
224								
225			57	D	1-7/8	225.0 to 230.0	60	RQD 44%
226								
227								
228		228.3 - 229.4 Trace clay on joint surfaces.						
229								
230		Bottom of Hole: 230 ft						
231								
232								
233								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-18

SITE: Borrow Site D — SHEET NO. 1 OF 13

CONTRACTOR: Denali Drilling Inc. — STARTED A.M. July 29 19 82; FINISHED A.M. August 19 82

METHOD OF DRILLING: SOIL Rotary Casing w/3-7/8" Tricone Bit; ROCK — CASING DIAM. HW, 4" I.D. 4" O.D.; CORE DIAM. NQ

LOCATION: LATITUDE N 3,235,590; DEPARTURE E 754,176; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2341.4'; GROUND SURFACE 2341.4'; ROCK SURFACE -; BOTTOM OF HOLE 2152.1'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Silt, cobbles, and boulders with organics.						
1								
2								
3								
4	Sand	Gray brown, dense, with little clayey silt, cobbles, and gravel. Subangular, well graded. Moisture content approximately 13%.	1	AS	2-1/2	3.5 to 5.5	12	29 40 20 10
5								
6			2	AS	2-1/2	5.5 to 7.5	19	6 9 18 14
7		Cobbles and gravel throughout.						
8			3	AS	2-1/2	7.5 to 8.5	10	17 17
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - RISERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.C. Powell

APPROVED

DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-18

SITE: Borrow Site D — SHEET NO. 2 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Gray-brown with silt, gravel, and cobbles. Well graded, dense.						
10			4	AS	2-1/2	9.5 to 10.4	12	16 50/.4
11								
12			5	AS	2-1/2	11.5-12.1	7	30 50/1
13		Continually drilling through gravel and cobbles.						
14								
15			6	AS	2-1/2	15.0 to 16.3	14	33 46 50/4
16								
17								
18		Thin ice lenses <1mm found below 17 ft.	7	AS	2-1/2	18.0-18.7	8	15
19								
20								
21								
22			8	AS	2-1/2	22.0 to 23.3	12	13 26 50/4
23								
24								
25								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 3 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
25	Silt	Gray, clayey with little sand, frozen, very dense. Moisture content approximately 12%.	9	AS	2-1/2	25.0 to 27.0	24	10 19 23 27
26								
27			10	AS	2-1/2	27.0-27.2	0	50/2
28								
29								
30			11	AS	2-/12	29.0 to 31.0	20	12 30 29 28
31								
32			12	AS	2-1/2	31.0 to 33.0	15	11 39 15 22
33								
34			13	AS	2-1/2	33.0 to 35.0	10	Not Recorded
35								
36			14	AS	2-1/2	35.0 to 36.5	15	17 32 50/6
37								
38			15	AS	2-1/2	37.0 to 38.4	10	16 37 50/5
39								
40			16	AS	2-1/2	39.0 to 40.4	11	12 38 50/5
41								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 4 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
41	Silt (cont)	Gray, clayey, with little sand. Very dense, frozen. Moisture content 15%.	17	AS	2-1/2	41.0 to 43.0	23	16 30 46 46
42								
43			18	AS	2-1/2	43.0 to 45.0	23	14 29 29 27
44								
45								
46	Sand	Brown, with gravel and cobbles, very dense. Coarse fragments subangular to subrounded.	19	AS	2-1/2	50.0-50.8	0	14 60/4
47								
48								
49								
50			20	AS	2-1/2	54.0 to 50.8	0	14 60/4
51								
52		Numerous cobbles and boulders causing difficulty in sampling.						
53								
54			21	AS	2-1/2	54.0-54.3	0	30/3
55								
56								
57								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 5 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
58	Sand (cont)	Brown, with numerous cobbles and boulders.						
59								
60			24	AS	2-1/2	59.0 to 60.3	0	7 30/3
61								
62								
63								
64		Very rocky, cannot drive sampler.						
65			23	AS	2-1/2	65.0-65.3	0	30/3
66								
67								
68								
69								
70			24	AS	2-1/2	70.0 to 71.3	9	17 40 60/4
71								
72								
73								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 6 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
74	Sand (cont)	Brown, very dense to hard with numerous cobbles and boulders.						
75			25	AS	2-1/2	75.0-76.0		50/.3
76		Some cobbles, subrounded to rounded.						
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								
88		Losing approximately 50% of drill water.						
89								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 7 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
89	Sand (cont)	Brown with numerous cobbles and boulders.						
90								
91								
92								
93		Performed falling head test and then mudded hole.						
94								
95								
96								
97								
98	Silt	Gray, clayey, with some fine to medium sand. Laminated, stiff to very stiff with occasional red-brown staining on laminations. Water content approximately 18%.						
99			26	AS	2-1/2	98.0 to 100.0	24	25 46 34 51
100								
101			27	AS	2-1/2	100.0 to 100.9	5	22 75/5
102								
103			28	AS	2-1/2	102.0 to 103.0	3	32 76
104								
105			29	AS	2-1/2	104.0-304.5	2	76/6

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 8 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
105	Silt	Gray, clayey, very dense, laminated.						
106			30	AS	2-1/2	106.0 to 107.8	18	13 13 31 60/4
107								
108		Some fine, angular gravel included.	31	AS	2-1/2	108.0-108.7	4	45 50/2
109								
110			32	AS	2-1/2	110.0 to 111.2	9	17 63 50/2
111								
112		Becomes sandy at 112 ft, olive gray, wet, dense. Weakly laminated.	33	AS	2-1/2	112.0 to 113.8	14	8 31 57 50/3
113								
114								
115		Alternating silt and sand continues.	34	AS	2-1/2	114.0 to 116.0	13	7 18 25 33
116								
117			35	AS	2-1/2	116.0 to 118.0	15	12 50 54 80
118		Faint traces of organics.						
119			36	AS	2-1/2	118.0 to 120.0	12	14 26 47 17
120								
121								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 9 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
121	Silt	Gray, clayey, laminated with little gravel.						
122								
123			37	AS	2-1/2	123.0-123.4	0	63/5
124								
125			38	AS	2-1/2	125.0-125.4	4	75/5
126								
127			39	AS	2-1/2	127.0-127.1	0	20/1
128	Clay	Gray, silty, gravelly, with angular and subangular gravel, very stiff. Gravel mainly diorite but some andesite and argillite as well as gravel dispersed throughout clay matrix. Moisture content approximately 13%.	40	AS	2-1/2	128.0	0	-
129			41	AS	2-1/2	129.0-129.3	0	50/3
130								
131								
132			42	AS	2-1/2	132.0 to 132.8	4	58 85/4
133								
134								
135			43	AS	2-1/2	135.0 to 136.3	15	12 22
136								
137								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 10 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
137	Clay (cont)	Gray, gravelly, sandy, gravel portion subangular, very stiff, moist.	44	AS	2-1/2	137.0-137.3	4	50/3
138								
139			45	AS	2-1/2	139.0-139.6	4	73 25/1
140								
141								
142			46	AS	2-1/2	142.0-142.3	2	65/4
143		Gravel layer 142-144 ft. Losing drill water.	47	AS	2-1/2	143.0-143.5	2	100/6
144								
145								
146								
147		Many cobbles and boulders.						
148								
149								
150								
151								
152			48	AS	2-1/2	152.0-152.6	6	32 50/1
153								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 11 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
154	Clay (cont)	Gray, silty, sandy, very dense. Numerous cobbles throughout.						
155			49	AS	2-1/2	155.0 to 155.9	0	7 50/5
156								
157	Silt	Gray, sandy, gravelly, moist, very dense.	50	AS	2-1/2	157.3-158.1	3	40 50/3
158								
159								
160			51	AS	2-1/2	160.0-160.4	5	62/5
161								
162		Difficult to sample due to gravel and numerous cobbles.	52	AS	2-1/2	162.5-162.7	1	31 50/2
163								
164								
165								
166			53	AS	2-1/2	166.0-166.0	5	52 30/1
167								
168			54	AS	2-1/2	168.0-168.8	6	17
169								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 12 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
169	Silt (cont)	Gray, sandy, with subangular gravel, very dense, moist. Water content approximately 14%.						
170								
171								
172			55	AS	2-1/2	172.0 to 173.0	2	32 84
173								
174								
175								
176			56	AS	2-1/2	176.0 to 177.3	5	17 14 55/4
177		Occasional weak laminations.						
178			57	AS	2-1/2	178.0 to 179.8	2	14 11 18 45/3
179								
180								
181			58	AS	2-1/2	181.0-181.3	3	80/4
182								
183								
184								
185								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-18
SITE Borrow Site D — SHEET NO. 13 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	
185	Silt (cont)	Gray, clayey, with some gravel dispersed throughout. Very dense, moist.	59	AS	2-1/2	185.0-185.4	1	92/5
186								
187								
188								
189			60	AS	2-1/2	189.0-189.3	0	65/4
190		Bottom of Hole 189.3 Ft. (No Bedrock)						

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-19

SITE: Borrow Site D — SHEET NO. 1 OF 14

CONTRACTOR: Denali Drilling Inc. — STARTED 9:00 A.M. August 3 19 82 — FINISHED 1:00 P.M. August 13 19 82

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone Bit — CASING DIAM. HW, 4" I.D. 4-1/2" O.D.

ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,233,072; DEPARTURE E 750,455; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2261.7'; GROUND SURFACE 2261.7'; ROCK SURFACE -; BOTTOM OF HOLE 2046.7'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE*	SIZE	DEPTH	RET'D	PENETRATION TEST
0	Surficial Deposits	Sand, organics. Tundra vegetation and roots.						
1								
2			1	AS	2-1/2	2.0 to 4.0	24	11 10 12 30
3								
4			2	AS	2-1/2	4.0 to 6.0	17	14 18 12 13
5								
6	Sand	Brown, clayey, silty, gravelly. Fine to coarse grained. Gravel subrounded to angular. Medium to dense consistency. Poorly graded. Moist.	3	AS	2-1/2	6.0 to 8.0	5	21 24 25 23
7								
8			4	AS	2-1/2	8.0 to 9.0	8	14 50/.5
9								

*SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: H - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; T - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.G. Adams

APPROVED [signature]

DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-19

SITE: Borrow Site D — SHEET NO. 2 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
9	Sand (cont)	Brown, clayey, silty, gravelly. Fine to coarse grained. Gravel subrounded to angular. Poorly graded. Medium to dense consistency. Moist to wet. Occasional black spotting.						
10			5	AS	2-1/2	10.0 to 12.0	19	9 24 13 18
11								
12			6	AS	2-1/2	12.0 to 13.2	14	47 32 50/.2
13								
14		Numerous rock fragments.						
15			7	AS	2-1/2	14.0 to 16.0	22	12 16 22 26
16	Sand	Gray, clayey, gravelly. Trace silt. Medium to coarse grained. Gravel subrounded to angular. Loose to medium consistency. Moist. Poorly graded.						
17			8	AS	2-1/2	16.0 to 17.8	20	7 4 12 50/.3
18	Cobbles	Coarse gravel and cobble zone. Hole advanced with tricone roller bit. No sampling due to material coarseness.						
19								
20								
21								
22								
23								
24								
25								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 3 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Cobbles (cont)	Coarse gravel and cobbles.						
26	Sand	Gray, clayey. Trace to some gravel. Trace silt. Fine to medium grained. Gravel generally subangular. Dense. Moist. Poorly graded.	9	AS	2-1/2	26.0 to 28.0	24	14 50 42 48
27								
28			10	AS	2-1/2	28.0-28.8	7	18 50/.3
29								
30								
31		Gray, clayey, gravelly. Trace silt. Poorly graded. Very dense. Slightly moist.	11	AS	2-1/2	31.0 to 32.9	23	30 50 53 65/.4
32								
33	Cobbles	Cobble zone 33.0 to 34.0 ft.						
34	Sand	Gray, gravelly. Trace to some clay and silt. Very dense. Poorly graded. Moist.	12	AS	2-1/2	34.0 to 35.8	18	12 18 42 50/.3
35								
36			13	AS	2-1/2	36.0 to 38.0	22	9 9 21 65
37								
38	Cobble	Coarse gravel and cobbles.	14	A	2-1/2	38.0-38.3	0	50/.3
39								
40	Sand	Gray, clayey, gravelly. Fine to coarse grained. Dense. Moist.	15	AS	2-1/2	40.0 to 42.0	24	21 39
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 4 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Gray, clayey, gravelly. Some orangish bands, dense, moist.	15	AS		(continued)		35 48
42	Cobbles	Coarse gravel and cobbles.						
43	Sand	Gray, clayey, gravelly. Fine to coarse grained. Some silt. Poorly graded. Slightly moist. Dense.	16	AS	2-1/2	43.0 to 44.3	15	9 45 50/.3
44								
45		45.3 ft ice lense (1 inch).	17	AS	2-1/2	45.0-45.7	8	54 50/.2
46								
47			18	AS	2-1/2	47.0-47.8	8	57 75/.3
48		Some yellow-brown markings.						
49	Gravel	Cobbles, boulders, and coarse gravel zones. Occasional 4 to 6 inch [illegible]ft sand. Lenses [illegible]ecky areas. No [illegible]due to material [illegible]s.	19	A	2-1/2	49.0-49.8	0	75 50/.3
50								
51								
52								
53								
54								
55								
56								
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 5 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Gravel (cont)	Cobbles, boulders, and gravel zone. Some layers 4 to 6 inches thick of softer material.						
58								
59	Sand	Gray with some brownish areas, clayey, silty, gravelly. Fine to coarse grained. Gravel subrounded to subangular. Poorly graded. Very dense. Moist.	20	AS	2-1/2	59.0 to 59.9	10	51 75/.4
60								
61			21	A	2-1/2	61.0-61.4	0	50/.4
62								
63		Cobble zone. Hole triconed ahead.						
64								
65			22	AS	2-1/2	65.0-65.7	3	62 50/.2
66								
67		Cobble zone. Hole triconed ahead.						
68								
69		Gravel up to 2 inches recovered in sample. Same material as above.	23	AS	2-1/2	69.0-69.5	4	70/.5
70								
71	Sand	Gray, clayey, gravelly. Trace silt. Fine to medium grained, subrounded to subangular gravel to 2 inches in samples. Very dense. Moist.	24	A	2-1/2	71.0-71.6	0	7 50/.1
72								
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 6 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Sand (cont)	Gray, clayey, gravelly. Trace silt. Fine to medium grained. Occasional to some cobbles. Very dense. Moist.	25	A	2-1/2	73.0-73.4	3	50/.4
74								
75		Cobble zone.						
76								
77		Same material as above retained in sample.	26	AS	2-1/2	77.0 to 78.0	12	25 85/.5
78								
79								
80		Cobble zone. No sampling due to material coarseness.						
81								
82								
83								
84		No recovery due to rock.	27	A	2-1/2	84.0-84.6	0	19 50/.1
85								
86								
87		Cobble zone. Triconed to softer material.						
88								
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 7 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Sand (cont)	Brownish-gray, clayey, silty, gravelly. Fine to coarse grained. Gravel subrounded to subangular. Poorly graded. Very dense. Slightly moist. Numerous cobble and boulder zones.						
90								
91								
92								
93								
94			28	AS	2-1/2	93.0 to 94.7	19	41 53 47 50/.2
95		Cobble zone.						
96								
97			29	AS	2-1/2	97.0-97.3	2	50/.3
98								
99			30	AS	2-1/2	99.0 to 100.0	12	49 85/.5
100								
101		Cobbles, boulders, and coarse gravel zone. Hole triconed. No sampling due to material coarseness.						
102								
103								
104								
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 8 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Sand (cont)	Cobble zone to 108.5 ft No sampling due to material coarseness.						
106								
107								
108								
109		Gray, silty, clayey. Trace gravel in sample. Sand generally fine grained. Very dense. Poorly graded. Slightly moist.	31	AS	2-1/2	109.0 to 110.5	18	16 33 85/.5
110								
111								
112			32	AS	2-1/2	112.0-112.9	2	28 80/.4
113								
114	Sand and Silt	Gray, clayey. No visible gravel in sample. Fine grained sand. Dense. Poorly graded. Moist.	33	AS	2-1/2	114.0-114.8	9	54 65/.3
115								
116								
117		Occasional brown silt layers approximately 1/8 inch thick.	34	AS	2-1/2	117.0-117.8	9	31 80/.3
118								
119								
120			35	AS	2-1/2	120.0-120.7	3	33 50/.2
121								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 9 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
121	Sand and Silt (cont)	Gray, clayey. No gravel seen in samples. Fine grained. Dense. Poorly graded. Moist.						
122								
123	Clay and Silt	Gray clay and brown silt with some laminations. Sandy. Dense. Slightly moist.	36	AS	2-1/2	124.0 to 125.4	17	24 54 70/.4
124								
125								
126	Sand	Gray (some brownish areas), silty, gravelly. Trace clay. Fine to coarse grained. Very dense. Poorly graded. Moist.	37	A	2-1/2	126.0-126.7	0	58 50/.2
127								
128								
129								
130		Boulder and cobble zone. Hole triconed.						
131								
132								
133		Sand, as above.	38	AS	2-1/2	133.0-133.8	8	45 75/.3
134	Cobbles and Boulders	Cobbles, boulders, and coarse gravel. Sand matrix. No sampling due to material coarseness.						
135								
136								
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 10 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
137	Cobbles and Boulders (cont)	Very coarse material. No sampling due to coarseness and density.						
138			39	A	2-1/2	138.0-138.2	[illegible]	50/.2
139								
140								
141								
142								
143								
144	Sand	Gray, silty, gravelly. Trace clay. Fine to medium grained. Gravel subrounded to angular. Poorly graded. Very dense. Moist. Occasional to some cobbles.	40	AS	2-1/2	144.0-144.5	[illegible]	75/.5
145								
146								
147			41	A	2-1/2	147.0-147.3	[illegible]	50/.3
148								
149			42	A	2-1/2	149.0-149.8	[illegible]	72 50/.3
150								
151		Gray, silty, clayey, gravelly. Fine to coarse grained.	43	AS	2-1/2	151.0-151.5	5	80/.5
152								
153								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 11 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
153	Sand (cont)	Gray, clayey, silty, gravelly. Fine to coarse grained. Gravel subangular to subrounded. Poorly graded. Very dense. Moist. Many cobbles.	44	A	2-1/2	153.0-153.3	0	80/.3
154								
155								
156		Cobble zone.						
157								
158			45	A	2-1/2	158.0-158.5	0	95/.5
159		No recovery; rock in sample shoe.						
160								
161								
162								
163								
164								
165			45A	DS	1-7/8	164.0 to 169.0	26	-
166	Clay	Gray, silty, gravelly. Trace sand. Gravel angular to subrounded. Clay and silt laminated throughout. Stiff. Slightly moist.						
167								
168								
169								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 12 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
169	Clay (cont)	Gray, silty. Trace fine grained sand. Laminated. Very stiff. Moist.	46	AS	2-1/2	169.0-169.4	5	80/.4
170								
171								
172			47	AS	2-1/2	171.0 to 172.5	18	30 39 69/.5
173		Slight organic odor.						
174								
175	Sand	Gray, very clayey, silty. Trace gravel. Very fine grained. Organic odor.	48	AS	2-1/2	175.0 to 176.2	6	39 55 50/.2
176								
177	Clay	Gray, silty. Trace very fine grained sand. Laminated. Some thin brown layers present. Stiff. Moist. Slight organic odor.	49	AS	2-1/2	177.0 to 178.5	18	18 27 70/.5
178								
179								
180								
181			50	AS	2-1/2	181.0 to 182.6	11	15 19 29 50/.1
182		Same material, as above.						
183								
184								
185								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Site D — SHEET NO. 13 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
185	Clay (cont)	Gray with brown layering, silty. Trace fine grained sand. Laminated (1/4 inch). Stiff. Moist.	51	A	2-1/2	185.0 to 186.5	0	15 21 34
186								
187								
			52	AS	2-1/2	187.0 to 188.4	17	16 26 60/.4
188								
189		Occasional cobble lenses.						
190								
191			53	A	2-1/2	191.0-191.4	0	59 50/.2
192								
193	Silt	Brown, clayey. Trace fine to medium grained sand. Trace subrounded gravel. No laminations. Medium consistency. Moist.	54	AS	2-1/2	193.0-193.8	8	23 50/.3
194								
195								
196	Cobbles and Boulders	Very coarse material. Consists of cobbles, boulders, and coarse gravel. Matrix appears to be brown silts and sands.						
197								
198			55	A	2-1/2	198.0-198.4	0	50/.4
199								
200								
201								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-19
SITE Borrow Area D — SHEET NO. 14 OF 14

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
201	Cobbles and Boulders (cont)	Very coarse, cobbles, boulders, and coarse gravel. Some brown sand and silt matrix.						
202								
203								
204		No successful sampling due to material coarseness.						
205			56	A	2-1/2	205.0-205.5	5	60/.5
206								
207								
208								
209		Hole advanced with tricone bit. No sampling.						
210								
211								
212		Same material.						
213								
214								
215		Bottom of Hole 215 Ft.	57	A	2-1/2	215.0	0	50/Ref.
216		* Pneumatic piezometer tips installed at 210.0 and 212.0 ft.						
217								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20

SITE Borrow Site D — SHEET NO. 1 OF 10

CONTRACTOR: Denali Drilling Inc. — STARTED 10:00 A.M. August 13 1982 — FINISHED 1:00 P.M. August 19 1982

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.

ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,231,729; DEPARTURE E 744,658; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2162.1'; GROUND SURFACE 2162.1'; ROCK SURFACE 2027.1'; BOTTOM OF HOLE [illegible]; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial	Tundra vegetation.						
1								
	Cobbles and Boulders	2 ft zone of loose rock material.						
2								
3	Sand	Gray and brown. Fine to coarse grained. Little to some clayey silt present. Little fine gravel (sub-rounded to subangular). Moist. Very dense.	1	AS	2-1/2	3.0 to 5.0	11	13 24 42 52
4								
5								
6			2	AS	2-1/2	5.0 to 6.4	5	11 29 50/.4
7								
8			3	AS	2-1/2	7.0	7	31 51
9						9.0		54 48

*SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: H - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY E.J. Kleinkauf

APPROVED [signature]

DATE 12/7/82

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20

SITE Borrow Site D — SHEET NO. 2 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Gray and brown with little clayey silt and trace fine gravel. Wet. Very dense. Moisture content 9%.	4	AS	2-1/2	9.0 to 9.8	[illegible]	35 50/3
10								
11			5	A	2-1/2	11.0-11.5	[illegible]	50/6
12		Cobble or boulder.						
13			6	A	2-1/2	13.0 to 14.4	[illegible]	45 37 50/5
14								
15			7	A	2-1/2	15.0-15.5	[illegible]	30 25/Ref.
16								
17		Fine to coarse grained sand with fine gravel to cobbles.	8	AS	2-1/2	17.0 to 17.9	[illegible]	34 50/5
18								
19								
20		Brown, fine to coarse grained. Some silt and clay. Trace fine gravel.	9	AS	2-1/2	19.5 to 20.8	10	14 42 50/3
21								
22			10	AS	2-1/2	22.0 to 23.3	13	30 45 50/4
23								
24	Sand	Brown, fine to coarse grained. Moist. Little clayey silt.	11	AS	2-1/2	24.0 to 25.8	5	23 45
25								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 3 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand (cont)	Brown, fine to coarse grained. Little clayey silt and fine gravel. Very dense. Moisture content 8%.	11	(continued)				49 50/3
26								
27			12	AS	2-1/2	26.0 to 27.8	10	4 42 51 50/4
28								
29			13	AS	2-1/2	28.0 to 30.0	6	2 8 39 59
30		Trace fine gravel (subrounded to subangular).						
31			14	A	2-1/2	30.0 to 32.0	0	34 37 45 48
32	Sand	Brown, fine to medium grained. Wet. Trace to little clayey silt. Sorted.	15	AS	2-1/2	32.0 to 34.0	22	19 29 43 50
33								
34			16	AS	2-1/2	34.0 to 36.0	14	4 14 24 33
35								
36			17	AS	2-1/2	36.0 to 38.0	7	17 29 33 34
37								
38		Brown, fine to coarse grained. Little fine gravel (subrounded to rounded). Very dense.	18	AS	2-1/2	38.0 to 40.0	17	14 26 36 54
39								
40			19	AS	2-1/2	40.0 to 42.0	15	15 28
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 4 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Brown, fine to coarse grained. Trace clayey silt. Little fine gravel. Wet. Very dense. Moisture content 20%.	19	(continued)				34 49
42								
43								
44								
45			20	AS	2-1/2	44.0 to 46.0	17	17 35 40 58
46								
47								
48			21	AS	2-1/2	48.0 to 50.0	17	24 38 52 67
49								
50								
51								
52			22	AS	2-1/2	52.0 to 54.0	19	18 21 37 43
53		Moisture content 22%.						
54								
55								
56			23	AS	2-1/2	56.0 to 57.8	18	17 27
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 5 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Sand (cont)	Brown, fine to coarse grained. Very dense. Wet. Occasional zones appear to have higher fine content.	23	(continued)				42 50/3
58								
59								
60			24	AS	2-1/2	60.0 to 62.0	19	17 28 41 51
61		Increasing fine content.						
62								
63								
64			25	AS	2-1/2	64.0 to 65.2	8	25 63 50/2
65								
66	Clay and Silt	Gray, little fine to medium sand. Trace to little fine gravel (subrounded to sub-angular). Hard.	26	AS	2-1/2	66.0- 66.2	0	50/2
67								
68								
69			27	AS	2-1/2	69.0- 69.8	7	46 50/3
70								
71			28	AS	2-1/2	71.0- 71.8	9	21 50/3
72								
73								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 6 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Clay and Silt (cont)	Gray. Little fine to coarse grained sand. Little fine gravel. Moist. Hard.	29	A	2-1/2	73.0- 73.8	5	40 50/4
74								
75			30	AS	2-1/2	75.0- 75.7	5	32 50/2
76								
77								
78								
79	Clay	Gray, silty, sandy (fine to coarse grained). Some fine gravel. Very dense.	31	AS	2-1/2	79.0 to 80.3	13	33 41 50/4
80								
81								
82		Gray and brown, silty. Trace fine sand and fine gravel. Laminated.	32	AS	2-1/2	81.0 to 83.0	23	17 18 27 37
83								
84			33	AS	2-1/2	83.0 to 84.8	19	13 26 41 50/3
85								
86								
87	Sand	Gray, fine grained. Some silty clay present. Very dense. Sorted.	34	AS	2-1/2	87.0 to 89.0	7	34 21 34 64
88								
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 7 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
89	Clay	Gray and brown, silty. Trace fine sand and fine gravel (subrounded to rounded). Laminated. Hard.	35	AS	2-1/2	89.0 to 90.4	17	19 30 50/5
90								
91								
92								
93								
94		Moisture content 28%.	36	AS	2-1/2	93.0 to 95.0	22	19 18 23 44
95								
96								
97			37	AS	2-1/2	97.0 to 98.8	19	14 17 32 50/3
98								
99		Gray and brown, silty. Laminated.						
100								
101			38	AS	2-1/2	101.0 to 102.0	24	9 6 23 27
102								
103								
104								
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 8 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
105	Clay (cont)	Gray and brown, silty. Trace fine sand and fine gravel (subrounded to rounded). Laminated.	39	AS	2-1/2	105.0 to 107.0	24	9 17 24 46
106								
107								
108								
109								
110			40	A	2-1/2	109.0 to 110.3	7	28 50 50/3
111	Clay and Silt	Brown, some fine to medium sand; little coarse sand. Very dense.	41	AS	2-1/2	111.0- [illegible]	4	39 50/1
112								
113	Sand	Brown. Fine to medium grained with little coarse grained sand. Little clayey silt. Very dense.	42	AS	2-1/2	113.0 to 114.1	12	23 45 50/3
114								
115	Gravel, Cobbles, Boulders							
116								
117		Many cobbles and boulders present.						
118								
119								
120								
121								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 9 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Gravel, Cobbles, Boulders (cont)	Very coarse material. Difficult to sample.						
122			43	AS	2-1/2	122.5-122.8	0	50/3
123								
124		Rock fragments.	44	AS	2-1/2	124.0-124.7	2	49 50/2
125								
126								
127			45	AS	2-1/2	127.0-127.4	0	50/5
128								
129								
130								
131								
132								
133								
134								
135		Gravel and cobbles with fragments of decomposed bedrock.	46	DS	1-7/8	135.0 to 137.0	16	-
136	Bedrock Diorite	Moderately to highly weathered. Jointed and fractured.						
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-20
SITE Borrow Site D — SHEET NO. 10 OF 10

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Bedrock	Moderately to highly weathered. Jointed and fractured. Iron staining present on discontinuities.	47	DY	1-7/8	137.0 to 141.5	52	-
138								
139								
140								
141		141.5-144.5 Fresh diorite.						
142								
143			48	DY	1-7/8	141.5 to 146.5	52	-
144		Returns to being moderately to highly weathered condition.						
145								
146								
147		Iron staining evident on joints and fractures throughout.						
148			49	DY	1-7/8	146.5 to 151.5	50	-
149								
150								
151								
152		Bottom of Hole 151.5 Ft.						
153		* Thermistor string installed to 148.5 ft.						

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-21

SITE: Borrow Site D — SHEET NO. 1 OF 13

CONTRACTOR: Denali Drilling Inc. — STARTED 12:00 P.M. August 14 1982; FINISHED 7:00 P.M. August 21 1982

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. 4-1/2" O.D. 4" I.D.

ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. 1-7/8"

LOCATION: LATITUDE N 3,234,649; DEPARTURE E 747,467; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2272.7'; GROUND SURFACE 2272.7'; ROCK SURFACE 2098.7'; BOTTOM OF HOLE 2084.0'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Sand, silt, roots, and tundra vegetation.						
1								
2	Sand	Brown to tan, silty, gravelly. Some organics present. Mostly fine with some medium grained. Loose. Wet. Well graded.	1	AS	2-1/2	2.0 to 4.0	20	6 5 7 10
3								
4								
5		Gravel is subrounded to subangular.	2	AS	2-1/2	4.0 to 6.0	12	9 7 7 15
5								
7			3	AS	2-1/2	6.0 to 7.0	6	11 13 50/Ref.
8		Brown, silty, gravelly. Fine to coarse grained. Well graded. Loose to dense. Wet.	4	AS	2-1/2	8.0 to 10.0	13	22 24
9								

SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.G. Adams, R.A. Werneiwski

APPROVED [signature]

DATE 12/7/82

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-21

SITE: Borrow Site D — SHEET NO. 2 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Brown, silty, gravelly. Medium to coarse grained. Gravel subrounded to subangular. Medium density. Well graded. Occasional angular rock fragments.	4	(continued)				15 15
10			5	AS	2-1/2	10.0 to 12.0	13	14 20 26 55
11								
12		Trace clay.	6	AS	2-1/2	12.0 to 14.0	16	18 21 17 16
13								
14		Wet.	7	AS	2-1/2	14.0 to 16.0	14	16 24 18 19
15								
16								
17		No recovery of sample due to piece of diorite gravel lodged in sampling shoe	8	AS	2-1/2	16.0 to 18.0	0	46 29 26 26
18	Sand	Cobble 18.0 to 19.0 ft. Brown, silty, gravelly. Trace clay. Fine to medium grained. Gravel subangular to subrounded with occasional pieces to 2 inches. Medium density. Well graded. Moist.						
19								
20			9	AS	2-1/2	19.0 to 21.0	12	13 16 25 20
21								
22								
23			10	AS	2-1/2	22.0 to 24.0	9	27 19 15 12
24								
25			11	AS	2-1/2	24.0 to 26.0	12	9 11

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 3 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand (cont)	Brown, silty, gravelly. Trace clay. Fine to medium grained. Gravel angular to subrounded. Occasional angular pieces or diorite. Well graded. Moist. Medium density.	11	(continued)				14 16
26			12	AS	2-1/2	26.0 to 27.5	10	23 52 75/.5
27								
28			13	AS	2-1/2	28.0 to 29.9	19	33 43 60 65/.4
29								
30	Sand	Gray, clayey, silty, gravelly. Occasional brown zones. Fine to medium grained. Partly to well graded. Very dense. Moist. Becomes more well graded with depth.	14	AS	2-1/2	30.0 to 31.0	8	41 85/.5
31								
32			15	AS	2-1/2	32.0-32.8	6	41 60/.3
33								
34		No recovery of samples due to rocky/cobbly conditions.	16	A	2-1/2	34.0-34.4	0	70/.4
35								
36			17	A	2-1/2	36.0-36.1	0	30/.1
37								
38								
39	Sand	Brown, gravelly, silty. Little clay. Medium to coarse grained. Gravel subrounded to subangular. Moist to wet.	18	AS	2-1/2	39.0 to 40.0	8	49 /.5
40								
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 4 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Brown, silty, gravelly. Little clay. Medium to coarse grained. Occasional cobbles. Gravel subrounded to subangular. Partly to gap graded. Moist to wet. Dense.	19	A	2-1/2	41.0-41.5		80/.5
42								
43								
44			20	AS	2-1/2	43.5 to 44.3		59 75/.3
45	Gravel	Gravel, cobbles, and coarse sand. Fines probably present in small quantities but washed out during drilling.	21	A	2-1/2	45.0-45.4		85/.4
46								
47			22	A	2-1/2	47.0 to 47.9		16 75/.4
48								
49		Poor to no recovery of samples due to cobbly nature of deposit.	23	AS	2-1/2	49.0-49.8		55 85/.3
50								
51								
52			24	A	2-1/2	52.0-52.3		50/.3
53								
54			25	A	2-1/2	54.0-54.3		50/.3
55								
56			26	A	2-1/2	56.0-56.3	0	80/.3
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 5 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
57	Gravel (cont)	Very cobbly. Coarse sand present. No sample recovery due to rocky material.						
58			27	A	2-1/2	58.0-58.2	0	70/.2
59								
60			28	A	2-1/2	60.0-60.3	0	50/.3
61								
62	Silt and Gravel	Light and dark gray laminations of silt and clay. Some fine to medium grained sand. Slightly moist to dry. Very stiff to hard.	29	AS	2-1/2	62.0 to 64.0	14	17 25 31 58
64			30	AS	2-1/2	64.0 to 65.7	15	14 20 41 50/.2
66		Occasional brown laminae.	31	AS	2-1/2	66.0 to 68.0	20	10 16 18 24
68			32	AS	2-1/2	68.0 to 70.0	24	16 25 47 51
70								
71		Hole triconed ahead in same material.						
72								
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE rrow Site D — SHEET NO. 6 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
73	Silt and Clay (cont)	Light and dark gray. Some fine to medium grained sand. Laminated. Slightly moist. Stiff to very stiff.						
74			33	AS	2-1/2	74.0 to 75.5	[illegible]	5 26 43
75								
76								
77								
78		78.0-80.0 ft Not laminated.						
79			34	AS	2-1/2	78.0 to 79.5	[illegible]	19 33 53
80		Gray with some brownish areas. Laminated. Very stiff. Moist.	35	AS	2-1/2	80.0 to 81.2	[illegible]	20 33 50/.2
82								
84			36	A	2-1/2	83.0 to 84.0	[illegible]	43 71/.5
85			[illegible]	A	2-1/2	85.0 to 85.9	[illegible]	52 100/.4
86		Gravelly zone. Very dense.						
87								
88		Occasional brown tan laminated clay layers present.	38	AS	2-1/2	87.3 to 88.1	13	28 45 50/.1
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 7 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
89	Clay	Dark gray, silty. Laminated. Little to no sand. Thin silt layers throughout. Very stiff. Moist. Occasional gravel to 1 inch diameter.	39	AS	2-1/2	89.0 to 91.0	24	10 19 21 23
90								
91								
92								
93								
94			40	AS	2-1/2	93.0 to 95.0	18	15 23 42 30/.1
95		Mottled appearance with gray, brown, and tan layers.						
96								
97								
98								
99		Silt layer 99.0 to 99.3 ft.	41	AS	2-1/2	98.0 to 99.3	19	11 16 50/.3
100								
101	Sand	Brown, silty, clayey. Fine to coarse grained. Occasional gravel to 1/2 inch.	42	AS	2-1/2	101.0-101.3	4	75/.3
102								
103		Very dense. Moist.						
104		Drilling easy but difficult sampling.	43	AS	2-1/2	104.0-104.2	2	75/.2
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 8 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
105	Sand (cont)	Brown, silty, clayey. Occasional gravel and cobbles. Very dense. Moist. Cobbles to 6 inches diameter from 105.0 to 107.5 ft.						
106								
107								
108	Sand	Brown-tan, silty. Little or no coarse material. Moist to wet. Dense.	44	AS	2-1/2	108.0-108.8		33 70/.3
109								
110			45	AS	2-1/2	110.0 to 111.4		22 52 90/.4
111								
112								
113								
114			46	A	2-1/2	114.0 to 114.6		55 50/.1
115		Boulder at 115.0 ft.						
116	Gravel, Cobbles, and Boulders	Very hard drilling. Continuously in rock. Wash water contains some silt and sand.						
117								
118								
119								
120								
121								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 9 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Gravel, Cobbles, and Boulders	Very coarse material. Difficult drilling. Some silt and sand in wash water.						
122								
123			47	DS	2-5/32	123.0-123.5	2	-
			48	A	2-1/2	123.5-125.8	0	75/.3
124								
125		No sampling due to coarseness of material.						
126								
127								
128								
129								
130		Matrix is fine to coarse grained sand with gravel. Trace silt and clay. Very dense. Moist. Gravel sub-rounded to subangular.	49	AS	2-1/2	130.0 to 131.0	4	60 7o
131								
132								
133								
134			50	A	2-1/2	134.0-134.2	0	75/.2
135								
136			51	DS	2-5/32	136.5-136.0	2	-
			52	DS	2-5/32	136.0-136.5	2	-
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 10 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Cobbles, etc. (cont)							
138	Sand and Gravel	Softer material. Tan. Fine to coarse grained. Little silt and clay. Dense. Moist. Very cobbly.						
139								
140			53	AS	2-1/2	139.5-140.0	3	100/.5
141								
142		Slow drilling. In and out of cobbles and/or boulders.						
143								
144								
145								
146								
147								
148		No recovery due to coarseness of material.	54	A	2-1/2	147.5-148.0	0	100/.4
149								
150								
151								
152								
153								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydrcelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 11 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
153	Sand and Gravel (cont)	Brown. Fine to coarse grained. Gravel is sub-rounded to subangular. Little clay and silt. Very dense. Damp. Occasional cobbles.						
154								
155								
156								
157		Few cobbles and/or boulders.						
158								
			55	AS	2-1/2	158.5-158.7	2	100/.2
159								
160								
161								
162								
163								
164								
			56	A	2-1/2	164.5-164.6	0	100/.1
165		Increasing amounts of large cobbles (to 10 inches).						
166								
167		Cuttings indicate same material as above.						
168								
169								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21
SITE Borrow Site D — SHEET NO. 12 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
169	Sand and Gravel (cont)	Brown. Fine to coarse grained. Little clay and silt. Occasional to ma . cobbles and boulders. Very dense. Damp.	57	A	2-1/2	169.5	[illegible]	50/0.0
170								
171								
172								
173								
174	Bedrock Diorite	Jointed. Slightly weathered on joint planes. Hematite/limonite staining present.						
175								
176		176.0-179.0 ft Drill rate 20 minutes/foot.						
177								
178								
179								
180		RQD = 51%.	58	DY	1-7/8	179.0 to 183.7	[illegible]	-
181								
182								
183								
184			59	DY	1-7/8	183.7 to 188.7	[illegible]	-
185		RQD = 52%.						

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-21

SITE Borrow Site D — SHEET NO. 13 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
185	Bedrock Diorite (cont)	Jointed, slightly weathered. Hematite/limonite staining present on joint surfaces.	59	DY	1-7/8	(continued)		
186								
187								
188								
189		Bottom of Hole 188.7 Ft.						
190		* PVC pipe filled with ethylene glycol installed to 183.7 ft.						
191		Pneumatic piezometer tips set at 50.0 and 120.0 ft.						
192								
193								
194								
195								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-22

SITE: Borrow Site D — SHEET NO. 1 OF 2

CONTRACTOR: Denali Drilling Inc. — STARTED 9:00 A.M. August 30 1982 — FINISHED 1:30 P.M. August 21 1982

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. SW

ROCK HX Core Barrel — CORE DIAM. 2-5/16"

LOCATION: LATITUDE N 3,229,532 — DEPARTURE E 746,961 — BEARING - — INITIAL DIP 90° — OTHER DIPS None

ELEVATIONS: DATUM Ground Surface — DRILL PLATFORM 2092.8' — GROUND SURFACE 2092.8' — ROCK SURFACE 2086.8' — BOTTOM OF HOLE 2068.8' — WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra vegetation. Cobbles and diorite boulders present. Fine material washed out during drilling.						
1			1	DY	2-5/16	0.5 to 4.5	27	-
2								
3								
4								
5		Highly weathered bedrock?	2	DY	2-5/16	4.5 to 8.0	0	-
6	Bedrock Diorite	Fractured, weathered. Joints and fractures are generally hematite stained. RQD 0%.						
7								
8								
9				NO sampling.				

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.C. Powell

APPROVED

DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-22

SITE: Borrow Site D — SHEET NO. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Diorite (cont)	Fractured, weathered. Hematite staining present on fractures.	3	AS	2-1/2	9.0 to 9.9	4	43 93/5
10								
11			4	DY	2-5/16	10.0 to 14.0	36	-
12		RQD 0%.						
13								
14								
15		RQD approximately 20%.	5	DY	2-5/16	14.0 to 19.0	56	-
16								
17		Fractured, weathered, hematite stained.						
18								
19								
20		RQD 0%.	6	DY	2-5/16	19.0 to 24.0	60	-
21								
22								
23		Many parallel fractures at 45° to the core axis. Highly fractured in bottom 3 inches.						
24		Bottom of hole 24.0 ft.						
25								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 1 OF 11

CONTRACTOR: Denali Drilling Inc. — STARTED 9:30 A.M. August 21, 19 82 — FINISHED 11:30 A.M. September 2, 19 82
METHOD OF DRILLING: SOIL Rotary Casing & 3-7/8" Tricone — CASING DIAM. HW 4-1/2" O.D. 4" I.D.
ROCK None — CORE DIAM. None

LOCATION: LATITUDE N 3,232,870; DEPARTURE E 744,336; BEARING -; INITIAL DIP 90°; OTHER DIPS None
ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2163.0'; GROUND SURFACE 2163.0'; ROCK SURFACE -; BOTTOM OF HOLE 2003.0'; WATER TABLE -

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Cobbles and Boulders	Vegetation and surficial deposits.			No Sampling			
-1								
-2								
-3			1	D	4"	2.3 to 5.2	9"	
-4		Actual contact depth unknown.						
-5	Sand	Tan, silty. Sand fine to coarse grained. Well graded. Occasional fine, subangular gravel. Moist. Medium consistency.						
-6			2	A	2-1/2	6.0-6.2	0"	50/2"
-7								
-8								
9			3	AS	2-1/2	8.5-10.5	10"	13

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH
SHIPPING CONTAINER: H - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf
LOGGED BY R.C. Powell
APPROVED [signature]
DATE 12/7/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 2 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Tan, silty. Sand fine to coarse grained. Well graded. Occasional sub-angular grave. Moist.	3					17 24 29
-10								
-11			4	D	4"	11.0-11.3	3"	
-12		Little fine gravel. Dense, 1' layer of red-brown sand.	5	AS	2-1/2	11.3 to 13.1	18"	9 21 31 50/4"
-13								
-14								
-15		Tan, silty. Partly graded. Little coarse gravel. Moist. Dense.	6	AS	2-1/2	14.5 to 16.5	25"	20 22 22 25
-16								
-17			7	AS	2-1/2	17.0 to 19.0	23"	16 15 22 43
-18	Sand and Silt	Tan with some red-brown to black layers. Fine to medium grained sand. Weakly laminated. Occasional dark sand lenses. Moist. Dense.						
-19								
-20								
-21			8	A	2-1/2	21.0-21.4	0"	60/5"
-22		Boulders and cobbles common throughout.						
-23			9	A	2-1/2	23.0-23.4	0"	50/4"
-24								
25								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 3 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand and Silt (cont)	Tan. Weakly laminated. Fine to medium grained sand. Moist. Dense.						
26								
27	Sand	Tan. Some silt. Fine to medium grained. Very poorly graded. Moist. Dense.	10	AS	2-1/2	27.0 to 29.0	16"	22 35 41 45
28								
29		Silty. Occasional 1/4" thick silt lenses.	11	AS	2-1/2	29.0 to 31.0	13"	27 35 40 57
30								
31		Occasional fine, sub-angular to angular gravel.	12	AS	2-1/2	31.0 to 33.0	12"	21 32 32 53
32								
33		Tan, silty. Fine to medium grained. Very poorly graded. Moist. Very dense.	13	AS	2-1/2	33.0 to 35.0	14"	21 33 47 51
34								
35								
36								
37		One large piece of gravel-diorite. Wet.	14	AS	2-1/2	37.0 to 38.3	5"	58 61 50/4"
38								
39	Sand	Tan, silty, Fine to coarse grained. Partly graded. Medium consistency. Wet. Some fine gravel.	15	A	2-1/2	39.0	0"	8/0"
40								
41								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 4 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand	Tan, silty. Fine to coarse grained. Some fine subangular gravel. Partly graded. Medium consistency. Wet.	16	AS	2-1/2	41.0 to 42.3	[illegible]	12 36 40/3"
42								
43			17	A	2-1/2	43.0-43.8	[illegible]	14 60/4"
44								
45			18	AS	2-1/2	45.0 to 46.5	[illegible]	27 35 72
46	Silt	Tan-gray, sandy, gravelly. Moist. Very Dense.						
47	Sand and Silt	Tan-gray, gravelly. Both sand and gravel are fine to coarse grained. Gravel is subrounded to subangular. Poorly graded. Moist. Very dense. 49.0-50.5 possibly frozen.	19	AS	2-1/2	47.0-48.0	[illegible]	30 65
48								
49			20	AS	2-1/2	49.0 to 50.3	[illegible]	29 45 45/3"
50								
51			21	AS	2-1/2	51.0 to 52.4	[illegible]	21 40 58/5"
52		Becomes more sandy with depth. Wet. Dense.						
53		Gravel to 2" diameter. Multi-colored sand lenses.	22	AS	2-1/2	53.0-53.8	[illegible]	50 50/3"
54								
55	Sand	Multi-colored. Little gravel to 1" (subrounded to angular). Poorly graded. Clean. Wet. Dense.	23	AS	2-1/2	55.0-55.5	[illegible]	70/6"
56								
57								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE Borrow Site D — SHEET NO. 5 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Sand (cont)	Tan, silty, gravelly. Sand is fine to coarse grained. Gravel is fine grained and subangular to angular. Partly graded. Wet. Dense.	24	AS	2-1/2	57.0-57.7	2"	40 35/2"
58								
59			25	AS	2-1/2	59.0 to 61.0	9"	11 19 44 55
60		Well graded. Gravel to 1-1/2 subrounded to subangular. Occasional cobbles.						
61			26	AS	2-1/2	61.0 to 63.0	15"	17 31 49 74
62								
63		Dense to very dense.						
63	Sand and Silt	Gray-tan, clayey. Trace gravel (fine grained). Sand is fine to coarse grained. Very dense to hard. Moist.	27	AS	2-1/2	63.0-63.4	5"	35/5"
64								
65								
66			28	AS	2-1/2	66.0-66.8	5"	30 50/4"
67								
68	Gravel	Tan-gray. Some sand, silt and clay matrix. Gravel to 2" subrounded to angular. Very dense to hard. Moist.	29	AS	2-1/2	68.0-68.7	4"	37 50/2"
69								
70								
71			30	A	2-1/2	71.0-71.2	0"	50/2"
72		Large amounts of coarse gravel and cobbles.						
73								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE Borrow Site D — SHEET NO. 6 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Gravel (cont)	Tan-gray. Some sand, silt, clay matrix. Very dense to hard. Moist. Large amounts of coarse gravel and cobbles present.						
74								
75								
76								
77		Boulder 77.0-78.0'.						
78								
79								
80			31	A	2-1/2	80.0-80.1	1"	40/1"
81								
82								
83		Numerous cobbles.						
84								
85								
86								
87								
88								
89								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 7 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Gravel (cont)	Tan-gray, sand, silt and clay matrix. Very dense to hard. Numerous cobbles and large amount of coarse gravel.						
-90								
-91								
-92								
	Sand	Tannish gray. Some silt and clay. Fine to coarse grained. Some subrounded to subangular gravel. Partly graded. Medium consistency. Wet. Temperature 12°C.	32	AS	2-1/2	92.5-93.8	9"	22 52 50/3"
-93								
-94								
-95			33	AS	2-1/2	95.0-96.3	9"	37 66 50/4"
-96								
-97								
-98		Well graded.	34	AS	2-1/2	98.0-99.4	13"	48 62 50/5"
-99								
-100		Little gravel to 1". Dense to very dense.	35	AS	2-1/2	100.0 to 102.0	13"	15 31 47 63
-101								
-102								
-103			36	AS	2-1/2	103.0-104.3	5"	26 61 50/4"
-104		Occasional pockets of overconsolidated clay, with hematite staining.						
105								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 8 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Sand (cont)	Tannish-gray, some silt and clay. Little gravel to 1-1/2" (subrounded to subangular). Clay present in overconsolidated pockets. Moist. Dense to very dense. Temperature 14°C.						
-106								
-107								
-108			37	AS	2-1/2	107.0 to 108.8	13"	14 34 63 50/4"
-109								
-110			38	AS	2-1/2	109.0-109.8	9"	38 50/4"
-111		Increasing silt content. Contains red-brown lamina. Temperature 11°C.	39	AS	2-1/2	111.0-112.3	8"	36 55 50/4"
-112								
-113		Dark gray, silty. Very dense. Moist to wet. Temperature 10°C.	40	AS	2-1/2	113.0-114.3	8"	27 46 50/4"
-114								
-115								
-116								
-117								
-118		Gray to dark gray. Some silt. Sand is fine to medium grained. Very dense. Wet.	41	AS	2-1/2	118.0-119.3	8"	29 50 50/3"
-119								
-120								
121								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 9 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Sand (cont)	Dark olive gray. Fine grained. Trace silt. Very dense. Wet. Temperature 10°C.						
-122			42	AS	2-1/2	122.0-123.3	11"	22 53 50/3"
-123								
-124								
-125								
-126			43	AS	2-1/2	126.0-127.2	9"	24 51 50/2"
-127		1/2" thick clay layer. Temperature 8°C.						
-128			44	AS	2-1/2	128.0-129.2	13"	23 56 50/2"
-129		Occasional gravel to 1".						
-130			45	AS	2-1/2	130.0-131.3	14"	21 40 50/3"
-131		3" layer of silt. Fine to medium grained. Moist. Temperature 11°C.						
-132			46	AS	2-1/2	132.0-133.3	12"	21 51 50/3"
-133								
-134								
-135								
-136		Weakly laminated.	47	AS	2-1/2	136.0-137.0	12"	24 96
137								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23
SITE: Borrow Site D — SHEET NO. 10 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Sand (cont)	Olive gray, silty. Fine to coarse grained (mostly fine), occasional gravel to 1-1/2. Very dense. Moist. Weakly laminated. Temperature 12°C.						
-138								
-139								
-140			48	AS	2-1/2	140.0-141.0	11"	24 93
-141								
-142								
-143								
-144			49	AS	2-1/2	144.0-145.2	13"	16 42 50/2"
-145	Silt and Clay	Olive gray. Thinly laminated with fine sand. Occasional fine gravel. Dense to very stiff. Temperature 10°C.						
-146			50	AS	2-1/2	146.0-147.2	14"	16 31 50/2"
-147								
-148			51	AS	2-1/2	148.0-149.2	14"	22 38 50/2"
-149		Alternating layers of fine sand, silt, and silty clay. Thinly to weakly laminated.						
-150								
-151	Sand	Olive gray, silty. Fine grained. Very dense. Moist.						
-152			52	AS	2-1/2	152.0-153.0	5"	10 94
153								

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-23

SITE: Borrow Site D — SHEET NO. 11 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
153 -154 -155 -156 -157 -158 -159 -160	Sand (cont)	Olive gray, silty. Fine grained. Very dense. Moist. Occasional layers of laminated silt and clay.	53	AS	2-1/2	156.0-156.7	8"	44 50/2"
-161 -162 -163 -164 -165 -166 -167 -168		Bottom of Hole: 160.0'						

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-24

SITE: Borrow Site D — SHEET NO. 1 OF 5

CONTRACTOR: Denali Drilling Inc. — STARTED 12:30 P.M. August 23 19 82; FINISHED 5:00 P.M. August 26 19 82

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.

ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,231,080; DEPARTURE E 741,250; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2165.9; GROUND SURFACE 2165.9; ROCK SURFACE 2135.9; BOTTOM OF HOLE 2107.0; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Brown sandy gravel. Some silt. Trace organics. Damp.						
1								
2			1	AS	2-1/2	1.5 to 3.5	6	5 5 8 9
3								
4	Sand	Tan to brown. Fine to coarse grained. Gravel to 1 inch. Silty with up to 25% total fines content. Well graded. Dense. Damp. Temperature 8°C.						
5			2	AS	2-1/2	4.5 to 6.3	10	7 7 7
6								
7		Gravel is subrounded to sub-angular. Temperature 10°C.						
8			3	AS	2-1/2	7.0 to 9.0	8	7 8 8 7
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: H - INCENT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.A. Werneiwski

APPROVED: [signature]

DATE 12/8/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-24

SITE: Borrow Site D — SHEET NO. 2 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Tan, gravelly, silty. Gravel to 1-1/2 inch, subrounded to subangular. Damp.	4	AS	2-1/2	9.0 to 11.0	8	10 14 15 17
10								
11								
12	Sand and Gravel	6 to 8 inch cobble at 11.5 ft. Hole sloughing. Wash is tan colored.						
13		Sand is fine to coarse grained. Silty, gravelly.						
14		Temperature 8°C.						
15		Moisture content 8 %.	5	AS	2-1/2	14.0 to 16.0	12	15 22 28 35
16								
17		Gravel to 1-1/2 inch. Clayey. Tan-gray. Very dense. Moist. Temperature 5°C.	6	AS	2-1/2	16.5 to 18.5	6	7 22 43 59
18								
19			7	AS	2-1/2	19.0 to 19.9	6	10 50/.4
20								
21		Fine content increasing with depth	8	A	2-1/2	20.0	0	18/0.0
22			9	A	2-1/2	22.0-22.1	0	50/.1
23								
24	Clay	Silty, sandy (fine to coarse grained). Gravel and rock fragments.	10	AS	2-1/2	24.0-24.7	6	27 50/.2
25								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-24
SITE Borrow Site D — SHEET NO. 3 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
25	Clay? (cont)	Silty, sandy. Many cobbles and/or boulders. Rock fragments.						
26			11	A	2-1/2	26.0-26.3	0	75/.3
27								
28								
29								
30	Bedrock	Very hard, slow drilling. Spoon sampler bouncing on either boulder or bedrock.						
31								
32								
33								
34								
35								
36								
37	Andesite	Started coring at 37.0 ft. Jointed.						
38		Run #1 had 100% core recovery and an RQD of 93%.	12	DY	1-7/8	37.0 to 41.5	54	-
39								
40								
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-24
SITE Borrow Site D — SHEET NO. 4 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
41	Bedrock Andesite (cont)	Diorite breccia. Weathered, fractured. Joints at 45° to core axis on a 4 to 12 inch spacing.	12	(continued)				
42								
43			13	DY	1-7/8	41.5 to 46.5	60	-
44		Run #2 had 100% recovery. 80% RQD.						
45								
46								
47								
48		48.8-49.4 Weathered zone.	14	DY	1-7/8	46.5 to 51.5	59	-
49		Run #3 had 98% recovery. 87% RQD.						
50		Rock becomes much harder. Very slow drilling.						
51								
52			15	DY	1-7/8	51.5 to 53.9	29	-
53		Run #4 had 100% recovery. 100% RQD.						
54								
55			16	DY	1-7/8	54.0 to 56.0	24	-
56		Run #5 had 100% recovery. 0% RQD.						
57			17	DY	1-7/8	56.0 to 58.9	35	-

Run #6 had 100% recovery. 100% RQD.

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-24

SITE Borrow Site D — SHEET NO. 5 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	
57	Bedrock		17	(continued)				
58	(cont)							
59								
		Bottom of Hole 58.9 Ft.						
60		* Installed pneumatic piezometer with tip at 25.8 ft.						
		* 2-inch PVC pipe installed to 30.8 ft.						

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-25
SITE Watana Relict Channel — SHEET NO. 1 OF 7

CONTRACTOR: Denali Drilling Inc. — STARTED 11:00 A.M. August 27 1982 — FINISHED 11:30 A.M. September 5 1982
METHOD OF DRILLING: SOIL Rotary Casing With 3-7/8" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.
ROCK NQ Core Barrel With Diamond Bit H Size Denison Core Barrel — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,232,611 — DEPARTURE E 742,262 — BEARING - — INITIAL DIP 90° — OTHER DIPS None
ELEVATIONS: DATUM Ground Surface — DRILL PLATFORM 1986.7 — GROUND SURFACE 1986.7 — ROCK SURFACE - — BOTTOM OF HOLE 1896.7 — WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Roots, peat, and other organic material.						
1								
2								
3			1	A	2-1/2	3.0 to 5.0	0	5 1 1 1
4								
5			2	A	2-1/2	5.0 to 7.0	0	1 W/R 1 1
6								
7	Sand	Gray, clayey, with sub-angular and angular gravel, wet. Cobbles throughout.	3	A	2-1/2	7.0 to 9.0	0	12 7 6 6
8								
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH
SHIPPING CONTAINER: M - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf
LOGGED BY R.G. Adams
APPROVED
DATE 12/6/82

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-25
SITE Watana Relict Channel — SHEET NO. 2 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Gray, clayey, with angular and subangular gravel throughout. Well graded. Coarse fragments and cobbles, mostly diorite.	4	AS	2-1/2	9.0 to 11.0	5	8 4 3 2
10								
11			5	A	2-1/2	11.0-11.7	8	7 30/.2
12								
13								
14								
15			6	AS	2-1/2	14.0 to 16.0	11	52 45 34 43
16								
17		Cobbles encountered throughout.						
18			6A	DS	1-7/8	17.0 to 18.0	11	-
19		Sampling mode changed often from split spoon to rock coring when boulders were encountered.						
20			7	A	2-1/2	20.0	0	30/Ref.
21								
22			8	A	2-1/2	22.0	0	30/Ref.
23			8A	DS	1-7/8	22.4 to 25.4	15	-
24		Very cobbly.						
25								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric — HOLE NO. AH-D-25
SITE Watana Relict Channel — SHEET NO. 3 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand (cont)	Gray, mostly medium grained with some coarser material present. Trace silt. Wet. Moisture content 14%.	8A	(continued)				
26			9	AS	2-1/2	25.5 to 27.5	12	10 10 15 16
27								
28								
29	Sand	Rusty brown, clayey, gravelly, very dense, moist to wet. Coarse fraction subrounded. Moisture content 13%.	10	AS	2-1/2	29.0 to 30.8	16	17 31 48 60/.3
30								
31								
32			11	AS	2-1/2	32.0-32.7	6	59 60/.2
33		Sand moderately to highly oxidized. Fractured rock to 2 inches present.						
34								
35								
36		Becomes more rocky, numerous cobbles throughout.	12	A	2-1/2	36.0-36.4	0	70/.4
37								
38			13	AS	2-1/2	38.0 to 38.9	5	41 80/.4
39								
40			14	A	2-1/2	40.0-40.5	0	90
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-25
SITE Watana Relict Channel — SHEET NO. 4 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Red-brown, gravelly, with numerous cobbles throughout. Very dense.						
42			15	A	2-1/2	42.0-42.3	0	60/.3
43								
44			16	A	2-1/2	44.0-44.2	0	50/.2
45								
46			17	A	2-1/2	46.0-46.1	0	30/.1
47		Sampling difficult due to numerous cobbles and boulders.						
48								
49								
50								
51			18	A	2-1/2	51.0-51.2	0	40/.2
52								
53	Silt	Silt layer 53.0-54.0, laminated. Some gravel and coarse sand throughout. Very stiff, moist, oxidated.	19	AS	2-1/2	53.0 to 54.0	4	25 85
54								
55								
56								
57		Very rocky.						

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. A J-25
SITE Watana Relict Channel — SHEET NO. 5 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
57	Sand (cont)	Brown, fine-coarse grained. Gap graded. Gravelly, silty. Very dense. Moist. Very rocky.	20	A	2-1/2	57.0	0	30/Ref
58								
59								
60								
61			20A	DS	2-5/16	59.0 to 63.5	17	-
62								
63								
64								
65								
66								
67			21	A	2-1/2	66.0-66.1	0	40/.1
68		Predominately medium grained with some fine and trace coarse. Trace silt. Very dense. Moisture content 17%.	22	AS	2-1/2	68.0 to 69.1	9	42 68 40/.1
69								
70								
71								
72		Coarse, subangular. Many Cobbles.						
73	Gravel		23	DS	2-5/16	72.0 to 77.0	21	-

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. A J-25
SITE Watana Relict Channel — SHEET NO. 6 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
73	Gravel (cont)	Coarse, subangular. Many cobbles.	23	(continued)				
74								
75		Denison sampler used because of coarseness and hardness.						
76								
77								
78								
79			24	DS	2-5/16	78.0 to 81.5	7	-
80								
81								
82								
83		Gravel and cored rock. Gravel averages 1/2 inch, subrounded to subangular.	25	DS	1-7/8	83.0 to 85.0	18	-
84								
85								
86		No sampling. Triconed.						
87								
88								
89								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-25

SITE Watana Relict Channel — SHEET NO. 7 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	
89	Gravel (cont)	Gravel and cored rock. No sampling. Hole triconed to 90.0 ft.						
90		Bottom of Hole 90 Ft.						
91		* Pneumatic piezometer tip installed at 84.5 ft.						
92								
93								

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-26

SITE: Watana Relict Channel — SHEET NO. 1 OF 8

CONTRACTOR: Denali Drilling Inc. — STARTED 9:30 A.M. September 3 1982; FINISHED 6:00 P.M. September 9 1982

METHOD OF DRILLING: SOIL Rotary Casing and 5-5/8" Tricone — CASING DIAM. SW, 6-3/4"O.D. 6" I.D.

ROCK HX Core Barrel — CORE DIAM. HX, 2-5/16"

LOCATION: LATITUDE N 3,230,658; DEPARTURE E 746,598; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2214.7'; GROUND SURFACE 2214.7'; ROCK SURFACE 2118.7'; BOTTOM OF HOLE 2104.8'; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Boulder at edge of hole. Numerous cobbles to 4 ft.						
4	Sand	Tan, fine to coarse grained, silty, gravelly. Gravel to 2 inches, subangular to angular. Moist. Very dense. Scattered larger material.	1	AS	2-1/2	4.2 to 6.2	13	37 55 25 34

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.C. Powell

APPROVED [signature]

DATE 12/16/82

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-26

SITE: Watana Relict Channel — SHEET NO. 2 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Tan, fine to coarse grained, silty, gravelly. Dense. Moist.	2	AS	2-1/2	9.0 to 11.0	11	20 15 14 20
13		Tan, very silty, well graded. Gravel subrounded to subangular to 1-1/2 inches. Temperature 9°C.	3	AS	2-1/2	14.0 to 15.2	11	32 58 40/2
15	Silt	Tan, sandy, gravelly. Sand is fine to coarse grained. Gravel is angular to subangular (to 2 inches). Well graded. Very dense. Moist.						
18		Temperature 8°C.	4	A	2-1/2	19.0-19.1	0	50/1
20		Scattered coarse gravel and cobbles.						
23			5	AS	2-1/2	22.5 to 23.6	11	41 72 50/1

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 3 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Silt (cont)	Tan, sandy, gravelly. Well graded. Very dense. Moist.						
26								
27	Clay	Olive gray. A mixture of clay, silt, and sand. Well graded. Gravelly, sub-angular to angular, to 2-1/2 inches. Very dense to hard. Moist.	6	AS	2-1/2	27.0 to 28.4	16	19 26 50/5
28								
29								
30		Temperature 10°C.						
31								
32		6 inch cobble at 32.0 ft.	7	A	2-1/2	32.0-32.3	0	20/3
33								
34			8	A	2-1/2	33.0 to 34.3	0	33 48 50/4
35								
36								
37								
38	Silt	Olive gray, clayey, sandy. Some gravel to 1 inch (sub-angular to angular). Sand is fine to coarse grained. Partly graded. Moist. Hard.	9	AS	2-1/2	38.0-38.8	7	38 50/3
39								
40		Temperature 12°C.						
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 4 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Silt (cont)	Olive gray, clayey, sandy, gravelly. Sand fine to coarse grained. Gravel to 2 inches, subangular to angular. Partly graded. Hard. Moist. Temperature 13°C.						
42								
43			10	AS	2-1/2	43.0 to 43.8	6	26 50/4
44								
45								
46	Silt	Mottled olive gray to light olive brown, clayey, sandy. Partly graded. Sand fine to coarse grained. Trace gravel to 1 inch (rounded to angular). Very stiff to hard. Moist. Temperature 11°C. Numerous cobbles.						
47								
48			11	AS	2-1/2	48.0 to 48.8	6	48 50/4
49								
50								
51								
52								
53		Olive gray, clayey, sandy. Some gravel to 1 inch. Partly graded. Hard.	12	AS	2-1/2	53.2 to 53.9	7	53 50/3
54								
55								
56								
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. J700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 5 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Silt (cont)	Olive gray, clayey, sandy. Trace gravel to 3/4 inch. Sand fine to coarse grained. Well graded. Hard. Moist.						
58			13	AS	2-1/2	58.0 to 58.9	5	19 50/5
59		Temperature 9°C.						
60								
61		Scattered coarse gravel and cobbles present throughout.						
62								
63	Clay	Olive black, silty. Some fine to coarse grained sand. Trace subangular gravel to 1 inch. Poorly graded. Very stiff to hard. Moist.	14	AS	2-1/2	63.0 to 64.3	10	20 44 50/3
64								
65								
66		Temperature 7°C.						
67								
68			15	AS	2-1/2	68.0 to 68.3	12	44 50/4
69		Scattered cobbles.						
70								
71								
72								
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. J700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 6 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Clay (cont)	Olive gray, silty. Some sand, trace gravel. Poorly graded. Very stiff to hard. Moist.	16	A	2-1/2	73.0-73.7	0	31 50/2
74								
75	Clay	Gray to dark gray and olive brown, silty. Trace sub-rounded to subangular gravel. Laminated at an angle to horizontal. Very stiff to hard.						
76								
77								
78								
79		Temperature 9°C.	17	AS	2-1/2	78.0 to 79.5	19	12 21 62
80								
81								
82								
83	Silt	Light olive gray, sandy, gravelly. Gravel rounded to angular (to 2 inches). Sand fine to coarse grained. Some clay. Mottled. Hematite staining present. Very dense. Moist.	18	AS	2-1/2	83.3-83.7	5	70/5
84								
85								
86			19	AS	2-1/2	85.5-86.1	5	48 50/1
87								
88		Clayey. Green-gray staining around some gravel. Temperature 11°C.	20	A	2-1/2	88.0	0	20/0
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 7 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Silt (cont)	Mottled olive gray, sandy, gravelly, clayey. Sand fine to coarse grained. Gravel rounded to angular (to 2-1/2 inches). Hematite staining. Dense. Moist.						
90								
91			21	A	2-1/2	91.0-91.2	0	50/2
92								
93		Triconed through rock (boulder?) from 93 to 96 ft.	22	A	2-1/2	93.0	0	20/0
94								
95								
96	Bedrock Diorite	Fractured. 50% of fractures at 20° to horizontal. Slightly to moderately weathered. More weathered at 97.5 to 99.0 ft with sand infilling joints.	23	DY	2-5/16	96.0 to 99.9	47	- REC=100% RQD=20%
97								
98								
99		98.5 2 to 3 inches andesite gravel layer.						
100								
101		Fractured. Slightly weathered. 4 to 5 inches of argillite and diorite gravel to 2 inches.	24	DY	2-5/16	99.9 to 104.9	30	REC= 50% RQD=15%
102								
103		Highly weathered. Becomes less weathered with depth.						
104								
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-26
SITE Watana Relict Channel — SHEET NO. 8 OF 8

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Bedrock Diorite (cont)	Jointed and fractured. Slight weathering present on joint surfaces.	25	DY	2-5/16	104.9 to 109.9	60	- REC=100%
106								
107								
108								
109								
110		Bottom Of Hole 109.9 Ft.						
111								

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE: Borrow Site D — SHEET NO. 1 OF 13

CONTRACTOR: Denali Drilling Inc. — STARTED 5:30 P.M. September 5 1982; FINISHED 3:00 P.M. September 17 1982

METHOD OF DRILLING: SOIL Rotary Casing; 3-7/8 and 2-15/16" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.
ROCK NQ Core Barrel with Diamond Bit — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,231,126; DEPARTURE E 749,709; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2148.8'; GROUND SURFACE 2148.8'; ROCK SURFACE -; BOTTOM OF HOLE 1953.8'; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra vegetation and surficial soils						
5	Sand	Brown, gravelly. Little silt. Mostly fine grained with some coarser sand. Coarse, subangular gravel. Medium density. Moist. Temperature 4°C.	1	AS	2-1/2	5.0 to 7.0	5	16 13 7 7

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: H - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf
LOGGED BY R.G. Adams
APPROVED [signature]
DATE 12/6/82

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE: Borrow Site D — SHEET NO. 2 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Brown, gravelly. Little silt. Mostly fine grained with some coarser sand. Coarse, subangular gravel. Medium density. Moist.	2	A	2-1/2	10.0 to 12.0	0	21 15 16 21
15		Brown, gravelly. Some silt and clay. Dense. Moist. Temperature 7°C.	3	AS	2-1/2	15.0-15.7	7	38 70/.2
20	Cobbles and Gravel	Very rocky. Cobbles and coarse gravel. Poor sampling results. Very slow drilling.	4	A	2-1/2	20.0-20.2	0	70/.2

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 3 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Cobbles and Gravel (cont)	Very coarse gravel and cobbles.						
26								
27								
28								
29	Sand	Gray, gravelly, clayey. Some silt. Sand is predominately fine grained with occasional layers of coarser material. Gravel is subangular. Very dense. Partly graded. Temperature 7°C. Occasional to some cobbles.	5	AS	2-1/2	28.0 to 29.3	9	51 46 70/.3
30			6	A	2-1/2	30.0-30.2	0	75/.2
31								
32								
33								
34								
35			7	A	2-1/2	35.0-35.3	0	90/.3
36		Very cobbly. Poor sampling results due to coarseness of material.						
37								
38								
39								
40			8	A	2-1/2	40.0-40.2	0	65/.2
41								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 4 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Sand (cont)	Gray, gravelly, clayey. Some silt. Sand is mostly fine grained with some coarser layers. Gravel is subangular to angular. Very dense to medium dense. Moist. Partly graded. Temperature 10°C.	9	AS	2-1/2	41.0-41.8	9	42 80/.3
42								
43								
44								
45			10	AS	2-1/2	44.0-44.8	9	33 85/.3
46		(Hole sampled on 5 ft interval)						
47								
48								
49								
50			11	AS	2-1/2	49.0-50.0	12	19 70 30/Ref.
51								
52								
53								
54		Same material.	12	AS	2-1/2	54.0-54.4	9	80/.4
55								
56		Some rocky zones.						
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 5 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Sand (cont)	Gray gravelly, clayey. Some silt. Mostly fine grained sand. Very dense to medium dense. Moist. Partly graded.						
58								
59								
60	Sand	Gray, silty, clayey. Little gravel (subrounded to subangular). Mostly medium and fine grained sand. Partly graded. Moist. Very dense.	13	AS	2-1/2	60.0 to 61.2	14	52 59 50/.2
61								
62								
63	Sand	Brown, gravelly, silty, clayey. Gravel subrounded to subangular. Sand mostly medium and fine grained. Poorly to partly graded. Damp. Very dense.						
64								
65			14	AS	2-1/2	65.0-65.6	4	64 40/.1
66								
67								
68								
69								
70		Brown, gravelly, silty. Trace clay. Slightly moist. Partly graded.	15	AS	2-1/2	70.0 to 71.2	8	15 52 70/.2
71								
72								
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 6 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Sand (cont)	Brown, silty, gravelly. Trace clay. Mostly medium grained sand with some fine and coarse grained. Very dense. Partly graded. Moist.						
74								
75			16	AS	2-1/2	75.0-75.3	3	75/.3
76								
77								
78								
79								
80		No recovery - rock.	17	A	2-1/2	80.0-80.3	3	75/.3
81		81.0 - 84.0 Wash water showing gray color.						
82								
83								
84		Very slow drilling due to cobbles in hole.						
85			18	A	2-1/2	85.0-85.8	0	56 80/.3
86								
87								
88								
89								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 7 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Sand (cont)	Brown, silty, gravelly, trace clay. Very dense. Cobbly. Poorly to partly graded. Moist.						
90			19	A	2-1/2	90.0-90.5	0	75
91								
92								
93		93.0 ft Sand or gravel zone - lost drill water, mudded hole.						
94								
95			20	A	2-1/2	95.0-95.8	0	33 75/.3
96								
97								
98								
99	Gravel	Coarse gravel and cobbles.						
100		Refusal on Rock.	21	A	2-1/2	100.0-100.4	0	50/.4
101								
102		Rocky. Very slow drilling.						
103								
104								
105								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 8 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Gravel (cont)	Coarse gravel and cobbles. No successful sampling due to density and coarseness of material.	22	A	2-1/2	105.0-105.7	0	85 60/.2
106								
107								
108								
109								
110			23	A	2-1/2	110.0-110.2	0	70/.2
111		Very slow drilling due to rocky material.						
112								
113		Very hard. Hole triconed ahead.						
114								
115								
116								
117								
118								
119	Gravel and Cobbles	Very coarse, dense material. Very difficult drilling.						
120								
121								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 9 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
121	Gravel and Cobbles (cont)	Cobbles and coarse gravel. Very dense. Difficult drilling.						
122								
123								
124								
125			24	A	2-1/2	125.0-125.3	0	50/3
126			25	DS	1-7/8	125.3 to 130.0	18	-
127								
128								
129								
130			26	DS	1-7/8	130.0 to 133.5	18	-
131								
132								
133								
134								
135			27	DS	1-7/8	135.0 to 140.0	23	-
136		Very hard.						
137								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 10 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
137	Gravel and Cobbles (cont)	Very dense, coarse material. Very difficult, slow drilling. Repeated drill water loss in highly permeable zones.	27	(continued)				
138								
139								
140								
141			28	DS	1-7/8	140.0 to 145.0	23	-
142								
143								
144								
145			29	DS	1-7/8	145.0 to 146.5	13	-
146		Gravel jammed coring bit.						
147								
148		Hole advanced with tricone bit.						
149								
150								
151								
152								
153								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 11 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
153	Gravel and Cobbles (cont)	Very coarse gravel and cobbles. Very slow, difficult drilling.						
154								
155		155 - 157 ft. Some brown plastic clay returned on drill tools.	30	DS	1-7/8	155.0 to 157.0	18	
156								
157	Clay	Gray. Trace fine grained sand. Stiff Moist. No laminations.						
158								
159								
160			31	AS	1-1/2	160.0 to 162.0	14	53 58 64 73
161								
162								
163								
164		Gray. Laminated throughout with silt on interfaces. No sand visible. Hard. Dry to slightly moist.	32	AS	1-1/2	164.0 to 166.0	24	22 42 39 68
165								
166								
167								
168								
169								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27
SITE Borrow Site D — SHEET NO. 12 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
169	Clay (cont)	Gray. Laminated throughout with slight amounts of silt. Stiff to very stiff. Moist.						
170								
171			33	AS	1-1/2	170.0 to 172.0	24	19 24 32 36
172								
173								
174								
175		Gray. Laminated with thin layers of light gray silt. Trace sub-rounded gravel. Hard. Moist						
176			34	AS	1-1/2	175.0 to 177.0	22	20 31 29 40
177								
178	Gravel and Cobbles	Coarse, rocky material.						
179								
180								
181		Diamond cored.	35	DS	1-7/8	180.0 to 185.0	27	-
182								
183								
184								
185								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-27

SITE Borrow Site D — SHEET NO. 13 OF 13

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
185	Gravel and Cobbles (Cont)	Cobbles and very coarse gravel. Hole advanced with tricone bit from 185.0 - 195.0 ft, no sampling.						
186								
187								
188								
189								
190								
191		Very rock drilling.						
192								
193								
194								
195		Bottom of Hole: 195.0 ft						
196		* Installed thermistor string to 175.0 ft						
197								
198								
199								
200								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28

SITE Watana Relict Channel — SHEET NO. 1 OF 16

CONTRACTOR: Denali Drilling Inc. — STARTED 10:00 A.M. September 11 1982; FINISHED 1:30 P.M. September 21 1982

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. HW, O.D. 4-1/2" I.D. 4"

ROCK NQ Core Barrel With Diamond Bit — CORE DIAM. NO, 1-7/8"

LOCATION: LATITUDE N 3,232,782; DEPARTURE E 751,610; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2226.3'; GROUND SURFACE 2226.3'; ROCK SURFACE -; BOTTOM OF HOLE 1992.3'; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra vegetation and surficial soil deposits.						
1								
2			1	AS	2-1/2	2.0 to 4.0	12	2 3 4 3
3	Silt and Sand	Light olive gray, fine to coarse grained, trace fine gravel to 3/4 inches diameter. Moist. Loose to medium density. Partly graded.						
4			2	A	2-1/2	4.0 to 6.0	0	6 7 6 8
5								
6			3	A	2-1/2	6.0 to 8.0	0	8 7 8 10
7								
8		Scattered cobbles.	4	A	2-1/2	8.0- 10.0	0	13 10
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: M - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.C. Powell

APPROVED [signature]

DATE 12/6z/82

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28

SITE Watana Relict Channel — SHEET NO. 2 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Silt	Light olive gray, sandy, some gravel (rounded to angular) to 1-1/2 inches. Partly graded. Very dense. Moist.	4	(continued)				13 13
10			5	AS	2-1/2	10.0 to 12.0	12	10 13 17 16
11								
12		Poorly graded. Slightly plastic.	6	AS	2-1/2	12.0 to 14.0	12	9 13 13 20
13								
14		Stratified with occasional layers of silty sand.	7	AS	2-1/2	14.0 to 16.0	16	6 21 15 18
15								
16		Light olive gray, some fine to coarse grained sand. Poorly graded. Some gravel (subrounded to subangular). Very dense.	8	AS	2-1/2	16.0 to 18.0	9	20 20 26 30
17								
18			9	AS	2-1/2	18.0 to 20.0	17	18 18 26 28
19	Clay	Light olive gray, silty, some fine to coarse grained sand, trace gravel to 3/4 inch (subangular to angular). Decomposed diorite cobbles. Moist. Very dense, some iron staining present on gravel. Striations appear on some gravel. Clay content increases with depth. Moisture content %.						
20			10	AS	2-1/2	20.0 to 22.0	16	9 15 20 24
21								
22			11	AS	2-1/2	22.0 to 24.0	18	15 13 15 15
23								
24		Light olive gray, silty, trace sand. Striated gravel.	12	AS	2-1/2	24.0 to 26.0	21	9 14
25								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 3 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Clay (cont)	Hematite staining on gravel. Very stiff to hard. Changing to a medium gray color with increasing depth.	12	(continued)				21 30
26			13	AS	2-1/2	26.0 to 27.8	16	12 20 40 50/4
27								
28		Gravel subrounded to subangular. Hard. Mosit. Cobbly.	14	AS	2-1/2	28.0-28.3	3	50/3
29								
30		Scattered coarse gravel and cobbles.						
31								
32			15	A	2-1/2	32.0-32.3	0	25/3
33								
34		Olive gray. Contains striated gravel. Mosit. Decomposed diorite fragments present.	16	AS	2-1/2	34.0 to 35.8	19	21 48 63 50/3
35								
36								
37			17	AS	2-1/2	36.0 to 38.0	21	27 41 75 80
38		Temperature 7°C.						
39								
40		Olive gray, trace striated gravel to 1-1/2 inches (8-10%). Hard. Moist.	18	AS	2-1/2	40.0 to 41.3	12	29 59
41								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 4 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Clay (cont)	Olive gray, silty, trace gravel (subrounded to subangular). Trace fine to medium grained sand. Gravel is striated. Moist. Temperature 9°C.	18	(continued)				50/3
42								
43								
44			19	D	2-5/16	44.0-44.2	0	-
45								
46		Striated gravel to 2 inches. Trace fine to coarse grained sand. Temperature 8°C.	20	AS	2-1/2	45.0 to 47.0	19	17 47 60 66
47								
48								
49								
50		Silty, trace gravel to 1 inch. Gravel is subrounded to subangular. Some gravel striated and/or polished.	21	AS	2-1/2	49.0 to 51.0	17	13 30 49 68
51								
52								
53	Gravel	Olive gray, clayey. Gravel size to 1 1/2 inch; subrounded and striated. Trace silt. Hard, moist.	22	AS	2-1/2	53.0-53.2	2	30/2
54								
55								
56								
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 5 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Clay	Olive gray, silty. Some gravel (to 2 inches) sub-rounded to subangular. Gravel is striated. Trace sand, mostly coarse grained. Hard. Moist. Temperature 5.5°C.	23	AS	2-1/2	57.0 to 59.0	22	16 23 33 52
58								
59								
60								
61		Scattered cobbles.	24	AS	2-1/2	61.0 to 62.1	11	15 24 30/1
62		High plasticity, silty clay. Several vertical gray fine sand seams present, decreasing in prominence with depth.						
63								
64								
65			25	AS	2-1/2	64.0 to 66.0	21	12 28 38 39
66								
67								
68								
69		Moisture content %.	26	AS	2-1/2	68.0 to 69.8	14	16 20 45 50/4
70								
71								
72		Temperature 5.5°C.	27	AS	2-1/2	72.0 to 74.0	20	18 22
73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 6 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Clay (cont)	Olive gray, silty, some gravel to 2 inches (sub-rounded to subangular), striated. Trace fine to mostly coarse grained sand. Hard. Moist.	27	(continued)				30 42
74								
75								
76		Occasional cobbles.						
77		Sand content <5%.						
78		Temperature 4.5°C.	28	AS	2-1/2	77.0 to 79.0	24	17 30 37 53
79								
80								
81		Moderate plasticity. Gravel striated. Temperature 5.0°C.	29	AS	2-1/2	81.0 to 83.0	24	22 43 56 69
82								
83								
84		Gravel and/or cobbles encountered.						
85								
86		Temperature 4°C.	30	AS	2-1/2	85.0 to 86.3	16	26 55 50/4
87								
88		Trace fine to coarse grained sand.						
89		Temperature 5°C.						

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 7 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Clay (cont)	Olive gray, silty, some round to subangular gravel to 2 inches. Trace fine to coarse grained sand. Gravel is striated. Moist. Moderate plasticity. Temperature 5°C.	31	AS	2-1/2	89.0 to 90.0	11	28 67
90								
91								
92								
93								
94		Temperature 7°C.	32	AS	2-1/2	93.0 to 95.0	24	17 29 36 60
95								
96								
97			33	AS	2-1/2	97.0-97.6	7	24 20/1
98	Gravel	Material type changed. Numerous cobbles and much coarse material causing poor sample returns.						
99								
100								
101			34	A	2-1/2	101.0-101.2	0	50/2
102								
103		Diorite cobbles ranging from 4-9-1/2 inches. Striations appear occasionally. Trace argillite gravel. Some silty sand adhered to cobbles.	35	A	2-1/2	103.0	0	25/0
104			36	DY	1-7/8	103.0 to 105.0	6	-
105								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 8 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Gravel (cont)	Diorite cobbles and gravel. Gragmented cobbles to 9-1/2 inches. Partly graded.						
106		Olive brown silty sand adhered to rocks. Argillite gravel to 2-1/2 inches (sub-rounded to subangular); striated.	37	DY & DS	1-7/8	105.0 to 109.5	30	-
107								
108								
109								
110		Diorite and argillite gravel; striated. Trace silty sand adhering to gravel.	38	DS	1-7/8	109.5 to 112.6	10	-
111								
112								
113		9 inches diorite cobble. Striated.	39	DY	1-7/8	112.6 to 113.5	8	-
114			40	DY	1-7/8	113.5 to 115.2	4	-
115		3-1/2 inches diorite cobble, fractured.	41	DY	1-7/8	115.2 to 117.5	5	-
116		Drilling rate slow due to circulation being blocked by what silty sand is present.						
117								
118								
119								
120								
121								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 9 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Gravel (cont)	Diorite and argillite cobbles and gravel in a silty sand matrix.						
122								
123	Clay	Olive gray, silty, sandy (fine to medium grained) with weak laminations of clay and silt. Very stiff to very dense. Slightly plastic. Moist. Wood embedded in sand layer.						
124								
125			42	AS	2-1/2	125.0 to 126.3	16	17 34 50/4
126								
127								
128			43	A	2-1/2	127.0 to 128.2	0	28 29 50/2
129	Sand	Olive gray, fine to medium grained, trace silt. Very dense.	44	AS	2-1/2	129.0-129.8	9	47 50/4
130								
131		Temperature 5°C.	45	AS	2-1/2	131.0 to 132.0	12	20 74
132								
133		Silty, very dense, moist. Occasional very thin layers of clay.						
134								
135								
136	Clay	Olive gray, silty, thinly laminated, very stiff to hard. Some gravel.	46	DS	1-7/8	136.0 to 141.0	28	-
137								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 10 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Clay (cont)	Olive gray, silty. Thinly laminated, slightly plastic. Occasional gravel present. Very stiff to hard. Moist. Temperature 6°C.	46	(continued)				
138								
139								
140								
141								
142								
143								
144		Laminated, very stiff. Occasional nodules of very hard overconsolidated clay. Highly plastic. Temperature 5°C.	47	AS	2-1/2	143.5 to 145.5	24	11 16 20 27
145								
146								
147								
148								
149		Olive gray to olive black. Occasional very thin laminations of very light gray silt. Temperature 3°C.	48	AS	2-1/2	148.5 to 150.5	24	13 16 17 25
150								
151								
152								
153								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 11 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
153	Clay (cont)	Olive gray to grayish black, silty. Laminated. Very stiff. Highly to moderately plastic. Thin laminations of light gray silt present.						
154			49	AS	2-1/2	153.5 to 155.5	24	8 15 20 28
155								
156								
157								
158		Olive gray to olive black. Very stiff. Laminated. Temperature 6°C.						
159			50	AS	2-1/2	158.5 to 160.5	24	13 16 20 25
160								
161								
162								
163								
164		Rare nodules of very hard overconsolidated clay present.	51	AS	2-1/2	163.5 to 165.0	18	14 16 20
165								
166								
167								
168								
169			52	AS	2-1/2	168.5-170.0	18	11

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 12 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
169	Clay (cont)	Olive gray to dark gray, silty, laminated. Very stiff. Slightly to highly plastic. Rare nodules of overconsolidated clay present. Thin laminations of very light gray silt common. Temperature 7°C.	52	(continued)				19 21
170								
171								
172								
173								
174			53	A	2-1/2	173.5 to 175.0		11 17 23
175								
176								
177								
178								
179		Olive gray to medium gray, silty, laminated. Modera ely to highly plastic. Thin layers of light gray silt. Temperature 5°C. Moist.	54	AS	2-1/2	178.5 to 180.0	18	16 19 26
180								
181								
182								
183								
184								
185								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 13 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
185	Clay (cont).	Olive gray to medium gray, silty, laminated. Moderately to highly plastic. Very stiff. Moist. Thin layers of very light gray silt present. Temperature 5°C.						
186								
187								
188								
189		Drilled without sampling until next material change was noted.						
190								
191								
192								
193								
194								
195								
196								
197	Silt	Olive gray, sandy (fine to coarse grained). Poorly graded. Trace round to subangular gravel. Scattered cobbles. Layers of brown silt to 1-1/2 inch thick present. Slightly moist. Dense. May contain organics.	55	A	2-1/2	197.5	0	20/0
198								
199								
200								
201								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 14 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
201	Silt (cont)	Olive gray, sandy. Poorly graded. Trace gravel (round to subangular). Scattered cobbles. Layers of brown silt to 1-1/2 inch thick. Slightly moist. Dense. May contain organics.						
202								
203			56	AS	2-1/2	202.5 to 203.3	[illegible]	37 50/4
204								
205								
206								
207		Several layers of medium to dark brown silt to 1/4 inch thick. Organics.	57	AS	2-1/2	206.0 - 206.7	[illegible]	24 40/2
208								
209			58	AS	2-1/2	208.5 - 209.2	[illegible]	56 50/2
210		Olive gray to grayish brown.						
211	Silt	Light olive gray to tan, clayey. Trace fine to medium grained sand. Very stiff. Slightly moist. Occasional zones of very thinly laminated dark brown and red brown silt. Organics (wood) present throughout. Trace striated gravel (subrounded to subangular).	59	AS	2-1/2	210.5 to 212.3	[illegible]	19 31 48 50/4
212								
213			60	AS	2-1/2	212.5 to 214.2		23 30 52 50/2
214								
215		Temperature 6°C.						
216		Poorly graded.						
217								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 15 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
217	Silt (cont)	Light olive gray, clayey. Trace sand. Very stiff. Organics. Poorly graded.						
218								
219	Sand	Gray-brown, gravelly (to 1-1/4 inch). Gravel is sub-rounded to subangular and fragmented. Moist. Very Dense Partly graded.	61	AS	2-1/2	218.5-218.8	4	500/4
220								
221								
222								
223	Sand and Silt	Grayish tan. Fine to medium grained (mostly fine). Layered with weakly laminated silt. Moist. Very Dense.	62	AS	2-1/2	222.5-223.0	5	135
224	Sand							
225			63	A	2-1/2	225.0-225.4	0	160/5
226								
227								
228								
229								
230								
231								
232		Grayish tan, gravelly. Sand is fine to coarse grained. Gravel is subrounded to subangular to 1-1/4 inch. Trace silt. Well graded. Moist	64	AS	2-1/2	231.5-231.8	3	200/4
233								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-28
SITE Watana Relict Channel — SHEET NO. 16 OF 16

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
233	Sand (cont)	Grayish tan, gravelly. Very dense. Thin layers of silt. Moist.	65	A	2-1/2	233.5-234.0		160
234		Bottom of Hole 234.0 ft.						
235		* Pneumatic piezometer installed in hole with depth to tip 226.0 ft.						
236								
237								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29

SITE: Borrow Site D — SHEET NO. 1 OF 11

CONTRACTOR: Denali Drilling Inc. — STARTED 7:00 A.M. September 19, 19 82 — FINISHED 4:30 P.M. September 24, 19 82

METHOD OF DRILLING: SOIL Rotary Casing & 3-7/8" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.

ROCK None — CORE DIAM. None

LOCATION: LATITUDE N 3,238,258; DEPARTURE E 757,174; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2411.0; GROUND SURFACE 2411.0; ROCK SURFACE -; BOTTOM OF HOLE 2253.0; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra material, organics. Spongy with root and other vegetation.						
1								
2								
3								
4	Sand	Tan to light brown. Mostly fine grained with some medium grained. Little silt and gravel. Gravel is fine grained and angular to subangular. Poorly graded. Medium density. Moist.	1	AS	2-1/2	4.0 to 6.0	18	11 20 22 37
5								
6			2	AS	2-1/2	6.0 to 8.0	12	13 20 23 20
7								
8								
9			3	AS	2-1/2	8.0-10.0	13	13 20

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: N - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIGFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R.G. Adams

APPROVED [signature]

DATE 12/6/82

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29

SITE: Borrow Site D — SHEET NO. 2 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
- 9	Sand (cont)	Light brown, silty, gravelly. Mostly fine with some medium to coarse grained. Fine gravel (subrounded to subangular). Dense. Moist. Poorly to partly graded. Trace clay.	3	(continued)				18 21
-10			4	AS	2-1/2	10.0 to 12.0	4	11 15 16 19
-11								
-12								
-13			5	AS	2-1/2	12.0 to 14.0	14	9 16 21 32
-14	Sand	Brown, gravelly, silty, clayey. Predominately fine grained. Clay content decreases with depth. Very dense. Poorly to partly graded. Moist.	6	AS	2-1/2	14.0 to 16.0	16	22 38 42 47
-15								
-16			7	AS	2-1/2	16.0 to 18.0	16	23 47 48 45
-17								
-18	Sand	Brown to rusty brown. Gravelly, silty, trace clay. Mostly fine with some coarse and little medium grained. Fine gravel (subrounded to subangular). Very dense. Poorly graded. Moist. 18.5-20.0 Cobbly zone.						
-19								
-20			8	AS	2-1/2	20.0 to 21.0	10	34 90/
-21								
-22								
-23								
-24			9	AS	2-1/2	24.0 to 26.0	18	24 54
-25								

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CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE: Borrow Site D — SHEET NO. 3 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
-25	Sand (cont)	Brown-rust, gravelly, silty. Little clay. Mostly fine grained sand with some coarse and little medium. Gravel is subangular to sub-rounded. Very dense. Poorly graded. Moist.	9	(continued)				50
-26								59
-27								
-28			10	AS	2-1/2	28.0 to 29.1	9	32 58 50/.1
-29								
-30			11	AS	2-1/2	30.0 to 32.0	6	22 48 52 60
-31								
-32		Cobbly zone.						
-33								
-34								
-35		Brown, gravelly, silty. Little clay. Very dense. Poorly graded. Moist. Gravel in sample is fine grained.	12	AS	2-1/2	35.0 to 37.0	14	1[illegible] 3. 61 63
-36								
-37		Cobbly zone. Very rocky. No sampling due to coarseness of material.						
-38								
-39								
-40			13	A	2-1/2	40.0-40.3	0	60/.3
-41								

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CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE: Borrow Site D — SHEET NO. 4 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
-41	Sand (cont)	Brown, gravelly, silty. Little clay. Sand mostly fine grained. Occasional cobbles. Very dense. Poorly graded. Moist.						
-42								
-43								
-44								
-45			14	AS	2-1/2	45.0-45.5	[illegible]	[illegible] SS.
-46		Cobbly zone.						
-47								
-48			15	A	2-1/2	48.0-48.1	0	60/.1
-49		Cobbly zone causing sampling difficulty.						
-50								
-51								
-52			16	A	2-1/2	52.0-52.4	0	60/.4
-53								
-54		Brown-gray, very silty. Sand mostly fine grained. Some gravel. Sample taken between cobble zones. Very dense. Moist.	17	AS	2-1/2	54.0 to 54.9	2	43 60/.4
-55								
-56								
57								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE Borrow Site D — SHEET NO. 5 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
-57	Sand (cont)	Brown-gray, very silty. Sand mostly fine grained. Some small gravel in sample. Very dense. Moist						
-58			18	A	2-1/2	58.0-58.2	0	50/.2
-59								
-60		Cobbly zone.						
-61								
-62								
-63								
-64								
		Sand sloughing into hole from above.	19	A	2-1/2	64.0	0	30/Ref.
-65								
-66								
		Cobbly zone.						
-67								
-68								
-69								
			20	AS	2-1/2	69.0 to 70.5	12	28 62 70 30/Ref.
-70		Brownish gray, silty, gravelly. Trace clay. Poorly graded. Moist. Gravel is subangular. Sand mostly fine grained.						
-71								
-72		Cobbly zone.						
-73								

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CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE Borrow Site D — SHEET NO. 6 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE	SIZE	DEPTH	RET'D	PENETRATION TEST
-73	Sand (cont)	Brown-gray, silty, gravelly. Trace clay. Sand mostly fine and medium grained. Poorly to partly graded. Moist. Very dense.						
-74								
-75			21	AS	2-1/2	75.0-75.7	4	62 70/.2
-76								
-77		Cobbly. Very difficult, slow drilling. Lack of samples due to rocky nature of deposit.						
-78								
-79			22	A	2-1/2	79.0	0	30/Ref.
-80								
-81								
-82								
-83			23	A	2-1/2	83.0-83.3	0	65/.3
-84		Cobbly zone.						
-85								
-86								
-87			24	AS	2-1/2	87.0 to 88.5	10	78 69 95/.5
-88		Brown-gray, gravelly, silty. Trace clay. Occasional diorite gravel. Gravel is subangular to subrounded. Partly graded. Very dense. Moist.						
-89								

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DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE: Borrow Site D — SHEET NO. 7 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
89	Sand (cont)	Brownish-gray, silty, gravelly. Mostly fine and medium with some coarse grained. Gravel subangular to subrounded. Partly graded. Moist. Very dense.						
90								
91			25	AS	2-1/2	91.0 to 92.0	11	19 55 40/Ref
92								
93								
94		Very rocky-cobbly. Little sampling done. Poor recoveries of samples due to coarseness of material.						
95			26	A	2-1/2	95.0-95.4	0	75/.4
96								
97								
98			27	A	2-1/2	98.0	0	30/Ref.
99								
100								
101								
102			28	A	2-1/2	102.0-102.5	0	12 30/Ref
103								
104		Very cobbly.						
105								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE: Borrow Site D — SHEET NO. 8 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
105	Sand (cont)	Brownish-gray, silty. Some subrounded to subangular gravel. Sand mostly fine and medium grained. Partly graded. Very dense. Moist.						
106								
107								
108								
109			29	AS	2-1/2	109.0-109.8	4	41 60/.3
110	Cobbles and Gravel	Sand is probably matrix for cobbles and coarse gravel.						
111								
112								
113		Very slow drilling. Approximate rate 1-1/2 feet per hour.						
114			30	A	2-1/2	114.0-114.3	0	60/.3
115								
116								
117								
118		Very rocky.						
119			31	A	2-1/2	119.0	0	30/Ref.
120								
121								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE Borrow Site D — SHEET NO. 9 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
121	Cobbles and Gravel (cont)	Very rocky. Difficult drilling. No successful sampling. Sand as above is probable matrix for cobbles and coarse gravel.						
-122								
-123								
-124			32	A	2-1/2	124.0-124.2	0	50/.2
-125								
-126								
-127								
-128								
-129		Very difficult, slow drilling.						
-130								
-131								
-132								
-133								
-134								
-135	Sand	Gray-tan, silty, some gravel. Fine to coarse grained. Well graded. Very hard. Overconsolidated.	33	AS	2-1/2	135.0 to 135.9	3	7 100/.4
-136								
137								

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-29
SITE Borrow Site D — SHEET NO. 10 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
137	Cobbles and Gravel (cont)	Very rocky. No sampling due to coarseness of material. Sand probable matrix for cobbles and coarse gravel.						
-138								
-139								
-140								
-141								
-142								
-143								
-144								
-145		Very rocky. Slow, difficult drilling.						
-146								
-147								
-148								
-149								
-150		Much softer material. No sample recovery for description.	34	A	2-1/2	149.5 to 151.2	0	8 28 60 50/.2
-151								
-152								
153		153.0-156 Boulder						

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DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-29

SITE Borrow Site D — SHEET NO. 11 OF 11

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
153	Boulder	153.0-156.0 Boulder.						
-154								
-155								
-156								
		Much softer material. No sample for description.						
-157								
-158		Bottom of Hole: 0'						
-159								
-160								

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-30

SITE: Watana Relict Channel — SHEET NO. 1 OF 7

CONTRACTOR: Denali Drilling Inc. — STARTED 10:00 A.M. September 22 19 82; FINISHED 5:00 P.M. September 25 19 82

METHOD OF DRILLING: SOIL Rotary Casing and 3-7/8" Tricone — CASING DIAM. HW, 4-1/2" O.D. 4" I.D.

ROCK NQ Core Barrel with Diamond Bit — CORE DIAM. NQ, 1-7/8"

LOCATION: LATITUDE N 3,231,062; DEPARTURE E 746,716; BEARING -; INITIAL DIP 90°; OTHER DIPS None

ELEVATIONS: DATUM Ground Surface; DRILL PLATFORM 2221.4; GROUND SURFACE 2221.4'; ROCK SURFACE -; BOTTOM OF HOLE 2121.4; WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0	Surficial Deposits	Tundra vegetation.						
1								
2					No Sampling			
3								
4								
5			1	A	2-1/2	4.0 to 6.0	0	4 3 3 4
6	Sand	Olive gray, fine to coarse grained. Silty, some gravel to 1-1/2 inch (subrounded to subangular). Medium density. Moisture content 9%. Temperature 14°C. Well graded.	2	AS	2-1/2	6.0 to 8.0	6	7 8 7 8
8			3	AS	2-1/2	8.0-9.7	6	9 14
9								

* SAMPLING METHOD: A - SPLIT TUBE; B - THIN WALL TUBE; C - PISTON SAMPLER; D - CORE BARREL; E - AUGER; F - WASH

SHIPPING CONTAINER: H - INSERT; O - TUBE; P - WATER CONTENT TIN; Q - GLASS JAR; R - CLOTH BAG; S - PLIOFILM BAG; Z - DISCARDED

INSPECTOR E.J. Kleinkauf

LOGGED BY R. C. Powell

APPROVED

DATE 12/6/82

ACRES AMERICAN INCORPORATED - CONSULTING ENGINEERS
BUFFALO, NEW YORK
DRILLING REPORT

CLIENT: ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT: Susitna Hydroelectric Project — HOLE NO. AH-D-30

SITE: Watana Relict Channel — SHEET NO. 2 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
9	Sand (cont)	Light olive gray, fine to coarse grained. Silty, trace gravel. Medium dense to dense.	3	(continued)				17 50/2
10								
11		Temperature 15°C.						
12		10.0-13.0 Boulder. Numerous cobbles and boulders from 9.5 ft.						
13			4	DS	1-7/8	12.5 to 14.0	5	-
14		Poorly graded. Very dense.	5	AS	2-1/2	14.0 14.4	5	50/5
15								
16		Scattered cobbles.						
17								
18	Sand	Light olive gray, fine to coarse grained. Silty, some gravel to 1 inch (subrounded to subangular). Well graded. Occasional thin silt layer. Moist. Very dense. Temperature 5°C	6	AS	2-1/2	18.0 to 19.2	11	21 5 50/2
19								
20								
21								
22	Sand and Silt	Fine to coarse grained sand layered with fine sand to silt. Well graded. Trace gravel to 3/4 inches (subrounded to subangular). Moist. Dense. Temperature 4°C.	7	AS	2-1/2	22.0 to 22.9	10	23 50/5
23								
24	Sand	Light olive gray to grayish tan, silty. Some gravel.	8	AS	2-1/2	24.0 to 25.8	16	11 29
25								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-30
SITE Watana Relict Channel — SHEET NO. 3 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
25	Sand (cont)	Light olive gray to grayish tan, silty. Some gravel to 2 inches (subrounded to subangular). Very dense. Moist.	8	(continued)				48 50/4
26								
27			9	A	2-1/2	26.0 to 28.0	0	11 20 38 38
28		Multicolored. Fine to coarse grained with fine at top of sample and medium grained at bottom. Trace silt. Dense. Wet. Temperature 3°C. Ungraded.	10	AS	2-1/2	28.0 to 29.8	13	5 24 62 50/3
29								
30								
31								
32	Silt	Olive gray, sandy. Trace gravel (subrounded to subangular) to 1-1/2 inch. Poorly graded. Very dense. Moist.	11	AS	2-1/2	32.0 to 33.2	13	16 32 50/2
33								
34								
35								
36		Thin cobble zone.	12	A	2-1/2	36.0-36.2	0	50/2
37								
38								
39								
40								
41			13	AS	2-1/2	40.0 to 41.3	6	6 28

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-30
SITE Watana Relict Channel — SHEET NO. 4 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
41	Silt (cont)	Brown and gray, clayey. Some fine to medium grained sand. Little fine gravel (angular to subangular). Dense to very dense.	13	(continued)				50/3
42								
43								
44		Thin zones of gravel/cobble rich material.	14	AS	2-1/2	44.0 to 45.3	16	36 56 50/3
45								
46								
47								
48		Sample refusal on cobble.	15	AS	2-1/2	48.0-48.7	5	27 50/2
49								
50								
51								
52		Light olive gray, sandy (fine to coarse grained). Poorly graded. Trace subrounded to subangular gravel. Very dense. Moist.	16	AS	2-1/2	52.0 to 53.4	5	6 26 80/5
53								
54								
55								
56			17	AS	2-1/2	56.0-56.8	9	43 50/3
57								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-30
SITE Watana Relict Channel — SHEET NO. 5 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
57	Silt (cont)	Light olive gray to grayish tan, sandy. Sand fine to coarse grained. Poorly graded. Trace subrounded to subangular gravel to 1-1/2 inch. Dense to very dense. Moist.						
58								
59								
60								
61			18	AS	2-1/2	60.5 to 61.3	10	45 50/4
62								
63								
64		Light olive gray, sandy, gravelly. Gravel is subangular and fragmented. Sand is fine to coarse grained. Partly graded. Very dense. Moist.	19	AS	2-1/2	64.0-64.3	4	50/4
65								
66								
67								
68								
69		Temperature 8°C.	20	AS	2-1/2	69.0-69.7	8	45 50/2
70	Silt and Clay	Olive gray, sandy, gravelly. Sand fine to coarse grained. Gravel is subrounded to subangular, disintegrated diorite. Poorly graded. Very dense. Moist.						
71								
72								
73								

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BUFFALO, NEW YORK
DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55
PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-30
SITE Watana Relict Channel — SHEET NO. 6 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
73	Silt and Clay (cont)	Olive gray, sandy, gravelly. Poorly graded. Sand fine to coarse grained. Gravel subrounded to subangular. Very dense. Moist.						
74			21	A	2-1/2	74.0-74.3	3	100/3
75								
76								
77								
78								
79		Trace striated gravel. Some gravel disintegrated diorite. Partly graded.	22	AS	2-1/2	79.0-to 79.8	7	35 50/3
80								
81		50% drill water loss.						
82								
83		Full drill water returns.						
84		Olive gray, sandy, gravelly. Gravel to 1-1/2 inch (subangular to angular). Sand fine to coarse grained. Partly graded. Very dense. Moist.	23	AS	2-1/2	84.[illegible] to 84.[illegible]	[illegible]	40 50/4
85								
86								
87								
88								
89								

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BUFFALO, NEW YORK

DRILLING REPORT

CLIENT ALASKA POWER AUTHORITY — JOB NO. P5700.55

PROJECT Susitna Hydroelectric Project — HOLE NO. AH-D-30

SITE Watana Relict Channel — SHEET NO. 7 OF 7

DEPTH	SOIL TYPE	DESCRIPTION: COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE PEN'D	PENETRATION TEST
89	Silt and Clay (cont)	Olive gray, sandy. Sand is fine to coarse grained. Partly graded. Some gravel to 1-1/2 inch. Gravel is subangular to angular. Some gravel pieces are disintegrated diorite. Very dense. Moist.	24	AS	2-1/2	89.0 to 90.3	13	16 49 50/4
90								
91								
92								
93								
94								
95								
96								
97								
98								
99			25	A	2-1/2	99.0 to 100.0	0	21
100		Bottom of Hole 100 Ft.						
101								
102								
103								
104								
105								

APPENDIX B
WATANA RELICT CHANNEL/ BORROW SITE D-LABORATORY TEST DATA

LABORATORY TEST DATA LEGEND SHEET (EXPLANATION IN ITALICS)

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/16/82
SHEET __ OF __

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D19	19-28	93.0	E						100	98	89	83	76	67	57	48	41	36	32	8.5				SM-SC
	19-29	97.0-97.3	E	Too Small To Test *SMALL RECOVERY*																				
	19-30	99.0-100.0	E					100	95	91	85	80	73	64	55	47	40	36	31	8.9				SM
	19-31	109.0-110.5	E							100	99	97	99	86	81	78	75	73	70	15.3	25	20	5	ML-CL
	19-32		E	No Recovery *NO SAMPLE RECOVERED*																				
	19-33	114.0-114.8	E								100	99	98	96	94	93	91	87	83					ML-CL
	19-34	117.0-117.8	E	On Hold *SAMPLE NOT TESTED, SAVED*																				
	19-34	120.0-120.7		On Hold *SAMPLE NOT TESTED, SAVED*																				
	19-35	124.0-125.4	E								100	99	98	97	96	95	94	92	90	17.0				CL-CH
	19-43	151.0-151.5	F					100	95	92	85	80	74	66	57	51	47	44	41	10.6				SM-SC
	19-46	169.0-169.4	G							100	98	98	98	97	97	96	96	96	95					CL-MC

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422-53

BOREHOLE NUMBER	SAMPLE NUMBER	DEPTH (FEET)	STRATIGRAPHIC UNIT	MOISTURE CONTENT ASTM D2216-80	LIQUID LIMIT ASTM D423-66	PLASTIC LIMIT AND PLASTICITY INDEX ASTM D424-59	UNIFIED SOIL CLASSIFICATION ASTM D2487-69

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/3/82
SHEET 1 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D15	15-1	2.5-5.0	E					100	97	91	85	80	75	67	58	*44	41	-	29					SM
	15-2a	5.0-6.0	E									100	98	89	73	*48	44	-	28					SM
	15-2b	6.0-7.0	E				100	89	85	85	81	79	75	69	60	*45	42	-	31					SM
	15-3	7.0-9.0	E					100	97	95	89	86	81	73	63	*47	43	-	29					SM
	15-4	9.0-11.0	E							100	95	90	85	78	69	*56	53	-	41					SM
	15-5	11.0-13.0	E						100	97	90	87	83	76	68	*54	52	-	40					SM
	15-6a	13.0-15.0	E						100	97	92	88	83	76	67	*54	51	-	39					SM
	15-6b	13.0-15.0	E																					
	15-7	15.0-17.0	E							100	98	93	87	85	77	69	63	57	52		17	15	2	SM
	15-8	17.0-19.0	E/F	Contact				100	94	86	77	72	68	62	49	*44	42	-	32	9.0				SM
	15-9	19.0-21.0	E/F	Contact						100	95	90	85	78	69	*56	53	-	42	10.3				SM
	15-10	21.0-23.0	F							100	95	92	87	79	70	*57	54	-	42	8.8				SM
	15-11	23.0-25.0	F						100	96	94	91	86	78	69	*56	53	-	43	9.9				SM
	15-14	34.0-35.5	F/G	Contact																21.0				
	15-15	35.5-37.0	G																	23.1				
	15-16	37.0-39.0	G																	36.7				
	15-17	39.0-41.0	G																	38.5				
	15-18	41.0-43.0	G																	30.6				
	15-19	43.0-45.0	G																	39.7				
	15-20	45.0-47.0	G																	31.2				

REMARKS: * #80 sieve used in place of #60 seive.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/3/82
SHEET 2 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D15	15-21	47.0-49.0	G																	35.3				
	15-22	49.0-51.0	G																	37.5				
	15-23	51.0-53.0	G																	35.5				
	15-24	53.0-55.0	G																	35.4				
	15-25	55.0-57.0	G																	33.5	55	28	27	CH-MH
	15-26	57.0-59.0	G																	33.2				
	15-27	59.0-61.0	G																	31.7				
	15-28	61.0-63.0	G																	31.9				
	15-29	63.0-65.0	G																	25.7	42	24	18	CH
	15-30	65.0-67.0	G																	26.0				
	15-31b	67.0-68.5	G																	20.0				
	15-32	69.0-70.4	G																	22.9				
	15-33	72.0-73.5	H			100	79	63	55	55	54	54	54	53	21	4	2	1	1	11.9				SP
	15-34	74.0-74.5		No Recovery																				
	15-35	74.5 75.9		Cobbles																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 1 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D16A	16A-1	3.0-5.0	C						100	97	91	87	84	77	70	61	51	45	39	9.9				SM
	16A-4a	9.0-11.0	C							100	99.5	98	95	89	82	76	70	65	60	16.8				CL-ML
	16A-4b	9.0-11.0	C								100	99	91	62	32	*9	7	-	1	11.2				SP
	16A-6	13.0-13.5	C				100	89	89	89	81	78	71	61	49	38	30	25	21	9.2				SM-SC
	16A-7	15.0-15.7	C				100	81	77	71	70	65	55	42	31	24	19	16	13	8.3				SM-SW
	16A-8	17.0 17.2	C						100	92	90	88	82	70	55	44	37	33	29	10.7				SM-SC
	16A-9	19.0-19.7	C							100	92	88	82	71	59	49	41	35	31	11.6				SM
	16A-10	21.8-23.0	C						100	99	94	89	80	65	50	40	32	27	23	11.3				SM
	16A-11	24.0-25.4	C	Cobble Fragments																				
	16A-12a	26.2-26.5	C	Cobble Fragments																				
	16A-12b	27.4-28.2	C							100	99	97	92	85	76	67	60	54	49	15.3				SM-ML
	16A-13	28.2-28.6	C	Cobble Fragments																				
	16A-14a	29.5-30.0	M	Cobble Fragments					100	95	87	80	75	70	63	55	47	43	39	11.7				SM
	16A-14b	30.2-31.0	M							100	95	93	89	84	78	68	60	54	49	13.0				CL-SC
	16A-15	31.0-31.9	M	Cobble Fragments																				
	16A-16	33.0-33.4	M	Cobble Fragments																				
	16A-17	34.0-36.0	M					100	84	78	74	73	71	69	67	66	64	63	61		33	20	13	CL
AH-D16B	16B-18	36.0-38.0	M																	10.8				
	16B-19	38.0-38.2	M																	13.7				
	16B-20	38.2-39.0	M																	12.5				

REMARKS: * #80 sieve used instead of #60 sieve.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 2 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D16B	16B-21a	40.0-42.0	M					100	92	92	87	84	81	78	74	71	67	64	60	11.5				CL
	16B-21b	41.0 41.3	M							100	99	97	95	93	90	87	80	70	60	17.2				ML
	16B-22	42.0-43.5	M					100	94	91	90	88	85	80	77	73	70	66	63	13.8				CL
	16B-23	44.0 46.0	D								100	98	89	69	48	29	16	9	5	12.9				SP
	16B-24a	46.0-46.6	D*																					GP
	16B-24b	46.6-47.5	D								100	99	98	97	95	88	69	48	33	28.3				SM
	16B-24 23	44.0-46.6	D			100	93	88	79	77	72	69	62	49	35	22	13	8	4					SP
	16B-25	48.0-49.5	D					100	86	80	74	72	72	71	71	68	57	45	41	17.1				SM
	16B-26	49.5-50.7	D						100	96	94	93	89	83	72	69	57	43	32	15.9				SM
	16B-27	51.0-51.3	D	Not Representative																				
	16B-28	51.0-52.7	D*																					GW
	16B-29a	54.9-55.5	D							100	100	100	99	98	96	90	77	58	38	21.9		NP		ML
	16B-29b	54.2-54.9	D				100	89	64	56	48	41	37	34	31	28	23	16	11	9.4				GW-GM
	16B-30	56.0-56.7	D*																					GP
	16B-31a	58.0-58.9	D				100	64	60	53	48	44	40	38	35	31	26	21	15	9.4				GM-GW
	16B-31b	58.9-59.3	D'								100	99	98	97	94	87	73	61	49	20.9				SM-ML
	16B-32	60.5-61.3	D'	Same as 31b - not tested																		NP		ML
	16B-33	62.4-62.8	D'								100	99.7	99	98	97	95	88	79	68	19.7				ML
	16B-34	64.3-64.9	D'						100	98	97	96	94	92	90	87	84	79	74	17.9				ML
	16B-35	65.3-66.9	D'								100	99	99	95	90	88	85	83	81	28.2	47	31	16	ML

REMARKS: * Not representative sample. Too small for maximum particle size.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

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SHEET 3 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D16B	16B-36a	67.3-67.8	D'/E																24.2		NP		ML
	16B-36b	67.8-68.8	E							100	98	96	91	80	65	45	29	21	16	18.4				SM
	16B-37	69.5-71.0	E						100	99	96	93	88	78	62	45	33	25	19	16.0				SM
	16B-38	71.3-72.9	E					100	97	95	91	88	80	63	38	20	12	8	6	15.2				SP
	16B-40	75.0-77.0	E								100	96	82	75	63	41	22	11	7	4.8				SP-SM
	16B-41	80.0-81.0	F					100	86	84	78	75	70	64	58	52	47	43	39	8.5				SM-SC
	16B-42	81.7-82.0	F																					
	16B-43	83.0-84.0	F					100	97	96	90	85	79	73	65	59	54	49	45	9.3	21	15	7	SM-SC
	16B-44	85.0-85.7	F																					
	16B-45	86.0-87.0	F				100	85	82	82	80	77	69	57	47	40	35	31	29	16.9				SC
	16B-46	87.0-87.5	F																					
	16B-47	89.0-89.3	F																					
	16B-48	91.3-92.0							100	93	79	73	66	58	51	44	38	34	31	7.3				SC
	16B-49	94.0-94.7																						
	16B-50	96.0-96.4	F																					
	16B-51	98.0-98.5	F																					
	16B-52	100.6-101.2	F					100	94	89	85	80	75	67	59	52	46	42	38	10.0				SC
	16B-53	102.3-102.4	F	Rock Fragments																				
	16B-54	104.5-104.6	F	Too Small to Test																				
	16B-55	106.5-106.7	F	Rock Fragments																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 4 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	PI	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D16B	16B-56	108.0-108.1	F	Rock Fragments																			
	16B-57	112.0-112.7	G					100	91	89	85	80	76	67	60	53	48	45	42	10.0				SC
	16B-58	116.0-118.0	G												No Upper Limit				98	29.3	52	29	23	MH-CH
	16B-59	118.0 120.0	G																	28.2				
	16B-60	120.0-121.7	G																	28.9				
	16B-61	124.0-126.0	G						100	98	98	98	98	98	98	98	98	97	97	28.6				CL-CH
	16B-62	128.0-130.0	G																					
	16B-63	132.0-133.5	G																100	34.1	52	28	24	CH
	16B-64	136.0-137.5	G																	33.4				
	16B-65	140.0-141.5	G																100	30.6				CL-CH
	16B-66	144.0-145.5	G																	28.1	31	25	6	ML
	16B-67	148.0-149.2	I					100	93	85	69	63	58	52	46	41	37	34	31	10.4				SC
	16B-68	151.0-152.0	I						100	95	94	94	93	92	92	91	91	91	91	27.1				CL-ML
	16B-69	153.0-154.4	I																					
	16B-70	155.0-156.0	I					100	96	96	93	88	84	79	73	68	63	59	56	15.2				CL
	16B-71	157.0-158.3	J																	15.8				
	16B-72	159.0-161.0	J				100	88	88	88	82	79	76	73	69	66	62	60	58	14.9				SC-SM
	16B-73	163.0-164.1	J						100	98	96	95	94	93	91	90	89	88	86	25.5				ML-MH
	16B-74	167.0-168.4	J																	28.1				
	76 16B-79			NX Core - Bedrock																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D17	17-1	2.0-4.0	C				100	91	81	76	67	63	58	51	45	39	35	31	27	10.5				SM
	17-2	4.0-6.0	C						100	99	94	89	79	64	52	42	35	30	26	11.1				SM
	17-3	6.0-8.0	C							100	96	86	65	40	31	26	22	19	17	15.8				SM
	17-4	8.0-10.0	C																					
	17-5	10.0-12.0	C						100	97	94	91	85	75	64	54	46	40	35	9.6				SM
	17-6	12.0-13.9	C																					
	17-7	14.0-15.3	C																					
	17-8	16.0-17.3	C				100	85	81	80	77	74	68	61	53	46	39	34	30	7.5				SM-SC
	17-9	18.0-18.8	C							100	93	89	83	74	63	54	46	40	35	8.3				SM
	17-10	20.0-20.6	C						100	95	94	89	83	74	64	55	47	41	35	9.2				SM
	17-11	22.0-22.7	C																					
	17-12	24.0-25.9	C					100	94	89	85	81	75	67	58	50	42	37	32	7.5				SM
	17-13	26.0-28.0	C						100	98	95	90	82	70	59	48	40	34	30	9.3				SM
	17-14	28.0-29.3	C					100	92	88	81	77	72	64	56	49	43	38	34	9.0				SC
	17-15	30.0-30.7	C																					
	17-16	32.0-33.3	C					100	90	82	74	71	64	56	47	39	33	28	24	7.6				SM-SC
	17-17	34.0-34.8	C					100	80	77	75	71	66	59	52	46	40	36	33	8.6				SM
	17-18	40.0-41.0	C																	7.5	18	15	3	SC
	17-19	42.0-42.9	E				100	86	65	62	58	54	49	43	36	30	26	22	20	7.4				SM-GM
	17-20	45.3-45.7	E					100	94	91	84	78	70	62	53	45	39	33	29	18.4				SM

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)																W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D17	17-21	48.0-48.4	E																					
	17-22	53.0-53.7	E				100	84	79	74	70	65	59	51	44	37	32	27	24	7.8				SM
	17-24	60.0-60.7	F					100	94	86	81	77	69	60	51	43	37	32	28	9.9				SM
	17-29	77.0-77.8	G					100	92	92	91	91	90	90	89	88	86	82	76	21.3				CL
	17-30a	80.0-81.0	G					100	96	96	89	84	78	71	64	57	51	46	41	13.7				SC
	17-30b	81.0-82.0	G				100	92	89	85	78	73	67	62	56	51	45	41	38	9.1				SC
	17-31	85.0-86.9	G						100	98	94	91	86	79	72	65	57	52	47	12.2				SC-CL
	17-32	87.0-89.0	G**																					
	17-33	89.0-90.6	G**																					
	17-34	-	No Recovery																					
	17-35	94.0-95.2	G'				100	94	94	90	88	83	78	72	63	54	48	43	40	11.3				SC
	17-36	96.0-97.9	G'																	13.9				
	17-37	98.0-99.7	G'					100	97	97	91	86	81	73	66	59	54	51	48					SC-CL
	17-39	102.0-102.8	G'							100	93	87	79	70	63	56	51	46	42	13.6				SM-SC
	17-40	120.0-120.7	I	Center						100	99	99	98	93	86	84	84	83	82	21.9				CL
	17-41	122.0-122.8	I	Center						100	99.8	99.5	99	96	94	92	91	89	87	24.0				CL
	17-43	136.0-136.4	I							100	95	92	88	85	82	77	70	63	55	15.3				CL-SC
	17-43a	136*	I	Sand Ran Into Spoon							100	99.9	99	78	29	20	16	14	12	24.6				SP-SM
	17-45	140.0-145.8	I								100	99	96	84	73	35	25	21	18	24.6				SM-SP
	17-47	147.0-147.8	I							100	93	79	69	64	53	35	22	16	12	18.4				SW-SM

REMARKS: * Sand that ran into spoon after sample 17-43 was taken.

** Organics in sample. Held for carbon 14 dating.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/15/82
SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D17	17-50	164.0-164.5	I							100	99	95	93	90	88	85	80	74	65	13.1				CL
	17-51*	169.0-169.8	I				100	72	72	72	70	67	62	58	54	52	50	48	48					SC-CL
	17-51a**	169.0	I																					SP
	17-53	185.0-186.8	J'																	23.6	51	25	26	CH
	17-54	191.0-191.7	J	NX Core																				

REMARKS: * Sample not representative. One large fragment.
** Sand slough (wash), not representative.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/3/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D13	18-1	3.5-5.5	C				100	74	68	63	59	52	46	38	31	25	21	18	15					GM-SM
	18-2	5.5-7.5	C					100	96	96	90	86	81	72	60	50	43	37	33					SM
	18-3	7.5-9.5	C						100	96	91	84	77	67	58	48	40	34	29					SM
	18-4	9.5-10.3	C					100	92	91	87	83	78	70	61	53	47	41	37	14.9				SM-SC
	18-5	11.5-12.0	C	Cobble Fragments																				
	18-6	15.0-16.3	C						100	97	92	86	79	68	59	49	41	36	31	12.0				SM-SC
	18-7	18.0-18.7	C	Cobble Fragments																				
	18-8	22.0-23.3	C						100	97	94	88	81	72	63	55	48	43	39					SC
	18-9	25.0-27.0	D'						100	99	95	92	88	84	80	75	71	68	65	15.5				CL-CH
	18-11	29.0-31.0	D'	Sample Too Small To Test																				
	18-12	31.0-33.0	D'	On Hold																				
	18-13	33.0-35.0	D'				100	84	71	65	56	51	45	40	35	32	29	27	26	9.8				GC-SC
	18-14	35.0-36.5	D'	On Hold																				
	18-15	37.0-38.4	D'						100	97	89	83	78	72	66	61	56	52	50	11.5				CL-SC
	18-16	39.0-40.4	D'	On Hold																				
	18-17	41.0-43.0	D'																	14.6	30	17	13	CL
	18-18	43.0-45.0	D'							100	99	99	98	96	94	92	90	89	87	22.2				CL
	18-24	70.0-71.3	E/F			100	74	66	59	57	44	33	26	19	14	10	7	5	4	7.8				GW
	18-25	75.0-75.3	E/F	Wash and Cobble Fragments																				
	18-26a	98.0-100.0	G							100	99	98	95	93	90	85	77	68	59	18.0				CL-ML

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
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ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/14/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_c %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D18	18-26b	98.0-100.0	G																26.0	44	26	18	ML-CL
	18-27	100.0-100.9	G	Too Small To Test																			
	18-28	102.0-103.0	G	Too Small To Test																			
	18-29	104.0-104.5	G	Too Small To Test																			
	18-30a	106.0-107.8	G								100	99	99	99	99	99	99	99	97	22.7				ML-MH
	18-30b	106.0-107.8	G																	14.7	27	20	7	ML-CL
	18-31	108.0-108.7	G	Too Small To Test																			
	18-33a	112.0-113.7	G									100	99.5	99	97	95	93	87	76	23.9				ML-MH
	18-33b	112.0-113.7	G							100	99	97	93	82	64	50	40	34	28	13.1				SM
	18-34	114.0-116.0	G							100	99	97	91	87	75	59	40	26	20	18.1				SP-SM
	18-35	116.0-118.0	G							100	99.5	97	91	80	68	58	51	45	42	17.5				SM
	18-36	118.0-120.0	G						100	96	94	92	88	78	60	45	33	26	22	15.9				SM
	18-38	125.-125.4	G			100	73	73	69	69	64	59	53	46	39	34	29	25	21	6.0				SM
	18-42	132.0-132.8	G	Pieces Of Boulder Caught In Spoon																			
	18-43	135.0-136.3	G					100	97	96	94	91	87	81	74	68	64	60	57	14.1				CL-CH
	18-47	143.0-143.5	G	Pebbles In Spoon																			
	18-48	152.0-152.6	G					100	93	89	84	81	77	71	66	62	58	55	53	12.0				SC
	18-50	157.3-158.0	G	On Hold																			
	18-51	160.0-160.4	G						100	97	94	90	84	75	67	58	51	45	41	9.3				
	18-52	162.5-163.2	G																	7.8				SM

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
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SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

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SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D18	18-53	166.0-166.6	G'						100	96	94	92	86	76	70	65	61	57	54	15.8				CL-ML
	18-54	168.0-168.7	G'						100	96	88	84	79	72	65	59	54	50	46	10.4				SC
	18-55	172.0-173.0	G'								100	95	78	61	51	44	39	34	30	11.2				SM-SC
	18-56	176.0-177.3	G'						100	97	93	91	89	82	79	77	75	72	67	18.1				ML-CL
	18-57	178.0-179.7	G'	Too	Small	To	Test																	
	18-58	180.0-181.3	G'					100	91	91	88	82	77	73	69	66	64	62	59	13.5				ML-CL
	18-59	185.0-185.4	G'	Too	Small	To	Test																	

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/16/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-DI9	19-1	2.0-4.0	A/B				100	85	85	81	75	71	66	60	54	48	43	39	34					SM
	19-2	4.0-6.0	A/B						100	94	89	83	78	72	65	59	53	49	45	15.7				SM
	19-3	6.0-8.0	C			100	59	59	59	59	46	43	40	36	33	30	28	26	24	8.6				GM-GC
	19-4	8.0-10.0	C					100	78	78	58	52	47	41	35	31	27	24	21	12.1				GM SM
	19-5	10.0-12.0	C				100	82	76	71	64	60	56	50	44	39	34	31	27	13.4				SM
	19-6	12.0-13.2	C						100	93	82	73	66	57	49	42	37	33	29	12.2				SM-SC
	19-7	14.0-16.0	C					100	95	93	87	83	79	72	64	58	51	46	42	13.2				SC
	19-8	16.0-17.8	M					100	89	89	83	76	70	63	55	49	42	38	34	13.0				SC
	19-9a	26.0-26.5	M							100	98	89	45	16	9	7	5	4	3	12.0				SP
	19-9b	26.5-28.0	M						100	95	91	87	81	74	67	60	54	49	44	10.9				SC-SM
	19-10	28.0-28.8	M						100	97	89	84	78	72	65	54	52	47	43	9.7				SC-SM
	19-11	31.0-32.9	M						100	89	86	82	76	69	62	56	51	47	43	10.2	19	15	4	SC-SM
	19-12a	34.0-34.3	M				100	59	59	55	49	45	41	30	18	14	12	9	7	8.3				GP
	19-12b	34.3-35.8	M					100	97	95	91	86	79	71	63	55	48	44	40	8.6				SM-SC
	19-13a	36.0-37.5	M				100	92	79	75	72	69	61	32	17	12	10	9	7	11.6				SW-SM
	19-13b	37.5-38.0	M					100	84	83	76	70	63	56	50	44	39	36	32	6.1*				SC
	19-15	40.0-42.0	M						100	99	92	88	82	74	66	58	52	47	43					SM-SC
	19-16	43.0-44.3	M				100	87	87	85	78	73	64	54	46	40	35	32	28	9.7				SM-SC
	19-17	45.0-45.7	M					100	76	74	70	66	60	53	47	41	37	34	31	8.6				SM-SC
	19-18	47.0-47.8	M					100	90	89	86	81	75	67	58	51	44	39	35	9.4				SM-SC

REMARKS: * Small holes in sample bag. Moisture content may be low.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/16/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D19	19-20	59.0-59.9	M				100	91	81	81	77	70	59	49	42	36	31	27	24	8.0				SM-SC
	19-22	65.0-65.7	M	Too Small To Test																				
	19-23	69.0-69.5	M					100	92	84	76	68	60	52	44	37	32	28	24	7.4				SM-SC
	19-26	77.0-78.0	E				100	88	88	88	80	75	69	61	53	46	40	35	30	8.3				SC
	19-28	93.0-94.7	E						100	98	89	83	76	67	57	48	41	36	32	8.5				SM-SC
	19-29	97.0-97.3	E	Too Small To Test																				
	19-30	99.0-100.0	E					100	95	91	85	80	73	64	55	47	40	36	31	8.9				SM
	19-31	109.0-110.5	E							100	99	97	92	86	81	78	75	73	70	15.3	25	20	5	ML-CL
	19-33	114.0-114.8	E								100	99	98	96	94	93	91	87	83	22.9				ML-CL
	19-34	117.0-117.8	E	On Hold																				
	19-35	120.0-120.7	E	On Hold																				
	19-36	124.0-125.4	E								100	99	98	97	96	95	94	92	90	17.1				CL-CH
	19-38	133.0-133.8	E					100	95	89	84	80	74	65	57	49	43	39	35	7.8				SM
	19-40	144.0-144.5	E					100	94	92	86	82	75	66	56	48	42	38	34	7.9				SM-SC
	19-43	151.0-151.5	F					100	95	92	85	80	74	66	57	51	47	44	41	10.6				SM-SC
	19-46	169.0-169.4	G							100	98	98	98	97	97	96	96	96	95					CL-ML
	19-47	171.0-172.5	G																	25.5	33	23	10	CL-ML
	19-Run 1a	164.0-169.0	G	NX Core + Cobbles																				
	19-Run 1b	164.0-169.0	G							100	99	97	95	92	89	87	86	84	83	28.5				CL-ML
	19-48	175.0-176.2	G								100	98	96	94	93	91	87	80	74	18.6				ML-MH

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/16/82
SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)																W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D19	19-49	177.0-178.5	G																	28.5	37	23	14	CL-ML
	19-50	181.0-182.6	G												No Upper		Limit		98	29.3				CL
	19-52	187.0-188.4	G																	27.4	34	27	7	ML
	19-54	193.0-193.8	G												No Upper		Limit		99	27.6				ML

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/4/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D20	20-1	3.0-5.0	C				100	91	88	84	70	62	51	40	30	23	18	15	12	8.2				SM
	20-2	5.0-6.3	C				100	87	72	63	53	43	33	25	19	15	12	9	7	6.9				GM
	20-3	7.0-9.0	C				100	92	92	88	79	66	56	46	36	28	23	20	18	8.1				SM
	20-4	9.0-9.7	C				100	81	76	68	55	49	42	34	26	19	15	12	10	7.1				GM
	20-5	11.0-11.5	C	No Recovery																				
	20-6	13.0-14.4	C	No Recovery																				
	20-7	15.0-15.5	C	No Recovery																				
	20-8	17.0-17.9	C	Not Tested, Too Small																				
	20-9	19.5-20.7	C					100	96	96	93	91	85	77	69	62	55	50	45	12.7				SM-SC
	20-10	22.0-23.3	C						100	98	92	89	85	75	50	37	32	29	26	11.7				SM-SC
	20-11	24.0-25.7	E					100	94	87	74	59	49	37	25	18	16	14	13	8.3				SC-SM
	20-12	26.0-27.9	E					100	98	91	74	60	47	29	19	13	10	9	7	9.0				SW-SC
	20-13	28.0-30.0	E					100	87	82	67	54	40	26	18	15	12	11	10	8.0				SP-SC
	20-14	30.0-32.0		No Recovery																				
	20-15	32.0-34.0	F								100	100	100	99	88	51	31	23	19	17.9				SM
	20-16	34.0-36.0	F							100	99	99	99	99	71	27	13	8	5	21.4				SP-SM
	20-17	36.0-38.0	F						100	99	76	65	61	58	45	28	17	12	9	13.1				SP-SM
	20-18	38.0-40.0	F							100	100	99	99	99	99	98	70	45	39	22.0				SM
	20-19	40.0-42.0	F								100	100	100	99	99	95	91	82	69	22.5				ML-MH
	20-20	44.0-46.0	F								100	100	100	100	99	82	39	19	15	22.3				SM

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/4/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D20	20-21	48.0-50.0	F								100	100	100	100	99	84	38	19	14	29.1				SM-SP
	20-22	52.0-54.0	F								100	100	100	100	100	99	82	53	35	21.6				SM
	20-23	56.0-57.7	F								100	100	99	99	98	98	95	69	61	24.1				ML-MH
	20-24	60.0-62.0	F								100	100	99	99	98	98	78	46	36	22.5				SM
	20-25	64.0-65.1	G							100	93	84	75	67	58	47	36	28	21	13.0				SM
	20-26	66.0-66.1		No Recovery																				
	20-27	69.0-69.7	G							100	95	91	86	81	76	71	66	61	56	13.0				CL-CH
	20-28	71.0-71.7	G						100	98	96	94	90	84	82	78	72	64	56	15.5				CL-ML
	20-29	73.0-73.8		No Recovery																				
	20-30	75.0-75.6	G	Too Small To Test																				
	20-31	79.0-80.3	G					100	94	85	78	73	67	62	57	53	45	39	36	13.4				SM
	20-32a	81.0-81.4	G					100	58	56	52	46	42	37	33	31	29	28	24	8.2				GM-GC
	20-32b	81.4-83.0	G							100	95	91	88	85	81	78	75	73	71	18.1				CL
	20-33	83.0-84.7	G						100	99	95	92	89	85	82	78	75	72	67	16.1				CL-CH
	20-34	87.0-89.0	G							100	97	95	91	88	87	85	82	70	59	15.8				CL-CH
	20-35	89.0-90.4	G							100	98	97	95	94	93	91	89	87	85	24.0				ML
	20-36	93.0-95.0	G																100	30.2				ML
	20-37	97.0-98.7	G																100	28.3	49	29	20	ML
	20-38	101.0-103.0	G												No Upper Limits				98	29.1	47	29	18	ML
	20-39	105.0-107.0	G																100	29.1	43	28	15	ML

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/4/82
SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)																W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D20	20-40	109.0-110.3	No Recovery																					
	20-41	111.0-111.6	G'							100	97	95	93	91	90	88	86	83	77	20.9				ML
	20-42	113.0-114.2	G'							100	97	94	89	84	78	71	64	59	54	10.5				ML
	20-43	122.5-122.8	I	No Recovery																				
	20-44	124.0-124.6	I	Rock Fragments																				
	20-45	127.0-127.4	I	Rock Fragments																				
	20-46	135.2-137.0	BR	Rock Fragments HX Core																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/2/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D21	21-1*	2.0-4.0		Organics																			
	21-2	4.0-6.0	C				100	93	86	84	77	71	64	55	45	38	32	28	24	10.5				SM
	21-3	6.0-7.0	C				100	88	80	80	72	64	52	41	33	28	23	20	18	9.4				SM
	21-4	8.0-10.0	C				100	83	78	78	74	69	62	52	43	36	30	26	22	8.0				SM-SC
	21-5	10.0-12.0	C					100	94	92	84	78	70	59	48	40	33	29	25	8.2				SM-SC
	21-6	12.0-14.0	C					100	92	89	82	76	69	59	47	38	29	24	20	8.5				SM
	21-7	14.0-16.0	C					100	94	93	87	82	74	64	53	43	34	28	23	9.9				SM
	21-8	16.0-18.0		No Recovery																				
	21-9	19.0-21.0	E				100	89	80	75	68	63	55	47	38	32	26	22	19	7.8				SM-SC
	21-10	22.0-24.0	E						100	94	79	73	65	56	48	41	36	32	29	9.4				SC
	21-11	24.0-26.0	E					100	91	87	83	78	72	64	55	48	41	36	32	10.5				SC-SM
	21-12**	26.0-28.0	E				100	62	56	53	47	43	37	32	26	22	19	16	14	5.2				GC
	21-13	28.0-29.9	E					100	97	93	87	82	76	67	57	49	41	36	32	8.4				SC
	21-14	30.0-31.0	E					100	92	89	82	77	69	61	52	45	39	35	30	8.4				SC
	21-15	32.0-32.8	E					100	92	92	82	76	70	61	52	44	37	32	28	8.4				SC
	21-16	34.0-34.4		No Recovery																				
	21-17	36.0-36.1		No Recovery																				
	21-18	39.0-40.0	F					100	81	72	59	54	47	39	32	27	24	21	19	6.9				SM
	21-19	41.0-41.5		No Recovery																				
	21-20	43.5-44.3	F						100	92	78	72	62	50	33	22	18	16	14	9.5				SM

REMARKS: * Organics, sample not tested.

** Sampler size too small for maximum particle size, large pieces suspected to be fragments of larger pieces.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/2/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D21	21-21	45.0-45.4		No Recovery																			
	21-22	47.0-47.9		No Recovery																			
	21-23*	49.0-49.8	F	Not Representative																			GP
	21-24	52.0-52.3		No Recovery																			
	21-25	54.0-54.3		No Recovery																			
	21-26	56.0-56.3		No Recovery																			
	21-27	58.0-58.2		No Recovery																			
	21-28	60.0-60.3		No Recovery																			
	21-29	62.0-64.0	G																	21.8	37	25	12	ML-CL
	21-30	64.0-65.7	G								100	100	100	99	99	98	98	97	97	25.1				ML-CL
	21-31	66.0-68.0	G								100	100	99	98	97	96	96	95	94	28.0				CL-ML
	21-32	68.0-70.0	G															100	99	26.0				ML
	21-33	74.0-75.5	G							100	100	99	99	98	98	97	97	96	96	24.4				CL
	21-34	78.0-79.5	G									100	100	99	97	93	88	82	74	16.8	30	21	9	CL
	21-35	80.0-81.2	G							100	100	100	99	98	96	90	81	70	58	17.4				CL
	21-36	83.0-84.0		No Recovery																				
	21-37	85.0-85.4	G	Wash Material																				
	21-38a	87.0-87.7	G							100	96	90	83	72	59	52	49	46	43	17.4				SM-SC
	21-38b	87.7-88.1	G						100	97	96	95	94	91	88	86	84	83	82	17.2				CH-MH
	21-39	89.0-91.0	G																	30.0	51	30	21	MH

REMARKS: * Clean gravel not representative (fines washed out).

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/2/82
SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)														W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D21	21-40	93.0-94.6	G					100	95	95	95	94	94	94	93	93	93	92	92	24.5				MH
	21-41a	98.0-99.0	G	No Upper Limit															98	28.8	38	28	10	ML
	21-41b	99.0-99.3	G	No Upper Limit															94	19.4	33	28	5	ML
	21-42	101.0-101.3	G'						100	94	82	73	66	58	50	46	44	42	37					SM-SC
	21-43	104.0-104.2	G'	Small Sample						100	96	91	80	67	64	62	60	59	56	15.1				CL
	21-44	108.0-108.8	H							100	99	98	97	95	94	94	94	93	83	21.9				ML
	21-45	110.0-111.4	H	Small Sample							100	98	94	92	91	91	89	84	71	26.5				ML
	21-46	114.0-114.6		No Recovery																				
	21-47	123.0-123.5		NX Core																				
	21-48	123.5		No Recovery, No Penetration																				
	21-49	130.0-131.0	I						100	96	87	76	58	40	27	20	17	14	12	11.6				SM-SW
	21-50	134.0-134.2		No Recovery																				
	21-51	135.0-136.0		NX Core																				
	21-52	136.0-139.5		NX Core																				
	21-53	139.5-140.0	J					100	84	78	65	53	41	32	26	22	18	16	14	8.6				SM
	21-54	149.5-149.9		No Recovery																				
	21-55	158.5-158.7	J						100	94	77	68	54	42	33	26	21	18	15	8.9				SM

REMARKS:

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 8/21/82
SHEET 1 OF 1

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZE (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D22	22-1	0.5-4.5		No Recovery (Denison Sample)																			
	22-1	4.5-8.0		No Recovery (Denison Sample)																			
	22-3	9.0-9.9		Bedrock																			

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/7/82
SHEET 1 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D23	23-1a	2.3-5.2	A&B	Rock Fragments																			
	23-1b	2.3-5.2	A&B	Rock Fragments																			
	23-2	6.0-6.1		No Recovery																			
	23-3	8.5 10.5	C						100	99	97	93	84	72	59	41	28	[illegible]	17	11.0			SM
	23-4	11.0-11.3		No Recovery																			
	23-5	11.3-13.1	C				100	91	91	91	87	78	63	48	37	28	21	17	13	9.1			SM
	23-6	14.5-16.5	C						100	99	97	95	90	80	65	49	36	27	20				SM
	23-7a	17.0-19.0	C						100	96	85	80	74	67	60	51	41	30	21	12.5			SM
	23-7b	17.0-19.0	C							100	98	97	91	81	71	63	52	40	31	15.5			SM
	23-8	21.0-21.4		No Recovery																			
	23-9	23.0-23.3		No Recovery																			
	23-10	27.0-29.0	D									100	100	98	71	41	24	16	11	14.9			SM-SP
	23-11	29.0-31.0	D							100	99	98	97	93	72	47	32	23	18	15.2			SM
	23-12	31.0-33.0	D							100	98	97	95	91	71	45	27	19	14	15.1			SM
	23-13	33.0-35.0	D							100	100	100	99	97	78	44	26	16	11	16.7			SM-SP
	23-14	37.0-38.3	D				100	84	71	64	56	51	46	41	33	25	20	17	14	9.1			SM-GM
	23-15	39.0		No Recovery, No Penetration																			
	23-16	41.0-42.3	E							100	95	83	73	63	47	27	17	13	10	13.3			SM-SW
	23-17	43.0-43.8		No Recovery																			
	23-18	45.0-46.5	E					100	99	95	90	85	78	72	64	56	48	42	37	10.8			SC

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/7/82
SHEET 2 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)																W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D23	23-19	47.0-48.0	E	Same Material As 18 and 20																10.9				
	23-20	49.0-50.3	E						100	98	96	93	89	82	75	66	56	49	44	12.0				SM-SC
	23-21	51.0-52.4	E							100	100	96	88	79	72	56	41	32	24	16.2				SM-SC
	23-22	53.0-53.8	E	Not Representative, Fines Washed Out																				
	23-23	55.0-55.5	E						100	90	84	75	29	5	3	2	1	1	1	14.9				SP
	23-24	57.0-57.7	E	Small Sample						100	69	53	44	36	30	25	21	18	14	11.5				SM-GM
	23-25	59.0-61.0	E					100	92	84	72	53	33	23	18	14	11	9	7	8.2				SM-GM/SP-GP
	23-26	61.0-63.0	E					100	94	91	88	87	82	61	32	19	13	10	8	13.1				SW-SM
	23-27	63.0-63.4	E				100	81	81	79	74	70	66	58	51	44	39	34	31	8.3				ML
	23-28	66.0-66.8	E							100	97	91	81	70	60	52	45	40	35	12.0				ML
	23-29	68.0-68.6	E	Small Sample, Rock Fragments																				
	23-30	71.0-71.2		No Recovery																				
	23-31	80.0-80.1		No Recovery																				
	23-32	92.5-93.7	G						100	97	90	82	74	66	60	55	51	47	44	13.2				SM-ML
	23-33	95.0-96.3	G					100	96	94	81	74	65	46	25	17	14	12	10	12.5				SM
	23-34	98.0-99.4	G				100	93	93	90	81	74	63	44	27	19	16	14	12	11.1				SM
	23-35	100.0-102.0	G						100	96	90	85	77	59	37	25	19	16	13	11.7				SM
	23-36	103.0-104.3	G						100	90	81	77	69	57	36	26	21	19	17	14.6				SM
	23-37a	107.0-108.8	G	Not Representative																				
	23-37b	107.0-108.8	G							100	99	99	97	97	95	47	28	20	16	23.6				SM

REMARKS:

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/7/82
SHEET 3 OF 3

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D23	23-38	109.0-109.8	G							100	99	98	97	96	94	83	53	35	25	21.8				SM
	23-39	111.0-112.3	G								100	99.9	99.5	99	98	88	61	41	29	22.3				SM
	23-40	113.0-114.3	G									100	99.6	99	98	65	32	20	13	24.4				SM-SP
	23-41	118.0-119.3	G							100	99	99	99	99	98	97	67	41	26	24.9				SM
	23-42	122.0-123.3	G									100	99.8	99	99	95	48	29	25	22.4				SM
	23-43	126.0-127.2	G							100	99	99	98	96	95	94	93	91	87	22.4				ML
	23-44	128.0-129.2	G						100	98	98	97	96	95	94	93	93	89	80	21.4				ML
	23-45	130.0-131.3	G								100	99.7	99	98	98	98	98	95	92	22.9				ML
	23-46	132.0-133.3	G							100	100	99	99	98	97	96	91	71	59	21.3				ML
	23-47	136.0-137.0	G					100	97	97	96	95	94	93	92	91	89	84	76	20.0				ML
	23-48	140.0-141.0	G						100	99	97	95	93	90	88	86	84	81	76	19.4				ML
	23-49	144.0-145.2	G							100	99.7	99	98	97	96	95	89	81	75	22.2				ML-CL
	23-50	146.0-147.2	G							100	99	99	98	97	96	95	93	90	87	24.1				ML
	23-51	148.0-149.2	G							100	99.6	99	99	98	98	97	97	96	95	25.5	23	24	-1	ML
	23-52	152.0-153.0	G								100	100	99	98	98	97	97	96	91	21.0				ML
	23-53	156.0-156.7	G									100	100	99	98	98	94	85	70	23.1				ML

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/9/82
SHEET 1 OF 1

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D24	24-1	1.5-3.5	A&B			100	78	78	69	64	49	39	32	27	23	19	16	14	12					SM-SW
	24-2	4.8-6.3	E					100	93	84	70	60	49	40	34	29	25	22	20	8.6				SM-SC
	24-3	7.0-9.0	E					100	88	79	67	57	47	37	31	27	24	22	19	8.6				SM-SC
	24-4	9.0 11.0	E	Fines Washed Out																				
	24-5	14.0-16.0	F					100	82	77	57	47	41	34	24	20	18	16	15	7.3				SM-SC
	24-6	17.0-18.5	F				100	90	90	87	78	70	61	52	44	37	31	25	20	9.7				SM
	24-7	19.0-19.7	F				100	90	90	87	81	73	65	59	53	49	46	44	43	7.9				SM
	24-8	20.0	F	No Recovery, No Penetration																				
	24-9	22.0-22.1	F	No Recovery																				
	24-10	24.0-24.7	F	Not Representative, Fragments																11.7				
	24-11	26.0-26.3	F	No Recovery																				
	24-12	32.0	BR	No Recovery, No Penetration																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/14/82
SHEET 1 OF 1

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D25	25-1	3.0-5.0	D	No Recovery																			
	25-2	5.0-7.0	D	No Recovery																			
	25-3	7.0-9.0	G'	No Recovery																			
	25-4	9.0-11.0	G'				100	88	88	85	81	78	72	63	56	51	47	42	37	14.5				SC
	25-5	11.0-11.7	G'	No Recovery																			
	25-6	14.0-16.0	G'			100	79	79	62	56	52	48	41	32	25	20	16	14	11	5.8				GM
	25-7	20.0	G'	No Recovery, Refusal																			
	25-8	22.0	G'	No Recovery, Refusal																			
	25-9	25.5-27.5	G'						100	98	91	83	71	50	22	12	9	7	6	13.6				SP-SM
	25-10	29.0-30.8	I							100	99	96	93	87	79	75	72	68	63	18.0	24	20	4	ML-CL
	25-11	32.0-32.7	I				100	70	64	63	56	51	45	39	35	32	30	28	26	10.6				GM-SC/SM-SC
	25-12	36.0-36.4	I	No Recovery																			
	25-13	38.0-38.9	I				100	75	75	72	64	58	48	40	35	33	31	29	26	9.5				ML-CL
	25-14	40.0-40.5	I	No Recovery																			
	25-15	42.0-42.3	I	No Recovery																			
	25-16	44.0-44.2	I	No Recovery																			
	25-17	46.0-46.1	I	No Recovery																			
	25-18	51.0-51.2	I	No Recovery																			
	25-19	53.0-54.0	I					100	94	94	86	85	82	79	78	77	77	76	75	20.8				ML-CL
	25B-22	68.0-69.1	I							100	98	95	89	59	34	21	14	10	8	16.6				SW

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/15/82
SHEET 1 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D26	26-1	4.2-6.2	C				100	89	68	64	51	43	36	28	22	17	13	11	9	6.8				GW-GM
	26-2	9.0-11.0	C					100	98	83	77	71	64	53	41	31	24	19	16					SM
	26-3	14.0-15.2	C					100	89	84	72	64	56	48	41	35	30	26	24	8.2				SM-SC
	26-4	19.0-19.1	E	No Recovery																				
	26-5	22.5-23.6	E					100	92	87	82	77	71	62	53	46	40	36	32	8.2				SC
	26-6	27.0-28.4	E					100	90	86	78	75	69	61	53	46	40	36	32	7.7				SC
	26-7	32.0-32.2	E	No Recovery																				
	26-8	33.0-34.3	F	No Recovery																				
	26-9	38.0-38.8	E							100	94	90	84	76	67	59	53	47	42	8.2				SC
	26-10	43.0-43.8	E																					
	26-11	48.0-48.8	F					100	96	96	91	88	82	74	66	59	52	46	40	10.8				SM-SC
	26-12	53.2-53.9	F																	9.7				SC
	26-13	58.0-58.9	F						100	98	90	87	81	72	63	56	49	44	40	9.3				SC
	26-14	63.0-64.3	F						100	97	93	90	86	81	76	70	65	60	55	9.1				ML-CL
	26-15	68.0-68.8	F						100	98	92	89	84	78	71	66	62	59	56	10.7				ML-CL
	26-16	73.0-73.6	F	No Recovery																				
	26-17	78.0-79.5	G							100	99	99	98	98	97	96	95	94	92	25.8	42	29	13	ML-CL
	26-18	83.3-83.7	I	Combined		100	78	68	64	60	49	44	39	33	28	25	23	21	19	6.3				GM-GC
	26-19	85.5-86.1	I																					
	26-20	88.0	I	No Recovery, No Penetration																				

REMARKS: 26-18 and 26-19 Ran as 1 sample combined.

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/15/82
SHEET 2 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D26	26-21	91.0-91.1	I	No Recovery																			
	26-22	93.0-93.0	I	No Recovery																			

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/30/82
SHEET 1 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)														W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D27	27-1	5.0-7.0	C					100	62	53	45	41	37	31	26	22	18	15	12	6.9				GM
	27-2	10.0-12.0	C	No Recovery																				
	27-3	15.0-15.7	C				100	92	81	80	75	70	62	53	45	38	32	28	25	8.4				SM-SC
	27-4	20.0-20.2	D	No Recovery																				
	27-5	28.0-29.3	D					100	96	88	81	77	66	57	49	43	37	33	29	7.8	17	13	4	SC-SM
	27-6	30.0-30.2	D	No Recovery																				
	27-7	35.0-35.3	D	No Recovery																				
	27-8	40.0-40.2	D	No Recovery																				
	27-9	41.0-41.8	D						100	92	83	77	66	52	44	39	35	31	27	11.9				SC-SM
	27-10	44.0-44.8	D						100	92	85	78	69	61	54	48	42	38	34	8.8				SC
	27-11a	49.0-49.5	D					100	93	90	83	80	72	63	55	49	45	41	38	11.1	25	15	10	SC
	27-11b	49.5-50.0	D				100	85	85	83	77	74	68	60	53	48	43	40	37	11.1				SC
	27-12	54.0-54.4	D						100	98	94	92	89	85	82	77	74	72	70	11.7				CL
	27-13	60.0-61.2	D'						100	99	94	89	82	71	60	52	45	40	36	9.5				SM-SC
	27-14	65.0-65.6	E					100	97	93	84	79	71	63	54	46	40	35	31	9.2				SC
	27-15	70.0-71.2	E	combined																				
	27-16	75.0-75.3	E	Not tested too small																				
	27-17thru 24			No recovery																				
	27-25	125.0-130.0	F	NX Core - cobbles/boulders																				
	27-26	130.0-133.5	F	"			"																	

REMARKS: 27-14 and 27-15 ran combined
Samples 27-17 thru 27-24 No Recovery

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/30/82
SHEET 2 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D27	27-27	135.0-140.0	F	NX	Core	- cobbles/boulders																		
	27-28	140.0-145.0	F	"		"		"																
	27-29	145.0-146.5	F	No	Recovery																			
	27-30	155.0-157.8	F	No	Recovery																			
	27-31	160.0-162.0	G																	29.8				
	27-32	164.0-166.0	G													No upper limit			92	31.5				ML-CL
	27-33	170.0-172.0	G																	30.4	31	23	8	ML-CL
	27-34	175.0-177.0	G													No Upper Limit			97.5	29.7				ML-CL

REMARKS: Samples 27-27, 27-28, 27-29, 27-30 No Core

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/21/82
SHEET 1 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D28	28-1a	2.0-4.0	A/B						100	98	95	88	79	69	60	52	45	39	33	16.9				SM
	28-1b		C							100	93	89	82	72	62	54	46	41	35	13.3				SM
	28-2	4.0-6.0	C	No Recovery																				
	28-3	6.0-8.0	C	No Recovery																				
	28-4	8.0-10.0	C	No Recovery																				
	28-5	10.0-12.0	C					100	87	84	76	70	59	48	40	33	27	23	20	9.0				SM
	28-6	12.0-14.0	C					100	93	89	84	80	74	66	58	51	46	42	38	11.1				SC
	28-7	14.0-16.0	C					100	98	93	88	83	79	73	66	60	53	48	43	14.0				SC
	*28-8	16.0-18.0	C				100	80	75	62	52	45	39	33	29	26	22	20	18					GC
	28-9	18.0-20.0	M							100	94	90	84	77	70	63	57	52	48	12.9				SC-CL
	28-10	20.0-22.0	M							100	94	89	84	78	72	67	63	59	55	13.0				CL-CH
	28-11	22.0-24.0	M							100	96	92	83	74	69	65	61	57	53	17.7				ML-CL
	28-12	24.0-26.0	M					100	98	95	93	90	86	81	77	74	70	68	65	13.9				CL
	28-13	26.0-27.8	M						100	94	89	84	79	74	70	66	62	59	55	11.3	28	17	11	CL
	28-14	28.0-28.2	M	Too small																				
	28-15	32.0-32.2	M	No Recovery																				
	28-16	34.0-35.8	M																					
	28-17	36.0-38.0	M						100	97	86	81	75	71	65	60	54	50	46	9.4				SC-CL
	28-18	40.0-41.3	M																					
	28-19	44.0-44.2	M	No Recovery																				
	28-20	45.0-47.0	M																					

REMARKS: *Not representative one large particle in sample

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

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BUFFALO, NEW YORK

DATE: 9/21/82
SHEET 2 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)														W_C %	L.L.	P.L.	P.I	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D28	28-21	49.0-51.0	M						100	94	89	85	80	76	71	67	63	60	57	10.3				CL
	28-22	53.0-53.2	M																					CL
	28-23	57.0-59.0	M																	11.4	26	17	9	CL
	28-24	61.0-62.1	M						100	95	85	82	78	73	69	65	61	58	55	11.0				CL
	28-25	64.0-66.0	M																	10.7	25	16	9	CL
	28-26	68.0-69.8	M																					CL
	28-27	72.0-74.0	M										100							15.2				CL
	28-28	77.0-79.0	M																	14.7				
	28-29	81.0-83.0	M																	13.9				
	28-30	85.0-86.3	M						100	96	91	87	83	79	74	70	66	63	60	11.9				ML
	28-31	89.0-90.0	M																	11.3				
	28-32	93.0-95.0	M				100	88	81	79	75	70	65	60	55	51	47	44	41	8.8				SM-SC
	28-33	97.0-97.6	M																	10.0				
	28-34	101.0-101.1	E/F	No Recovery																				
	28-35	103.0	E/F	No Recovery, No Penetration																				
	28-36	103.0-103.5	E/F	No Recovery, NX Core																				
	28-37	105.0-109.5	E/F	NX Core of Cobbles																				
	28-38	109.5-112.6	E/F	NX Core of Cobbles																				
	28-39	112.6-113.5	E/F	No Recovery																				
	28-40	113.5-115.3	E/F	No Recovery																				

REMARKS:

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

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BUFFALO, NEW YORK

DATE: 9/21/82
SHEET 3 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D28	28-41	115.3-117.5	E/F	No Recovery																			
	28-42	125.0-126.3	G										100	100	98	93	87	80	73	21.6				ML
	28-43	127.0-128.1	G	No Recovery																				
	28-44	129.0-129.8	G							100	99	98	96	86	52	32	22	17	14	18.3				SM
	28-45	131.0-132.0	G									100	100	99	99	93	70	51	39	23.3				SM
	28-46	136.0-141.0	G																	28.6				
	28-47	143.5-145.5	G										100							29.6	60	27	33	CH
	28-48	148.5-150.5	G										100						98	33.2				CH
	28-49	153.5-155.5	G																	31.6				
	28-50	158.5-160.5	G																	31.9				
	28-51	163.5-165.0	G																	31.7				
	28-52	168.5-170.5	G																	31.2				
	28-53	173.5-175.0	G	No Recovery																				
	28-54	178.5-180.5	G										100						96	29.8				CL-CH
	28-55	197.5	G	No Recovery, No Penetration																				
	28-56	202.5-203.3	H							100	96	94	90	85	79	73	68	63	59	16.2				CL-CH
	28-57	206.0-206.7	H							100	95	93	90	84	79	74	70	67	63	19.3				CL-CH
	28-58	208.5-209.2	H	Sample Lost, No Results																14.4				
	28-59	210.5-212.3	I							100	100	99	98	96	93	92	90	88	86	20.4				CL-CH
	28-60	212.5-214.2	I							100	97	95	92	87	81	77	74	72	71	18.8				CL

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

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GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/21/82
SHEET 4 OF 4

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D28	28-61	218.5-218.8	I						100	96	76	65	53	44	38	30	24	20	17	7.5				SM
	28-62	222.5-223.0	I							100	100	99	99	99	98	96	77	57	46	18.5				SM-ML
	28-63	225.0-225.4	I	No Recovery																				
	28-64	231.5-231.8	I	Sample too small to test																				
	28-65	233.5-234.0	I									100	100	100	99	94	84	71	58	18.0				ML

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/24/82
SHEET 1 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D29	29-1	4.0-6.0	C						100	95	89	84	78	68	57	47	38	31	26	10.5				SM
	29-2	6.0-8.0	C						100	98	95	91	84	73	62	51	41	33	26	11.7				SM
	29-3	8.0-10.0	C					100	98	96	88	83	76	66	55	43	34	27	21	11.6				SM
	29-4	10.0-12.0	C																					
	29-5	12.0-14.0	C						100	98	96	93	87	77	67	57	48	40	35	12.8				SM
	29-6	14.0-16.0	D					100	94	92	88	85	79	70	59	50	43	38	34	10.2				SM
	29-7	16.0-18.0	D					100	98	97	93	90	84	75	66	57	50	45	40	10.4				SM
	29-8	20.0-21.0	E				100	87	87	84	80	76	69	61	53	46	39	34	30	9.2				SM
	29-9	24.0-26.0	E					100	98	96	94	89	82	73	64	54	46	40	34	10.2				SM
	29-10	28.0-29.1	E						100	97	91	85	78	69	59	57	44	38	33	9.1				SM
	29-11	30.0-32.0	E	Combined			100	95	91	88	85	82	76	66	57	48	41	36	32	9.8				SM
	29-12	35.0-37.0	E																					
	29-13	40.0-40.3	E	No Recovery																				
	29-14	45.0-45.5	E																					
	29-15	48.0-48.1	E	No Recovery																				
	29-16	52.0-52.4	E	No Recovery																				
	29-17	54.0-54.9	E																					
	29-18	58.0-58.2	E	No Recovery																				
	29-19	64.0	E	No Recovery				Refusal																
	29-20	69.0-70.5	E					100	98	93	87	83	77	69	60	52	45	40	36	8.8				SC

REMARKS: Samples 29-11 & 29-12 combined analysis

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/24/82
SHEET 2 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D29	29-21	75.0-75.7	F																				
	29-22	79.0	F	No REcovery			Refusal																
	29-23	83.0-83.3	F	No Recovery																			
	29-24	87.0-88.5	F	Cobble fragments																			
	29-25	91.0-92.0	F					100	91	88	84	79	72	61	51	43	37	32	27	8.1				SC
	29-26	95.0-95.4	F	No Recovery																			
	29-27	98.0	F	No Recovery Refusal																			
	29-28	102.0-102.5	F	No Recovery																			
	29-29	109.0-109.8	F							100	93	88	80	68	56	47	40	35	31	10.1				SM-SC
	29-30	114.0-114.3	F	No Recovery																			
	29-31	119.0	F	No Recovery Refusal																			
	29-32	124.0-124.2	F	No Recovery																			
	29-33	135.0-135.9	F	Too small to test																			
	29-34	149.5-150.7	G	No Recovery																			
	29-35	158.0	G	No Recovery																			

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/25/82
SHEET 1 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D30	30-1	4.0-6.0	A/B	No Recovery																			
	30-2	6.0-8.0	C					100	96	93	85	80	75	67	58	51	44	39	35	10.2				SC-SM
	30-3	8.0-9.7	C	Combined																				
	30-4	12.5-14.0	C	NX Cobble core																				
	30-5	14.0-14.4	C	Too small to test																				
	30-6	18.0-19.2	E/F						100	94	83	76	67	58	48	41	35	30	26	8.8				SC-SM
	30-7	22.5-22.9	E/F																					
	30-8	24.0-25.8	E/F					100	90	86	77	70	63	55	48	42	36	32	28	9.2				SC-SM
	30-9	26.0-28.0	E/F	No Recovery																				
	30-10	28.0-29.8	E/F	Not representative																				
	30-11	32.0-33.2	E/F					100	91	87	84	80	75	68	60		46	42	37	9.3				SC
	30-12	36.0-36.2	E/F	No Recovery																				
	30-13	40.0-41.1	E/F	On Hold																				
	30-14	44.0-45.2	E/F					100	93	91	86	81	75	66	58	50	44	39	35	9.3				SC
	30-15	48.0-48.6	E/F	On Hold																				
	30-16	52.0-53.2	E/F	On Hold																				
	30-17	56.0-56.8	E/F	On Hold																				
	30-18	60.5-61.3	E/F					100	93	89	84	79	72	64	55	47	41	36	31	9.6				SC
	30-19	64.0-64.3	E/F	On Hold																				
	30-20	69.0-69.7	E/F	On Hold																				

REMARKS: _____

SUSITNA HYDROELECTRIC PROJECT
WATANA BORROW SITE D AND RELICT CHANNEL
SUMMARY OF LABORATORY TEST DATA

ACRES

ACRES AMERICAN INCORPORATED
GEOTECHNICAL LABORATORY
BUFFALO, NEW YORK

DATE: 9/25/82
SHEET 2 OF 2

HOLE NO.	SAMPLE NO.	DEPTH	SOIL UNIT	U.S. STANDARD SIEVE SIZES (PERCENT FINER THAN BY WEIGHT)															W_C %	L.L.	P.L.	P.I.	UNIFIED SOIL CLASSIFICATION
				12"	6"	3"	2"	1-1/2"	1"	3/4"	3/8"	#4	#10	#20	#40	#60	#100	#140	#200					
AH-D30	30-21	74.0-74.3	G'	On Hold																			
	30-22	79.0-79.8	G'	On Hold																			
	30-23	84.0-84.8	G'	On Hold																			
	30-24	89.0-90.3	G'	On Hold																			
	30-25	99.0-100.0	G'	On Hold																			

REMARKS: _____

APPENDIX C
SEISMIC REFRACTION SURVEYS, SUMMER 1982

Susitna Hydroelectric Project
Seismic Refraction Surveys
19[illegible]

Prepared for

Acres American Incorporated
Consulting Eningeers
1577 C Street
Anchorage, Alaska 99501

701 Sesame Street
Anchorage, Alaska 99503
(907) 276-2335

Woodward-Clyde Consultants

13 December 1982
Project No. 15434A

Acres American Incorporated
1577 C Street
Anchorage, Alaska 99501

Attention: Mr. Vern Smith

SUBJECT: SUSITNA HYDROELECTRIC PROJECT
SEISMIC REFRACTION SURVEYS, 1982
FINAL REPORT

Gentlemen:

With this letter, we are transmitting our final report of seismic refraction surveys performed in the vicinity of the Watana Dam site during the summer of 1982. As specified by Agreement No. P5700.10.13, under which the surveys were performed, we are sending ten copies of the report, one to you in Anchorage and nine to your Buffalo office to the attention of Mr. Lance Duncan.

This report incorporates a number of changes prompted by your review of our draft report issued November 12, 1982. Your review comments, which we recieved on December 7, 1982, pointed out several areas in which preliminary interpretations from this year's surveys were in conflict with previous seismic refraction interpretations and, in a few cases, with boring or mapping control information of which we were not aware. In some cases, we were able to derive alternate interpretations of the data in order to minimize the conflicts. In other cases, wherein the data would not permit suitable alternate interpretations, we have suggested possible reasons for the apparent conflicts.

Several other items specified by the Agreement are being transmitted to your Buffalo office with copies of this report. These include: the original text and figures of the report; time-distance plots for the 1982 lines; original seismograph records; and field notes.

We have enjoyed working with you and your staff on the Susitna project over the past three years. If questions arise regarding this report, or if we can be of further service, please do not hesitate to call.

Very truly yours,

Jan D. Rietman
Deputy Director of Geophysics
Registered Geophysicist, GP-58

Dennis E. Jensen
Project Geologist
Certified Engineering
Geologist, RG3531, EG1034

JDR:DEJ/hab

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ACKNOWLEDGEMENTS

Preparation of this report by Woodward-Clyde Consultants was accomplished in close cooperation with Acres American Incorporated (AAI) personnel who critically reviewed draft text and figures, and contributed to the interpretations in the report based on their overall understanding of conditions at the Watana site. The agreement under which the 1982 seismic refraction survey was performed was administered for AAI by Mr. Vern Smith, Deputy Resident Manager. Technical coordination was through Mr. Robert Henschel (AAI, Anchorage) and Mr. Lance Duncan (AAI, Buffalo). Site coordinator for AAI was Mr. Thomas Drexhage.

Project Manager for Woodward-Clyde Consultants was Mr. Rupert Tart. Technical aspects of the survey were under the direction of Dr. Jan Rietman and were reviewed for conformance with Woodward-Clyde Consultants standards by Mr. Carl Stepp. Mr. Dennis Jensen supervised field operations, interpretation, and report preparation with the assistance of Mr. Stan Clarke. Woodward-Clyde Consultants field personnel included Mr. Ron Mees, second crew supervisor, Mr. Keith Mobley, and Mr. Dale Berry. Mr. Mark Winters assisted with drafting and computer operations.

1.0 INTRODUCTION

This report presents the results of seismic refraction surveys performed during the summer of 1982 in the vicinity of the proposed Watana damsite on the Upper Susitna River, approximately 125 miles north of Anchorage, Alaska. These surveys were performed under contract to Acres American Incorporated (AAI) in accordance with Agreement Number P5700.10.13.

Following this introductory section in which the background, purpose, and scope of the refraction survey are discussed, a summary of the field operations and data reduction procedures is given in Section 2.0. The general limitations of the seismic refraction method are discussed in Section 3.0. The interpretations of the seismic refraction data from the damsite abutment areas, the Watana relict channel area, and the Fog Lakes area are discussed in Sections 4.0, 5.0 and 6.0, respectively.

1.1 Background

The 1982 geophysical program was a continuation of surveys performed by Woodward-Clyde Consultants during 1980 and 1981 under contract to R&M Consultants (R&M) as part of their contract with AAI. Prior to the 1980 and 1981 surveys, seismic refraction data had also been collected at the site for the U. S. Army Corps of Engineers by Dames and Moore (1975) and Shannon and Wilson (1978).

1.2 Survey Objectives and Scope of Work

The purpose of the 1982 seismic survey was to investigate the seismic velocities, distribution of shallow subsurface materials, and depth to bedrock at specified locations in the vicinity of the Watana damsite. The survey was

designed by AAI to supplement the previous seismic refraction survey results and to provide continuity of data among borings and outcrops. Survey lines were run in three areas: the proposed dam abutments, the Watana relict channel area, and the Fog Lakes relict channel area.

In 1982, a total of 94,725 linear feet (92,339 ft in horizontal projection) of seismic refraction lines was surveyed in the three areas (Figures 1, 2, and 3). Figure 1 covers the abutment areas of the damsite. Figure 2 covers a larger area and includes the emergency spillway alignment and the area of a large buried channel (the Watana relict channel). Figure 3 shows the Fog Lakes area southeast of the damsite, which is also underlain by buried channels (the Fog Lakes relict channels).

The base maps for Figures 1, 2, and 3 were provided by AAI. These maps show the location of previous years' seismic refraction lines and selected boring locations. The locations of the 1982 refraction lines are based on surveying information provided by R&M. All three figures are oriented with the direction of river flow toward the right, consistent with AAI project standards.

Table 1 is a summary of seismic refraction lines run during the 1982 survey. The lines are grouped into the three previously discussed survey areas. Lines were numbered in chronological order as they were surveyed. The table indicates the number of the figure that shows the location of each line and the figure(s) showing the interpreted profile for that line. The fourth column in the table indicates the letter designation for the planned lines as referenced in the Agreement. Letters in parentheses were assigned by AAI in the field. The remaining columns in the

TABLE 1

1982 Seismic Refraction Line Data

Line Number	Location Figure	Profile Figure	Planning Line	Line Length (ft)	Horizontal Length (ft)	Spreads/ Shots
			Dam Abutments			
82-1	1	4	E	1,300	1077.1	3/8
82-2	1	4	K(a)	550	517.3	1/3
82-3	1	4	F	550	447.9	1/3
82-4	1	5	D	1,950	1897.1	4/11
82-5	1	6	J(a)	3,375	3268.7	7/20
82-6	1	7	H	1,650	1609.1	3/9
82-7	1	8	J(b)	350	306.5	1/3
82-8	1	8	G	1,100	916.7	2/6
82-9	1	9	K(b)	1,100	1057.9	2/6
82-10	1	9	O	1,100	1025.9	2/6
82-11	1	10	K(c)	1,650	1517.1	3/9
82-12	1	11	M	2,200	2160.7	4/12
82-13	1	12	N	1,500	1459.2	3/9
82-14	1	13	L	3,150	3083.3	6/18
82-15	1	14	P	1,100	1028.6	2/6
	Subtotal Abutments			22,625	21,372.6	
			Watana Relict Channel Area			
82-16	2	15	C	1,100	1087.7	1/5
82-17	2	16-17	A	6,500	6214.9	6/28
82-18	2	18-20	B	6,600	6506.8	6/29
82-19	2	21	U	1,700	1677.9	2/7
82-20	2	22-24	S	6,400	6270.3	6/27
82-21	2	25	V	1,100	1087.6	1/5
82-22	2	26-27	(X)	3,200	3173.0	3/14
	Subtotal Watana			26,600	26,018.2	
			Fog Lakes Area			
FL-1	3	28-35	FL-C	23,100	22788.8	21/91
FL-2	3	36-39	FL-E	15,800	15702.4	14/63
FL-3	3	40-42	FL-G	6,600	6557.1	6/28
	Subtotal Fog Lakes			45,500	45,048.3	
	TOTAL FOOTAGE			94,725	92,439.1	

table list the nominal length of each line, the horizontally projected length, and the number of 12-geophone spreads and shots included in the line. Horizontal line lengths were calculated from R&M control survey data and do not include overlaps or distances of offset shots.

At the Watana damsite abutments, the primary objective of the seismic refraction surveys was to investigate the depth-to-bedrock and bedrock velocity variations. A total of 22,625 feet (21,373 feet in horizontal projection) of survey was run on 15 lines. The individual line segments were designed with a 12-channel spread over a 550-foot distance to accommodate a maximum expected overburden thickness of 100 feet. Three lines, totaling approximately 4,000 feet of line, were dropped from the original program because the steep topography restricted access.

Survey lines were run in the Watana relict channel area for the primary objective of obtaining top-of-rock profiles. Seven lines, totaling 26,600 feet (26,018 feet projected horizontally), were run in this area. These lines were predominately fill-in lines to supplement data collected in 1980 and 1981. Line lengths varied from 1,100 to 6,600 feet and were comprised of 12-channel spreads, 1,100 feet in length. Offset shots, typically 1,100 feet from the ends of each spread, were used to achieve a maximum planned depth of investigation of 800 feet.

The survey lines in the Fog Lakes area were designed to investigate the relict channels that had been identified during the 1981 survey. The primary objective of the survey lines was to obtain rock velocity data and estimate the depth to bedrock. The original survey program planned for this area totaled 37,400 feet of line following the

projected thalwegs of the channels. However, after consultation with the AAI field engineer, the survey program was modified during the course of the field operations to cross the channels and more acurately identify the locations of the thalwegs. A total of 45,500 feet (45,048 feet projected horizontally) of refraction data were collected on three lines. Each line consisted of between six and twenty-one, 1,100-foot segments.

During the course of the field operations, daily progress reports and preliminary interpretations were submitted to the AAI site engineer. The final interpretations of the seismic data are presented on 39 figures and are discussed in the following sections of the report. One copy each of the field notes, seismic records, and time-distance plots are being submitted with the original copy of this report.

2.0 DATA ACQUISITION AND REDUCTION

2.1 Field Operations

The field work began on August 23rd and continued through September 20th. Two Woodward-Clyde Consultants' seismic refraction crews participated in the field work. The first crew was on the site for the entire field survey. The second crew worked at the site for the last 10 days of the project. Each crew included a geophysicist/supervisor, an explosives handler, and a lead lineman. Two helpers were supplied for each crew by R&M. R&M also flagged and brushed traverse alignments under the direction of AAI field personnel prior to the refraction survey. Geophone locations were staked during the seismic work by Woodward-Clyde Consultants and later surveyed by R&M.

Refraction survey procedures used during the 1982 surveys were similar to those used in the previous two years and are discussed in detail in the report of 1981 surveys (Woodward-Clyde Consultants, 1982). As before, data was recorded on a Geometrics/Nimbus model ES-1210F 12-channel seismograph and explosives were used as an energy source on all lines. Most shots were detonated by long wire lines between the blasting machine attached to the seismograph, and the charge. The second Woodward-Clyde Consultants crew, also utilized a short wire line and a radio seismograph trigger. This equipment allowed more distant and more rapid offset shots. Delays associated with the radio trigger were calibrated by periodic comparisons with hard-wired shots.

Typically, shots were placed at both ends and at the center of a 12-geophone spread. For end shots, the end geophone was moved back one-half normal spacing to prevent damage and

to provide more detailed coverage of shallow materials. In deep overburden areas, offset shots, normally 1100 feet from the end geophones, were used to extend the depth of investigation.

During the course of the field work, preliminary interpretations of the data were made for all lines. This procedure provided a check on the quality and adequacy of the data for the intended objectives of the investigation. Additional offset shots were made to further extend the depth of investigation when a need was indicated by preliminary checks.

2.2 Factors Affecting Data Quality

Several local environmental conditions existed at the survey sites that affected the quality or quantity of data. These included surficial soils conditions, vegetation, and adverse weather and topography.

The ability of a geophone to sense the arrival of an incoming seismic wave depends to a large extent on the coupling of the geophone to the ground and on the ability of the ground to transmit vibrations from deeper layers to the geophone. Two conditions in some parts of the Watana area produced coupling and shallow transmission deficiences: surficial talus blocks or residual boulders; and thick mossy vegetation cover.

Surficial blocks of rock provide a poor surface on which to anchor a geophone. In most cases, it was possible to place the geophone in a mud pack molded onto the rock surface. In some cases, the surface was simply too steep to support a mud pack, thereby preventing placement of the geophone and producing a loss of data at that station. Often, even

though geophone placement was possible, air voids were visille within the talus or residual boulder deposit that reduced the ability of the deposit to transmit the seismic signal.

Most flat portions of the survey area were covered with thick mossy vegetation. This vegetation provides a poor medium in which to seat a geophone and greatly attenuates a seismic signal. This problem was overcome in most cases by placing the geophones in shallow holes dug through the uppermost drier vegetation. In some areas, however, the vegetation was too thick to provide adequate geophone coupling, even in deep holes.

Brushy vegetation and archaeological clearance constraints restricted the possibility of changing line locations or of adding auxiliary lines, since it was necessary to obtain clearance and remove the brush before laying geophone cable. Lines were flagged and brushed well ahead of the seismic crew, and few changes or additions were made during the survey.

Heavy rains and high winds that occurred several times during the survey produced sufficient noise to require operations to stop. During marginally noisy periods, operations were continued and records were carefully examined to assure, in the judgment of the field supervisor, that first arrivals could be discerned. Records collected during those periods were not, however, of the same quality as those collected on quiet days. Under the time an fiscal constraints of the project, it was not possible to collect records only on quiet days, so some detail in interpretation was thereby lost.

Topography restricted the ability to run seismic lines in some areas. The area west of line SL82-8 in the damsite abutment area (Figure 1), where an extension of SL82-6 and two additional lines had been planned, was too steep to flag and brush, much less to run seismic lines. Another topography limitation involved the irregularity of recorded arrival times when nearby geophones were placed at widely varying elevations. This was particularly evident in the abutment areas. These irregularities are corrected, for the most part, by the computer-assisted data reduction techniques used for this project. The irregularities, however, made it difficult to assess the adequacy of the data in the field.

2.3 Data Reduction Procedures

Geologic velocity models were developed from computer-assisted data reduction programs using a combination of reciprocal, delay-time, and intercept-time methods similar to those used for the 1980 and 1981 surveys (Woodward-Clyde Consultants, 1982). The delay time and intercept time methods are explained in a practical seismic refraction manual by Redpath (1973). A more rigorous development of the principals involved in these two methods and in the reciprocal method is presented in a thesis by Palmer (1974).

The reciprocal method produces the most detailed model of subsurface conditions and was used for all lines for which sufficient data was available. The reciprocal method requires coincident seismic wave arrivals from shots at either end of a line of geophones (reciprocal shots) arriving at several geophone locations from the same refracting layer. The method also requires an accurate knowledge of the arrival times at the opposite far end shot points. The delay-time method requires less overlap

of coincident arrivals and the intercept-time method is independent of coincident arrivals and requires only a knowledge of apparent velocities from a refracting layer from both end shot points. Intercept-time calculations were used in all cases to verify the results of the other two methods, especially where arrival times at reciprocal shots were not well known.

Computer processing was based on software developed by Heatherly (1978 and 1979), which has been adapted to and combined with Woodward-Clyde Consultants' proprietary refraction reduction and plotting programs. These programs first produce the graphics necessary for interpretation, providing arrival time-distance, velocity analysis, and time section plots. The interpreter then selects appropriate time section values, making adjustments as required, for submittal to a program that graphically performs terrain corrections and migrates time-depth data for dipping refractors. Several crosschecks are incorporated into this system to ensure that the final interpretation is consistent with the basic geophysical data and available geologic information.

The presence of frozen ground in some portions of the Watana relict channel area was indicated on two of the lines run this year (SL82-18 and SL82-20 discussed in Section 4.0) by large delays in arrival times at the edges of shallow, anomalously high velocity zones. Since borings in the area have not shown frozen ground to an appreciable depth, computer assisted interpretation methods were used in those cases to model a velocity inversion condition with frozen ground overlying unfrozen, lower velocity channel fill materials. In previous years' seismic refraction surveys,

the effects of shallow frozen ground may not have been recognized. This may account for some of the misties among lines run over the past few years.

3.0 LIMITATIONS OF THE SEISMIC REFRACTION METHOD

Seismic refraction is a common geophysical exploration technique used for the investigation of shallow subsurface soil and rock properties. However, under certain geologic and environmental conditions, the data is subject to uncertainties that need to be recognized and understood for the correct evaluation and interpretation of the data. Since several of these adverse conditions occur within this project area, they are discussed in general terms in this section and specifically referenced in the discussion of the lines to which they apply.

The effects of localized lateral velocity variations, irregular contacts between units, velocity anisotropy, thin layers, and velocity inversions are discussed below. Site environmental conditions such as weather, topography, vegetation, and surficial soils are discussed with respect to the Watana site in Section 2.3. These conditions also affect the quality and quantity of data that is collected, and therefore on impact the accuracy of the interpretations.

3.1 Lateral Velocity Variations and Irregular Contacts

The seismic refraction technique is based upon the measurement of the first arrival of seismic waves at geophones (receivers) placed on the ground surface at progressively further distances from an explosive charge or other seismic source. Arrivals at the phones nearest to the source generally indicate travel directly through low-velocity surface materials. At points further from the source, the seismic waves arrive sooner than would be expected from travel through low-velocity surface materials because they have been refracted and have traveled, in part, through deeper higher velocity layers. If the seismic velocities

within layers are relatively uniform, the layer velocities increase progressively with depth; and the thickness of the units changes gradually (in comparison with the geophone spacing) a mathematical model can be developed from the arrival time data that closely approximates actual subsurface conditions. However, several conditions may exist that make interpretation of the data less precise than desired and introduce ambiguity into the mathematical model.

In ideal situations, plots of arrival times versus distance produce straight lines, the inverse slopes of which represent the apparent seismic velocity of the subsurface material. Deviations of the data from straight lines indicate inhomogeneity within layers, irregular contacts, or inaccuracies in identification of the first arrival times. Sufficient data is seldom available to distinguish among these possibilities. It may also be difficult to determine if irregularities occur in the near-surface layer or at depth. In many cases, the data resulting from local lateral velocity changes in the surficial layers can also be interpreted as contact irregularities. Reciprocal data reduction procedures (discussed in the previous section) will tend to reduce these ambiguities, but experience has shown that uncertanties in the interpretation will still remain.

3.2 Velocity Anisotropy

The seismic velocity within a geologic unit may vary depending on the direction in which the velocity is measured. This condition is known as velocity anisotropy. It is most likely to occur in steeply dipping, thinly bedded sedimentary rock units where the velocity of the individual thin layers varies considerably. Steeply dipping zones of

alternating fractured and in-tact rock can have a similar geometry and contrast in velocities. Such zones are known to be present on the Watana site from outcrop mapping.

In the case of dipping thinly bedded units, velocities measured parallel to the strike of the unit will reflect the velocity of the nearest high-velocity bed. Velocities measured perpendicular to the bedding will tend to be an average velocity of both the high-velocity and low-velocity beds.

Fracture and joint systems that break up the rock and provide open space within the rock body lower the apparent seismic velocity of the rock unit when measured across the fracture or joint system. However, velocity measurements made parallel to the fracture/joint system reflects the higher velocity of the nearest "rib" of unbroken rock. If the seismic line is aligned over a lower velocity zone, sidewards refraction produces a time-distance plot exactly the same as if the lower velocity material formed a discrete layer overlying the higher velocity material.

3.3 Thin Layers

Ideally each velocity layer is represented on a time-distance plot as a separate straight line segment. Thin layers may produce no indication of their existance in the data regardless of the detail of the survey. This condition occurs when the refraction from a lower, higher-velocity layer arrives at the surface prior to the arrival from the "thin" layer. The minimum thickness of a layer that can be detected by the seismic refraction technique is dependent on the geophone spacing, the depth of the unit, and the velocity ratios. If an undetected thin layer exists, the calculated depth to the underlying higher velocity

layers will be too shallow. Depending upon the thickness of the undetected layer and the velocity ratios, the depth estimates for the deeper layers may be in error by as much as 50 percent (Redpath, 1973). However, based on the depth of investigations and velocity ratios observed in this study the error is not likely to exceed 30 percent.

3.4 Velocity Inversions

Layers with seismic velocities lower than overlying layers are not detectable by the seismic refraction technique. This situation is suspected to exist at several areas near the Watana damsite where unfrozen sediments appear to underlie frozen, high-velocity layers. Nonseismic information, such as boring data, is required to detect and resolve this "hard-over-soft" condition. Knowledge of the thickness of the low-velocity layer allows for correction of the refraction model, which is otherwise likely to be in error by as much as 20 percent for the depth calculations of deeper layers.

3.5 Depth Estimates in Channels

Accurate estimates of the deepest points along the thalwegs of buried channels require the identification of first arrival refractions from the base of the channel at several geophones. If the channel has steep walls and a relatively narrow base, refractions from the base of the channel may not be first arrivals and will not be detected. First arrivals may therefore be sidewall refractions and the estimated depths of the thalweg could then be too shallow. This situation may occur whether the seismic line is run parallel to the axis or across the channel.

The ability of the seismic refraction technique to "see" the base of a buried channel depends on a complex relation-

ship between: channel width; channel depth; the slope of the channel walls; velocity contrasts between the bedrock and channel fill material; geophone spacing; and line orientation with respect to the channel axis. Therefore depth estimates of the base elevation of buried channels should not be considered as maximum possible depths.

3.6 Summary

During this project, field data reduction was performed to assure the adequacy of results from each line and to recognize possible uncertainties in the interpretation at that time. However, access problems and time constraints precluded running additional lines that may have been required to resolve some of these uncertainties.

In interpreting seismic refraction data that is complex, the most efficient approach is to produce as simple a geologic-velocity model as possible without violating the restraints of the data. In these cases, the experience and judgment of the interpreter is important in producing a geologically reasonable picture. The presence of a geologist experienced with the geologic conditions at the site both during shooting of the lines and during interpretation, combined with the results of previous investigations, increased the likelihood that profiles presented herein reflect a fairly accurate model of existing conditions suitable for evaluation of the feasibility of the project. Further exploration will be required to resolve some of the uncertainties identified during these surveys. Many of the remaining uncertainties and apparent conflicts can best be resolved by additional borings at selected locations to provide control data against which the seismic interpretation can be adjusted.

4.0 DAMSITE ABUTMENT LINES

Seismic lines in the abutment areas (Figure 1) are grouped into four general localities which are discussed in separate subsections: the outlet portal area; near the centerline on the right abutment; the upper right abutment slopes; and the left abutment. Ranges of seismic velocities encountered in these areas and their interpreted material types are as follows:

1,500 to 4,000 fps	Surficial deposits: soil, talus, and residual deposits, dry to partially saturated.
6,000 to 7,000 fps	Recent sedimentary deposits at the edge of Watana relict channel, possible terrace deposites, and local till deposits. Also, may include zones of dry, highly fractured bedrock in areas of bedrock exposures.
7,000 to 12,000 fps	Highly fractured bedrock.
13,000 to 14,000 fps	Low-velocity bedrock, moderately fractured or altered.
15,000 to 19,000 fps	Typical fresh bedrock.
20,000 to 22,000 fps	Very high velocity bedrock, probably small areas or zones of extremly fresh, unfractured rock.

4.1 Portal Area

Eight of the fifteen lines in the damsite abutment areas were run on the steep slopes on the right abutment, downstream from the proposed centerline of the dam. These lines, SL82-1 through SL82-4 (Figures 4 and 5) and SL82-6 through SL82-9 (Figures 7, 8, and 9) cover an area planned for the outlet portals of the diversion and tailrace tunnels.

Lines SL82-4 and SL82-6 were run low on the slope roughly parallel to the contours. Both encountered thin surficial materials (5 to 25 feet) with apparent seismic velocities of 1400 to 1800 feet per second (fps) overlying bedrock with apparent seismic velocities of 13,000 to 20,000 fps.

At the northwest end of line SL82-6, an intermediate 7,000 fps velocity layer up to 50 feet thick is found over 13,000 fps bedrock. The same intermediate layer and low bedrock velocity are reflected in lines SL82-7 and SL82-8, which cross SL82-6. Fractured bedrock is exposed at several locations on the steeper parts of the lines in that area, indicating that the fracturing and associated weathering may be responsible for the low velocities. The 7000 fps velocity appears to represent a surficial jointed and weathered zone overlying less weathered, but not entirely fresh, bedrock. Marked differences in depth of the 7000 fps layer interpreted for the three lines indicate a very irregular contact with underlying materials. This irregularity is apparently averaged out on any given line but is clearly indicated when the data from crossing lines are compared.

Lines SL82-1 and SL82-3 were run directly downslope across the central portions of SL82-4 and SL82-6. Both lines

confirm the thin layer of surficial materials (including talus), but indicate a bedrock velocity of 21,000 to 22,000 fps compared to 18,200 fps and 15,500 fps on lines SL82-4 and SL82-6, respectively. The velocity differences are interpreted to reflect anisotropy across the north trending joint sets or fracture zones that have been mapped in the area. In this case, it appears that the lines running parallel to the set are reflecting the velocity of the least fractured rock in the area, whereas lines run at an angle to the joints indicate an average velocity of both fractured and unfractured rock (refer to section 3.2).

Line SL82-2 crosses the east end of SL82-4 at a low angle and line SL82-9 runs parallel to SL82-2 farther up slope. Both lines indicate widely varying bedrock velocities ranging from 13,000 to 22,000 fps. These two lines run nearly perpendicular to northwest-trending fracture and shear zones that cross the area and the velocity contrasts may be reflecting changes in bedrock properties across the zones.

The southwest end of line SL82-9 and the northern half of SL82-1 are relatively close to each other near the top of the steep abutment slope. Both lines indicate an intermediate velocity layer of approximately 6000 fps, to a depth of 50 to 100 feet. Although this intermediate velocity may represent highly fractured rock similar to that interpreted at the western end of line SL82-6, no outcrops were observed on this portion of the lines during the seismic survey. The configuration and location of these two intermediate velocity layers suggests the possibility that they may be portions of a remnant terrace deposit.

4.2 Lines Near The Proposed Centerline, Right Abutment

Three lines were run on the right abutment slopes upstream from the outlet portal area. Line SL82-10 (Figure 9) was run from north to south, downslope, connecting the other two lines (SL82-11 and SL82-13), which were run essentially parallel to contours. SL82-10 indicates thin surficial materials over a 9200 fps intermediate layer, apparently representing fractured bedrock, which thins downslope and then appears to thicken abruptly near the lowest point of the line near the center of line SL82-11. Line SL82-11 (Figure 10) shows the intermediate velocity layer to be over 150 feet thick at the southwest end, thinning to the northeast. At the point where SL82-11 crosses line SL80-3, shallow and intermediate layers are indicated to be approximately 60 feet thick. The intermediate velocity layer was not shown on the interpretation of line SL80-3. The reason for this apparent anomaly is not clear from existing data.

Line SL82-13 (Figure 12) intersects the ends of four other lines and is in reasonably good agreement with them. At its northeast end, an intermediate velocity layer of 10,600 fps is similar to the 9,200 fps velocity indicated for SL82-10 and 12,000 fps indicated for SL81-15. A possible change to 20,000 fps "fresh" bedrock is indicated at that end of the line at approximately 220 feet below the surface. At the center of SL82-13, the northern end of SL80-3 shows a velocity of 14,800 fps. The velocity beneath nearby line SW-2 was interpreted to be 13,500 fps. SL82-13 shows the shallow bedrock velocity to be approximately 13,000 fps in that area, to a depth of investigation of about 200 feet.

4.3 Top of Right Abutment Slopes

The remaining two lines on the right abutment, SL82-5 (Figure 6) and SL82-14 (Figure 13) were run with northeasterly trends across the relatively gentle topography at the top of the abutment slopes. At the northeastern ends of these lines, both show the edge of the Watana relict channel with velocities of approximately 6,800 fps. These velocities are similar to those reported in Woodward-Clyde Consultants (1981) for the channel fill materials. Bedrock velocities under the edge of the relict channel appear to range from 14,500 fps to 17,400 fps.

The southwestern ends of SL82-5 and SL82-14 are close together near the intersection of lines SW-2 and SL80-2. Boring BH-1 was drilled at the approximate intersection of SL82-14 and SW-2. Both SL82-5 and SL82-14 indicate a 50-foot thick intermediate layer with a seismic velocity ranging from 7,000 to 9,000 fps at their southwestern ends. This layer appears to coincide with a zone of highly jointed bedrock encountered in BH-1. This layer is also present beneath the high end of SL82-8 (7000 fps), approximately 350 feet to the west, and can be traced downslope along that line to an area of exposed fractured bedrock (refer to the discussion in Section 4.1).

Data from the southern end of SL80-2 does not indicate the presence of 7000 to 9000 fps velocity layer. The wider geophone spacing (100 feet) used on the 1980 line may be responsible for the layer not being detected.

The low-velocity intermediate layer is indicated on Line SW-2, but was interpreted to have a velocity of 6,020 fps and to represent overburden (Shannon and Wilson, 1978). The 6,020 fps layer is carried the entire length of SW-2. We

believe that this velocity may represent overburden (terrace deposits) near the eastern end of SW-2 (refer to Section 4.2) in which case a transition from overburden to highly fractured bedrock must occur at some point east of BH-1.

4.4 Left Abutment Lines

Two lines, SL82-12 (Figure 11) and SL8 15 (Figure 14), were run on the proposed left abutment. SL82-12 extended northeastward from the end of SL81-20 along the top of the steep cliffs above the river. SL82-15 was run from the top of a prominent knob adjacent to the river near the proposed upstream cofferdam location, into a low saddle, almost at river level.

Surficial materials with velocities less than 2000 fps extend along the entire length of Line SL82-12 and are up to 20 feet thick in some locations. Thin layers (less than 20 feet thick) of intermediate velocity materials (7500 to 8000 fps) are indicated beneath surficial soils at two locations. Bedrock velocities are indicated to be 14,000 fps beneath the southwestern half of the line and 11,800 fps near the northeastern end. Since the line was run on a north-facing slope, it is possible that the 11,800 fps velocity could represent frozen material which, if not frozen, would have a velocity of 8000 fps similar to shallower intermediate velocity material. A narrow (150 ft), anomalously high velocity zone (20,000 fps) appears beneath the center of the line.

Bedrock velocity beneath the eastern end of Line SL81-20 was interpreted to be 18,000 fps which is similar to but higher than the 14,000 fps indicated for Line SL82-12 where the lines intersect. It is likely that a transition between these velocities occurs in the vicinity of the intersection

but it is not clear from the data where it is located. Boring DH-25, which is located approximately 180 feet southeast of the intersection, encountered glacial till to a depth of 50 feet. The till would be expected to have a seismic velocity as high as that of the 8000 fps intermediate velocity material indicated further northeast on line SL82-12. On the basis of the seismic data, therefore, it appears that the till thins southward and eastward from DH-25 and is either not present or is very thin beneath the intersection of Line SL82-12 and Line SL81-20.

Bedrock velocities beneath Line SL82-15 range from 16,000 to 17,000 fps. Surficial materials (2000 fps) are thin (10 feet or less) on the slopes on the northeastern portion of the line and thicken to as much as 25 feet at lower elevations. A 7700 fps intermediate velocity layer is indicated. At the southwestern end of the line it is 80 feet thick. This velocity zone could represent either sedimentary deposits or highly fractured bedrock.

5.0 WATANA RELICT CHANNEL LINES

Seven refraction lines, numbered SL82-16 through SL82-22, were run in the Watana relict channel area (Figure 2). These lines were intended to augment the existing seismic refraction coverage in that area, and to obtain additional top-of-rock profiles in the area of the channel and on the Susitna River (south) side of Borrow Site D. Material types interpreted for velocity ranges encountered in the Watana relict channel area are as follows:

1,500 to 2,000 fps	Dry surficial deposits.
4,200 to 4,800 fps	Partially saturated channel fill deposits.
5,000 to 6,000 fps	Saturated typical channel fill deposits.
7,000 to 9,000 fps	More compact channel fill deposits. May be more bouldery; may represent earlier episode of channel fill or locally derived fill material; may be partially frozen where it occurs on shallow channel edges.
9,500 to 10,500 fps	Frozen ground: probably limited in depth; probably overlies lower velocity materials.
10,800 to 14,000 fps	Fractured or altered low-velocity bedrock.
15,000 to 19,000 fps	Relatively unaltered bedrock.

5.1 Line SL82-16

Line SL82-16 (Figure 15) was run as a short (1,100 foot) line overlapping the ends of line SL80-2 on the southwest and line SL81-14 on the northeast. Offset shots were placed 1,100 feet from each end of the line. The line indicates a 6,000 fps velocity layer underlying thin surficial materials (2,000 fps) and overlying a 9,000 fps material at a depth of approximately 200 feet. The base of the 9,000 fps layer is shown by time-distance plots as rising rapidly toward the southeast. Because of the apparent steep dip of the bedrock contact, neither the depth nor its true velocity can be determined from data collected on line SL82-16 alone. However, the model shown on Figure 13 is suggested by the data and agrees well with the interpretations for adjacent lines. Line SL81-14 shows the top of bedrock to be at an elevation of 1,700 feet at the point where SL82-16 data shows the 9,000 fps velocity layer to be very thick. SL80-2 shows 6,000 fps directly over bedrock with a velocity of 15,000 fps at the point where SL82-16 data shows the 9,000 fps layer to be thin. It is likely that 9,000 fps material does exist beneath the northeastern end of SL80-2, but the data at the end of that line was insufficient to detect it.

5.2 Lines SL82-17 and SL82-18

Lines SL82-17 (Figures 16 and 17) and SL82-18 (Figures 18 through 20) were run across the relict channel northwest of SL82-16. SL82-17 shows the edge of the relict channel approximately 2,200 feet from the southwest end of the line. The deepest part of the channel is near the northeast end of the line and is indicated to be at an elevation of approximately 1,665 feet, somewhat deeper than expected from the elevation of nearby Tsusena Creek. Bedrock velocities are indicated to be relatively low beneath the

line (13,000 to 14,000 fps). The velocities of the channel fill material are between 5,200 and 7,100 fps.

The northeastern end of Line SL82-17, on which the deepest part of the relict channel is indicated, is within 500 feet of the southwest end of Line SL81-13 which shows a much shallower (150 foot) maximum depth to bedrock. The velocity of channel fill on Line SL81-13 was interpreted to be 7000 fps in that area in contrast to the 5200 fps velocity interpreted for Line SL82-17. It is possible that the 7000 fps may represent partially frozen ground that was not indicated by the data from this year's line. If an average channel fill velocity of about 6000 fps were used in the interpretation of both lines, the calculated depth to bedrock would be in closer agreement at about elevation 1700.

Data collected along Line SL82-18 (Figures 18, 19, and 20) indicates the deepest part of the channel is at an elevation of approximately 1,770 feet, which is much shallower than expected. Based on other refraction lines in the vicinity, the most likely location of the channel thalweg is about 3100 feet from the northeast end of the line. A dashed line has been added to the interpretation shown in Figure 19 to show its possible shape. The most probable reason that such a deepened thalweg cannot be interpreted from the data is that the channel width is relatively narrow and its base cannot be detected by refraction (see discussion in Section 3.5). Alternative possibilities include the presence of thin layers of high-velocity channel fill either near the surface (possible frozen ground) or at depth within the deepest part of the channel (basal deposits).

Shallow frozen ground with a velocity of 10,500 fps is interpreted to be overlying typical channel fill material with velocities ranging from 5,800 to 7,000 fps to the northeast of the most likely position of the relict channel thalweg. This velocity inversion situation prevents mapping the base of the frozen layers and limits the accuracy of the interpreted channel depths. In Figures 19 and 20, the base of the shallow high velocity layer is estimated. If the frozen ground is thicker than modeled, then the actual depth of the channel would be greater than indicated.

5.3 Line SL82-20

Line SL82-20 (Figures 22, 23, and 24) was intended to approximately follow the thalweg of the main relict channel from a point near the southwest end of SL81-16 near the Susitna River, northwest toward Tsusena Creek. It crosses lines SW-3, DM-A, SL82-16, SL82-18, SL80-1, and SL82-17 progressively toward the northwest. Shallow frozen ground has been interpreted in the vicinity of line DM-A, which also shows the velocity inversion condition. For the present interpretation a section of frozen ground (approximately 25 milliseconds thick) was assumed to overlie the 6,200 fps channel fill material. This assumption produced a model bedrock elevation of approximately 1,700 feet. This bedrock elevation about 100 feet deeper than interpreted for Lines DM-A and SW-3. This apparent mistie (about 20% of total depth) can be reduced by assuming a thinner layer of frozen ground.

The southeastern end of Line SL82-20 is coincident with the northeastern end of Line SL82-19 and the southwestern end of Line SL81-16. Interpretations of the coincident ends of Lines SL82-19 and SL82-20 are in good agreement but differ considerably from the previous interpretation of

Line SL81-16. We reviewed the data for that line and suggest that alternative interpretations are probable. In the 1981 interpretation, high channel fill and bedrock velocities (10,000 fps and 19,000 fps, respectively) appear to have resulted from averaging apparent velocities from different layers for reversed shots. The shallow depth to bedrock shown at the southwestern end of Line SL81-16 is based on only two arrival-time picks. The velocities used for the interpretation of the 1982 data are based on additional data points. If the 1982 velocities are used, the resulting re-interpretation of Line SL81-16 is similar to that for both Lines SL82-19 and SL82-20 where the end points are coincident.

Toward the northwest, Line SL82-20 appears to be located to the southwest of the main channel with bedrock elevations as high as 1,950 feet. Although not apparent from the data, a thin 9000 fps layer has been modeled directly overlying bedrock beneath the central portion of the line so that the interpretation more closely matches those for lines SL82-16 and SL82-18.

Bedrock velocities along the line appear to be approximately 14,000 fps. The channel fill velocities range from 5,000 to 6,200 fps and the frozen ground has an apparent velocity of 9,500 fps.

5.4 Lines SL82-19, SL82-21, and SL82-22

Line SL82-19 (Figure 21) was run from the coincident end points of lines SL81-16 and SL82-20 southwestward to overlap the northeast end of Line SL81-15X. Bedrock is interpreted to be shallow under the end of Line SL82-15X, thickening to the northeast. At the northeast end of the line, channel fill material with a velocity of 7000 fps is approximately

350 feet thick. This is in good agreement with Line SL82-20 and with a reasonable reinterpretation of Line SL81-16 (see Section 5.3 for an explanation of the reinterpretation). Bedrock velocity is indicated to be 16,700 fps beneath the line.

Line SL82-21 (Figure 25) was intended to be a tie line between SL81-16 and SL81-18. The actual location of the line (based on R&M survey data), however, overlaps SL81-16 for approximately half of its length. Although the shape of the bedrock surface can be deduced from the data, the depth cannot be because reciprocal times from offset shots are not available. The profile for Line SL82-21 shows the inferred shape of the bedrock surface tied to the most likely depth interpreted for Line SL81-16. As previously explained (Section 5.3) problems exist in the 1981 interpretation of Line SL81-16. This interpretation is also shown in Figure 25 where the lines overlap. A reexamination of the 1981 data shows that the contact shown to be between 5000 fps and 9000 fps layers is more probably the channel-fill/bedrock contact. Also, the channel fill velocity appears to be in error and is more likely to be 8000 fps which is in good agreement with the present line. Averaging the velocities for the deeper layers previously interpreted for the northeastern end of Line SL81-16 produces a velocity of about 14,000 fps, similar to that indicated for bedrock by the present data.

Line SL82-22 (Figures 26 and 27) was run southerly from the south end of SW-4, across line SL81-18, to the top of the Susitna River bluffs, which are nearly vertical at that point. The southern end of the line indicates 15,000 fps bedrock very near the surface. Bedrock appears to deepen to an elevation of about 1,800 feet beneath

the south-central portion of the line. The intermediate velocity material near the ends of the line has a velocity of 7,000 fps. In the center, the velocity appears to drop below 5,000 fps.

6.0 FOG LAKES AREA

The two relict channel areas that were discovered on the 1981 Fog Lakes line (SL81-FL) were crossed during the present survey and more precisely defined. The largest and southernmost channel was encountered near the center of line SL82-FL1 (Figures 28 through 35), and near the center of line SL82-FL2 (Figures 36 through 39). The channel appears to be less than one-half mile wide beneath line SL82-FL2 and more than one and a quarter miles wide beneath SL82-FL1. Velocities within the channel at both locations are between 8,500 and 11,000 fps, which could represent frozen ground. If the channel deposits are frozen to the depth of the bedrock contact, the indicated minimum elevation of the deepest part of the channel on both lines would be approximately 1,750 feet. If the material is not frozen to bedrock (approximately 350 feet deep) a velocity inversion condition is indicated. Assuming that only half the total depth is frozen, the minimum elevation of the deepest part of the channel would be approximately 1,900 feet. This depth escimate is similar to that interpreted for line SL81-FL. There is not sufficient information to determine the thickness of the frozen layer soley on the basis of refraction data.

The second relict channel area on the south side of the river was crossed, at least in part, by the north end of line SL82-FL1 and by line SL82-FL3 (Figures 40 through 42). Several relatively narrow (1000 to 1500 feet wide) channels are indicated in that area. The deepest of these channels is apparent on both lines and appears to coincide with that interpreted on the west end of line SL81-FL. The minimum elevation in this deepest channel appears to be

approximately 1920 to 1950 feet, which is 70 to 100 feet lower than interpreted in the 1981 survey data. Again, if the shallow frozen ground in this area does not extend to bedrock, a velocity inversion condition may exist and the interpreted depth of the channel would decrease.

REFERENCES

Dames and Moore, 1975, Subsurface exploration, proposed Watana damsite on the Susitna River, Alaska; report for Department of the Army, Alaska District, Corps of Engineers, Contract DACW85-C-004, 12 pages.

Heatherly, P.J., 1978, A program for the reduction and plotting of seismic refraction data using the generalized reciprocal method: Geological Survey of New South Wales, Report No. GS1976/236, 9 pages, program and sample exection.

Heatherly, P.J., 1979, A FORTRAN program for the calculation and plotting of seismic refraction depth sections: Geological Survey of New South Wales, Report No. GS1979/049, 9 pages, program listing and sample execution.

Palmer, Derecke, 1974, An application of the time section in shallow seismic refraction studies: masters thesis, University of Sydney, Australia, 157 pages, (reprinted 1980).

Redpath, B.B., 1973, Seismic refraction exploration for engineering site investigations: U.S. Army Engineer Waterways Experiment Station, Explosive Excavation Research Laboratory, Livermore, California, Technical Report E-73-4, 55 pages.

Shannon and Wilson, Inc., 1978, Seismic refraction survey, Susitna Hydroelectric Project, Watana damsite; report for Department of the Army, Alaska District, Corps of Engineers, Contract DACW85-78-C-0027, 17 pages.

Woodward-Clyde Consultants, 1980, Susitna Hydroelectric Project, seismic refraction survey, summer, 1980: report to R&M Consultants, Anchorage, Alaska, 14 pages, 14 figures, 1 appendix.

Woodward-Clyde Consultants, 1982, Susitna Hydroelectric Project, seismic refraction surveys, 1981; Report to R&M Consultants, Anchorage, Alaska, 33 pages, 23 figures, 3 appendices.

KEY TO NOTATION ON FIGURES

Maps, Figures 1, 2, and 3

1. Line locations are shown as straight line segments that closely approximate the actual locations of the lines as surveyed in the field. Small deviations in line locations are not shown.

2. Triangles indicate the ends of lines and significant bends in the lines.

Profiles, Figures 4 through 42

1. Locations of bends in the lines are indicated by the letter B. The orientation of each line segment is indicated by notation at the top of each profile.

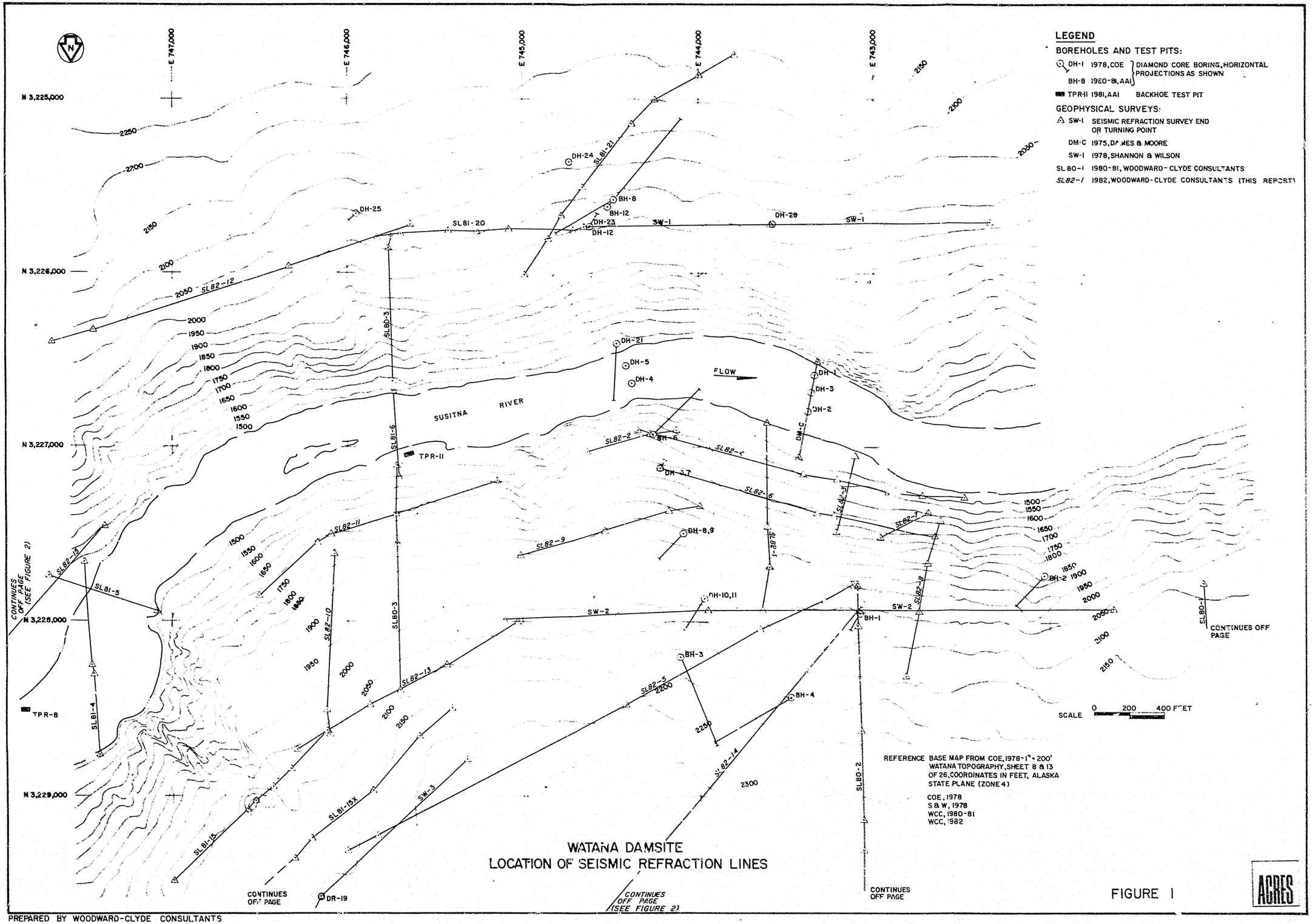
2. The locations of crossing points with other lines are shown by reference to the crossing lines.

3. Compressional wave velocities are given in fe per second.

4. Contacts between velocity units shown as solid lines are based on closely spaced data points and have an estimated accuracy of 10 to 15 percent of the indicated depth.

5. Contacts between velocity units shown as dashed lines indicate extrapolation between more widely spaced data points. The actual depth to the contacts is estimated to be within 25 percent of the indicated depth.

6. Queried dashed lines between velocity units indicate uncertainty as to the location of the contact. These contacts are based primarily on data from borings or previous refraction lines and are not the result of the reduction and interpretation of the 1982 seismic data.



LEGEND

BOREHOLES AND TEST PITS:

- DH-1 1978, COE } DIAMOND CORE BORING, HORIZONTAL PROJECTIONS AS SHOWN
- BH-8 1980-81, AAI }
- TPR-11 1981, AAI BACKHOE TEST PIT

GEOPHYSICAL SURVEYS:

- SW-1 SEISMIC REFRACTION SURVEY END OR TURNING POINT
- DM-C 1975, DAMES & MOORE
- SW-1 1978, SHANNON & WILSON
- SL80-1 1980-81, WOODWARD-CLYDE CONSULTANTS
- *SL82-1* 1982, WOODWARD-CLYDE CONSULTANTS (THIS REPORT)

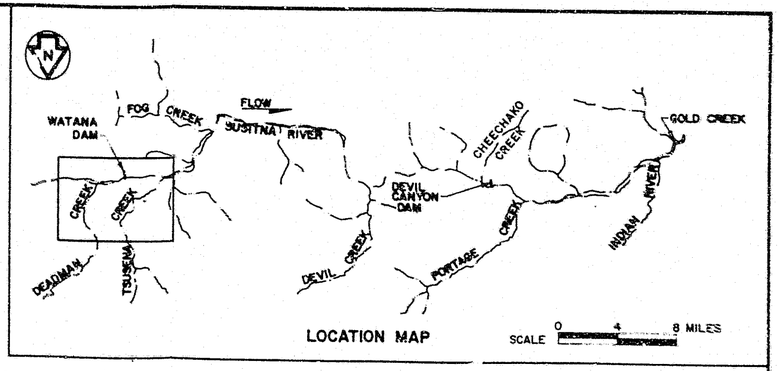
REFERENCE BASE MAP FROM COE, 1978-1" = 200' WATANA TOPOGRAPHY, SHEET 8 & 13 OF 26, COORDINATES IN FEET, ALASKA STATE PLANE (ZONE 4)

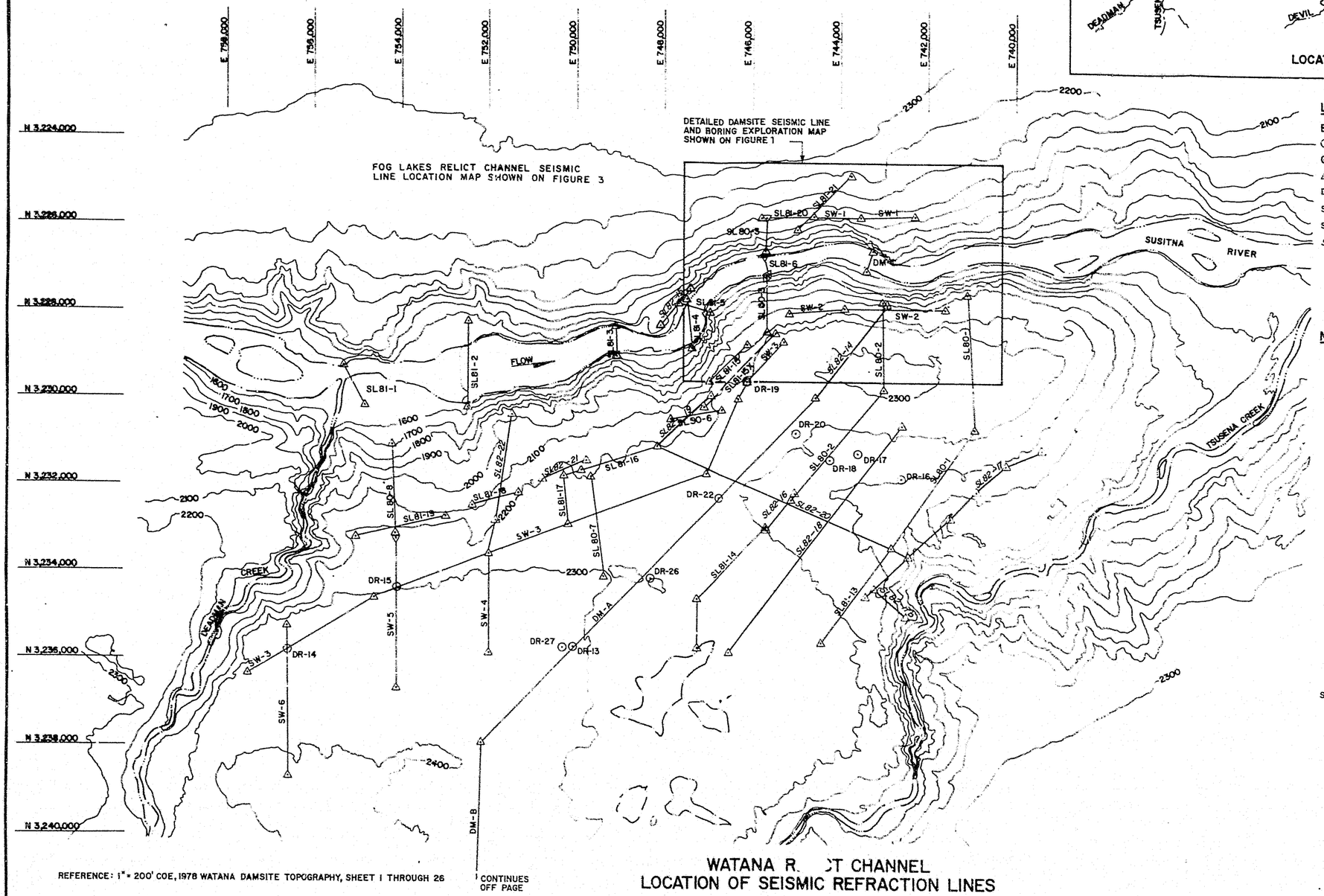
COE, 1978
S & W, 1978
WCC, 1980-81
WCC, 1982

WATANA DAMSITE
LOCATION OF SEISMIC REFRACTION LINES

FIGURE 1

PREPARED BY WOODWARD-CLYDE CONSULTANTS





LEGEND

BOREHOLES AND TEST PITS:

⊙ DR-16 1978, COE ROTARY DRILL BORING

GEOPHYSICAL SURVEYS:

△ SEISMIC REFRACTION SURVEY END OR TURNING POINT

DM-C 1975, DAMES & MOORE

SW-2 1978, SHANNON & WILSON

SL81-5 1980-81, WOODWARD-CLYDE CONSULTANTS

SL82-15 1982, WOODWARD-CLYDE CONSULTANTS (THIS REPORT)

NOTES

1. LOCATIONS ACCURATE TO ±100 FEET.
2. MINOR MIDLINE CHANGES OF DIRECTION NOT SHOWN.

SCALE 0 1000 2000 FEET

REFERENCE: 1"= 200' COE, 1978 WATANA DAMSITE TOPOGRAPHY, SHEET 1 THROUGH 26

WATANA R. CT CHANNEL
LOCATION OF SEISMIC REFRACTION LINES

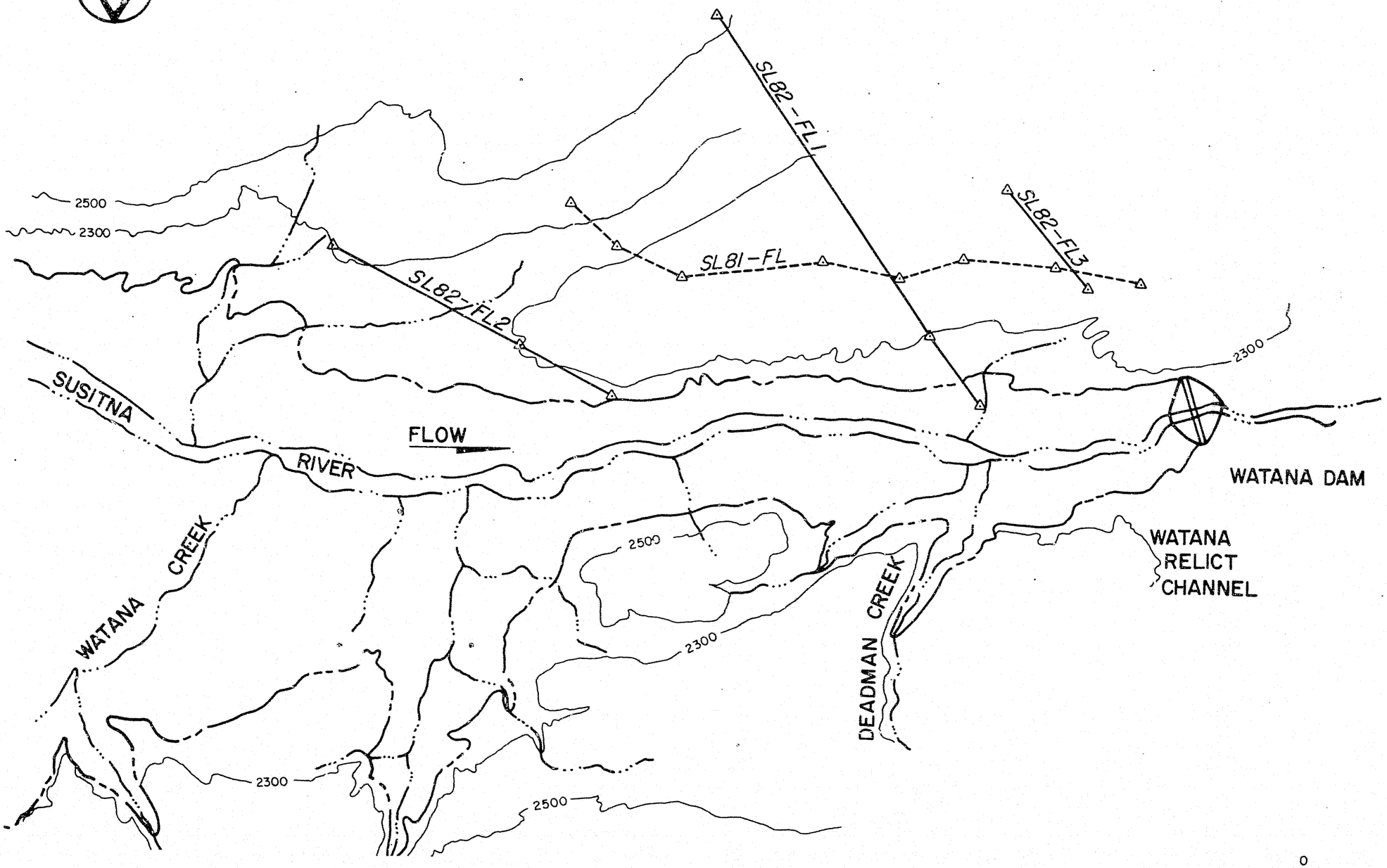
FIGURE 2

PREPARED BY WOODWARD-CLYDE CONSULTANTS

ACRES

NOTES

1. LOCATIONS ACCURATE TO ±500 FEET.
2. MINOR MIDLINE CHANGES OF DIRECTION NOT SHOWN.

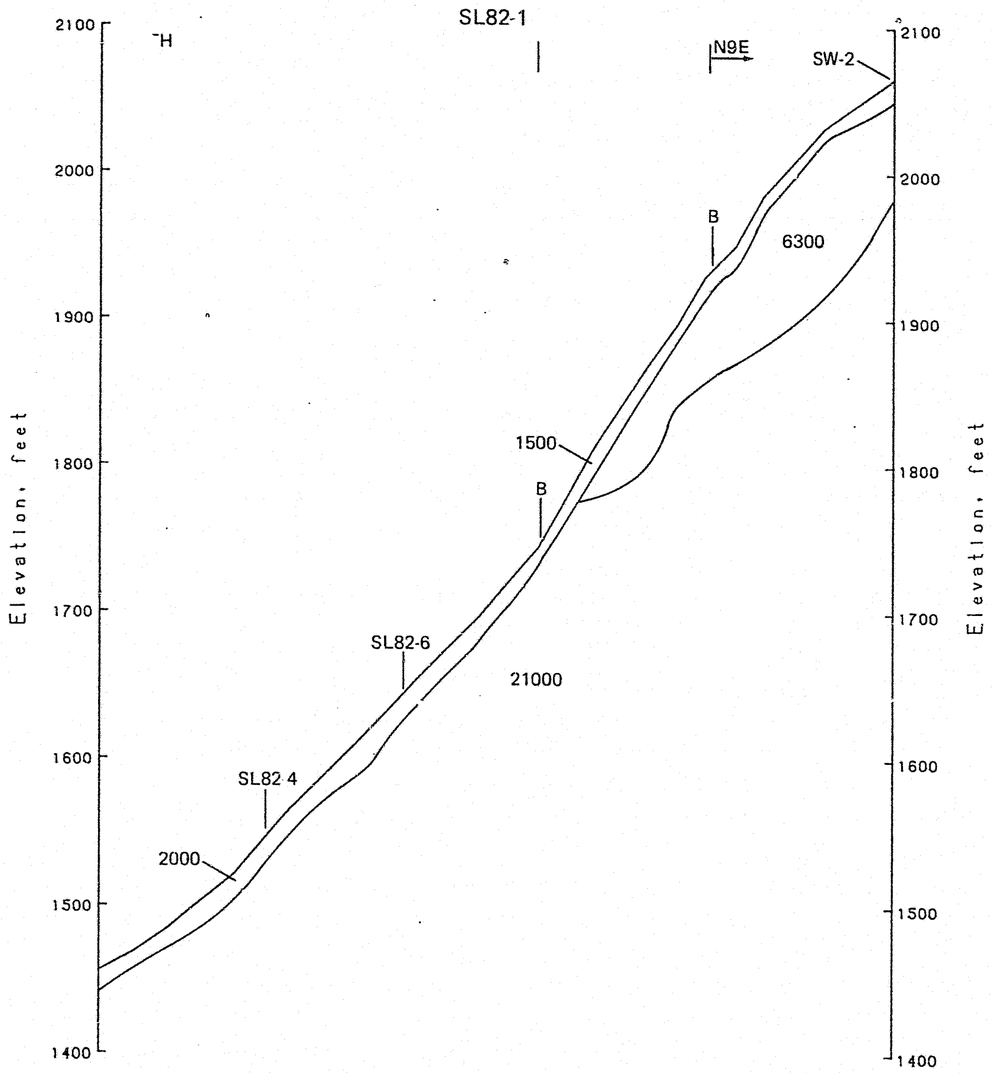


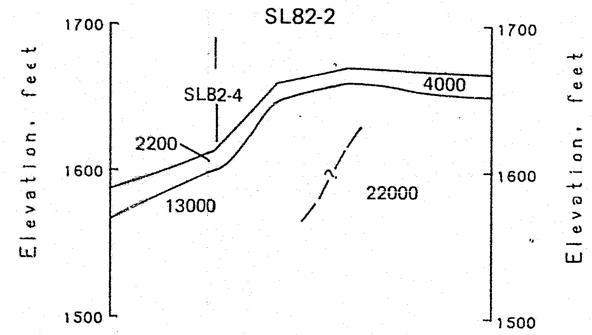
WATANA VICINITY MAP
APPROXIMATE LOCATION OF REFRACTION LINES
FOG LAKES RELICT CHANNEL

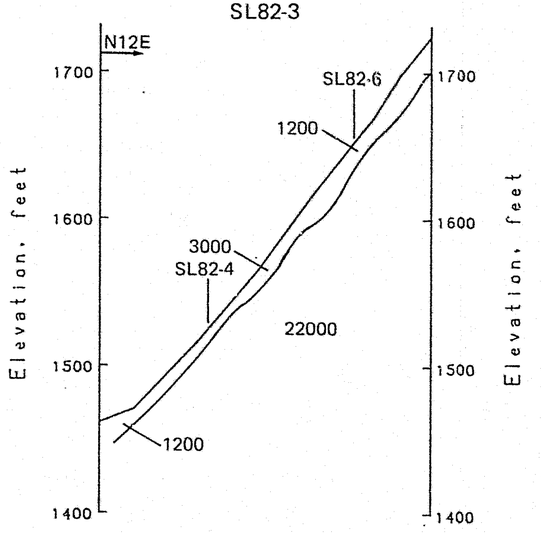
PREPARED BY WOODWARD-CLYDE CONSULTANTS

FIGURE 3

ACRES







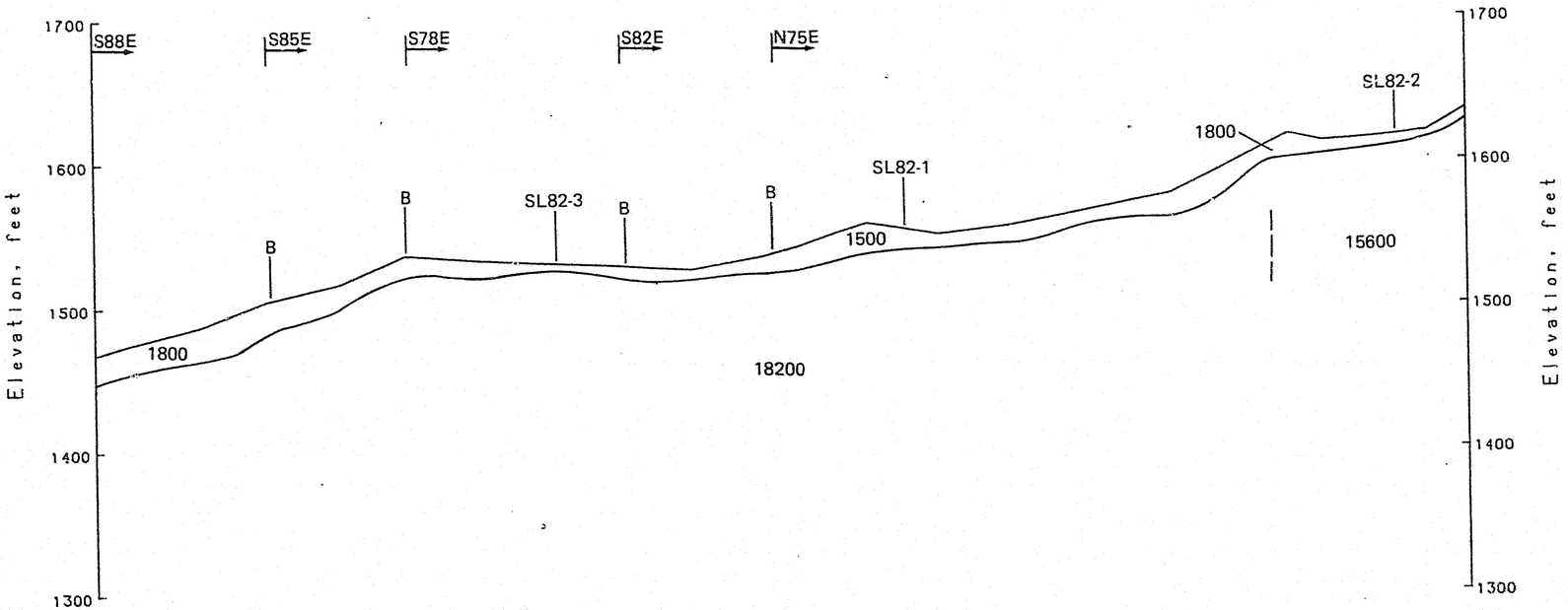
Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-1
LINE SL82-2
LINE SL82-3

FIGURE 4

PREPARED BY WOODWARD-CLYDE CONSULTANTS



Compressional velocities
in feet per second

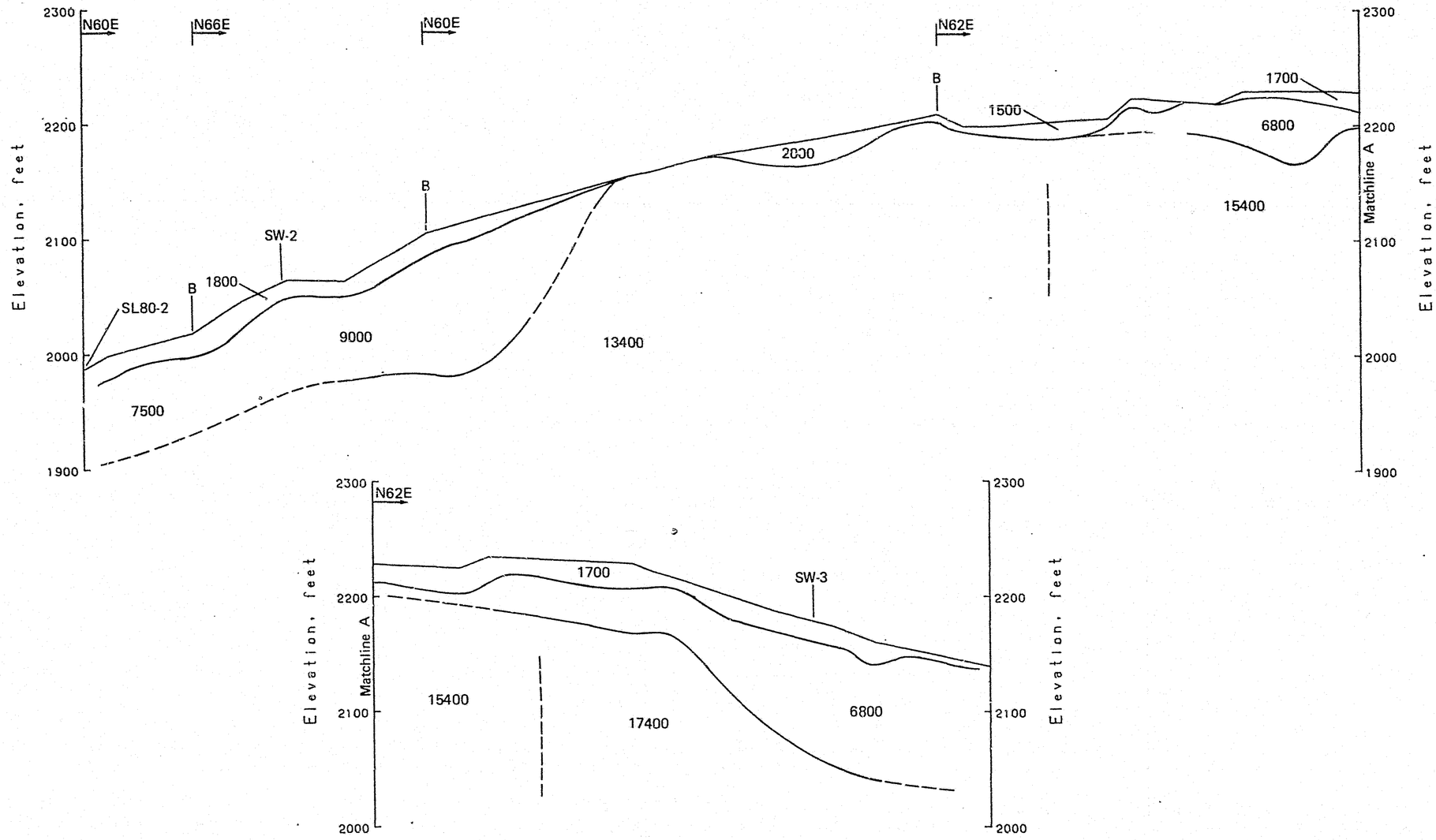
0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-4

FIGURE 5

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS



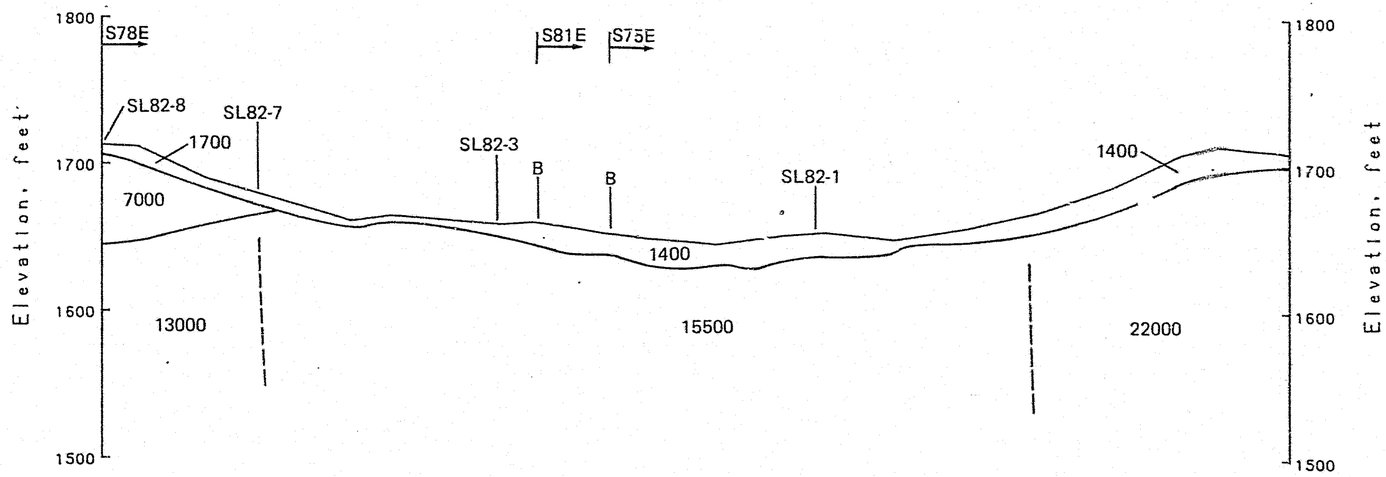
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-5

FIGURE 6

PREPARED BY WOODWARD-CLYDE CONSULTANTS



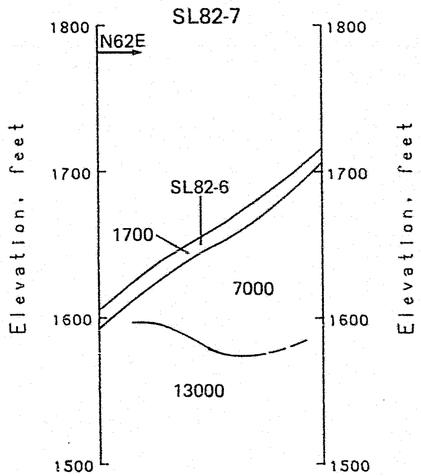
Compressional velocities in feet per second

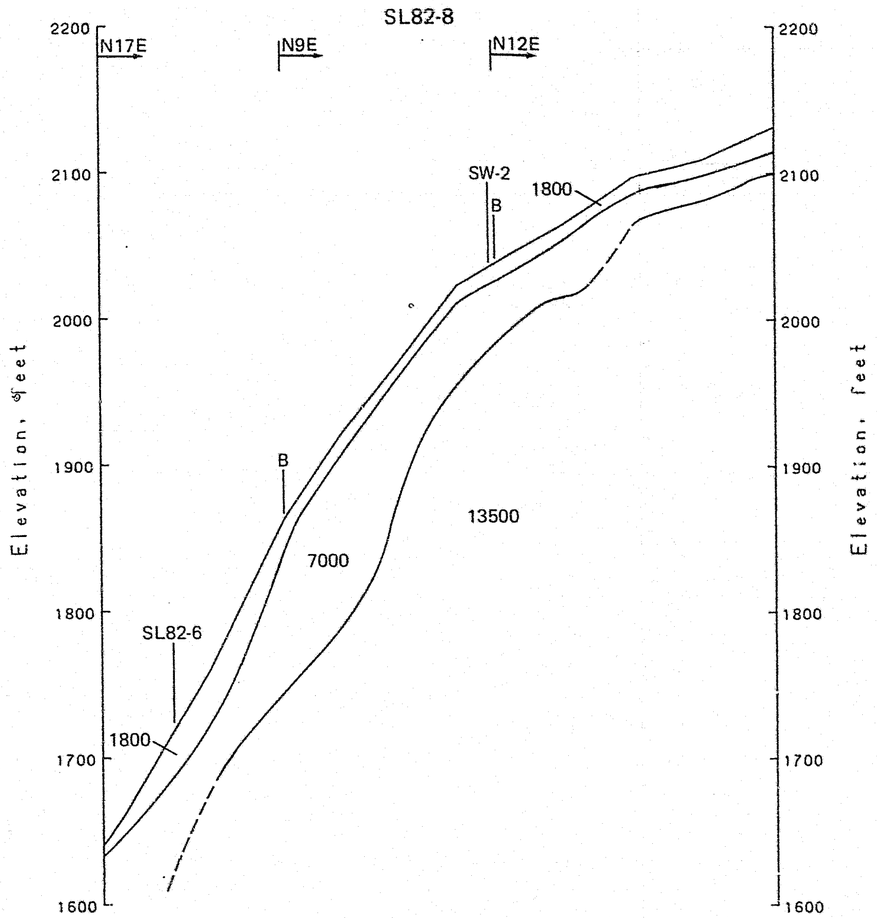
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-6

FIGURE 7

PREPARED BY WOODWARD-CLYDE CONSULTANTS





Compressional velocities
in feet per second

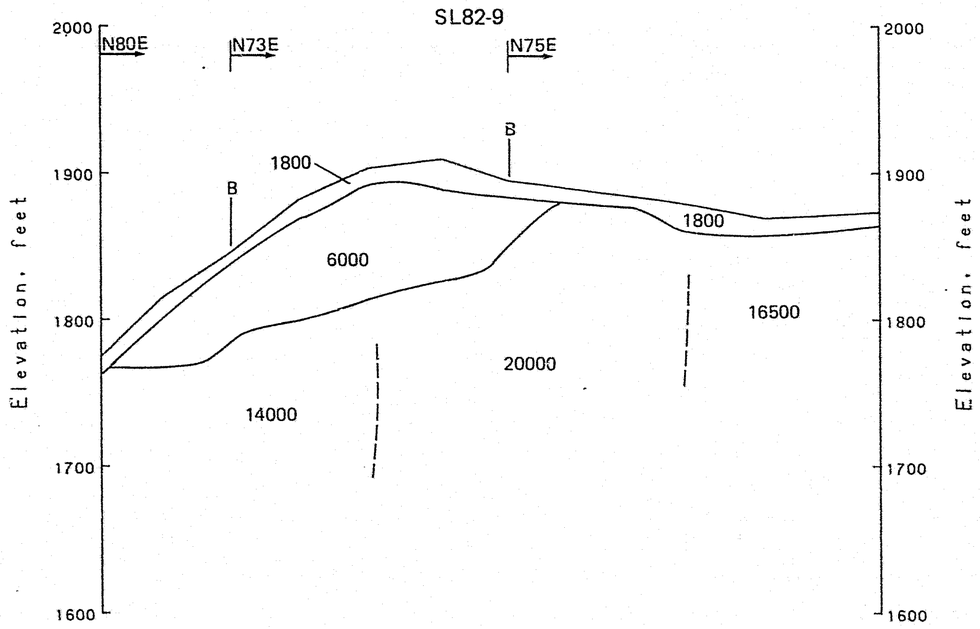
0 100 200
HORIZONTAL SCALE
IN FEET

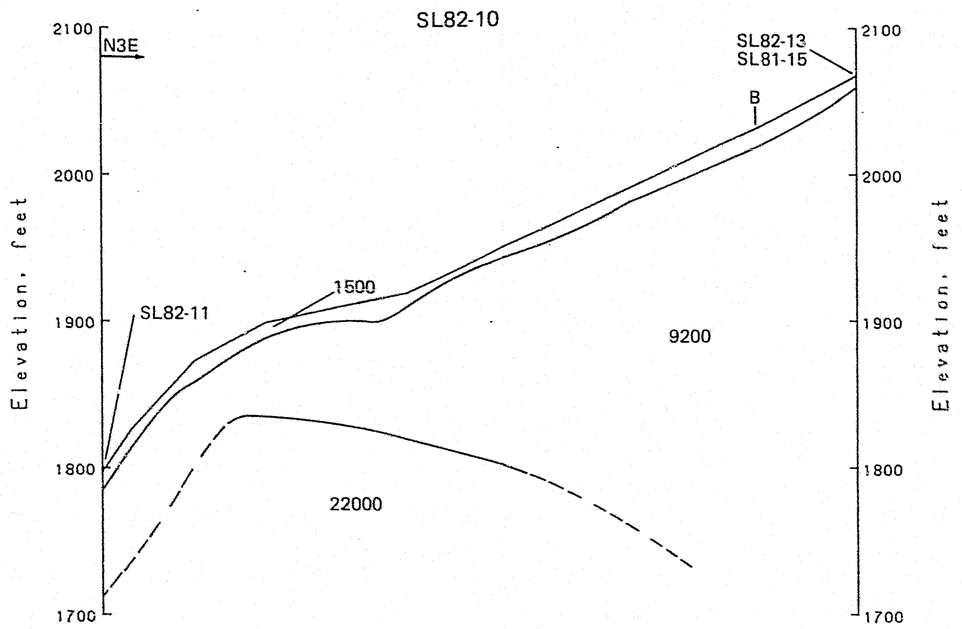
SEISMIC REFRACTION PROFILES
LINE SL82-7
LINE SL82-8

FIGURE 8

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS





Compressional velocities
in feet per second

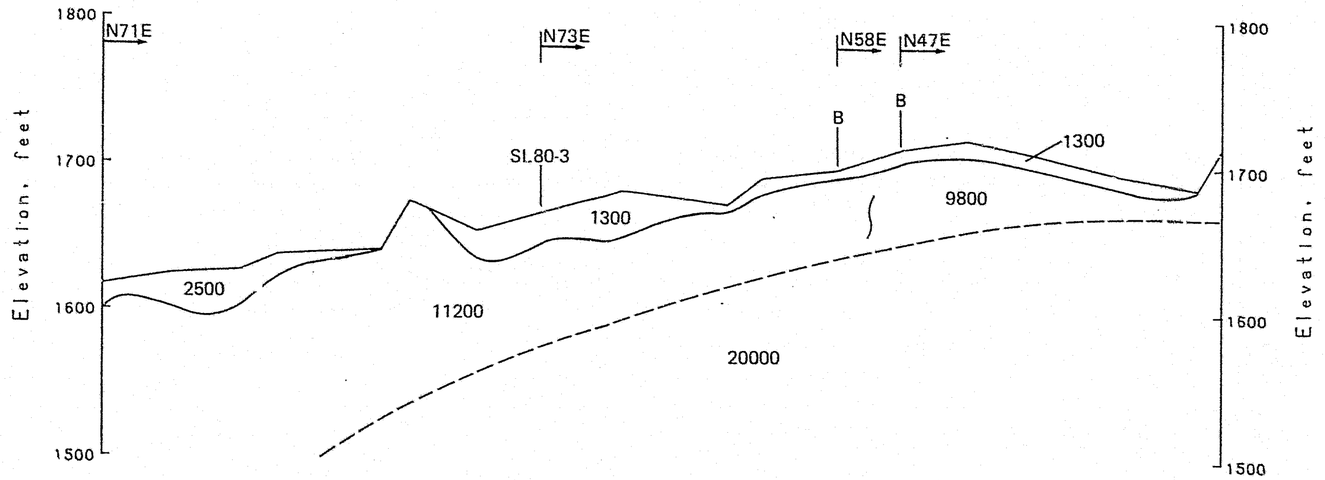
0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-9
LINE SL82-10

FIGURE 9

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS



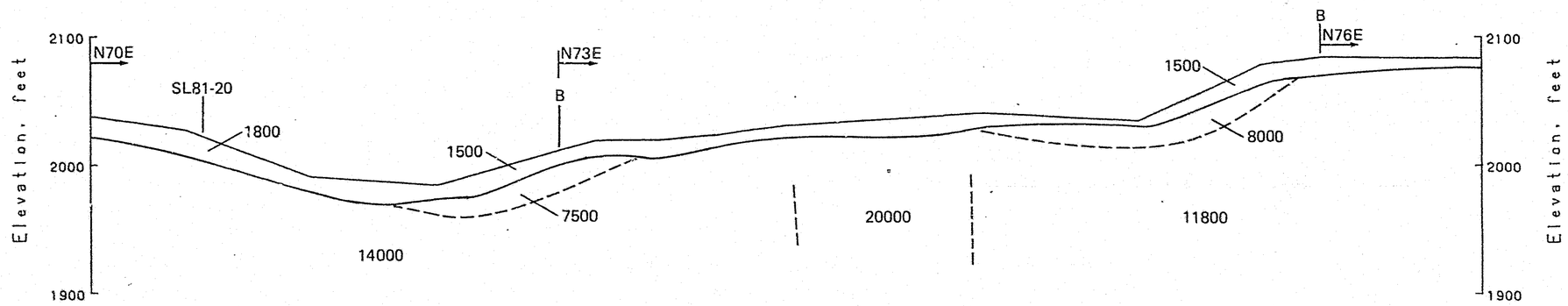
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-11

FIGURE 10

PREPARED BY WOODWARD-CLYDE CONSULTANTS



Compressional velocities
in feet per second

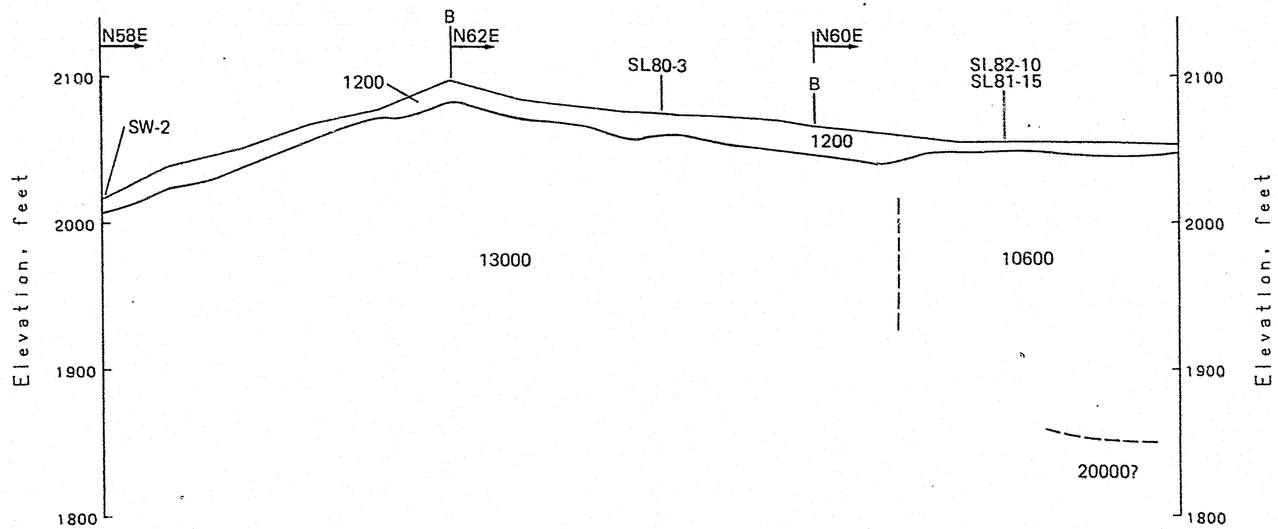
0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-12

FIGURE 11

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS



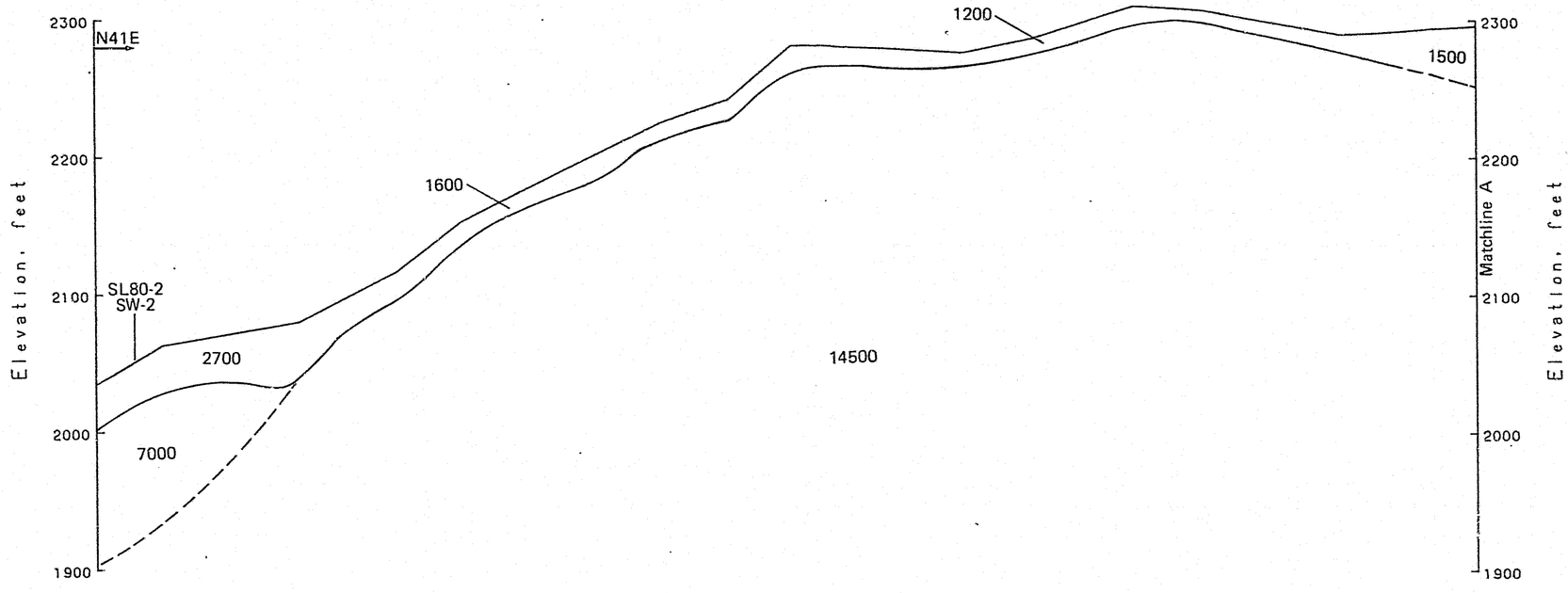
Compressional velocities in feet per second

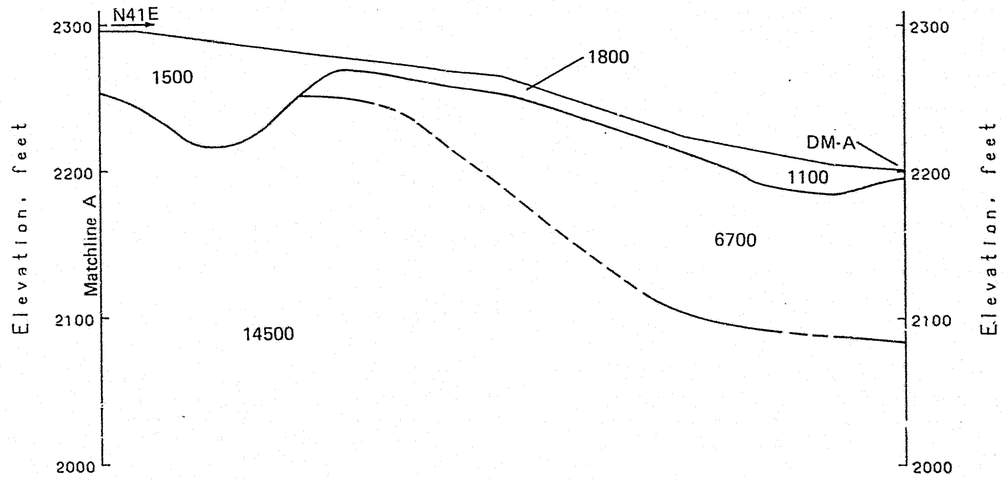
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-13

FIGURE 12

PREPARED BY WOODWARD-CLYDE CONSULTANTS





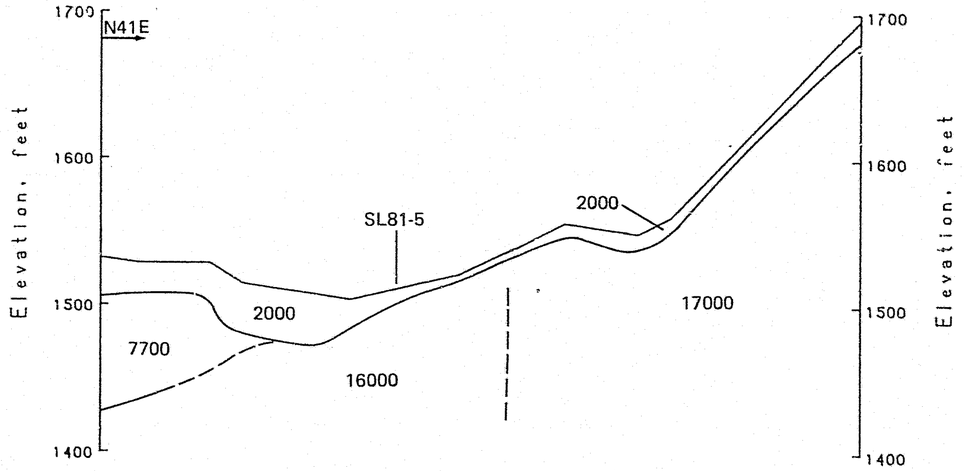
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-14

FIGURE 13

PREPARED BY WOODWARD-CLYDE CONSULTANTS



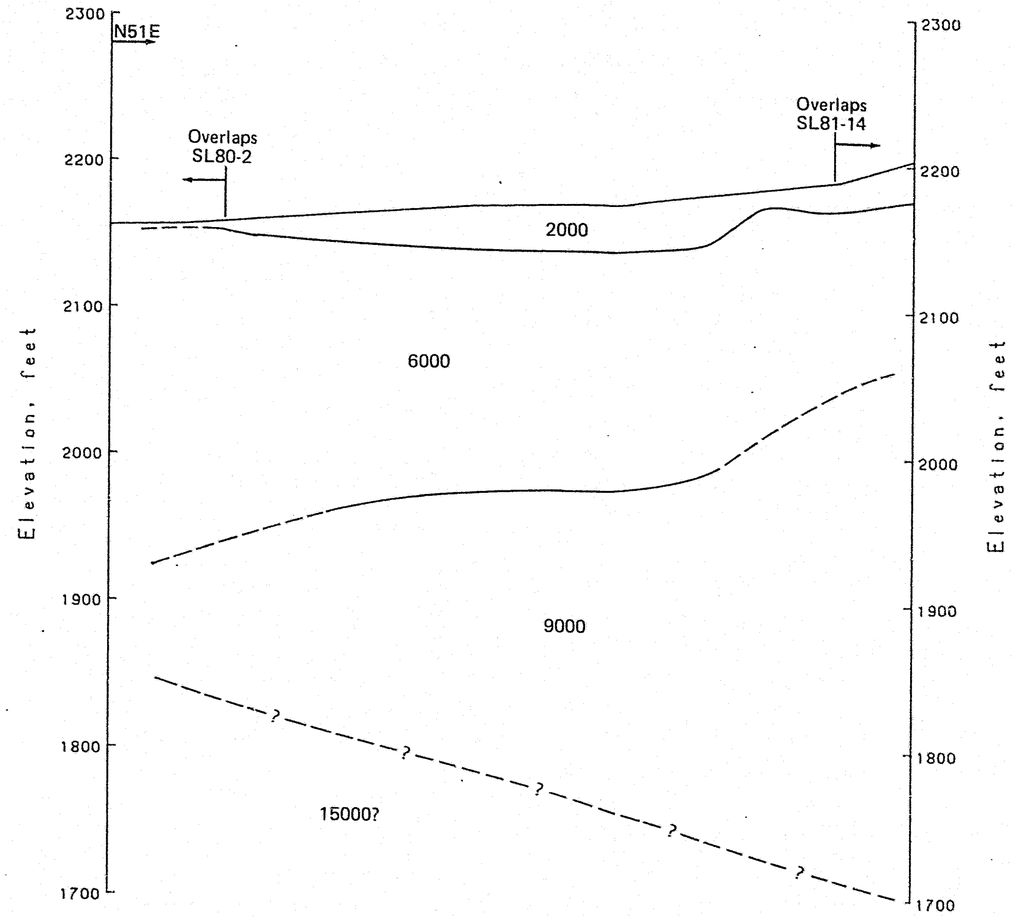
SEISMIC REFRACTION PROFILE
LINE SL82-15

Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

FIGURE 14

PREPARED BY WOODWARD-CLYDE CONSULTANTS



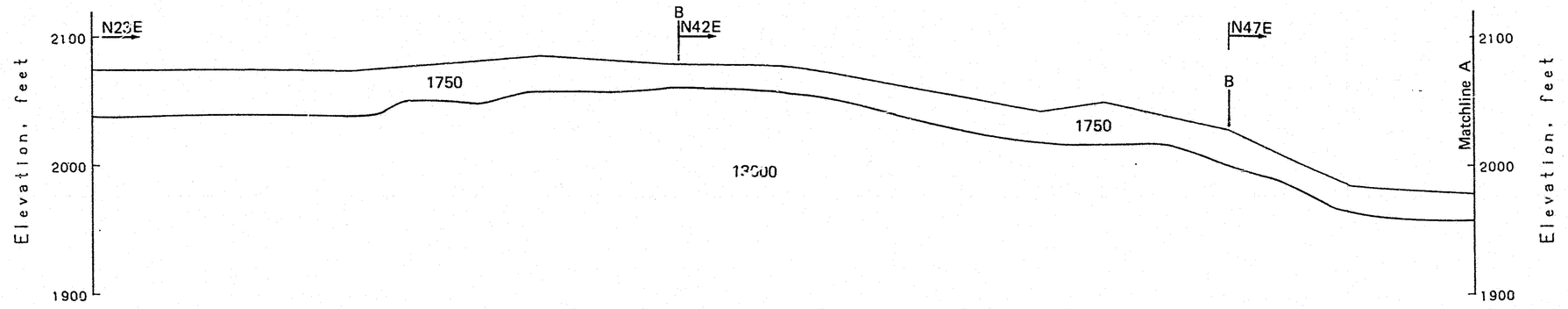
Compressional velocities in feet per second

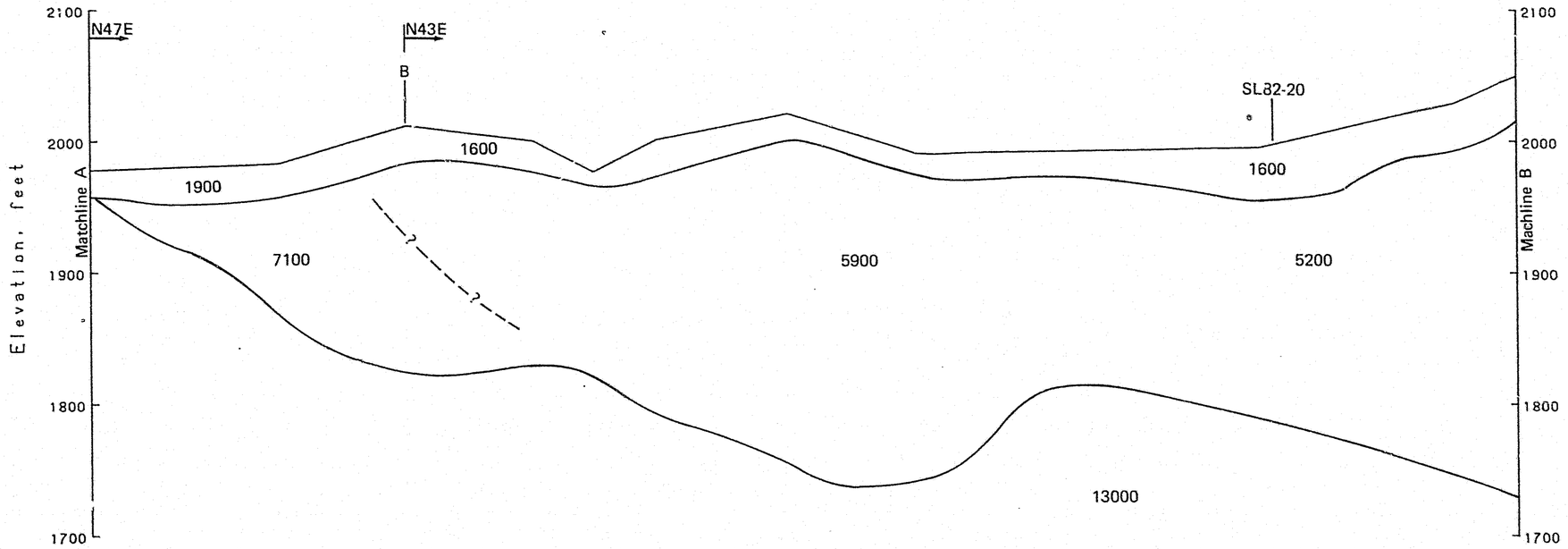
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-16

FIGURE 15

PREPARED BY WOODWARD-CLYDE CONSULTANTS





Compressional velocities in feet per second

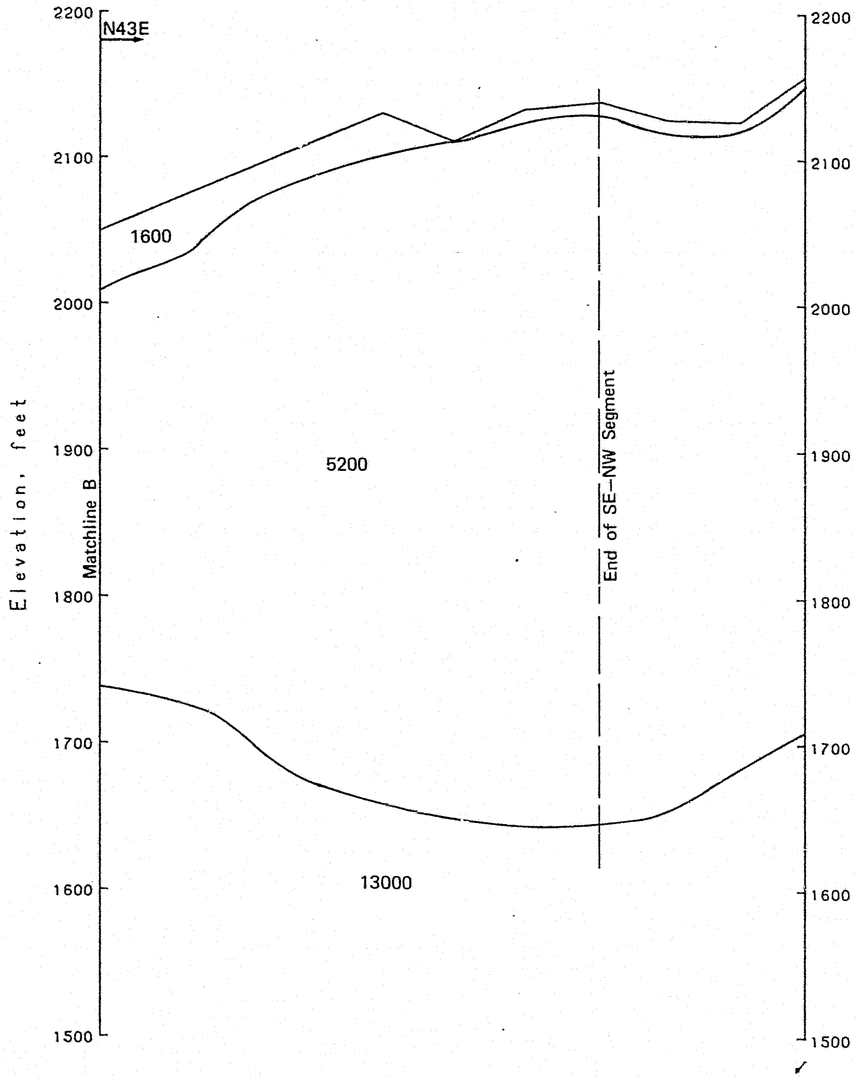
0 100 200
HORIZONTAL SCALE IN FEET

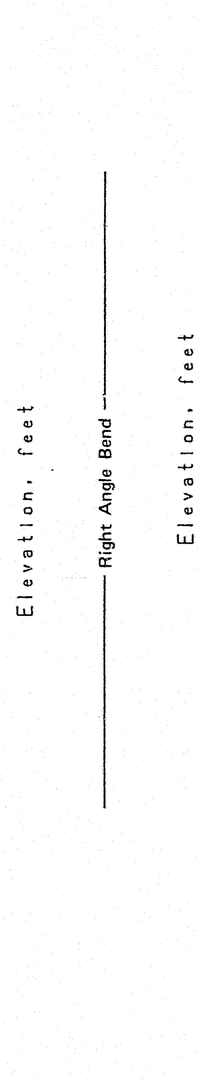
SEISMIC REFRACTION PROFILES
LINE SL82-17 (1 of 2)

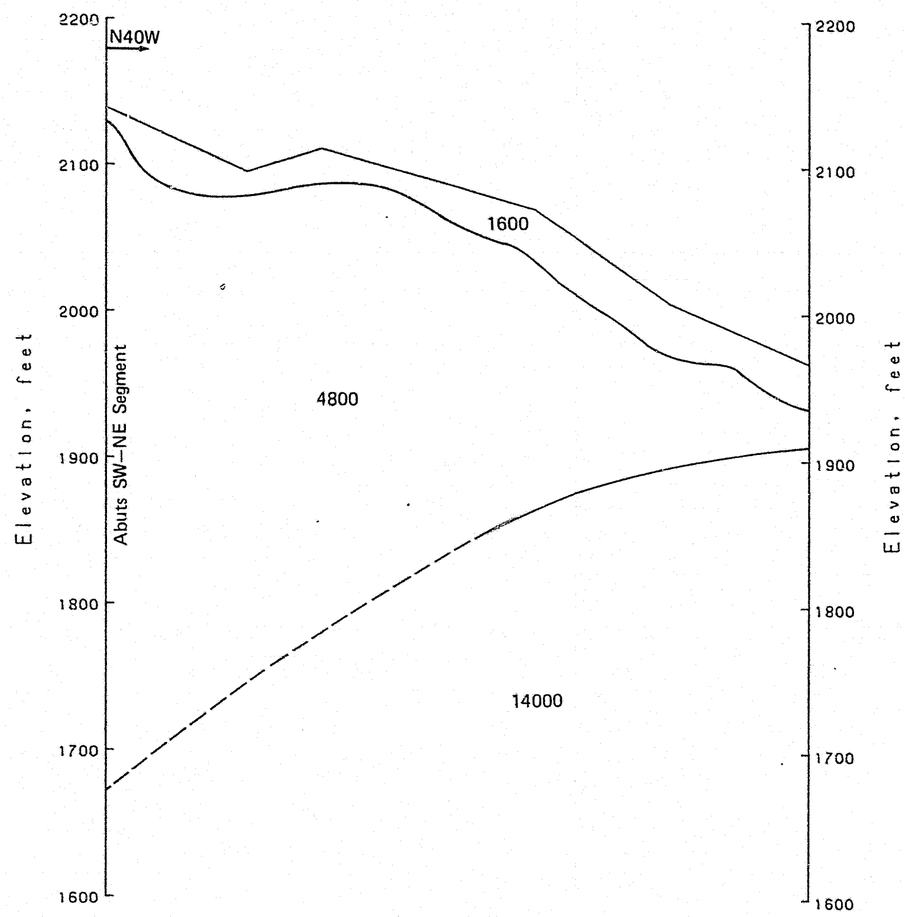
FIGURE 16

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS







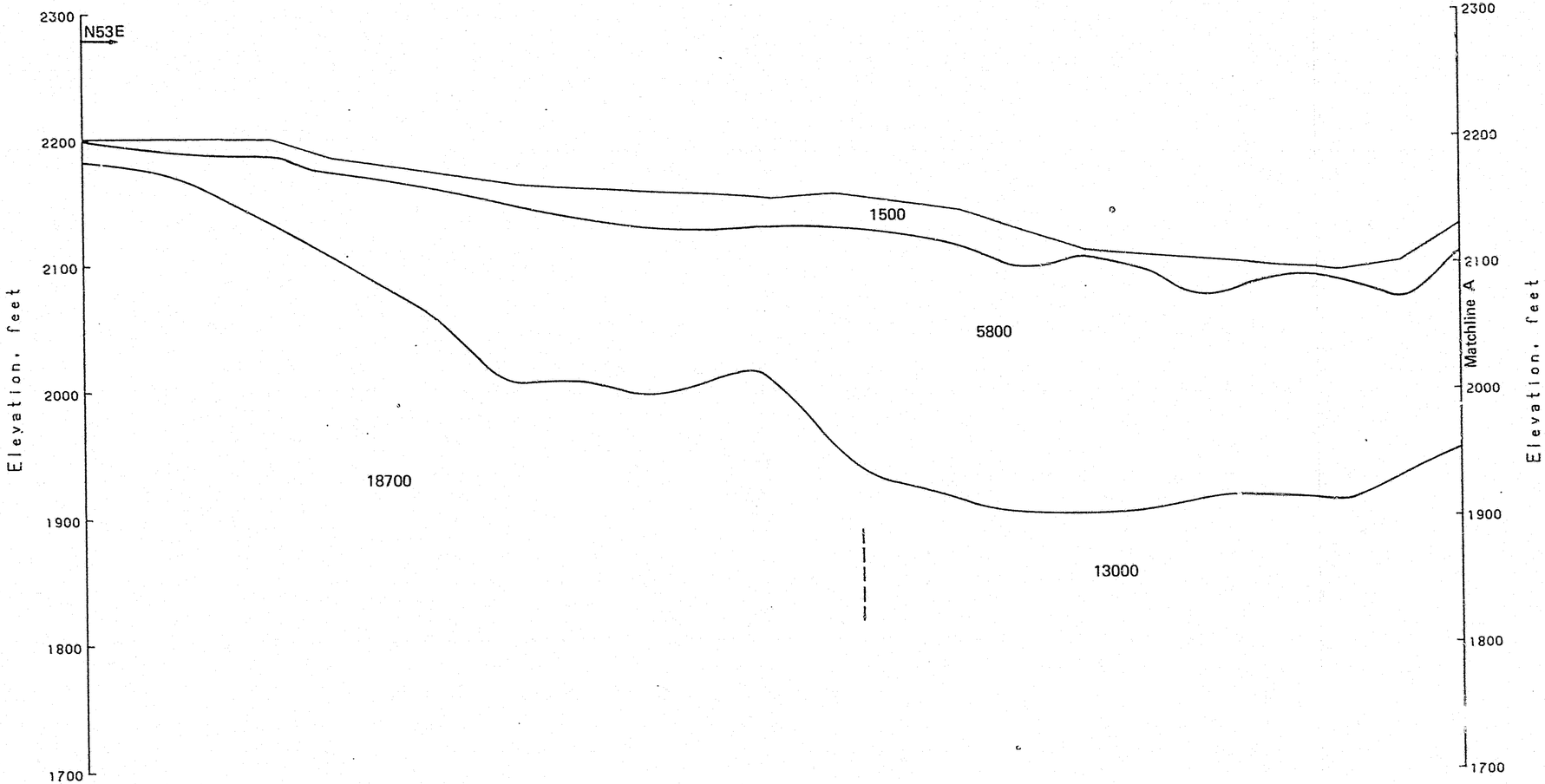
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-17 (2 of 2)

FIGURE 17

PREPARED BY WOODWARD-CLYDE CONSULTANTS



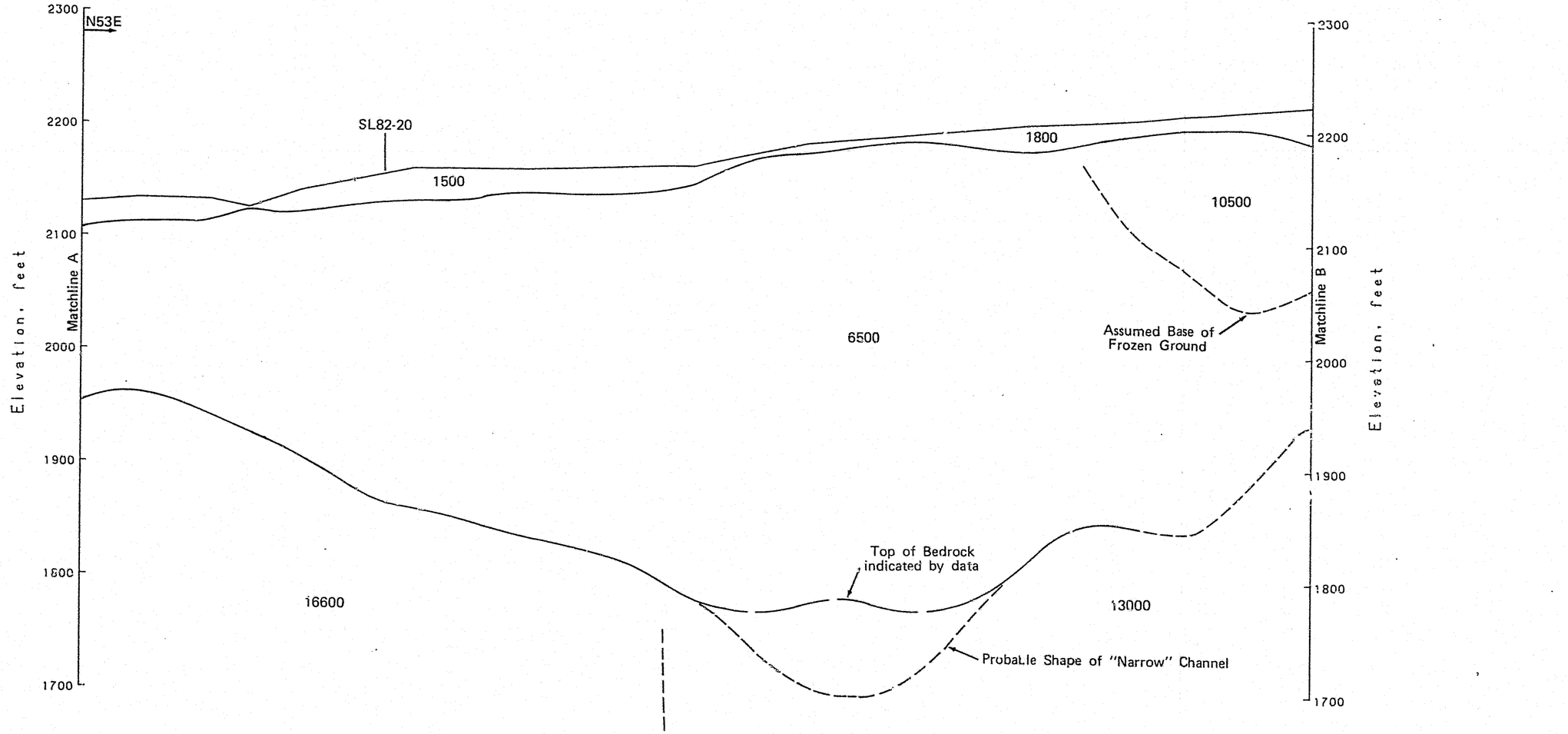
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-18 (1 of 3)

FIGURE 18

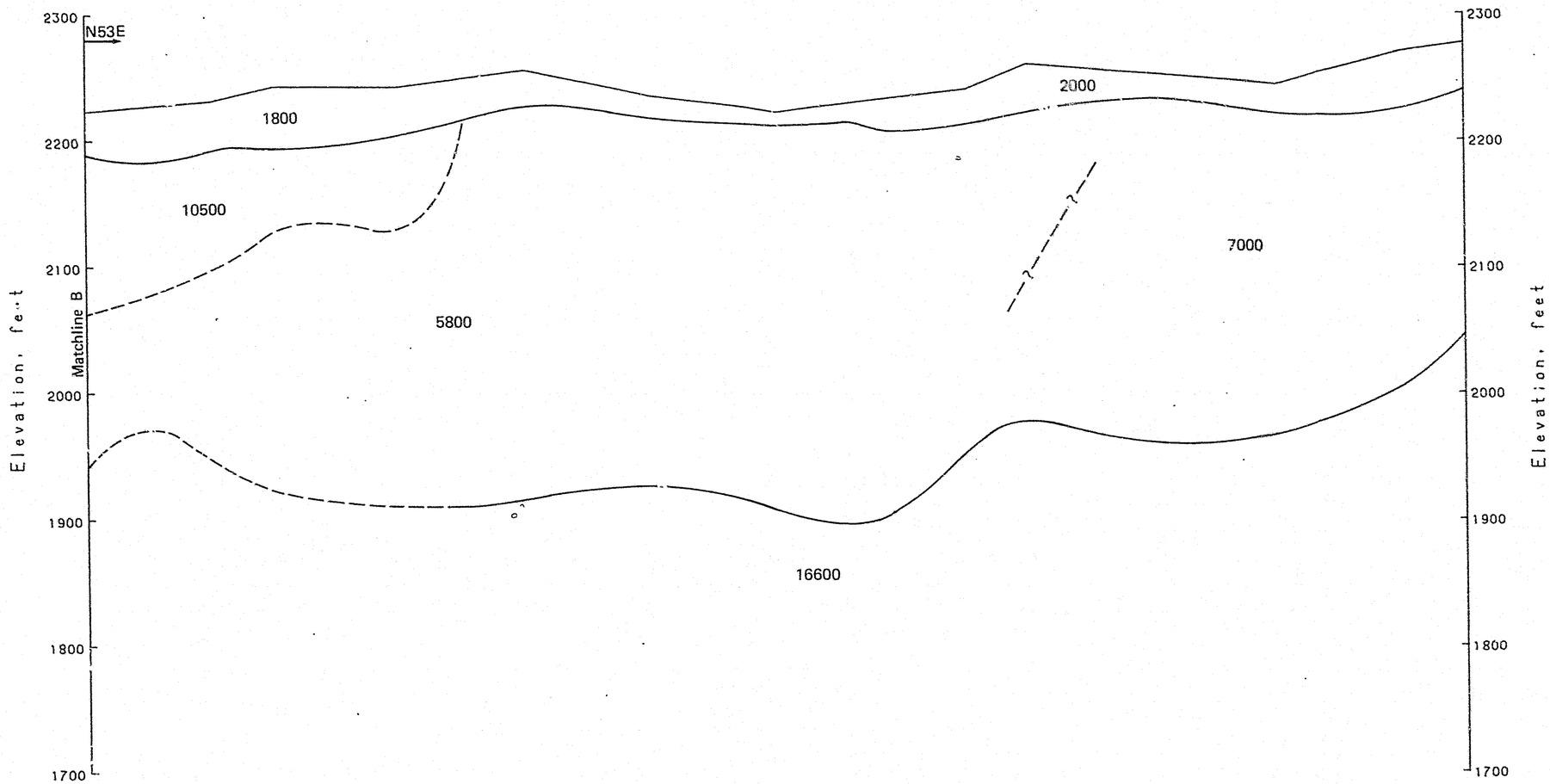
PREPARED BY WOODWARD-CLYDE CONSULTANTS



SEISMIC REFRACTION PROFILE
LINE SL82-18 (2 of 3)

FIGURE 19

PREPARED BY WOODWARD-CLYDE CONSULTANTS



Compressional velocities in feet per second

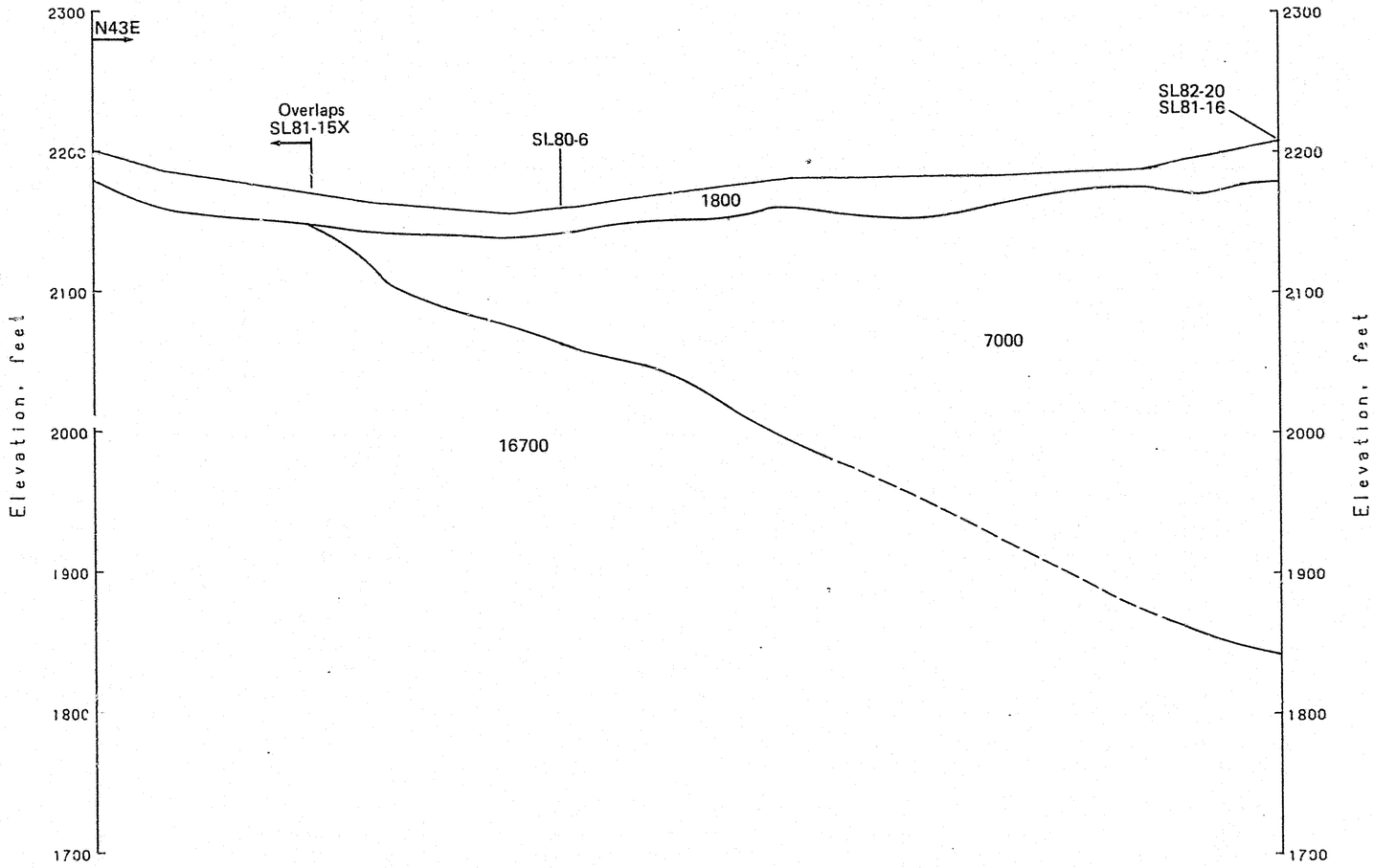
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-18 (3 of 3)

FIGURE 20

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS



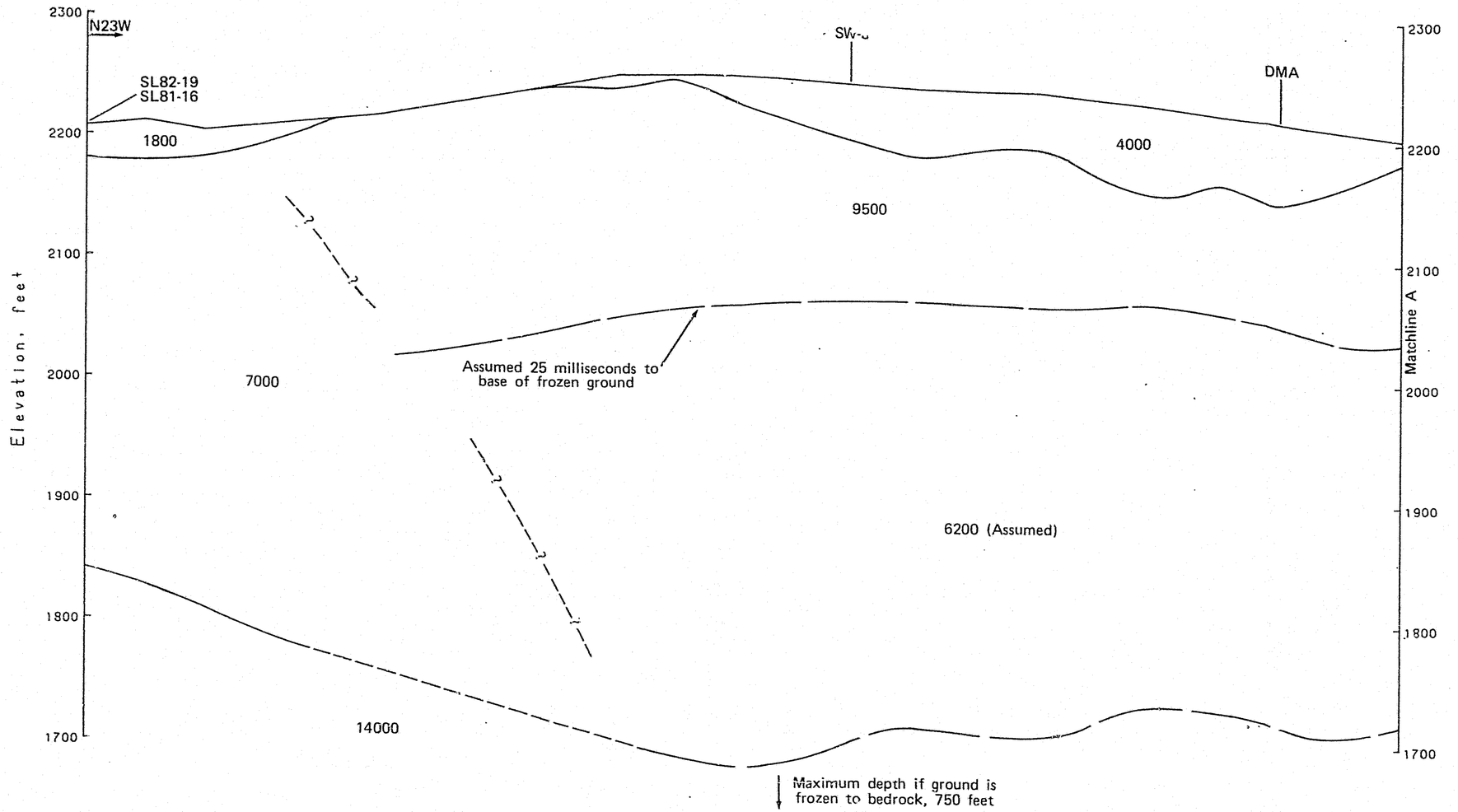
Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-19

FIGURE 21

PREPARED BY WOODWARD-CLYDE CONSULTANTS



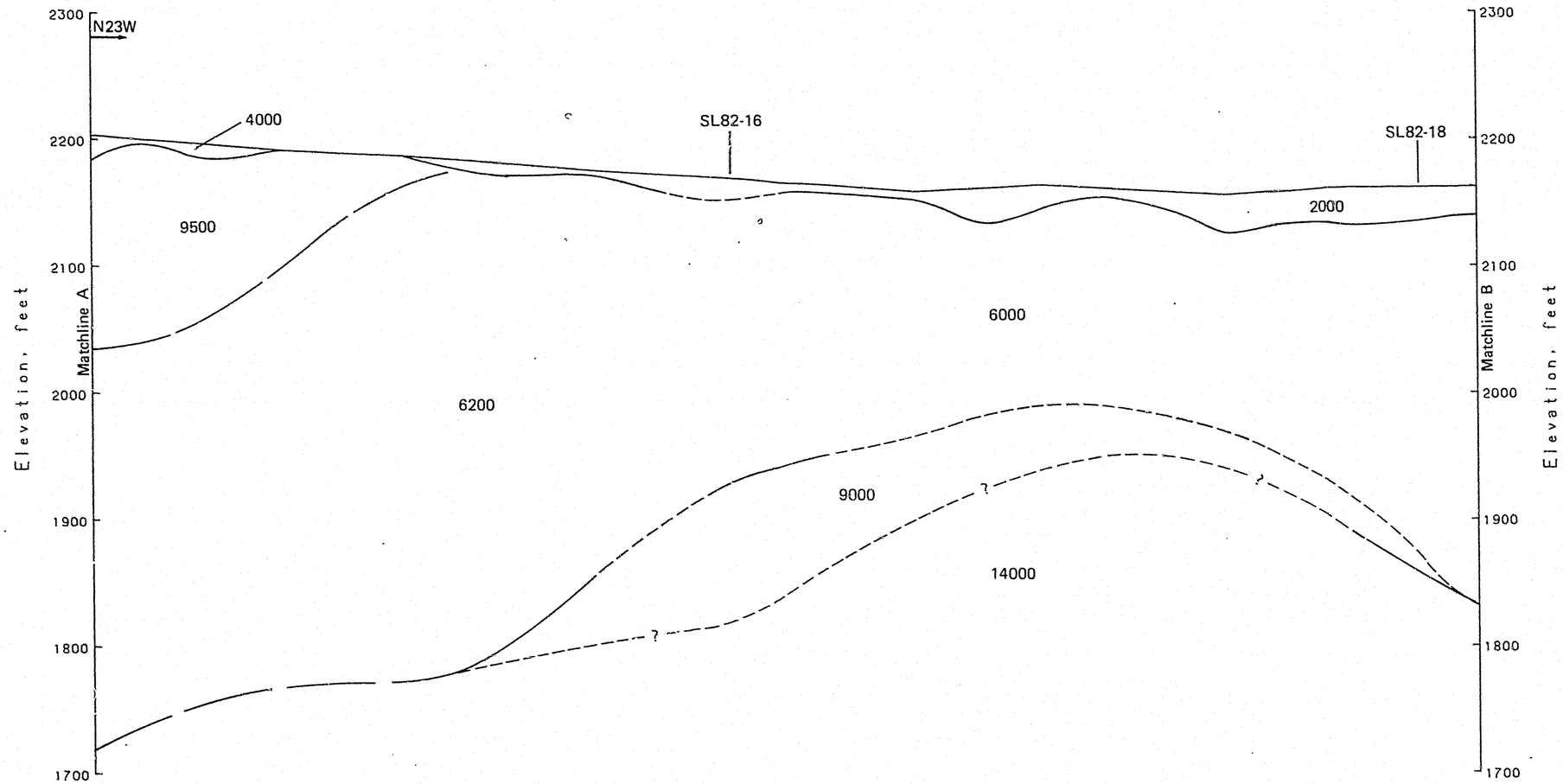
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-20 (1 of 3)

FIGURE 22

PREPARED BY WOODWARD-CLYDE CONSULTANTS



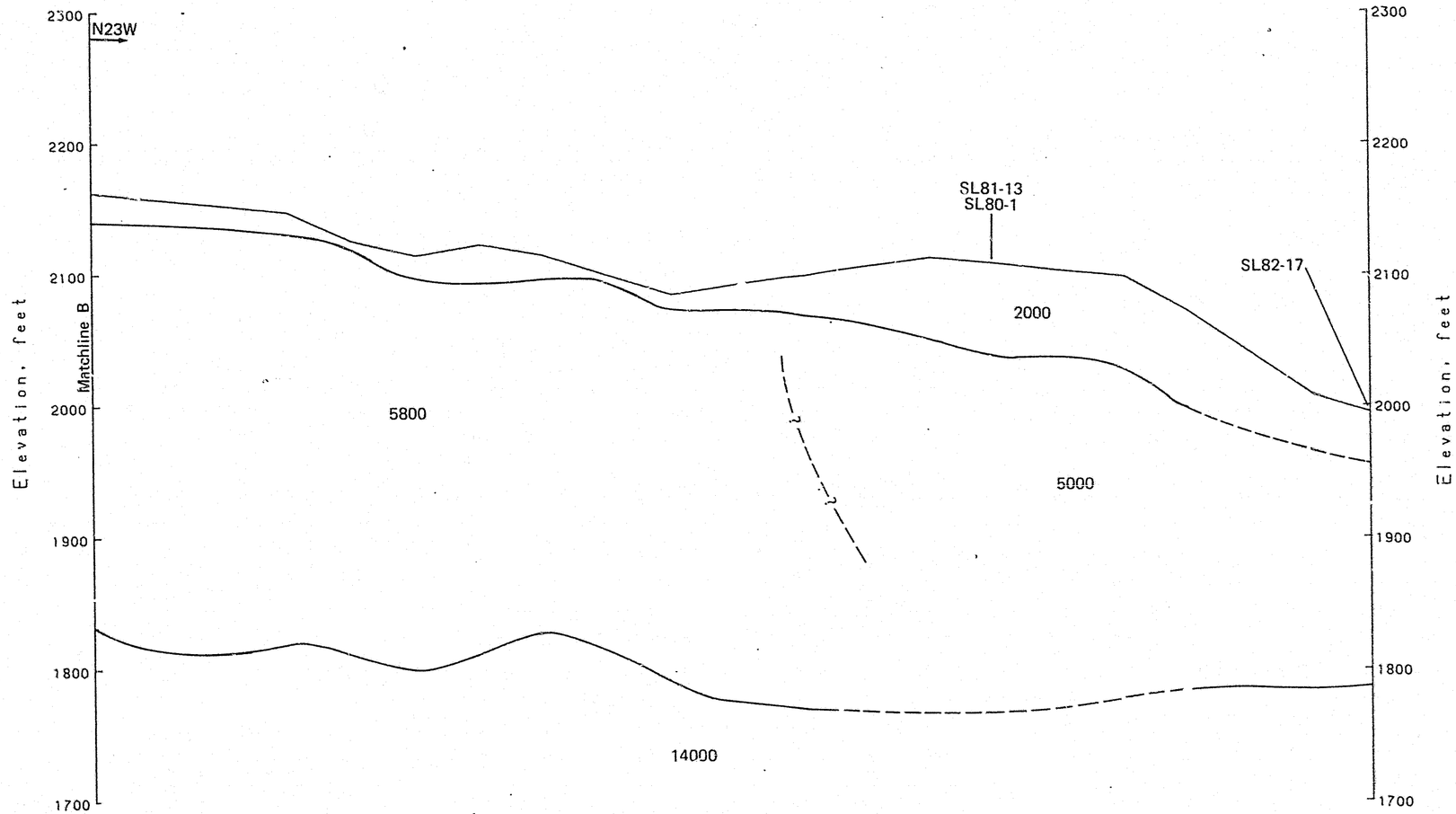
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-20 (2 of 3)

FIGURE 23

PREPARED BY WOODWARD-CLYDE CONSULTANTS



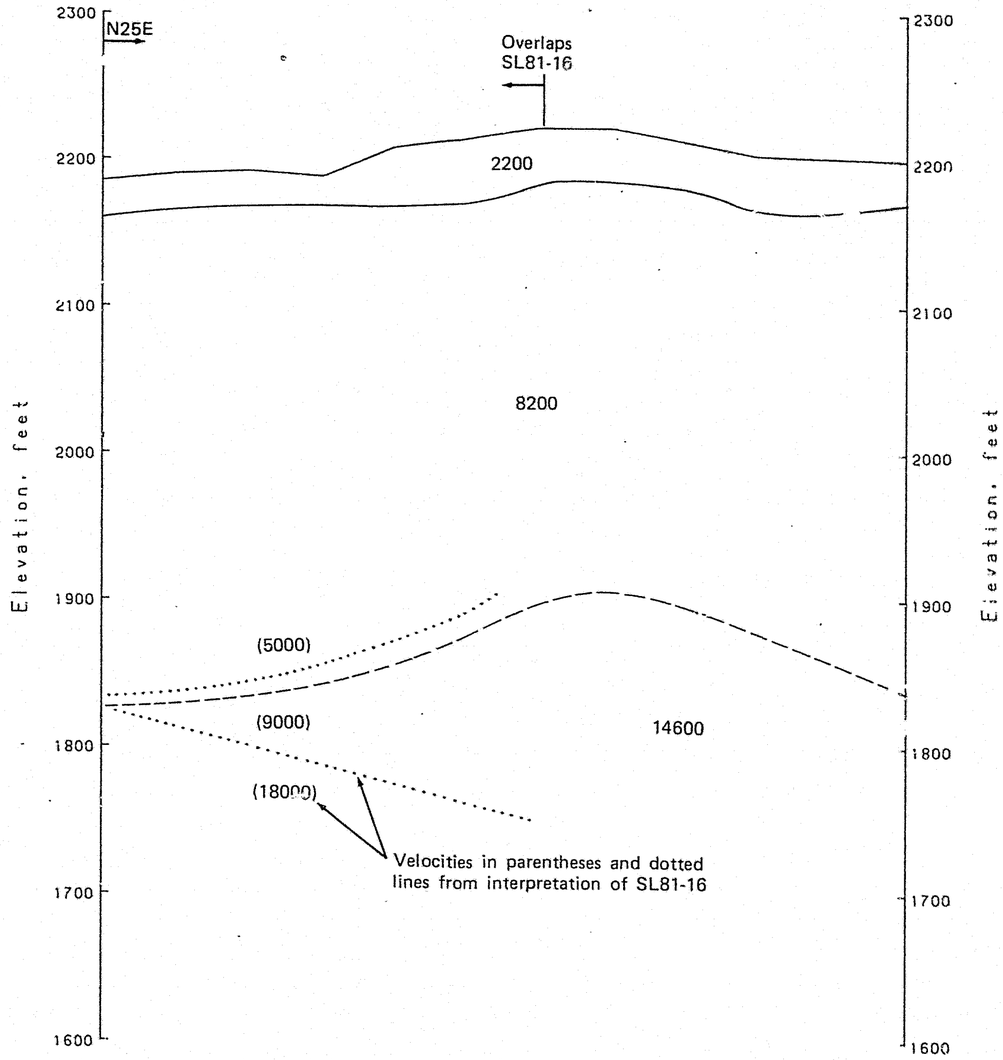
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-20 (3 of 3)

FIGURE 24

PREPARED BY WOODWARD-CLYDE CONSULTANTS



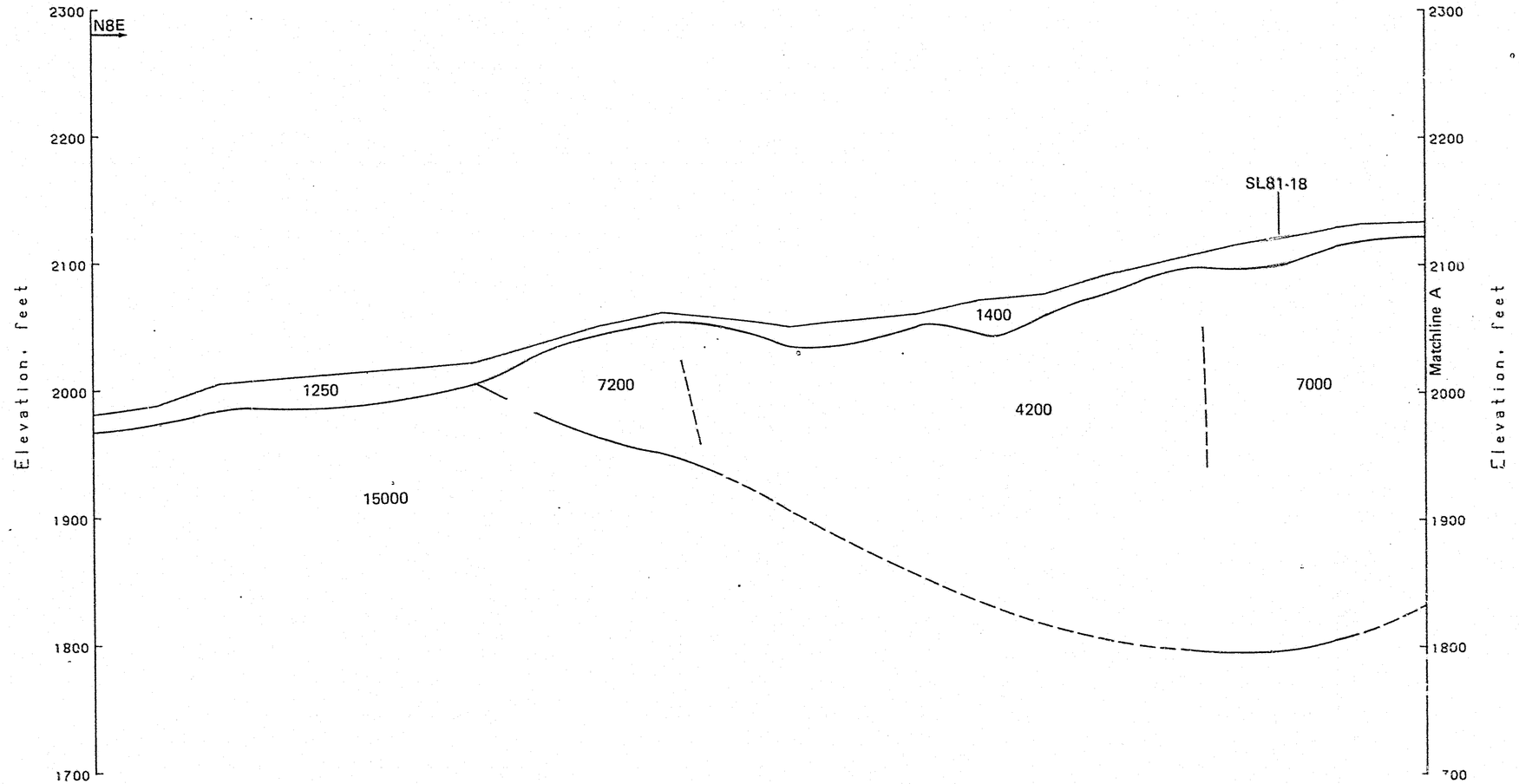
SEISMIC REFRACTION PROFILE
LINE SL82-21

Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

FIGURE 25

PREPARED BY WOODWARD-CLYDE CONSULTANTS



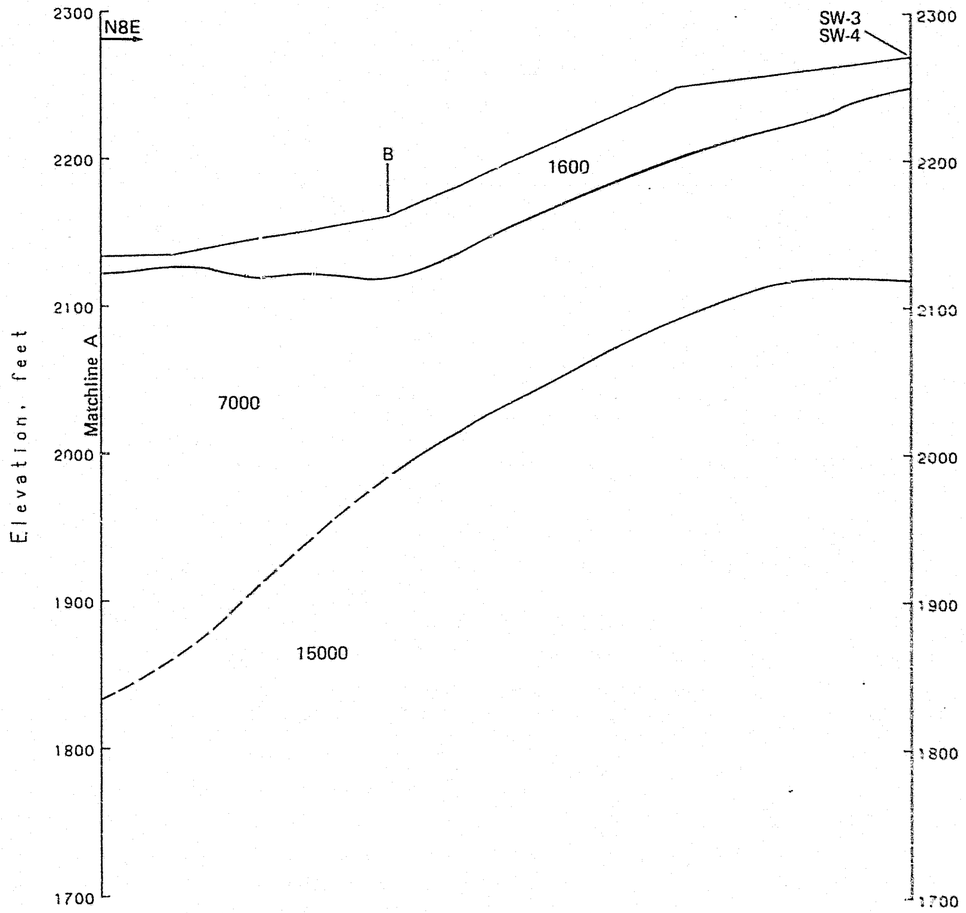
Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-22 (1 of 2)

FIGURE 26

PREPARED BY WOODWARD-CLYDE CONSULTANTS



Compressional velocities in feet per second

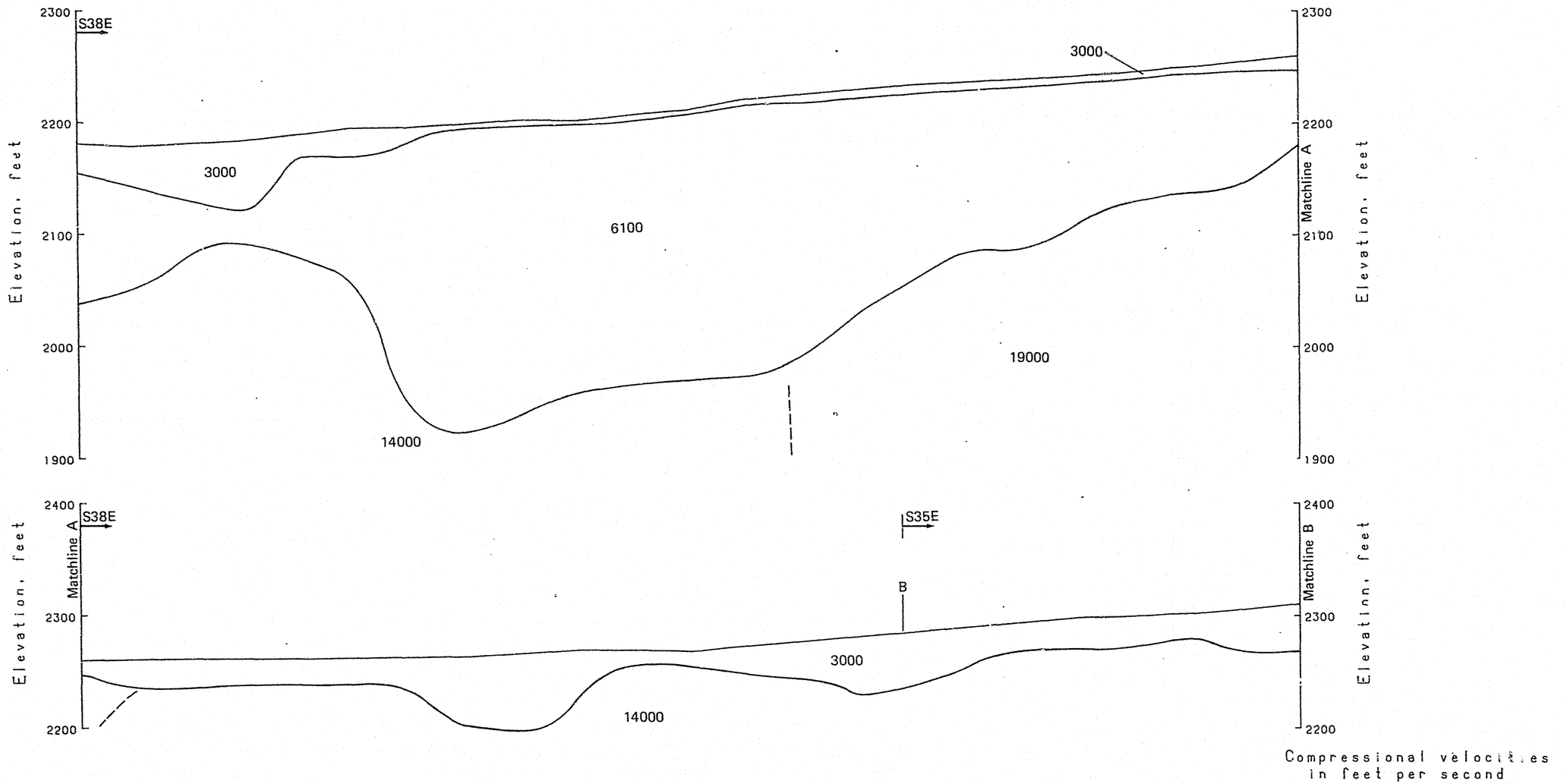
0 100 200
HORIZONTAL SCALE FEET

SEISMIC REFRACTION PROFILE
LINE SL-22 (2 of 2)

FIGURE 27

ACRES

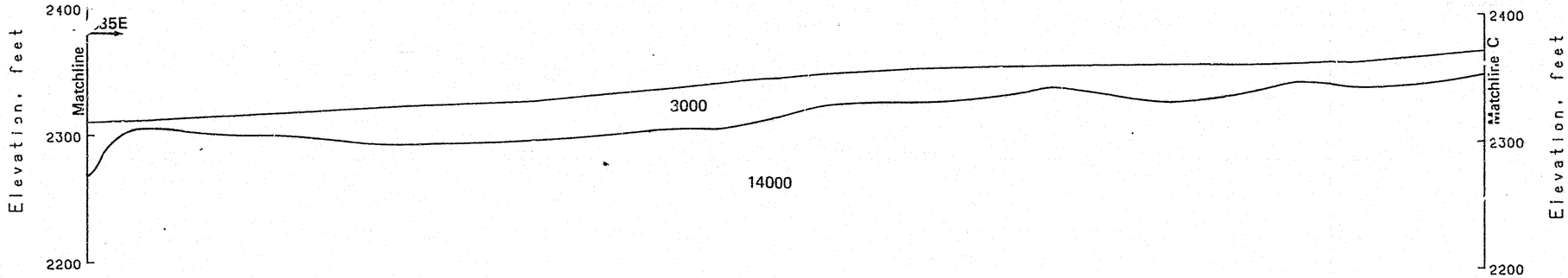
PREPARED BY WOODWARD-CLYDE CONSULTANTS

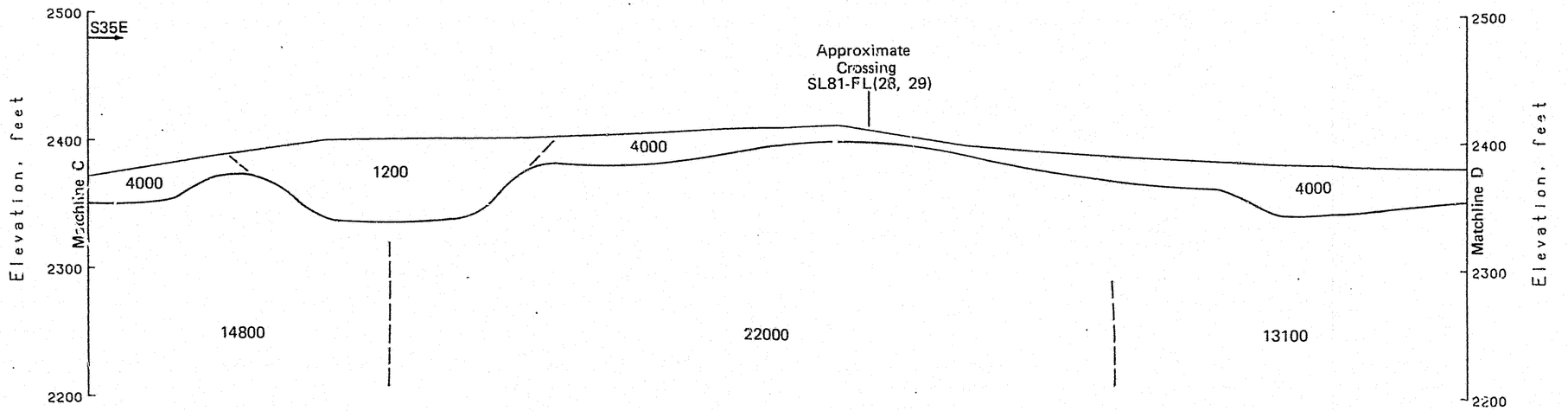


SEISMIC REFRACTION PROFILES
LINE SL82-FL1 (1 of 8)

FIGURE 28

PREPARED BY WOODWARD-CLYDE CONSULTANTS





Compressional velocities in feet per second

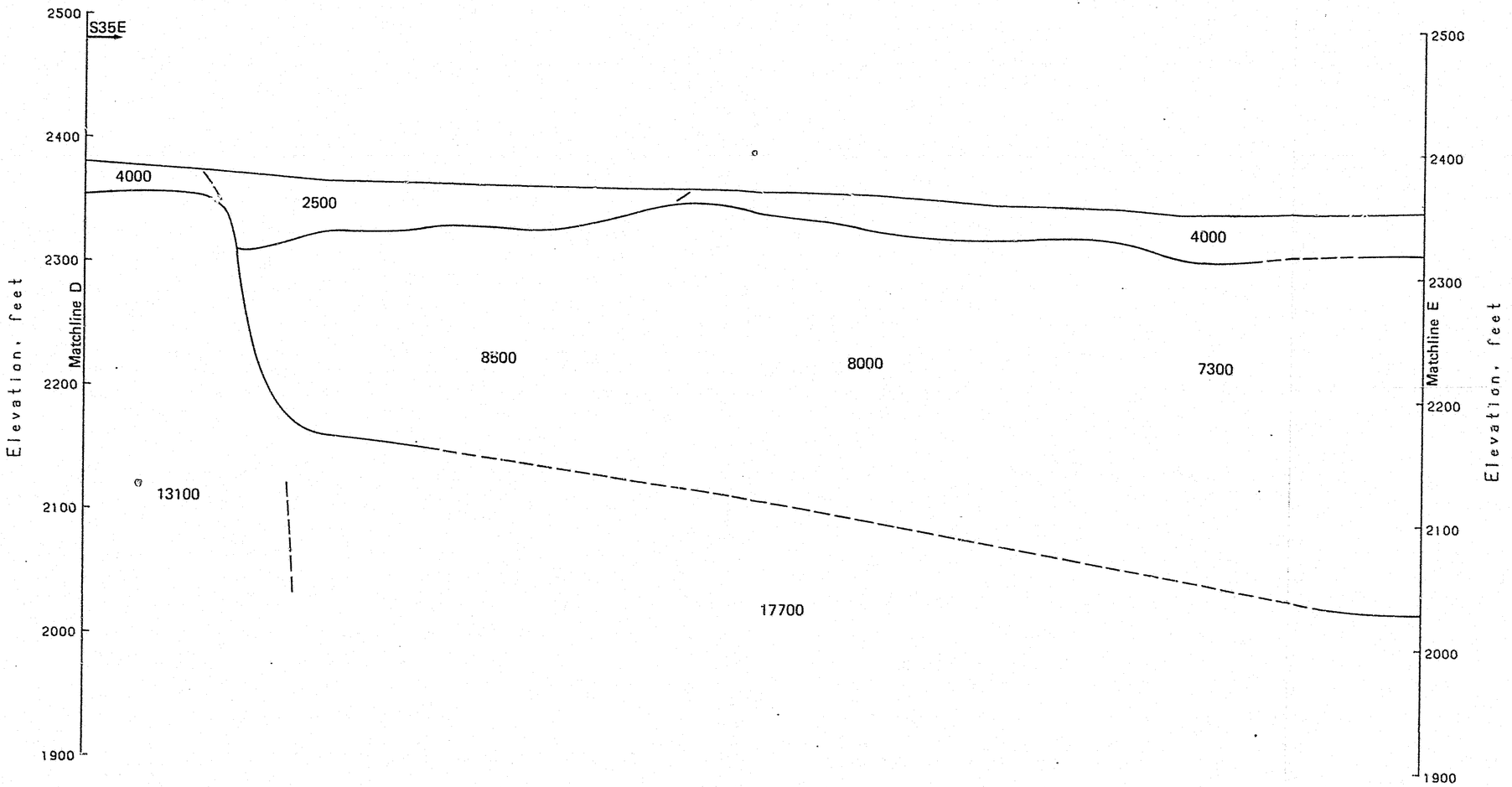
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-FL1 (2 of 8)

FIGURE 29

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS

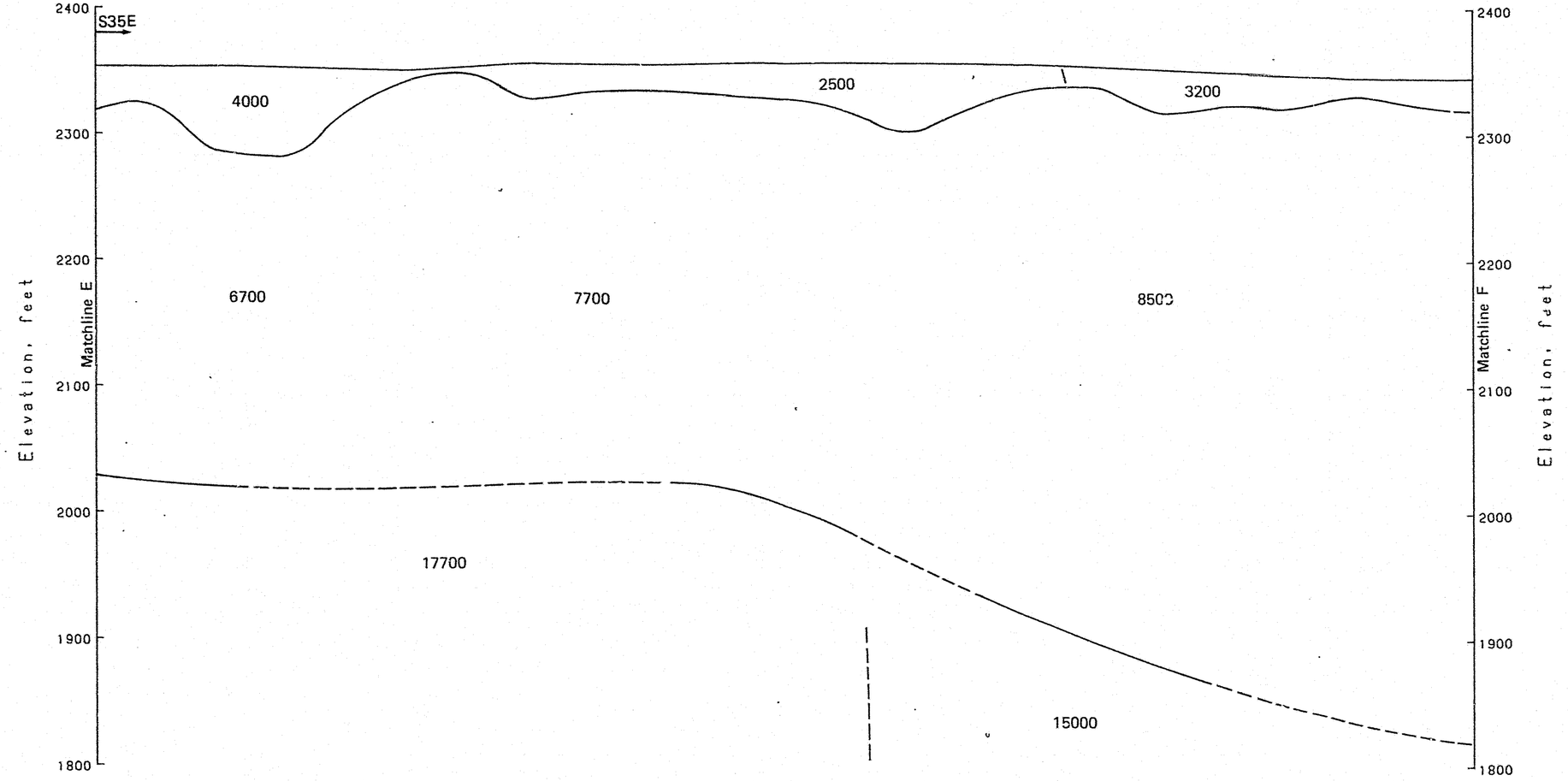


SEISMIC REFRACTION PROFILE
LINE SL82-FL1 (3 of 8)

PREPARED BY WOODWARD-CLYDE CONSULTANTS

FIGURE 30

ACRES



Compressional velocities in feet per second

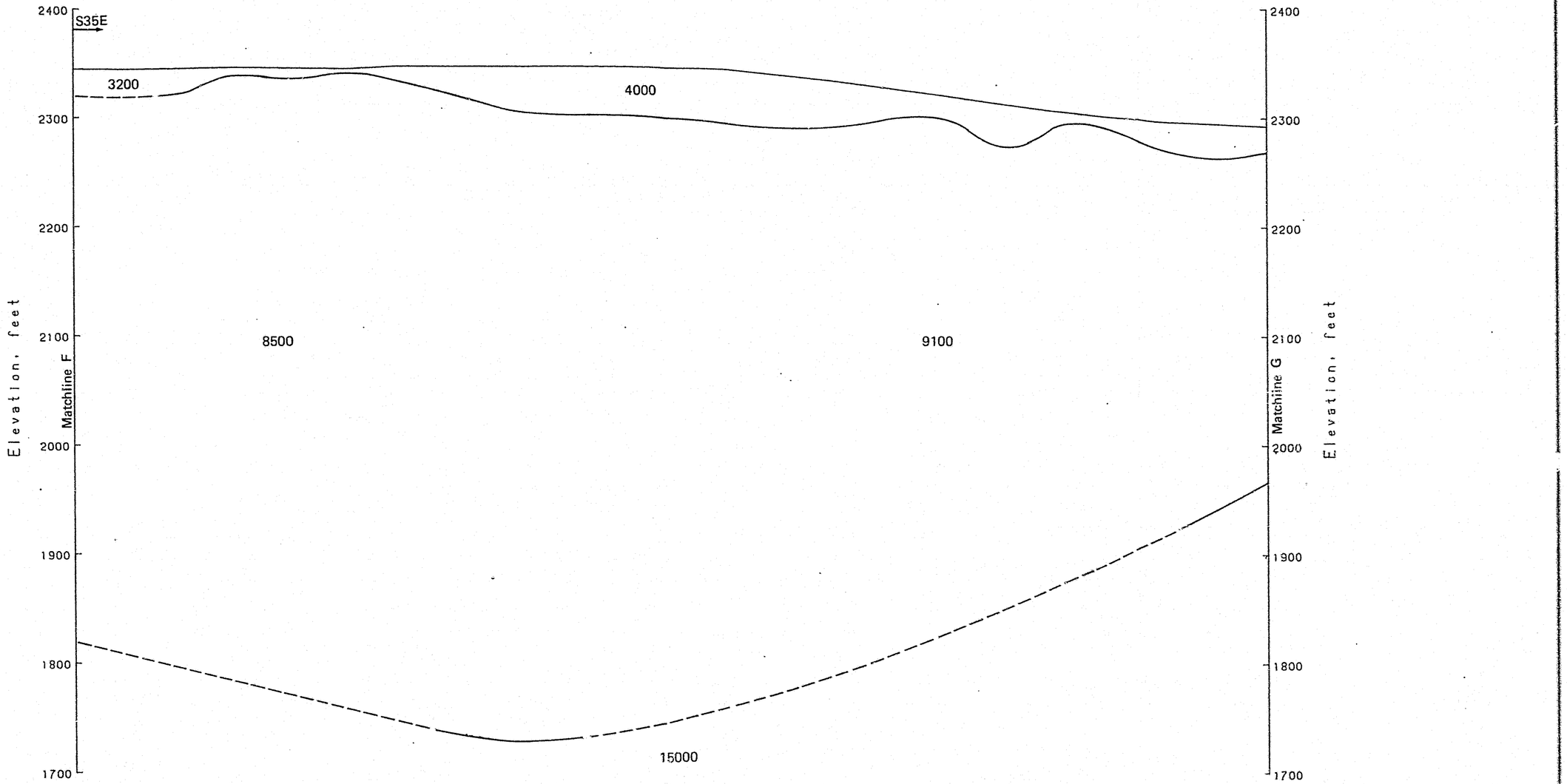
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL1 (4 of 8)

FIGURE 31

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS



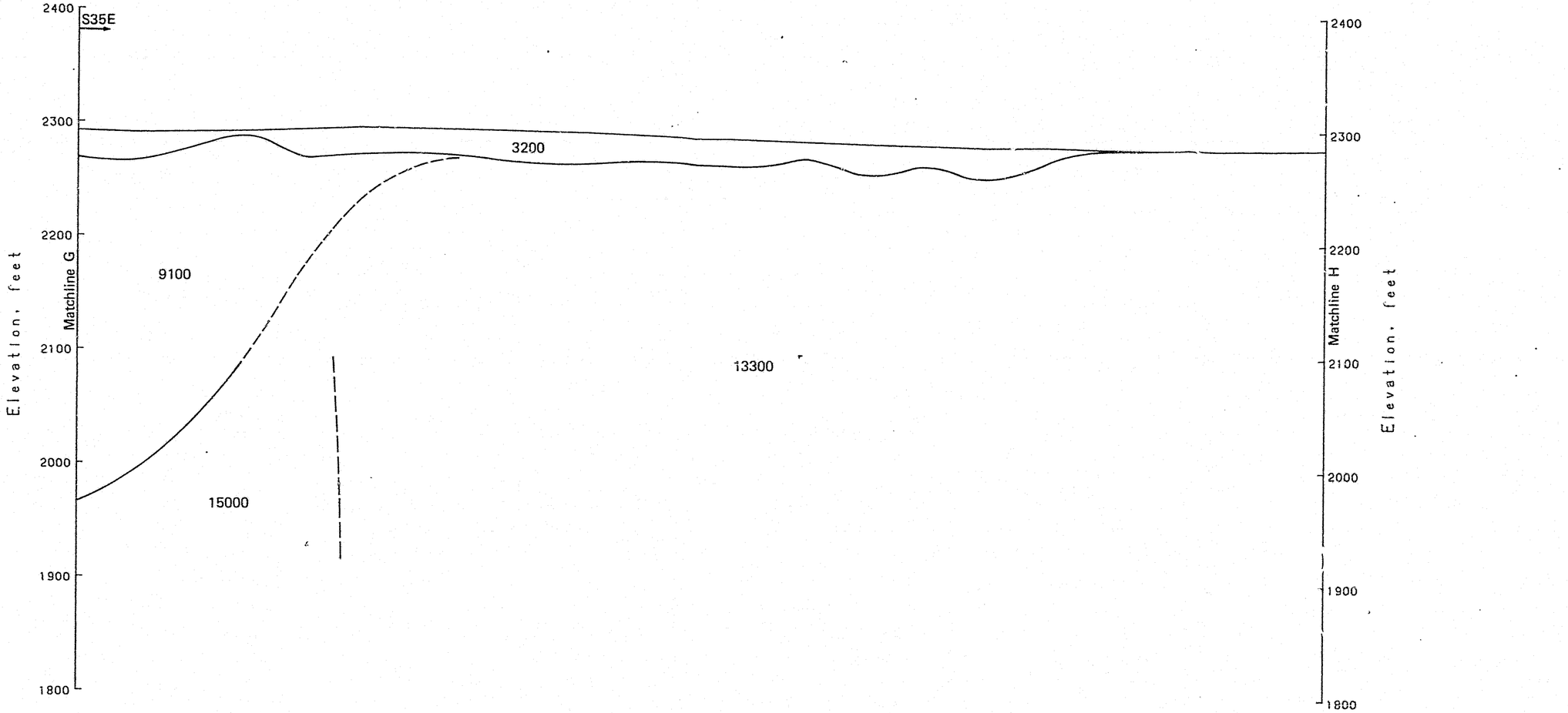
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL1 (5 of 8)

FIGURE 32

PREPARED BY WOODWARD-CLYDE CONSULTANTS



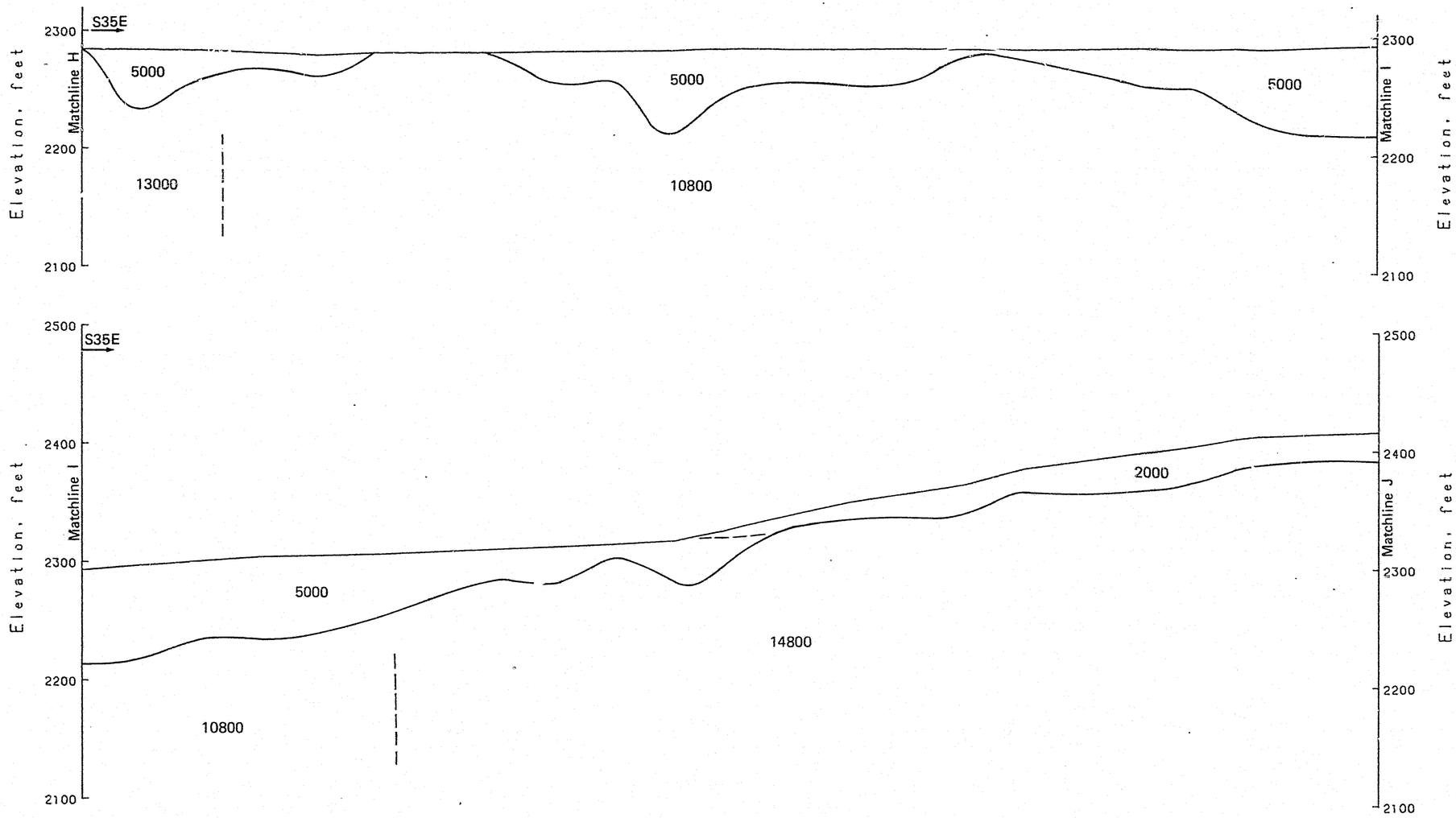
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL1 (6 of 8)

FIGURE 33

PREPARED BY WOODWARD-CLYDE CONSULTANTS



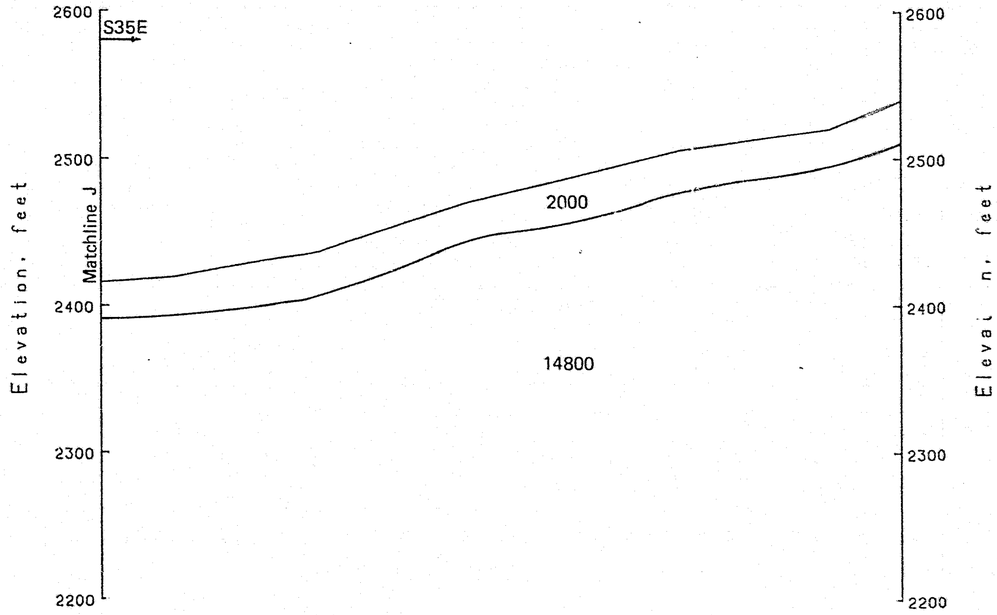
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-FL1 (7 of 8)

FIGURE 34

PREPARED BY WOODWARD-CLYDE CONSULTANTS



Compressional velocities in feet per second

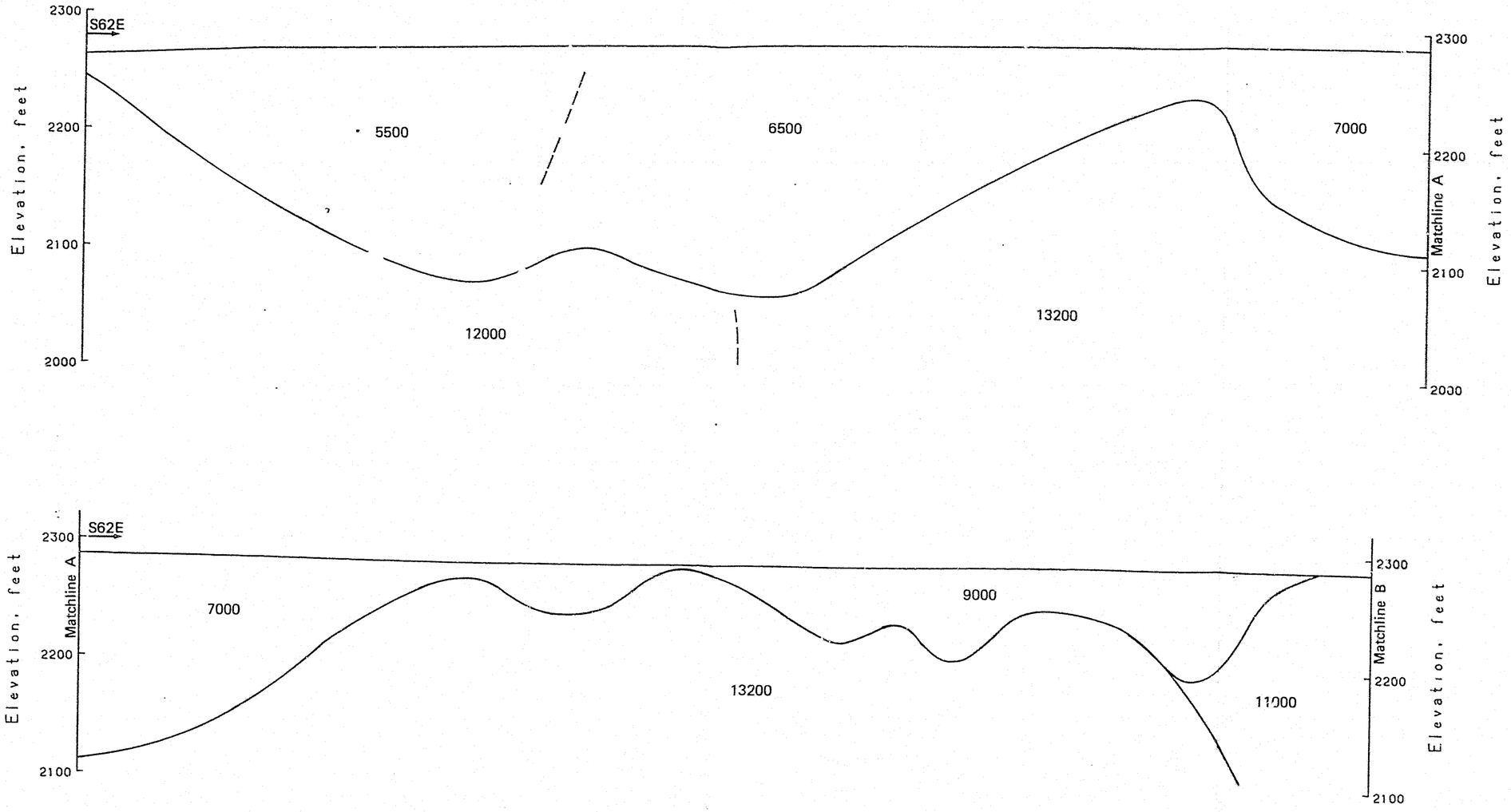
0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL1 (8 of 8)

FIGURE 35

ACRES

PREPARED BY WOODWARD-CLYDE CONSULTANTS

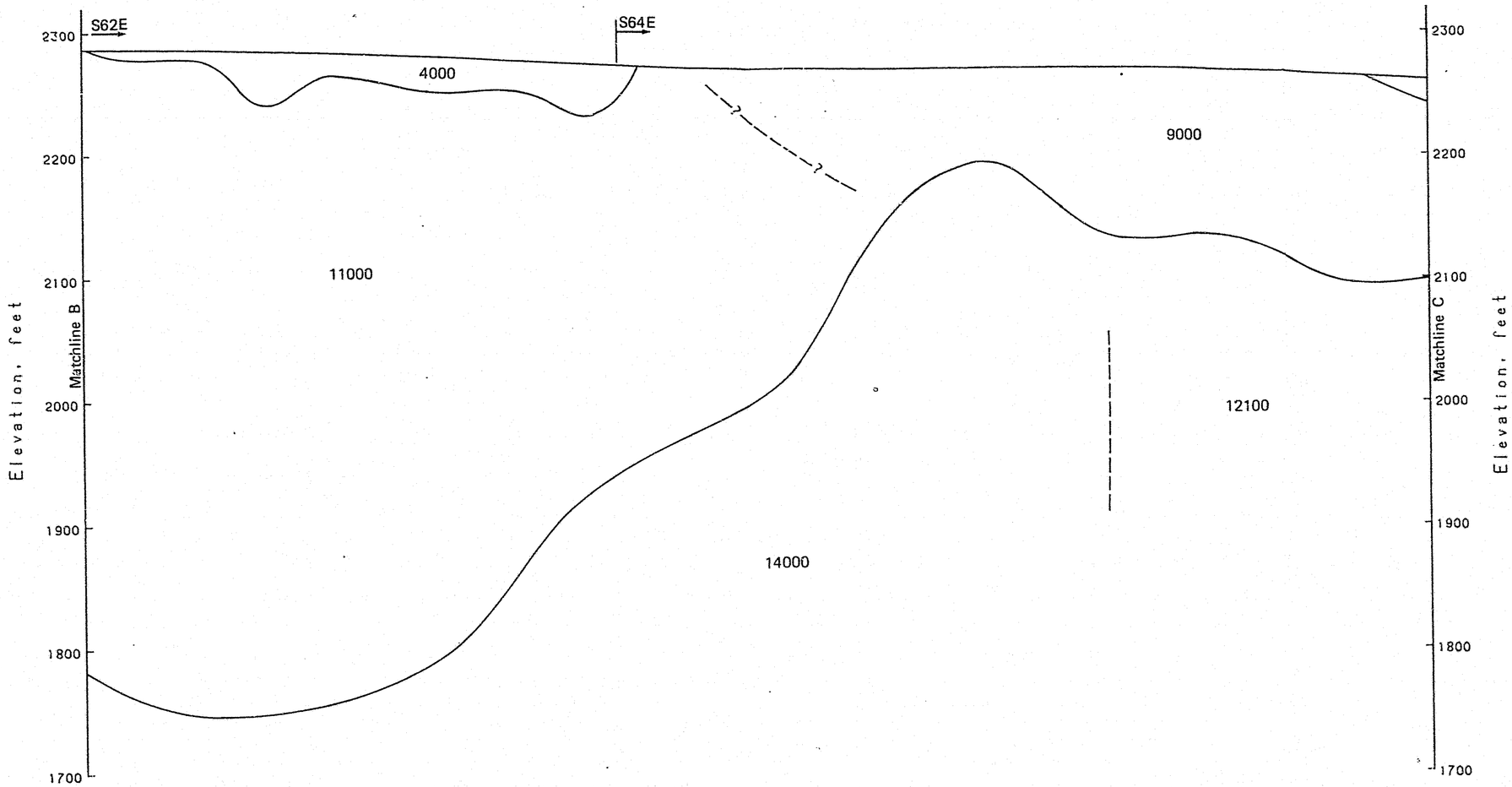


SEISMIC REFRACTION PROFILES
LINE SL82-FL2 (1 of 4)

PREPARED BY WOODWARD-CLYDE CONSULTANTS

FIGURE 36

ACRES



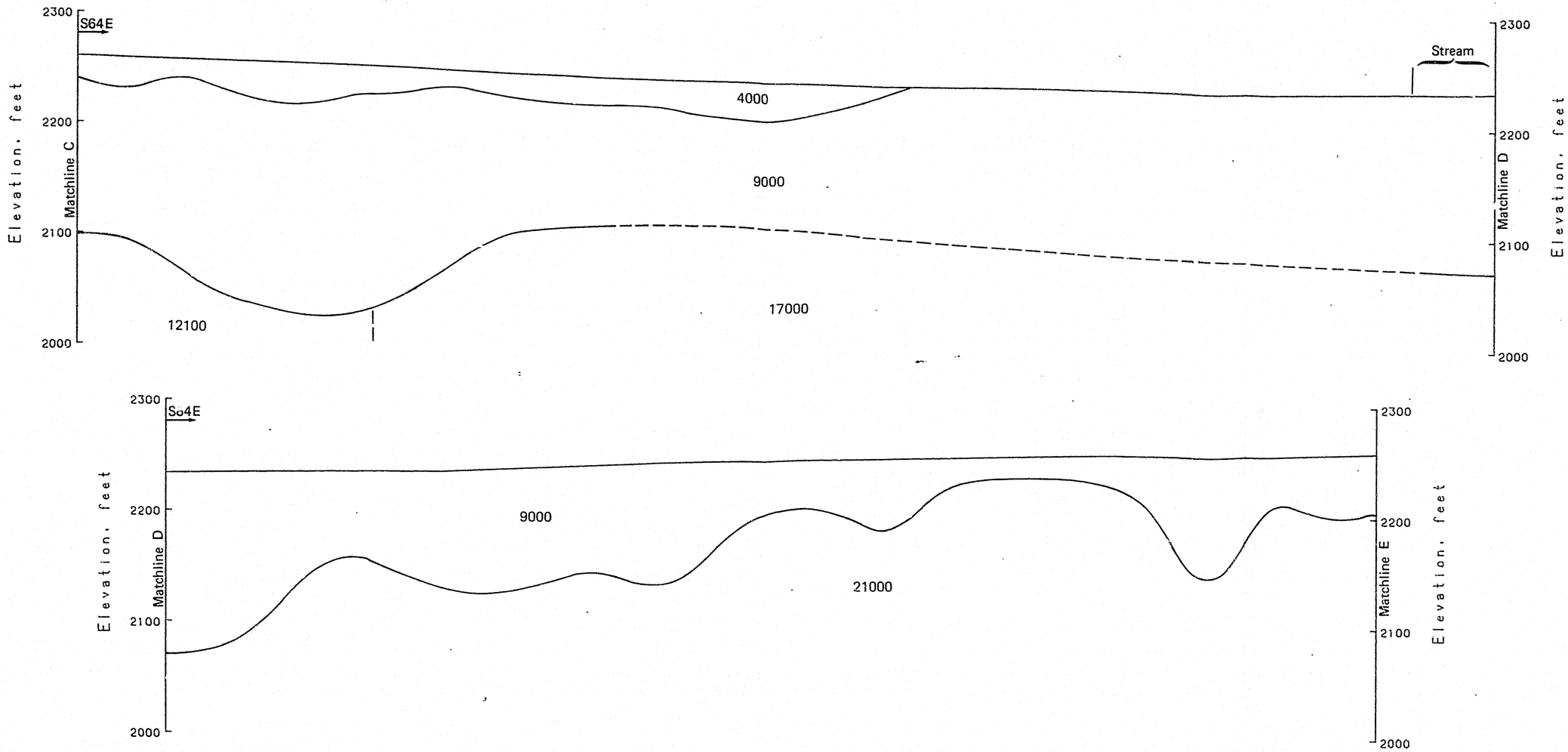
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL2 (2 of 4)

FIGURE 37

PREPARED BY WOODWARD-CLYDE CONSULTANTS



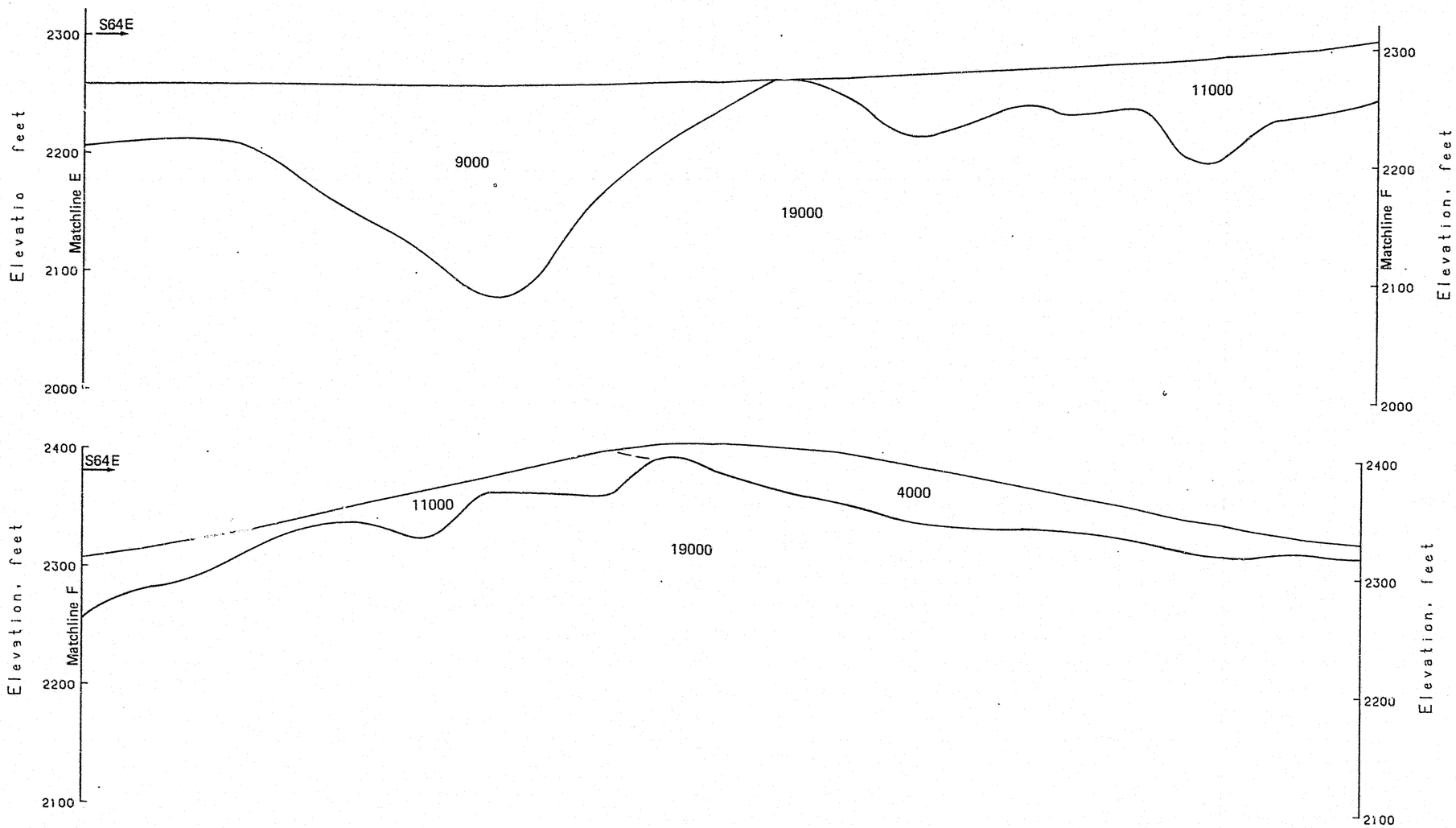
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-FL2 (3 of 4)

FIGURE 38

PREPARED BY WOODWARD-CLYDE CONSULTANTS



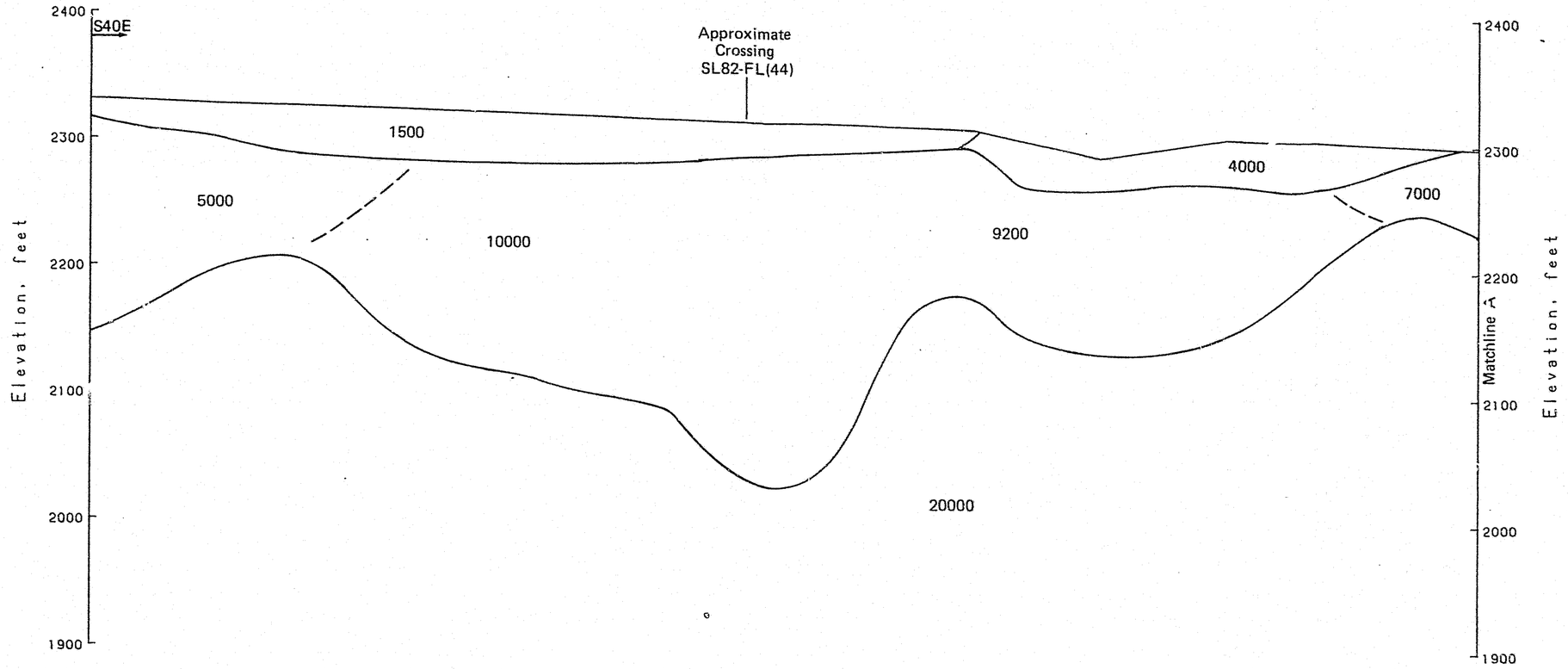
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILES
LINE SL82-FL2 (4 of 4)

FIGURE 39

PREPARED BY WOODWARD-CLYDE CONSULTANTS



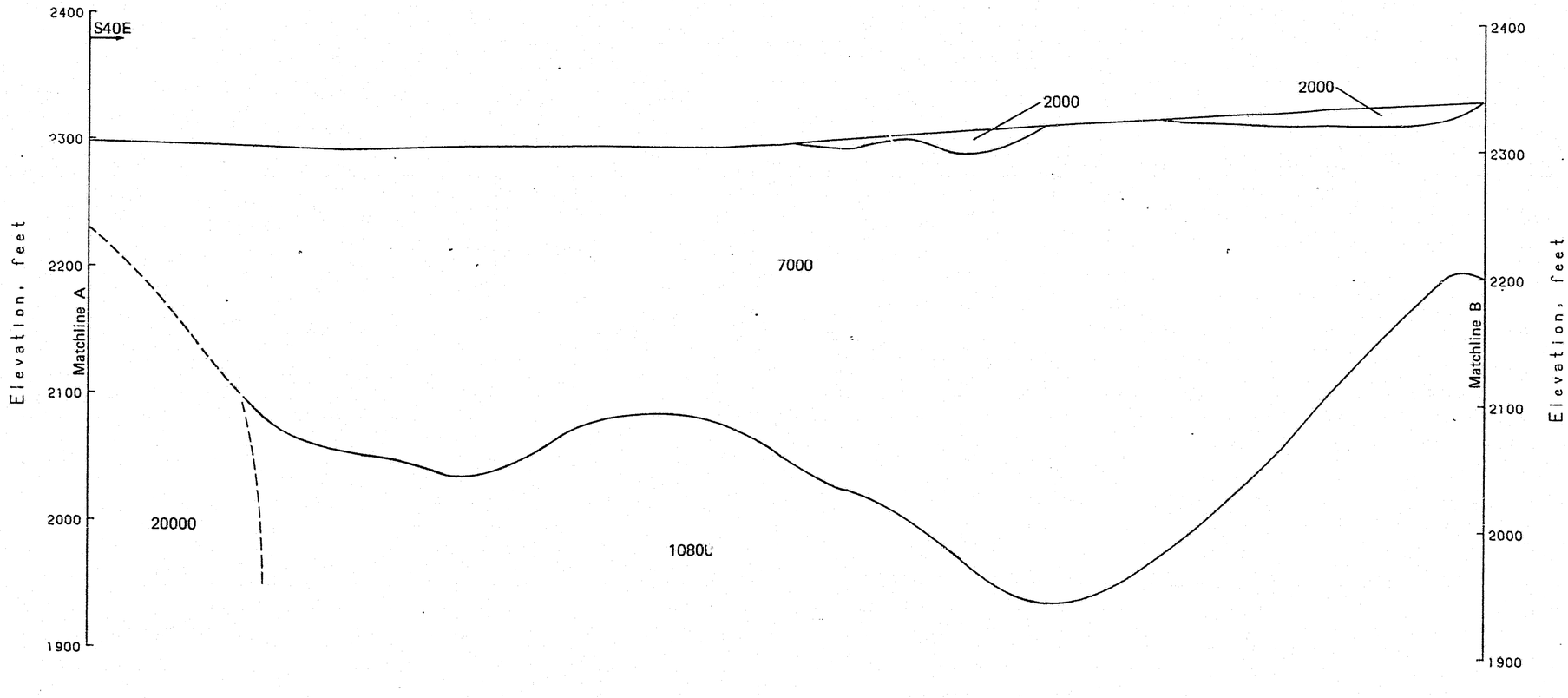
Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL3 (1 of 3)

FIGURE 40

PREPARED BY WOODWARD-CLYDE CONSULTANTS



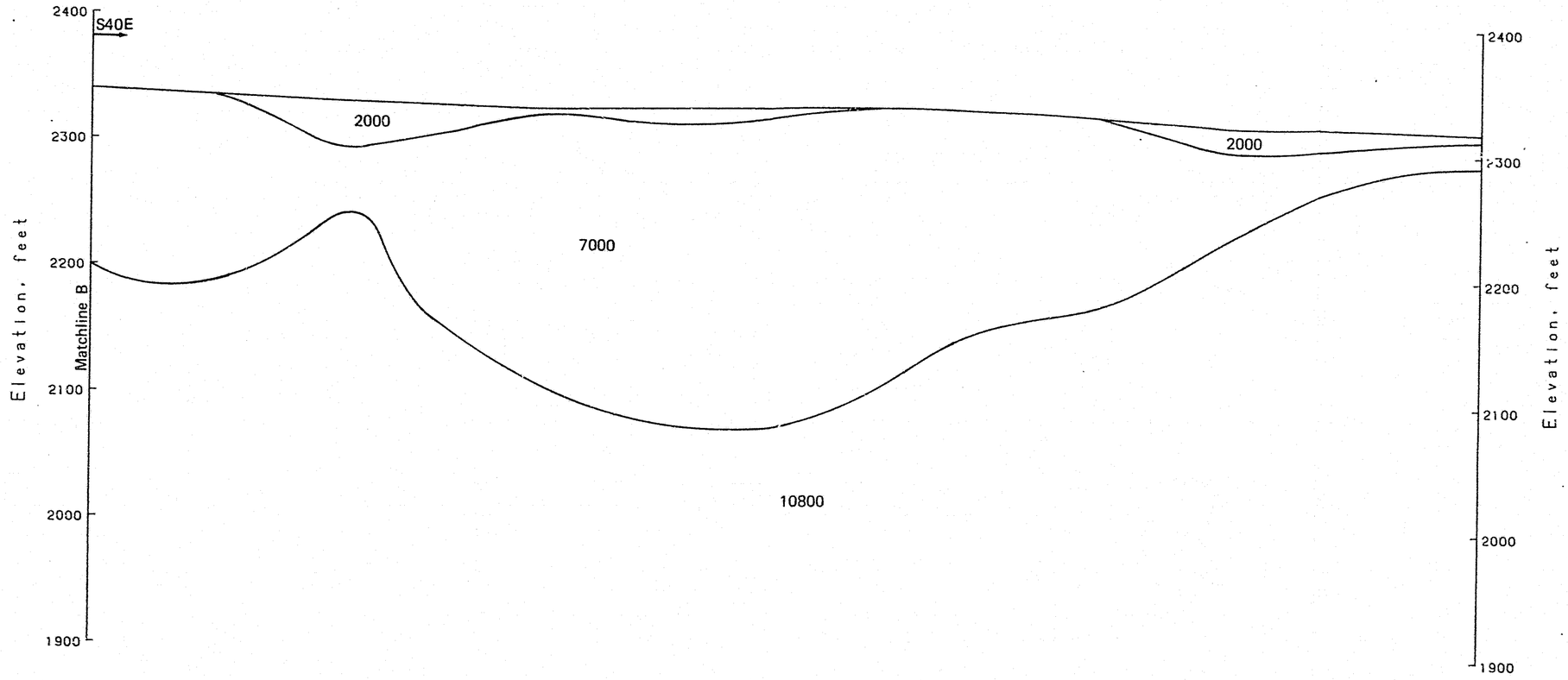
Compressional velocities in feet per second

0 100 200
HORIZONTAL SCALE IN FEET

SEISMIC REFRACTION PROFILE
LINE SL82-FL3 (2 of 3)

FIGURE 41

PREPARED BY WOODWARD-CLYDE CONSULTANTS



SEISMIC REFRACTION PROFILE
LINE SL82-FL3 (3 of 3)

Compressional velocities
in feet per second

0 100 200
HORIZONTAL SCALE
IN FEET

PREPARED BY WOODWARD-CLYDE CONSULTANTS

FIGURE 42

ACRES