

APR 20 1984
ALASKA RESOURCES LIBRARY
U.S. DEPT. OF THE INTERIOR



1K
1425
.58
A23
no. 37E

SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
WINTER 1983 GEOTECHNICAL EXPLORATION PROGRAM

VOLUME 2

APPENDICES

Prepared for the

ALASKA POWER AUTHORITY

BY

HARZA-EBASCO Susitna Joint Venture

September 1983

ARLIS
Alaska Resources
Library & Information Services
Anchorage, Alaska

VOLUME 2 APPENDICES

TABLE OF CONTENTS

<u>TITLE/SECTION</u>	<u>PAGE</u>
<u>APPENDIX A</u>	
GEOPHYSICAL EXPLORATION	A-1
1. GROUND PENETRATING RADAR (GPR).	A-2
1.1 Data Acquisition	A-2
1.2 Conclusions.	A-3
2. SEISMIC REFRACTION	A-3
2.1 Data Acquisition	A-3
2.2 Data Reduction and Analysis	A-4
2.3 Interpretation	A-5
2.4 Conclusions	A-5
2.4.1 Downstream Cofferdam Foundation	A-6
2.4.2 Centerline and Upstream Foundation Area	A-7
2.4.3 Upstream Cofferdam Foundation	A-8
3. BOREHOLE GAMMA LOGGING	A-8
3.1 Data Acquisition	A-8
3.2 Analysis and Interpretation	A-8
3.3 Conclusions	A-9
REFERENCES	A-10
4. TABLES	
Seismic Refraction Survey - River Channel Tables A-1 through A-11	
5. FIGURES	
Location Map	A-1
Ground Penetrating - Radar Profiles	A-2
Seismic Profiles	A-3 through A-12
Gamma Logs	A-13 through A-43

VOLUME 2 APPENDICES
TABLE OF CONTENTS

<u>TITLE/SECTION</u>	<u>PAGE</u>
<u>APPENDIX D</u>	
LABORATORY TESTING	D-1
1. PROCEDURES	D-1
1.1 Sample and Control Processing	D-1
1.2 Particle Size Analyses	D-2
1.3 Atterberg Limits (Liquid and Plastic Limits). .	D-2
1.4 Moisture Content	D-3
1.5 Organic Content	D-3
1.6 Specific Gravity	D-4
1.7 Compaction Tests	D-4
1.8 Visual Classification	D-4

TABLES

2. LAB TEST SUMMARIES
2.1 River Channel
2.2 Relict Channel
3. GRADATION CURVES
3.1 River Channel
Main Dam
Upstream Cofferdam
Downstream Cofferdam
Portals
3.2 Relict Channel

APPENDIX A — GEOPHYSICAL EXPLORATION

1. GROUND PENETRATION RADAR — RIVER CHANNEL
 - 1.1 Data Acquisition
 - 1.2 Conclusions
2. SEISMIC REFRACTION SURVEY — RIVER CHANNEL
 - 2.1 Data Acquisition
 - 2.2 Data Reduction and Analysis
 - 2.3 Interpretation
 - 2.4 Conclusions
 - 2.4.1 Downstream Cofferdam Foundation
 - 2.4.2 Centerline and Upstream Dam Foundation Area
 - 2.4.3 Upstream Cofferdam Foundation
3. BOREHOLE GAMMA LOG — RIVER CHANNEL AND RELICT CHANNEL
 - 3.1 Data Acquisition
 - 3.2 Analysis and Interpretation
 - 3.3 Conclusions
4. TABLES
5. FIGURES

APPENDIX A

GEOPHYSICAL EXPLORATION

The purpose of the winter geophysical program in the river channel at the Watana damsite was to provide overburden and bedrock foundation information in the area between the upstream and downstream cofferdams. The data obtained from this program will be used for rapid determination of subsurface conditions, correlation between borings, and to determine general stratigraphy at greater depths than those penetrated by borings in the river channel and in the relict channel area. Ground penetrating radar (GPR), seismic refraction, and borehole gamma logging methods were employed. The radar and seismic refraction surveys were run by a four-man field crew under the direction of a Harza-Ebasco geophysicist. Two members of the team and the equipment and instruments were provided by Harding Lawson & Associates. The borehole logging was done by a Harza-Ebasco geophysicist.

The ground penetrating radar was used as a rapid reconnaissance tool to delineate shallow overburden depths to bedrock in the river channel, thereby allowing the seismic refraction and drilling programs to be used where they would be most effective. GPR was also used to determine ice thicknesses and river channel profiles to aid in the safe movement of men and equipment over the frozen river surface.

The purposes of the seismic refraction was to provide seismic sections delineating overall depth to bedrock in the river channel.

Borehole gamma logs were run in all open boreholes to assist in hole-to-hole correlations. The ultimate goal of the geophysical program was to provide a better understanding of subsurface conditions above bedrock.

1. GROUND PENETRATING RADAR (GPR) - RIVER CHANNEL

1.1 Data Acquisition

The GPR survey was performed with a Geophysical Survey Systems, Incorporated (GSSI), SIR-7 radar system. The system consists of a power supply, control unit, EPC graphic display recorder, and two transmitting/receiving antennas. All instrumentation was mounted in a Nodwell FN-20 flatbed snow vehicle and the antenna was towed behind. Two antennas were used for this survey: one with a central frequency of 120 MHZ and the other of 300 MHZ.

The GSSI system uses radar technology to obtain a continuous high resolution electromagnetic profile of the subsurface. The depth of penetration is dependent upon the electrical properties of the subsurface materials and the frequency of the radar antenna employed, and may penetrate several tens of feet. The penetration depth was limited to approximately 15 feet for this survey.

Figure A-1 shows the locations of the fourteen radar profiles obtained between January 23, and January 26, 1983. The profiles total 8486 lineal feet of coverage. The profiles that cross the river at the upstream and downstream cofferdams and at the dam centerline were located by utilizing, on the ground, general topography. Profiles at other locations were positioned by taking bearings with a Brunton compass and making use of the survey reference marks available along with the

general topography. Measurements along each line were made with either a tape measure or hip chain.

For this survey, dielectric constants of 30 for saturated material and 81 for water were assumed in order to produce the profiles presented in Figure A-Z.

1.2 Conclusions

The primary objective of the radar survey was to locate local areas in the channel where overburden is very shallow (less than 15 feet below the surface).

Since the bedrock surface was in most instances greater than 15 feet the radar survey was primarily utilized to ascertain ice thickness and river bottom profile information. These data were used in constructing a topographic map of the surface of the river alluvium. The radar data was also used by the ice building and survey crews to check ice conditions in questionable areas of the river channel prior to moving equipment over the ice. The information was thus utilized in planning the routes to be taken by the hammer drill rig during its river channel operation.

2. SEISMIC REFRACTION - RIVER CHANNEL

2.1 Data Acquisition

The seismic refraction survey was conducted with a Geometrics ES-1210 12-channel signal enhancement seismograph and 4 hertz Mark Products vertical geophones. The energy source was Kinestik explosives; Atlas Staticmaster electric blasting caps were used to initiate the explosions.

Ten reversed refraction lines were run totalling 8785 lineal feet of geophone coverage as shown in Figure A-1. Each seismic line contained from one to three spreads of 12 geophones each with an interval of 50 feet between geophones. Shorter geophone spacings were used where necessary.

Generally, two shots were detonated at each end of each spread at distances of 10 to 25 feet and 200 to 600 feet from the end geophones. All geophones were placed either on grounded ice or floating river ice due to the seasonal conditions.

2.2 Data Reduction and Analysis

During the seismic surveying the presence of a high speed ice surficial layer acted to mask seismic arrivals from the slower velocity of the underlying alluvial deposits. It was anticipated that the bedrock velocity would be sufficiently faster than the ice so that it could be detected. This was the case with the first seismic arrival times from the ice preceding and obliterating the slower arrival times from the underlying river sand and gravel deposits, therefore, the seismic velocity of the saturated alluvium was never actually measured. However, the bedrock velocities were sufficiently faster than ice velocities so that with a long offset between the shot and geophone spread, seismic energy from the bedrock surface was detectable. Consequently, refraction profiles were run parallel or oblique to the river channel to take advantage of the long offset method.

Compressional wave (p-wave) arrival times were determined by observing the first break on each of the 12 horizontal wave traces recorded by the seismograph. These arrival times were then plotted against the horizontal distance from the shotpoint to the receiving geophones and grouped by apparent refractors. Standard velocity/intercept time

(Dobrin, 1976), velocity/delay time (Cummings, 1979; Hagedorn, 1959; Scott et al, 1972), and ray tracing (Scott et al, 1972) techniques were applied to these data to provide P-wave velocities and thicknesses for refractors.

2.3 Interpretation

Due to the surface ice layer, velocity data were not obtained for the saturated alluvium beneath the river bottom. In order to make depth calculations, it was assumed that the velocities for this material range between 6000 and 7000 fps velocities for the alluvium provided the best fit. In those exceptions, 6000 to 6250 fps velocities were used, which were still within the expected range.

Seismic velocities of 14,750 to 18,000 fps. were interpreted as indicative of bedrock.

2.4 Conclusions

Seismic profiles for S83-1 and S83-3 through 10 are presented in Figures A-3 through A-12, and show the interpreted bedrock elevations and assumed velocities in feet per second for the alluvium and bedrock. Also shown are the shotpoint positions, time-distance data, and depths to bedrock measured by hammer drilling, and seismic line intersections. Time-distance data for each seismic line are shown in Tables A-1 through A-10. A summary of the velocities in the alluvium (V_1) and bedrock (V_2), and the depth to bedrock are presented in Table A-11. These velocities do not include those of ice or ice-bonded soils.

There is generally good correlation between borehole data and the seismic profile sections where geophone spreads actually cross the

locations of the borings. Typically the variation in the depth to bedrock between these sets of data ranges from 2 to 15 feet.

The upstream end of S83-10 does not agree with data from DH-3, which was drilled during previous exploration. This hole shows bedrock at 78 feet below ice surface while the seismic data indicates depths 20 to 30 feet deeper in this vicinity. It is quite possible that extremely irregular bedrock topography in this location has distorted the seismic data.

In general, the depth to bedrock was shallow (less than 25 feet) along the north shore at the downstream cofferdam, moderately deep (60-80 feet) in the center of the channel at the upstream and downstream cofferdams and at the main dam, and very deep (greater than 150 feet) in localized areas between the main dam centerline and upstream cofferdam. A discussion of each major seismic line follows.

2.4.1 Downstream Cofferdam Foundation

Profiles S83-1 and S83-3 are aligned along the north shore. Profiles S83-4 and S83-10 are oriented parallel to the course of the river channel and are near the center portion of the channel.

Profile S83-1 shows relatively shallow bedrock (2 to 27 feet) with a seismic velocity of 15,300 fps. The apparent dip of the bedrock surface is to the east. An attempt to gather seismic information across the river channel along refraction Line S83-2 was made, but because of the short shore to shore distance, only direct arrivals through the river ice were recorded.

Line S83-3 indicated a single velocity layer with an average seismic velocity of 14,500 fps. This could be interpreted as bedrock at the

surface. Borehole data, however, indicates that rock is over 20 feet deep near this line. Since the velocity is between that of ice and those noted as bedrock on other lines, it was concluded that the alluvium under this line is frozen or partly frozen.

Profiles S83-4 and S83-10 provide subsurface information below the center of the river channel. The depth of bedrock averages 75 feet and the seismic velocity ranges from 15,000 to 17,000 fps. Both profiles indicate that the apparent dip of the bedrock surface is to the south.

2.4.2 Centerline and Upstream Dam Foundation Area

Profile S83-5 intersects the centerline of the proposed Watana Dam, Profiles S83-6 and S83-9 are centered 900 and 1600 feet upstream (east) of the centerline, respectively. All three profiles are oriented parallel to the course of the river and within the river channel.

Profile S83-5 shows an undulating bedrock surface with an average depth of 70 feet. Bedrock velocities (V_2) range between 14,750 and 18,000 fps. Bedrock begins to dip moderately to the east in the eastern portion of the profile. The lateral change in bedrock velocities could be caused by fracturing or shearing of the bedrock.

Profile S83-6 could not be handled by conventional computer modeling techniques, probably because of severe distortion of the field data by near-vertical displacements in the bedrock topography. A delay-time method (Cummings, 1979; Hagedorn, 1959) was applied to the arrival times. The model indicates a vertical displacement of 80 feet in the bedrock surface and bedrock may be as much as 170 feet deep at the base of the scarp.

Profile S83-9 shows a deep bowl-shaped bedrock surface. The maximum depth to rock is 162 feet; the seismic velocity is 15,500 fps.

2.4.3 Upstream Cofferdam Foundation

Profile S83-7 intersects the centerline of the upstream cofferdam. Profile S83-8 is located 550 feet upstream of the centerline and crosses the northeast portion of Profile S83-7.

Both profiles show a slightly undulating to level bedrock surface with an average depth of 65 feet and a velocity of 16,500 fps.

3. BOREHOLE GAMMA LOGGING - RIVER CHANNEL AND RELICT CHANNEL

3.1 Data Acquisition

Natural gamma logs were run in all open boreholes drilled during the winter program using a Mt. Sopris Model II borehole geophysical logging system. With the exception of DH83-4, all boreholes were logged through 2 inch PVC; DH83-4 was steel cased to 60 feet and open below 60 feet. Eight of the boreholes logged were located in the relict channel and 23 were in or near the river channel. The locations of the river channel boreholes are shown in Figure A-1. Individual gamma logs are shown on Figures A-13 through A-47.

3.2 Analysis and Interpretation

The natural-gamma logs were all run at a speed of 10 feet/min. and at a time constant of 5 cps (counts per second) for good definition of gamma anomalies. Chart deflection was set at 5 cps per division horizontally and 10 feet per inch vertically.

Gamma logs of adjacent holes were analyzed by matching log intervals having the same amplitude and similar anomaly signature. Those matches were then checked against the borehole sample logs for geologic identification. Individual gamma/litho units were then checked for their reasonableness according to standard geofluvial processes.

3.3 Conclusions

The gamma ray profile along seismic line DMA indicates that the gamma ray log is quite useful for extrapolation of point lithologic samples both vertically and horizontally. Unit E/F is recognizable in this profile and refinements in the boundaries are suggested from its examination.

The gamma-ray profiles for the river channel demonstrate a similar practicality in the much more complex geologic situation of rapid vertical and horizontal facies changes. The gamma ray anomalies recorded agree reasonably well with the point samples taken from the boreholes. Each of the river gamma/lithologic profiles permit better resolution of the river sections than the samples alone.

REFERENCES

1. Dobrin, M.B., 1976, Introduction to geophysical prospecting, 3rd ed., New York, McGraw-Hill Book Co., Inc., pp. 292-338.
2. Cummings, D., 1979, Determination of depths to an irregular interface in shallow seismic refraction surveys, Geophysics, v. 44, pp. 1987-1998.
3. Hagedoorn, J.G., 1959, The plus-minus method for interpreting seismic refraction lines, Geophysical Prospecting, v. 6, p. 285-294.
4. Scott, J.H., B.L. Tibbett, and R.G. Burdick, 1972, Computer analysis of seismic refraction data, U.S. Bureau of Mines, Report of Investigation 7595, p. 95.

4. TABLES

WATANA DEVELOPMENT SEISMIC REFRACTION SURVEY RIVER CHANNEL

TABLE A-1

TIME-DISTANCE DATA FOR S83-1

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>	
1	1454	0	10	
2	1453	225	10	
3	1454	450	0	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 1</u>	<u>SP 2</u>	<u>SP 3</u>
1	10	1.0	16.0	32.0
2	25	2.0	15.2	31.0
3	50	4.0	14.0	29.4
4	100	8.0	10.8	27.0
5	150	12.0	6.5	24.0
6	200	15.5	2.5	21.0
7	250	18.5	2.5	18.0
8	300	22.0	6.2	13.0
9	350	25.0	10.5	8.5
10	400	29.5	15.0	4.0
11	425	31.5	17.7	2.0
12	440	32.5	18.5	1.0

TABLE A-2

TIME-DISTANCE DATA FOR S83-2

NOTE: S83-2 was an attempt to obtain a seismic section perpendicular to the river channel. River surface geometry precluded placing shotpoints at sufficient stepouts to provide first arrivals from bedrock; therefore, only ice arrivals were recorded.

TABLE A-3

TIME-DISTANCE DATA FOR S83-3

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
7	1457	720	0
8	1456	460	10
9	1456	200	0
10	1456	0	0
11	1457	920	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>				
		<u>SP 7</u>	<u>SP 8</u>	<u>SP 9</u>	<u>SP 10</u>	<u>SP 11</u>
1	210	35.5	16.5	1.3	13.0	49.5
2	235	-	-	3.5	15.0	-
3	285	30.0	11.5	5.5	18.0	44.5
4	335	26.8	8.5	10.0	22.0	41.0
5	385	23.5	5.0	12.5	25.0	38.0
6	435	20.0	2.0	16.0	28.5	34.0
7	485	16.0	2.0	19.5	32.0	31.0
8	535	13.0	5.0	23.0	35.0	27.5
9	585	9.5	8.5	26.5	39.0	24.5
10	635	6.3	12.0	30.5	42.0	21.0
11	685	3.0	15.5	34.5	47.0	18.5
12	710	1.3	17.2	35.8	49.0	15.0

TABLE A-4

TIME-DISTANCE DATA FOR S83-4

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>	
12	1456	1110	0	
13	1455	540	30	
14	1453	0	0	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 12</u>	<u>SP 13</u>	<u>SP 14</u>
1	20	83.0	47.8	3.0
2	50	82.0	44.4	6.0
3	100	81.0	41.2	10.5
4	150	76.0	35.0	15.0
5	200	72.0	30.7	19.0
6	250	67.5	25.8	23.8
7	300	65.0	21.2	28.0
8	350	62.0	17.0	35.0
9	400	55.0	12.5	39.5
10	450	52.0	8.2	43.0
11	500	48.0	4.5	47.2
12	550	45.0	-	52.3
13	550	43.8	1.5	50.0
14	600	41.8	5.0	52.0
15	650	37.0	8.5	55.0
16	700	34.0	12.5	59.0
17	750	31.0	16.0	62.0
18	800	27.5	20.5	70.0
19	850	23.5	25.5	69.0
20	900	19.0	30.5	70.0
21	950	15.0	32.0	73.0
22	1000	10.0	36.3	77.5
23	1050	5.5	-	-
24	1100	1.5	44.7	83.0

TABLE A-5

TIME-DISTANCE DATA FOR S83-5

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>WEST</u>			
		<u>X LOCATION (FT)</u>		<u>Y LOCATION (FT)</u>	
15	1460	1700			
16	1458	1125			
19	1456	525			
20	1455	25		165	
<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>			
		<u>SP 15</u>	<u>SP 16</u>	<u>SP 19</u>	<u>SP 20</u>
1	550	92.0	47.5	2.7	49.5
2	600	89.0	45.0	7.0	53.5
3	650	86.3	41.5	11.5	56.5
4	700	83.5	39.0	15.5	60.0
5	750	81.5	36.0	20.5	61.5
6	800	80.0	35.0	25.0	64.5
7	850	77.0	26.0	29.7	70.5
8	900	74.0	22.0	34.0	75.0
9	950	71.0	17.2	39.0	79.0
10	1000	67.0	12.5	42.5	81.0
11	1050	64.0	7.5	44.0	82.5
12	1100	61.0	3.0	46.0	84.0

TABLE A-5 (continued)
TIME-DISTANCE DATA FOR S83-5

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>EAST</u>		<u>Y LOCATION (FT)</u>
		<u>X LOCATION (FT)</u>		
15	1460	1130		0
16	1458	550		0
17	1456	0		0
18	1462	1660		0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>			
		<u>SP 15</u>	<u>SP 16</u>	<u>SP 17</u>	<u>SP 18</u>
1	575	57.0	3.0	48.0	85.0
2	625	55.5	7.5	52.0	-
3	675	51.5	12.0	54.0	80.0
4	725	41.0	17.0	57.5	-
5	775	35.5	22.0	61.0	75.0
6	825	31.0	26.5	64.0	73.0
7	875	26.0	32.0	67.5	69.0
8	925	21.0	37.5	72.0	65.0
9	975	16.0	42.0	76.0	58.0
10	1025	12.0	46.0	80.0	53.0
11	1075	7.0	50.5	84.5	49.0
12	1125	3.0	55.0	89.0	46.0

TABLE A-6

TIME-DISTANCE DATA FOR S83-6

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
21	1461	450	0
22	1464	1050	0
23	1459	25	0
23A	1459	0	0
24	1464	1585	0
25	1461	600	0
26	1462	1125	190

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>					
		<u>SP 21</u>	<u>SP 22</u>	<u>SP 23</u>	<u>SP 23A</u>	<u>SP 24</u>	<u>SP 25</u> <u>SP 26</u>
1	25				3.0		51.5 84.5
2	75				6.5		48.0 83.0
3	125				11.0		43.5 79.0
4	175				15.5		39.0 77.0
5	225				20.0		34.0 75.0
6	275				25.0		29.5 73.0
7	325				30.0		25.0 70.0
8	375				34.0		20.0 66.0
9	425				39.0		15.5 63.0
10	475	2.2	46.0	43.0	44.0	93.0	11.5 61.0
11	525	6.5	40.5	47.5	48.0	91.0	7.0 58.5
12	575	11.0	36.5	51.5	52.5	90.5	3.5 57.3
13	625	15.2	33.0	54.5		89.0	
14	675	20.5	29.5	59.0		90.0	
15	725	24.0	25.0	62.0		85.0	
16	775	27.0	21.0	67.5		78.0	
17	825	32.0	17.0	72.0		75.0	
18	875	36.0	12.0	78.5		58.0	
19	925	39.0	9.0	75.5		52.0	
20	975	42.0	5.8	76.5		49.0	
21	1025	46.7	2.3	79.5		46.0	
22	1025	47.0					
23	1075	52.0					
24	1125	60.5					
25	1175	64.5					
26	1225	66.0					
27	1275	70.5					
28	1325	76.0					
29	1375	80.5					
30	1425	85.0					
31	1475	87.5					
32	1525	91.5					
33	1575	95.0					

TABLE A-7
TIME-DISTANCE DATA FOR S83-7

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
27	1465	825	0
28	1469	1425	8
29	1463	300	0
30	1470	1700	0
31	1464	875	15
32	1463	285	0
33	1463	0	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>						
		<u>SP 27</u>	<u>SP 28</u>	<u>SP 29</u>	<u>SP 30</u>	<u>SP 31</u>	<u>SP 32</u>	<u>SP 33</u>
1	300		85.0			48.5	3.0	27.0
2	350		80.0			42.5	7.0	31.0
3	400		76.0			39.5	11.5	35.0
4	450		72.5			35.8	16.0	38.5
5	500		69.5			33.0	20.0	43.0
6	550		67.0			29.0	24.5	47.5
7	600		66.0			26.5	28.0	51.0
8	650		65.0			21.4	32.0	57.0
9	700		60.0			17.0	36.0	61.0
10	750		56.0			12.0	41.5	63.5
11	800		55.0			7.8	43.5	67.0
12	850		53.5			3.5	46.0	72.5
13	850	2.8	53.0	47.0	76.0			
14	900	9.0	50.0	52.0	75.0			
15	950	13.5	45.0	55.0	70.0			
16	1000	17.5	40.5	60.5	67.0			
17	1050	22.5	36.5	64.0	66.0			
18	1100	25.5	31.0	67.0	61.5			
19	1150	30.0	27.5	73.0	59.0			
20	1200	42.0	21.5	74.0	51.0			
21	1250	44.0	16.0	75.0	46.0			
22	1300	47.0	11.5	78.0	39.5			
23	1350	50.5	7.0	81.5	36.0			
24	1400	53.5	3.0	84.5	30.0			

ALASKA DEPARTMENT OF INTERIOR
U.S. DEPT. OF INTERIOR

TABLE A-8

TIME-DISTANCE DATA FOR S83-8

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
34	1466	0	0
35	1470	600	0
36	1470	1125	0
37	1470	550	0
38	1470	1150	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>				
		<u>SP 34</u>	<u>SP 35</u>	<u>SP 36</u>	<u>SP 37</u>	<u>SP 38</u>
1	25	2.0	51.5	84.0	3.0	52.5
2	75	6.5	51.0	84.0	7.0	48.0
3	125	12.0	-	-	12.5	46.0
4	175	16.0	-	-	17.0	44.5
5	225	22.0	34.0	79.5	22.0	37.5
6	275	27.5	30.0	79.0	26.0	32.0
7	325	32.0	25.0	74.0	30.5	27.0
8	375	36.0	20.0	69.0	36.0	22.5
9	425	38.0	16.0	62.0	41.5	18.0
10	475	41.0	12.5	59.0	47.0	13.0
11	525	46.0	7.0	55.0	50.0	8.0
12	575	49.0	3.0	52.0	51.5	3.0
13	575	50.0				
14	625	54.0				
15	675	57.5				
16	725	59.0				
17	775	63.0				
18	825	66.0				
19	875	68.5				
20	925	72.0				
21	975	75.0				
22	1025	78.0				
23	1075	80.0				
24	1125	84.0				

TABLE A-9
TIME-DISTANCE DATA FOR S83-9

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
39	1467	1705	0
40	1461	0	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>	
		<u>SP 39</u>	<u>SP 40</u>
1	550	98.0	45.0
2	600	95.0	49.0
3	650	-	56.0
4	700	90.5	58.0
5	750	87.5	62.0
6	800	83.0	65.0
7	850	77.0	71.0
8	900	72.0	76.0
9	950	68.0	89.0
10	1000	65.5	89.0
11	1050	61.5	92.0
12	1100	57.0	96.0

TABLE A-10

TIME-DISTANCE DATA FOR S83-10

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>	
41	1453	0	20	
42	1453	600		
43	1454	1150		

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 41</u>	<u>SP 42</u>	<u>SP 43</u>
1	25	2.2	49.0	82.5
2	75	6.8	47.0	79.5
3	125	11.0	43.0	78.0
4	175	15.0	38.0	77.5
5	225	20.0	34.0	76.0
6	275	24.0	29.0	74.5
7	325	28.5	24.0	71.0
8	375	33.5	20.0	68.0
9	425	38.0	15.5	65.0
10	475	42.5	11.0	60.0
11	525	46.5	8.0	56.0
12	575	50.0	2.5	52.0
13	575	48.0		
14	625	51.5		
15	675	53.8		
16	725	56.0		
17	775	59.5		
18	825	62.5		
19	875	66.0		
20	925	69.5		
21	975	72.5		
22	1025	76.5		
23	1075	80.0		
24	1125	83.5		

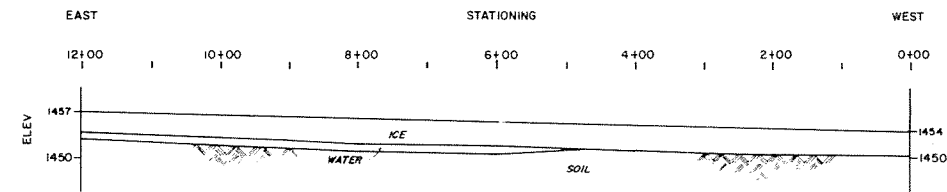
TABLE A-11

SUMMARY OF SEISMIC VELOCITIES AND LAYER DEPTHS

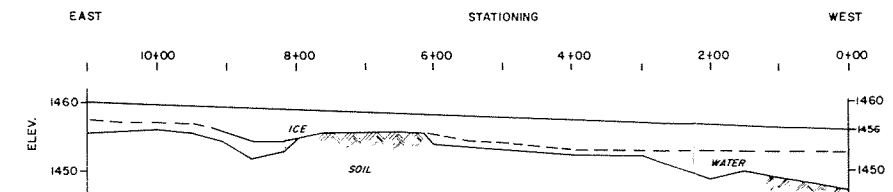
Refraction Profile	Spread	V ₁ (fps)	Depth Below Ice Surface to V ₂ (feet)	V ₂ (fps)
S83-1	1	7000	2 - 27	15350
S83-2	1	not used	-	-
S83-3	1	-	uninterpretable	14500 (frozen soils?)
S83-4	1	6750	54 - 88	15,000
	2	7000	20 - 57	16500
S83-5	1	7000	58 - 83	18000
	2	6250	51 - 100	14750
S83-6	1	-	uninterpretable	-
	2	6750	82 - 168	17500
	3	-	uninterpretable	-
S83-7	1	7000	47 - 76	16500
	2	7000	62 - 87	16500
S83-8	1	6000	21 - 82	16500
	2	6000	41 - 63	16500
S83-9	1	7000	105 - 164	15500
S83-10	1	6750	10 - 69	17000
	2	6750	67 - 110	17000

5. FIGURES

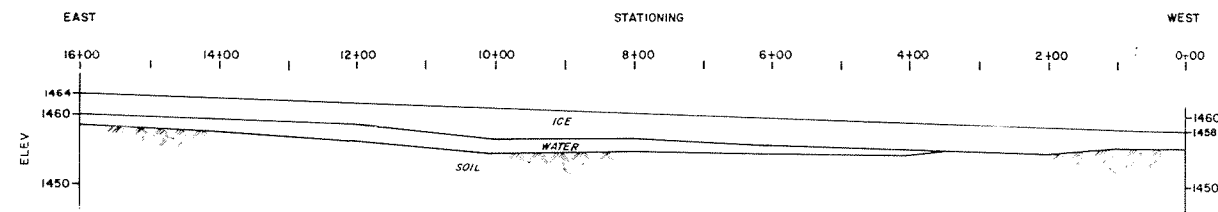
WATANA DEVELOPMENT GEOPHYSICAL EXPLORATIONS



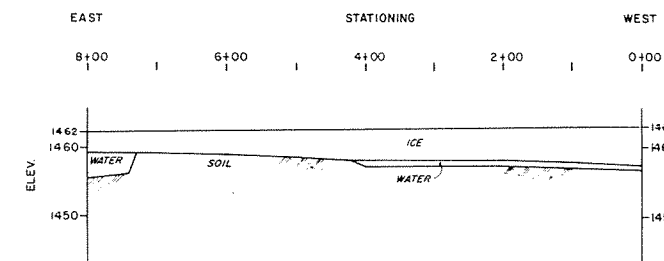
R83-1



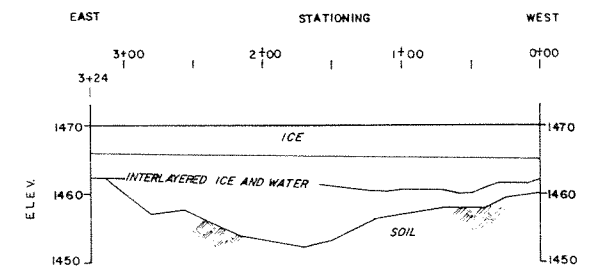
R83-6



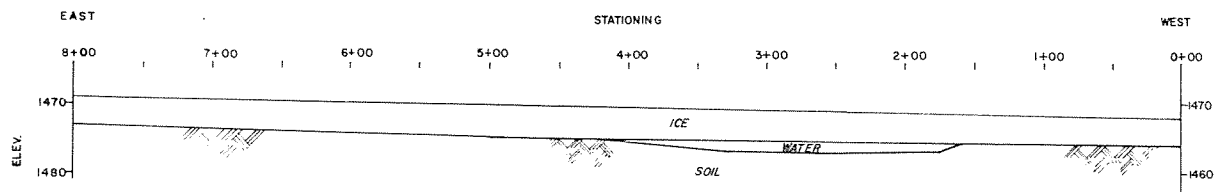
R83-2



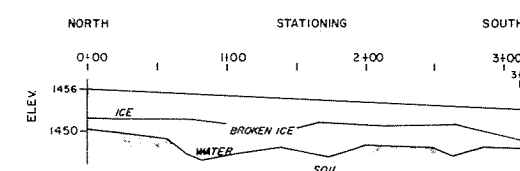
R83-4



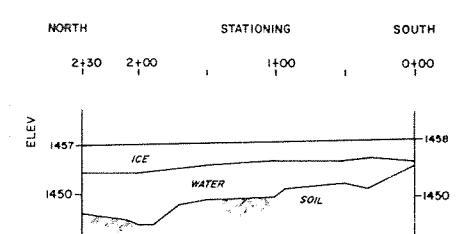
R83-12



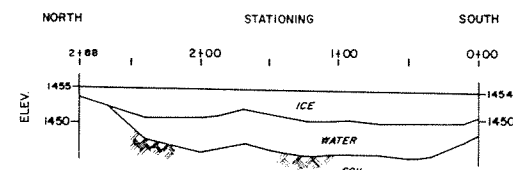
R83-5



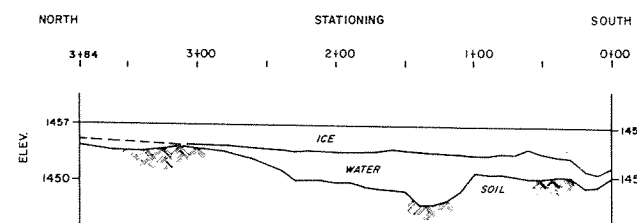
R83-14



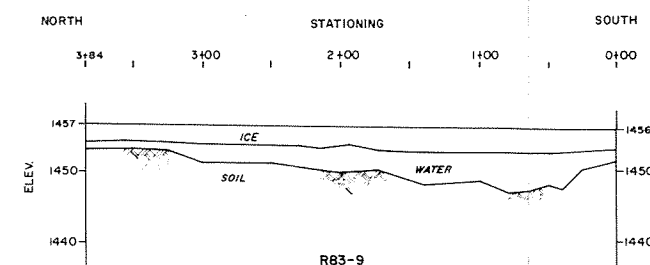
R83-10



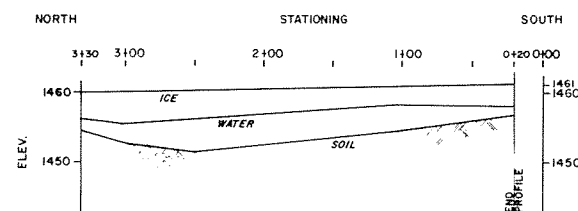
R83-7



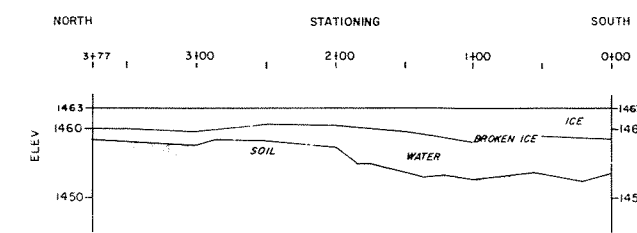
R83-8



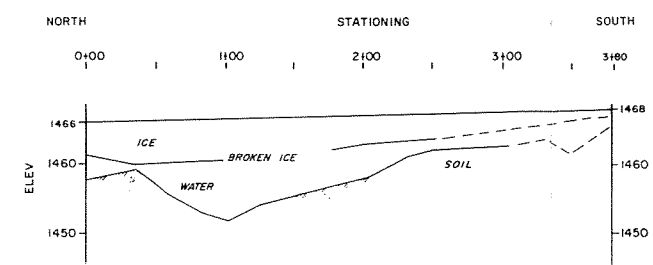
R83-9



R83-3



R83-11



R83-13

- NOTES:
1. SEE DRAWING NO. **A1** FOR PROFILE LOCATIONS.
 2. VERTICAL SCALE 1"=10', HORIZONTAL SCALE 1"=100' FOR LONGITUDINAL SECTIONS & 1"=50' FOR TRANSVERSE SECTIONS.
 3. PROFILES BASED ON INTERPRETATIONS OF GEOPHYSICAL DATA AND ARE SUBJECT TO FUTURE VERIFICATION.
 4. ALL ELEVATIONS & STATIONING SHOWN IN FEET.

ALASKA POWER AUTHORITY

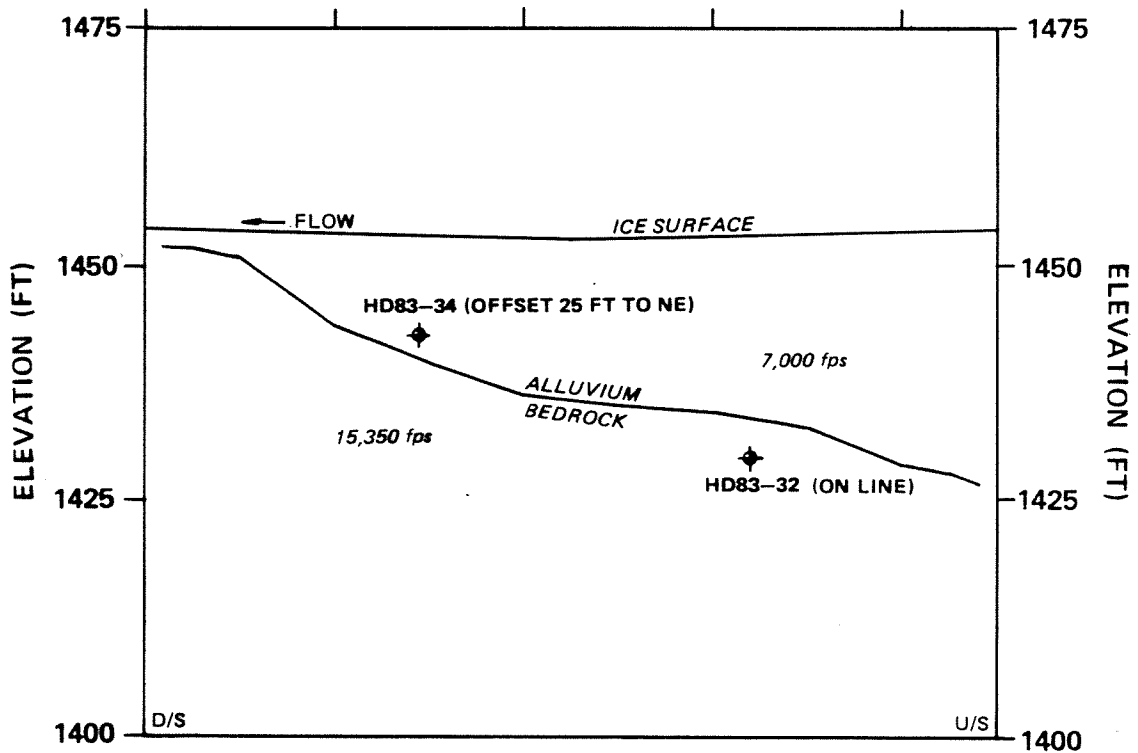
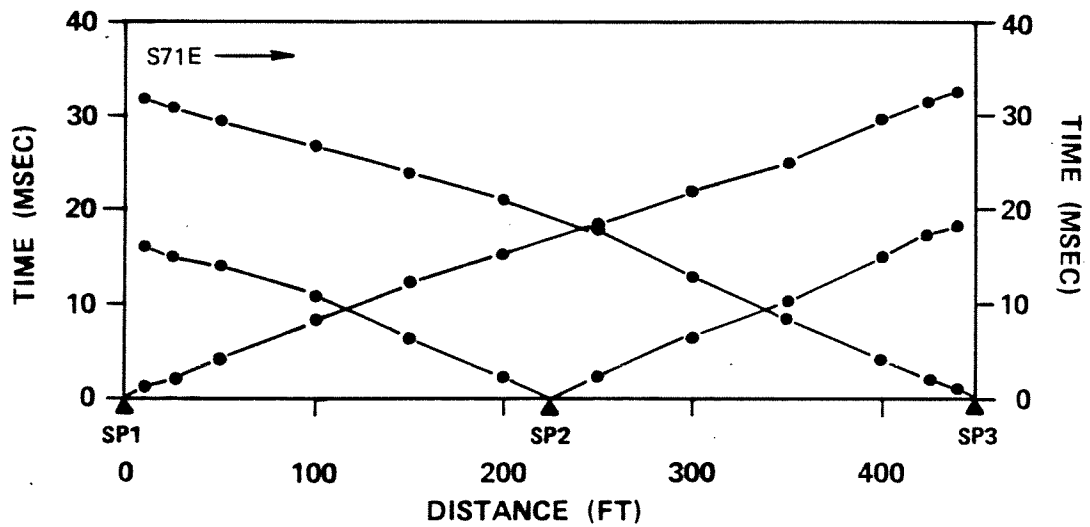
SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT
- RIVER CHANNEL -
GROUND PENETRATING
RADAR PROFILES

HARZA-ERASSO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-2



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

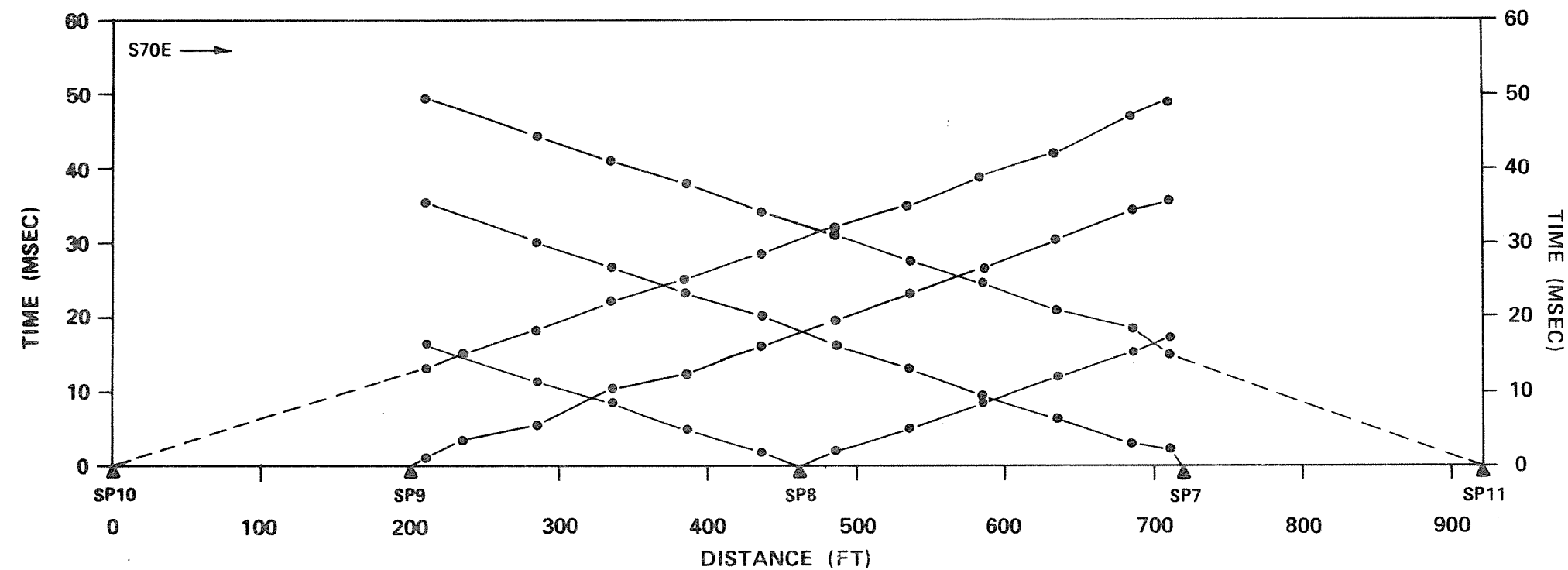
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-1

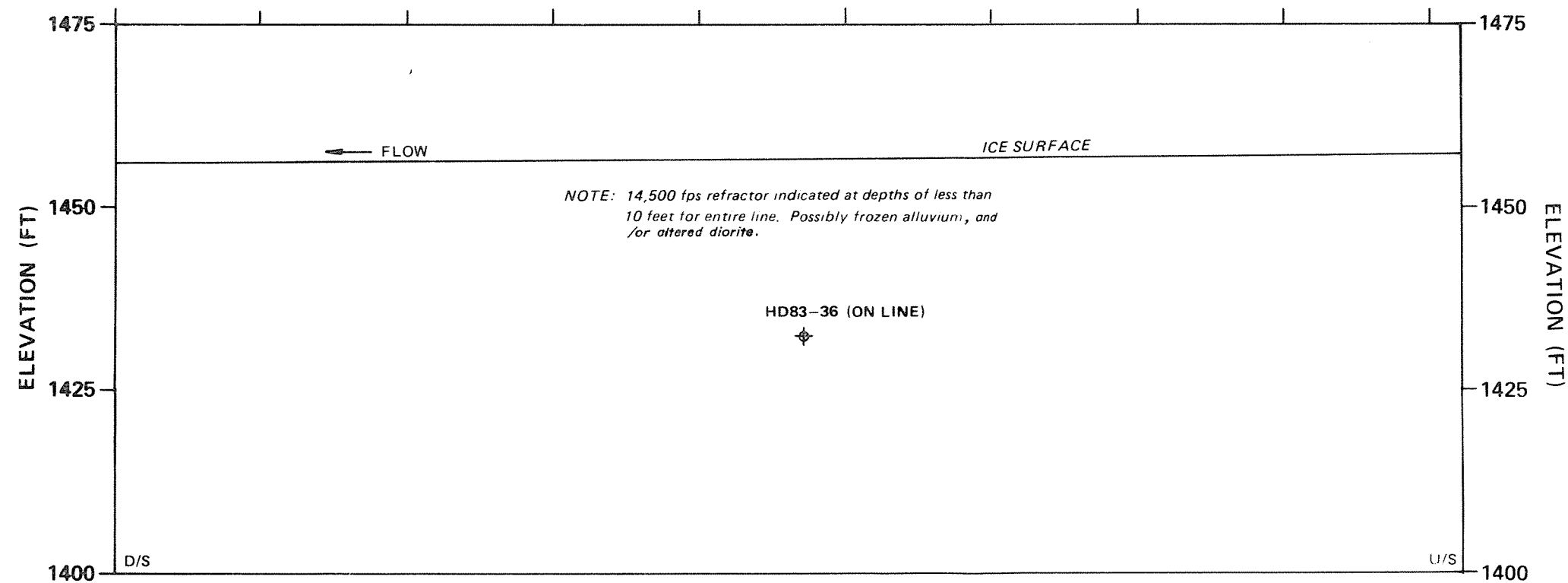
HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

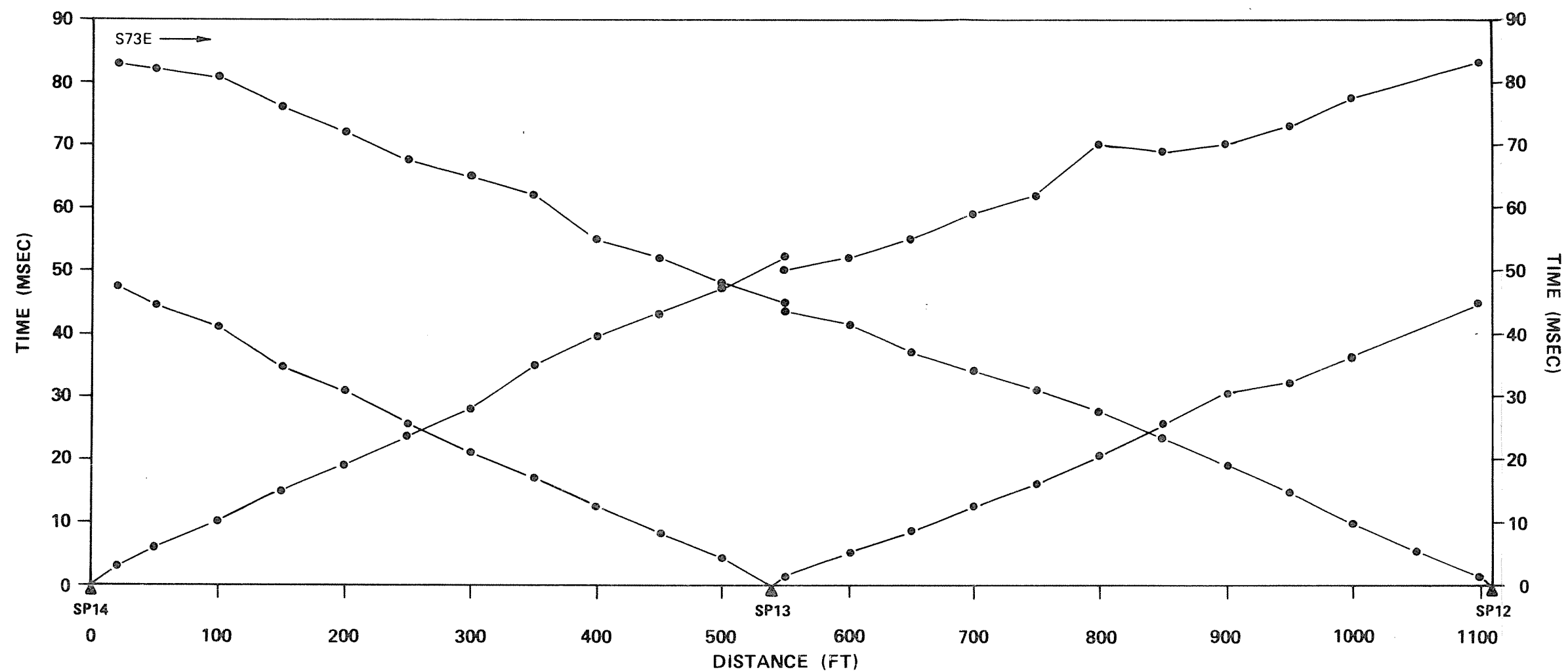
FIGURE
A-3



- EXPLANATION**
- ◆ BOREHOLE DEPTH CONTROL
 - | DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
 - ▲ SHOTPOINT LOCATION

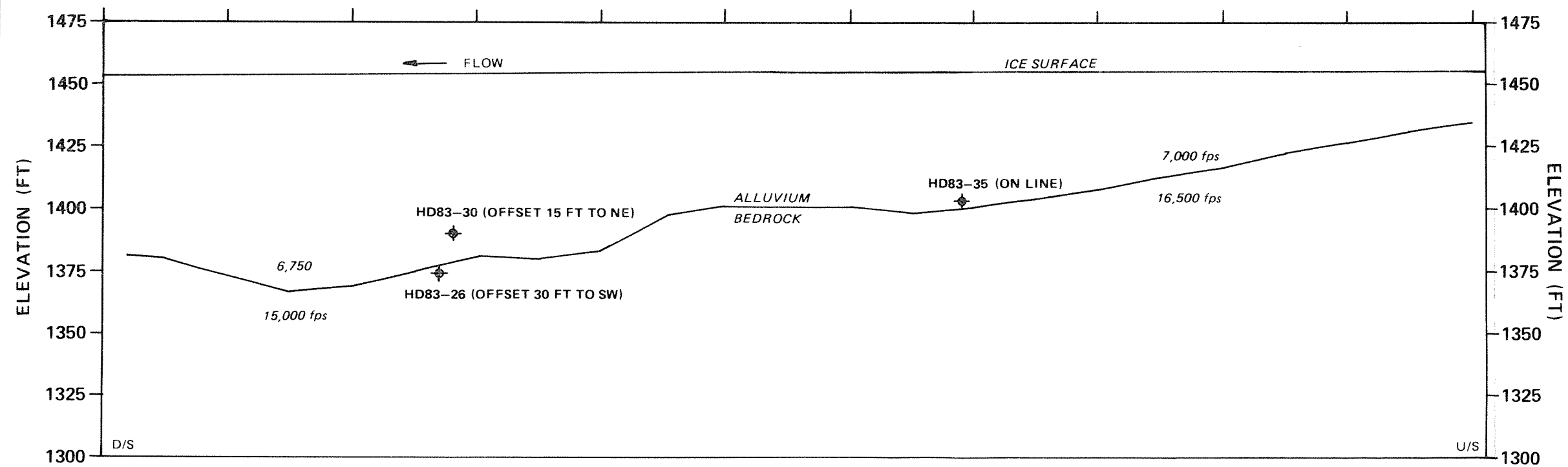


ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-3		
MARZA-EBASCO SUSITNA JOINT VENTURE	DATE AUG83	FIGURE A-4



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- | DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION



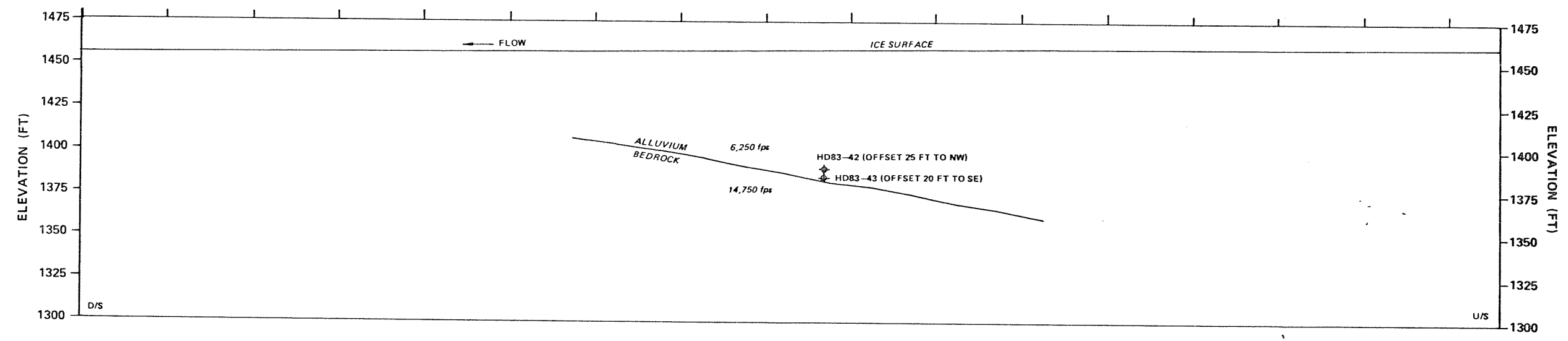
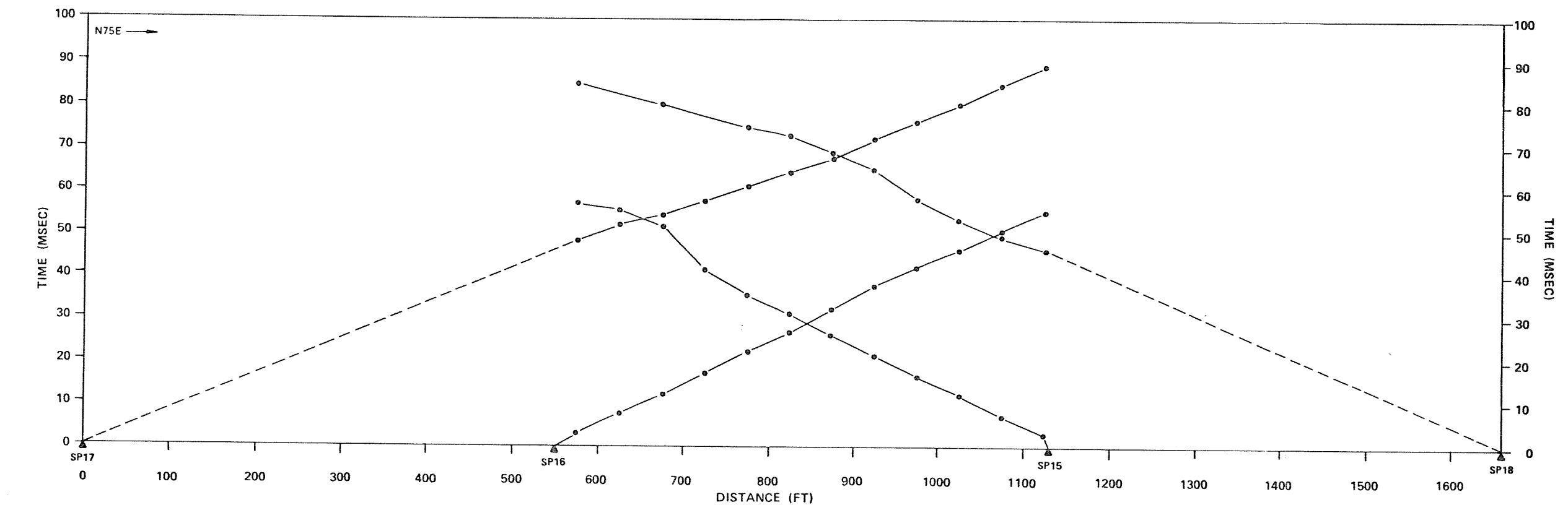
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-4

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

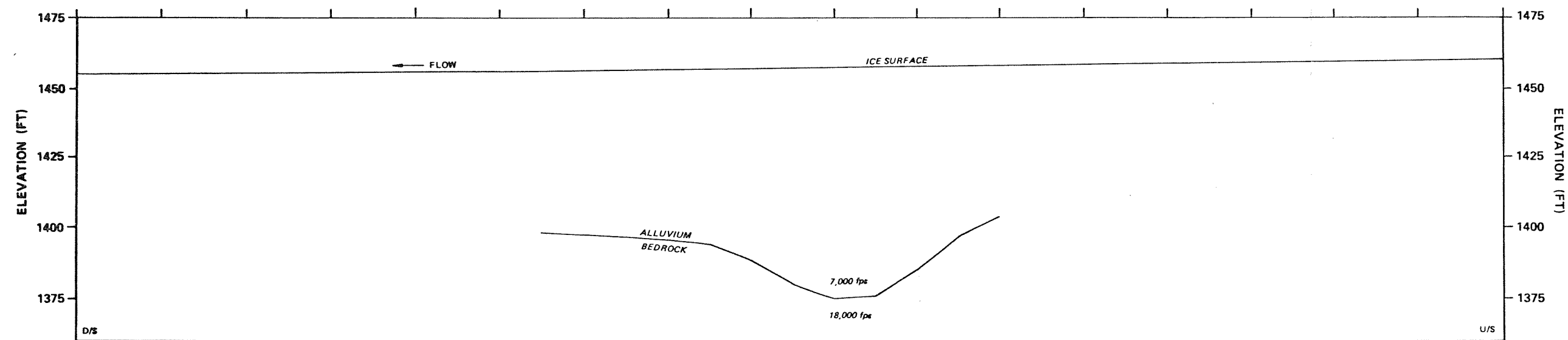
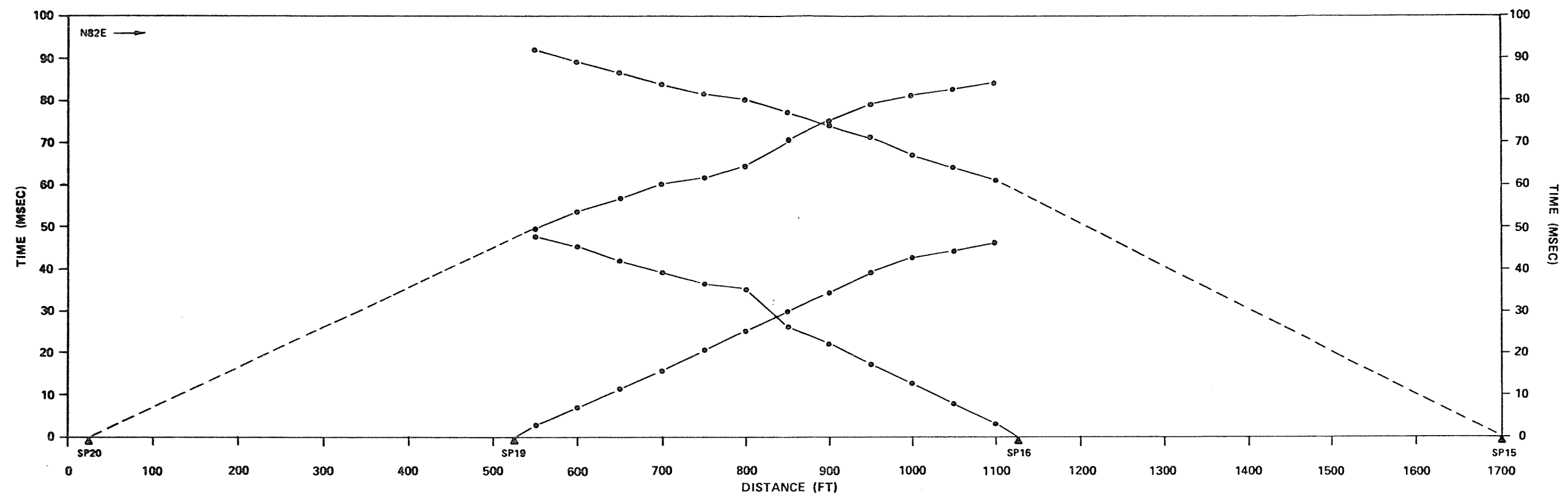
FIGURE
A-5



EXPLANATION

- ⊕ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
└ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-5		
MARZA-EBCO A JOINT VENTURE	DATE AUG83	FIGURE A-6



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

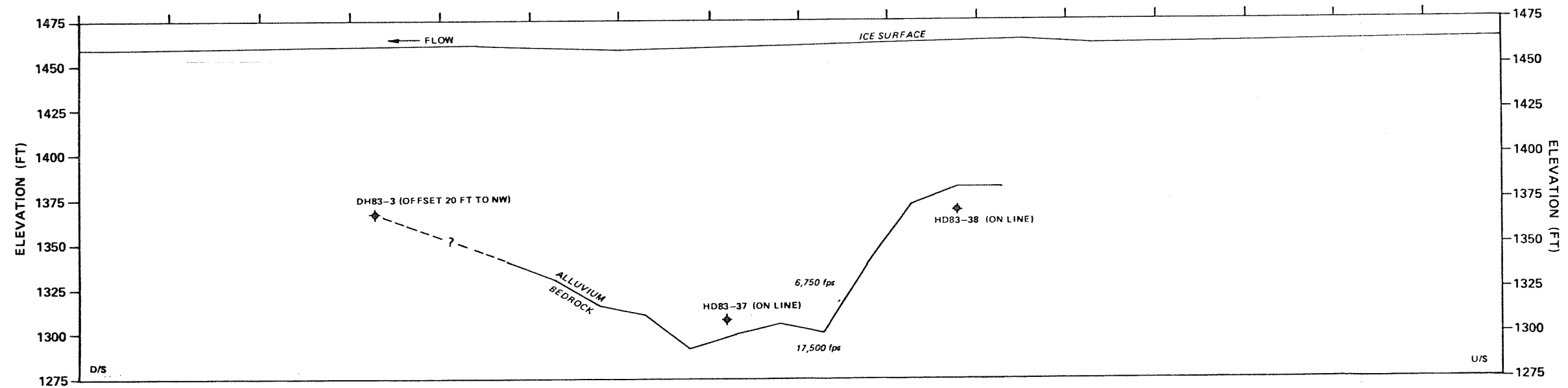
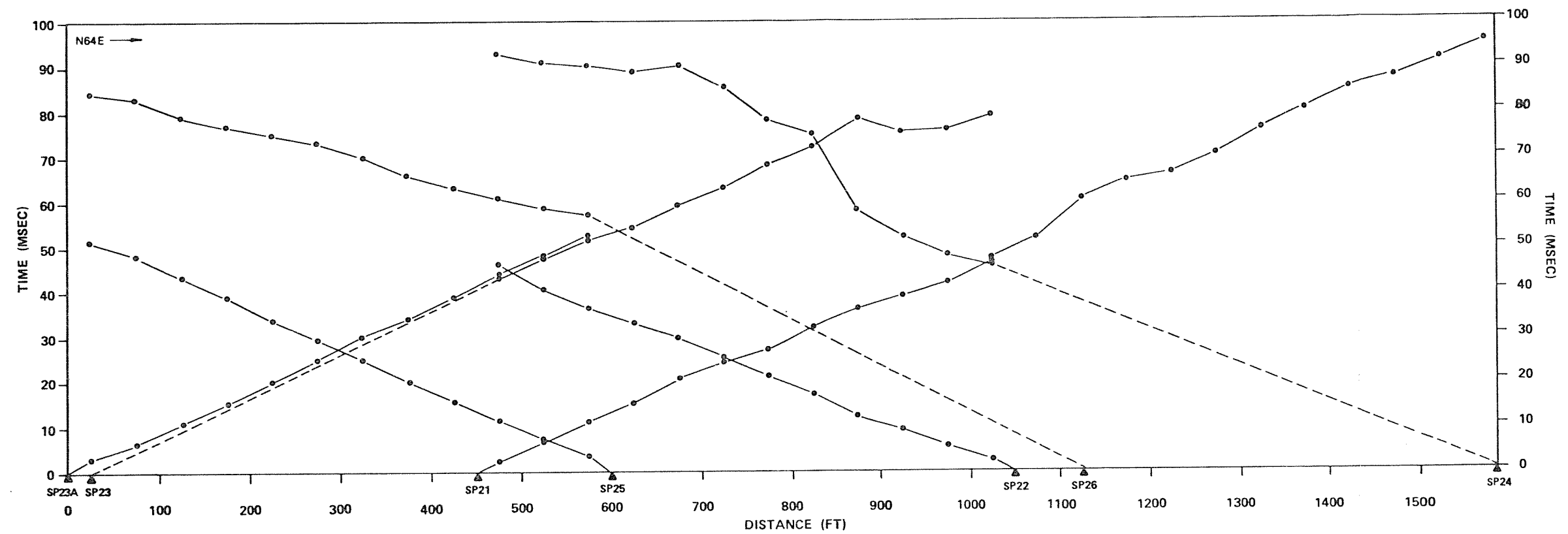
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-5 (WEST)

MARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A- 7



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

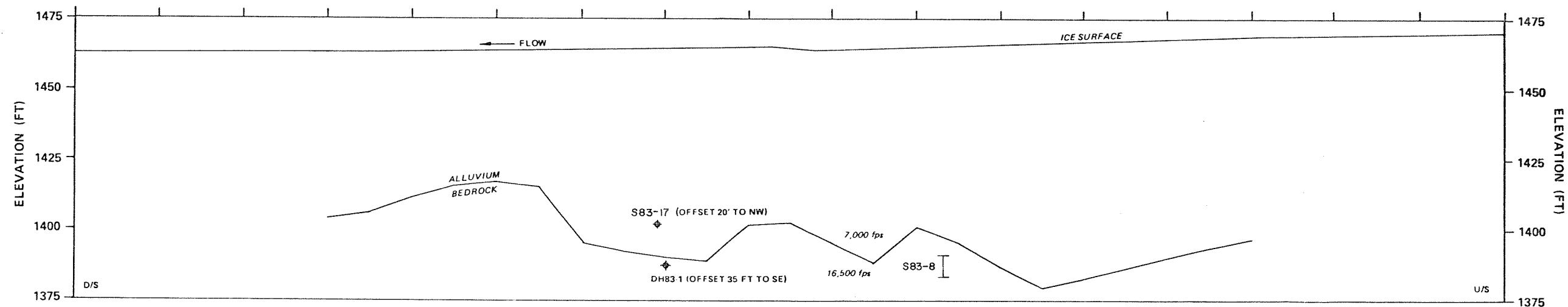
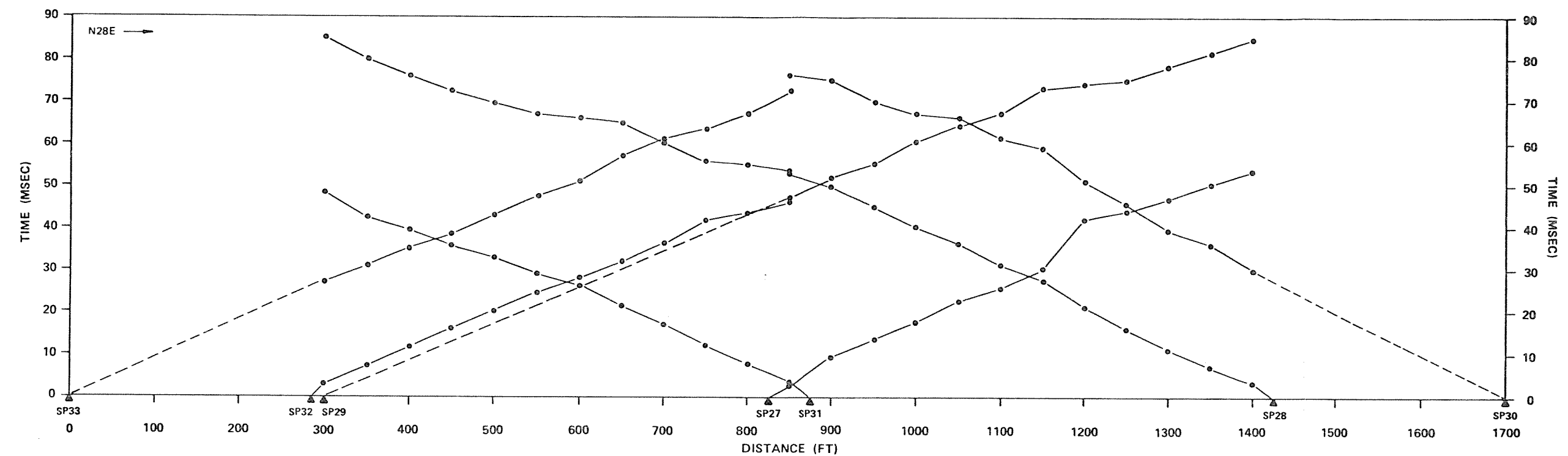
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-6

MARZA-EEASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-8



EXPLANATION

- ⊕ BOREHOLE DEPTH CONTROL
- | DEPTH RANGE INDICATED BY
CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

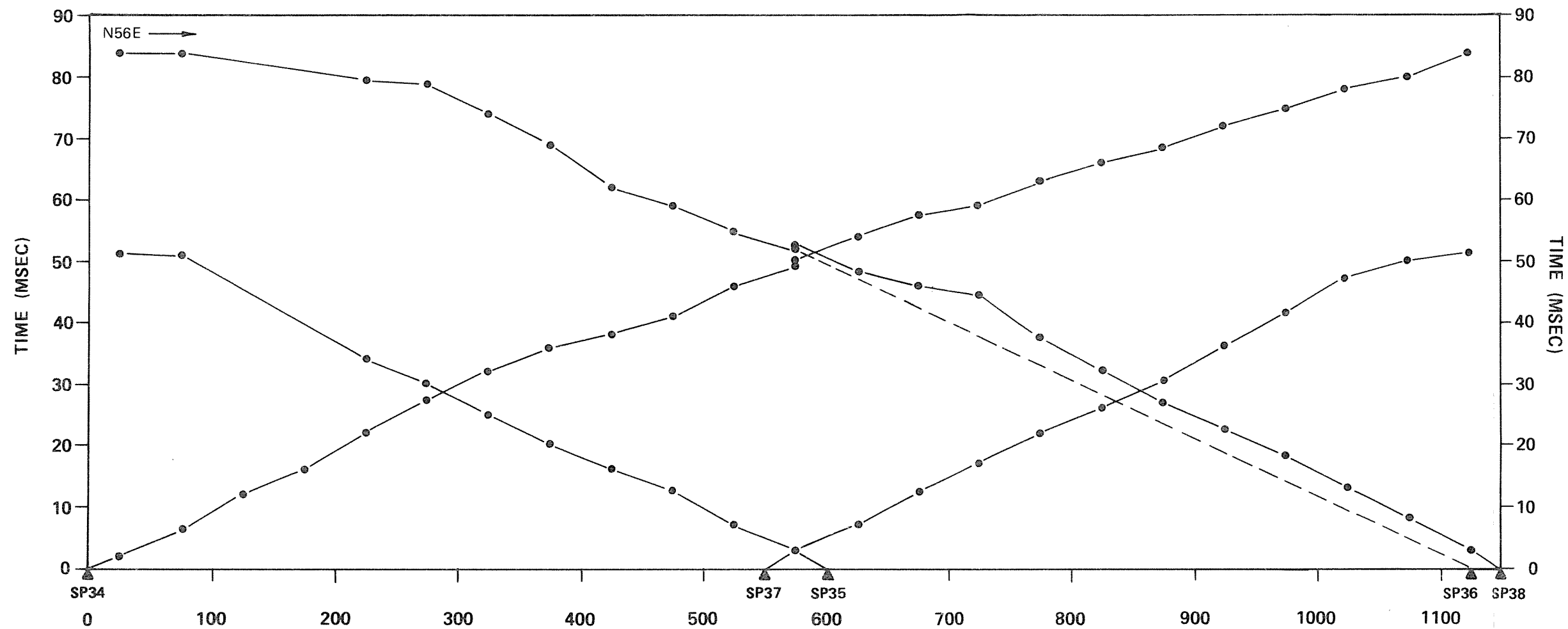
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-7

MARZA-EBASC
SUSITNA JOINT VENTURE

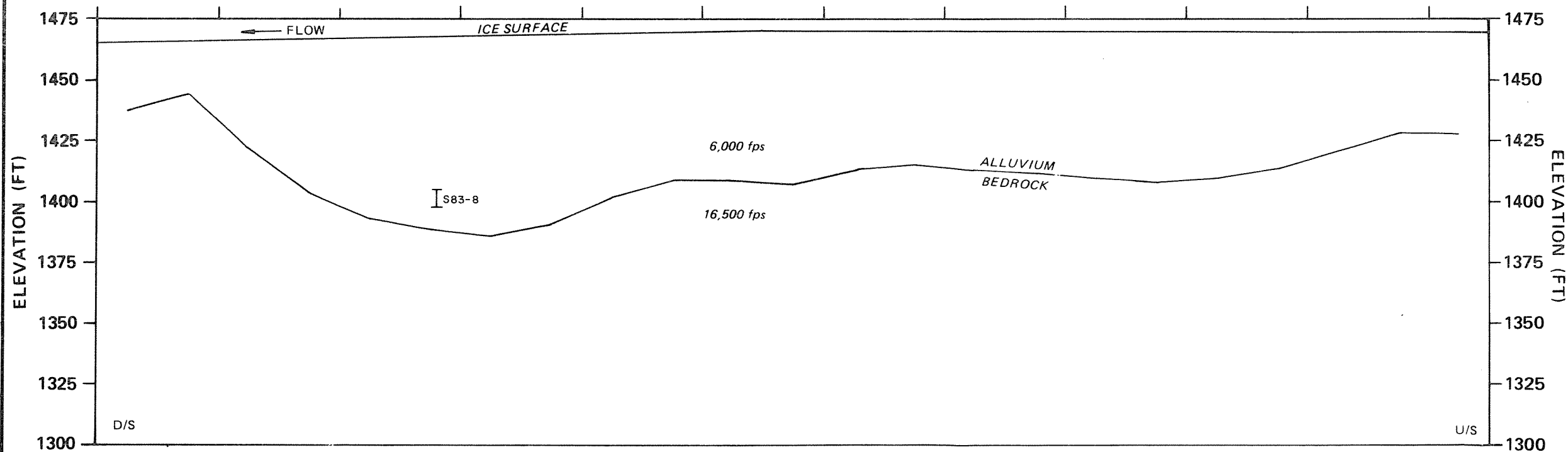
DATE
AUG.83

FIGURE
A-9



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION



ALASKA POWER AUTHORITY

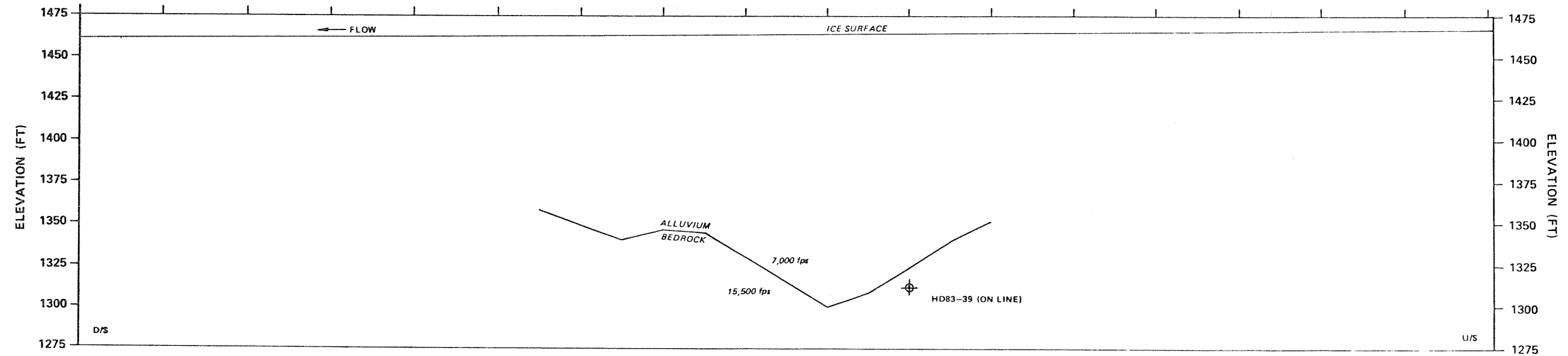
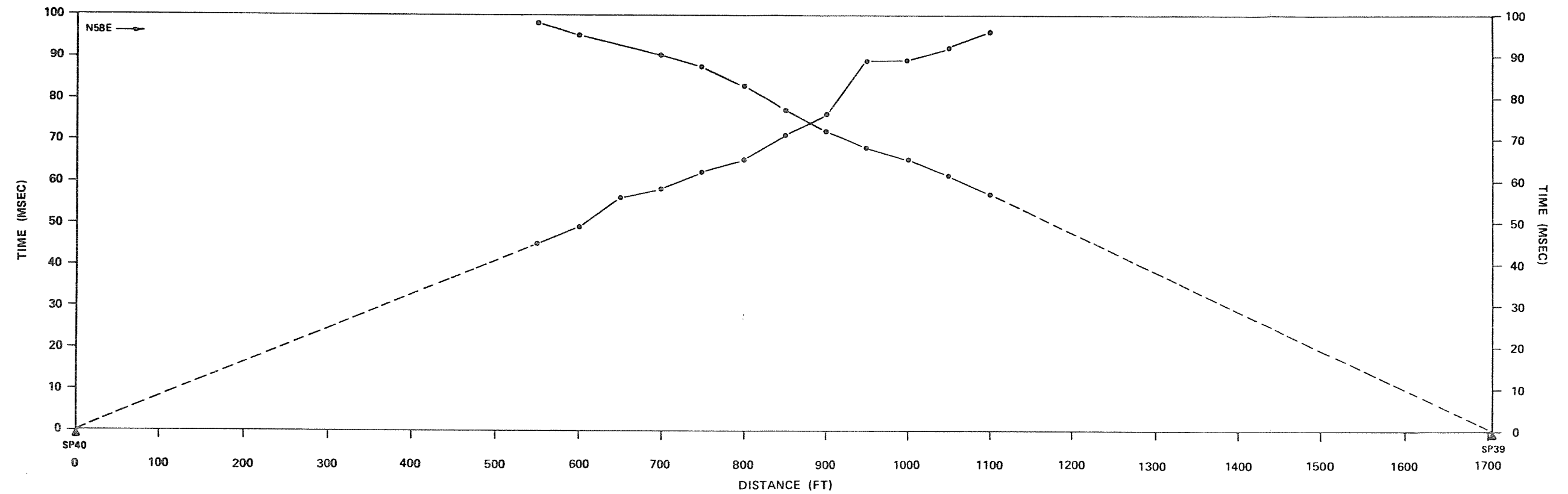
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-8

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-10



EXPLANATION

- ⊕ BOREHOLE DEPTH CONTROL
- I DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

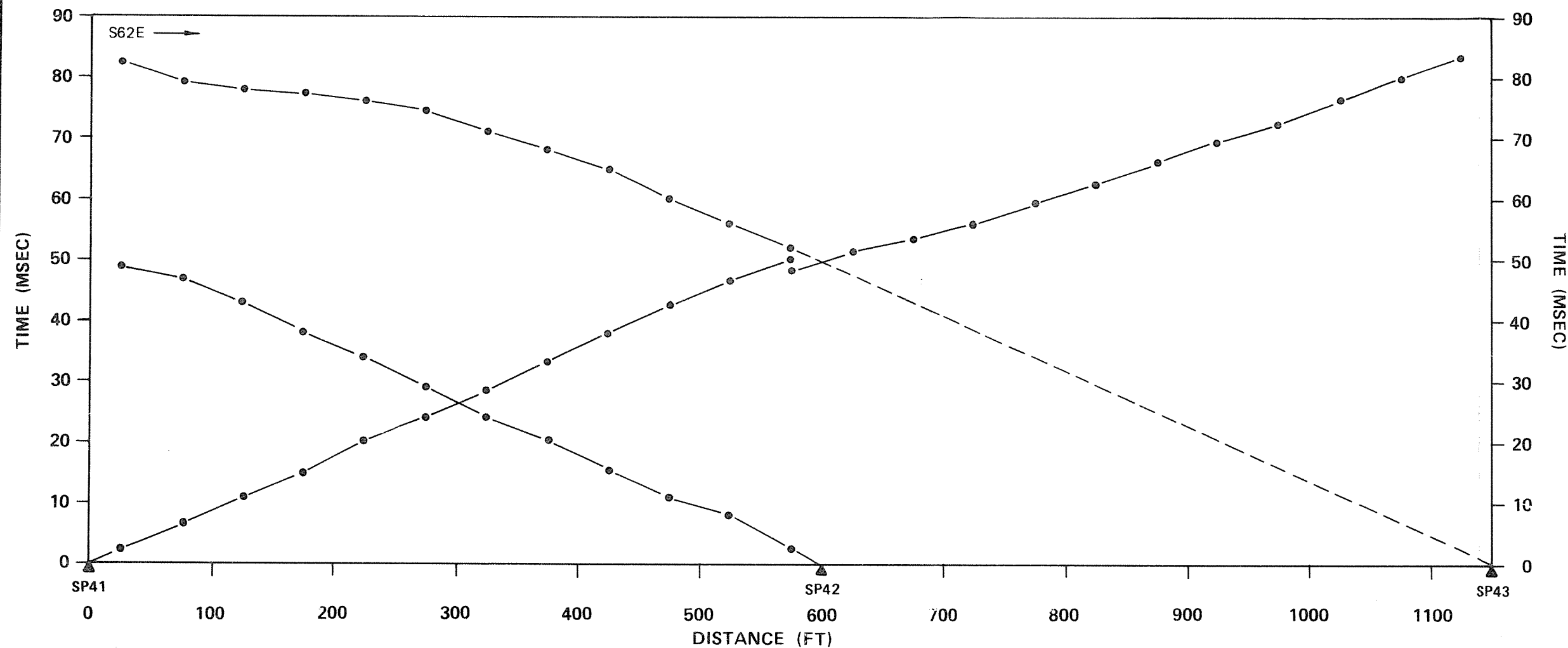
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT AND SEISMIC SECTION FOR S83-9

MARZA-ESASCO
SUSITNA JOINT VENTURE

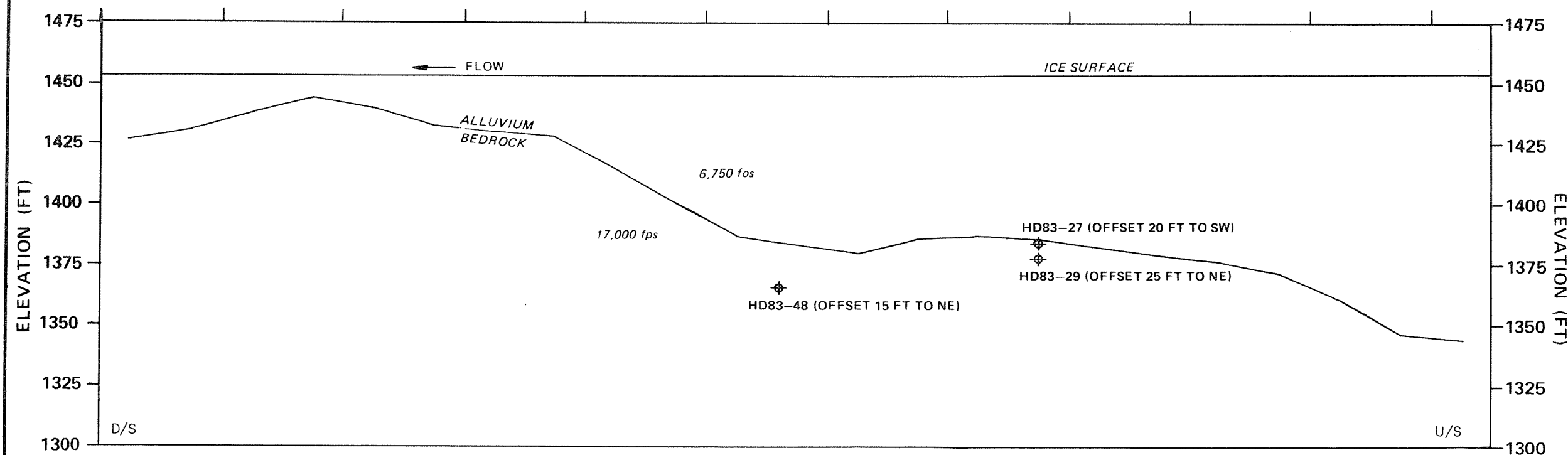
DATE
AUG.83

FIGURE
A-11



EXPLANATION

- BOREHOLE DEPTH CONTROL
- DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- SHOTPOINT LOCATION



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

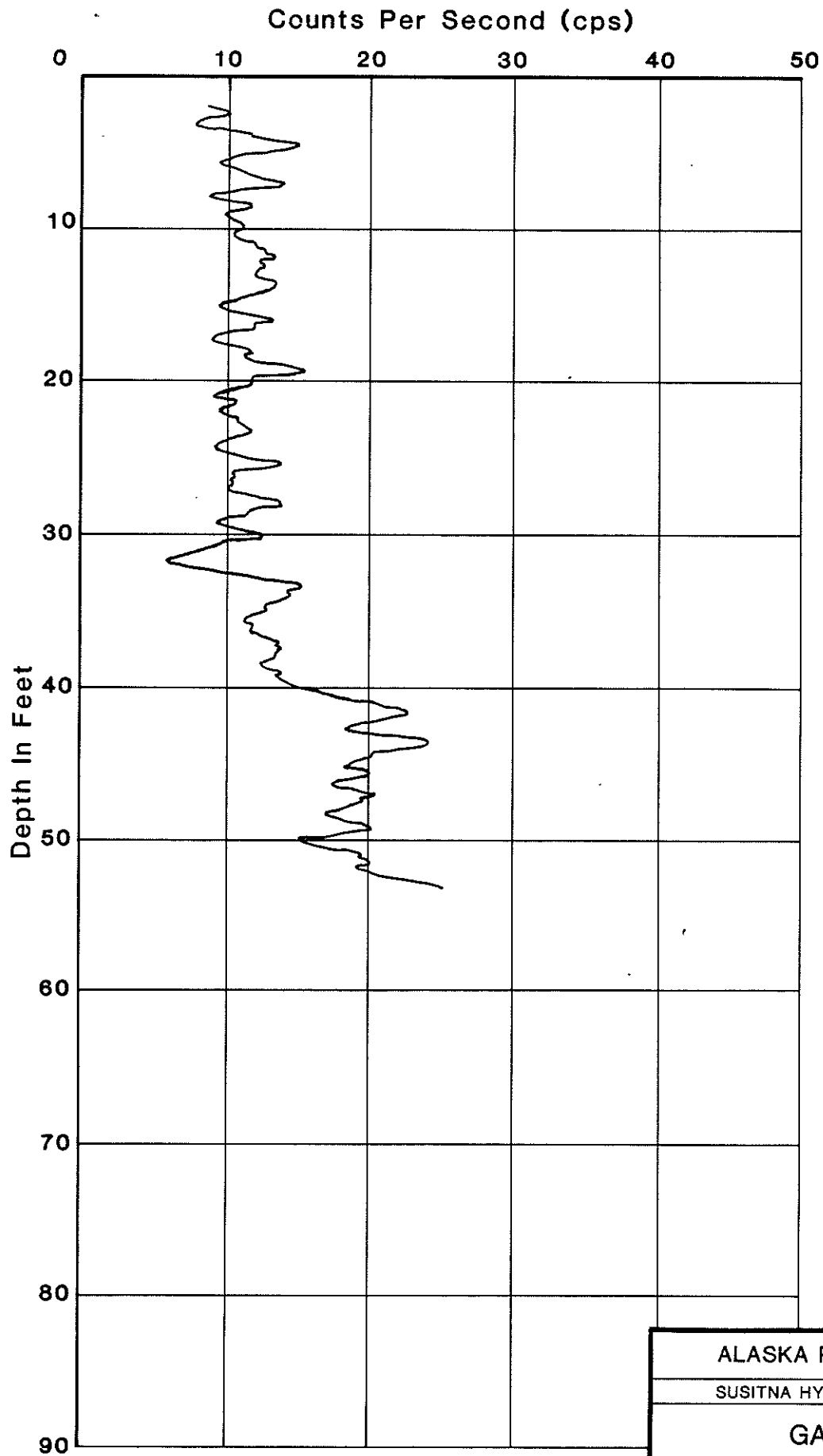
TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-10

MARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-12

GAMMA LOGS — RIVER AND RELICT CHANNELS



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

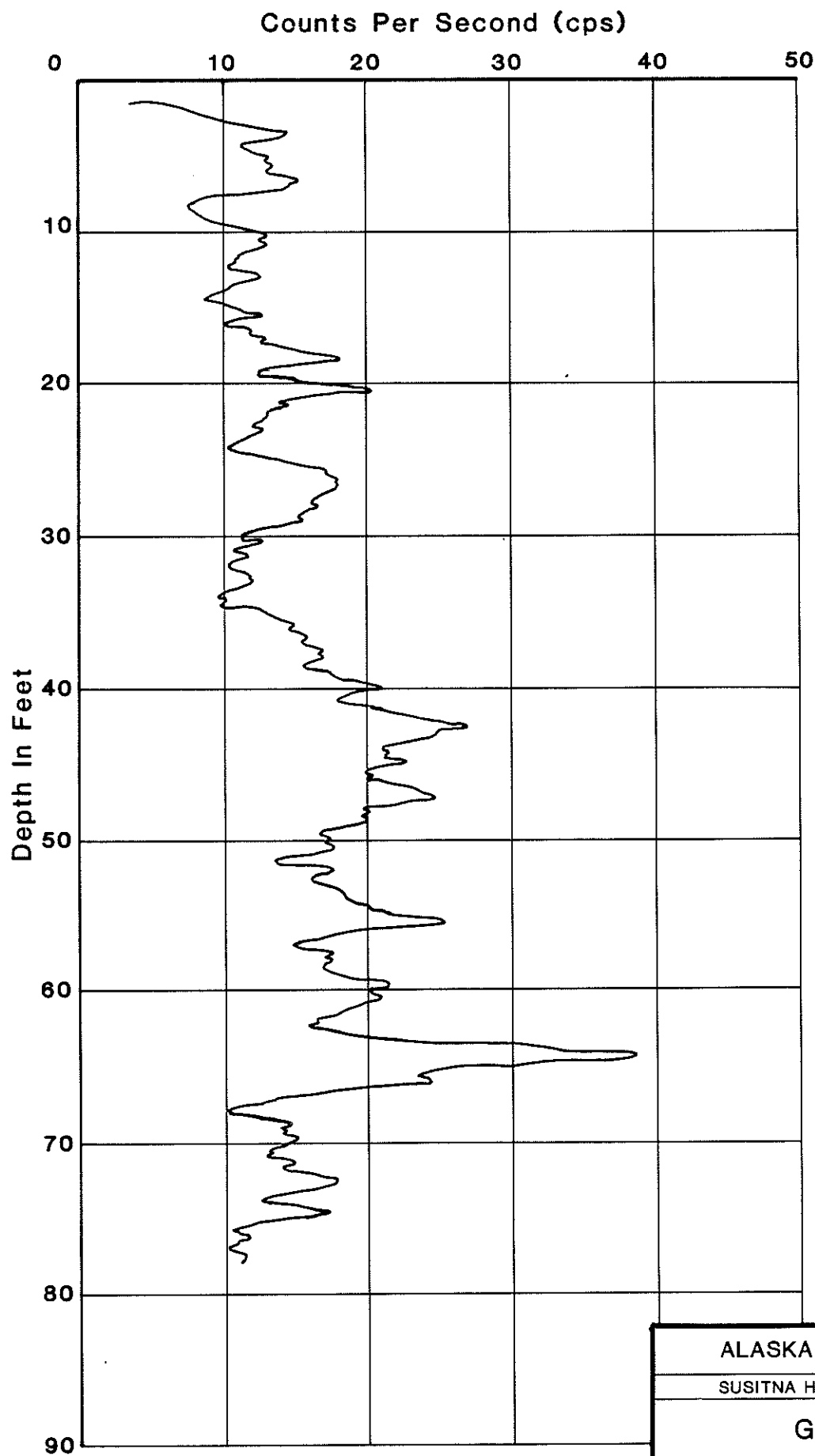
GAMMA LOG

HD83-4

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-13



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

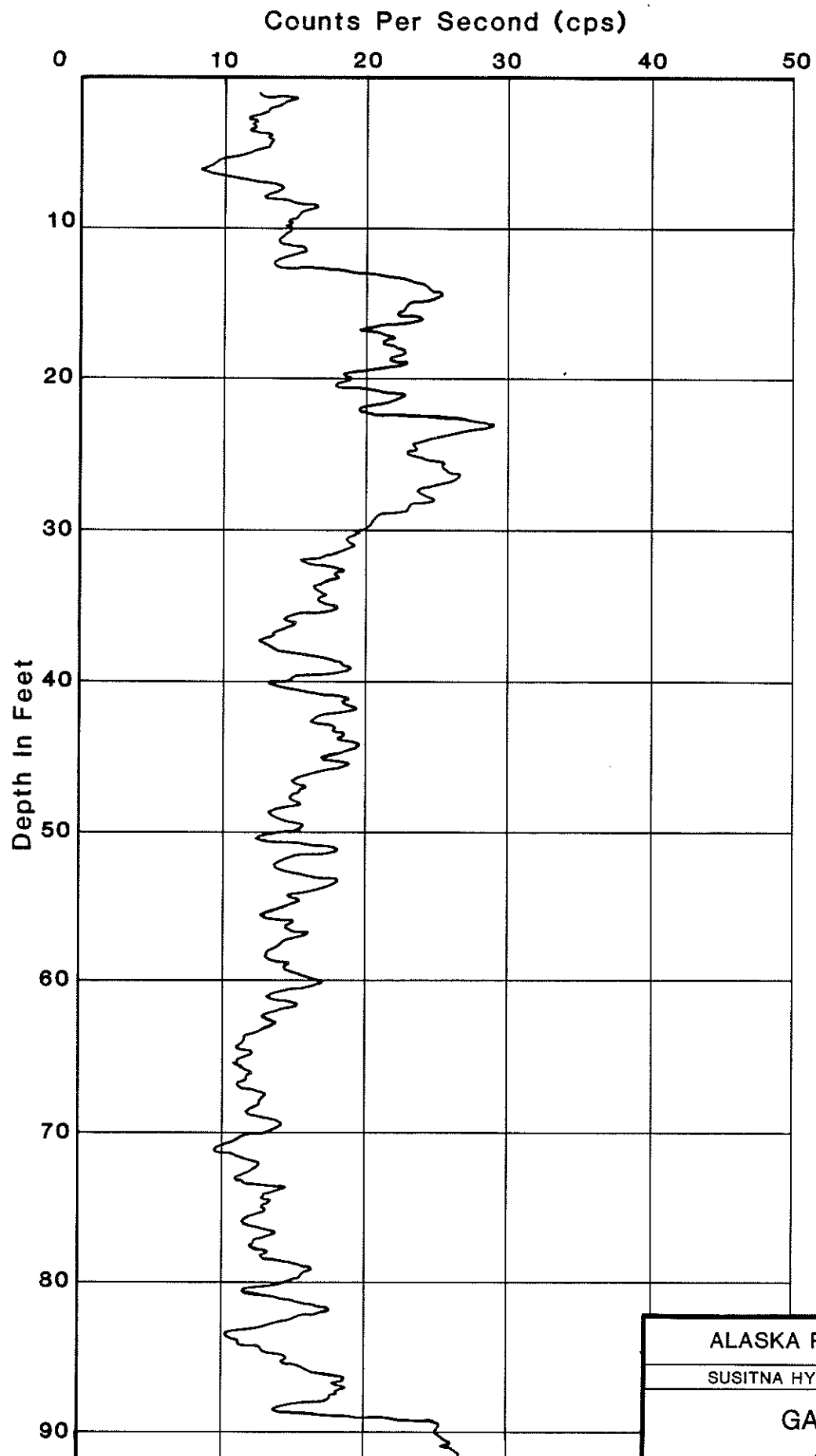
GAMMA LOG

HD83-5

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-14



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

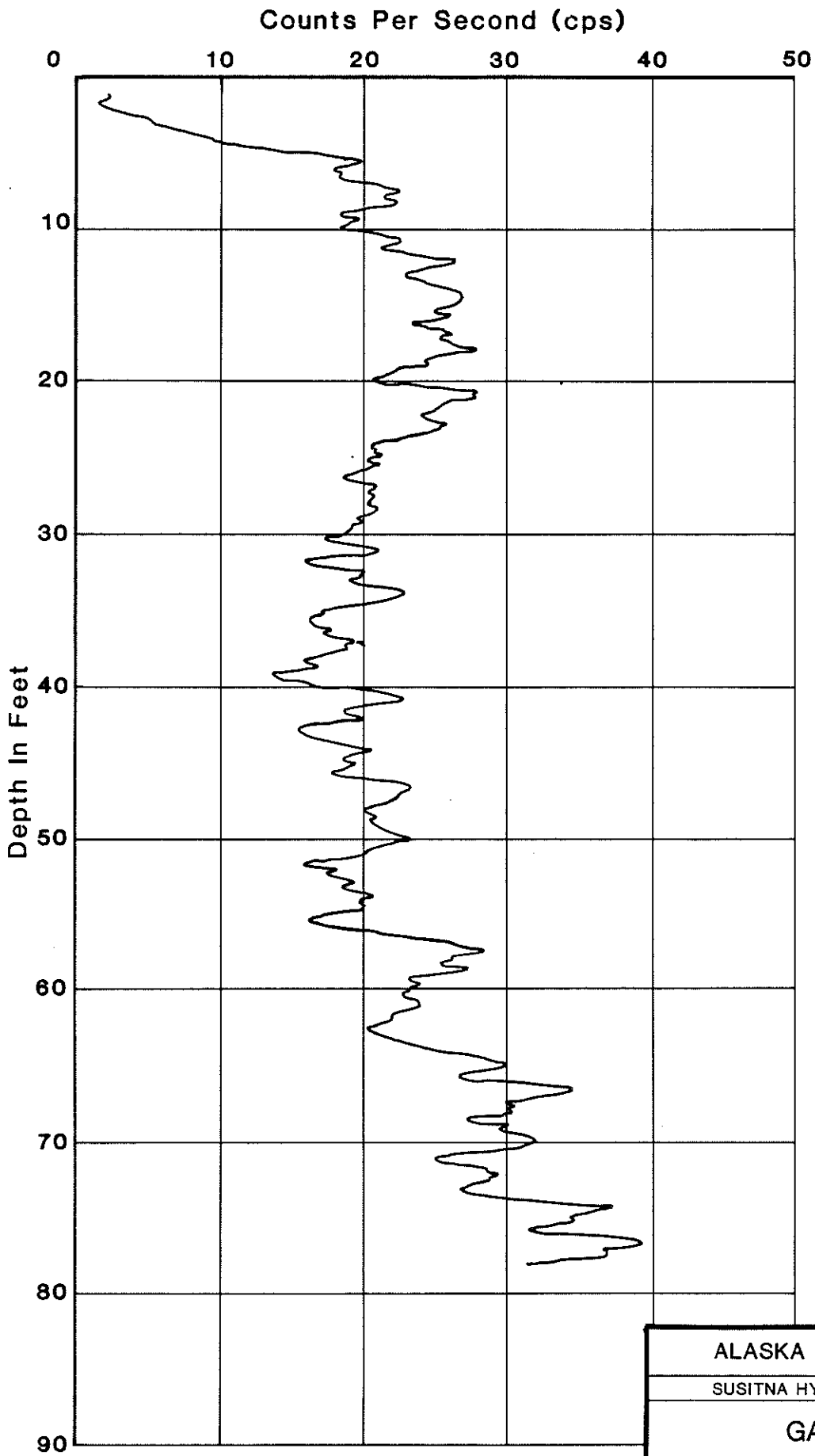
GAMMA LOG

HD83-6

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-15



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

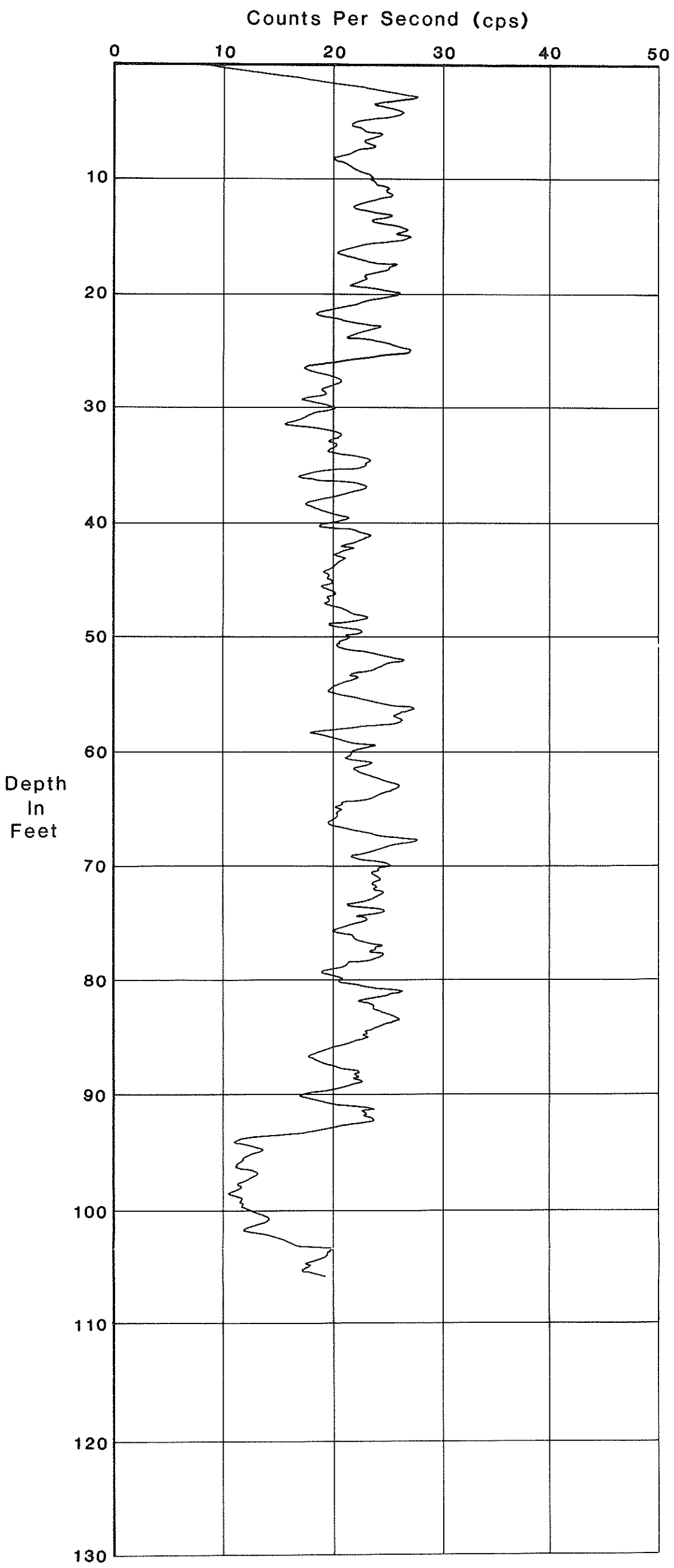
GAMMA LOG

HD83-8

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 83

FIGURE
A-16



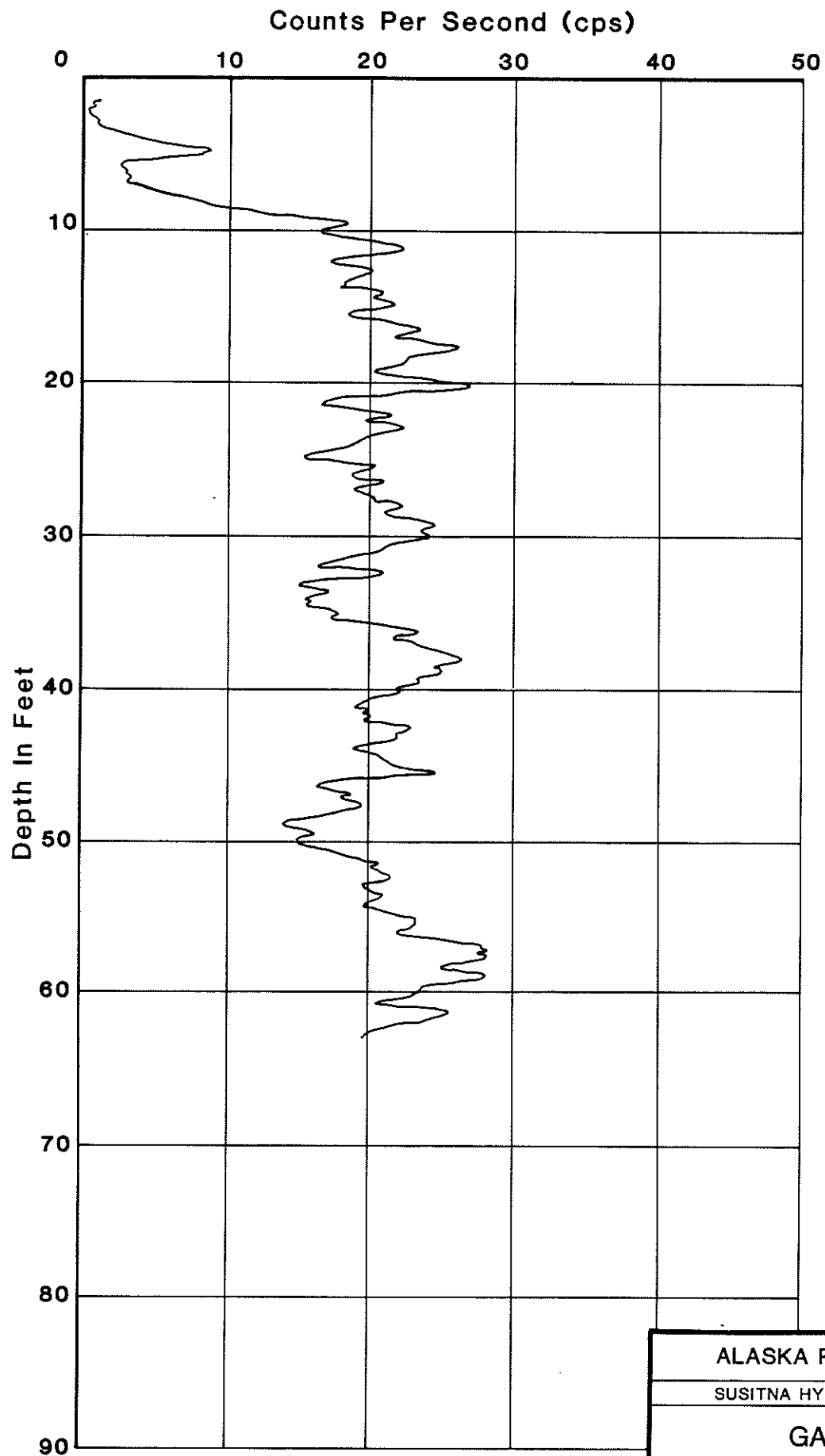
ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

HD83-9

HARZA-ESASCO
SUSITNA DIVISION
DATE
AUG83
FIGURE
A-17



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

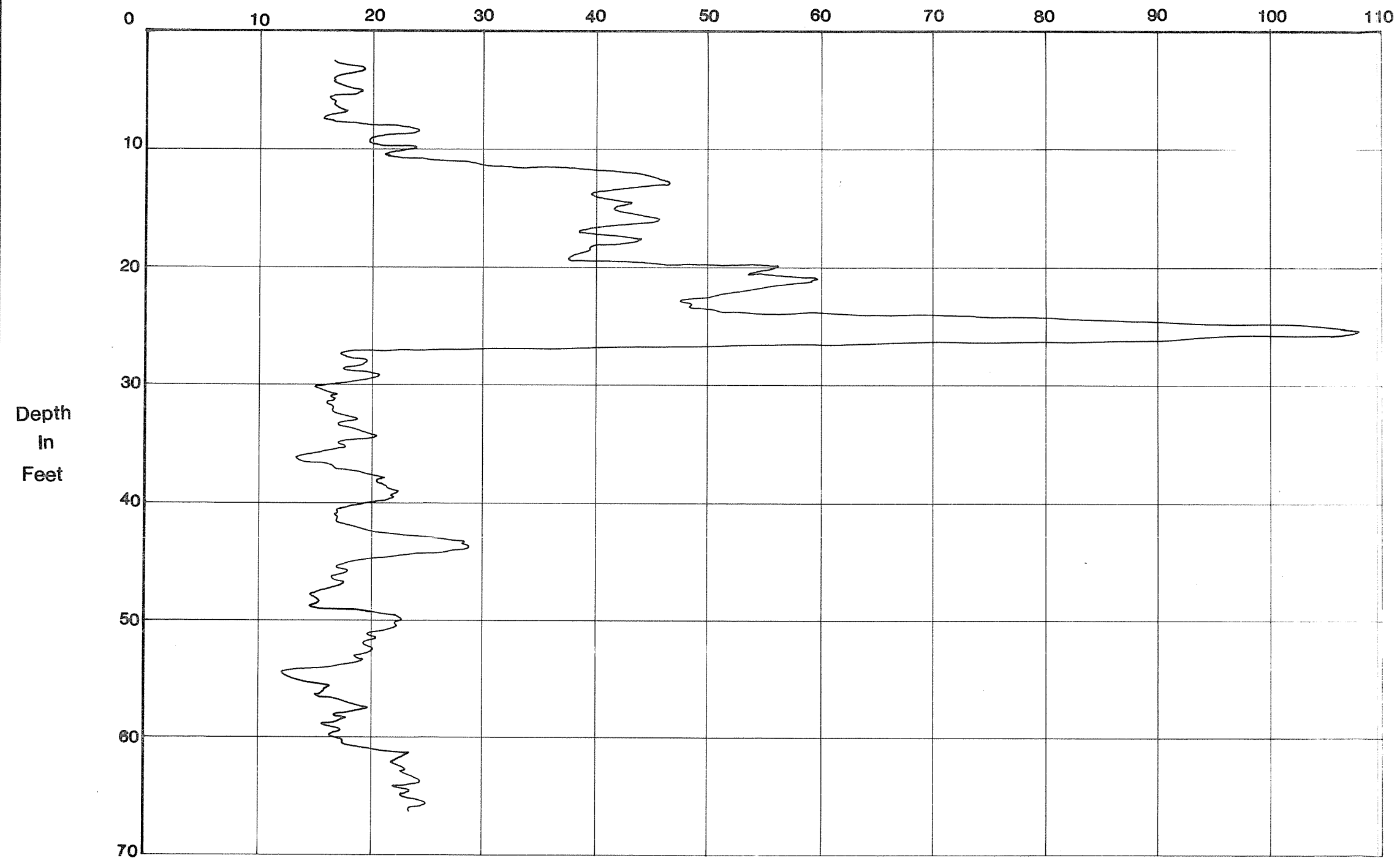
HD83-20

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-18

Counts Per Second (cps)



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

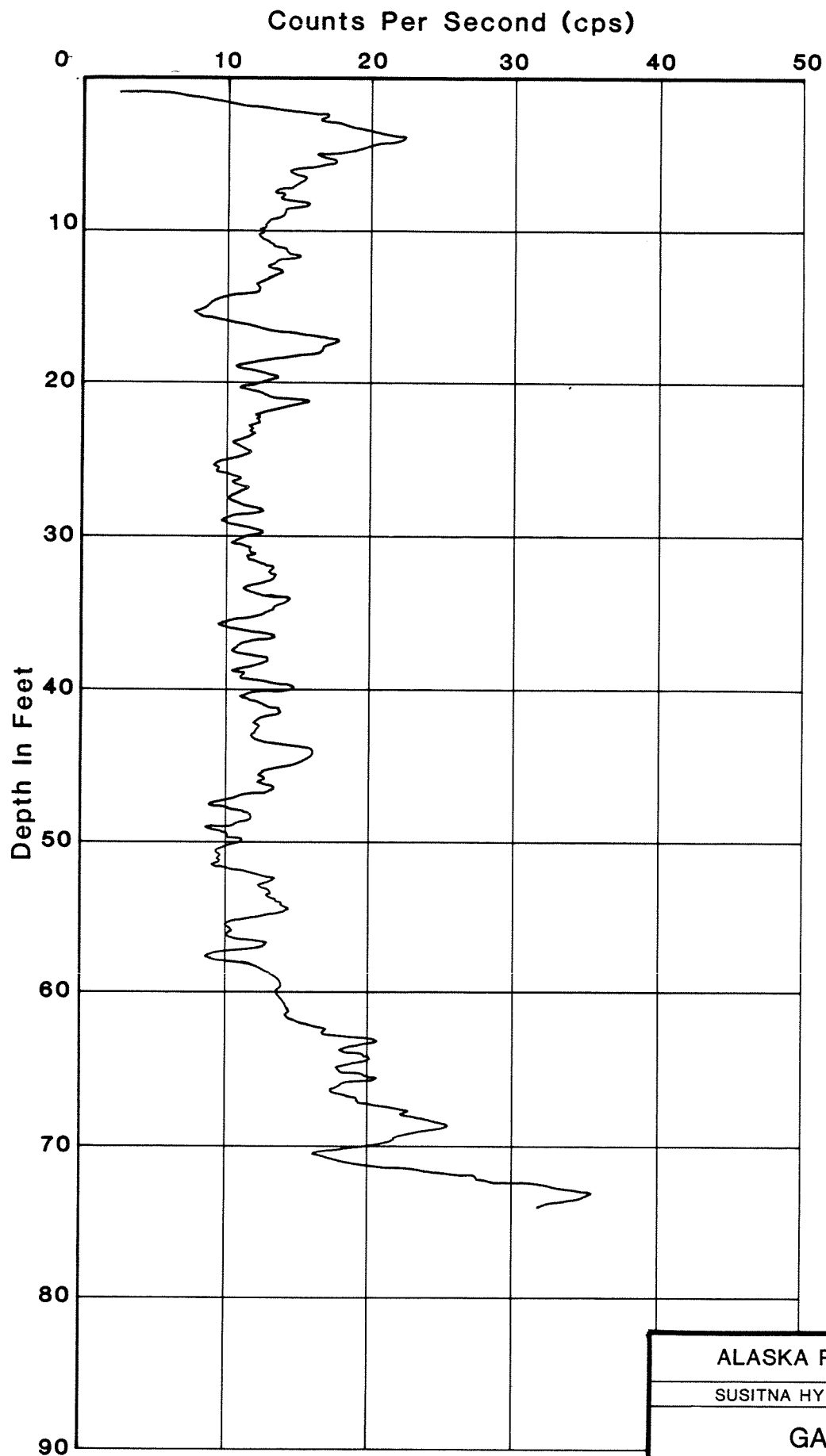
GAMMA LOG

HD83-21

MARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-19



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

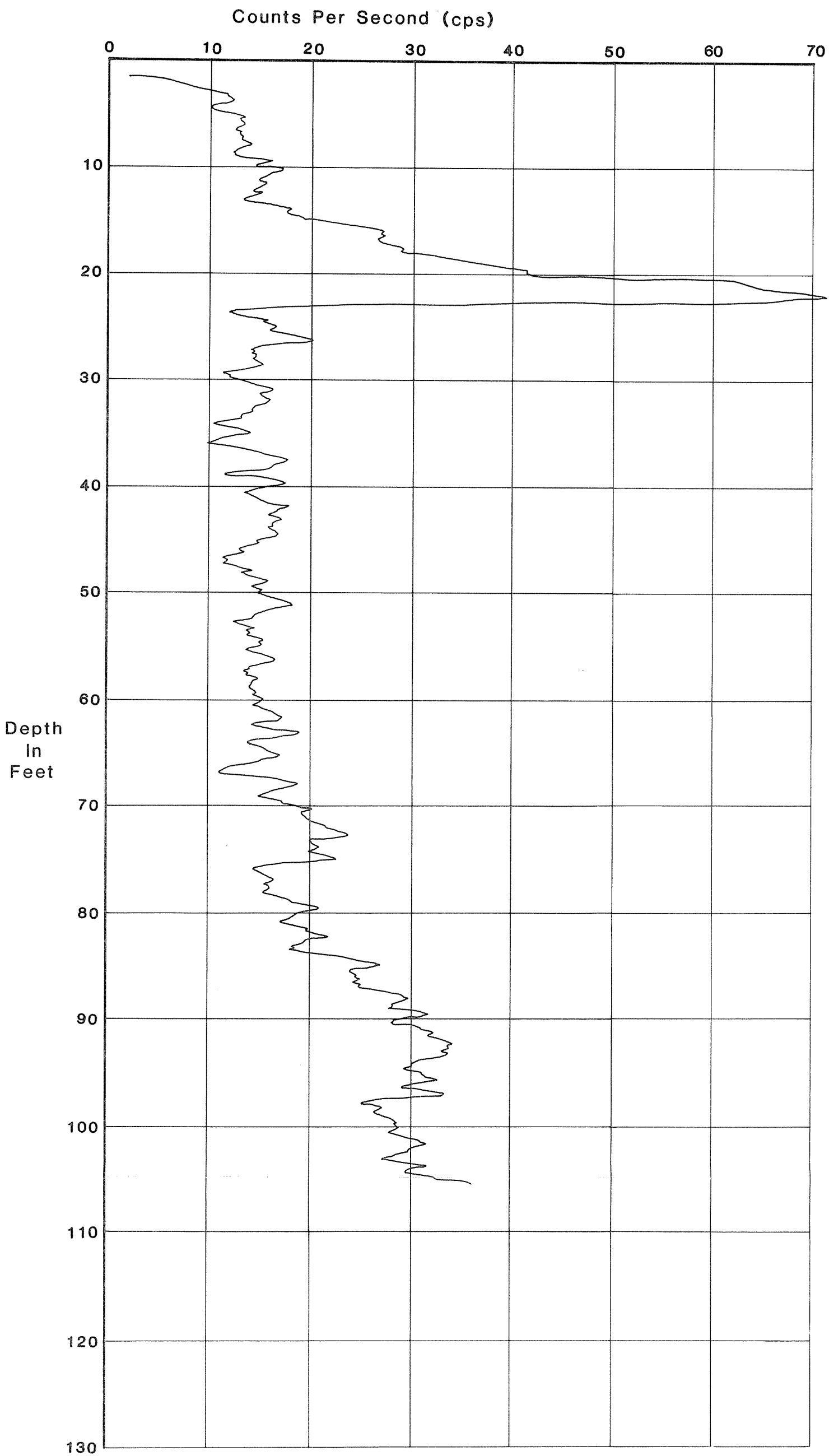
GAMMA LOG

HD83-23

HARZA-EBASCO
SUSITNA JOINT VENTURE

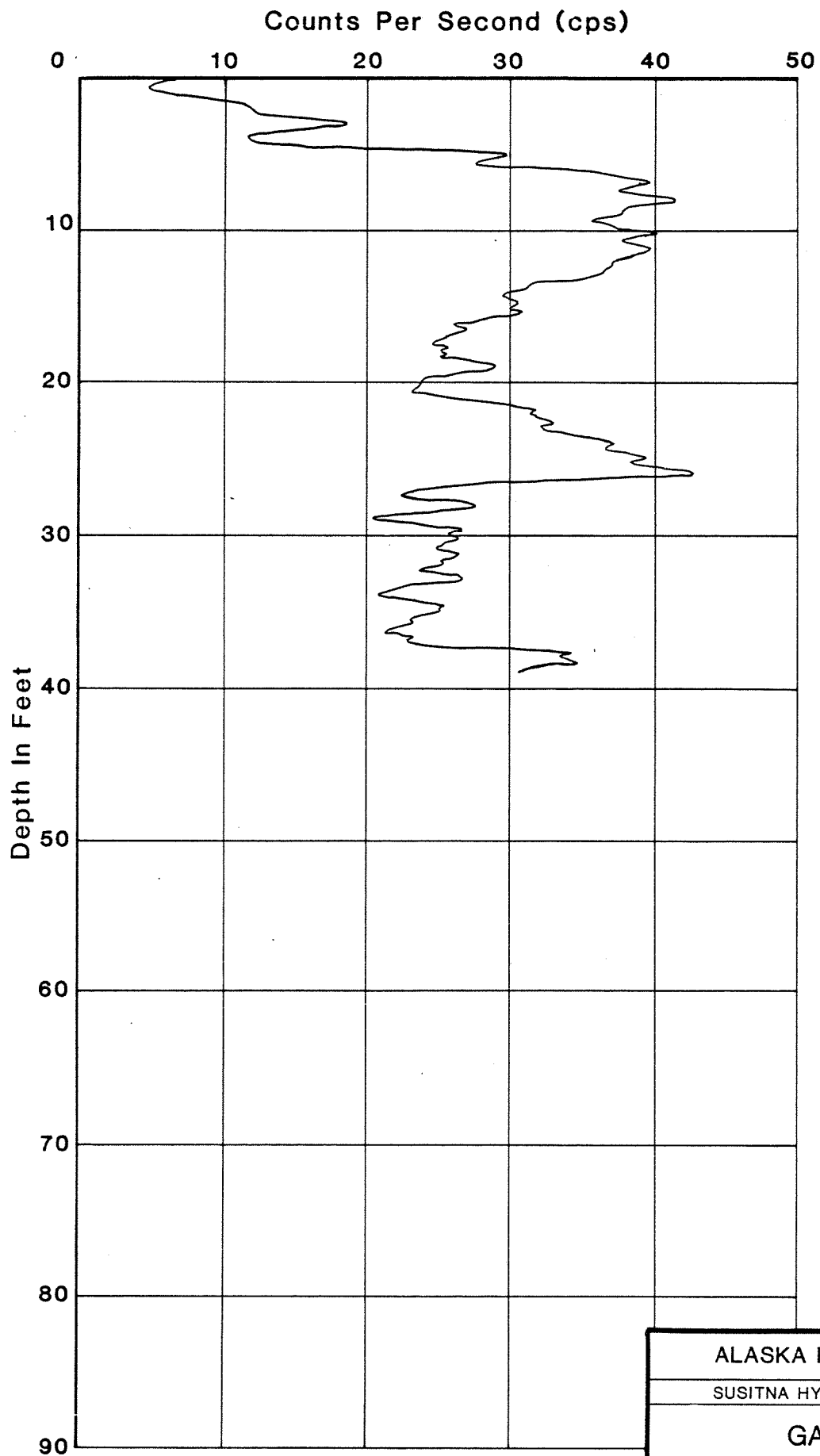
DATE
AUG.83

FIGURE
A-20



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG
HD83-22



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

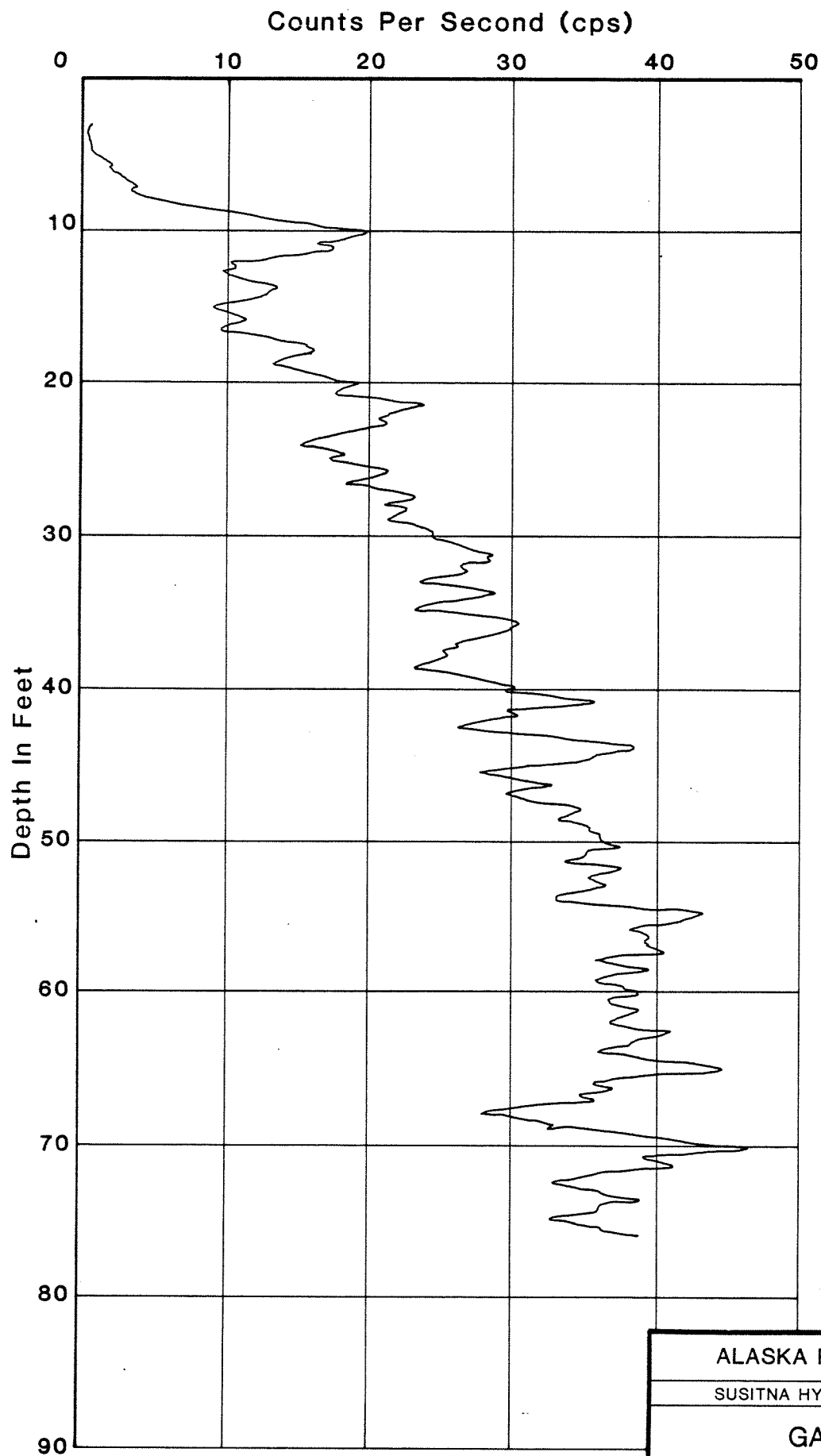
GAMMA LOG

HD83-24

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-22



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

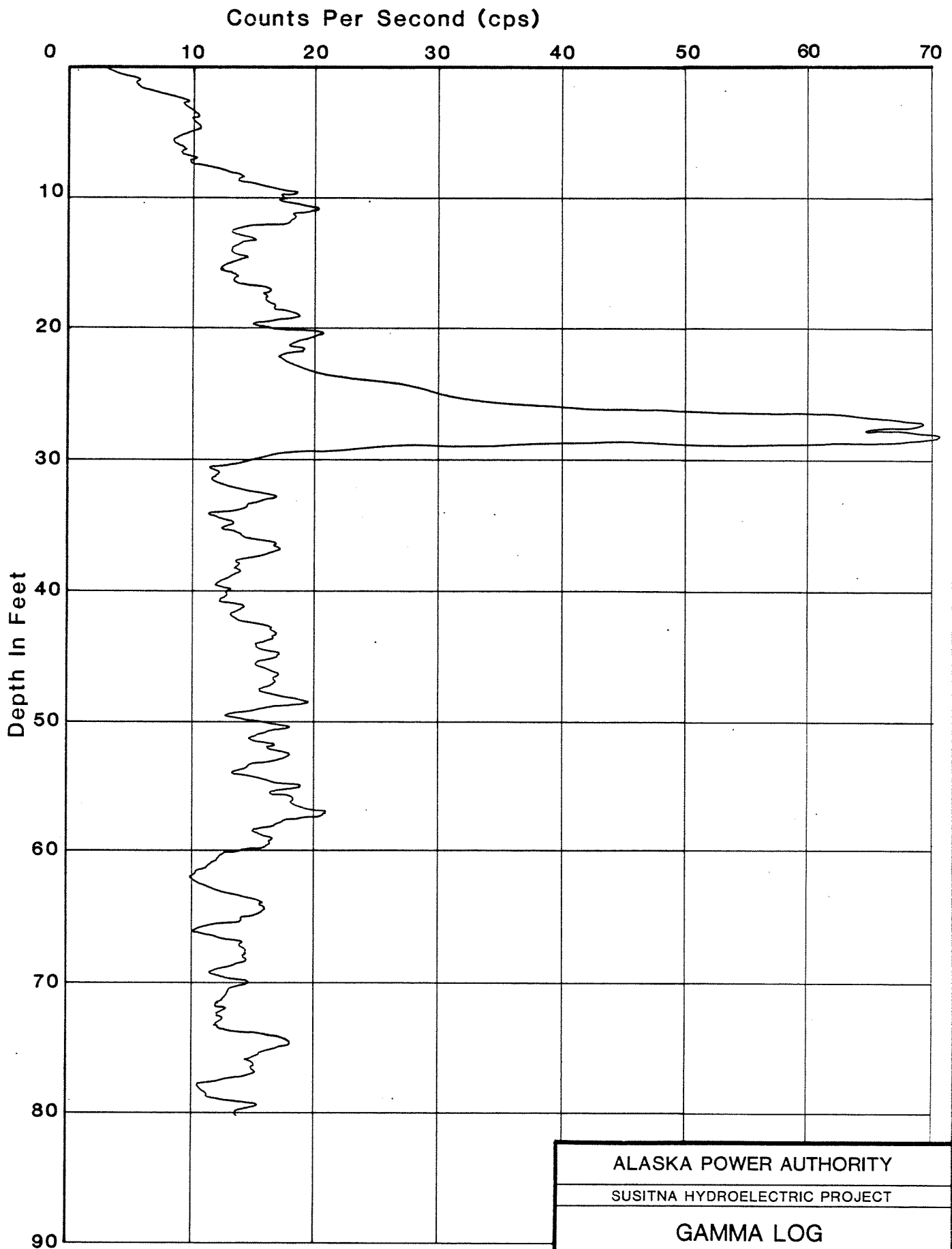
GAMMA LOG

HD83-26

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 23



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

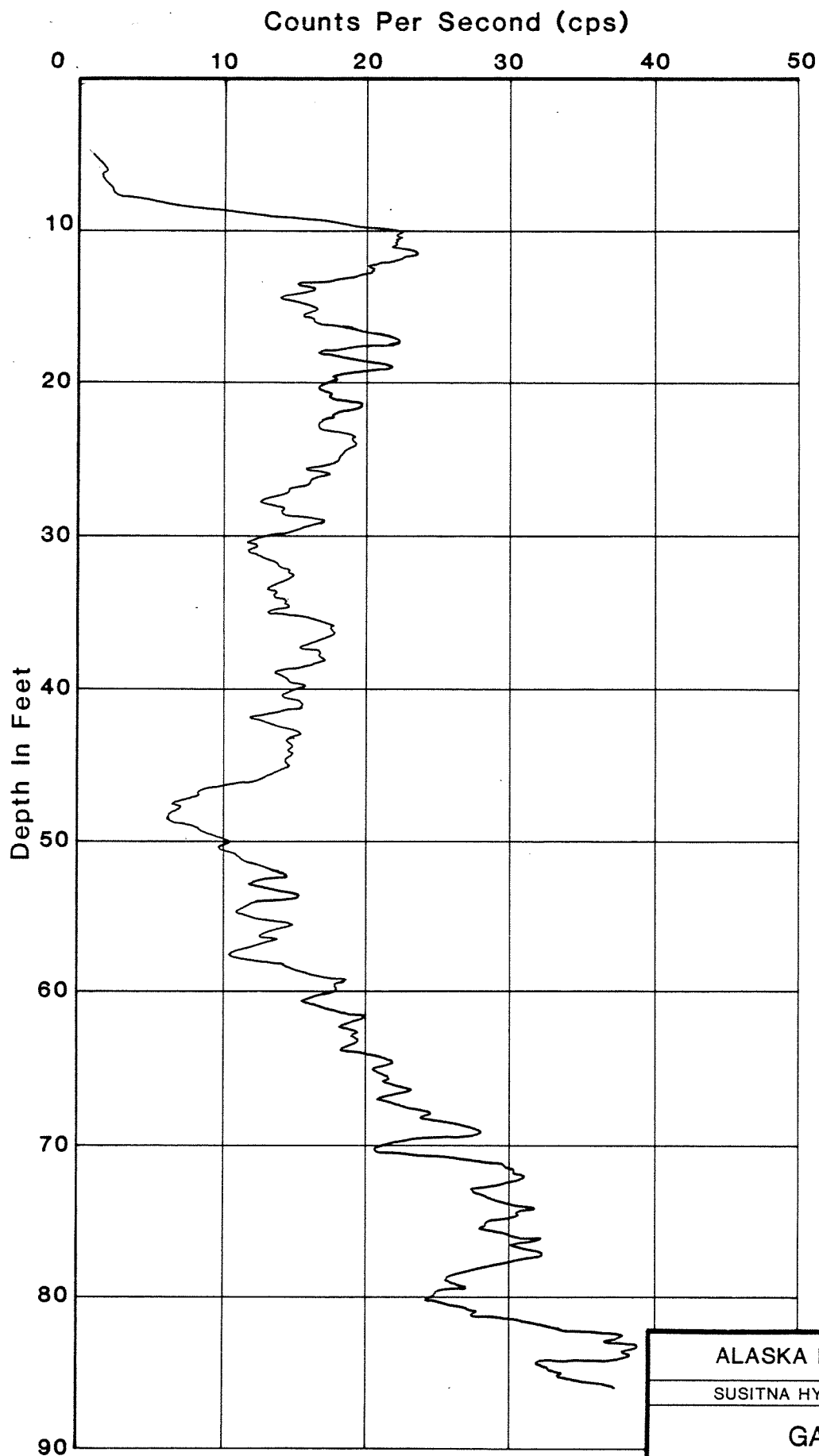
GAMMA LOG

HD83-27

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 24



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

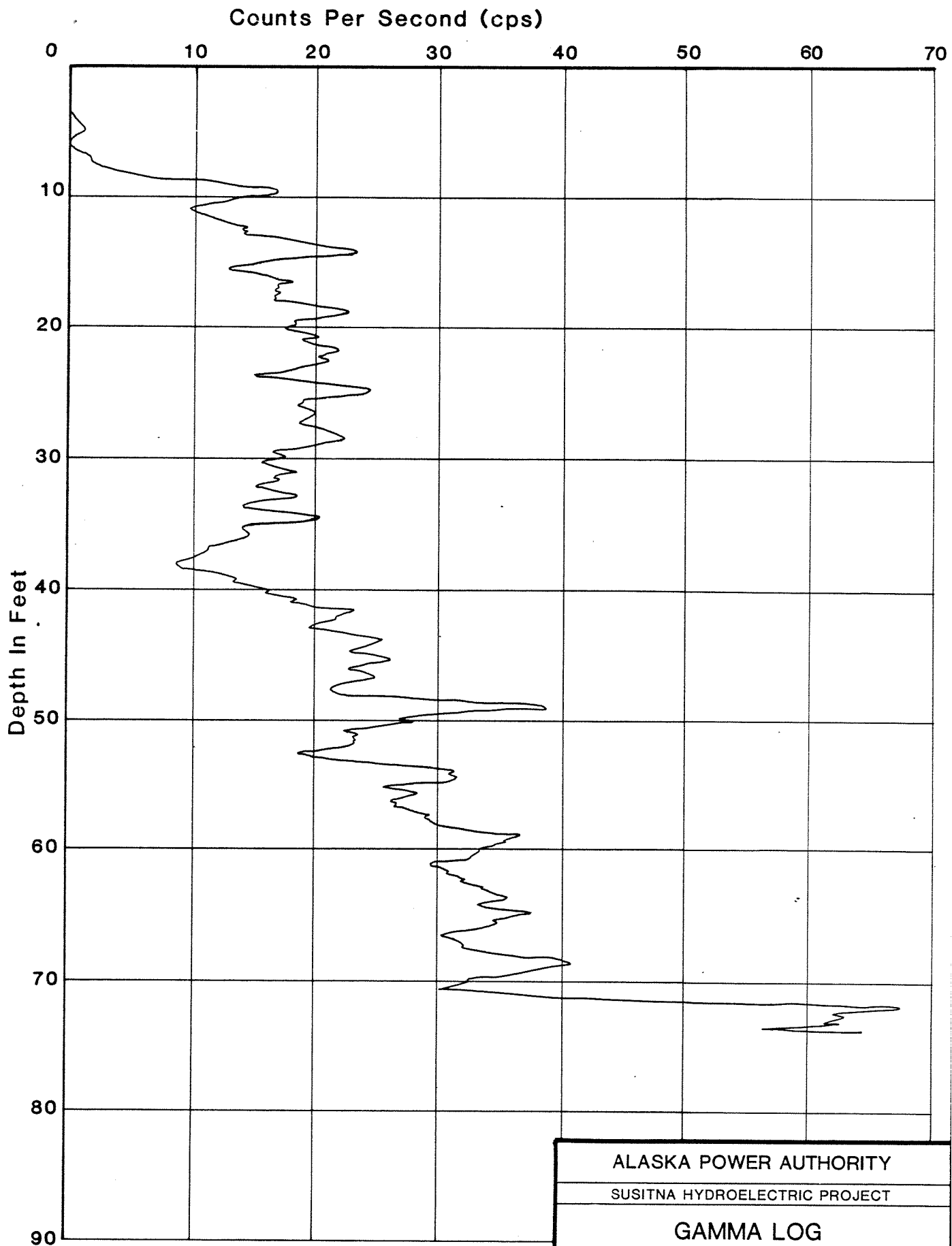
GAMMA LOG

HD83-28

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 25



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

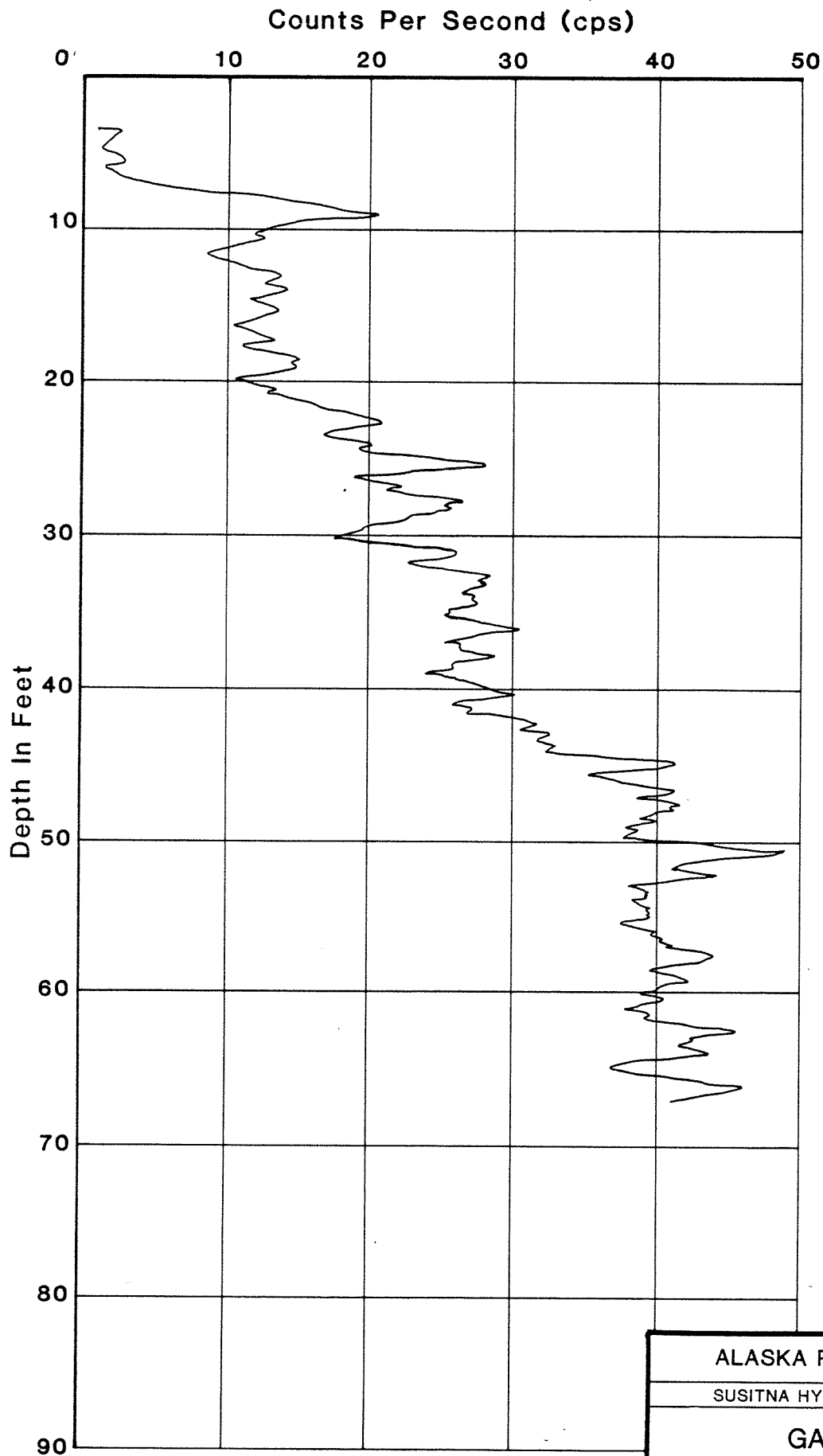
GAMMA LOG

HD83-29

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG. 83

FIGURE
A-26



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

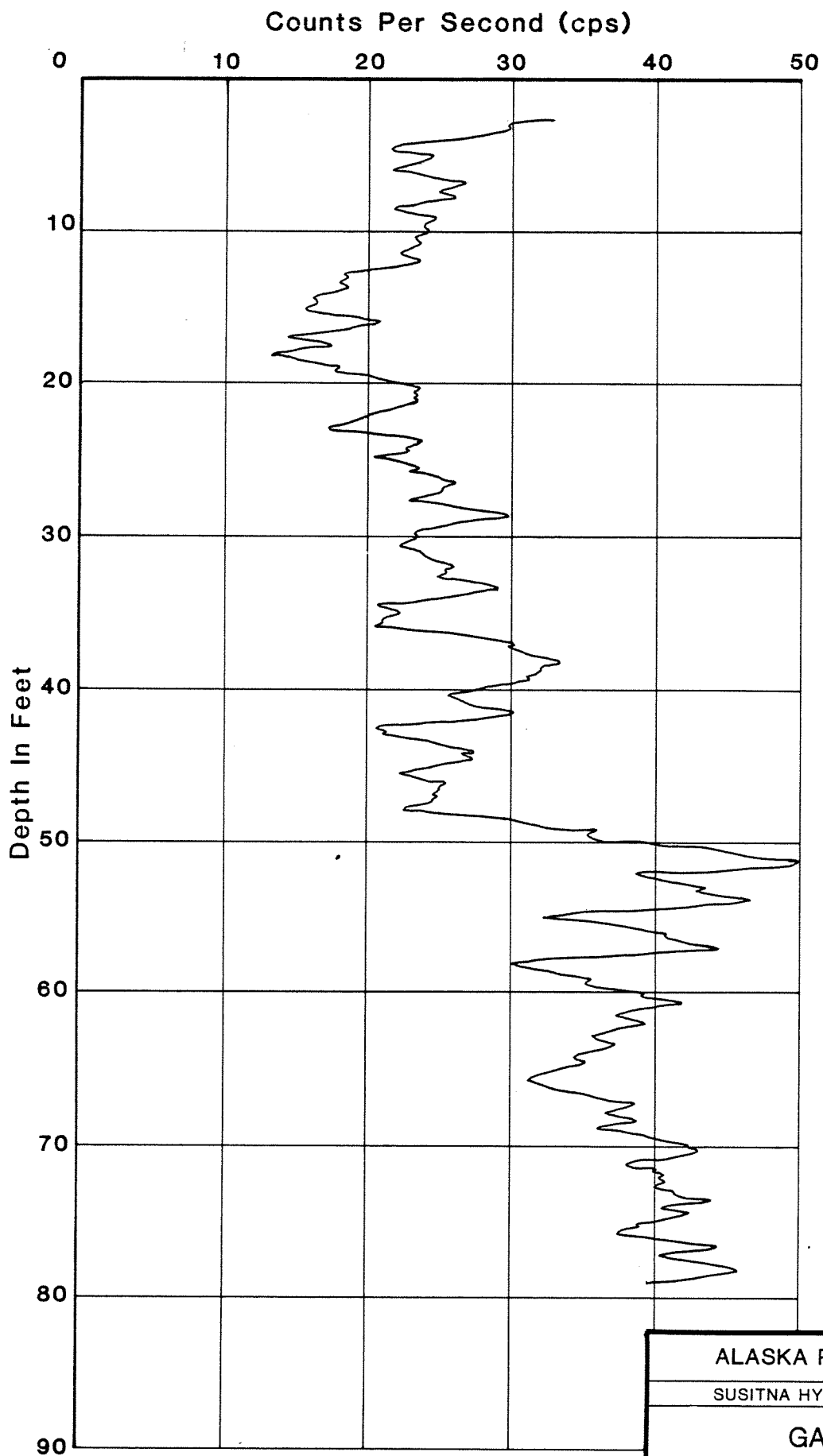
GAMMA LOG

HD83-30

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A -27



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

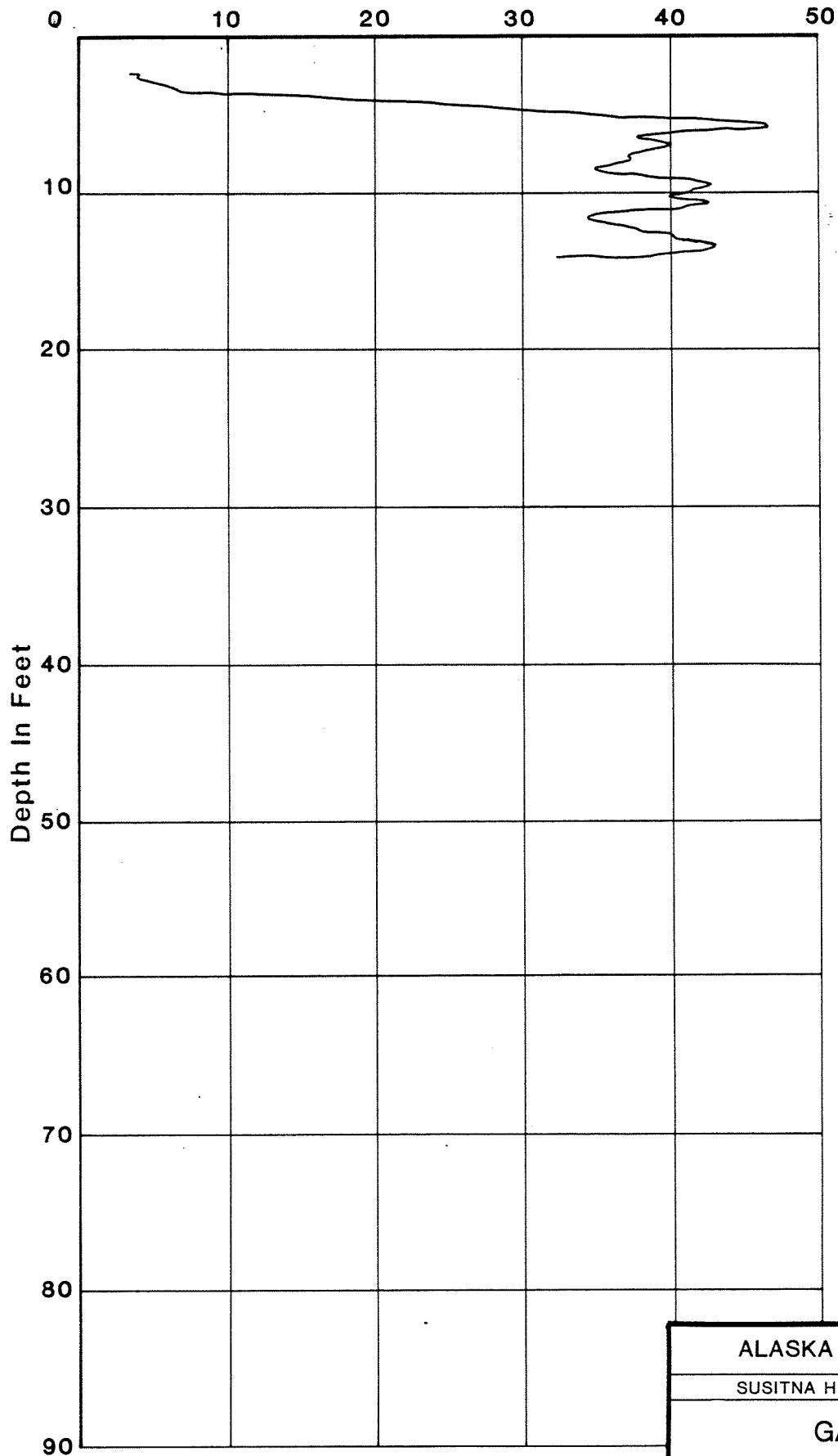
HD83-31

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-28

Counts Per Second (cps)



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

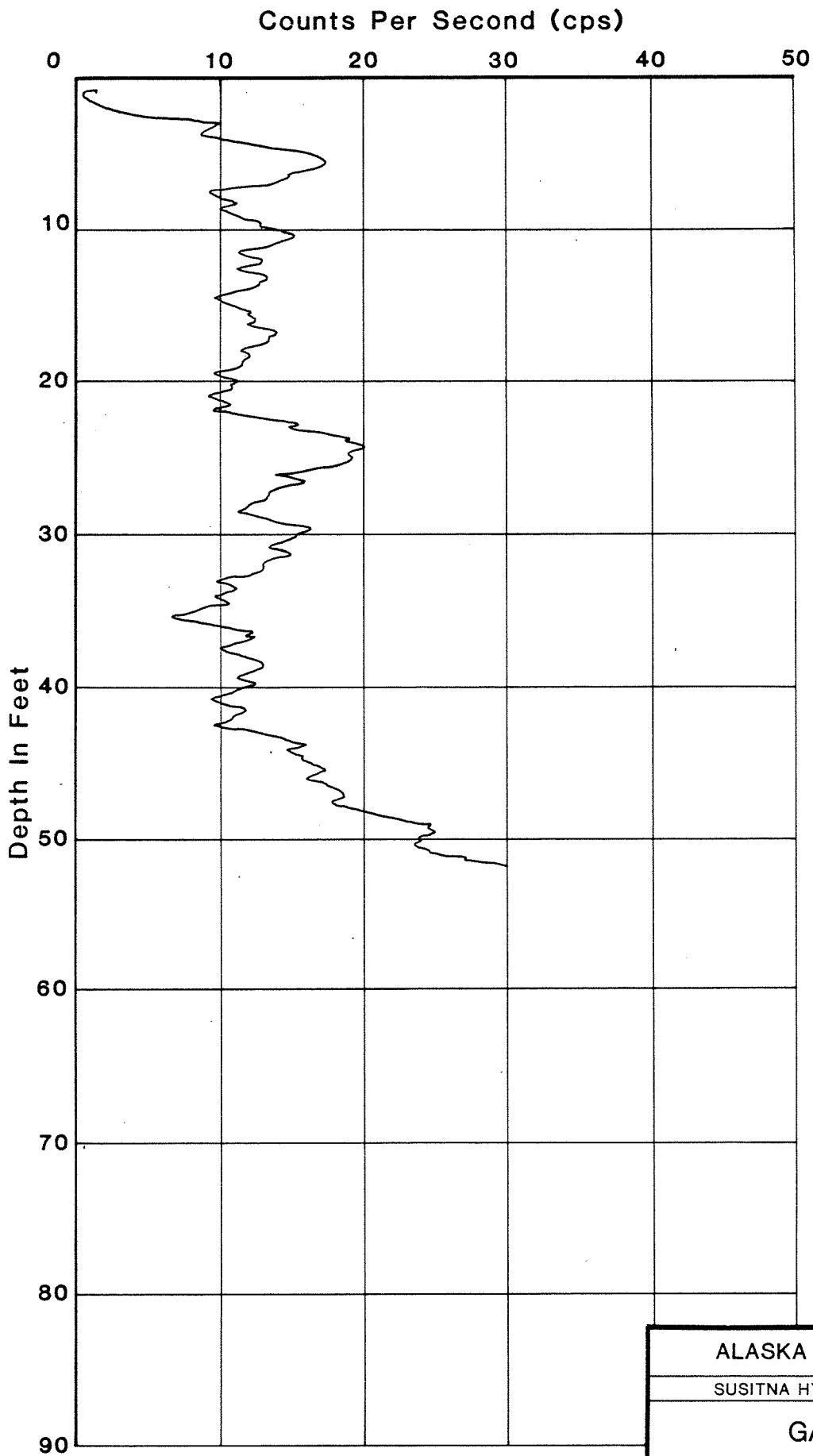
GAMMA LOG

HD83-34

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-29



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

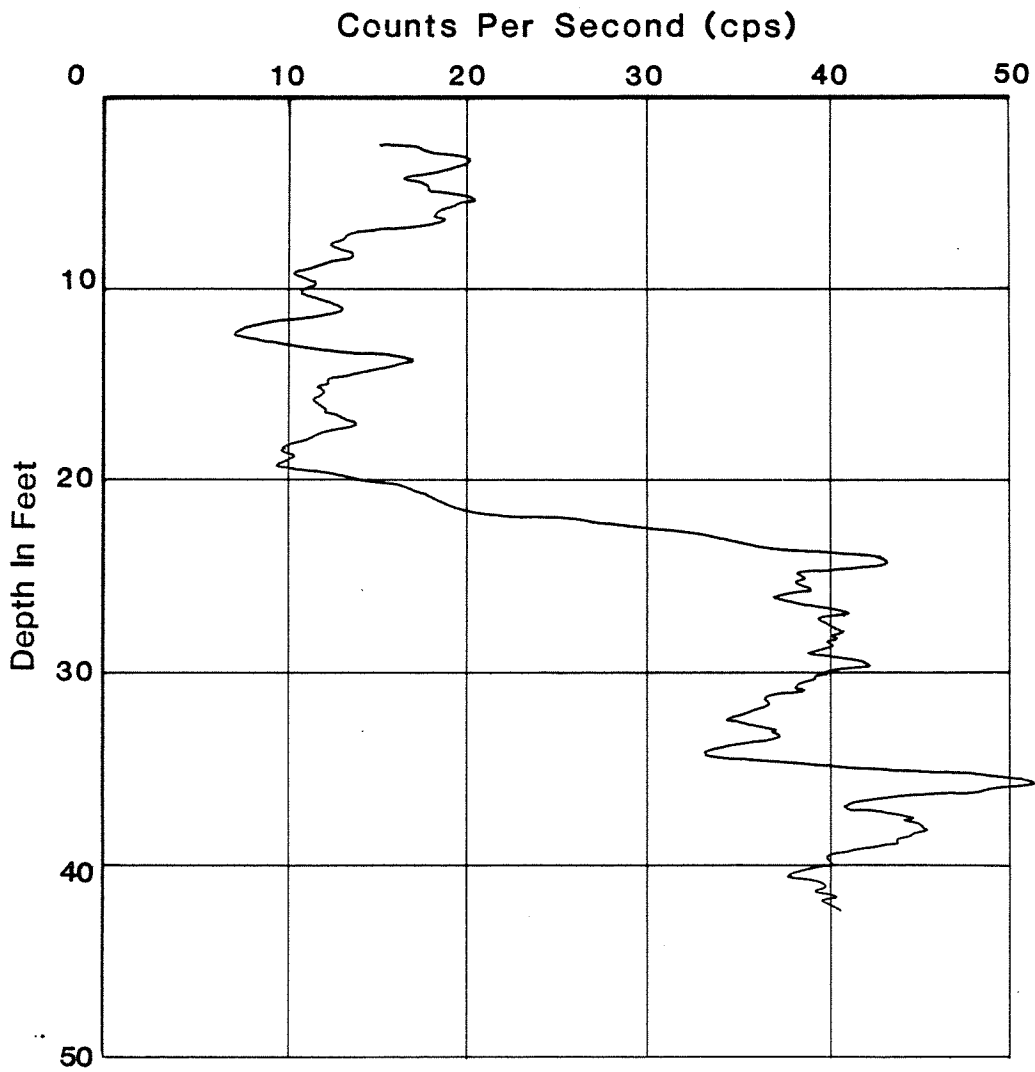
GAMMA LOG

HD83-35

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-30



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

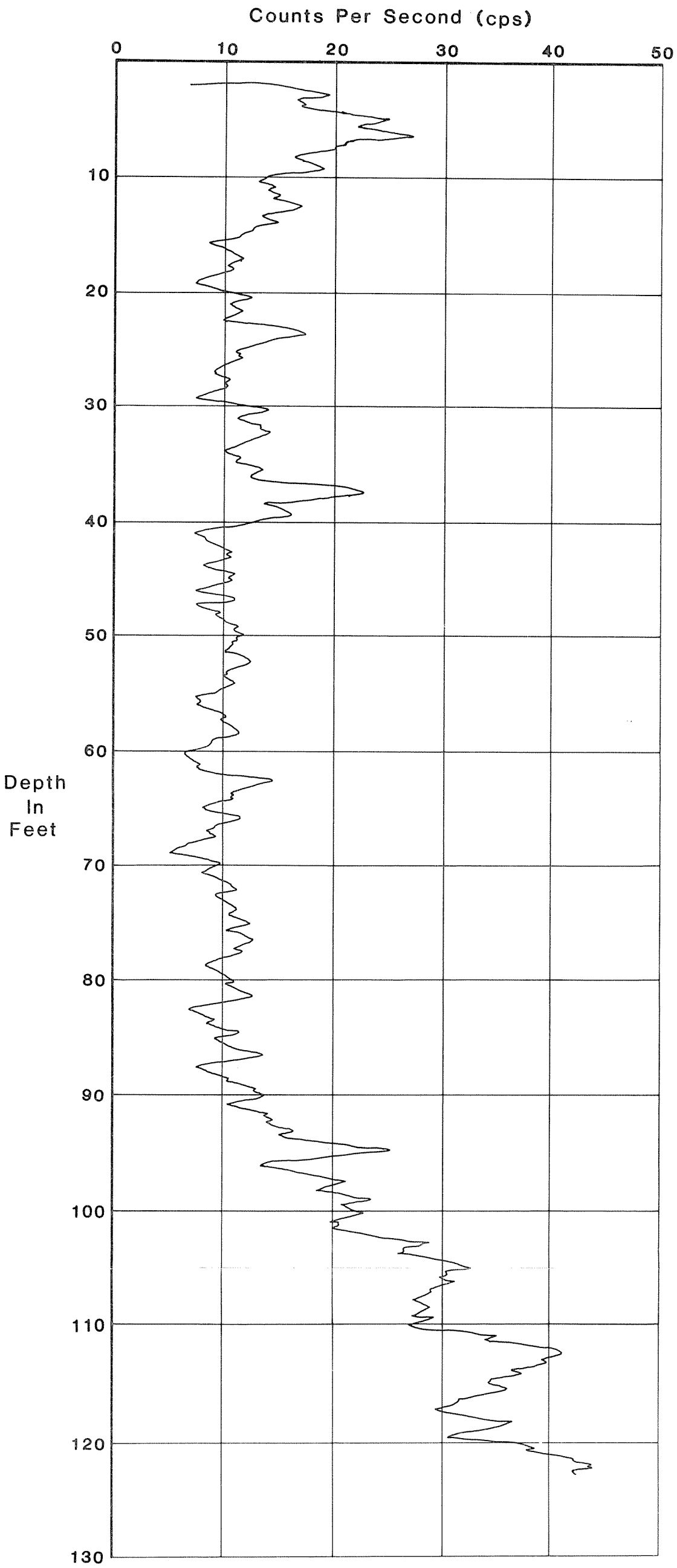
GAMMA LOG

HD83-36

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-31



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

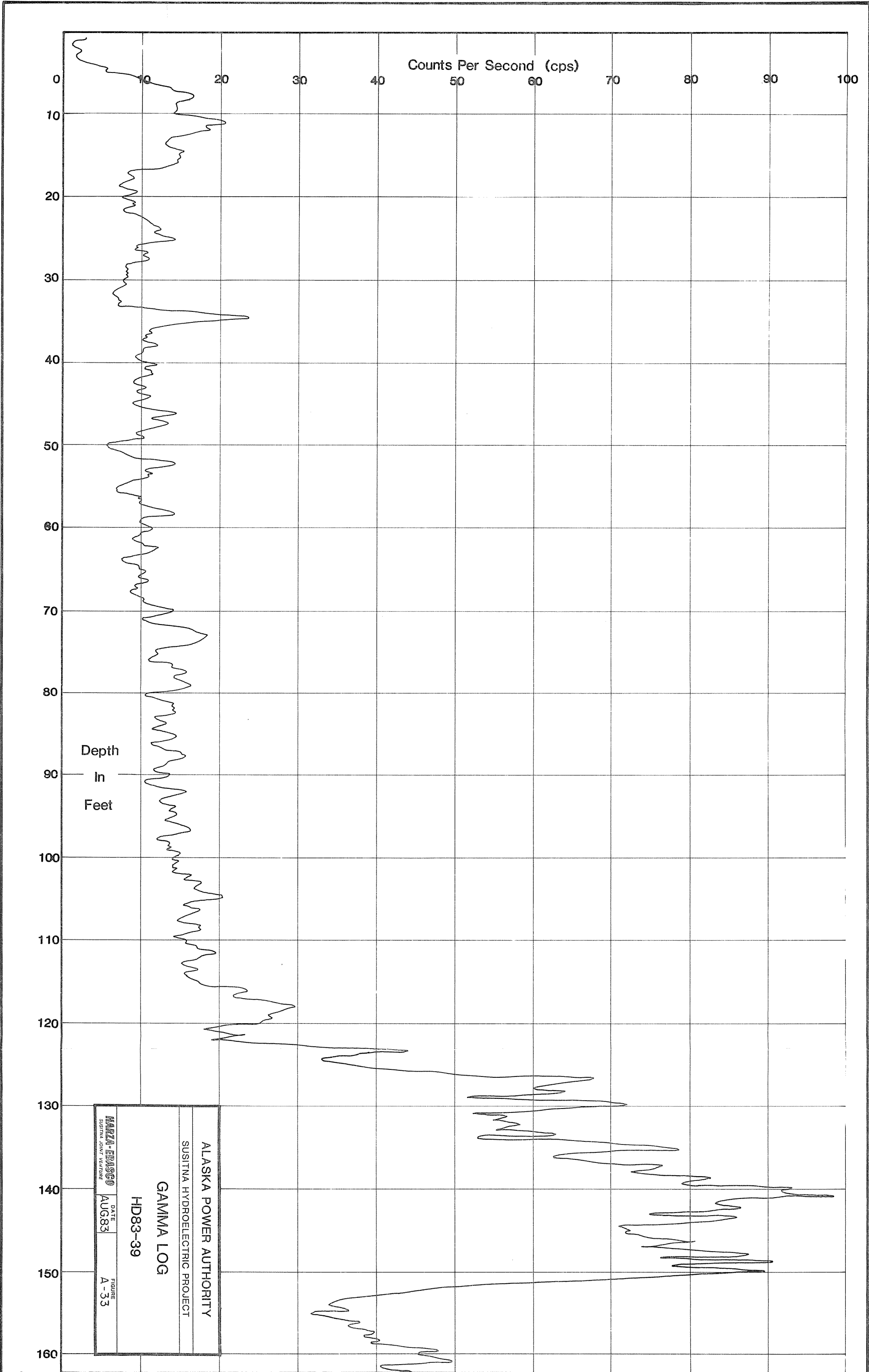
GAMMA LOG

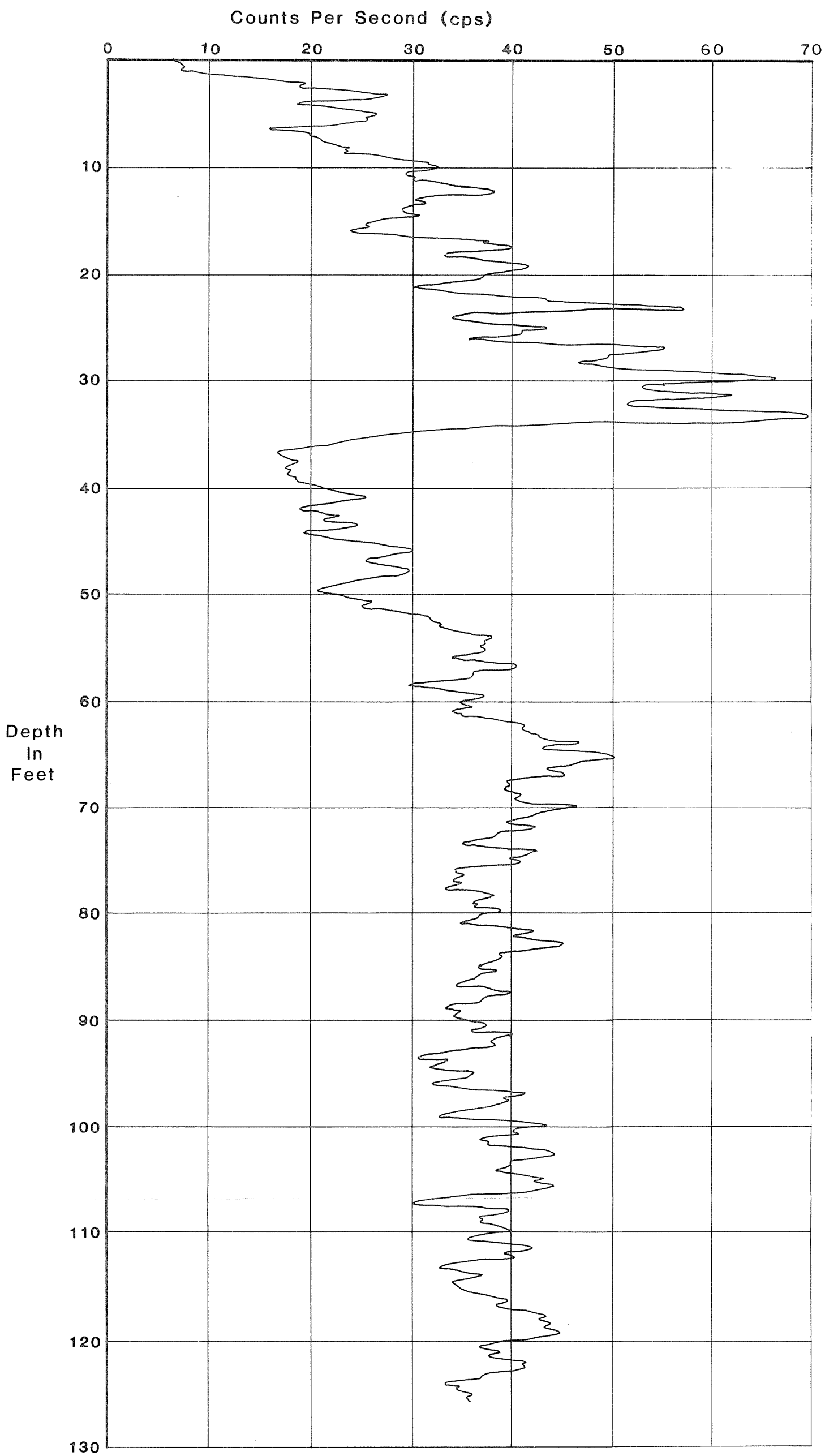
HD83-37

MARZA-ESASCO
SUSITNA JOINT VENTURE

DATE
AUG 83

FIGURE
A-32





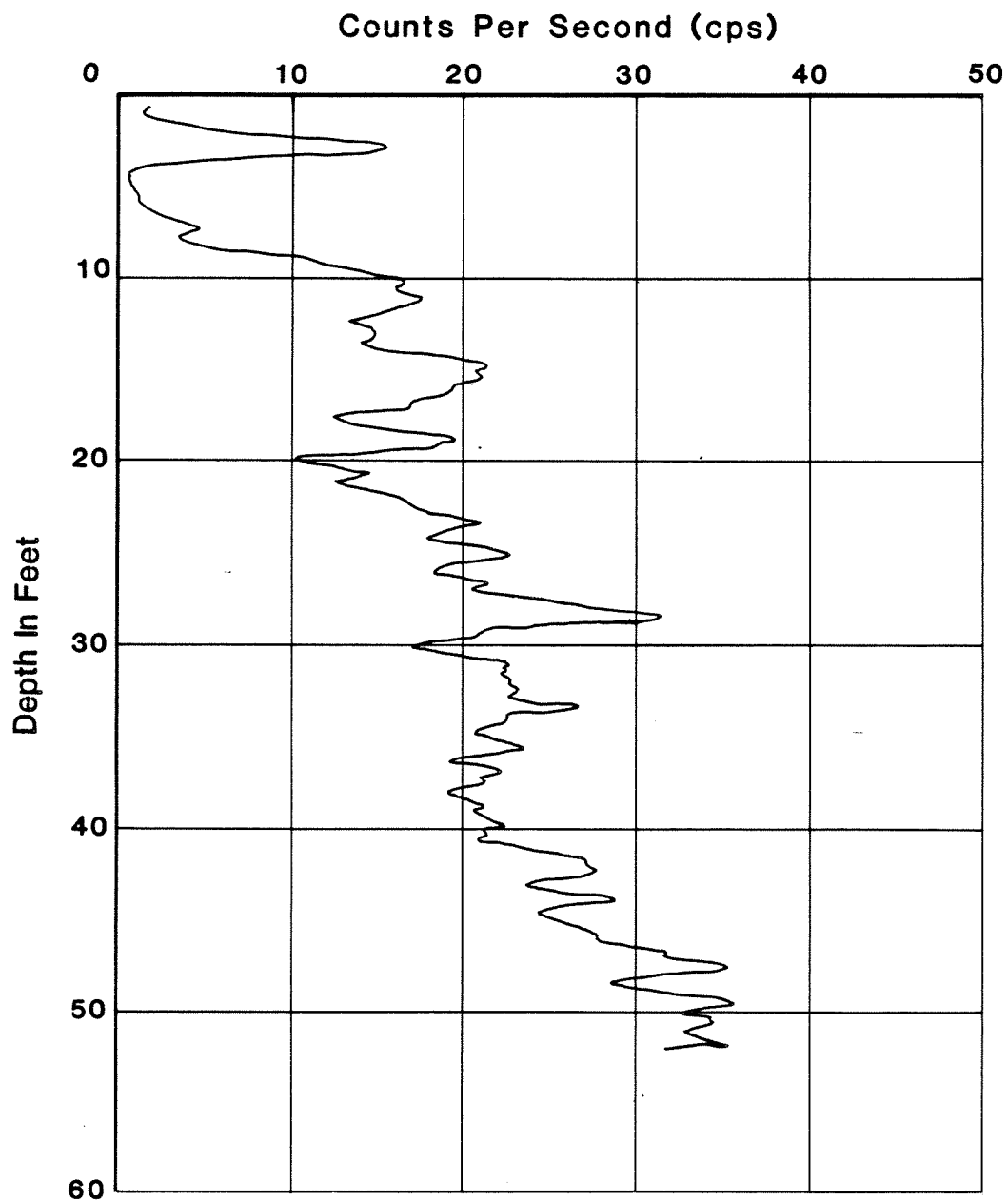
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG
HD83-42

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-34



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

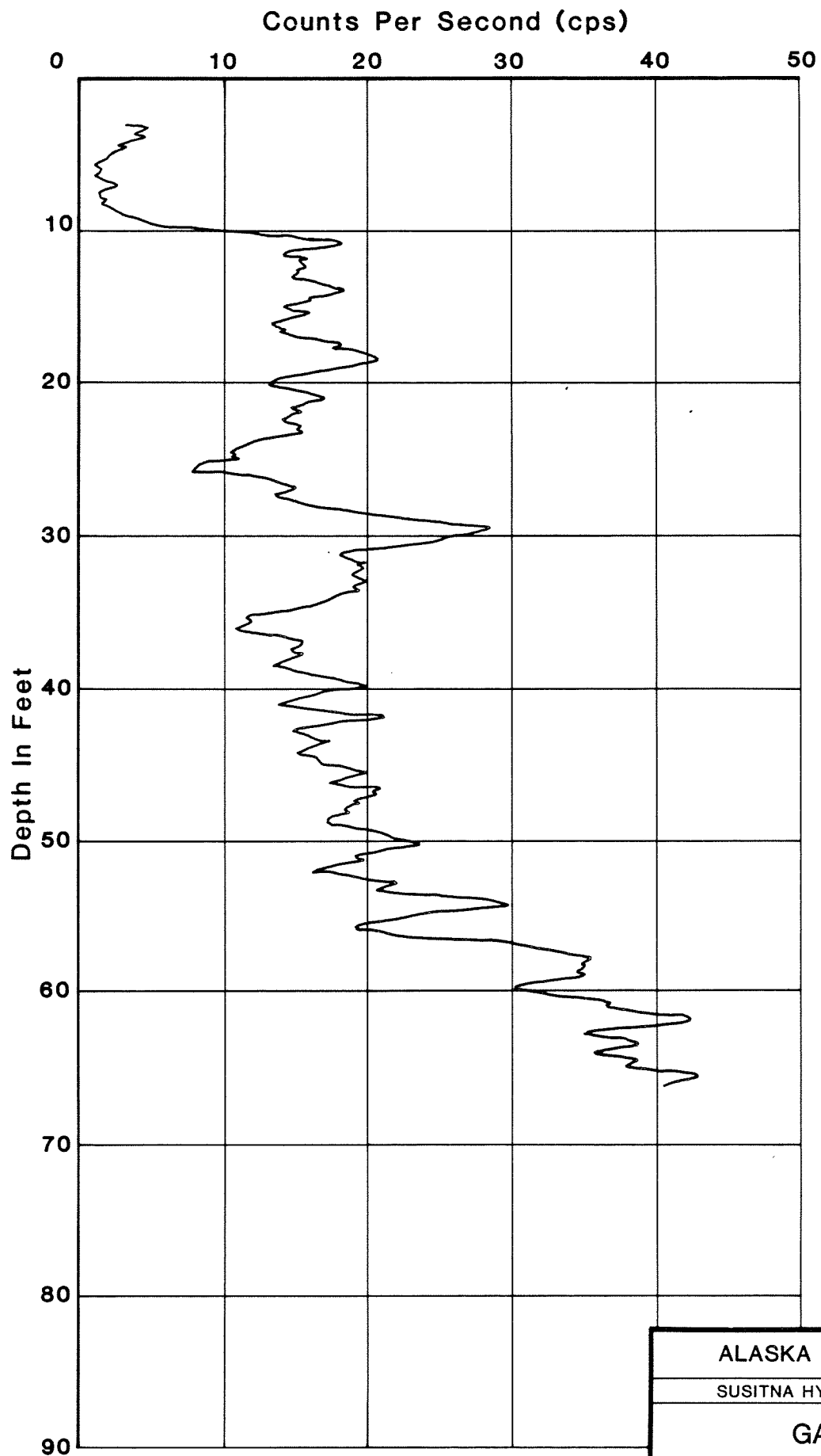
GAMMA LOG

HD83-43

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-35



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

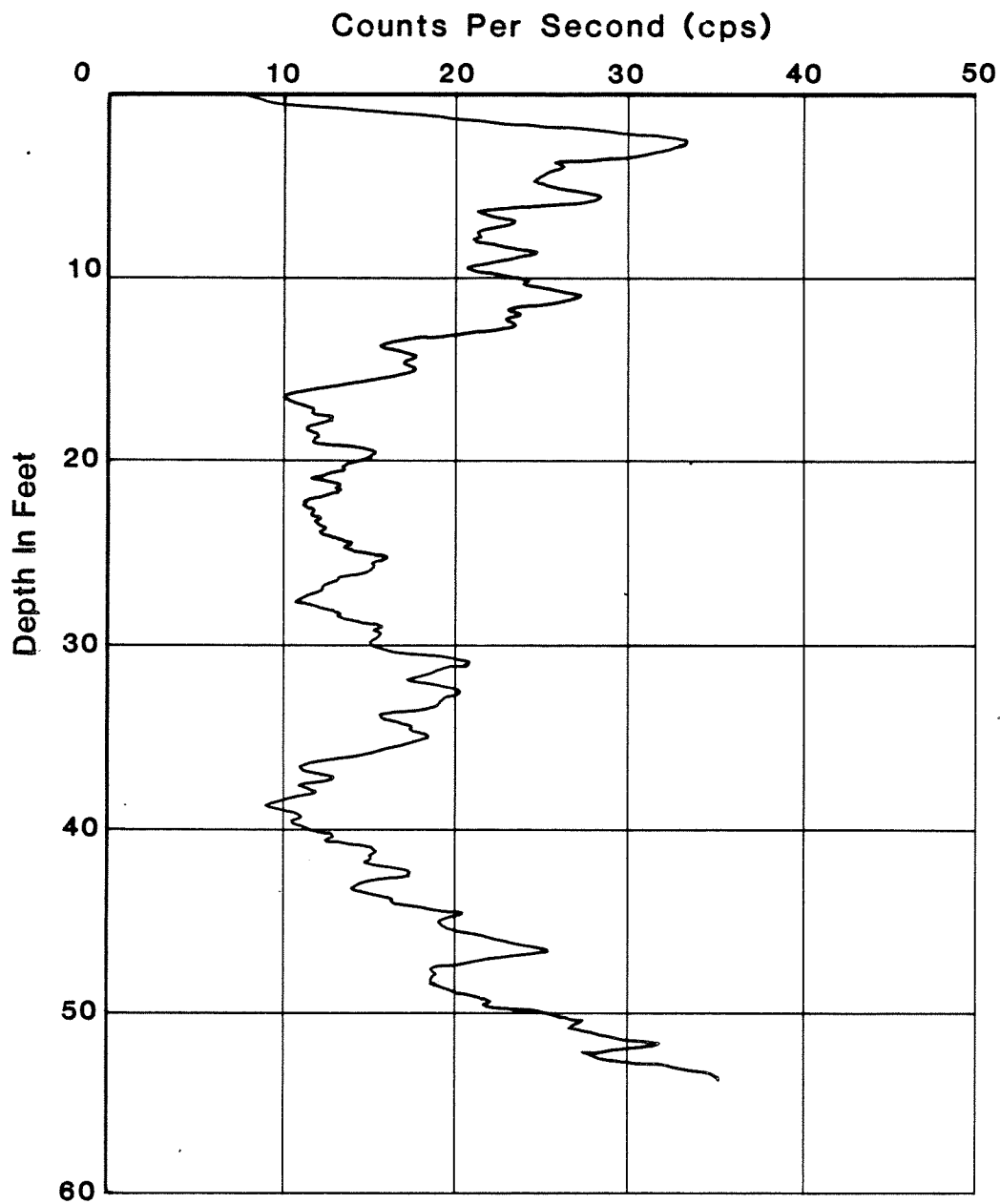
GAMMA LOG

HD83-44

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-36



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

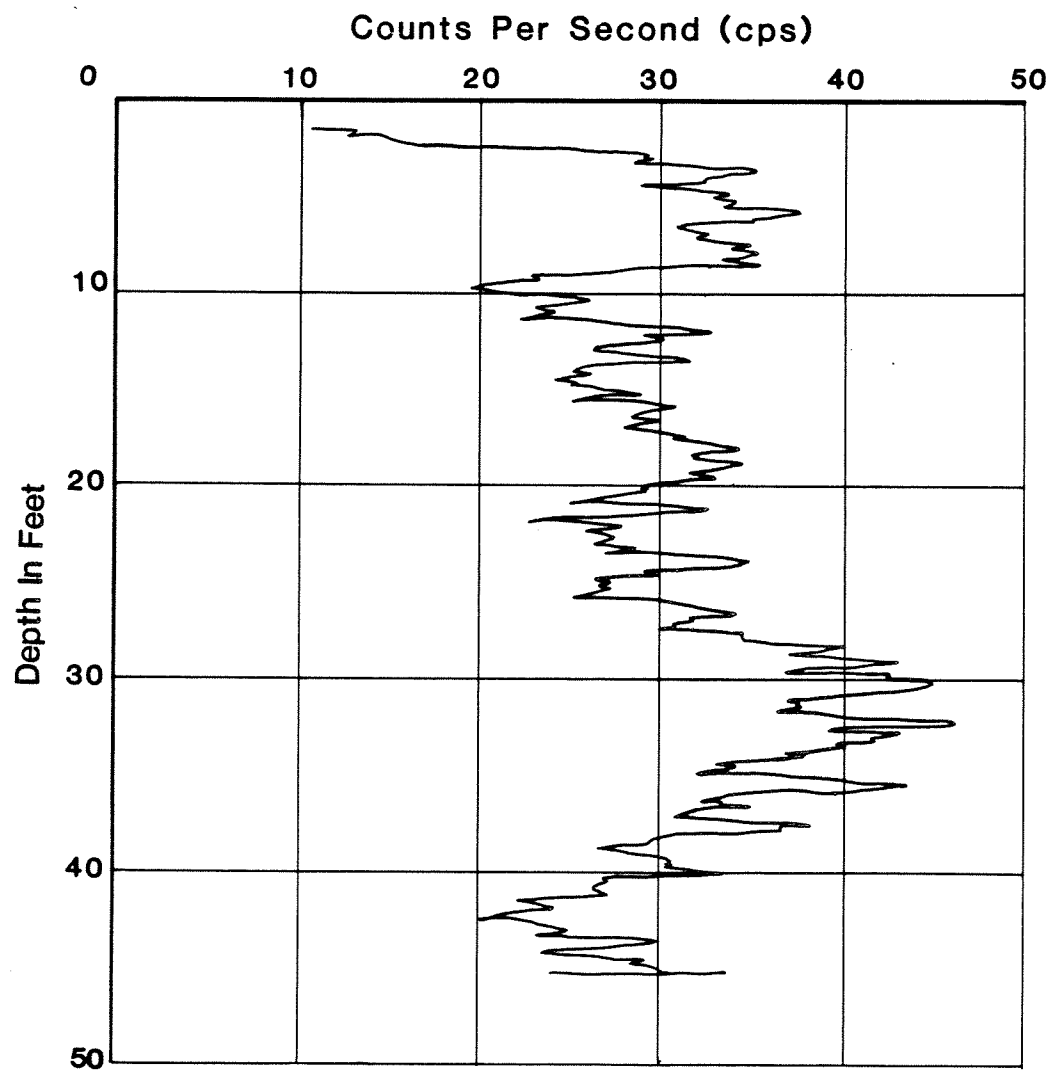
GAMMA LOG

HD83-46

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-37



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

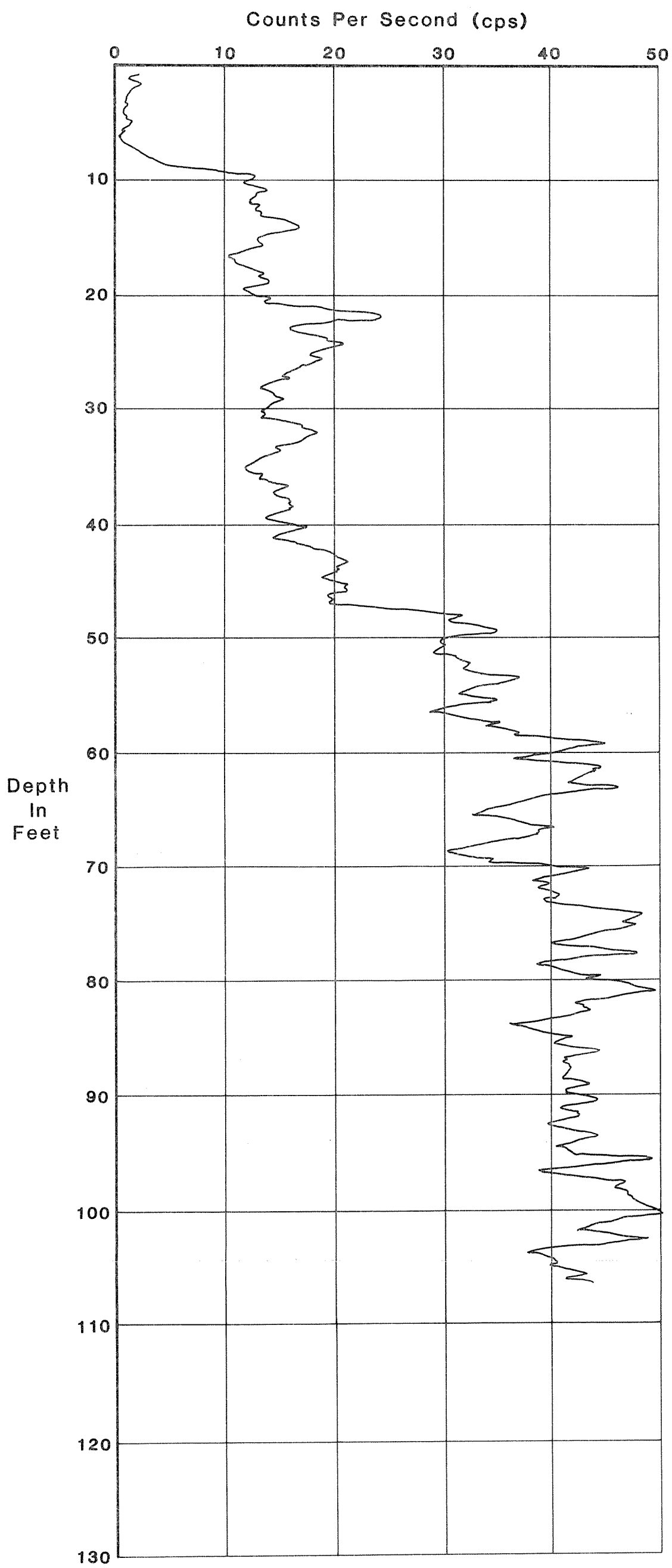
GAMMA LOG

HD83-45

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-38

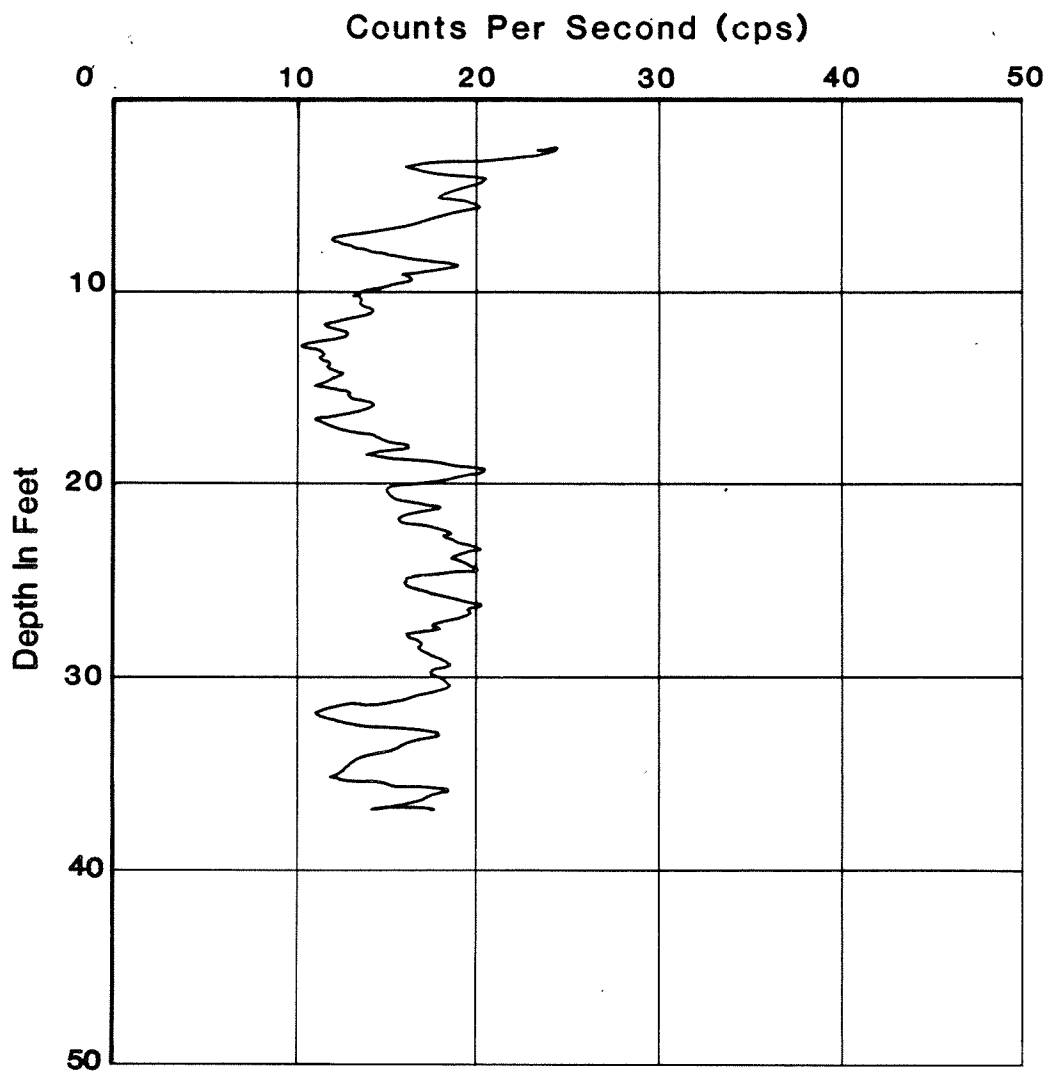


ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

HD83-48

HARZA-EBASCO
SUSITNA JOINT VENTURE
DATE
AUG 83
FIGURE
A - 39



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

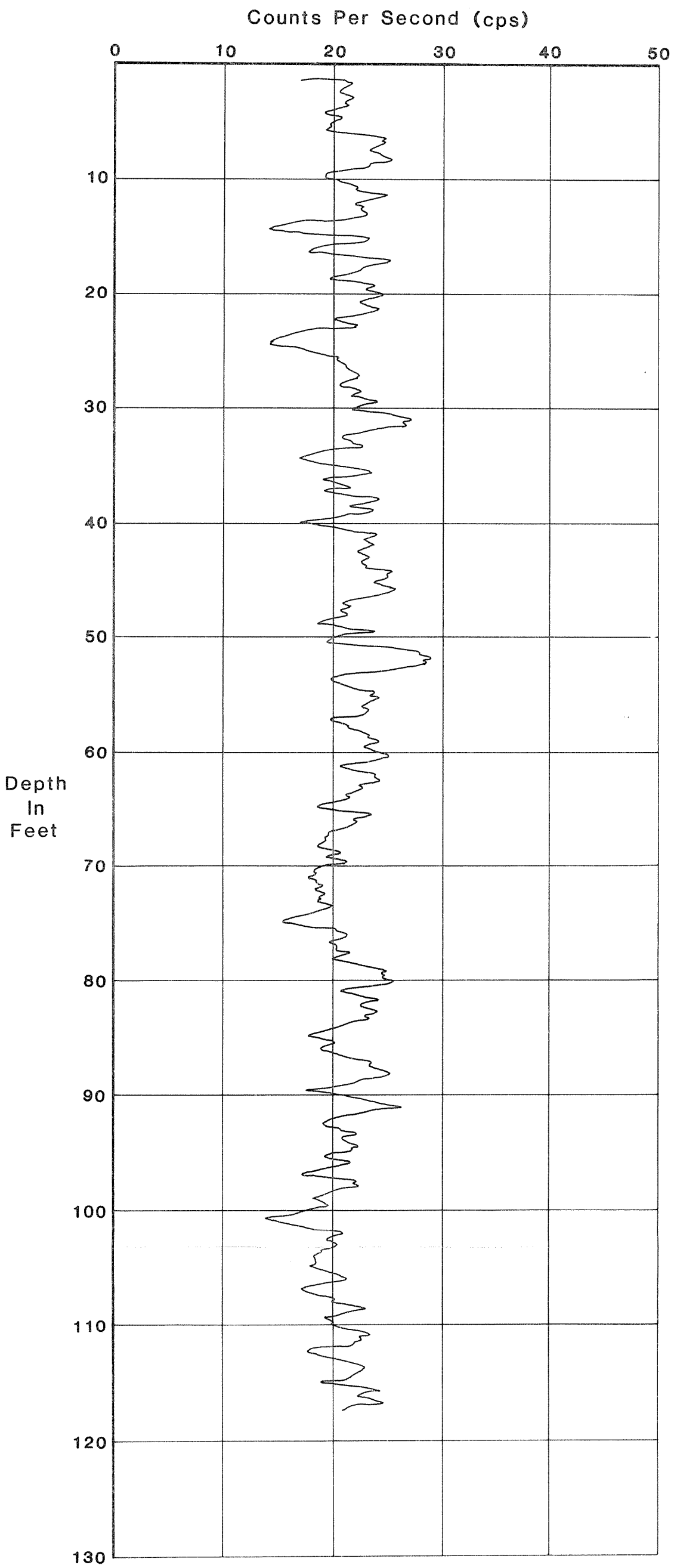
GAMMA LOG

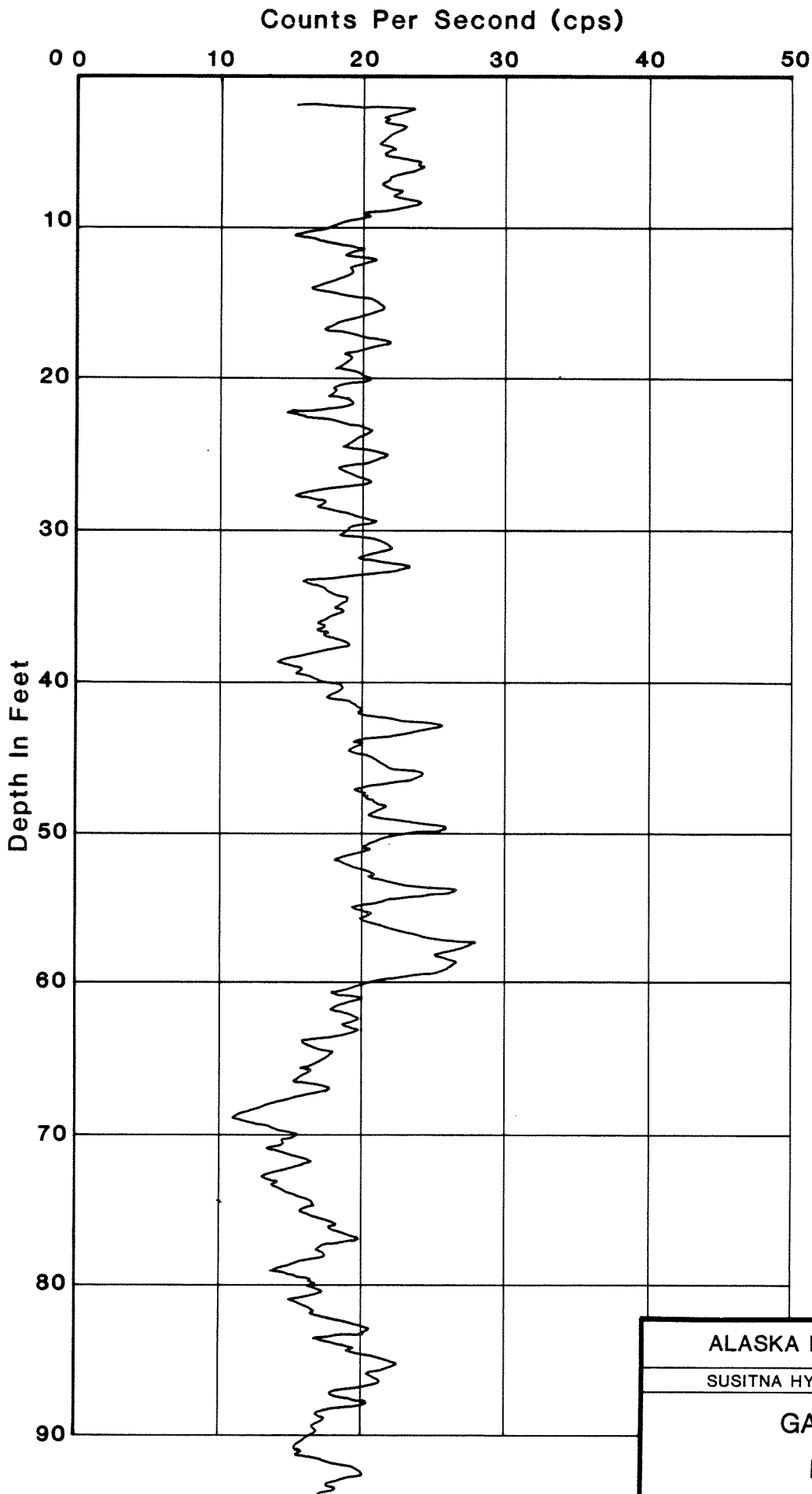
HD83-49

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-40





ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

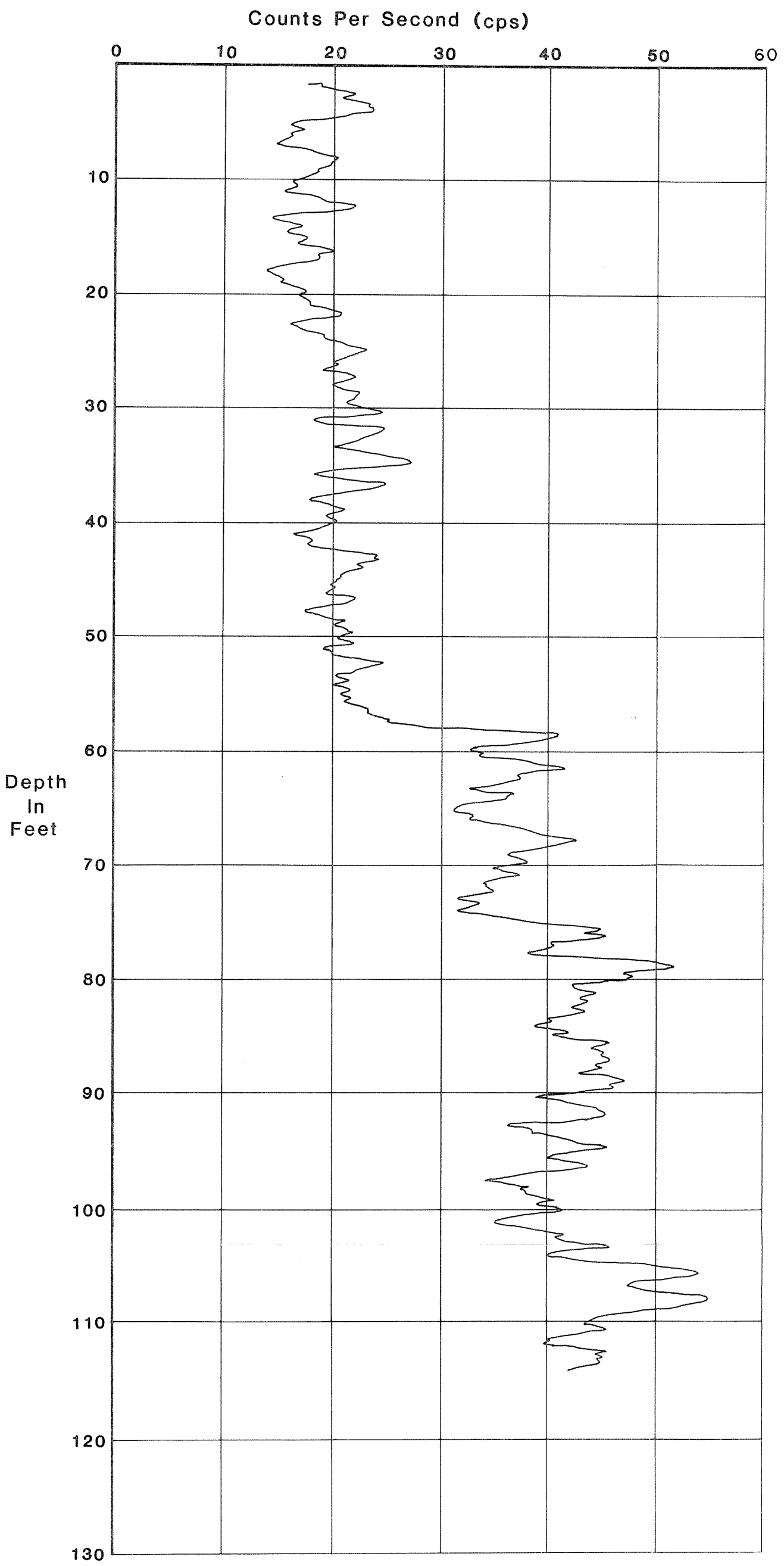
GAMMA LOG

HD83-51

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-42



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG
DH83-4

HARZA-ESASCO
SUSITNA JOINT VENTURE
DATE
AUG83
FIGURE
A-43

APPENDIX B — DRILLING AND SAMPLING METHODS

1. HAMMER DRILL RIG
 - 1.1 Percussive Hammer
 - 1.2 Rotary Drilling
 - 1.3 Additional Equipment
2. ROTARY DRILL RIG
3. SAMPLING
4. DRILLING PERFORMANCE

APPENDIX B

DRILLING AND SAMPLING METHODS

The January to April 1983 Winter Exploration Program included subsurface drilling along the Susitna River Channel of the Watana Damsite and in the Watana Relict Channel. Early drilling in the relict channel area was discontinued when the river ice became thick enough to support drilling operations and was resumed after the completion of the river drilling program.

A Becker AP-1000 hammer rig drilled 5,239 feet of borehole, using a percussive hammer, occasionally switching to a rotary attachment when drilling conditions became difficult in deeper boreholes. A lightweight rotary coring drill rig was mobilized late in the program for the river areas where ice conditions prohibited the use of the heavier hammer drill rig. The long year 38 rotary drill rig accounted for 398 feet of the total 5,637 feet drilled during the winter program.

1. HAMMER DRILL RIG

1.1 Percussive Hammer

The hammer drill rig used a diesel pile hammer to drive a double-wall pipe while a reverse air circulation system removed the cuttings as the pipe advanced. The inner pipe of the double-wall pipe directs the incoming air through the annulus between the inner and outer pipe to the bottom of the pipe. The returning air with drill cuttings then passes up through the inner pipe into an energy dissipating cyclone that vents the air from the sample. Specially designed tooth bits are

used to penetrate the soil formations and to direct the soil into the inner pipe. The drive pipe is withdrawn by a puller system comprising two 50-ton hydraulic cylinders operating tapered slips that grip the pipe.

The hammer drill rig used for the winter program was an AP 1000 (All Purpose) manufactured by Drill Systems, Calgary, Alberta. The basic elements of this rig include a Link Belt 180 diesel pile drive hammer delivering 8,100 foot-pounds per blow operating at variable speeds to a maximum of 95 blows per minute; a Sullair Rotary Screw Compressor rated at 750 cfm at 250 psi; an 18 gpm Beam mud pump; a hydraulic hoist, a hydraulic pipe puller; a mast; and a cyclone.

The hammer energy is delivered to the drive pipe when the hammer strikes the drive spout which sits atop the drive pipe. The double-wall drive pipe is designed so that only the thicker outer pipe transmits the hammer energy to the bit. The two sizes of double-wall pipe used in this program were 5-1/2 inch O.D. X 3-1/4-inch I.D., and 9-inch O.D. X 6-inch I.D. The 9-inch pipe was used for approximately half of the footage in the relict channel while the 5-1/2-inch was used for the remainder of the relict channel and most of the river channel. A triple-wall drive pipe system using a 7-inch pipe over the 5-1/2-inch double-wall was unsuccessfully attempted at the beginning of the program.

There were two basic bit designs used with the drive pipe, crowd-in or web tooth and crowd-out. The crowd-in bit has the cutting edge diameter slightly larger than the outer pipe diameter which forces all the material within the hole up the inner pipe. The crowd-out bit, with the cutting edge at the inner pipe, samples only the material directly below the inner pipe and pushes the remainder aside as the pipe advances. A 5-5/8-inch web-tooth crowd-in bit was used almost

exclusively for the project. Crowd-out bits were used occasionally when crowd-in bits were unavailable.

1.2 Rotary Drilling

The AP 1000 had the capability of rotary drilling by replacing the drive spout with a rotary drive head. One drive head, the Center Stem Recovery (C.S.R.), using a high-torque, slow-speed gearing, advanced the 5-1/2-inch double-wall drive pipe by rotation. The C.S.R. rotary normally used standard tricone or button tricone bits. The same reverse circulation system used in hammer drilling was used for the C.S.R. rotary.

The rotation of the drill pipe helped to reduce wall skin friction. This allowed more drilling energy to be transferrred to the drill bit and helped to increase penetration. Also, the C.S.R. rotary with a tricone bit was used to penetrate boulders. Unfortunately, the recovered sample was usually comprised of rock fragments and did not give a representative grain size distribution. For this reason, the percent by weight of fractured material retained on the 3/4 inch sieve was always recorded during testing to serve as an indicator of the crushing effect. Also, every change between C.S.R. rotary and hammer drilling, or change of drill bits, required the removal of the entire drill string which contributed to borehole instability and redrilling of caved borehole sections.

The 7-inch, triple-wall system using the C.S.R. rotary and an 8-inch tricone bit was attempted in the last hole in the relict channel. Excessive wall skin friction limited penetration and forced the abandonment of the borehole.

The other rotary drivehead, the Diamond Drill Rotary, had a high-speed, low-torque gearing for N-size conventional and wireline core drilling through the drive pipe after bedrock or refusal was encountered.

1.3 Additional Equipment

A down-hole hammer fitting through the drive pipe was also used to drill a pilot hole ahead of the drive pipe when the drive pipe encountered refusal. The down-hole hammer easily penetrated boulders and bedrock, but did not penetrate the softer unconsolidated materials because the resilience necessary to complete the hammer compression cycle was reduced.

Occasionally, a 2-7/8 inch tricone bit was used with the diamond drill rotary to penetrate very dense refusal zones where the hammer drill or the down-hole hammer were ineffective.

To drill angle holes, two 45-degree angle blocks were placed beneath the mast. Four 45-degrees angles holes were drilled by the hammer drill in the river channel.

2. ROTARY DRILL RIG

A light-weight rotary core drill rig was mobilized later in the program for the river areas where ice conditions prohibited the use of the heavier hammer drill rig. A Longyear 38, sectionalized for helicopter transport, performed standard diamond drilling using NX-size wireline with NC-size casing.

3. SAMPLING

The reverse circulation system used on the hammer drill rig provided a composite sample of the materials penetrated. A geologist/soil engineer continuously monitored the drill cuttings dropped from the cyclone. A sample was usually collected every five feet by first clearing the inner pipe. Then the pipe was driven one to two feet before retrieving the sample. Sometimes, when sample recovery was reduced, the sample section was extended beyond two feet. The sample was classified and placed in a canvas bag for transportation to the field laboratory. Samples for moisture determination were placed in plastic bags and sealed.

Disturbed but intact samples were recovered using a split-spoon drive sampler. A 2-1/2-inch diameter sampler was used with 5-1/2-inch pipe, while a 3-inch diameter sampler was used with 9-inch pipe. The first two 5-5/8-inch bits used were reamed for the express purpose of passing the 3-inch sampler.

Standard penetration resistance blow counts per six inches of penetration were recorded during the driving of the split-spoon sampler for estimating the relative densities of the materials sampled. The material directly beneath the drive pipe is considered highly disturbed due to the hammering action of the drive pipe.

Blow counts were also recorded during the drive of the double-wall pipe for estimating material relative densities. However, the energy delivered by the diesel hammer was not always constant because the driller adjusted the fuel injection control pipe penetration rate. Also, the resistance to penetration, due to wall skin friction, increases with depth thereby absorbing an increasing amount of hammer

energy that could be delivered to the drive bit. Therefore, drive pipe blow counts will not be used to estimate finite density values.

Grain size distributions run on those samples recovered by the hammer drill rig are not fully representative of the insitu materials. The hammering action of the drive pipe bit fractures the coarse gravel, cobbles, and boulders producing a gradation skewed toward the fine fraction. The hammer drill system also has a tendency to recover a larger portion of the fine particles, especially when a cobble or boulder is pushed ahead or aside and the finer material moves into the displaced volume. At the other extreme, a small portion of the fine fraction was lost in the air vented from the cyclone and in water overflowing the sample collection bucket. The air used in the reverse circulation system has a tendency to dry the material as it was moving up the pipe to the surface. This action increases the chance of losing fines through the cyclone.

4. DRILLING PERFORMANCE

Early in the program the 5-1/2-inch drive pipe sheared because of faulty welds on the threaded pipe ends. . Drilling of shallow boreholes in the relict channel continued with the 9-inch pipe while the substandard 5-1/2-inch pipe was being rewelded.

Excessive build-up of skin friction along the drive pipe walls limited realistic penetration to approximately 300 feet. Deep holes required additional air capacity and special additives for the air to prevent the cuttings from freezing in the bottom of the drive pipe. Also, the deep hole required several changes between hammer and C.S.R. rotary which generally caused caving of the hole due to the removal of the drill string during changeover. In the two deeper holes drilled, the

borehole wall deteriorated enough to allow the circulating air to pass along the outside of the drive pipe rather than up the inner pipe. The drilling equipment limitations prevented the scheduled drilling and installation of test wells.

Occasionally, when shallow cobble and boulder zones were encountered, the drive pipe was deflected sufficiently to require redrilling of the hole. Deeper cobbles and boulders would bend the pipe, but the soil along the pipe would provide enough support that the pipe sections at the surface would not deflect. As a consequence, in several boreholes, the coring of bedrock was precluded due to the difficulty in passing the core barrel through the bent drive pipe. Other cobble/boulders halted the penetration of the drive pipe which also required redrilling.

The hammer drill rig penetrated very well while drilling shallow holes (less than 200 feet) and in water bearing sands and gravels. Having the drilling and casing combined in one operation provided a rapid, stable borehole. In the river channel, particularly, the hammer drill rig provided useful information in a limited amount of time while penetrating difficult subsurface conditions.

APPENDIX C — BORING LOGS

1. BORING LOG NOMENCLATURE

1.1 Unified Soil Classification System

2. BORING LOGS

2.1 River Channel

2.2 Relict Channel

APPENDIX C

BORING LOGS

1. BORING LOG NOMENCLATURE

Notes:

1. Hammer drill blow counts are for variable energy.
2. Ground surface datum for river borings is for the ice surface.
3. Hammer drill sample cuttings were taken, except where split-spoon samples are noted.
4. Disturbed samples were taken with 2" and 3" split- spoons with a 140 and 300 pound hammer falling 30" and 18" respectively.

Soils:

Grain Size: Unified Soil Classification System

Boulders > 1 foot	Silt 0.0039-0.074mm
Cobbles 3 in - 1 ft.	Clay < 0.0039 mm

Gravel

Coarse	16-64mm
Fine	2-16mm

Sand

Coarse	0.5-2mm
Medium	0.25-0.5mm
Fine	0.074-0.25mm

Density:	<u>N Values</u> (Blows/Foot)
Very Dense	> 50
Dense	30-50
Medium Dense	10-30
Loose	4-10
Very Loose	0-4

Consistency:	<u>N Values</u> (Blows/Foot)
Hard	> 30
Very Stiff	15-30
Stiff	8-15
Medium	4-8
Soft	2-4
Very Soft	0-2

Moisture:	<u>%</u>	<u>Comments</u>
Saturated	100	voids filled with water
Wet	76-99	visible signs of water
Moist	51-75	varying degrees of wetness
Damp/Humid	1-50	
Dry	0	

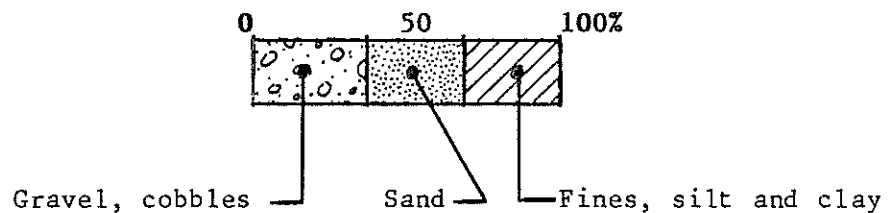
Color:

Munsell Color Chart (wet condition)

Particle Shape:

Angular	Subrounded
Subangular	Rounded

Gradation Graphics:



Rock:

Fracture Spacing:	Feet
Massive	>3.0
Slightly Fractured	1.0-3.0
Moderately Fractured	0.5-1.0
Closely Fractured	0.1-0.5
Intensely Fractured	0.05-0.1
Crushed	5 microns - 0.1

Strength:

Very strong	-	resists breakage from hammer blows, will yield dust and small chips
Strong	-	withstand a few hammer blows but will yield large fragments
Moderately		
Strong	-	withstands a few firm hammer blows
Weak	-	crumbles with light hammer blows
Friable	-	crumbles by rubbing or breaks easily in hands
Plastic	-	penetrated by fingers

Hardness:

Very Hard	-	cannot be scratched with a knife
Hard	-	scratched with difficulty, often faintly visible little dust.
Moderately Hard	-	readily scratched with knife, considerable dust and visible.
Low Hardness	-	deeply gouged or carved with knife
Friable	-	easily crumbled or pulverized, too soft to cut with knife
Soft	-	plastic material (grooved by fingernail)

Drilling Abbreviations:

<u>Type</u>		<u>Bits</u>
HAM	- Hammer	CI - Crowd In
CSR	- Center Stem Rotary	CO - Crowd Out
COR	- Rock Coring	TC - Tricone
DDH	- Down Hole Hammer	PC - Pentacone
TW	- Triple Wall	HC - Hexacone
LY38	- Longyear 38	BB - Button Bit
		OB - Open Bit

<u>Size</u>	
5 1/2 ϕ	- 5 1/2" Diameter Drive Pipe
7 ϕ	- 7" Diameter Drive Pipe (TW)
9 ϕ	- 9" Diameter Drive Pipe

Abbreviations:

Engineering Properties:

M/C	-	Moisture Content
LL	-	Liquid Limit
PL	-	Plastic Limit
PI	-	Plastic Index
NP	-	Nonplastic
SS	-	Split Spoon
G _s	-	Specific Gravity
K	-	Permeability

Geologic Properties and Nomenclature

AND	-	Andesite
DIO	-	Diorite
Plagio	-	Plagioclase
Bio	-	Biotite
Qtz	-	Quartz
K-Feldspar	-	Potassium Feldspar
K-feld		
Hornbl.	-	Hornblende
Fe	-	Iron
Mag	-	Magnesium
PY	-	Pyrite
Kaolin	-	Kaolinite
Chlor	-	Chlorite
CaCo ³	-	Calcium Carbonate
Fract.	-	Fractured
Frctrd	-	
Weath	-	Weathered
Unweath	-	Unweathered

Alter.	-	Altered
Unstd	-	Unstained
Hrd	-	Hard
Mass	-	Massive
Strg	-	Strong
Xyln	-	Crystalline
Mins	-	Minerals
Pseudo	-	Pseudomorphs
Reheal	-	Rehealed
Jt	-	Joint
Coat	-	Coating
F. Grain	-	Fine Grained
Med. Grain	-	Medium Grained

General Abbreviations

m	-	Medium	lt	-	Light
frzn	-	Frozen	drkr	-	Darker
v	-	Very	mod	-	Moderate
dcrs	-	Decreases	modt	-	
prbly	-	Probably	occas	-	Occasional
lmtd	-	Limited	pc	-	Piece
fr	-	Fresh	sl	-	Slight
mech	-	Mechanical	max	-	Maximum
brkg	-	Breaking	min	-	Minimum
inclu	-	Inclusions	consid-	-	Considerable

1.1 Unified Soil Classification System

The unified System classified all soils as coarse or fine-grained based on the larger amount by weight retained or passing the No. 200 sieve. Coarse grained soils (sand, gravel) are further classified both by the uniformity of the gradation of the soil (GW, GP, SW, SP) as well as the amount and type of fines (silt, clay) filling voids in the coarse soils (GM, GC, SM, SC). Fine grained soils are further classified according to plasticity (CL, ML, CH, MH) as determined by Atterberg Limit tests. Thus, grain size analyses and Atterberg Limit tests are used to classify all non-organic soils into a group symbol which defines the texture and plasticity of the soil. Each group symbol indicates that a soil classified as such should exhibit a broad range of the engineering properties of strength, compressibility and permeability. This range is further defined if a measure of the relative density of the soil and moisture content are provided in conjunction with the group symbol. Given the group symbol, relative density, moisture content, and observations of particle shape, it is possible to predict engineering properties and anticipated behavior within an accuracy suitable for many engineering purposes.

Boring No EXAMPLE Angle (from Horizontal) _____ Ground Elevation _____
Feature _____ Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started _____ Total Depth _____
E _____ Date Completed _____ Ground-Water Elevation _____

Logged by _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							Coarse Gravel: Texture, prefix for >25% coarse or >12% fines; density, moisture, color, particle shape, particle distribution, organics, geologic characteristics		more than 50% visible or retained on #200 sieve
	38 49		1			GM	Silty Sand GRAVEL, medium dense, humid olive grey, light grey silt and clay clumps, fine to coarse, with trace organic matter.		 Organic 4%
							Fine Grained: Texture, prefix for >25% coarse, consistency, moisture, color structure, organics, geologic characteristics		more than 50% not visible or passing #200 sieve
			3SS	12 26 29			Silty CLAY, 10-20% fine to medium sand - less than 5% gravel. Frozen, olive grey, clay layers 6" thick, ice lenses occasional cobble.		 LL31 P120 PI11 CL M/C 75%

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date _____

Boring No. EXAMPLE Angle (from Horizontal) _____ Ground Elevation _____
 Feature _____ Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started _____ Overburden Thickness _____
 E _____ Date Completed _____ Ground-Water Elevation _____
 Core Sizes _____ Total Depth _____ Logged by _____

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
				Interval, <u>ROCK TYPE</u> , color, texture (size and shape of crystals, phenocrysts etc.) percentage of, alteration products.				
				fracturing, size of pieces, hardness, hardness, strength, weathering, coating and fillings on joints, thickness of; roughness of joint surfaces, special physical characteristics				
70								
15°	///			72.5-77.2 Diorite, grey, medium Xyln				
30°	///			massive Plagio, hornbl, some pyrite,				
50°	X			closely-mod frac., max 1.0, min.				
75	60°			<0.05' mostly 0.3-0.5', hard, strong,				
50°	60°			unweath, unstained, mech. brkg. common.				
60°	X							
40°	X							
80								

2.1 RIVER CHANNEL BORING LOGS

Boring No DH83-1 (River Y)Angle (from Horizontal) 90°Ground Elevation 1,464.0Feature U/S CofferdamBearing -Rock Elevation 1,386.0Coordinates: N 3,227,912.0Date Started 3/3/83Overburden Thickness 62.5E 747,211.2Date Completed 3/12/83Ground-Water Elevation -Core Sizes HX/NXTotal Depth 91.0Logged by MSC/SEW/DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
				4.0 Ice					LY 38 - COR, NX
5									
10									
15				15.5 Water					
				15.5 - 78.0 Alluvium					HW Casing to 18.0 very hard drilling
20				15.5-52 BOULDERS, COBBLES AND COARSE GRAVEL recovered. Max 0.6 mostly 0.2 - 0.4		40			
25				Heterolithic subrounded to rounded. Finer grained 40-50% based on recovered pieces. Fines washed away cuttings indicate mostly sand.		66			
30						82			
35						42			Hole caved. Reamed to 40 ft.
40									
45									
50						12			

SUSITNA JOINT VENTURE

WATANA DEVELOPMENT

Boring No DH 83-1 Angle (from Horizontal) 90° Ground Elevation 1464.0
 Feature U/S Cofferdam Bearing - Rock Elevation 1386.0
 Coordinates: N 3227912.0 Date Started 3/03/83 Overburden Thickness 62.5
 E 747211.1 Date Completed 3/12/83 Ground-Water Elevation -
 Core Sizes HX/NX Total Depth 91.0 Logged by MSC /SEW /DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
50								
55				52-63 Recovered COBBLES AND COARSE GRAVEL 0.05-0.2, sand, silt in wash water. Much redrilling because of filling of casing with sand.	25			Running sand reported by driller filling casing, reported encountered @ 52
60					20			
					8			No water return, 60 ft.
					0			Tricone
					0			Tricone
65				Boulder 2.0'	98			Core barrel is getting blocked.
				Boulder with cobbles.	100			
70				63-78 BOULDERS, COBBLES, COARSE GRAVEL recovered fines washed away Max 2.0' min 0.05 Mostly 0.1-0.2 subrounded to rounded.	18			
75				Boulder 1.0'	100			
				TOP OF ROCK 78.0				Core loss in Alluvium
80	85° 0°			78-89.1 Diorite Med - lt. gray Med. Xyln. Plagio. Hornblends, Bro. Massive Fresh	94/67			
	60°			Modt fract Max 1.2', Min 0.1'				
85	60°			closely fract 78-80 possibly mech Hard, strong fresh unweathered				
	60°			CaCO ₃ filling jts. some re-				
	75°			sl. more fract 86-88				
	45°			sl. weath 88-89				
90	75°			89.1-91.0 Altered Diorite lt gray crushed, feld Alter to Kaolin no matrics crshed to closely frct weak fr clay	83/28			
				T.D. 91.0 ft.				Core loss in Alt.Dio.

Boring No DH83-2 (FF) Angle (from Horizontal) 90° Ground Elevation 1,470.6
 Feature U/S Portals Bearing - Rock Elevation 1,424.6
 Coordinates: N 3,228,775.3 Date Started 3/13/83 Overburden Thickness 41.5 Ft.
 E 747,566.6 Date Completed 3/15/83 Ground-Water Elevation -
 Core Sizes HW/NX Total Depth 64.0 Logged by SEW/MS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
0									
5				4.5 Ice					
10				4.5-46.0 Alluvium Boulders, cobbles, pebbles recovered fines wash away Max boulder 1.0' mostly pebbles and cobbles recovered 0.2-0.4' Subrounded - round.		70			Casing No Recovery
15						50			
20						53			
25						60			
30									
35						46			
40									
45				TOP OF ROCK 46.0 Ft.					
50	70° 0° 20°	///		fe 46-64 Diorite med. gray, med. Xyl fe Plagio, hornblende, some bio & qtz fe CaCO ₃ Fresh Massive.	100/86 (in Rock)				

Boring No DH83-2 (FF) Angle (from Horizontal) 90° Ground Elevation 1470.6
 Feature U/S Portals Bearing - Rock Elevation 1424.6
 Coordinates: N 3228775.3 Date Started 3/13/83 Overburden Thickness 41.5'
 E 747566.6 Date Completed 3/15/83 Ground-Water Elevation -----
 Core Sizes HW/NX Total Depth 64.0' Logged by MSC/SEW

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
50									
				Diorite as above.					
	70°	/		Slightly fract to massive max 72.0'		100/84			
	60°	/		Min 0.2 mostly 0.6-1.0					
55	10°	=		closely fract: 46-47.2' and @ 55					
	25°	W*		Fe					
	70°	W*		Fe					
	100°	W*		Fe					
	60°	/		Hard strong fresh Fe stains on jts		100/54			
	40°	/		as noted: occas CaCO ₃ on jt					
60	100°	/		surfaces. No Fe stains					
	60°	/		below 56'.		100/50			
	40°	/							
	25°	W*							
64	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							
	40°	/							
	25°	W*							
	100°	W*							
	60°	/							

SUSITNA JOINT VENTURE

WATANA DEVELOPMENT

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
 Feature Seismic Line Bearing --- Rock Elevation 1367.5
 Coordinates: N 3,226,820.9 Date Started 3/15/83 Overburden Thickness 83.3
 E 745,565.9 Date Completed 3/25/83 Ground-Water Elevation ---
 Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MSJ/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
0				4.0 Ice				
5				9.8 Water				
10				9.8-92.9 Alluvium				
15				9.8-~70' Cobbles, boulders & coarse gravel recovered. Max pc 0.6' min <0.05" mostly 0.3-0.4", heterolithologic subangular to subrounded, larger pcs fract w/ sl Fe stain	55	1/5		
20				Fines, sand/silt washed away.	60			
25					85			
30					56			
35					53			
40					93	2/5		
45					20			No water return
50					50			
					44			

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
 Feature Seismic Line Bearing --- Rock Elevation 1367.5
 Coordinates: N 3226820.9 Date Started 3/15/83 Overburden Thickness 83.3
 E 745565.9 Date Completed 3/25/83 Ground-Water Elevation ---
 Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
50						36			
55						48			
60						7			
65						40			
70						25			
75				≈ 70-88 Coarse gravel recovered max 0.2' min 0.05' finer & more uniform recovery than above, Heterolithologic but mainly Andesite, subrounded		44			
80						53			
85						11			
90						10			
92.9				88-92.9 Cobbles, coarse gravel, some boulders, as above 9.8-70		65			
95						80			
100						56			
92.9				Top of Rock 92.9		100/51			
95				92.9-126.5 Diorite, med grey, med Xyln, Plagioclase, hornblende some Bio minor qtz, massive					

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
 Feature Seismic Line Bearing --- Rock Elevation 1367.5
 Coordinates: N 3226820.9 Date Started 3/15/83 Overburden Thickness 83.3
 E 745565.9 Date Completed 3/25/83 Ground-Water Elevation ---
 Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
100	100	100	100	CaCO ₃ Close-mod fract, max 1.4' min 0.1' mostly 0.4-0.7', local close fract intervals, hard, strong, fresh & unweath, unstained jt surfaces, jt surfaces commonly w/CaCO ₃ coating or rehealed w/CaCO ₃ .	100/70	4/5			At 105.3-114.3 Ft K= 2.0E-04
105	105	105	105	CaCO ₃	100/100/100/70				
110	110	110	110	CaCO ₃	100/100/100/63				
115	115	115	115	CaCO ₃	100/80	5/5			
120	120	120	120	CaCO ₃	100/88				
125	125	125	125						
126.5	126.5	126.5	126.5	T.D. 126.5 Ft.					

Boring No DH83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature ☒ Dam Rt Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3,226,978.0 Date Started 3/28/83 Overburden Thickness 20.0 ✓
 E 744,958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4 ✓
 Core Sizes NX Total Depth 116.5 Logged by SEM/MSJ/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
0				0-2 Snow, Ice					
5				2-22 Talus, frzn, 3' ice in top 10' mixed w/peat, angular blocks to 1+1' fract in clay/silt/sand matrix, consid Fe stains on fract in blocks & surfaces, blocks mostly Diorite w/some Andesite.	66				
10					83		1/8		
15					100				
20					92				
22.0				Top of Rock 22.0					
25	30° 45° 60° X			22-25.3 Diorite med grey, med Xyl mass sl weath near jt, close fract 0.7-0.1, hard, strong Fe stain.	98/21				
30	60° X	No Recov		25.3-34.6 Alter Diorite hi weath. red brn, med grain qtz, clay sand hi Fe stain, core loss prbly this material, grade to weath Diorite.	36/0		2/8		Core recovery enhance because of frzn cond.
35	60° X	No Recov		30.2-31, low hard-friable weath, weak.	36/16				
40	60° X			34.6-36.4 Alter Diorite, v weath decompose, no Fe stain, low hard, weak.	100/21				
45	45° 15° 45° 60° 60° X			36.4-39.4 Diorite med grey, med Xyl, sl bleached, close fract 0.6-0.1', hard, mod-strong.	100/0		3/8		
45	45° 60° 60° X			39.4-44.5 Alter Diorite, f grain, lt grey clay & qtz, no mafics, mod-close fract, grades to below	100/0				
50	45° 60° 60° X			Alter Diorite, sl drkr more mafic close fract, Fe stain on jts, clay on others w/Kaolinized feldspar.	100/48				Some mech brkg
	45° 60° 60° X			44.5-49.5 Diorite grey, some clay on jts dcrs w/depth, mod-close fract, sl weath, hard, strong.	100/48				

Boring No DH83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature C Dam Rt Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3226978.0 Date Started 3/28/83 Overburden Thickness 20.0
 E 744958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4
 Core Sizes NX Total Depth 116.5 Logged by SEM/MSJ/MJS

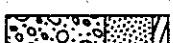
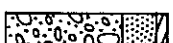
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
50	80°	X		Fe 50-50.8 Alter Diorite crushed, weak, friable, clayey alter of feldspar.					Hole caving @ 50.0
45°	X			Fe					
30°	X			Fe					
75°	X			CaCO ₃		100/35			
55	75°	X		Fe 50.8-95.7 Diorite med grey, med Xyln, Plagio, hornblende, bio, minor qtz, fresh to v.sl. weath.			4/8		At 55-64 Ft K= 2.7E-05
45°	X			Fe					
30°	X			Fe					
30°	X			51-62 Close-mod fract, max 1.1' min 0.1' mostly 0.3-0.6', mod hard					
50°	X			CaCO ₃ mod strong, fresh to sl weath,		100/72			
45°	X			Fe Fe stains on jts common to 55' & occas below CaCO ₃ coat & reheal					
70°	X			on some jts, little or no alter of feldspars.					
50°	X			CaCO ₃					
60°	X								
65	30°	X		62-73 Mod-sl fract, max 1.8' min 0.2 mostly 0.5-0.9, hard, strong,					
40°	X			Fe fresh, unweath, sl-mod Fe stain on jts as noted, surfaces occas		100/79			
45°	X			CaCO ₃ healed rough-sl rough.					
50°	X			Fe					
70	45°	X		Fe					
50°	X			Fe					
90°	X			Fe					
60°	X			Fe					
50°	X			Fe					
75	45°	X		73-95.7 Mod fract w/local close fract intervals, max pc 1.5' min 0.3' mostly 0.5-0.6', hard, strong,			5/8		
60°	X			CaCO ₃ fresh, unweath, Fe stains on jts as noted, CaCO ₃ coat and reheal					
45°	X			Fe more common below 82.					
45°	X			Fe					
60°	X			Fe					
80	45°	X		Fe		100/67			At 81-100 Ft. K= 1.0E-05
60°	X			Fe/CaCO ₃					
45°	X			Fe					
60°	X			CaCO ₃			6/8		
85	20°	X		CaCO ₃					
60°	X			Fe					
30°	X			CaCO ₃		100/80			
45°	X			CaCO ₃					
90	45°	X		CaCO ₃					
0°	X			CaCO ₃					
45°	X			CaCO ₃					
95	45°	X		CaCO ₃		100/43	7/8		At 97.5-116.5 K= 3.5E-04
60°	X			95.7-100 Alter Diorite lt grey-white, med-fine grain, soft-low hard, weak to friable, clayey coat on jt surfaces, Plagio alter to Kaolin.					
60°	X								
90°	X								
100	X								

Boring No DH83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature 4 Dam Rt. Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3226978.0 Date Started 3/28/83 Overburden Thickness 20.0
 E 744958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4
 Core Sizes NX Total Depth 116.5 Logged by SEM/MS/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
100	90°	///		CaCO ₃ 100-103 Diorite grey med grain,					Water return, white
45°		///		CaCO ₃ sl alter, close-mod fract, max					
45°		///		CaCO ₃ 1.0' min 0.3' mostly 0.5', mod					
60°		///		CaCO ₃ hard, mod strong.					
105	60°	///		Fe 103-116.5 Alter Diorite mod-sl;					
45°		///		Fe lt grey-grey, mafics bleached,					
60°		///		CaCO ₃ Plagio intact becomes less alter					
45°		///		Fe below 110.					
60°		///		Fe Close fract max 0.6' min < 0.05'					
110	45°	///		CaCO ₃ mostly 0.3', mod-hard, mod strong					
45°		///		Fe sl weath, Fe stains on jts as					
60°		///		Fe noted, some CaCO ₃ coat and reheat					
45°		///		CaCO ₃ of jts, some clayey matl on jts,					
60°		///		Fe clay smooth-rough.					
115	60°	///							
116.5				T.D.=116.5 Ft.					

Boring No HD83-10 (River H) Angle (from Horizontal) 90° Ground Elevation 1459.4
Feature ☒ Main Dam Bearing --- Rock Elevation 1363.4
Coordinates: N 3226920.3 Date Started 2/20/83 Total Depth 119.5
E 745009.1 Date Completed 2/21/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							3.5 Ice		5 1/2'-HAM, CI
5			1			GM	Silty, sandy GRAVEL WITH COBBLES, saturated, very dark greyish brown, sub-angular to subrounded, fine to coarse, occasional boulders.		
10			2				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, very dark greyish brown, rounded to subrounded, fine to coarse, occasional boulders.		
15			3			GP GM			
20			4			GP GM			
25	180		5						
30	21		6			SM	Silty GRAVELLY, SAND, wet, very dark greyish brown, fine to coarse.		Pipe cocked @28 ft., move hole, redrill
35	75		7			GW	Sandy GRAVEL, less than 5% fines, olive grey, angular to subangular, fine to coarse, with COBBLES and occasional boulders. Water @ 39.0		 HAM, CO.
40	65		8				Boulder, Andesite.		
45			9			GW GM	5-12% silt, dark olive grey, rounded to subrounded		
50									

Boring No HD83-10 (River H)Angle (from Horizontal) 90°Ground Elevation 1459.4Feature Q Main DamBearing ---Rock Elevation 1363.4Coordinates: N 3226920.3Date Started 2/20/83Total Depth 119.5E 745009.1Date Completed 2/21/83Ground-Water Elevation ---Logged by WMB, RLJ, NBH, JEB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	45		10			GP GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, damp, dark olive grey, rounded to sub- rounded.		
55						GW GM	Very dark grey.		
60	35		11			GW	Less than 5% silt.		
65	35		12						
70	40		13			GW GM	5-12% silt.		
75	32		14						
80	50		15			GP GM	Dark grey.		
85	75		16			GW GM	BOULDER AND COBBLE ZONE 80.0 to 87.0'		
	70						Olive grey.		lots of water at 75.5 ft.
			17						Hard drilling, 81 ft.
90									Less water
	45		18			GP GM	Dark grey.		
95							TOP OF ROCK 96.0'		Hard drilling at 96 ft.
100									Started coring at 99 ft.

Boring No HD83-11 (River A) Angle (from Horizontal) 90° Ground Elevation 1459.1
Feature Q Main Dam Bearing --- Rock Elevation 1385.9
Coordinates: N 3226653.1 Date Started 2/21/83 Total Depth 89.4
E 745064.3 Date Completed 2/22/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" HAM, CO
5							5.0 Ice		
							8.0 Water		
10	64		1				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, occasional boulder.		Pipe cocked @ 12.5 Ft. Moved hole 4 times, re-drill
15	65		2				Boulder layer 12.5-25.0 ft. 5 attempts at penetrating this layer.		
20	45		3			GW GM			
25									
	25		4			SP SM	Gravelly SAND, 5-12% clayey silt, saturated, very dark grey, fine to coarse Water @ 28.0'		
30									
35	40		5				Sandy GRAVEL, 5-12% clayey silt, with COBBLES, saturated, dark grey, rounded to subrounded.		
			6						
40									
	85		7				Water @ 41.0'		Hard Drilling, 41.5 Ft.
45									
	70						Less water.		
50									

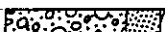
Boring No HD83-11 (River A) Angle (from Horizontal) 90° Ground Elevation 1459.1
Feature ☒ Main Dam Bearing --- Rock Elevation 1385.9
Coordinates: N 3226653.1 Date Started 2/21/83 Total Depth 89.4
E 745064.3 Date Completed 2/22/83 Ground-Water Elevation ---
Logged by WMB, RLJ, NBH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50			8			GP GM	Dark olive grey.		
55			9						
60							Water @ 58.0'		
							COBBLE AND BOULDERS		
65									
70							TOP OF ROCK 73.2 FT		
75									Hard Drilling @ 72.0 Ft.
80									
85									
90									

Boring No	<u>HD83-11</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1459.1</u>
Feature	<u>E Dam AX15</u>	Bearing	<u>---</u>	Rock Elevation	<u>1385.9</u>
Coordinates: N	<u>3226653.1</u>	Date Started	<u>2/21/83</u>	Overburden Thickness	<u>65.2</u>
E	<u>745064.3</u>	Date Completed	<u>2/22/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes		Total Depth	<u>89.4</u>	Logged by	<u>WMB, RLJ, NBH, JFB/LEM, DA</u>

[illegible]

Boring No HD83-12 (River B) Angle (from Horizontal) 90° Ground Elevation 1459.0
Feature £ Main Dam Bearing --- Rock Elevation 1382.0
Coordinates: N 3226694.4 Date Started 2/22/83 Total Depth 87.5
E 745072.0 Date Completed 2/22/83 Ground-Water Elevation ---
Logged by WMB/RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½ Ø HAM, CI
5							5.0 Ice		
							7.5 Water		
10			1				Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, saturated, olive grey, rounded to subrounded, fine to coarse, occasional boulder.		
15			2						
20	40		3			GP GM			
25			4			GP GM	Less sand.		
30	25		5						
	25								
35			6				More sand.		
40	40								
	60		7						
45			8						
50	5								

Boring No HD83-12 (River B)

Angle (from Horizontal) 90°

Ground Elevation 1459.0

Feature E Main Dam

Bearing ---

Rock Elevation 1382.0

Coordinates: N 3226694.4

Date Started 2/22/83

Total Depth 87.5

E 745072.0

Date Completed 2/22/83

Ground-Water Elevation ---

Logged by WMB, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	15		9						
55			10						
60	10								
65									
70	40		11				Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, saturated, dark grey, rounded to subrounded, fine to coarse.		
75	65		12			GP GM	COBBLES AND BOULDERS.		
			13				TOP OF ROCK 77.0 FT		Hard Drilling 72.5 Ft. Hard Drilling 77.0 Ft.
80									
85									
90									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/26/83

Boring No HD83-13 (River G) Angle (from Horizontal) 90° Ground Elevation 1458.5
 Feature E Main Dam Bearing --- Rock Elevation 1374.5
 Coordinates: N 3226856.3 Date Started 2/22/83 Total Depth 89.0
 E 745023.2 Date Completed 2/23/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB, LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½ Ø HAM, CI
5									
							6.0 Ice		
							9.0 Water		
10	60		1				Gravelly SAND, less than 5% silt, saturated, olive grey, fine to coarse, rounded to subrounded, coarse gravel, occasional cobble.		
15	31		2			SP			
20			3				Sandy GRAVEL, 5-12% clayey silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, occasional cobble and boulder.		
25	44		4			GP GM			
30	46		5			SP SM	More sand, less clay.		
35	59		6						
40			7						
	20								
45			8						
	39								
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 3/27/83

Boring No. HD83-13 (River G)

Angle (from Horizontal) 90°

Ground Elevation 1485.5

Feature	E Main Dam
---------	------------

Bearing _____

Rock Elevation 1374.5

Coordinates: N 3226856.3

Date Started 2/22/83

Total Depth 89.0

E 745023.2

Date Completed 2/23/83

Ground-Water Elevation _____

Logged by WMB, RLJ, NBH, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	68		9				Sandy GRAVEL, 5-12% silt, moist, dark grey, rounded to subrounded, fine to coarse, occasional cobble and boulder.		
55									
	24		10			GW GM			
60									
	45		11				Wet.		
65									
	42		12						
70									
	57		13			GP GM	Clayey silt fines.		
75									
							COBBLES AND BOULDERS to 5.0' diameter.		
80									
							TOP OF ROCK 83.8 FT		
85							No recovery		Hammer to 89.0, Core Barrell won't fit down drive pipe.
							T.D. = 89.0 Ft.		

Boring No HD83-14 (River DD) Angle (from Horizontal) 90° Ground Elevation 1464.8
Feature U/S Cofferdam Bearing --- Rock Elevation ---
Coordinates: N 3228343.0 Date Started 2/23/83 Total Depth 57.5
E 747142.4 Date Completed 2/27/83 Ground-Water Elevation ---
Logged by WMB, RLJ, REH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" - HAM, CO
							4.0 Ice		
5							5.0 Water		
							No sample recovered.		
							Probable cobble and boulder layer.		
10									
			1				GRAVEL AND COBBLES, 15-20% fine to coarse sand, less than 5% silt, damp, dark greyish brown, subrounded to subangular, fine to coarse.		
15									
			2						
20	30								
			3			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, damp, dark olive grey, sub-rounded, fine to coarse.		
25	30								
			4			GW GM	More sand and silt. Olive.		
30	35								
			5			GW	Less silt.		
35	35								
	100						TOP OF ROCK 34.0 FT		Hard Drilling @ 33.0 Ft.
40									
45									
50									

Boring No HD83-14 Angle (from Horizontal) 90° Ground Elevation 1464.8
 Feature U/S Cofferdam Bearing --- Rock Elevation ---
 Coordinates: N 3228343.0 Date Started 2/23/83 Overburden Thickness 29.0
 E 747142.4 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 57.5 Logged by WMB,RLJ,REH,JFB/LEM,DAI

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20									
25									
30									
35				TOP OF ROCK 34.0 Ft.					
35	30°	✓		35-53.5 Diorite M gray, M Xlnl.	100/80				Started Coring 35.0
	20°	✓		Mass Plagio, hornbl. some bio qtz					
	45°	✓		fr unweat, some inclu of andesite					
	5°	✓		47-53.5 Mod to closely fract max					
	90°	✓		1.0-min 0.1 mostly 0.5 closely fr					
40	85°	✓		intervals at 38-39 42-42.5 along					
	20°	✓		hi x jts. Hrd, strg. Fr & unweat.					
	90°	✓		chlorite coating on some jts. Jt					
	90°	✓		surfaces smooth to rough. Some					
	30°	✓		chlor. mechanical breakage.					
45	40°	✓							
	40°	✓							
	30°	✓							
	60°	✓		mech					
50									

Boring No HD83-15 (River CC) Angle (from Horizontal) 90° Ground Elevation 1465.1
Feature U/S Portal Cofferdam Bearing --- Rock Elevation 1435.6
Coordinates: N 3228232.7 Date Started 2/24/83 Total Depth 46.0
E 747112.7 Date Completed 2/27/83 Ground-Water Elevation ---

Logged by REH, JFB, JEP, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" - HAM, CI
							3.0 Ice		Boulder at 3 ft.
5							5.0 Water		moved hole, re-
			1				Gravelly SAND WITH COBBLES, less than 5% silt, saturated, grey, medium to coarse.		drill.
10									Pipe cocked at 7 ft. moved hole, redrill.
	90		2			GW	Sandy GRAVEL, less than 5% silt, moist, olive, fine to coarse, with occasional cobble and boulder.		
	250								Water return at 13.2 Ft.
15	500		3			GW			
	300								Water return at 16.4 Ft.
20									
			4				Wet.		
	25								
25									
			5			GP GM	GRAVEL WITH COBBLES, 20-25% fine to coarse sand, 5-12% silt, dark grey, subrounded, fine to coarse.		
	44								
30							TOP OF ROCK 29.5 Ft.		
35									
40									
45									
50									

Boring No HD83-15 Angle (from Horizontal) 90° Ground Elevation 1465.1
 Feature U/S Portal Cofferdam Bearing --- Rock Elevation 1435.1
 Coordinates: N 3228232.7 Date Started 2/24/83 Overburden Thickness 24.5
 E 747112.7 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes --- Total Depth 46.0 Logged by REH, JFB, JEP, RLJ/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20									
25									
30									
30				TOP OF ROCK 29.5 Ft.					
30				29.5-46. Diorite Med gray, Med					
45				Xyln. Massive sl porphyritic					
30				@ 36.5 sl finer grained in					
25				some intervals					
35				Modt - slightly frctrd w/lmtd					
50				CaCO ₃ closely fract intervals max					
45				piece 1.8' min CO.I mostly					
50				CaCO ₃ 0.4 Hard & strong, fr & un-					
				weathered. Several rehealed					
40				jts w/CaCO ₃ 39.8 & below rock					
				appears sl brecciated and re-					
				healed. Unstained.					
30				reheated					
45				reheated					
40									
60									
				T.D. = 46.0 Ft.					
50									

Boring No HD83-16 (River BB) Angle (from Horizontal) 90° Ground Elevation 1465.5
Feature U/S Cofferdam Portal Bearing --- Rock Elevation 1446.5
Coordinates: N 3228135.0 Date Started 2/24/83 Total Depth 39.5
E 747102.7 Date Completed 2/27/83 Ground-Water Elevation ---
Logged by REH, JFB, JEP, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" - HAM, CO
5							4.0 Ice		Pipe cocked at 9 Ft. moved, redrill
							8.0 Water		
10	140		1				Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, greyish brown, sub- rounded, fine to coarse.		
			2				Dark grey.		
15									
			3			GW	Moist.		
	17								
	30						TOP OF ROCK 19.0 FT.		Pipe cocked at 19 Ft. moved, redrill
20	700								
25									
30									
35									
40									
45									
50									

Boring No HD83-17 (River Z) Angle (from Horizontal) 90° Ground Elevation 1464.4
Feature U/S Cofferdam Bearing --- Rock Elevation 1401.4
Coordinates: N 3227931.0 Date Started 2/24/83 Total Depth 77.5
E 747161.2 Date Completed 2/27/83 Ground-Water Elevation ---
Logged by REH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" - HAM, CI
5							Ice 5.0		
10									
15							Water 15.0		
20	30 50		1			SP	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, rounded to subrounded gravel, with occasional cobble.		
25	70		2			GP GM	Sandy GRAVEL, 5-12% clayey silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, with occasional cobble.		
30	15 18		3				Increasing fine to coarse sand.		
35			4						At 28 Ft., moved hole, redrill Rock in bit, pushing ahead
40			5			SP SM	Gravelly SAND, 5-12% clayey silt, olive grey.		
45	52 49		6			GW	Well graded GRAVEL, 10-15% coarse sand, less than 5% silt, saturated, olive, rounded to subrounded, fine to coarse.		
50			7			GP	Gravelly SAND, less than 5% silt, saturated, olive grey, fine to coarse, subrounded to subangular, fine to coarse gravel.		

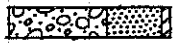
WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Angle (from Horizontal) 90°
Bearing ---
Date Started 2/24/83
Date Completed 2/27/83

Ground Elevation 1464.4
Rock Elevation 1401.4
Total Depth 77.5
Ground-Water Elevation ---

Boring No HD83-18 (River AA) Angle (from Horizontal) 90° Ground Elevation 1465.7
Feature U/S Cofferdam Bearing --- Rock Elevation 1435.7
Coordinates: N 3227953.7 Date Started 2/24/83 Total Depth 39.0
E 747110.2 Date Completed 2/26/83 Ground-Water Elevation ---
Logged by RLJ, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									90-HAM, CI
5							4.5 ICE		
10	200	1				GP GM	Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, wet, dark olive grey, subangular, fine to coarse.		
15	50	2				GM	Clayey silty sandy GRAVEL WITH COBBLES saturated, dark greyish brown, coarse.		
20	100	3				SM	More sand, subangular, fine to coarse gravel.		
20	250	4				GW GM	Less sand.		Hard Drilling, 20.5 Ft. 
25	150	5				SW SM	Gravelly SAND, 5-12% silt, humid, olive brown, fine to coarse, weathered rock fragments with oxidized coating.		
30							TOP OF ROCK 30.0 FT		Started coring @ 24.5 Ft.
35									
40									
45									
50									

Boring No HD83-18 Angle (from Horizontal) 90° Ground Elevation 1465.7
 Feature U/S Cofferdam Bearing --- Rock Elevation 1435.7
 Coordinates: N 3227953.7 Date Started 2/24/83 Overburden Thickness 25.5
 E 747110.2 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 39.0 Logged by RLJ, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20									
25									
29.5				No Recovery - wash water lt. brn. Possibly weathered Diorite		0/0			Started Coring 24.5'
30	90° x			TOP OF ROCK 30.0 FT.					Possible Mismatch
30	30° x			29.5-39.0 Diorite med grey, med. xyl. Massive, Plagio, Hornb. bio. Modt - closely fractured.					
35	60° x			Max piece 1.0' min 0.1' mostly 0.2-0.4' Hard & strong, fresh and unstained except on jt. surfaces to 33' where Fe stain common little CaCO ₃ on jts. Rough - sl rough jt. surfaces. Sl weather on jts.		91/28	1/1		Sl. grinding of core.
35	45° x								
35	45° x								
35	70° x								
35	85° x								
35	10° x								
40				T. D. = 39 ft.					
45									
50									

Boring No. HD 83 - Sheet 1 of 3

Boring No HD83-19 (River X) Angle (from Horizontal) 90° Ground Elevation 1463.5
Feature U/S Cofferdam Bearing --- Rock Elevation 1383.5
Coordinates: N 3227888.3 Date Started 2/25/83 Total Depth 98.0 ft.
E 747264.4 Date Completed 2/26/83 Ground-Water Elevation ---

Logged by JEP, RLJ, REH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
	95		8			SP			
55									
60	300		9			SP SM	Gravelly SAND, 5% silt, very dense, saturated, very dark grey, fine to coarse.		
65	144		10						
			11			GW	Sandy GRAVEL, less than 5% clayey silt, very dense, saturated, dark grey, fine to coarse.		
70									
			12			GP	COBBLE AND BOULDERS.		
			13						
75									
			14						
80							TOP OF ROCK 80.0'		COR, NX; 72-76 Ft. HAM, CI Hard Drilling
			15						
									Started Coring
85									
90									
95									
100									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 3

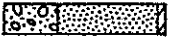
Date 3/27/83

Boring No. HD83-19 (River X) Angle (from Horizontal) 90° Ground Elevation 1463.5
 Feature U/S Cofferdam Bearing --- Rock Elevation 1383.5
 Coordinates: N 3227888.3 Date Started 2/25/83 Overburden Thickness 69.5
 E 747264.4 Date Completed 2/26/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 98.0 ft. Logged by JEP, RLJ, REH, JFB/LEM, DAF

[illegible]

Boring No HD83-20 (River W) Angle (from Horizontal) 90° Ground Elevation 1464.9
 Feature U/S Cofferdam Bearing --- Rock Elevation 1388.4
 Coordinates: N 3227868.8 Date Started 2/27/83 Total Depth 76.5 ft.
 E 747316.0 Date Completed 2/28/83 Ground-Water Elevation ---

Logged by JEP, RLJ, REH, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½" HAM, C.O.
5							5.0 Ice		
							9.5 Water		
10	20		1			GW	Well graded GRAVEL WITH COBBLES, less than 5% silt, 20-25% medium to coarse, sand, saturated, dark olive grey, subrounded to rounded, fine to coarse coarse gravel and cobbles decreasing with depth.		
15	60		2						
20									
	30		3			GW	Dark grey.		
25	50								
30	90		4						
35	200		5			GW	Increasing fine to coarse sand 5-12% silt.		
	120								Hard Drilling, 34-37 Ft.
40	35								
45	110		6			SP	Gravelly SAND, less than 5% silt, saturated, very dark grey, fine to coarse, subrounded, coarse gravel.		
			7			GW	More fine gravel.		
50									K= 7.4E-03

Boring No HD-83-20 (River W) Angle (from Horizontal) 90° Ground Elevation 1464.9
Feature U/S Cofferdam Bearing --- Rock Elevation ---
Coordinates: N 3227868.8 Date Started 2/27/83 Total Depth 76.5
E 747316.0 Date Completed 2/28/83 Ground-Water Elevation ---
Logged by JEP,RLI,REH,JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55	22		8				Fine to coarse SAND -lense.		
60	45		9			GW	Sandy GRAVEL WITH COBBLES and boulders, less than 5% silt, saturated, very dark grey. Rounded to subrounded, fine to coarse.		 Hard Drilling
65	95		10			GW	Subrounded to subangular.		
70	200		11			GM	Sandy, silty GRAVEL WITH COBBLES, wet, grey, rounded to subrounded, fine to coarse.		
75	380		12				GRAVEL, COBBLES & BOULDERS, Wet, grey, subrounded, fine to coarse.		Hard Drilling
80							T.D. = 76.5 ft.		Refusal; core barrell won't go down
85									
90									
95									
100									

SOIL BORING LOG

Sheet 1 of 3
Date 3/27/83

Boring No HD83-21 (River V) Angle (from Horizontal) 90° Ground Elevation 1467.7
 Feature U/S Cofferdam Bearing --- Rock Elevation 1401.7
 Coordinates: N 3227846.7 Date Started 2/28/83 Total Depth 86.5 Ft.
 E 747373.1 Date Completed 3/01/83 Ground-Water Elevation ---
 Logged by REH, JFB, RLJ, JEP, WMB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
	42		1			SM	Silty fine SAND, 5-10% coarse gravel, damp, olive grey.		 5 1/2' - HAM, CI
5									
			2				More gravel, medium to coarse sand.		
10									
	12 22		3				Sandy GRAVEL, 5-12% silt, moist, olive grey, subangular. Fine to coarse, occasional cobble.		
15									
	58 48					GW GM	More sand, wet.		 K= 5.0E-02
20									
			5			GW	Less sand, less than 5% silt, dark grey.		
25									
			6			GW	More fine sand, 5-12% silt. Saturated.		
30									
	23		7				Gravelly SAND, 5-12% silt, saturated, very dark grey, fine to coarse, subrounded gravel.		Fine washed out.
35									
			8			SP	Less than 5% silt.		 K= 1.2E-02
40									
	95		9				Boulder @ 41.5 Ft. Dark olive grey.		 Hard Drilling, refusal moved hole, redrill
45									
	42		10			GP	More gravel, dark grey.		 K= 2.1E-02
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No HD83-21 (River V) Angle (from Horizontal) 90° Ground Elevation 1467.7
Feature U/S Cofferdam Bearing --- Rock Elevation 1401.7
Coordinates: N 3227846.7 Date Started 2/28/83 Total Depth 86.5
E 747373.1 Date Completed 3/01/83 Ground-Water Elevation ---
Logged by REH, JEB, RLJ, JEP, WMB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55			11				Less coarse gravel, very dark grey.		
60			12			SP			 K= 2.6E-02
65			13			GP	Sandy GRAVEL with cobbles and boulders, 5-12% silt, damp, dark grey, subrounded to subangular, fine to coarse. COBBLE/BOULDER TOP OF ROCK 66.9 Ft.		
70									
75									
80									
85									
90									
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Boring No	<u>HD83-22 (River U)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1467.6</u>
Feature	<u>U/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1380.6</u>
Coordinates: N	<u>3227828.8</u>	Date Started	<u>3/01/83</u>	Total Depth	<u>107.3</u>
E	<u>747416.2</u>	Date Completed	<u>3/01/83</u>	Ground-Water Elevation	<u>---</u>

Logged by WMB, REH, NBH, JEP/LEM, DAF

[illegible]

Boring No HD83-22 (River U) Angle (from Horizontal) 90° Ground Elevation 1467.6
Feature U/S Cofferdam Bearing --- Rock Elevation 1380.6
Coordinates: N 3227828.8 Date Started 3/1/83 Total Depth 107.3 Ft.
E 747416.2 Date Completed 3/1/83 Ground-Water Elevation ---
Logged by WMB, REH, NBH, JEP / LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
	250		10						Hard Drilling @ 51 Ft.
	13								
55									
	28		11			GW	Sandy GRAVEL, less than 5% silt, saturated, dark grey, rounded to subrounded, fine to coarse, with occasional cobble.		
	39								
60									K = 1.1E-02
									Hard Drilling
	104		12						
	115								
65									
	145		13			GP/GM	More clayey silt, grey.		
	95								
70									
			14			GW	Less clayey silt, very dark grey. Subrounded-subangular.		
75									
			15						
80									
	132		16				Less sand.		
							COBBLES AND BOULDERS.		
85			17			GP/GM	TOP OF ROCK 87.0 Ft.		
	55								
90									
95									
100									

Boring No HD83-22 Angle (from Horizontal) 90° Ground Elevation 1467.6
Feature U/S Cofferdam Bearing _____ Rock Elevation 1380.6
Coordinates: N 3227828.8 Date Started 3/1/83 Overburden Thickness 84.9
E 747416.2 Date Completed 3/1/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 107.3 ft. Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55									
60									
65									
70									
75									
80									
85									
				Top of Rock 87.0 Ft.					
90	60° 60°	X-X		Mech 87.5-97.3 Diorite med gray Med. Xyln. massive, fresh.					Started Coring 87.5
	45° 90°	/		Closely - modt. frctrd. max piece 1.0' min 0.1 mostly 0.3- 0.6' hard & strong, fresh & un- stained.					Mechanical Brkg and some grinding.
95	60°	/		Low mech. brkg.					
	50°	/							
	45°	//							
100				97.3-107.3 Diorite as above w/ Xenoliths of fine gr. gray Amd.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-23 (River T) Angle (from Horizontal) 90° Ground Elevation 1468.0
 Feature U/S Cofferdam Bearing --- Rock Elevation 1397
 Coordinates: N 3227810.9 Date Started 3/1/83 Total Depth 87.0
 E 747469.8 Date Completed 3/2/83 Ground-Water Elevation ---
 Logged by NBH, JEP, REH, WMB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5	87		1				Sandy GRAVEL with cobbles, 5-12% silt, damp, olive grey, subrounded, fine to coarse.		5 1/2" - HAM, CI
	63		2			GW			
10	56		3			GW	Olive brown, subrounded to subangular, moist.		
	54								
15			4				Wet.		
20	52		5			GW	Less silt.		
	34								
25			7			SP	Gravelly SAND, less than 5% silt, saturated, olive, fine to coarse, rounded to subrounded coarse gravel.		
30	50								
35	63		8				Silty, Gravelly SAND, wet, olive brown, fine to coarse, subrounded to subangular fine gravel.		
40	30		9			SM			Hard Drilling at 41 Ft.
45									
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	HD83-23 (River T)	Angle (from Horizontal)	90°	Ground Elevation	1468.0
Feature	U/S Cofferdam	Bearing	---	Rock Elevation	1397
Coordinates: N	3227810.9	Date Started	3/1/83	Total Depth	87.0
E	747469.8	Date Completed	3/2/83	Ground-Water Elevation	---

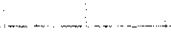
Logged by NBH, JEP, REH, WMB/LEM, DAF

[illegible]

Boring No HD83-23 Angle (from Horizontal) 90° Ground Elevation 1468.0
 Feature U/S Cofferdam Bearing --- Rock Elevation 1397
 Coordinates: N 3227810.9 Date Started 3/1/83 Overburden Thickness 71.0
 E 747469.8 Date Completed 3/2/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth --- Logged by NBH, JEP, RSH, WMB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
55									
60									
65									
70									
				TOP OF ROCK 71.0 Ft.					
60	/			72-87 Diorite Med gray					Started Coring 72.0'
50	/			Med Xyln. massive plagioclase,					
75	/			Hornblende, some qtz.					
50	/			72-78 closely-modt fract. Max					
45	/			0.7, min 0.2 mostly 0.3-0.4					
50	/			hard & strong, fresh CaCO ₃					
5	/			on some jts. Unstained.					
80	/			Brkn. 78-87 modt-sl. fract. w/few					
5	/			closely fract zones 79-80, max					
90	/			1.1', min 0.1', mostly 0.6					
10	/			20% CaCO ₃ coatings on jts. Hard					
85	/			and strong, fresh, unstained jt					
15	/			surfaces rough.					
				T.D. = 87.0 Ft.					
90									
95									
100									

Boring No. HD83-24 (River I) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1409.8
Coordinates: N 3226748.3 Date Started 3/2/83 Total Depth 57.0
E 742979.2 Date Completed 3/2/83 Ground-Water Elevation ---
Logged by NBH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2' - HAM, CI
							4.0 Ice		
5							5.5 Water		
							Sandy GRAVEL WITH COBBLES, less than 5% clayey silt. Saturated, olive grey, subangular, fine to coarse.		
10	58		1			GW			
	60		1A			GP	More sand and clayey silt.		
	115					GM			
15	105		2				Cobbles and boulders.		
									Refusal @ 18 Ft.
20									COR, NX - got 4 Ft., bit broke moved hole, re-drill
25									HAM, CI
									Refusal @ 27 Ft.
30									Started Coring
35									
40									
							TOP OF ROCK 44.0 Ft.		
45									
50									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 3Date 3/27/83

Boring No HD83-24 Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1409.8
 Coordinates: N 3226748.3 Date Started 3/2/83 Overburden Thickness 38.5
 E 742979.2 Date Completed 3/2/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 57.0 Logged by NBH, JEF/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20									
25									
30	60° / 45° / 90° \			27-40 Diorite med gray, med Xyln. Plagio, Hornbl. bio, some Kspar & aplite veins to 2", massive fresh.	100/100	1/2			Started Coring 27.0'
35	30° - 10° - 30° \ 15° \			Modt-sl. fractrd. max 2.0' min o.l. mostly 0.5-2.0', fresh unweathered. Slight Fe stains on jts. Hrd & strg, fresh & unstained except on jts. Some CaCO ₃ fillings on jts.	70/28				
40	45° / 10° -			Core Loss 40-44 Alluvium					
45	70° X 45° X 80° X 20° / 45° > 50° >			Heterolithologic pebbles & cobbles recvd. 3.0' core loss. TOP OF ROCK 44.0 Ft. 44-47 Diorite as above w/some pink k-feldspar. Closely intensely fract. 0.05-0.5' sl-modt weath hard, mdt strg.		2/2			

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3

Date 3/27/83

Boring No	HD83-25	Angle (from Horizontal)	90°	Ground Elevation	1454.4
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1379.4
Coordinates: N	3226970.9	Date Started	3/3/83 (D)	Total Depth	95.9 Ft.
E	743087.1	Date Completed	3/3/83 (N)	Ground-Water Elevation	---

Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½Ø - HAM, CI
5									
							6.0 Ice		
							8.0 Water		
10									
							Sandy GRAVEL with cobbles, less than 5% silt, saturated, olive grey, rounded to subrounded, fine to coarse.		
15			1			GW			
							Water @ 18.0 ft.		Blow by, discharge hose plugged.
20									
							Less sand.		
25			2						
							More sand.		
30			3						
35									
							Loose, easily penetrated		
40							Gravelly SAND?		Drive bit plugged, 20. Ft. of sample collected for #4 (?)
									
45			4				Formation probably a loose sand, saturated, very dark grey.		
									
50			5			SW			

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	HD83-25	Angle (from Horizontal)	90°	Ground Elevation	1454.4
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1379.4
Coordinates: N	3226970.9	Date Started	3/3/83 (D)	Total Depth	95.9 ft.
E	743087.1	Date Completed	3/3/83 (N)	Ground-Water Elevation	---

Logged by WMB, REH, NBH, JEP/LEM, DAF

[illegible]

Boring No	<u>HD83-25</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1454.4</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1379.4</u>
Coordinates: N	<u>3226970.9</u>	Date Started	<u>3/3/83(D)</u>	Overburden Thickness	<u>67.0</u>
E	<u>743087.1</u>	Date Completed	<u>3/3/83 (N)</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>95.9 ft.</u>	Logged by	<u>WMB, REH, NBH, JEP/LEM</u>

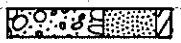
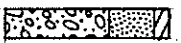
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55									
60									
65									
70									
75				Top of Rock 75.0 Ft.					
80	45° /			76-94 Altered Diorite Lt gray, med. grained, variably altered, partially to totally. Mostly Kaolin pseudo-morphs after feldspar, some chlorite talc and quartz. Closely-slightly fract. 76-86.	97/65		1/2		Started Coring 76.0
85	30° /			Max 2.5' min 0.05', mostly 0.3-0.8 SI. hard, SI strong, occasionally sugary & friable where more altered Unstained.					Low fract's due to mech brkg.
90	40° /			86-94 closely fract. to modt. fract. Max 0.8', min <0.05', mostly 0.3-0.6, no staining, some mechanical brkg., Rough j't surfaces. Some talc on j'ts.	95/51				
95	45° /			94-95.9 Diorite med gray, med Xyln. closely-modt fract. Hard, strong.			2/2		
100	45° /			T.D. = 95.9 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-26 (River M) Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1372.8
 Coordinates: N 3226895.5 Date Started 3/4/83 (N) Total Depth 96.0 Ft.
 E 743049.9 Date Completed 3/4/83 Ground-Water Elevation ---
 Logged by JEP, NBH/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2' HAM, CI
5							5.5 Ice		
							8.0 Water		
10	30		1				Sandy GRAVEL, 5-12% silt. Medium dense, saturated, olive grey, rounded to subrounded, fine to coarse. Occasional cobble.		
15			2			GW GM			
20	97		3						
25			4			GP GM	More gravel, coarse gravel, sub- rounded to subangular.		
30	93 49		5			GP GM	Dark grey.		 Hard Drilling 31- 32.5 Ft.
35	55 58 50		6						
40			7			SP SM	Gravelly SAND, 5-12% silt. M. dense. Saturated, very dark grey. 40% fine sand, gravel rounded to subrounded.		 Easy Drilling @ 40.5-42.5 Ft.
45			8				Fine to coarse sand.		
50									

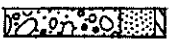
Boring No HD83-26 (River M) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1372.8
Coordinates: N 3226895.5 Date Started 3/4/83 Total Depth 96.0 ft.
E 743049.9 Date Completed 3/4/83 Ground-Water Elevation ---
Logged by JEP, NBH/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
55			9			GM	Silty, Sandy GRAVEL, 17% clayey silt, saturated, dark grey, rounded to sub-rounded, fine to coarse, occasional cobble.		
60			10						
65	39		11			SW SM	Gravelly SAND, 5-12% clayey silt. Medium dense, saturated, very dark grey, rounded to subrounded gravel.		
70			12				GRAVEL WITH COBBLES, less than 5% silt, medium dense, saturated, dark grey, rounded to subrounded, fine to coarse.		Hard Drilling @ 70.5 Ft.
75	93		13			GC	Sandy, silty GRAVEL WITH COBBLES, dense, saturated, dark grey, rounded to subrounded. 30% clayey silt.		 LL 25 PL 19 PI 6 G _s = 2.76
80							COBBLES AND BOULDERS, rounded, hetero-lithologic		Refusal Started Coring @ 76.0 Ft. Water return med. grey
85							TOP-OF-ROCK-81.0-Ft.		

Boring No HD83-26 (River M) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1372.8
Coordinates: N 3226895.5 Date Started 3/4/83 Overburden Thickness 73.0
E 743049.9 Date Completed 3/4/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 96.0 ft. Logged by JEP, NBH/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
76				Cobbles & Boulders Recovered.					Start Coring 76.0
80									
				<u>TOP OF ROCK 81.0</u>					
85	45° 45° 30° 40° 70°			81-84.7 Diorite gray, med Xyln. Fresh w/some mineralization along jts. Modt fract. 1.3-0.5', hard, strong, fresh, unweath, unstained.	12/31		1/2		Water return lt. grey
90	30° 70° 40° 85°			84.7-96.0 Altered Diorite Lt gray to white, med. grained. Variably altd, partially to totally strong and hard to soft and friable, re- spectively. 84.7-86 Deeply alter. 86-93 sl altd. 93-96 Altered.	96/30		2/2		
96	50° 45° 50° 30° 45°			Closely-modt. fract. Max 0.7, min 0.1. Mostly 0.3-0.7 unstained clayey in highly altered intervals.					
				T.D. = 96.0 Ft.					

Boring No HD83-27 (River K) Angle (from Horizontal) 90° Ground Elevation 1453.7
Feature D/S. Cofferdam Bearing --- Rock Elevation 1383.7
Coordinates: N 3226824.2 Date Started 3/3/83 Total Depth 98.5
E 743007.9 Date Completed 3/4/83 Ground-Water Elevation ---
Logged by JEP, NBH, REH, WMB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 $\frac{1}{2}$ " HAM, CI
5							5.5 Ice		
							8.0 Water		
10							Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, dark grey, rounded BOULDER to subrounded, fine to coarse, occasional boulder		
	153		1			GW			
15									
	70		2			GP GM	GRAVEL WITH COBBLES, 20-25% fine to coarse sand, 5-12% silt, wet, olive grey, subangular to angular, fine to coarse		
20									
	43		3				Subrounded		
25									
	35						Increase water @ 27'		
30			4				Saturated		
	29					GP GM	Dark olive grey		
35			5				Rounded to subrounded		
40			6				GRAVEL WITH COBBLES, 20-25% fine to coarse sand, less than 5% silt, satur- ated, dark grey, rounded to subrounded fine to coarse		
			7			GP			
45									
			8			GP	More sand, very dark grey		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	HD83-27 (River K)	Angle (from Horizontal)	90°	Ground Elevation	1453.7
Feature	D/S Cofferman	Bearing	--	Rock Elevation	1383.7
Coordinates: N	3226824.2	Date Started	3/3/83	Total Depth	98.5
E	743007.9	Date Completed	3/4/83	Ground-Water Elevation	---

Logged by JEP, NBH, REH, WMB/LEM, DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 3

Date 3/27/83

Boring No HD83-27 (River K)

Angle (from Horizontal) 90°

Ground Elevation 1453.7

Feature D/S Cofferdam

Bearing _____

Rock Elevation 1383.7

Coordinates: N 3226824.2

Date Started 3/3/83

Overburden Thickness 62.0

E 743007.9

Date Completed 3/4/83

Ground-Water Elevation

Core Sizes NX

Total Depth 98.5

Logged by JEP,NBH,REH,WMB/LEM,DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
55								
60								
65								
70				TOP OF ROCK 70. Ft.				
71-82	CaCO ₃	71-82 Andesite, med grey, fine grained, fresh. Mod-close fract			100/46	1/2		Started coring 71.0
71-76'	CaCO ₃	71-76', max pc 0.6" min <0.1"						
76-82'	CaCO ₃	mostly 0.4-0.5'. Close fract 76-82', most pcs 0.2-0.3', hard &						
81-82"	CaCO ₃	strong, fresh & unstained along jts, CaCO ₃ coatings. Rough jt surfaces increasingly fract & altered						
82-94		Altered Diorite, white to v.lt. grey, kaolin pseudomorphs after feldspar, talc & some qtz, variably altered, totally to partly friable & clayey to hard & strong, resp. 82-93' totally alter. 93-94' partial alter.			62/0			
93-94'		Intense-close fract, max pc 0.5 min <0.1' mostly 0.2-0.3, rough jt, surfaces unstained.						
94-98.5		Diorite, grey, med Xyln felspar hornblende, Bio, mod fract max 1.5' min 0.1' mostly 0.5-0.7', hard, strong, fresh unstained, some sl alter of chlor on jts			100/48	2/2		
T.D.		= 98.5 Ft.						

Boring No HD83-28 (River J) Angle (from Horizontal) 90° Ground Elevation 1453.6
Feature D/S Cofferdam Bearing --- Rock Elevation 1381.6
Coordinates: N 3226787.3 Date Started 3/5/83 Total Depth 88.5
E 742990.2 Date Completed 3/5/83 Ground-Water Elevation ---
Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½Ø - HAM, CI
5							5.0 Ice		
10							10.0 Water		
	95 61		1			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, saturated, dark grey subrounded to subangular, fine to coarse		Hard Drilling @ 13 Ft.
15	31 41		2			GW	5-12% silt		
20									
	28 20 21		3			GP GM	Sandy GRAVEL WITH COBBLES AND BOULDERS 5-12% silt, moist, dark grey, rounded to subrounded, fine to coarse		NP G _s = 2.75
25			4			GP GM	Olive grey		K = 2.0E-02
30									
	21 34 64		5			GW GM			Hard Drilling @ 34 Ft.
35			6				BOULDERS 34.5-44.5 ft with fine to coarse sand		G _s = 2.78 Started Coring 34.5 Ft.
40									
	28		7						5½Ø - HAM, CI @ 44.5 Ft.
45									
			8			SP	Gravelly SAND, less than 5% silt, saturated, very dark grey, medium, with trace fine and coarse subangular gravel		
50									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/27/83

Boring No	HD83-28 (River J)	Angle (from Horizontal)	90°	Ground Elevation	1453.6
Feature	D/S Confferdam	Bearing	---	Rock Elevation	1381.6
Coordinates: N	3226787.3	Date Started	3/5/83	Overburden Thickness	62.0
E	742990.2	Date Completed	3/5/83	Ground-Water Elevation	---
Core Sizes	NX	Total Depth	88.5	Logged by	WMB, REH, NRH, JEP/LEM

[illegible]

Boring No HD83-29 (River L) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1374.8
Coordinates: N 3226858.9 Date Started 3/5/83 Total Depth 104.3
E 743029.5 Date Completed 3/5/83 Ground-Water Elevation ---
Logged by NBH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5½" - HAM, CI
5							5.0 Ice		
							9.0 Water		
10	38		1				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, dark greyish brown, sub-rounded, fine to coarse		
	37								
15									
						GW	Olive grey		
			2			GM			
20	60								
						GW			
			3			GM			
25	48								
	44								
							More sand		
	44		4						
	44								
30	30								
			5			GP	Sandy GRAVEL, 5-12% silt, saturated, dark grey, subrounded, fine to coarse, occasional cobble		
						GM			
35									
			6						
40									
45							Slightly more sand, less silt		
			7						
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4

Date 3/27/83

Boring No HD83-29 (River L)

Feature	D/S Cofferdam
---------	---------------

Coordinates: N 3226858.9

743029.5

Angle (from Horizontal) 90°

Bearing _____

Date Started 3/5/83Date Completed 3/5/83

Ground Elevation 1453.8

Rock Elevation 1374.8

Total Depth 104.3

Ground-Water Elevation ---

Logged by ~~NBH, JEP/LEM, DAF~~

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 4

Date 3/27/83

Boring No	<u>HD83-29 (River L)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.8</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1374.8</u>
Coordinates: N	<u>3226858.9</u>	Date Started	<u>3/5/83</u>	Overburden Thickness	<u>70.0</u>
E	<u>743029.5</u>	Date Completed	<u>3/5/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>104.3</u>	Logged by	<u>NBH, JEP/LEM</u>

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 4 of 4

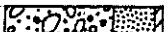
Date 3/27/83

Boring No	<u>HD83-29 (River L)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.8</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1374.8</u>
Coordinates: N	<u>3226858.9</u>	Date Started	<u>3/5/83</u>	Overburden Thickness	<u>70.0</u>
E	<u>7430 9.5</u>	Date Completed	<u>3/5/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>104.3</u>	Logged by	<u>NBH, JEP/LEM</u>

[illegible]

Boring No HD83-30 (River N) Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1388.8
 Coordinates: N 3226932.3 Date Started 3/6/83 Total Depth 66.0
 E 743068.2 Date Completed 3/6/83 Ground-Water Elevation ---

Logged by WMB, REH, RLJ, SEW/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5-10 HAM, CI
5							6.0 Ice		
							9.0 Water		
10	38		1				Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, dark olive grey, subrounded to subangular, fine to coarse, Increase water @ 13.0 ft		
15									
	30		2			GP			Pipe cocked at 18
20	16						Less sand, olive grey		Ft. moved, redrill
									
			3			GW			
25									
	11								
			4						
30									
							5-12% clayey silt, dark olive grey		
	30		5			GW GM			
35									
	35		6			SW SM	Gravelly SAND, 5-12% silt, saturated, very dark grey, fine to coarse, round to subround gravel		Difficulty with
40									sample return,
									formation probably
			7				COBBLE ZONE 40.0-45.0 ft		loose.
45	30								
	30		8			SP	More gravel, less silt		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	<u>HD83-30 (River N)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.8</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1388.8</u>
Coordinates: N	<u>3226932.3</u>	Date Started	<u>3/6/83</u>	Total Depth	<u>66.0</u>
E	<u>743068.2</u>	Date Completed	<u>3/6/83</u>	Ground-Water Elevation	<u>---</u>
Logged by	<u>WMB, REH, RLJ, SEW/LEM, DAF</u>				

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/27/83

Boring No	<u>HD83-30 (River N)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.8</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1388.8</u>
Coordinates: N	<u>3226932.3</u>	Date Started	<u>3/6/83</u>	Overburden Thickness	<u>56.0</u>
E	<u>743068.2</u>	Date Completed	<u>3/6/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>66.0</u>	Logged by	<u>WMB, REH, RJ, J. SEW/LEM, DAF</u>

[illegible]

Boring No HD83-31 (River P) Angle (from Horizontal) 90° Ground Elevation 1456.2
Feature D/S Cofferdam Bearing --- Rock Elevation 1396.2
Coordinates: N 3227015.2 Date Started 3/6/83 Total Depth 82.9
E 743107.3 Date Completed 3/6/83 Ground-Water Elevation ---
Logged by NBH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							1.0 Ice		
	101		1			GW	Sandy GRAVEL with cobbles. 5-12% silt, moist, dark grey, subrounded, fine to coarse, organics		 5 1/2" - HAM, CI
5									
	80		2				Sandy GRAVEL with cobbles, less than 5% silt, moist, olive grey, subrounded to subangular, fine to coarse.		
10									
	28		3			GW			
15									
			4				Saturated.		
20									
			5						
25									
			6			GW	Less sand, dark olive grey.		
30									
			7				Cobble.		
35							Gravelly SAND, less than 5% silt, loose, saturated, very dark grey, fine to coarse, rounded to subrounded gravel.		Easy drilling, 33-57.5 Ft.
40							Easy penetration 33-57.5 ft.		
			8			SP			
45									
			9			SW	Less coarse gravel.		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/27/83

Boring No HD83-31 (River P) Angle (from Horizontal) 90° Ground Elevation 1456.2

Feature D/S Cofferdam Bearing --- Rock Elevation 1396.2

Coordinates: N 3227015.2 Date Started 3/6/83 Total Depth 82.9

E 743107.3 Date Completed 3/6/83 Ground-Water Elevation ---

Logged by NBH, JFB/LEM, DAF

[illegible]

Boring No HD83-31 (River P) Angle (from Horizontal) 90° Ground Elevation 1456.2
 Feature D/S Cofferdam Bearing --- Rock Elevation 1396.2
 Coordinates: N 3227015.2 Date Started 3/6/83 Overburden Thickness 59.0
 E 743107.3 Date Completed 3/6/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 82.9 Logged by NBH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
				Top of Rock 60.0 Ft.					
62	45°	/		62-69.5 <u>Altered Diorite</u> Highly altd, lt. gray, med grained, pseudomorphs of Kaolin after feldspar. Fe-Mg mins. removed, sugary texture, some talc, clay, closely fract. max 1.0', min 0.05 mostly 0.2'-0.4'. Modt hard, modt strong w/high jts occas coated w/talc		100/60	1/2		Start coring 62.0 Ft.
65	30°	/							
65	20°	/							
70	45°	/							
70	30°	/							
75	90°	/		69.5-75 <u>Diorite</u> med gray, med Xyln closely-modt fract max 1.2', min 0.05', mostly 0.3-0.7 hard strg, fr		100/80	2/2		Lost Water
75	20°	/		75-82.9 <u>Altered Diorite</u> as above except w/less clayey alteration of feldspar.					
80	45°	/		80-82.9 <u>Altered Diorite</u> as above except w/less clayey alteration of feldspar.					
82.9	60°	/		T.D. = 82.9 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3

Date 3/27/83

Boring No HD83-32 (River Q) Angle (from Horizontal) 90° Ground Elevation 1454.0

Feature	D/S Diversion Portal	Bearing	---	Rock Elevation	1425.0
---------	----------------------	---------	-----	----------------	--------

Coordinates: N 3227138.2 Date Started 3/6/83 Total Depth

E 742798.9 Date Completed 3/7/83 Ground-Water Elevation 1000.0

Logged by NBH, JEP, WMB, RLJ/LEM, DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/27/83

Boring No	<u>HD83-32 (River Q)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1454.0</u>
Feature	<u>D/S Diversion Porta</u>	Bearing	<u>---</u>	Rock Elevation	<u>1425.0</u>
Coordinates: N	<u>3227138.2</u>	Date Started	<u>3/6/83</u>	Overburden Thickness	<u>22.5</u>
E	<u>742798.9</u>	Date Completed	<u>3/7/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>---</u>	Logged by	<u>NBH, JFP, WMB, RLJ/LEM</u>

[illegible]

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No	<u>HD83-33 (River G7)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.2</u>
Feature	<u>Diversion D/S Portal</u>	Bearing	<u>---</u>	Rock Elevation	<u>1432.2</u>
Coordinates: N	<u>3227126.4</u>	Date Started	<u>3/7/83</u>	Total Depth	<u>43.0</u>
E	<u>742668.9</u>	Date Completed	<u>3/7/83</u>	Ground-Water Elevation	<u>---</u>
Logged by	<u>R.H. WMB/LEM, DAF</u>				

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/27/83

Boring No	<u>HD83-33 (River G7)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.2</u>
Feature	<u>Diversion D/S Portal</u>	Bearing	<u>---</u>	Rock Elevation	<u>1432.2</u>
Coordinates: N	<u>3227126.4</u>	Date Started	<u>3/7/83</u>	Overburden Thickness	<u>13.5</u>
E	<u>742668.9</u>	Date Completed	<u>3/7/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>43.0</u>	Logged by	<u>RJL, WMB/LEM, DAF</u>

[illegible]

WATANA DEVELOPMENT

Ground Elevation _____ 1454.9 _____
Rock Elevation _____ 1442.8 _____
Total Depth _____ 32.4 _____
Ground-Water Elevation _____ --- _____

Boring No. HD83 Sheet 1 of 2
3/4

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/27/83

Boring No	HD83-34 (River S)	Angle (from Horizontal)	90°	Ground Elevation	1454.9
Feature	Diversion D/S Portal	Bearing	---	Rock Elevation	1442.8
Coordinates: N	3227212.5	Date Started	3/7/83	Overburden Thickness	7.0
E	742633.7	Date Completed	3/7/83	Ground-Water Elevation	---
Core Sizes	NX	Total Depth	32/4	Logged by	NBH, JFB, MSC/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
				Top of Rock 12.0 Ft.				
13	90°			13-32.4 Diorite Med gray, med grain.				Start Coring 13.0
15	60°			slightly weath/altd. Plagioclase				
	75°			Hornblende w/some Kaolinized alt.				
	45°			Plagioclase.				
	30°							
20	15°			13-18.7 intensely-modt. fract. max				
	0°			1.1, min 0.05 mostly 0.1-0.4, modt.				Water return lg.
	30°			weath w/heavy Fe stain on jts. De-				grey
	45°			crsd fracturing w/depth, hard, strg.				
	60°							
25	75°			18.7-32.4 closely-modt fract. max				
	90°			1.0' min 0.05 mostly 0.1-0.6 un-				
	45°			weathered except at 21 which is modt				
	30°			weath and modt-deeply weath @29 and				
	15°			modt hard, modt strong, mostly hard,				
	0°			strong fresh.				
30	30°							
	15°			Intensely fractured 30-30.5				
32.4	0°							
				T.D. = 32.4 Ft.				

Boring No HD83-35 (River G8) Angle (from Horizontal) 90° Ground Elevation 1458.4
 Feature Seismic Line ES-D Bearing ----- Rock Elevation 1406.9
 Coordinates: N 3226804.8 Date Started 3/7/83 Total Depth 71.5
 E 743456.5 Date Completed 3/8/83 Ground-Water Elevation ---
 Logged by NBH, JFB, RLJ, WMB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.5 Ice		5 1/2' - HAM, CI
5			1			GW	Sandy GRAVEL WITH COBBLES, 5-12% silt, moist, dark olive grey, rounded to		
			2			GM	subrounded, fine to coarse.		
						GW	Less silt, olive grey.		
10									
	25		3						
15							Water @14.0'		
			4			GW	Less sand, saturated.		
	29						Water @18.5'		Hard Drilling
20							to 19.0'		
	25		5				Water		
							20.5 to 24.5		
25									
			6						
30	43								
			7			GW	More sand and silt.		
						GM	Dark olive grey.		
	72								
35									
			8			GW	Slightly less silt very dark greyish brown.		
40									
			9						
45									Hard Drilling @ 47 Ft.
									
			10			GP	Less sand, dark olive grey.		
50									

Boring No	<u>HD83-35 (River G8)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1458.4</u>
Feature	<u>Seismic Line E5-D</u>	Bearing	<u>---</u>	Rock Elevation	<u>1406.9</u>
Coordinates: N	<u>3226804.8</u>	Date Started	<u>3/7/83</u>	Total Depth	<u>71.5</u>
E	<u>743456.5</u>	Date Completed	<u>3/8/83</u>	Ground-Water Elevation	<u>---</u>

Logged by ~~NBH, JFB, RLJ, WMB/LEM, DAF~~

[illegible]

Boring No HD83-35 (River G8) Angle (from Horizontal) 90° Ground Elevation 1458.4
 Feature Seismic Line ES-D Bearing --- Rock Elevation 1406.9
 Coordinates: N 3226804.8 Date Started 3/7/83 Overburden Thickness 49.0
 E 743456.5 Date Completed 3/8/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 71.5 Logged by NBH, JFB, RLJ, WMB/LEM
DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
				Top of Rock 51.5 Ft.					
52.5 45°									
55 60°				52.5-71.5 Diorite Lt. gray med. grained slightly weath/altd. Some alteration of Plagio to Kaolin.					Start coring @ 52.5
45°				Intensely-modt fract. Max 0.8, min. 0.05, mostly 0.3-0.5. Modt hard to hard. Mod strong to strong. Locally soft. Jts unstained but chalky and w/CaCO ₃ fillings. Some w/blk Mn(?) coatings. Much brkg along high & jts.					Core loss prob. @Top.
60 80°					100/33		1/2		
65 45°									
70 60°					88/15		2/2		
71.5 45°				T.D. = 71.5 Ft.					

Boring No HD83-36 (River G-9) Angle (from Horizontal) 90° Ground Elevation 1456.8
 Feature Seismic Line ES-C Bearing --- Rock Elevation 1432.8
 Coordinates: N 3226826.6 Date Started 3/8/83 Total Depth 43.6
 E 743569.8 Date Completed 3/8/83 Ground-Water Elevation ---
 Logged by WMB, RLJ, NBH, JFB/LEM, DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/27/83

Boring No	HD83-36 (River G9)	Angle (from Horizontal)	90°	Ground Elevation	1456.8
Feature	Seismic Line ES-C	Bearing	---	Rock Elevation	1432.8
Coordinates: N	3226826.6	Date Started	3/8/83	Overburden Thickness	21.0
E	743569.8	Date Completed	3/8/83	Ground-Water Elevation	---
Core Sizes	NX	Total Depth	43.6	Logged by	---

[illegible]

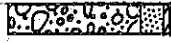
Boring No. HD83-37 (River G2) Angle (from Horizontal) 90° Ground Elevation 1462.5
 Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
 Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0
 E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							1.0 Ice		
5			1			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, moist, dark olive grey, rounded to subangular, fine to coarse.		 5 1/2' - HAM, CI Hard drilling at 4 Ft.
			2						
10			3			GP GM	Slightly more silt.		
15	50								
			4				More gravel		
20	45								
			5			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, moist, dark olive grey, subrounded, fine to coarse.		
25	61								
			6			GW	Saturated.		
30									
			7				Water 31.0-34.0		
35	40								
			8						
40									
			9			GW			
45									
			10			GW	Less medium sand.		
50									

Boring No HD83-37 (River G7) Angle (from Horizontal) 90° Ground Elevation 1462.5
Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0 ft.
E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
55			11						
60			12						
65			13			GW	Olive grey.		
70			14			GP GM	Slightly more clayey silt.		
75			15				Less gravel. Water 70.0 - 74.0 Ft.		
80			16			GP GM	More gravel, olive.		
85			17				Loose formation - easily penetrated.		Easy drilling at 80 - 88 ft.
90			18			GW	GRAVEL WITH COBBLES, 15-20% coarse sand. Less than 5% silt, wet, very dark grey, subrounded to subangular, fine to coarse.		
95			19				Water 87.0 - 88.0 Ft.		
100									

Boring No HD83-37 (River G7) Angle (from Horizontal) 90° Ground Elevation 1,462.5
 Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
 Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0
 E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
105						GP	More medium sand.		
110						GW	COBBLE @ 111.0 Ft. Less medium sand.		Hard Drilling @ 111 Ft. 
115									
120									
125									
130									
135						GP GC	More silty clay, saturated. Dark grey.		
140						GW GM	Water @ 135.0 Ft. Slightly less silty clay and sand.		
145							COBBLES AND BOULDERS.		
150									Refusal Started coring at 143.5 ft.

Boring No HD83-37 (G2) Angle (from Horizontal) 90° Ground Elevation 1462.5
 Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
 Coordinates: N 3226983.9 Date Started 3/8/83 Overburden Thickness ---
 E 475913.9 Date Completed 3/9/83 Ground-Water Elevation ---
 Core Sizes Nx Total Depth 155.0 Logged by NBH, JFB, WMB, RLJ/LEM,

[illegible]

Boring No HD83-37 (G-2)

Angle (from Horizontal) 90°

Ground Elevation 1462.5

Feature ~~Seismic Line ES-F~~

Bearing _____

Rock Elevation 1309.0

Coordinates: N 3226983.9

Date Started 3/8/83

Overburden Thickness

E 475913.9

Date Completed 3/9/83

Ground-Water Elevation Core Sizes NX

Total Depth 155.0

Logged by NBH, JFB, WMB, RLJ/LEM,

DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
150			3 6 9 12						
				Alluvium (as above.)					
155	45° 10°	⌵	■	Assumed Top of Rock 153.5 Diorite fresh, hard, stg. closely fractured. T. D. = 155.0 Ft.					

Boring No HD83-38 (River G1) Angle (from Horizontal) 90° Ground Elevation 1,462.7
Feature Seismic Line ES-F Bearing --- Rock Elevation 1,368.2 (Refuse)
Coordinates: N 3227099.9 Date Started 3/9/83 Total Depth 94.5
E 746148.4 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.5 Ice		5 1/2" - HAM, CI
5	50		1			GP GM	Sandy GRAVEL with COBBLES, 5-12% silt, moist, dark olive grey, rounded to sub-rounded, fine to coarse.		 Hard Drilling 3-12 Ft.
10			2				COBBLES 3.0 - 12.0 Ft.		
15			3			GW	Less silt.		
20			4				More gravel.		
25			5			GW	Less fine sand, wet.		
30			6						
35			7			GP GM	More fine sand, and silt, moist very dark greyish brown.		
40			8						
41			9			SM	Silty, gravelly SAND/ Sandy GRAVEL, moist, very dark greyish brown, subrounded coarse gravel, fine to coarse, occasional cobble.		
45			10						
50									

Boring No HD83-38 (River G1) Angle (from Horizontal) 90° Ground Elevation 1,462.7
Feature Seismic Line ES-F Bearing --- Rock Elevation 1,368.2 (Refusal)
Coordinates: N 3227099.9 Date Started 3/9/83 Total Depth 94.5
E 746148.4 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
	68		11			GM	Slightly less sand, more silt, dark greyish brown.		
55									
	236		12				Less sand and silt.		Hard Drilling @ 56 Ft.
60									
			13			GP GM			
							Saturated.		
65									Water 67.5 Ft.
			14						
70									Out of water, 70 Ft.
			15			GP GM	GRAVEL WITH COBBLES, 20-25% Coarse sand, trace fine to medium, 5-12% silt, saturated, olive, rounded to subangular, fine to coarse.		
75							Less silt, moist.		
	59		16						
80									
			17			GW	More gravel, dark olive grey, less silt.		
85									
			18						Hard Drilling @ 87-89 Ft.
90									
			19			GW GM	More gravel and silt.		
95							TOP OF ROCK 94.5 Ft.		Refusal
									Core barrel won't go below 56. Ft.
100									

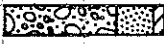
Boring No HD83-39 (River G4) Angle (from Horizontal) 90° Ground Elevation 1462.2
 Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
 Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
 E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by WMB, RLJ, REH, JFB/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2' - HAM, CI
5							5.0 Ice		
	500 200		1			GW GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, damp, dark olive grey, rounded to subangular, fine to coarse		 G _s = 2.74 Hard driving at 6 Ft., boulder (?) to 7Ft, moved hole, redrill
10									
	80		2						
15									
			3			GP GM	Subrounded to subangular		 G _s = 2.80
20									
	50		4						
25									
	50		5			GP GM	Saturated.		
30									
	50								
35									Water @ 33.0 Ft.
			6				Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, olive grey, subrounded to subangular, fine to coarse.		
40									
			7			GW			
45									
	70								
50									

Boring No HD83-39 (River G-4) Angle (from Horizontal) 90° Ground Elevation 1462.2
Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by LMB, RLJ, REH, JFB/LEM, NBH

Depth (Elevation) 50	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
95			8						
55							GRAVEL WITH COBBLES, 20-25% medium to coarse sand, 5-12% silt, saturated, dark olive grey, subrounded to subangular, fine to coarse.		
50			9			GW GM			
60									
90			10						
65									
220			11			GP GM	More fine sand.		 $G_s = 2.82$
70									
170			12						Hard Drilling 73-75 Ft.
75									
70			13			SM	Silty, gravelly SAND, saturated, olive grey, fine to coarse, sub- angular to subrounded gravel.		
80									
90			14						
85									
200			15			SP SM	More sand, less silt.		 $G_s = 2.76$
90									
225			16						
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 5
Date 3/28/83

Boring No HD83-39 Angle (from Horizontal) 90° Ground Elevation 1462.2
 Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
 Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
 E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by WMB, RLJ, REH, JFB/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100									
	93		17			GP GM	Sandy GRAVEL, 5-12% silt, moist, very dark grey, rounded to sub- rounded, fine to coarse, occasional cobble.		
	173								
105									
	137		18						
	125								
110									
			19			GW GM	Wet.		
	76								
115									
			20			GP GM	Dark grey.		
	54								
120									
			21				More gravel and cobbles, damp.		
125			22			GW GM	Less sand, Moist.		
130									
			23						
135							Less cobbles.		
			24			GP GM	More sand.		
140									
			25				Saturated.		
145									
			26			GW GM	More gravel.		
150									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 4 of 5
Date 3/28/83

Boring No	<u>HD83-39 (G-4)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1462.2</u>
Feature	<u>Seismic Line ES-I</u>	Bearing	<u>---</u>	Rock Elevation	<u>1309.6</u>
Coordinates: N	<u>3227400.0</u>	Date Started	<u>3/10/83</u>	Total Depth	<u>168.0 ft.</u>
E	<u>746828.3</u>	Date Completed	<u>3/10/83</u>	Ground-Water Elevation	<u>---</u>

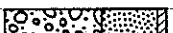
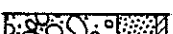
Logged by WMB, RLJ, REH, JFB/LEM, NBH

[illegible]

Boring No HD83-39 (G4) Angle (from Horizontal) 90° Ground Elevation 1462.2
 Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.6
 Coordinates: N 3227400.0 Date Started 3/10/83 Overburden Thickness 147.0
 E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 168.0 ft. Logged by WMB, RLJ, REH, JFB/LEM,
NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
				Top of Rock 152.0 Ft.					
155	10° 80° 30° 20° 80° 20° 15° 20° 80° 40°			152.5-157 Diorite lt. gray, med Xyln. sl. weathered/alterd. Closely fract. Max 0.5, min. 0.05 mostly 0.2-0.4", fresh to sl. weathered, hd. strg, unstained.		100/63			Start Coring 152.5 Brkg along vert jts.
160	15° 20° 80° 40° 50° 60° 80° 40°			157-159.2 Altered Diorite lt gray. intensely-closely fract. 0.05-0.2 modt hd, modt strg to weak & friable Much CaCO ₃ , unstained.		100/30			
165	50° 80° 40° 40°			159.2-164.2 Diorite as above closely-intensely fract 0.05-0.3 Hard, strg, except where more weath w/CaCO ₃ & clay on jts.					
168	40° 40°			164.2-168 Diorite. Med gray, med. Xyln fresh to sl. weathered. Sl.- mod fract unstained some CaCO ₃ .					
				T.D. = 168.0 Ft.					

Boring No HD83-40 (River G-3)
Feature Seismic Line ES-G/H
Coordinates: N 3228285.5
E 747386.5Angle (from Horizontal) 90°
Bearing ---
Date Started 3/11/83
Date Completed 3/11/83Ground Elevation 1,470.6
Rock Elevation ---
Total Depth 38.0 Ft.
Ground-Water Elevation ---Logged by RLJ, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.0 Ice		5 1/2" - HAM, CI Hit boulder at 2 Ft. moved hole, redrill
5	145		1				Sandy GRAVEL, 5-12% silt "damp", olive grey, very dense, subrounded to subangular, fine to coarse, occasional cobble.		Pipe cocked at 8 and 38 Ft. moved back three time, redrill.
10	104		2			GW GM			
15	92						Water @ 15.0 Ft.		Cobble to boulder surface layer at 2-3 Ft. on gravel bar.
	53		3				Sandy GRAVEL WITH COBBLES, less than 5%, dense, saturated, dark grey, subrounded to subangular, fine to coarse.		
20	170		4				Very dense.		
	177								
25	80					GW	Dense.		
	74		5						G _s = 2.76
30									
	140		6			GW GM	5 - 12% silt, very dense.		
35	131								Pipe cocked again @ 38.0 Ft. Bit broken, casing
40							T.D. = 38.0 Ft.		bent.
45									
50									

Boring No HD83-41 Angle (from Horizontal) 45° Ground Elevation 1,471.9
Feature II/S Cofferdam Bearing 098° Rock Elevation 1,413.2
Coordinates: N 3227786.1 Date Started 3/12/83 Total Depth 104.5 Ft.
E 747464.0 Date Completed 3/12/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JFB/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.0 Ice		5'-0"-HAM, CI
5	177 82 43	1				SM	Silty, gravelly SAND with COBBLES, moist, olive brown, 30% fine sand, little medium to coarse sand, sub- rounded to subangular coarse gravel.		
10	55								
	80 85	2							
15									
	184 195	3				GP GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, very dense, damp, dark greyish brown, subrounded to subangular, fine to coarse, occasional boulder.		 $G_s = 2.76$
20									
	285 310	4							
25	335								
	400	5				SP SM	Gravelly SAND, 5-12% silt, very dense, moist, olive grey, fine to coarse, subrounded coarse gravel, occasional cobble and boulder.		 $G_s = 2.76$
30	230								
	340 186	6				GP GM	Silty fine SAND layer 31.5'-34.0 Ft.		
35							More gravel		
	211 84 71	7					Less gravel.		
40	212								
	62 61	8							
45									
	7500	9				SM	More silt.		 $G_s = 2.78$
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4
Date 3/28/83

Boring No HD83-41 Angle (from Horizontal) 45° Ground Elevation 1471.9
Feature U/S Cofferdam Bearing _____ Rock Elevation 1413.2
Coordinates: N 3227786.1 Date Started 3/11/83 Total Depth 104.5 Ft.
E 747464.0 Date Completed 3/12/83 Ground-Water Elevation _____
Logged by RLJ, MPB, REH, JFB/LEM, NBH

Depth (Elevation) 50	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
	400		10				Sandy GRAVEL WITH COBBLES, 5-12% silt, very dense, damp dark olive grey, fine to coarse, rounded to subrounded, occasional boulder.		
55	900		11			GP GM			
60	350		12			GP GM	Boulder 62 - 63.0 Ft.		
65	138								
	234					SW SM	Gravelly SAND, 5-12% silt, dense, damp, olive, fine to coarse, occasional cobble and boulder.		
70	230		14			GM	Slightly more gravel and silt, olive brown, rounded to subrounded gravel.		G _s = 2.68
	100								
	239						Water @ 76.0 Ft.		
75			15				Saturated.		
80	145 88		16				TOP OF ROCK 83.0 Ft.		
85									
90									
95									
100									

Boring No	<u>HD83-41</u>	Angle (from Horizontal)	<u>45°</u>	Ground Elevation	<u>1471.9</u>
Feature	<u>U/S Cofferdam</u>	Bearing	<u>098°</u>	Rock Elevation	<u>1413.2</u>
Coordinates: N	<u>3227786.1</u>	Date Started	<u>3/11/83</u>	Overburden Thickness	<u>57.3 (vert)</u>
E	<u>747464.0</u>	Date Completed	<u>3/12/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>104.5 ft.</u>	Logged by	<u>RLJ,MPB,REH,JFB/LEM,NE</u>

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

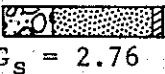
Sheet 4 of 4

Date 3/28/83

Boring No	<u>HD83-41</u>	Angle (from Horizontal)	<u>45°</u>	Ground Elevation	<u>1471.9</u>
Feature	<u>U/S Cofferdam</u>	Bearing	<u>098°</u>	Rock Elevation	<u>1413.2</u>
Coordinates: N	<u>3227786.1</u>	Date Started	<u>3/11/83</u>	Overburden Thickness	<u>57.3 (vert)</u>
E	<u>747464.0</u>	Date Completed	<u>3/12/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>104.5 ft.</u>	Logged by	<u>RLJ, MPB, REH, JFB/LEM, NBH</u>

[illegible]

Boring No HD83-42 (River D) Angle (from Horizontal) 90° Ground Elevation 1,462.1
Feature E Main Dam Bearing --- Rock Elevation 1,392.1
Coordinates: N 3226779.4 Date Started --- Total Depth 127.8
E 745042.1 Date Completed --- Ground-Water Elevation ---
Logged by RJL, MPB, REH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2' - HAM, CI
							4.5 Ice		
10							11.0 Water		
15	25 30 40		1				Gravelly SAND, WITH OCCASIONAL COBBLES, less than 5% silt. Medium dense to dense, saturated olive, medium to coarse.		
20	25 65 90		2			SP	Fine to coarse.		 G _s = 2.76
25	20 70 85		3			GW	Sandy GRAVEL, WITH OCCASIONAL COBBLES, less than 5% fines, dense, saturated, olive brown, subrounded, fine to coarse, medium to coarse sand.		
30	85 90 70 60		4			GP GM	5 - 12% clayey silt, olive.		
35	60 65 60		5			SW	Gravelly SAND, WITH COBBLES, less than 5% fines, dense, saturated, olive grey, rounded to subangular, fine to coarse.		
40	75 40 25		6				Medium dense, grey.		
45	40 40 35 35		7			SM	Silty SAND, with 20% Gravel, medium dense, saturated, grey fine to coarse.		
50	50								

Boring No. DH83-42 (River D) Angle (from Horizontal) 90° Ground Elevation 1462.1
Feature E Main Dam Bearing --- Rock Elevation 1392.1
Coordinates: N 3226779.4 Date Started 3/13/83 Total Depth 127.8
E 745042.1 Date Completed 3/14/83 Ground-Water Elevation ---
Logged by RJL, MPB, REH, JFB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	240								
55	151 89		8						
60	89 117		9			SP	Gravelly SAND with occasional cobbles, less than 5% silt, 48% gravel, silt is saturated, dark grey, subrounded gravel, fine to coarse.		 $G_s = 2.75$
65	151 125 102 104		10			GW GM	Sandy GRAVEL, 6% clayey silt, with occasional cobbles, very dense, saturated, very dark grey, rounded to subrounded, fine to coarse.		
70	124 105		11			SC	Gravelly, clayey SAND, dense, saturated, very dark grey, gravel rounded to subrounded, fine to coarse. Sandy GRAVEL AND COBBLES.		 LL26 PL18 PI8
70	620						TOP OF ROCK 70.0 Ft.		
75									
80									
85									
90									
95									
100									

Boring No HD83-42 Angle (from Horizontal) 90° Ground Elevation 1462.1
 Feature Main Dam Bearing --- Rock Elevation 1392.1
 Coordinates: N 3226779.4 Date Started 3/13/83 Overburden Thickness 59.0
 E 745042.1 Date Completed 3/14/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 127.8 Logged by RJL, MPB, REH, JEB/LEM, DA

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
70				Top of Rock 70.0 Ft.					
45	X			70-71.4 Altered Diorite. modt. lt. gray med Xyln. hard strong, modt-cl fract. 0.6-0.1'					Started coring 70.0
70	//			71.4-127.8 Diorite/Qtz Diorite med gray to grn gray, med coarse Xyln. Plagio, hornblde. bio. and variable Qtz. massive color varies w/% of mafics					
75	/								
60	/								
90	/								
60	/								
80	-			71.4-84.4 modt. fract. max 1.4' min. 0.1, mostly 0.3-0.8' hard-V. hard, strong, fresh & unweath, unstained. Jt surfaces modt rough-rough w/lt. coatings of CaCO ₃ .					
60	/								
80	/								
85	X			84.4-88.2 closely fract 0.05'-0.3' hard, strong, fresh.					
90	X			88.2-99.2 modt. fractured. max 1.6' min 0.1' mostly 0.5-1.0' V. hard strong, fresh & unstained, rough jt surfaces occas coated w/CaCO ₃ .					
60	X								
75	X								
90	/								
45	/								
90	/								
30	<								
70	<								
95									
45	X								
100	X								

Boring No HD83-42 Angle (from Horizontal) 90° Ground Elevation 1462.1
 Feature E Dam Axis Bearing --- Rock Elevation 1392.1
 Coordinates: N 3226779.4 Date Started 3/13/83 Overburden Thickness 59.0
 E 745042.1 Date Completed 3/14/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 127.8 Logged by R.J.L., MPB, REH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
80°	X			99.2-101.4 closely fract Max 0.6'					
30°	X			min 0.05', hrd, strg. Sl altd					Partial Water
				100.9-101.4					Loss 103.0
105									
80°	X			101.4-107.7 Modt fract. max 1.2'		100/77			
30°	X			min <0.1 mostly 0.5'-0.7'. Some			3/4		
60°	X			mech. brkg. Hard, strong, fresh,					Complete water loss
60°	X			some CaCO ₃ on jt surfaces.					109.0
110									
80°	X			107.7-115.1 Closely fractured, Max		90/60			
70°	X			0.3' min 0.05 w/evidence of mech					
60°	X			brkg and grinding, esp 113-115.					
60°	X			Hard & strong, fresh and unweathered					
115				unstained, rough -modt rough jt		100/80			
80°	X			surfaces.					
20°	-			115.1-127.8 Modt fract. Max 1.5',					
				min 0.1', mostly 0.3-0.8', hard &					
120				strong, fresh & unweath, unstained.					
60°	/			Jts healed w/CaCO ₃ , rough jt surface					
40°	/								
30°	=								
20°	/								
125						100/93	4/4		
0°	-								
40°	/								
				T.D. 127.8 Ft.					
130									
135									
140									
145									
150									

Boring No HD83-43 (River C) Angle (from Horizontal) 90° Ground Elevation 1,461.1
Feature E Main Dam Bearing --- Rock Elevation 1,385.7
Coordinates: N 3226736.8 Date Started 3/14/83 Total Depth ---
E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JFR/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5' - HAM, CI
							4.5 Toe		
10							10.0 Water		
	34		1			SP	Gravelly SAND/Sandy GRAVEL, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to sub-angular gravel, occasional cobble.		
15	49								
	75								
	30					GP	Slightly more gravel.		
	60								
	102								
20									
	40		3						
	50								
	50								
25	31								
			4						
	25					GW			No water return
30	25								
	110		5				Sandy GRAVEL, 5-12% clayey silt, saturated, olive, subrounded to sub-angular. Fine to coarse.		
	125								STANDARD PROCTOR MAX = 143.5 M/C 6%
35	125								
	78		6			SP	Gravelly SAND, less than 5% silt, saturated, olive, fine to coarse.		G _s = 2.83
	41								
40	50		7				GRAVEL, 20% medium to coarse sand, 5-12% silt.		
	41					GW			
	35					GM	Subrounded to subangular, fine to coarse, occasional cobble.		No water return 42.48 feet
45									
	34		8						
	30								
50	43								

Boring No. HD83-43 (River C) Angle (from Horizontal) 90° Ground Elevation 1461.1
Feature E Main Dam Bearing --- Rock Elevation 1385.7
Coordinates: N 3226736.8 Date Started 3/14/83 Total Depth ---
E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JFB/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
	42								
	34		9						
55						SC SM	Silty, clayey, gravelly SAND, saturated, dark olive grey, fine to coarse.		LL ZZ PL 18 PI 4 CL-ML
	53		10						
	31								
	68								
60									
			11			GM	Clayey, silty, sandy GRAVEL. Saturated, very dark grey, subrounded. Fine to coarse, occasional cobble.		
							COBBLES AND BOULDERS @ 63.0 Ft.		
65									Hard Drilling and water @ 63ft.
	126		12			SW			
70									Start coring at 67.0 Ft.
75							Top of Rock 75.4 Ft.		
80									
85									
90									
95									
100									

Boring No HD83-43Angle (from Horizontal) 90°Ground Elevation 1461.1Feature C Main DamBearing ---Rock Elevation 1385.7Coordinates: N 3226736.8Date Started 3/14/83Overburden Thickness 65.4E 745055.6Date Completed 3/14/83Ground-Water Elevation ---Core Sizes NXTotal Depth 107.7Logged by R.J.L., M.P.B., R.E.H., J.F.B./L.E.M.,

NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
67				Rounded heterolithologic Cobbles, Boulders & gravel. Recovered 70% greater than 4" Ø.					Start Coring 67
70									100% water loss @73
75				TOP OF ROCK 75.4					
75				75.4-89.4 Diorite/Monzanite Med. grn. gray, med-coarse Xyln. Plagio, Hornblde, pink K-feld, v. minor qtz. Massive, fresh.					No water return
80				75.4-85 Closely - modt fract. max 1.4' min 0.1 mostly 0.3-0.5 V. Hard, strg., fresh, unweath., rough fract. surfaces some CaCO ₃ jt. coatings.					
85				85-89.4 Closely-intensely fract. Brkn. Max 0.25 min 0.05' mostly 0.1-0.2. Hrd, strg, fresh to slightly weathered, some CaCO ₃ in jt surfcs.					Some mech. brkg.
90				89.4-94.4 Altered Diorite med grnd. lt. gray, some alter of Plagio to Kaolinite.					
95				Intensely-closely fract max 0.25 min 0.05 mostly 0.1-0.2, hard, modt strong, fresh-sl weather CaCO ₃ on fract. surfaces.					
100				94.4-104.4 Diorite/Monzanite (as above) moderately-closely fractd 94-100 Modt.					

Boring No. HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1,459.9
Feature E Main Dam Bearing --- Rock Elevation 1,392.4
Coordinates: N 3226818.9 Date Started 3/15/83 Total Depth 118.0
E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---

Logged by RLI,MPR,REH,JEP/LEM,NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2", HAM, CI
5							5.0 Ice		
10							Water		
14.4			1			SW	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to subangular gravel.		
15			2						
18						SP	Gravelly SAND, less than 5% silt, saturated, olive brown, fine to coarse.		
20	20 46 70		3						
25	24					SP	Gravelly SAND, less than 5% silt. Saturated, dark olive grey, fine to coarse, subrounded to subangular gravel, occasional cobble.		
30	39 73 74		4						
35	59 68 124 114 124		6						STANDARD PROCTOR Y Max = 135PCF
40	114 88 84		7			SP	Less gravel.		 G _s = 2.81
45	54 54								
50	79		8			SW SC/SM	Gravelly SAND, 5-12%, clay-silt, saturated, dark olive grey, medium to coarse.		 LL25 PL20 PI5 CL-ME

Boring No HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1459.9
Feature E Main Dam Bearing --- Rock Elevation 1392.4
Coordinates: N 3226818.9 Date Started 3/15/83 Total Depth 118.0
E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JEP/LEM, NBH

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
54	54		9			GW	Sandy GRAVEL, 5-12% clayey silt, saturated, very dark grey, subrounded to subangular, fine to coarse, medium to coarse sand, occasional cobble.		
55	68					GM			
56	67								
57									
58	76		10						
59									
60	139					GW	COBBLES AND BOULDERS.		
61	251					GM			
62	312		11						
63									
64	54								
65									
66							TOP OF ROCK 67.5 Ft.		Refusal at 67.5 Ft.
67									
68									
69									
70									
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									
81									
82									
83									
84									
85									
86									
87									
88									
89									
90									
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Boring No. HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1459.9
 Feature C Main Dam Bearing --- Rock Elevation 1392.4
 Coordinates: N 3226818.9 Date Started 3/15/83 Overburden Thickness 57.5
 E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 118.0 Logged by RLJ, MPB, REH, JEP/LEM,
NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
30°									
45°									
70									
45°									
45°									
45°									
75									
45°									
45°									
10°									
80									
45°									
45°									
50°									
45°									
85									
45°									
70°									
45°									
90									
60°									
60°									
45°									
45°									
50°									
70°									
30°									
50°									
90°									
45°									
70°									
60°									
100									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 4 of 4
Date 3/28/83

Boring No	HD83-44 (River E)	Angle (from Horizontal)	90°	Ground Elevation	1459.0
Feature	Main Dam	Bearing	---	Rock Elevation	1392.4
Coordinates: N	3226818.9	Date Started	3/15/83	Overburden Thickness	57.5
E	745032.9	Date Completed	3/16/83	Ground-Water Elevation	
Core Sizes		Total Depth	118.0	Logged by	RLJ, MPB, REH, JEP, LEM

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
105	50° 60° 70° 80° 90° 10°	Y Y Y Y Y Y		Diorite as above. diagonal dike 0.5" @ 104. 103-118 closely-mottled fract. max piece 0.7 min 0.05, mostly 0.1- 0.4 in interval. 103-108 and 0.2-0.6 108-118 Hard, strong, fresh, unweathered, unstained w/light CaCO ₃ coating on some jts.		80/24 100/95 95/95	3/4		Many mech. fract. Mech Brkg & grinding Grinding evident 100% water loss @ 111.75
115	30° 45° 60° 70° 80° 90°	Y Y Y Y Y Y				100/95	4/4		Mechanical brkg.
118	60°	Y		I.D. = 118.0 Ft.					

Boring No HD83-45 Angle (from Horizontal) 45° Ground Elevation 1,463.5
Feature E Dam, Right Abutment Bearing 328° Right Abutment Rock Elevation 1,423.9
Coordinates: N 3226933.2 Date Started 3/16/83 Total Depth 80.0 Ft.
E 745003.6 Date Completed 3/17/83 Ground-Water Elevation ---
Logged by NBH, MPB, JEP, REH/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							Ice		
			1				Sandy GRAVEL WITH COBBLES, 5-12%		5 1/2' - HAM, CI
5	21		2			GW GM	silt, humid, dark olive grey, rounded to subrounded, fine to coarse, occasional boulder.		Hard Drilling
10	31		3						
	40								
15			4			GW GM	Damp, subrounded.		
							Water @ 17.5 Ft.		
20	50		5						
	52								
25			6			GM	Wet, more silt.		
	38						Subrounded to subangular.		NP
30	70		7			SW SM	BOULDER.		Poor return 28-33.5 Ft
							Gravelly SAND, 5-12% silt, wet, dark olive grey, fine to coarse, subrounded to subangular gravel.		Hard Drilling
35			8			SW SM			33.5-34.5 Ft.
	150								
40			9						Alter. hard & easy
									Drilling, 42-47
45	250								Ft.
	35		10			GP GM	Sandy GRAVEL, 5-12% silt, wet, olive, subrounded, fine to coarse, occasional cobble.		Water return @
50									47 Ft.

Boring No. HD83-45 Angle (from Horizontal) 45° Ground Elevation 1463.5
Feature E Dam - Right Abutment Bearing 328 Rock Elevation 1423.9
Coordinates: N 3226933.2 Date Started 3/16/83 Total Depth 80.0 Ft.
E 745003.6 Date Completed 3/17/83 Ground-Water Elevation ---

Logged by NBH, MPB, JEP, REH/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	50		11						
55									
							TOP OF ROCK 56.0 Ft.		
60									
65									
70									
75									
80									
85									
90									
95									

Boring No HD83-45 Angle (from Horizontal) 45° Ground Elevation 1463.5
 Feature L Dam- Right Abutment Bearing 328 Rock Elevation 1423.9
 Coordinates: N 3226933.2 Date Started 3/16/83 Overburden Thickness 38.9 (vert)
 E 745003.6 Date Completed 3/17/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 80.0 ft. Logged by NBH, JEP, MPB, REH/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
				TOP OF ROCK 56.0 Ft.					
56	45°		Fe	56-60 Diorite/Granodiorite gray med-coarse Xyn. Plagio Hornblde. qtz some bio & K-feld. Modt-closely fract. max 1.6 min 0.1, mostly 0.4-0.6'. Hard, strong, fresh, unweath. except for modt Fe stain on jts surfaces. Core loss at top of run CaCO3 coatings on jts.		65/52			Started Coring 56
60									
			Core			0/0			Mislatch No. Recov
65									
			Loss	60-70 Mislatch - core loss minor recovered pcs suggests similar rock to above.		20/0	1/2		Mislatch core ground.
70	30°			70-72.1 Diorite as above modt. fract. Fe stained on jts w/CaCO3					
	60°			72-75 Altered Diorite r. lt gray-white plagio alter to Kaolin		100/42			Water return, lt. grey
	50°			Closely fract soft & friable to modt hard and strong.					
75	5°			75-80 Diorite grn. gray as above. Closely fract. 0.1-0.8', fresh & unweath. Lt to modt. Fe stains on jts w/CaCO3 Hard, strong, sl. altered 79-80.		100/50	2/2		
	60°								
	40°								
	70°								
80	10°								
	70°								
				T.D. = 80.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/28/83

Boring No. HD83-46 Angle (from Horizontal) 45° Ground Elevation 1,461.5
Feature Dam Bearing 155 Rock Elevation 1,406.0
Coordinates: N 3226614.7 Date Started 3/17/83 Total Depth 98.2 FT.
E 795075.3 Date Completed 3/18/83 Ground-Water Elevation ---

Logged by NBH, MPB, JEP, REH/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.0 Snow & Ice		5 1/2' - HAM, CT
5			1				Boulder		
						GW	Sandy GRAVEL, 5-12% silt, damp (frozen),		
			2			GM	very dark greyish brown, subangular, fine to coarse, occasional cobble and boulders.		
10	24						Wet.		
			3				Cobble or boulder.		
15	12		4			OH	Organic clay/silt (Peat)		LL56 PL52 PI4
							20-25% gravel, 15-20% fine sand, very dark brown, occasional cobbles.		O H Organic
			5			SM	Clayey silt, more fine sand.		N P
20							Sandy GRAVEL, 5-12% silt, humid, dark olive grey, rounded to subangular, fine to coarse, occasional cobble.		3% organic
			6						Hard Drilling at 19.5 - 22.0 Ft.
25						GP			
			7			GM			
30	50						Water @ 30.5 Ft.		Hard Drilling at 29.5 Ft.
			8						
35	30					GP			
	20					GM			
			9						
40	60								
			10			SP	Less silt and fine sand. Medium to coarse sand and fine gravel.		
45									
			11				More coarse gravel.		
50							Cobbles and boulders.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/28/83

Boring No	<u>HD83-46</u>	Angle (from Horizontal)	<u>45°</u>	Ground Elevation	<u>1461.5</u>
Feature	<u>C Dam</u>	Bearing	<u>155°</u>	Rock Elevation	<u>1406.0</u>
Coordinates: N	<u>3226614.7</u>	Date Started	<u>3/17/83</u>	Total Depth	<u>98.2 ft.</u>
E	<u>795075.3</u>	Date Completed	<u>3/18/83</u>	Ground-Water Elevation	<u>---</u>
Logged by	<u>NBH, MPB, JEP, REH/LEM, DAF</u>				

Logged by NBH, MPB, JEP, REH/LEM, DAF

[illegible]

Boring No HD83-46 Angle (from Horizontal) 45° Ground Elevation 1461.5
 Feature C Dam Bearing 155° Rock Elevation 1406.0
 Coordinates: N 3226614.7 Date Started 3/17/83 Overburden Thickness 37.8 (vert)
 E 795075.3 Date Completed 3/18/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 98.2 Ft. Logged by NBH, MPB, JEP, REH/LEM, D.

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55.6	70°			Top of Rock 55.5 Ft.					
40	30°			Fe 55.5-76 Diorite gray-grn gray med Xyln. Plagio hornbld. bio.	100/30				Start Coring 55.5
60	30°			Fe Massive fresh except for jt surf	100/67				
	60°			Fe 55.5-57.0 closely fract Mostly					
	30°			Fe 0.1 Fe stain along joints.					
	30°			Fe 57-65 modt fract max 0.8' min.					
	30°			Fe 0.5 mostly 0.5-0.6 Hard.					
65	30°			Fe Strong, fresh & unstained except for Fe stain on jt surfcs. jts.	100/56		1/3		
	45°			Fe Brkn 65-67 Closely fract 0.4'-0.8' w/	100/56				50% H ₂ O Loss ± 67'
	45°			Fe Fe stain, chlorite rough surfcs.					
	30°			67-76 modt-sl fract. max 1.4,	97/73				100% H ₂ O Loss
70	45°			Fe min 0.1, mostly 0.7-1.4'					
	45°			CaCO ₃ Modt - sl Fe stain w/CaCO ₃ on jt surfaces, hard, strong, fresh.	100/64				
75	45°			76-78.5 Altered Diorite wht, med grained sl-deeply altered.					H ₂ O Return
	45°			Closely intensely fract max 0.5					
	45°			min 0.05, var soft & fria. to					
80	45°			stg. modt Fe stain & CaCO ₃ .			2/3		
	45°			78.5-82.2 Diorite as above					
	30°			close fract max 0.5 min 0.1					
	30°			mostly 0.2-0.3 hard strg unweath					
	45°			82.2-84.8 Altered Diorite modt a.	100/55				
85	45°			close fract many incipient jts					
	30°			modt hard-modt strg to weak and friable CaCO ₃ in jt surfaces.					
	20°			84.8-98.2 Diorite as above.					
	45°			Modt fract to sl fract. max 2.0'					
90	45°			min 0.1 mostly 0.5-1.1 hard, strg fresh unweath V sl Fe stain and CaCO ₃ on jt surfaces.	100/90		3/3		
	10°								
95	60°			Fe					
	45°			CaCO ₃					
98.2				T.D. = 98.2 Ft.					

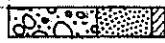
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 4/11/83

Boring No HD83-47 Angle (from Horizontal) 45° Ground Elevation 1,459.6
Feature D/S Cofferdam Bearing 010° Rock Elevation ---
Coordinates: N 3227033.0 Date Started 3/18/83 Total Depth 65.0
E 743094.6 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by JEP, REH, NBH, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
						GP	2.0 Ice		5 1/2' HAM, CI
5			1			GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, dry, (Frozen) dark olive grey, rounded to subrounded, fine to coarse.		
			2			SM	Silty, gravelly SAND with COBBLES, frozen, very dark greyish brown, 30% fine sand, trace medium to coarse.		N.P. Hard drilling at 2.5-6.0 ft.
10									
	21		3				Subrounded to subangular gravel.		V. Easy drilling 12-14 ft.
	12						COBBLE/BOULDER.		No recover, cobble in bit.
15									
20									
			4			GW	Sandy GRAVEL, 5-12% silt, dark olive grey, saturated, Water @ 22.0 Ft. subrounded to subangular.		
	45					GM			
25			5			SP	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to subangular gravel. Occasional cobble.		
30									
	45		6				Less fine sand.		
	74								
	27								
35			7			GW	More gravel, olive grey.		
40									
	200		9			SP	More fine to medium sand.		Hard drilling, 40 ft.
						SM			
45							Less fine sand.		
	10								
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 4/11/83

Boring No. HD83-47 Angle (from Horizontal) 45° Ground Elevation 1459.6
Feature D/S Cofferdam Bearing 010° Rock Elevation ---
Coordinates: N 3227033.0 Date Started 3/18/83 Total Depth 65.0 Ft.
E 743094.6 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by JEP, REH, NBH, MPB / LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
55									No recovery from 50-60 ft. Pipe blocked.
60	56								
	148					GW	Sandy GRAVEL, 5-12% clayey silt, moist, light yellowish brown, fine to coarse,		
	178					GM	COBBLES.		Core barrel won't go down through
65	110						REFUSAL @ 65.0 Ft.		rods.
							T.D. = 65.0 ft.		
70									
75									
80									
85									
90									
95									
100									

Boring No HD83-48 (River G6) Angle (from Horizontal) 90° Ground Elevation 1,455.6
Feature --- Bearing --- Rock Elevation ---
Coordinates: N 3226951.3 Date Started 3/19/83 Total Depth 108.0 Ft.
E 742833.4 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by NBH, MPB, REH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2" - HAM, CI
5							5.5 Ice		
							8.0 Water		
10							COBBLES/BOULDER		
14.8			1				Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, olive grey, rounded to subrounded, fine to coarse.		Easy Drilling at 14.5 Ft.
15									
			2			SP	Poorly graded SAND WITH COBBLES, 10-15% fine gravel, less than 5% silt, fine to medium, saturated, dark olive grey.		
20							COBBLE.		Hard Drilling
			3				More gravel.		
25									
			4			SP SM	Gravelly SAND, 5-12% silt, subrounded to subangular, less cobbles.		NP
30									
			5						
35									
			6			GW	Sandy GRAVEL, less than 5% silt, saturated, black, subrounded to subangular, fine to coarse.		
40									
			7			GW	More sand, very dark grey.		
45									
50									

Boring No HD83-48 (River GG) Angle (from Horizontal) 90° Ground Elevation 1,455.6
Feature --- Bearing --- Rock Elevation ---
Coordinates: N 3226951.3 Date Started 3/19/83 Total Depth 108.0
E 742833.4 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by NBH, MPB, REH, JEP/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
55	47 27 12		8						Poor return Hard Drilling at 55.5 Ft.
60			9			SP	Poorly graded SAND, 15-20% fine to coarse gravel, less than 5% silt, saturated, very dark grey, fine to medium.		 N.P.
65	53 41 42 42		10				Sandy GRAVEL, 5-12% silt. Saturated, very dark grey, subrounded, fine to coarse.		
70	48 85		11			SW SM	Gravelly SAND, 5-12% clayey silt, saturated, very dark grey, medium coarse, subrounded to subangular gravel.		
75	87 200 160		12				Sandy GRAVEL, 5-12% clayey silt, wet, very dark grey, subrounded to subangular, fine to coarse, occasional cobble.		
80	46 46 35		13				More coarse gravel and cobbles.		
85	38 40 46 51 46		14			GC	Clayey, sandy GRAVEL, wet, dark grey, subrounded to subangular, fine to coarse, occasional cobble.		 LL27 PL18 PI9 CL
			15			GP GC	Less clay. TOP OF ROCK 88.0 Ft.		 Refusal
90									
95									
100									

Boring No HD83-48 Angle (from Horizontal) 90° Ground Elevation 1455.6
 Feature --- Bearing --- Rock Elevation ---
 Coordinates: N 3226951.3 Date Started 3/19/83 Overburden Thickness 80.0
 E 742833.4 Date Completed 3/19/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 108.0 Logged by NBH, MPB, REH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
105	30° 45° 0° 60° Brkn			103-106 Altered Diorite modt-sl. alt It gray, med grained, intensely fract. max 0.2 CaCO ₃ on jts. Modt hard, Modt strong	98/33		2/2		Water loss 105- 105.5 Ft.
108	45° 5°			106-108 Diorite Modt fract. Hard, strong					
				T.D. = 108.0 Ft.					

2.2 RELICT CHANNEL BORING LOGS

Boring No Water Well Angle (from Horizontal) 90° Ground Elevation 2267.0 (Approx.)
Feature Watana Base Camp Bearing --- Rock Elevation 2060.5 (Approx.)
Coordinates: N --- Date Started 1/28/83 Total Depth 214.5
E --- Date Completed 1/31/83 Ground-Water Elevation ---

Logged by JEP, WMB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									70- HAM, CI, TW
5			1			SM	Silty SAND, 20-25% Fine to coarse gravel, moist, light olive gray. Fine to coarse. Occasional cobble.		
10			2			SM	Grayish brown, Angular to subangular gravel.		
15	65 56 59 63		3			SM	Less gravel.		 NP
20			4			SM	Less gravel.		
25			5				Dark grayish brown.		
Water @ 40 Ft.									
30			6			SM	Silty, gravelly SAND, moist dark gray, fine to coarse striated gravel, clay/silt clumps, occasional cobble.		
35			7			SM SC	More clay, very dark gray. Subangular gravel.		 LL19 PL14 PT5 ML-CL
40			8			SM SC	Dark olive gray.		 LL18 PL14 PT4 ML-CL G _s =2.72
45			9			SM	Dark gray.		
							Cobbles/Boulder		
50			10			SM			

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 5
Date 1/29/83

Boring No Water Well
Feature Watana Base Camp
Coordinates: N ---
E ---

Angle (from Horizontal) 90°
Bearing ---
Date Started 1/29/83
Date Completed 1/31/83

Ground Elevation 2267.0 (Approx.)
Rock Elevation 2060.5 (Approx.)
Total Depth 214.5
Ground-Water Elevation ---

Logged by JEP, WMB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
40	100		11			SM	Silty SAND, 15-20% gravel, humid, light olive gray. Fine to coarse, to angular gravel.		Hard Drilling.
55							BOULDER Occasional cobble/boulder.		moved hole
	100		12			SM	More sand.		5 1/2" HAM, CI re-
60							More cobbles/boulders. Light brown gray.		drill, hard drill
	170		13			SM	Brownish gray.		ing
	40								90" HAM, CI
65									
	160								
70									
	60		14			SM	Silty SAND, 10-15% gravel. Gray. Fine to coarse		
							Laminations.		
75									
	36		15			ML	Clayey SILT, 10-15% Fine to coarse		
80						CL	sand, moist, very dark gray.		
			16			ML	Laminations. More fine to medium sand, gray		
							varved silt/clay clumps.		
85									
	75								
	100		17			SM	More fine to coarse sand, fine gravel, olive gray.		
90									
	135		18			SM	Clayey, silty SAND, less than 5% gravel, very dark grayish brown, fine to coarse, occasional cobble.		
95									
	135								
100			19				Gravelly silty SAND, very dark grayish brown, fine to coarse.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 5
Date 1/29/83

Boring No Water Well Angle (from Horizontal) 90° Ground Elevation 2267.0 (Approx.)
Feature Watana Base Camp Bearing --- Rock Elevation 2060.5 (Approx.)
Coordinates: N --- Date Started 1/28/83 Total Depth 214.5
E --- Date Completed 1/31/83 Ground-Water Elevation ---

Logged by JEP, WMB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							(cont) Subangular coarse gravel, Laminated & varied silt clumps.		On boulder
105	540		20			GM	Less silt, more gravel. Light brownish gray, occ. cobble/bldr.		
110	350		21			SM	Less gravel, more silt and sand, dark gray.		
115	220		22			SM	Less gravel.		
	290						More cobbles and boulders.		
120	1200		23			SM	Silty SAND, 5-10% Fine gravel, dark grayish brown, fine to coarse, occasional cobbles/boulders.		
125	420		24			SM	More gravel, less sand and silt, humid.		
							More cobbles and boulders.		
130			25			GM	More gravel Boulder.		
135	1479		26			SM	Less gravel, damp.		
140			27			GP GM	More gravel, cobbles & boulders Water @ 138.5 to 143.0 Ft.		
145			28			CL	CLAY, saturated, dark gray. Some laminations?		LL43 PI23 PI20 CL
150									

Boring No Water Well Angle (from Horizontal) 90° Ground Elevation 2267.0 (Approx.)
Feature Water Base Camp Bearing --- Rock Elevation 2060.5 (Approx.)
Coordinates: N --- Date Started 1/28/83 Total Depth 214.5
E --- Date Completed 1/31/83 Ground-Water Elevation ---

Logged by JEP, WMB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							Moist.		
155									
162							More fine to medium sand, dark olive gray,		
173			29			CL	Brownish gray, more silt.		
			30			ML			
160			31			SM	Silty SAND, 15-20% Fine gravel, dark grayish brown, fine to coarse, sub-angular to subrounded gravel.		
2000			32				Grayish brown.		
165			33			GM	Silty, sandy GRAVEL, damp. Gray, subangular to subrounded, fine to coarse.		
170									Very hard Drilling go to water injection
175			34						
			35				Sandy GRAVEL WITH COBBLES Subrounded to subangular.		
			36				(Most fines washed away in water return).		
180			37						
			38				Rounded to subrounded gravel. Oxidation coating on gravel.		
							Subrounded gravel.		
185			39						
			40						
190			41						
	377								
	37								
	24		42						
195									
			43						
200									

Ground-Water Elevation

Boring No. Water Sheet 5 of 5
Well

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---
Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
37 24 27 16 15			1			SM	Silty, gravelly SAND, moist, olive brown, fine to coarse, subangular to subrounded gravel.		5 1/2" - HAM, CI 
35 19 19 18 57 54			2SS 2	24 19 17			Damp, dense.		MC 9%
26 62 80 69 78 101 125 150 137 115 158 218 197 180 159 182 226			3 4 5SS 6			SM SM SM SC	Clayey, silty SAND, 15-20% fine gravel. Damp, dark gray, sub-rounded, fine to coarse, occasional cobbles. More coarse gravel. Very dense. More silty clay, less gravel.	Thermal Probe to 230 Ft.	   LL18 PL13 PI5 ML-CL
			7 8SS	100/2.5"			COBBLE/BOULDER TO 38.5 FT. Striations on gravel.		
387			9				More sand, cobbles. Striations.		

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/8/83 Ground-Water Elevation ---
Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	102 119		10			SM	Less sand and gravel, moist.		 NP
55			11			SM SC	Clayey SAND, 15-20% gravel. Gray, fine to medium. Subrounded to subangular gravel, striations on gravel.		
60	118 158		12			SM SC	Moist, more gravel.		
65	248		13			SC	Damp.		
70	301		9SS 14	35 40 56		SC	Very dense.		LL24 PL14 PI10 CL LL42 PL18 PI24 CL M/C 12% 
75	313		15 16			SM	Silty SAND, 20-25% gravel Humid, dark gray. Fine to coarse.		
80	358		17			SM	Subangular gravel, striated, occasional cobble. Dry, more gravel.		
85	262 211 242		18			SM	Less gravel.		 NP
90	388		10SS 19	38 62/2 1/2		SM	Very dense.		M/C 11% 
95	487		20			SM	Less silt, more gravel, noticeable mica.		
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 7
Date 2/25/83

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100	269		21			SM	Silty gravelly SAND, Damp.		
105							COBBLE/BOULDER		
110	256		22			SM	Less gravel, striations.		
	336						More gravel.		NP
115	370		23			SM	Dry		
	482								Defective pipe abandoned hole @ 117.0
120									5 1/2" - CSR, BB Redrill twice
	230		24			SM	Less gravel		
125									LL17 PL15 PI2 ML M/C 4%
			25			SM			
130									LL17 PL15 PI2 ML M/C 3%
			26			SM SC	Clayey, silty SAND, 5-10% fine gravel, moist, dark grey		
135							fine to coarse, occasional cobble.		LL19 PL14 PI5 ML-CL M/C 5%
			27			SM SC			
140									LL20 PL14 PI6 ML-CL M/C 6%
			28			SM	Slightly less clay.		
145									LL18 PL16 PI2 ML M/C 3%
			29			SM	More gravel.		
150									NP M/C 5%

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
150									
155			30						
160							COBBLE/BOULDER 158.0 - 164.0 FT.		
165			31			SM	More gravel, subangular to subrounded Laminated silt clumps.		NP M/C 3%
170			32				Less gravel.		WATER LEVEL @ 165.0 Ft. 2/16/83 M/C 3%
175							COBBLE/BOULDER		
180			33				Dry.		M/C 1%
185			34			SM	Silty SAND, 10-15% fine gravel. Dry, olive gray, fine to coarse.		M/C 1%
190			35			SM	More gravel, moist, subrounded		NP M/C 2%
195			36			SM	Silty, gravelly SAND. More gravel, subrounded. WET 191-194.0 FT.		M/C 3%
200			37			SM	Less gravel, more fine to coarse sand Laminated silt clumps?		NP

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
200									
205			38			SM	Silty SAND, 15-20% fine gravel, saturated, very dark gray, fine to coarse, subrounded to rounded gravel.		 LL18 PL16 PI2 ML M/C 13%
210			39			SW SM	Well graded SAND, 20-25% fine to coarse gravel. 5-12% clayey silt. Saturated, olive gray. Fine to coarse.		 No recovery, material coming up return pipe when adding section. Plugged. Tried: CSR,OB; HAM,CI
215									
220									
225								P	PNEUMATIC PIEZOMETER @ 225.0 Ft.
230			40			SM	Silty SAND, 10-15% coarse gravel, saturated, olive gray, fine to medium.		 NP At 225 Ft., very easy drilling, just by weight of rods
235									
240									
245			41			SM SC	Clayey, silty SAND 20-25% fine to coarse gravel, wet, olive gray, fine to medium, trace coarse rounded to subrounded gravel striations and polished.		 LL20 PL16 PI4 ML-CL 2% ORGANICS
250									

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
250									
255									
260	45		42			CL	CLAY, 10-15% fine gravel, 20-25% fine to coarse sand. Damp, olive gray, trace organic.		 LL26 PL18 PI8 CL M/C 13%
265	48		43			SC	Clayey SAND, 20-25% gravel, damp, dark gray, fine to coarse, Angular to subangular gravel.		 LL31 PL17 PI14 CL M/C 9%
			44			SC	Varved silt clumps, trace organics.		 1% Org.
270	22		45			CL	CLAY, less than 5% gravel. 5-10% fine to medium sand, Moist, olive gray. Medium stiff.		 M/C 23%
275			46			CL ML	Less than 5% sand, dark grav. Laminated silt clumps.		 LL25 PL20 PI5 CL-ML M/C 21%
280			47			CL	Varved silt clumps?		 LL31 PL22 PI9 CL M/C 24%
285			48			CL	Laminated silt clumps.		 LL29 PL22 PI7 CL M/C 22%
290			49			GM	BOULDER.		
295			50			GM	Silty, sandy, GRAVEL Dry, olive gray. Subrounded to fine to coarse, oxidation on surface of gravel.		 Hard Drilling
300									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 7 of 7

Date _____

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/8/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
300									
305			51			GW	Sandy GRAVEL, 5-12% silt. Olive gray, fine to coarse with COBBLES, sub-rounded gravel.		CSR, TC w/ foam injection
			52			GM			
			53			GP	Less sand, fine to medium, olive brown.		
						GM			
310			54			GP	More sand, subrounded to subangular gravel.		NP
						GM			
3			55			GP	Less silt, rounded to subrounded gravel.		
315			56			GW	More sand.		
			57			SW	More sand.		
320									
			58			GP	Less sand, subrounded fine gravel.		
325									No recovery of cuttings
330							T.D. = 328 Ft.		
335									
340									
345									
350									

SOIL BORING LOG

WATANA DEVELOPMENT

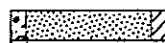
Sheet 1 of 2
Date 3/25/83

Boring No HD83-2 (F)
Feature Relict Channel
Coordinates: N 3229506.2
E 746104.4

Angle (from Horizontal) 90°
Bearing ---
Date Started 2/7/83
Date Completed 2/7/83

Ground Elevation 2,147.1
Rock Elevation 2069.6
Total Depth 87.0
Ground-Water Elevation ---

Logged by WMB, RAW/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							ORGANIC MATERIAL		90 - HAM, CI
5			1			SM	Silty, gravelly SAND, wet. Olive brown, fine to coarse, subangular to subrounded gravel.		 Pipe cocked at 10.5 Ft., moved hole, redrill
10			2	8 12 14 10		SM	Medium dense, grayish brown.		 M/C 13%
							Water @ 11.0 Ft.		LL20 PL17 PI3
15	46		3			GM	Silty sandy GRAVEL, medium dense wet, grayish brown, subrounded, fine to coarse, occasional cobbles, less sand and silt.		 ML
			4			GP			 M/C 18%
			5	100		GM			
20	45		6			GM	COBBLE. Dark grayish brown.		 M/C 13%
			7	87			Silty SAND, less than 5% gravel, moist, olive brown, fine to coarse weathered rock grains, sub-angular gravel.		 M/C 17%
25	45 46		8			SM			NP M/C 11%
			9	50			Very weathered,		M/C 12%
30	48 43 45								
			10			SM	Few dark gray silt clumps.		 M/C 8%
35	72 98		11			SW	Slightly less silt, light olive brown		 M/C 6%
			12	100		SM			M/C 6%
40	53		13			SC	Some dark gray clay clumps, olive brown, damp.		 LL 34 PL23 PI11 CL
			14			SM	Less clay, light olive gray.		 M/C 19%
45	76		15			SM	Olive brown.		 M/C 5%
50	202		16			SW SM	Olive gray.		

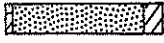
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2Date 3/25/83

Boring No HD83-2 (F) Angle (from Horizontal) 90° Ground Elevation 2,147.1
 Feature Relict Channel Bearing --- Rock Elevation 2069.6
 Coordinates: N 3229506.2 Date Started 2/7/83 Total Depth 87.0
 E 746104.4 Date Completed 2/7/83 Ground-Water Elevation ---

Logged by WMB, RAW/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	150								
55	130		17			SM	Occasional gray clay/silt laminations Olive brown.		 NP
	153		18			SW SM	Olive gray.		 NP
	183		19	100					M/C NP 6%
60			20			SW SM	More large gravel, occasional cobble. Yellowish brown.		
65	382		21			SM	Less gravel, olive yellow.		 NP
70	113		22			SW SM	More coarse gravel, olive gray. Becoming coarser and drier.		 NP M/C 6%
75			23				TOP OF ROCK 77.5	P	PNEUMATIC PIEZOMETER @ 75.5 Ft.
80							No recovery		HAM, DDH
85									
90							T.D. = 87.0 Ft.		
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/25/83

Boring No HD83-3 (L) Angle (from Horizontal) 90° Ground Elevation 2,220.0
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231246.7 Date Started 2/7/83 Total Depth 82.5'
 E 745855.1 Date Completed 2/8/83 Ground-Water Elevation ---
 Logged by REH, WMB, RAW, EJK, DAF/LEM

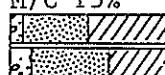
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5									9Ø - HAM, CI
10			1				Silty SAND, 20-25% gravel. Moist, olive brown.		
15	18		2			SM	Silty SAND, 10-15% gravel. Very dark gray, fine to coarse. Rounded to subrounded gravel. Occasional cobble, frozen.		 LL21 PL14 PI6 M/C CL-ML 15%
20	37		3SS	15 28 35 50	20				LL15 PL14 PI1 ML M/C 12%
25			4			ML	Slightly more clayey silt, sub-rounded to subangular gravel.		 LL19 PL15 PI4 ML-CL M/C 15%
30			5SS	50 5"	5"		Ice lenses.		
35	87		6			SM	Slightly less clayey silt, dark gray, rounded to subrounded gravel, polished and striated.		 LL20 PL14 PI6 CL-ML M/C 11%
40			7						M/C 14%
45			8SS	29 46 54 84	24	SM	Boulders/cobbles to 58.5 Ft.		 LL18 PL13 PI5 ML-CL M/C 11%
50			9						M/C 6% HAM, DDH at 49.75 Ft.

Boring No HD 83-3 (L) Angle (from Horizontal) 90° Ground Elevation 2,220.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231246.7 Date Started 2/7/83 Total Depth 82.5'
E 745855.1 Date Completed 2/8/83 Ground-Water Elevation ---
Logged by REH, WMB, RAW, EJK, DAF/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55									
60			10SS	52 50 3"					HAM, CI @ 58.5 Ft. M/C 12%
65	245		11				Moist.		M/C 4%
70	202		12				COBBLES/BOULDERS.		M/C 6%
75	252		13			GM	Silty, sandy GRAVEL, WITH COBBLES. Moist, dark gray, subrounded to subangular, fine to coarse.		 NP M/C 5% Refusal at 77 Ft. HAM, DDH at 77 Ft.
80									
85							T.D. = 82.5'		
90									
95									
100									

Boring No HD 83-4 (O) Angle (from Horizontal) 90 Ground Elevation 2,246.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3233160.2 Date Started 2/9/83 Total Depth 94.0
E 747719.7 Date Completed 2/9/83 Ground-Water Elevation ---

Logged by JEP, RAW LEM

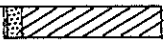
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5							Peat (?)		90 HAM, CI Easy Drilling to 20.0 Ft.
10			1SS 2	9 8 11 11	12"	SW SM	silty SAND, 10-15% gravel. Frozen, grayish brown fine to coarse. Subrounded to subangular gravel brown- ish gray. Contains 6" of peat in upper portion of spoon. Occasional cobble.		M/C 12%  NP.
15			3SS 4	0 3 17 37		SM SM	Olive brown, medium dense, 10-20% fine to coarse gravel subrounded, wet, dark grayish brown		M/C 15%  N.P.
20			5			SM	More gravel, moist Boulder @ 27ft.		N.P. Hard Drilling at 21.0 Ft.
25									
30									
35	51		6			ML	Sandy SILT, less than 5% gravel, dark gray, varied silt clumps Water @ 35.0ft.	Thermal Probe to 60.0 Ft.	LL 21 PL 18 PI 3 ML M/C 17%
40	22		7			SW SM	Gravelly SAND, 5-12% silt dark gray fine to coarse, saturated, angular to subangular gravel, occasional cobble. striations Loose Sand. More sand.		 N.P.
45									
50			8SS	2 4 13 20					

Boring No HD 83-4 (0) Angle (from Horizontal) 90 Ground Elevation 2,246.7
Feature Relict Channel Bearing ---- Rock Elevation -----
Coordinates: N 3233160.2 Date Started 2/9/83 Total Depth 94.0
E 747719.7 Date Completed 2/9/83 Ground-Water Elevation ----
Logged by JEP, RAW/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55							No water @ 51 ^{ft} More gravel/cobbles		Hard Drilling at 53-55 Ft.
60	78	9				SM			 LL17 PL16 PI1 ML
65		10				SM	Silty Sand, 15-20% fine to coarse gravel dark gray, fine to coarse, subangular to subrounded gravel		LL17 PL14 PI3 ML-CL
70									
75	49	11					Varied clumps		M/C 15%
80		12				CL	Clay, 10-15% fine to coarse sand. Varied silt/clay clumps dark gray		 LL 28 PL 19 PI 9 CL M/C 15%
85		13				SC	Clayey, gravelly sand, damp brownish gray, fine to coarse subangular to subrounded gravel		
90	280	14				SM	Less clay, grayish brown.		 LL 19 PL 14 PI 5 ML-CL Hard Drilling at 91.5 Ft. REFUSAL
95							T.D. = 94.0 ft.		
100									

Boring No HD 83-5 (Q) Angle (from Horizontal) 90 Ground Elevation 2,283.7
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0'
 E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5									90 - HAM, CI
10	51		1			SM	Silty SAND, less than 5% gravel, frozen olive brown, fine.		 G _s = 2.69
15			2			ML CL	Sandy clayey SILT, less than 5% gravel, dark gray, frozen laminations, ice lenses.		 LL22 PL16 PI5 CL-ML M/C 47%
20	22								
25	23		3			CL	Silty CLAY, 10-20% fine to medium sand, less than 5% gravel. Frozen, olive gray, clay layers 6" thick, Ice lenses Occasional cobble.		 LL31 PL20 PI11 CL M/C 75%
30	35		4 SS	11 28 17 5 13		CL ML	Gravel/Cobble layer Dark gray		LL46 PL28 PI18 CL/ML M/C 41% M/C 45%
35									
40			6			MH	Slightly laminated		G _s = 2.75 LL53 PL31 PI22 MH M/C 30%
45	116		7			CL			 LL31 PL21 PI10 CL
45	51		8			GW	Sandy GRAVEL, less than 5% silt, moist olive gray, rounded to subrounded, fine to coarse, occasional cobble		
50	55		9			GW	Wet.		 M/C 6%

SOIL BORING LOG

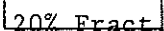
SUMMARY LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/26/83

Boring No HD 83-5 (Q) Angle (from Horizontal) 90 Ground Elevation 2,283.7
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0
E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	48		10			SP	Medium to coarse sand layer with gravel		 M/C 8%
55							Water @ 54.0ft to 86.0 ft		
60									
65							Flowing fine to medium sand		Easy Drilling, 61-66 Ft. lots of water
70								P	Pneumatic Piezometer @ 70 Ft.
75									At 74 Ft. water flow reduced
80			11				More gravel and cobbles, coarse sand.		 20% Fract
85	55		12						50% Fractured Out of water @ 86 Ft.
90			13			SM	Gravelly, silty SAND, damp, dark olive fine to coarse, subangular to subround- ed gravel, occasional cobble		 LL18 PL16 PT2 ML M/C 9%
95	74		14			SM	More silt, dark olive gray Water 94-95.0ft to 108.5ft Cobble/boulder 96.5 to 98.5 ft		 Hard Drilling, 86.5-98.5 Ft.
100									

SOIL BORING LOG

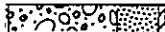
SUMMARY LOG

Sheet 3 of 3
Date 3/26/83

WATANA DEVELOPMENT

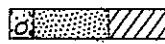
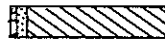
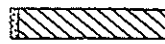
Boring No. HD 83-5(Q) Angle (from Horizontal) 90° Ground Elevation 2,283.7
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0
E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100			15			GM	Silty sandy GRAVEL, saturated, olive gray, subangular to subrounded, fine to coarse, with cobbles. Oxidized coating of gravel cobble/boulder 104.0 to 109.0ft		
105							End Water 108.5 ft		Hard Drilling 104-109 Ft.
110	64		16			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, moist olive gray, rounded to subrounded, fine to coarse.		
115							Less cobbles (?)		Hard Drilling, 111.5 Ft. more water return
120									Drilling easier @ 115.0
125	50		17			SM	Silty SAND less than 5% gravel, wet, olive gray, fine.		
							Less moisture @ 126ft		N.P.
130	145		18				GRAVEL WITH COBBLES, 20-25% silt and sand wet, olive green. Oxidized gravel @ 132ft.		
135	108		19				Yellowish brown sand and rock fragments		50% Fract. Hard Drilling, 131.5
			20						Easy Drilling, 133-134 Ft.
140							T.D. = 138.0 Ft.		
145									
150									

Boring No HD 83-6 (J) Angle (from Horizontal) 90° Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 126.5
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---

Logged by DAF, RAW, JEP, MPB/LEM

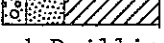
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5							Frozen to 11.0 ft. no samples taken		5 1/2" HAM, CI Drive pipe blocked
10									
15	26		1			SM	Silty SAND 15-20% gravel, damp, dark grayish brown, fine to coarse, subrounded gravel, striated and polished		 M/C 11% G _s = 2.69
20			2			SM	More gravel, less sand and silt, subangular to subrounded gravel, damp, olive gray		Pipe cocked, move hole, redrill 
25	56		3			SM	Clayey, silty SAND, 15-20% gravel, damp olive gray, fine to coarse, rounded to subrounded gravel, striated and polished Silt clumps contain coarse sand and fine gravel	Thermal Probe to 125.0 Ft.	 LL17 PL14 PI3 ML
30									
35			4			CL	Varved SILT/CLAY, moist, dark gray		 LL29 PL20 PI9 CL G _s = 2.74
40									
45			5			CL ML	Dark gray clay/light gray silt, less than 10% fine sand		 LL44 PL27 PI17 CL/ML
50			6			CL	Less sand, olive gray		 LL32 PL23 PI9 CL

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/26/83

Boring No HD 83-6 (J) Angle (from Horizontal) 90° Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 126.5
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---
Logged by DAF, RAW, JEP, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
	200			7			Gravelly, sandy-SILT, dry, olive gray Fine to coarse, subrounded to subangular gravel		 Hard Drilling
55				8		SM	More sand and gravel, brownish gray		
				9		GP GM	Sandy GRAVEL, 5-12% silt, damp, grayish brown, subrounded fine to coarse More sand, saturated WATER @ 60.0ft to 86.0 ft		
60									
65									
70	105			10		SW SM	Olive brown		
75									
80	74 20			11			More gravel subangular to subrounded, slight oxidation		
85	186 96			12		GP	Sandy GRAVEL, less than 5% silt, olive gray, saturated subrounded to subangular		
90				13			Silty sand, less than 10% gravel light olive brown, fine to medium oxidation coating.		
				14		SM	Laminated silt clumps		
95	264 90			15		SC SM	More clayey silt		 LL25 PL21 PI4 CL-ML
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/26/83

Boring No HD 83-6 (J) Angle (from Horizontal) 90 Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 136/5'
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---

Logged by DAF, RAW, JEP, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100							More gravel		
105	39 66		16			SC SM	Silty, clayey SAND, less than 5% gravel, olive yellow, fine to medium, silty/ clay/sand layers.		 LL28 PL22 PI6 CL-ML
110	76		17 SS 18	71 29		SM	Slightly more GRAVELLY, dark yellowish brown		 M/C 27%
115			19				Gravel altered/weathered to white/ yellowish brown		
120									Hard Drilling
125	321 660		20			SM	Less clay, gravel, yellow, bucy. REFUSAL @ 126.5 Ft.		 LL22 PL20 PI2 ML
130							T.D. = 126.5 Ft.		
135									
140									
145									
150									

Boring No HD 83-7 (D Acres)

Angle (from Horizontal) 90

Ground Elevation 2095.5

Feature Relict Channel

Bearing ---

Rock Elevation ---

Coordinates: N 3232100.1

Date Started 2/12/83

Total Depth 82.0'

E 743745.9

Date Completed 2/12/83

Ground-Water Elevation ---

Logged by JEP, DAF, RAW/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5									5 1/2" - HAM, CI
10			1			SP	Poorly graded SAND, 15-20% fine gravel less than 5% silt dark olive, fine to coarse, subrounded gravel. "Loose" 9.0 to 13.0 ft.		Easy Drilling, 9-13 Ft.
15	14-28		2			ML	WATER @ 13.0 ft Clayey SILT, 10-15% fine sand moist, olive gray. More fine to medium sand, gravel		
20			3			ML	Less sand, more silt Laminated silt/clay clumps more clay, moist olive gray		
25									
30									
35			4				Laminated silt/clay, moist		M/C 31%
40									
45			5			ML CL	Laminated silt/clay, 20-25% fine sand Olive.		M/C 23%
50									

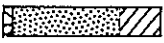
Boring No. HD 83-7 (D Acres) Angle (from Horizontal) 90° Ground Elevation 2095.5
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3232100.1 Date Started 2/12/83 Total Depth 82.0'
E 743745.9 Date Completed 2/12/83 Ground-Water Elevation ---
Logged by JEP, DAF, RAW/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55			6				More varved	LACUSTRINE	M/C 24%
60									Hard Drilling @ 59 Ft.
65			7			SM	Silty SAND, no gravel, damp pale olive fine.		NP M/C 3%
70			8			GM	Sandy clayey, silty GRAVEL "Dry", olive gray, fine to coarse subrounded with cobbles		LL18 PL14 PI4 ML-CL M/C 2%
75									
80			9			SP	Less clayey silt, more fine to coarse sand, Dark olive, gray rounded to subrounded gravel	ALLUVIUM	Pipe cocked, hole abandoned.
85							T.D. = 82.0'		
90									
95									
100									

Boring No HD 83-8 (E) Angle (from Horizontal) 90 Ground Elevation 2,217.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3228853.6 Date Started 2/13/83 Total Depth 78.0'
E 745428.5 Date Completed 2/13/83 Ground-Water Elevation ---
Logged by JEP, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5									5 1/2" - HAM, CI
20			1				Silty SAND, 10-25% gravel damp, dark grayish brown, fine to coarse, Angular to subangular gravel occasional cobbles.		
23			2			SM			
29									
15			3				Humid		
27									
20			4			SM	More gravel		
32									
45									N.P.
25			5						
93									
92									
30			6			SM	Less gravel, grayish brown. Subrounded to subangular gravel		
38									
79									
35									
40			8				Gravel/cobble		
42									
209									
45			9			SM	Gravel/cobble More silt, Olive gray		
50									

Boring No HD 83-8 (E) Angle (from Horizontal) 90 Ground Elevation 2,217.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3228853.6 Date Started 2/13/83 Total Depth 78.0
 E 745428.5 Date Completed 2/13/83 Ground-Water Elevation ---
 Logged by JEP, MPB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55	38		10			SP SM	Poorly graded SAND, 20-25% gravel. 5-12% silt, moist, dark gray. Fine to coarse, rounded to subrounded gravel.	ALLUVIUM	
60	33 37		11			SM	Silty, gravelly SAND, moist very dark grayish brown, fine to coarse. Subrounded to subangular gravel. WATER @ 59.0 ft. to 61.0 ft.		
65	19 39		12			SM	Silty SAND, less than 10% fine gravel, wet, dark olive gray, fine to coarse subangular to subrounded gravel.		 LL20 PL18 PI2 ML
70	675 770		13				Boulder/cobbles 66.0 to 72.0 ft.		Hard Drilling @ 66-72 Ft.
75			14			SM	Silty SAND, less than 10% gravel "Dry" olive, fine to medium subangular - subrounded gravel. Few weath. silt clumps (oxidized).	OUTWASH	
			15				Weathered/altered rock fragments		
			16				REFUSAL @ 78.0 ft.		
80							T. D. = 78.0 Ft.		
85									
90									
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/26/83

Boring No. HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
 E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
 Logged by JEP, REH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5			1				Silty, gravelly SAND, grayish brown, fine to coarse subangular to subrounded gravel.	THERMAL PROBE to 110.0 Ft.	5½Ø - HAM, CI
10			2			SM			
15			3						
20	60		4			SM			
25	125		5						
30	110		6			SM			
35	215		7						
40	400		8			SM	Silty SAND, 15-20% gravel. "Dry", olive, fine to coarse, rounded to subrounded gravel, few silt clumps.	Hard Drilling @ 39 Ft. NP	
45			9			SM	20-25% gravel, dark olive gray.	 LL16 PL14 PI2 ML	
50									

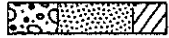
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/26/83

Boring No HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
 E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
 Logged by JEP, REH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55	102		10			SM	More gravel, Silty, gravelly SAND, "Dry" dark olive gray, fine to coarse, subangular gravel, occasional cobble.		 LL16 PL14 PI2 ML
60	140		11						
65	115		12			SM	Less silt		
70	160		13						
75	150		14			SM	Slightly more silt, dark gray.		 NP
80	300		15						
85	400		16			SM	Subangular to subrounded gravel.		
90	130		17						
95	250		18						
100	500		19			SM	More gravel.		
	500						Less gravel, more silt.		 LL18 PL15 PI3 ML

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/26/83

Boring No. HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
Logged by JEP, REH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100	150		20				Slightly more gravel.		
105			21			SC	Less gravel, more clay.		 LL23 PL15 PI8 CL
110							Boulder (?)		
115							T.D. = 110.0 Ft.		

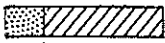
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 1
Date 3/31/83

Boring No HD83-49 (K) Angle (from Horizontal) 90° Ground Elevation 2,207.2
 Feature Relict Channel Bearing --- Rock Elevation N/A
 Coordinates: N 3230708.3 Date Started 3/20/83 Total Depth 38.0
 E 745271.5 Date Completed 3/20/83 Ground-Water Elevation ---

Logged by JEP, REH/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5	28		1	5	18"	GM	Silty, Sandy GRAVEL, Medium dense, humid, olive gray, light gray silt and clay clumps, fine to coarse, with trace organic matter.	THERMAL PROBE to 38.0 Ft.	5½Ø - HAM, CI  Organic 4%
10	28		2SS	4			Frozen (CL-ML)		LL23 PL19 PI4 (CL-ML)
			3	17		GM	Dark grayish brown, subrounded to subangular.		
15			4			GP GM	More gravel, 5-12% silt, dark olive gray.		
	41			28					
	6		5SS	39	15"				
20	13			41			CLAY, 20% fine sand, hard, humid, dark olive gray.		 LL34 PL20 PI14
	28		6			CL	Proportions of clay and silt vary slightly.		
25	27		7				Occasional lens of fine sandy silt, wet.		LL22 PL19 PI3 M/C 31
	27			9					
	30		8SS	42	18'	ML	SILT - moist to wet.		
	33			115					
	89		9						
35			10			CL	Less than 15% sand.		 LL32 PL22 PI10
40							T.D. = 38.0 Ft.		
45									
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3Date 3/31/83Boring No HD 83-50 (P)Angle (from Horizontal) 90Ground Elevation 2,290.8Feature Relict ChannelBearing ---Rock Elevation ---Coordinates: N 3233761.2Date Started 3/20/83Total Depth 119.5E 748255.0Date Completed 3/21/83Ground-Water Elevation ---Logged by JEP, REH, WMB, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5	59 37		1			SM	Silty SAND, less than 15% gravel medium dense (frozen), humid dark grayish brown, fine to coarse with occasional yellowish brown silt clumps.		NP $G_s = 2.70$ 5½Ø - HAM, CI
10	28 40		2						
15	37 48		3						
20	35 39		4			SM	Silty clumps with fine gravel varved silt clumps 40% fine to coarse subangular to subrounded gravel - dark olive gray. Occasional thin clay seams		M/C 16%
			5 SS	16 32 34	18"				
25	25		6			SC	Clayey SAND, less than 15% gravel medium dense, moist, dark olive gray, fine to coarse		LL24 PL16 PI8
30	60 69		7			SM SC	Gravelly, silty, clayey SAND, Dense, moist, dark olive gray, fine to coarse, silty clay clumps with fine gravel		LL20 PL15 PI5
35			8			SM SC	Very dark gray		Hard Drilling @ 33.5 Ft.
40	120 240		9			SM SC	Dark gray Cobbles and boulders to 52.0 ft.		LL20 PL16 PI4 $G_s = 2.70$ Very hard Drilling
45			10						
50			11			SC	Slightly more clay. Very dark gray		At 48-52 Ft HAM, DDH

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/31/83

Boring No. HD 83-50 (P) Angle (from Horizontal) 90 Ground Elevation 2290.8
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3233761.2 Date Started 3/20/83 Total Depth 119.5
 E 748255.0 Date Completed 3/21/83 Ground-Water Elevation ---
 Logged by JEP, REH, WMB, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
55	380		12				Gravelly, silty, clayey SAND, dense to very dense, humid, very dark gray, fine to coarse subrounded to subangular gravel silt/clay clumps with fine gravel with occasional cobbles.		At 52 Ft., HAM, CI
	116		13			SM SC	Moist		LL18 PL14 PI4
60	111		14						
65	93		15						
	148		15						
70	185		16			SM SC	Slightly more gravel.		LL18 PL14 PI4 G _s =2.72
75	117 172		17			SM SC	Dark olive gray		LL20 PL15 PI5
80			18SS	48 100	5" 3"				
	196		19						
85	200 200		20			SC	Slightly more clay		LL25 PL15 PI10 G _s 2.70
90			21SS	100	4"				
	200		22				More silt		
95	171 200 200		23			SM			LL20 PL17 PI3
100									

Boring No HD 83-50 (P) Angle (from Horizontal) 90 Ground Elevation 2290.8
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3233761.2 Date Started 3/20/83 Total Depth 119.5
E 748255.0 Date Completed 3/21/83 Ground-Water Elevation ---
Logged by JEP, REH, WMB, JFB/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100	198		24				Gravelly, silty SAND, WITH COBBLES very dense, moist, dark olive gray, fine to coarse, subrounded to subangular gravel		
105	200		25			SM	Slightly more clay		 LL20 PL19 PI1 M/C 8%
110	156		27			GC	Clayey, sandy gravel, very dense, humid olive gray, fine to coarse, rounded to subrounded		 LL23 PL16 PI7
115	300		28			SC SM	Silty, clayey sand, 20-25% gravel, humid dark olive gray, fine to coarse, sub- angular to subrounded gravel, silt-clay clumps with fine gravel		 M/C 7%
120							BOULDER @ 119.5 T.D. = 119.5 Ft.		Refusal
125									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/31/83

Boring No HD83-51 (N) Angle (from Horizontal) 90° Ground Elevation 2,236.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3232725.0 Date Started 3/21/83 Total Depth 98.5 Ft.
E 747293.4 Date Completed 3/22/83 Ground-Water Elevation ---

Logged by JEP/RLJ, WMB/JFB, LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2' - HAM, CI
5	20		1				Gravelly SAND, 5-12% silt, medium dense, frozen to 8.0, olive brown, subrounded to subangular gravel, fine to coarse. Trace of organic material to 8.0'.		Poor recovery, 0-9 Ft.
	18								
	18		2						3% ORGANIC
	28								
	26								
10			3SS	45			Occasional cobble.		
				50					
				40					
	33					SP	Laminations 5' to 8"		
	32		4			SM	Humid.		
15	45								
			5SS	70	6"	SM	Silty SAND, 20-25% gravel. Very dense, humid, olive brown, fine to coarse. Few small varved silt/clay clumps.		M/C 9%
				30/3"					
			6						
			7	100			Subangular to subrounded gravel.		M/C 11%
20	70						More gravel, olive moist.		NP
			8			SM	Occasional cobble.		
25			9SS	45	10"		More silt, less than 10% gravel.		M/C 9%
				55/4"			Olive brown.		NP
	300					SM			
	500		10						
30									
	44								
	63		11				Clayey/silty SAND, Dense, humid, dark olive gray, fine to medium. Trace rounded to subrounded fine gravel.		
	67								
	71								
35			12SS	60	12"	SM	Moist. Note: Slight variations in clay/silt proportions change classification.		
				60		SC			
	75		13						
			14SS	62	12"		Wet.		M/C 15%
40				80					
	70		15			SM	15-20% gravel, olive gray clay/silt clumps with fine gravel.		LL18 PL14 PI4
						SC	Occasional cobble.		MODIFIED PROCTOR
	200								Y MAX = 136 Bpf
	300								
45	200								
	300								
			16			SC	Humid.		LL21 PL13 PI9
									M/C 5%
	284								
50			17SS	100/4"	4"				

Boring No HD83-51 (N) Angle (from Horizontal) 90° Ground Elevation 2236.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3232725.0 Date Started 3/21/83 Total Depth 98.5 FT.
E 747293.4 Date Completed 3/22/83 Ground-Water Elevation ---

Logged by JEP/RLJ, WMB/JFB, LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
			18			SM SC	Clayey/silty SAND, 10-15% gravel, humid, olive gray, fine to coarse, occasional cobble.		LL18 PL14 PI4 (ML-CL)
55			19SS	100	6"		Very dense, wet.		M/C 15%
	117 116		20						
60			21SS	100	6"				LL19 PL16 PI3 ML M/C 7%
	62								Hard Drilling @ 59.5 Ft.
									HAM -DDH
65			23	22		SM	Silty SAND, less than 10% gravel.		
			24SS	79	11"		Very dense, wet, olive gray. 60% fine sand.		
	43		25			SM			NP M/C 10%
70									
	36		26			SM			NP
75									
	45								
			27			SC	Clayey SAND, 15-20% gravel, very dense, moist to wet, dark olive gray, fine to coarse, occasional cobble.		LL25 PL16 PI9 CL
80			28SS	100/2"	2"		Clay/silt clumps with fine gravel.		M/C 14%
	200		29						
85			30SS	67/100	8.5"				M/C 17%
	105 117		31						
			32SS	100	5.5"				M/C 20%
90									
	76		33			SM SC	Slightly more silt.		LL21 PL16 PI5 CL-ML
95			34SS	45/48					M/C 16%
	189		35			CL	CLAY, with 20-25% fine to coarse sand less than 5% gravel. Hard, moist, very dark gray.		LL33 PL18 PI15
							T.D. = 98.5 Ft.		
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 8

Date 3/31/83

Boring No. HD 83-52 (D) Angle (from Horizontal) 90 Ground Elevation 2251.4
 Feature Relict Channel Bearing --- Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
 E 747266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JER, JEP, RLJ, MPB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5			1			SP SM	Gravelly SAND, 5-12% silt, damp, dark grayish brown, fine to coarse, subangular to subrounded gravel limonite stain around gravel, occasional cobble.		5% HAM, CI
10			2 SS	29 24 29	13"	SM	(Silty SAND, 5-10% gravel, olive) very dense.		M/C 5%
15			3			SM	Silty, gravelly SAND, dark grayish brown, Humid, fine to coarse		N.P.
			4 SS	50/9' 55/6"	9"	SM	(Silty SAND, 20-25% gravel, olive) very dense.		M/C 6%
			5			SM			NP
20			6 SS	70 47	12"	SM	(Silty SAND, 20-25% gravel, olive)		M/C 7%
			7			GP GM	Humid Sandy GRAVEL, 5-12% silt, WATER @ 22' Olive gray. (Wet)		
25			8 SS	100/4"	4"				M/C 8% =
			9			SM SC	Clayey/silty, gravelly SAND WITH COBBLES Humid BOULDERS @ 25' -- 27'		
30			10 SS	100/4"	4"				
35			12 SS	70 100/5"	11"	SM SM	Gravelly, silty SAND WITH COBBLES, very dark gray, fine to coarse		M/C 8%
			13				Humid		
40			14			SM			LL16 PL14 PI2
45			15 SS	60 100	12"		Very dense		M/C 8%
			16				Damp		
50			17 SS	100	4"		Gravel and cobbles		M/C 4%

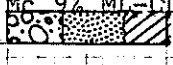
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 8
Date 4/1/83

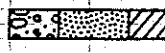
Boring No. HD 83-52 (D) Angle (from Horizontal) 90 Ground Elevation 2251.4
 Feature Relict Channel Bearing _____ Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
 E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JEB, JEP, RLJ, MPB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	120		18			SM	Gravelly, silty SAND WITH COBBLES, humid dark olive gray, fine to coarse, sub-angular to subrounded gravel.		
55	95	19SS	100	5"					M/C 14%
60	60	21SS	75						
65	180		22			SM	Wet		M/C 9%
	300		23SS	65	12"	SC	More clay, very dark gray		LL18 PL14 PI4
70	100		24			SM	Moist, very dense.		ML-CL
75	110		25SS	100	2"		Boulder 66' to 68'		LL20 PL15 PI5
	245		26				Fine argillite gravel striated.		M/C 9% ML-CL
80	100		27SS	100	1 1/2"				
85	130		28				Humid		V. Hard Drilling, 79.5-80 Ft.
	250		29						HAM-DDH
90			30			SC	Clayey SAND, 20-25% gravel, moist, very dark gray, fine to coarse		HAM, CI
95			31				Gravelly, silty SAND with cobbles, moist very dark gray, fine to coarse sub-rounded to subangular gravel.		
100			32SS	100	1"				CL
			33				Boulder @ 91		
			34						
			35SS	88	4"				
				100					

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100									
	200		36			SM	Silty, gravelly SAND with cobbles, dark gray, fine to coarse, sub-rounded to subangular striated gravel.		 NP
105			37						
	153		38SS	100/3"	0				
110	200		39						
	200								
115									
			40			SM SC	Clayey, silty, gravelly SAND. Very dark gray, fine to coarse.		
			41			SM	Boulder @ 118-123'		
120									Moved hole, re-drill. Bit broken @ 120.5 Ft.
									HAM, CI
	200		42				Clayey SAND WITH COBBLES AND BOULDERS, 5-10% gravel. Hard, wet, very dark gray, fine to coarse.		
125	200								
	200								
	200								
	200		43SS	40/4.5"	10.5"	SC			 LL31 PL17 PI14 CL M/C 9%
130									
	200		44			SM	Less clay, moist.		 NP
	200								
	200								
135			45						
	200								
	200		46				Wet.		LL34 PL17 PI17 CL M/C 8%
140									
	200		47			SC	More clay and fine to coarse gravel.		 LL26 PL14 PI12
	200						Moist.		
145							BOULDER @145'		
									HAM, DDH
150									CSR, BB

SOIL BORING LOG

WATANA DEVELOPMENT

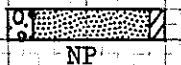
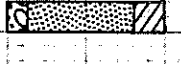
Sheet 4 of 8
Date 4/1/83

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
150			48			SM	Less clay, Dark olive grey.		NP
155			51			SM	Very dark grey		NP
160			52						
165			53			SM	Dark Olive grey		NP
170			54				Cobble Layer 171-173'		
175			55			SM			Hard Drilling, 177-178.5 Ft.
180			56			SW SM	Less silt		NP G _s = 2.81
185			57			SM			LL17 PL14 PI3 G _s = 2.77
190			58			CL ML	Sandy, silty CLAY, 15-20% gravel Moist, olive grey, fine to coarse sand.		NP HAM, CI LL23 PL17 PI6 G _s = 2.82 CL-ML
191			59						
200				100/ .05'	0				

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
 Feature Relict Channel Bearing --- Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
 E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
 Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

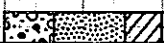
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
200									
			60			CL	CLAY 20-25% fine sand, wet, dark olive gray.		 LL29 PL19 PI10 CL
205	76								Hard Drilling
	200		61			SM SC	More medium to coarse sand, olive gray. WATER @ 206.5'		 LL22 PL18 PI4 CL - ML
	400								M/C 13%
210			62SS	100/5.5"			(silty SAND, olive), wet.		
							SAND, 5-12% silt, 15-20% gravel. Saturated, olive gray, fine to coarse.		 NP
215			63			SW SM			
			64			SP SM	No gravel, moist, dark olive gray.		
	29		65SS	64/100/4"	8"	SM	Silty, fine sand. Olive gray, very dense.		
220			66						
	39								
	55		67			SM	10-15% fine gravel.		 NP
225									
	69		68SS	66/100/4"	10"	SM	Very dense.		 M/C 21%
230									
	55		69			SM	Medium to fine sand, olive moist.		
	126								
235			70						
	52								
	57		71	100/3.5"			Very dense.		M/C 6%
240				4"					
	78								
	98		72			SM	Silty, gravelly SAND, very dense. Moist, olive, fine to coarse. Sub-rounded gravel, occasional laminated silt clumps. Oxidized surface on gravel.		
245									
	114		73						
	200								
	200								
	7		74SS	100/1.5"			More gravel.		
250									
			75						

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 6 of 8
Date 4/1/83

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
Logged by WMB, JEB, JEP, RLJ, MPB/LEM, DAF

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
250	350		75						
	650		Cont.			SM	Less gravel, humid.		
	225								
	60								
255	60								
	80								
	100		76						
	75								
			77SS	100/1"	0				
260						SM	COBBLE @ 258.5. Laminated silt clumps. Damp.		 NP
	300		78						
	120								
	160		79						
265									
	225								
	175								
	300								
			80SS	100/2"					
270	285		81			SM	COBBLE @ 268.0. Humid.		 NP
	135								
	150								
	150								
	180								
275	150								Hard Drilling
	600		82						275 Ft.
	150								
	225								
	600		83SS	100/6"	3"				Hard Drilling,
280	130					SM	COBBLE @ 278.5		278.5 Ft.
	350		84						
	180								G _s = 2.74
	1000								V. Hard Drilling
									282-283 Ft.
	130								
285	100		85				GRAVEL & COBBLE LAYER		
	120								
	170		86			SP SM	Less silt, gravel striated.		 NP
	380								
290	300		87						
	225								
	300								
	400								
	220								
295	525								
	350								
			88			SP SM	Gravelly SAND, 5-12% silt, humid.		
	50						Olive gray, fine to coarse.		
			89SS	100/2"	2"		Gravel subrounded to subangular, smooth, slightly striated.		
300	110		90						

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
 Feature Relict Channel Bearing --- Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Overburden Thickness 320.0
 E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 333 Logged by WMB, JFB, JEP, RLJ, MPR/
LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
320				TOP OF ROCK 320. Ft.					
70°				Diorite Medium grey, med. Xyln.		50/43			
65°				massive, Composed predom.					
60°				mantly of plagio. and horn-					
0°				blde. w/ some biotite & chlor					
325				Fresh modt. slightly fractrd.					
60°				max piece 1.5', min. piece			1/1		
				0.2'. Mostly 0.4-0.8' Hard					
				and strong. Fresh to v. sl.					
330	Fe			weath. Jt. surfcs w/sl Fe	100/89				
5°				stain occasionally. Coatings					
333				also chlorite and CaCo ₃					
55°				Rough jt surfaces					
0°				T.D. 333.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 5
Date 4/1/83

Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
 E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JEB, RLJ, MPB, JEP/LEM

Depth O (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									70 - CSR, PC, TW
5									
10									
15						SM	Silty SAND, 10-15% fine gravel. Damp, olive, fine to coarse, subrounded to subangular gravel.		Lots of blow by
20									
25			1			SM	Silty SAND, 15-20% fine gravel, damp, olive, fine to coarse, subrounded to subangular gravel, silt/sand clumps, occasional cobble.		LL16 PL16 PI10 ML
30	23		2SS	43	3"				At 25.5 Ft., hole blocked; use tricone.
35	90			21		SC	Gravelly, silty, clayey SAND, very dense, moist, olive gray, fine to coarse, subangular gravel, laminations, silt/clay clumps with gravel. Gravel polished and striated.		90 - HAM, CI
40	160			31		SM			
45	120								CL-ML G _s =2.72
50	75					SC	Less silt, dark olive gray.		
55	110		4						LL75 PL15 PL10CL
60	175					GC	Less sand, more fine to coarse gravel.		LL36 PL17 PI19
65	170		5SS	20	18"				CL M/C 13%
70	100			40					
75	100			50					
80	110								
85	180								
90	210								
95	210		6			SC	Less gravel, more sand.		
100	230					SM			LL20 PL14 PI6
105									CL-ML G _s =2.71
110	220								

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 5
Date 4/1/83

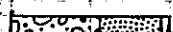
Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPB, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50	220								
	275								
	275								
55	320						COBBLE/BOULDER 55.0 to 57.0 Ft.		
	520								
60	400		7						
			8			GC	More gravel and cobbles.		LL24 PL15 PT9 CL
65									
			9						
70									
			10			SC	Clayey, gravelly SAND, "Dry", very dense, very dark gray. Fine to coarse, subangular to subrounded gravel.		LL21 PL13 PT8 CL
75							Clay clumps with coarse sand and fine gravel. Occasional cobble.		
			11						
80									
			12			SC	Less gravel.		LL19 PL11 PT8 CL
85									
			13						
90									
			14			SC	More gravel.		LL22 PL14 PT8 CL
95									
			15						
100									

Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPB, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100									
			16			GC	Less sand, more clay.		 LL22 PL14 PI8 CL
105									
			17						
110									
			18			GC	Less sand.		 LL25 PL16 PI9 CL
115									
			19						
120									
			20			SM SC	Less gravel, more sand.		 LL20 PL15 PI5 CL-ML
125									
			21						
130									Difficulty in lifting cuttings
	115 110		22			SM SC	More gravel, less sand COBBLE/BOULDER 132.0-135.0 FT		 LL19 PL14 PI5 ML-CL
135									
	600 300								Started w/water injection
140									
			23						
							Large cobbles.		
145	190 805 180 190 195								
			24			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, dark gray. Fine to coarse, subrounded to subangular.		Refusal @ 149.5 Ft  LL20 PL15 PI5 ML-CL G _s = 2.69
150									

Boring No HD83-53 (A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPB, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
150							BOULDER @ 149.0 FT.		HAM, DDH, -
155									CSR, HC, TW Poor sample re- covery, blocked?
160			25						HAM, DDH
165									Pipe clogged, pulled pipe
170							WATER @ 169.0 FT. to 197.0 FT.		CSR, HC, TW foam injection, material coring up outside of casing.
175									Inner tube plugged.
180									
185									
190									
195			26				Sandy SILT with thin layers of fine gravel, wet to 197.0 FT. Olive gray.		
200									

Boring No HD83-53 (A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, IEB, RLJ, MPB, JEP/LEM

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
200									
							Gravel and cobbles.		
205			27						Excessive skin friction on ro- tating drill pipe stopped penetra- tion.
210									
							T.D. - 212.0 ft.		
215									
220									
225									
230									
235									
240									
245									
250									

APPENDIX D — LABORATORY TESTING

1. PROCEDURES

- 1.1 Sample and Control Processing
- 1.2 Particle Size Analysis
- 1.3 Atterberg Limits
- 1.4 Moisture Contents
- 1.5 Organic Content
- 1.6 Specific Gravity
- 1.7 Compaction Tests
- 1.8 Visual Classification

2. LAB TEST SUMMARIES

- 2.1 River Channel
- 2.2 Relict Channel

3. GRADATION CURVES

- 3.1 River Channel
 - 3.1.1 Main Dam
 - 3.1.2 Upstream Cofferdam
 - 3.1.3 Downstream Cofferdam
 - 3.1.4 Portals
- 3.2 Relict Channel

APPENDIX D

LABORATORY TESTING

As part of the Winter 1983 Field Drilling Program, Harza-Ebasco established and operated a field soils laboratory at the Watana site. Routine index property and classification tests were performed on soil samples taken during the Drilling Exploration Program.

Soil index tests were performed to classify soils and determine their grain size distributions, plasticity indices, in-situ moisture contents, organic contents, specific gravity, and compaction characteristics. Also, visual descriptions of soils were made.

The procedures employed in the laboratory testing program were generally in accordance with those suggested by the American Society of Testing and Materials (ASTM). When deviations from ASTM recommended procedures were made, they were noted on the test forms. The specific test procedures and variations from ASTM methods are discussed in the following sections:

1. PROCEDURES

1.1 Sample and Control Processing

Samples collected during each shift of drilling were inventoried and recorded on the sample test schedule and inventory forms. The selected soil samples were then prepared for testing. Preparation of samples required splitting with a mechanical splitter to obtain representative portions for testing. Visual classifications were performed and the

results were recorded on the appropriate sheets thus starting the documentation cycle.

The untested portions of those samples used, and the samples not tested, were transferred to the storage cage for future use, as necessary. An accurate record of the stored samples with precise locations was kept to facilitate relocating samples for either further testing or visual examinations. Upon completion of each test, the tested portion of samples were passed through a 3/4-inch sieve to separate selected materials finer than 3/4-inch sieve. This material was used for back-filling of drill holes.

1.2 Particle Size Analyses

Gradation analysis (sieve and hydrometer tests) was performed on selected soil samples, based on ASTM D422-63 test procedures. All bulk samples collected from the Hammer Drill Cyclone used for sieve analysis met the minimum ASTM weight requirements. However, the majority of soil samples obtained with split-spoon sampler were usually smaller than this minimum weight. Whenever a smaller than ASTM recommended weight sample was used for testing, it was noted on the test data sheet.

Because the hammer drill uses a diesel pile-driver hammer to penetrate the soil, thus breaking boulders, cobbles and gravel into smaller pieces as the hole is advanced, the soil samples obtained have a high percentage of mechanically fractured materials. This percentage of fractured soils retained on the 3/4" sieve were recorded on the test data sheet so that the effect of this fractured material on the grain size distribution could be accounted for.

1.3 Atterberg Limits (Liquid and Plastic Limits)

The classification of samples containing fine grained soils was determined by performing Atterberg Limit Tests. The liquid and plastic limits were determined in accordance with ASTM D423-66 and D424-59 test procedures, respectively.

The soil samples tested for plasticity indices were prepared utilizing two different methods, dry or wet method. ASTM recommends "dry preparation of soil samples for grain-size analysis and determination of soil constants" (ASTM D421-58). In this method of sample preparation, the soil sample was air-dried and then sieved through a No. 40 screen to obtain the minus #40 sample fraction for Atterberg Limit Indices Testings.

In the wet method of preparation, the soil sample was first soaked in water for 12 hours and then washed through a No. 40 sieve. Both methods of sample preparation have been used at the Watana Site. The wet method was normally used for soil samples with large clay and silt clumps which could not be easily processed using the dry method.

1.4 Moisture Content

Moisture content tests were performed in accordance with the ASTM D2216-71 test procedure to evaluate the water content of the soils encountered.

Moisture contents were determined for most soil samples obtained with split-spoon samplers, and on those bulk samples which were secured in plastic bags. No moisture content tests were performed on bulk samples kept in cloth bags.

1.5 Organic Content

The organic contents of selected samples were determined by the "standard method of testing for organic content of soils" (State of Alaska, 1980), also known as the organic ignition test. The samples tested were oven-dried for 24 hours at a temperature of 105°C and the dry weight recorded. The samples were then weighed to the nearest 0.01 gram and placed in a tared crucible. The crucible containing the sample was then placed in a muffle furnace at a temperature of 950°C $\pm$ 50°C until all organic matter was combusted, usually about two hours. The samples, were then cooled to room temperature, weighed, and the percent of weight loss calculated and presented as the amount of organic materials.

1.6 Specific Gravity

Selected samples were tested to determine the specific gravity, G_s , of their soil constituents. Specific gravity tests were periodically performed to establish a representative range. The ASTM D854-58 test method was used for conducting specific gravity determinations.

1.7 Compaction Tests

A limited quantity of standard and modified proctor tests were performed to establish typical compaction characteristics of selected samples from the relict channel/borrow area. ASTM D698 and D1557-78 test procedures were used for the standard and modified proctor tests, respectively.

1.8 Visual Classification

Visual procedures, based on ASTM D2488-69 test method, were performed on the majority of soil samples to assist with the soil classifications. Visual descriptions of soils such as color, dry strength, toughness, dilatancy and roundness were recorded on each test data sheet.

A summary of the results of laboratory testing performed during the river channel and relict channel testing program are presented in the lab test summary sheets which follow. Interpretation of the laboratory gradation data is presented in a set of curves at the back of this appendix.

2. LAB TEST SUMMARIES

2.1 RIVER CHANNEL

BORING NO.

HD83-10

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	PI.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	4-5	GM	N/A	46.2	39.7	14.1	-	-	-	-	-	
2	BULK	8-10	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	14-15	GP-GM	N/A	61.9	30.0	8.1	-	-	-	-	-	
4	BULK	20-22	GP-GM	N/A	59.2	33.2	7.6	-	-	-	-	-	
5	BULK	23-27	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	30-31	SM	N/A	35.1	48.9	16.0	-	-	-	-	-	
7	BULK	34-36	GW	N/A	58.2	38.3	3.5	-	-	-	-	-	
8	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	46-48	GW-GM	N/A	72.7	21.2	6.1	-	-	-	-	-	
10	BULK	50-52	GP-GM	N/A	56.7	37.0	6.3	-	-	-	-	-	
11	BULK	55-57	GW-GM	N/A	57.0	37.2	5.8	-	-	-	-	-	
12	BULK	60-65	GW	N/A	60.6	35.8	3.6	-	-	-	-	-	
13	BULK	65-70	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	70-75	GW-GM	N/A	61.6	31.0	7.4	-	-	-	-	-	
15	BULK	75-80	GP-GM	N/A	56.1	33.3	10.6	-	-	-	-	-	
16	BULK	80-85	GW-GM	N/A	45.8	45.3	8.8	-	-	-	-	-	
17	BULK	85-90	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	90-95	GP-GM	N/A	70.7	20.1	9.2	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-10

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-11

Remarks:

Boring No.

HD83-11

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-12

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	20-25	GP-GM	N/A	54.5	37.0	8.5	-	-	-	-	-	
4	BULK	25-30	GP-GM	N/A	70.4	22.9	6.7	-	-	-	-	-	
5	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	35-40	GW-GM	N/A	51.0	41.9	7.1	-	-	-	-	-	
7	BULK	40-45	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	45-50	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-70	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	70-73	GP-GM	N/A	56.9	33.8	9.3	-	-	-	-	-	
13	BULK	75-76	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-12

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-13

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	SP	N/A	44.7	52.0	3.3	-	-	-	-	-	
3	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	GP-GM	N/A	54.1	35.8	10.1	-	-	-	-	-	
5	BULK	30-35	SP-SM	N/A	46.0	48.6	5.4	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	45-57	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-52	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	55-57	GW-GM	N/A	52.6	38.9	8.5	-	-	-	-	-	
11	BULK	60-62	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	65-67	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	70-72	GP-GM	N/A	63.2	27.5	9.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-13

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-14

Remarks:

Boring No.

HD83-14

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-15

Remarks:

Boring No.

HD83-15

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-16

Remarks:

Boring No.

HD83-16

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-17

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-18

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-18

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-19

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	14-15	GP	0.0	56.8	42.4	0.8	-	-	-	-	-	
2	BULK	19-20	-	0.0	-	-	-	-	-	-	-	-	
3	BULK	27-28	GW	0.0	68.3	28.5	3.2	-	-	-	-	-	
4	BULK	31-32	-	0.0	-	-	-	-	-	-	-	-	
5	BULK	37-38	SP	0.0	39.0	59.0	2.0	-	-	-	-	-	
6	BULK	41-42	-	0.0	-	-	-	-	-	-	-	-	
7	BULK	46-47	SP	0.0	9.3	88.3	2.4	-	-	-	-	-	
8	BULK	51-52	SP	0.0	5.5	92.3	2.2	-	-	-	-	-	
9	BULK	60-61	SP-SM	0.0	35.3	59.5	5.2	-	-	-	-	-	
10	BULK	65-66	-	0.0	-	-	-	-	-	-	-	-	
11	BULK	67-68	GW	0.0	54.8	41.2	4.0	-	-	-	-	-	
12	BULK	71-72	GP	0.0	74.9	24.5	0.6	-	-	-	-	-	
13	BULK	-	-	-	-	-	-	-	-	-	-	-	
14	BULK	77-78	-	0.0	-	-	-	-	-	-	-	-	
15	BULK	80-81	-	0.0	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-19

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-20

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	GW	N/A	78.5	20.9	0.6	-	-	-	-	-	
2	BULK	15-20	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	20-27	GW	N/A	77.2	20.2	2.6	-	-	-	-	-	
4	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	33-38	GW	N/A	55.9	35.9	8.2	-	-	-	-	-	
6	BULK	42-45	SP	33.5	62.8	3.9	-	-	-	-	-	-	
7	BULK	46-48	GW	N/A	49.2	47.9	2.9	-	-	-	-	-	
8	BULK	54-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	57-60	GW	N/A	73.3	25.1	1.6	-	-	-	-	-	
10	BULK	61-65	GW	N/A	64.6	31.3	4.3	-	-	-	-	-	
11	BULK	66-68	GM	N/A	36.0	30.5	33.5	-	-	-	-	-	
12	BULK	70-75	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-20

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-21

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	1-2	SM	N/A	7.5	74.6	17.9	-	-	-	-	-	
2	BULK	6-7	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-12	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	15-18	GW-GM	N/A	61.1	33.2	5.7	-	-	-	-	-	
5	BULK	20-25	GW	N/A	74.7	23.9	1.4	-	-	-	-	-	
6	BULK	26-28	GW	N/A	60.6	29.6	9.8	-	-	-	-	-	
7	BULK	30-33	SP	N/A	31.5	66.3	2.2	-	-	-	-	-	
8	BULK	36-38	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-45	SP	N/A	32.4	63.4	4.2	-	-	-	-	-	
10	BULK	45-50	GP	N/A	51.8	43.8	4.4	-	-	-	-	-	
11	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	55-60	SP	N/A	19.7	76.7	3.6	-	-	-	-	-	
13	BULK	60-65	GP	N/A	59.5	32.5	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-21

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-22

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	3-5	GP	N/A	74.5	23.6	1.9	-	-	-	-	-	
2	BULK	5-8	GW	N/A	72.7	23.8	3.5	-	-	-	-	-	
3	BULK	10-17	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	21-23	GW-GM	N/A	58.5	36.3	5.2	-	-	-	-	-	
5	BULK	25-28	GW	N/A	57.8	39.2	3.0	-	-	-	-	-	
6	BULK	30-34	GP-GM	N/A	67.9	26.1	6.0	-	-	-	-	-	
7	BULK	35-38	GW	N/A	61.2	34.2	4.6	-	-	-	-	-	
8	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-48	SP	N/A	27.7	69.0	3.3	-	-	-	-	-	
10	BULK	50-53	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	54-58	GW	N/A	66.1	31.0	2.9	-	-	-	-	-	
12	BULK	61-64	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	65-67	GP-GM	N/A	68.4	25.9	5.7	-	-	-	-	-	
14	BULK	70-72	GW	N/A	59.1	37.1	3.8	-	-	-	-	-	
15	BULK	74-78	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	85-87	GP-GM	N/A	69.1	23.0	7.9	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-22

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-23

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	2-4	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-8	GW-GM	N/A	66.7	28.1	5.2	-	-	-	-	-	
3	BULK	10-13	GW-GM	N/A	57.7	34.7	7.6	-	-	-	-	-	
4	BULK	15-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	21-24	GW	N/A	61.5	34.5	4.0	-	-	-	-	-	
6	BULK	25-28	GM	N/A	47.4	38.4	14.2	-	-	-	-	-	
7	BULK	32-34	SP	N/A	40.1	55.4	4.5	-	-	-	-	-	
8	BULK	39-41	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-48	SM	N/A	43.3	44.1	12.6	-	-	-	-	-	
10	BULK	51-53	GW-GM	N/A	60.1	33.7	6.2	-	-	-	-	-	
11	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	61-65	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	67-69	SM	N/A	34.8	50.6	14.6	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-23

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-24

[illegible]

Remarks:

LAB TEST SUMMARY

Working No. HD83-24

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-25

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-25

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-26

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-18	GW-GM	N/A	61.2	31.8	7.0	-	-	-	-	-	
3	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-28	GP-GM	N/A	68.9	25.7	5.4	-	-	-	-	-	
5	BULK	30-33	GP-GM	N/A	65.0	26.4	8.6	-	-	-	-	-	
6	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-43	SP-SM	N/A	27.0	65.8	7.2	-	-	-	-	-	
8	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	52-54	GM	N/A	48.7	34.0	17.3	-	-	-	-	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	61-63	SW-SM	N/A	34.7	58.0	7.1	-	-	-	-	-	
12	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	70-73	GC-GM	N/A	39.7	29.9	30.4	X	25	19	6	-	G _S =2.76

Remarks:

LAB TEST SUMMARY

Boring No. HD83-26

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-27

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-13	GW	N/A	77.3	19.6	3.1	-	-	-	-	-	
2	BULK	15-18	GP-GM	N/A	69.0	24.7	6.3	-	-	-	-	-	
3	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	28-30	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	31-35	GP-GM	N/A	70.6	24.3	5.1	-	-	-	-	-	
6	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-45	GP	N/A	72.9	22.7	4.4	-	-	-	-	-	
8	BULK	45-48	GP	N/A	58.1	38.0	3.9	-	-	-	-	-	
9	BULK	50-52	GP	N/A	73.2	22.9	3.9	-	-	-	-	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-64	GW-GM	N/A	71.6	23.1	5.3	-	-	-	-	-	
12	BULK	65-68	GP-GM	N/A	66.5	24.4	9.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-27

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-28

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-13	GW	N/A	73.3	23.6	3.1	-	-	-	-	-	
2	BULK	14-18	GP-GM	N/A	68.7	23.9	7.4	-	-	-	-	-	
3	BULK	20-24	GP-GM	N/A	62.0	28.8	9.2	X	Non-Plastic			-	G _S =2.75
4	BULK	25-28	GP-GM	N/A	64.6	29.0	6.4	-	-	-	-	-	
5	BULK	30-34	GW-GM	N/A	64.7	29.4	5.9	-	-	-	-	-	
6	BULK	34-35	SP-SM	N/A	12.6	81.6	5.8	X	-	-	-	-	G _S =2.78
7	BULK	41-45	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	46-48	SP	N/A	25.1	71.5	3.4	-	-	-	-	-	
9	BULK	52-55	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	65-68	GP-GM	N/A	65.3	25.7	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-28

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-29

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	GW-GM	N/A	56.8	37.6	5.6	-	-	-	-	-	
3	BULK	20-25	GW-GM	N/A	55.8	34.6	9.6	-	-	-	-	-	
4	BULK	25-30	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	30-33	GP-GM	N/A	49.1	41.0	9.9	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	43-48	GP	N/A	50.3	45.5	4.2	-	-	-	-	-	
8	BULK	50-54	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-58	SW	N/A	43.0	53.7	3.3	-	-	-	-	-	
10	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	73-75	GW	N/A	73.9	22.4	3.7	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-29

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-30

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-30

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-31

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	PI.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	1-2	GW-GM	N/A	59.7	33.4	6.9	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	GW	N/A	67.9	28.9	3.2	-	-	-	-	-	
4	BULK	16-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	21-24	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	25-28	GW	N/A	75.4	21.5	3.1	-	-	-	-	-	
7	BULK	30-32	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-43	SP	N/A	30.7	67.3	2.0	-	-	-	-	-	
9	BULK	45-48	SW	N/A	29.3	65.8	4.9	-	-	-	-	-	
10	BULK	55-56	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	56-58	GW-GM	N/A	59.4	33.6	7.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-31

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-32

Remarks:

Ordering No. HD83-32
Susitna Hydroelectric Project

SUSITNA JOINT VENTURE

HD83-33

Remarks:

oring No.

Susitna Hydroelectric Project

SUSITNA JOINT VENTURE

HD83-34

Remarks:

Boring No.

HD83-34

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-35

Remarks:

Boring No.

HD83-35

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD-83-36

Remarks:

Boring No. HD83-36
Susitna Hydroelectric Project

HARZA-EBASCO
SUSITNA JOINT VENTURE

BORING NO.

HD83-37

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	1-5	GW	N/A	70.4	25.9	3.7	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	GP-GM	N/A	63.9	30.6	5.5	-	-	-	-	-	
4	BULK	15-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	20-25	GW	N/A	73.7	23.5	2.8	-	-	-	-	-	
6	BULK	25-26	GW	N/A	75.3	22.9	1.8	-	-	-	-	-	
7	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-45	GW	N/A	74.2	22.2	3.6	-	-	-	-	-	
10	BULK	45-50	GW	N/A	81.8	14.4	3.8	-	-	-	-	-	
11	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	60-65	GW	N/A	81.7	15.4	2.9	-	-	-	-	-	
14	BULK	65-70	GP-GM	N/A	72.2	20.6	7.2	-	-	-	-	-	
15	BULK	70-75	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	75-80	GP-GM	N/A	75.6	19.2	5.2	-	-	-	-	-	
17	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	88-94	GW	N/A	77.6	20.1	2.3	-	-	-	-	-	
19	BULK	96-100	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	100-109	GP	N/A	55.2	41.6	3.2	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-37

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-37

Remarks:

Boring No.

HD83-37

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-38

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.	W _c (%)	
1	BULK	3-6	GP-GM	N/A	57.6	33.5	8.9	-	-	-	-	-	
2	BULK	7-10	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	13-15	GW	N/A	57.6	37.7	4.7	-	-	-	-	-	
4	BULK	17-20	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	23-25	GW	N/A	75.0	22.4	2.6	-	-	-	-	-	
6	BULK	25-27	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	30-33	GP-GM	N/A	57.8	32.8	9.4	-	-	-	-	-	
8	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-43	SM	N/A	42.3	43.3	14.2	-	-	-	-	-	
10	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	50-53	GM	N/A	41.3	40.1	18.6	-	-	-	-	-	
12	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	60-63	GP-GM	N/A	59.9	30.8	9.3	-	-	-	-	-	
14	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	70-73	GP-GM	N/A	70.0	23.0	7.0	-	-	-	-	-	
16	BULK	75-78	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	80-83	GW	N/A	77.1	18.0	4.9	-	-	-	-	-	
18	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	90-93	GW-GM	N/A	54.5	39.1	6.4	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-38

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-39

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	5-8	GW-GM	N/A	58.2	35.1	6.7	-	-	-	-	-	G _S =2.74
2	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	15-20	GP-GM	N/A	60.7	32.5	6.8	-	-	-	-	-	G _S =2.80
4	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	25-34	GP-GM	N/A	50.7	42.1	7.2	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-48	GW	N/A	59.5	36.6	3.9	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-60	GW-GM	N/A	72.4	21.2	6.4	-	-	-	-	-	
10	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-70	GP-GM	N/A	65.8	26.5	7.7	-	-	-	-	-	G _S =2.82
12	BULK	70-74	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	75-78	SM	N/A	40.2	43.3	16.5	-	-	-	-	-	
14	BULK	80-85	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	85-88	SP-SM	N/A	40.7	53.1	6.2	-	-	-	-	-	G _S =2.76
16	BULK	90-95	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	100-104	GP-GM	N/A	54.3	37.0	8.7	-	-	-	-	-	G _S =2.76
18	BULK	105-108	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	108-113	GW-GM	N/A	61.4	33.4	5.2	-	-	-	-	-	
20	BULK	115-118	GP-GM	N/A	52.4	37.8	10.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-39

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-39

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-39

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-40

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-40

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-41

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	5-10	SM	N/A	34.2	48.8	17.0	-	-	-	-	-	
2	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	15-20	GP-GM	N/A	55.1	35.9	9.0	-	-	-	-	-	G _S =2.76
4	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	25-30	SP-SM	N/A	32.6	57.5	9.9	-	-	-	-	-	
6	BULK	30-35	GP-GM	N/A	47.0	43.7	9.3	-	-	-	-	-	G _S =2.76
7	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-45	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-50	SM	N/A	32.5	51.3	16.2	-	-	-	-	-	G _S =2.78
10	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	55-60	GP-GM	N/A	54.7	39.4	5.9	-	-	-	-	-	
12	BULK	60-65	GP-GM	N/A	47.6	45.6	6.8	-	-	-	-	-	
13	BULK	65-70	SW-SM	N/A	40.1	48.1	11.8	-	-	-	-	-	
14	BULK	70-75	GM	N/A	45.7	38.8	15.5	-	-	-	-	-	G _S =2.68
15	BULK	75-80	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-41

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-42

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	12-17	N/A	-	-	-	-	-	-	-	-	-	
2	BULK	20-23	SP	N/A	32.1	63.2	4.7	-	-	-	-	-	G _S =2.76
3	BULK	25-28	GW	N/A	64.2	32.0	3.8	-	-	-	-	-	
4	BULK	30-33	GP-GM	N/A	64.0	29.1	6.9	-	-	-	-	-	
5	BULK	35-38	SW	N/A	46.7	48.9	4.4	-	-	-	-	-	
6	BULK	40-43	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	45-48	SM	N/A	19.1	66.9	13.2	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-60	SP	N/A	47.6	44.1	3.3	-	-	-	-	-	G _S =2.75
10	BULK	60-65	GW-GM	N/A	61.6	32.6	5.8	-	-	-	-	-	
11	BULK	65-68	SC	N/A	31.5	32.9	35.6	-	26	18	8	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-42

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-43

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	SP	N/A	46.3	50.2	3.5	-	-	-	-	-	
2	BULK	15-20	GP	N/A	50.1	46.8	3.1	-	-	-	-	-	
3	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	GW	N/A	50.6	46.9	2.5	-	-	-	-	-	
5	BULK	30-35	GW-GM	N/A	56.9	35.4	7.7	-	-	-	-	-	
6	BULK	35-40	SP	N/A	37.6	58.6	3.8	-	-	-	-	-	Proctor D698 max=143.5pcf
7	BULK	40-45	GW-GM	N/A	70.6	24.4	5.0	-	-	-	-	-	wopt=6.0% G _s =2.83
8	BULK	45-50	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-55	SM-SC	N/A	39.7	41.4	18.9	-	22	18	14	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-63	GM	N/A	56.5	25.5	18.0	-	-	-	-	-	
12	BULK	65-67	SW	N/A	41.1	56.8	2.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-43

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-44

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	SW	N/A	44.6	52.7	2.7	-	-	-	-	-	
2	BULK	15-18	SP	N/A	34.7	60.8	4.5	-	-	-	-	-	
3	BULK	18-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	SP	N/A	47.4	50.7	1.9	-	-	-	-	-	
5	BULK	30-35	GW	N/A	64.4	31.7	3.9	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	Proctor 698 max=135pct.
7	BULK	40-45	SP	N/A	33.5	63.6	2.9	-	-	-	-	-	wopt.=10.0 G _s =2.81
8	BULK	45-50	SW-SC	N/A	39.9	51.4	8.7	-	25	20	5	-	
9	BULK	50-55	GW-GM	N/A	51.0	43.4	5.6	-	-	-	-	-	
10	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-65	GW-GM	N/A	53.4	39.5	7.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-44

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-45

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	0-4	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	4-7	GW-GM	N/A	60.2	32.0	7.8	X	-	-	-	-	
3	BULK	10-13		N/A	-	-	-	-	-	-	-	-	
4	BULK	14-17	GW-GM	N/A	62.9	31.2	5.9	-	-	-	-	-	
5	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	24-27	GM	N/A	47.8	40.1	12.4	X	Non-Plastic			-	
7	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	35-38	SW-SM	N/A	39.2	51.5	9.3	X	-	-	-	-	
9	BULK	40-43	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	45-47	GP-GM	N/A	45.2	46.4	8.4	-	-	-	-	-	
11	BULK	50-53	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD93-45

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-46

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	2-5	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-10	GW-GM	N/A	54.3	33.1	10.6	-	-	-	-	-	
3	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	13-16	OH	N/A	24.7	18.0	57.3	-	56	52	4	-	Organic content=13.9%
5	BULK	17-20	SM	N/A	5.9	47.5	46.6	-	Non-Plastic			-	Organic content=2.8%
6	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	25-29	GP-GM	N/A	48.2	42.4	9.4	-	-	-	-	-	
8	BULK	30-34	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	34-39	GP-GM	N/A	46.8	43.7	9.5	-	-	-	-	-	
10	BULK	40-45	SP	N/A	32.3	63.5	4.2	-	-	-	-	-	
11	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-46

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-47

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	LIMITS			W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.		
1	BULK	2-4	GP-GM	N/A	63.3	30.5	6.2	-	-	-	-	-	
2	BULK	4-8	SM	N/A	35.5	45.8	18.7	-	Non-Plastic			-	
3	BULK	10-14	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	20-23	GW-GM	N/A	56.7	36.0	7.3	-	-	-	-	-	
5	BULK	24-28	SP	N/A	37.7	59.0	3.3	-	-	-	-	-	
6	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	34-38	GW	N/A	50.6	44.8	4.6	-	-	-	-	-	
8	BULK	40-41	SP-SM	N/A	14.1	77.7	8.2	-	-	-	-	-	
9	BULK	41-45	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-64	GW-GM	N/A	47.1	43.0	9.9	-	18	15	3	-	
12	BULK	64-65	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-47

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-48

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-19	SP	N/A	14.9	80.7	4.4	-	-	-	-	-	
3	BULK	19-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	SP-SM	N/A	42.5	48.9	8.6	-	Non-Plastic			-	
5	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	35-40	GW	N/A	67.2	31.2	1.6	-	-	-	-	-	
7	BULK	42-47	GW	N/A	53.2	43.9	2.7	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-58	SP	N/A	20.7	76.1	3.2	-	Non-Plastic			-	
10	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-69	GW-GM	N/A	32.9	60.9	6.2	-	-	-	-	-	
12	BULK	70-75	GP-GM	N/A	51.2	38.0	10.8	-	-	-	-	-	
13	BULK	75-78	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	80-85	GC	N/A	49.7	33.7	16.6	X	27	18	9	-	
15	BULK	85-88	GP-GM	N/A	57.2	33.8	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-48

Gusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

2.2 RELICT CHANNEL

BORING NO.

HD83-1

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	2-9	SM	N/A	33.4	48.3	18.3	-	-	-	-	-	
2	SPT	9-10	-	-	-	-	-	-	-	-	-	8.9	
3	BULK	19-20	SM	N/A	20.2	49.1	30.7	X	-	-	-	-	
4	BULK	26-28	SM	N/A	29.8	40.0	30.2	-	-	-	-	-	
5	SPT	28-29	-	-	-	-	-	-	-	-	-	-	
6	BULK	32-34	SM-SC	N/A	21.1	39.5	39.4	X	18	13	5	-	
7	BULK	37-38	-	-	-	-	-	-	-	-	-	-	
8	SPT	38-39	-	-	-	-	-	-	-	-	-	-	
9	BULK	44-45	-	-	-	-	-	-	-	-	-	-	
10	BULK	50-52	SM	N/A	11.3	42.7	46.0	X	Non-Plastic-				
11	BULK	55-56	SM	N/A	17.8	41.4	40.8	-	-	-	-	-	
12	BULK	60-62	SM	N/A	27.0	32.9	40.1	-	-	-	-	-	
13	BULK	65-66	SC	N/A	25.8	37.8	36.4	-	24	14	10	-	
13B	SPT	69-71	SC	-	-	-	-	-	42	18	24	12.4	
14	BULK	71-72	SM	N/A	19.7	35.1	45.2	X	-	-	-	-	
15	BULK	75-76	SM	N/A	22.6	41.1	36.3	-	-	-	-	-	
16	BULK	77	-	-	-	-	-	-	-	-	-	-	
17	BULK	80-81	SM	N/A	30.2	39.7	30.1	-	-	-	-	-	
18	BULK	85-88	SM	N/A	21.3	42.3	36.4	-	Non-Plastic-				
18B	SPT	89-90	-	-	-	-	-	-	-	-	-	11.3	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-1

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
19	BULK	90-92	SM	N/A	20.5	44.7	34.8	-	-	-	-	-	
20	BULK	95-96	SM	N/A	37.4	43.0	19.6	-	-	-	-	-	
21	BULK	100-101	SM	N/A	30.4	40.5	29.4	-	-	-	-	-	
22	BULK	107-108	SM	N/A	19.8	47.3	32.9	X	Non-Plastic			-	
23	BULK	114-116	SM	N/A	27.3	43.4	29.3	-	-	-	-	-	
24	BULK	121-123	SM	N/A	29.9	41.2	28.9	-	17	15	2	4.4	
25	BULK	126-128	SM	N/A	21.6	48.9	29.5	-	17	15	2	2.6	
26	BULK	131-133	SM-SC	N/A	9.2	54.3	36.5	-	19	14	5	5.3	
27	BULK	136-138	SM+SC	N/A	12.0	50.9	37.1	-	20	14	8	5.8	
28	BULK	141-143	SM	N/A	17.8	56.7	26.1	X	18	16	2	2.7	
29	BULK	146-148	SM	N/A	21.5	51.4	27.1	-	Non-Plastic			4.7	
30	BULK	151-153	-	-	-	-	-	-	-	-	-	-	
31	BULK	161-163	SM	N/A	35.3	41.6	23.1	-	Non-Plastic			2.9	
32	BULK	166-168	-	-	-	-	-	-	-	-	-	3.1	
33	BULK	174-176	-	-	-	-	-	-	-	-	-	1.3	
34	BULK	178-180	SM	N/A	13.6	74.4	12.0	-	-	-	-	0.6	
35	BULK	183-185	SM	N/A	38.1	49.8	12.1	-	Non-Plastic			2.2	
36	BULK	188-190	SM	N/A	43.4	44.0	12.6	-	-	-	-	2.7	
37	BULK	194-196	SM	N/A	10.8	64.0	25.2	X.	Non-Plastic			-	
38	BULK	200-202	SM	N/A	20.1	52.1	27.8	-	18	16	2	12.6	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-1

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
39	BULK	208-210	SW-SM	N/A	21.3	69.2	9.5	-	-	-	-	-	
40	BULK	225-233	SM	N/A	15.4	63.7	20.9	-	Non-Plastic			-	
41	BULK	243-245	SM-SC	N/A	22.0	38.9	39.1	X	20	16	4	-	
42	BULK	255-257	CL	N/A	11.7	21.8	61.0	-	26	18	8	13.2	Organic Content 2.1%
43	BULK	260-261	SC	N/A	22.4	37.8	39.8	-	31	17	14	8.5	Organic Content 1.4%
44	BULK	263-264	SM	N/A	18.5	32.4	49.1	-	-	-	-	18.0	
45	BULK	270-271	CL	N/A	0.7	6.1	93.2	-	-	-	-	22.7	
46	BULK	276-278	CL-ML	N/A	-0-	1.6	98.4	X	25	20	5	21.4	
47	BULK	282-284	CL	N/A	-0-	5.3	94.7	-	31	22	9	24.0	
48	BULK	290-291	CL	N/A	-0-	2.5	97.5	-	29	22	7	22.0	
49	BULK	295-296	GM	N/A	35.2	34.6	30.2	-	-	-	-	-	
50	BULK	299-300	GM	N/A	34.2	28.2	37.6	X	-	-	-	-	
51	BULK	304-305	-	-	-	-	-	-	-	-	-	-	
52	BULK	305-306	GW-GM	N/A	66.6	26.7	6.7	-	-	-	-	-	
53	BULK	308-309	GP-GM	N/A	72.5	19.7	7.8	-	-	-	-	-	
54	BULK	309-310	GP-GM	N/A	51.1	37.4	11.5	X	Non-Plastic			-	
55	BULK	312-313	GP	N/A	64.8	33.0	2.2	-	-	-	-	-	
56	BULK	314-315	GW	N/A	58.0	39.9	2.1	-	-	-	-	-	
57	BULK	316-317	SW	N/A	37.8	59.1	3.1	-	-	-	-	-	
58	BULK	321-322	GP	N/A	61.0	34.5	4.5	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-2

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	3-8	SM	12.2	27.1	47.5	13.2	-	-	-	-	-	
2	SPT	8-10	SM	0.0	26.0	55.1	18.9	-	-	-	-	12.5	
3	BULK	13-14	GM	9.7	44.4	31.3	13.1	-	20	17	3	8.1	
4	BULK	14-17	GP-GM	8.8	57.8	24.4	9.0	-	-	-	-	17.7	
5	SPT	-	-	-	-	-	-	-	-	-	-	-	
6	BULK	18-20	GM	0.0	51.0	36.9	12.1	-	-	-	-	12.7	
7	SPT	20-21	-	-	-	-	-	-	-	-	-	16.6	
8	BULK	24-25	SM	0.0	2.8	74.5	22.7	-	Non-Plastic			10.8	
9	SPT	28-29	-	-	-	-	-	-	-	-	-	12.1	
10	BULK	33-34	SM	0.0	4.8	79.2	16.0	-	-	-	-	8.2	
11	BULK	36-37	SW-SM	0.0	12.7	76.5	10.8	-	-	-	-	6.1	
12	SPT	38-39	-	-	-	-	-	-	-	-	-	5.9	
13	BULK	40-41	SC	0.0	2.1	64.9	33.0	-	34	23	11	19.2	
14	BULK	44-45	SM	0.0	0.9	85.7	13.4	-	-	-	-	-	
15	BULK	46-47	SM	0.0	15.1	70.1	14.8	-	-	-	-	6.4	
16	BULK	49-50	SW-SM	0.0	16.1	72.9	11.0	-	-	-	-	5.2	
17	BULK	52-53	SM	0.0	5.5	82.0	12.5	-	Non-Plastic			-	
18	BULK	55-56	SW-SM	0.0	3.5	84.9	11.6	-	Non-Plastic			6.1	
19	SPT	58-59	-	-	-	-	-	-	-	-	-	-	
20	BULK	61-62	SW-SM	0.0	29.1	59.8	11.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-2

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-2

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-2

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-3

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	7-9	-	-	-	-	-	-	-	-	-	-	
2	BULK	14-15	SM-SC	0.0	13.0	41.7	45.3	X	21	14	6	15.4	
3	SPT	18-19	ML	-	-	-	-	-	15	14	1	11.8	
4	BULK	22-23	ML-CL	0.0	12.0	37.0	51.0	-	19	15	4	14.6	
5	SPT	28-29	-	-	-	-	-	-	-	-	-	12.0	
6	BULK	30-31	SM-SC	0.0	7.6	44.0	48.4	-	20	14	6	10.5	
7	BULK	36-37	-	-	-	-	-	-	-	-	-	14.3	
8	SPT	38-40	SM+SC	0.0	12.9	45.8	41.3	X	18	13	5	10.6	
9	BULK	46-47	-	-	-	-	-	-	-	-	-	6.2	
10	SPT	58-59	-	-	-	-	-	-	-	-	-	12.3	
11	BULK	63-64	-	-	-	-	-	-	-	-	-	4.4	
12	BULK	68-69	-	-	-	-	-	-	-	-	-	5.5	
13	BULK	73-74	GM	0.0	44.2	30.2	25.6	-	Non-Plastic			4.6	

Remarks:

BORING NO. HD83-4

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	SPT	7-8	SM	0.0	14.4	51.6	34.0	-	-	-	-	12.2	
2	BULK	7-9	SM	0.0	30.3	44.8	24.9	-	Non-Plastic			-	
3	SPT	17-19	SM	0.0	8.2	43.7	48.1	-	-	-	-	15.0	
4	BULK	17-19	SM	0.0	17.5	46.2	36.3	-	Non-Plastic			-	
5	BULK	23-24	SM	0.0	18.6	44.8	36.6	-	-	-	-	-	
6	BULK	31-32	ML	0.0	1.8	27.0	71.2	X	21	18	3	16.7	
7	BULK	35-36	SW-SM	8.3	39.2	41.0	11.5	-	Non-Plastic			-	
8	SPT	47-49	-	-	-	-	-	-	-	-	-	-	
9	BULK	58-59	SM	0.0	24.3	46.5	29.2	-	17	16	1	-	
10	BULK	60-61	SM	0.0	16.1	37.7	46.2	X	17	14	3	-	
11	BULK	73-74	-	-	-	-	-	-	-	-	-	14.7	
12	BULK	77-78	CL	0.0	0.4	11.0	88.6	-	28	19	9	15.4	
13	BULK	85-86	SC	0.0	25.8	28.3	45.9	X	24	17	7	8.3	
14	BULK	87-88	SM-SL	0.0	20.5	43.4	36.1	-	19	14	5	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-4

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-5

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	8-9	SM	0.0	0.0	68.5	31.5	-	-	-	-	-	G _s =2.69
2	BULK	14-15	CL-MI	0.0	1.4	32.6	66.0	X	22	16	5	46.5	
3	BULK	21-22	CL	0.0	0.5	12.1	87.4	X	31	20	11	74.5	
4	SPT	28-30	CL-MI	-	-	-	-	-	46	28	18	40.7	
5	BULK	28-30	-	-	-	-	-	-	-	-	-	44.6	
6	BULK	38-39	MH	-	-	-	-	-	53	31	22	30.4	G _s =2.75
7	BULK	41-42	CL	0.0	3.3	18.6	78.1	X	31	21	10	-	
8	BULK	44-45	GW	0.0	59.4	36.3	4.3	-	-	-	-	-	
9	BULK	47-48	GW	0.0	67.9	29.4	2.7	-	-	-	-	6.4	
10	BULK	50-51	SP	0.0	35.4	61.1	3.5	-	-	-	-	8.4	
11	BULK	77-78	-	-	-	-	-	-	-	-	-	-	
12	BULK	83-84	-	-	-	-	-	-	-	-	-	-	
13	BULK	86-87	SM	0.0	28.2	34.6	37.2	X	18	16	2	9.0	
14	BULK	93-94	SM	0.0	21.0	29.9	49.1	X	-	-	-	7.0	
15	BULK	100-101	GM	5.2	40.6	34.1	15.8	X	-	-	-	-	
16	BULK	110-111	GW	0.0	71.3	24.1	4.6	-	-	-	-	-	
17	BULK	123-124	SM	0.0	0.0	58.1	41.9	X	Non-Plastic			-	
18	BULK	129-130	-	-	-	-	-	-	-	-	-	-	
19	BULK	135-136	-	-	-	-	-	-	-	-	-	-	
20	BULK	137-138	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-5

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-6

SAMPLE NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	11-15	SM	N/A	16.1	46.8	37.1	-	-	-	-	10.5	G _S =2.69
2	BULK	18-20	SM	N/A	35.9	36.8	28.3	-	-	-	-	-	
3	BULK	24-26	SM	N/A	15.4	43.6	41.0	X	17	14	3	-	
4	BULK	32-38	CL	N/A	10.2	31.0	58.8	X	29	20	9	-	G _S =2.74
5	BULK	41-43	CL/ML	N/A	2.5	8.0	89.5	X	44	27	17	-	
6	BULK	46-48	CL	N/A	0.2	4.3	95.7	-	32	23	9	-	
7	BULK	50-51	ML	N/A	17.1	23.1	59.8	X	-	-	-	-	
8	BULK	52-54	SM	N/A	30.6	42.0	27.4	X	-	-	-	-	
9	BULK	56-57	GP-GM	N/A	48.1	40.5	11.4	-	-	-	-	-	
10	BULK	69-70	SW-SM	N/A	36.7	52.2	11.1	-	-	-	-	-	
11	BULK	77-79	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	83-85	GP	N/A	68.0	27.5	4.5	-	-	-	-	-	
13	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	91-93	SM	N/A	5.8	58.6	35.6	-	-	-	-	-	
15	BULK	94-96	SM-SL	N/A	4.6	60.4	35.0	-	25	21	4	-	
16	BULK	104-106	SM-SL	N/A	0.6	57.0	42.4	-	28	22	6	-	
17	SPT	108-109	-	N/A	-	-	-	-	-	-	-	26.9	
18	BULK	108-109	SM	N/A	10.7	56.0	33.3	X	-	-	-	-	
19	BULK	115-117	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	124-126	SM	N/A	2.4	58.0	39.2	X	22	20	2	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-6

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-6

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-6

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-7

[illegible]

Remarks:

LAB TEST SUMMARY

Spring No. HD83-7

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-8

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	6-8	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	11-13	SM	N/A	9.5	61.4	29.1	-	-	-	-	-	
3	BULK	16-18	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	21-23	SM	N/A	28.4	51.3	20.3	X	Non-Plastic			-	
5	BULK	26-28	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	31-33	SM	N/A	12.1	68.2	19.7	-	-	-	-	-	
7	BULK	36-38	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	41-43	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	46-48	SM	N/A	19.0	46.6	34.4	-	15	14	1	-	
10	BULK	51-53	SP-SM	N/A	22.6	71.3	6.1	-	-	-	-	-	
11	BULK	56-58	SM	N/A	29.8	53.7	16.5	-	-	-	-	-	
12	BULK	61-63	SM	N/A	9.3	58.4	32.3	X	20	18	2	-	
13	BULK	66-68	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	72-73	SM	N/A	6.0	68.2	25.8	-	-	-	-	-	
15	BULK	75-76	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	76	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-8

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-9

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	5-7	SM	N/A	-	-	-	-	-	-	-	-	
2	BULK	10-12	SM	N/A	33.4	50.7	15.9	X	-	-	-	-	
3	BULK	15-17	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	20-22	SM	N/A	38.1	46.6	15.3	-	-	-	-	-	
5	BULK	25-27	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	30-32	SM	N/A	40.2	42.6	17.2	-	-	-	-	-	
7	BULK	35-37	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-42	SM	N/A	16.4	47.1	36.5	X	Non-Plastic			-	
9	BULK	46-48	SM	N/A	24.1	44.3	31.6	X	-	-	-	-	
10	BULK	50-52	SM	N/A	30.4	40.7	28.9	-	16	14	2	-	
11	BULK	56-58	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	60-62	SM	N/A	32.6	48.4	19.0	-	-	-	-	-	
13	BULK	66-68	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	70-72	SM	N/A	27.5	46.9	25.6	-	Non-Plastic			-	
15	BULK	76-78	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-82	SM	N/A	30.5	43.5	26.0	-	-	-	-	-	
17	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	90-92	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	95-97	SM	N/A	17.2	47.8	35.0	-	18	15	3	-	
20	BULK	100-102	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-9

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-9

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD8 3-9

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-49

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	3-8	GM	N/A	43.7	13.1	-	-	-	-	-	-	Organic Content 3.9%
2	SPT	8-10	CL-ML	N/A	-	-	-	-	23	19	4	-	
3	BULK	10-14	GM	N/A	44.1	41.9	14.0	-	-	-	-	-	
4	BULK	14-18	GP-GM	N/A	57.6	32.3	10.1	-	-	-	-	-	
5	SPT	18-19	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	20-24	CL	N/A	0.0	22.1	77.9	X	34	20	14	-	
7	BULK	24-28	-	N/A	-	-	-	-	-	-	-	-	
8	SPT	28-29	ML	N/A	-	-	-	-	22	19	3	30.8	
9	BULK	30-34	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	34-38	CL	N/A	0.0	13.5	86.5	X	32	22	10	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-49

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-50

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	1-4	SM	N/A	12.4	47.7	39.9	X	Non-Plastic			-	G _S =2.70
2	BULK	4-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	15-18	SM-SC	N/A	40.5	42.8	16.5	-	-	-	-	-	
5	SPT	18-20	-	N/A	-	-	-	-	-	-	-	16.5	
6	BULK	21-26	SC	N/A	11.4	41.7	46.9	-	24	16	18	-	
7	BULK	25-28	SM-SC	N/A	27.4	44.5	28.1	-	20	15	5	-	
8	BULK	30-34	SM-SC	N/A	29.1	46.1	24.8	-	-	-	-	-	
9	BULK	35-38	SM-SC	N/A	38.8	42.3	18.9	X	20	16	14	-	G _S =2.70
10	BULK	40-46	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	46-48	SM-SC	N/A	31.6	48.5	19.9	-	-	-	-	-	
12	BULK	52-54	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	55-58	SM-SC	N/A	27.4	43.2	25.1	-	18	14	4	-	
14	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	70-75	SM-SC	N/A	36.5	43.6	19.8	X	18	14	4	-	G _S =2.72
17	BULK	75-78	SM-SC	N/A	36.1	45.4	18.5	-	20	15	5	-	
18	SPT	78-79	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	80-85	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	85-88	SC	N/A	36.4	43.0	20.6	X	25	15	10	-	G _S =2.70

Remarks:

LAB TEST SUMMARY

Boring No. HD83-50

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-50

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-50

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-51

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
1	BULK	2-5	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	Organic Content 2.9%
3	SPT	8-10	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	10-14	Sp-SM	N/A	33.5	56.4	10.1	-	-	-	-	-	
5	SPT	15-16	-	N/A	-	-	-	-	-	-	-	8.7	
6	BULK	16-18	SM	N/A	21.2	54.9	23.9	-	-	-	-	-	
7	BULK	18-19	-	N/A	-	-	-	-	-	-	-	11.4	
8	BULK	20-24	SM	N/A	36.9	49.2	13.9	-	Non-Plastic			-	
9	SPT	24-25	-	N/A	-	-	-	-	-	-	-	9.1	
10	BULK	25-28	SM	N/A	9.1	45.1	45.8	-	Non-Plastic			-	
11	BULK	30-34	-	N/A	-	-	-	-	-	-	-	-	
12	SPT	34-35	SM-SC	N/A	0.0	69.4	30.6	X	-	-	-	13.3	
13	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
14	SPT	38-39	-	N/A	-	-	-	-	-	-	-	14.5	
15	BULK	40-43	SM-SC	N/A	19.6	38.5	41.9	-	18	14	4	-	Proctor D 155/ max.= 136
16	BULK	45-48	SC	N/A	20.4	39.5	40.1	-	21	13	9	-	W _{opt.} = 7.3 G _s = 2.72
17	SPT	48-49	-	N/A	-	-	-	-	-	-	-	5.2	
18	BULK	50-53	SM-SC	N/A	14.2	54.9	30.9	-	18	14	4	-	
19	SPT	55-56	-	N/A	-	-	-	-	-	-	-	14.5	
20	BULK	56-58	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-51

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-51

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	LIMITS			W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.		
21	SPT	58-59	ML	N/A	-	-	-	-	19	16	3	7.4	
22	BULK	60	-	N/A	-	-	-	-	-	-	-	-	
23	BULK	64-65	SM	N/A	7.9	66.7	25.4	-	-	-	-	-	
24	SPT	65-66	-	N/A	-	-	-	-	-	-	-	9.7	
25	BULK	66-70	SM	N/A	0.7	79.9	19.4	-	Non-Plastic			-	
26	BULK	70-75	SM	N/A	5.5	62.9	30.3	-	Non-Plastic			-	
27	BULK	76-78	SC	N/A	18.3	33.8	47.9	-	25	16	9	-	
28	SPT	78-79	-	N/A	-	-	-	-	-	-	-	14.2	
29	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	
30	SPT	84-85	-	N/A	-	-	-	-	-	-	-	17.0	
31	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
32	SPT	88-89	-	N/A	-	-	-	-	-	-	-	19.8	
33	BULK	90-94	SM-SC	N/A	9.5	61.3	29.2	-	21	16	5	-	
34	SPT	94-95	-	N/A	-	-	-	-	-	-	-	15.8	
35	BULK	96-98	CL	N/A	3.6	24.3	72.1	-	33	18	15	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-51

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	LIMITS			W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.		
1	BULK	3-8	SP-SM	N/A	39.5	50.6	9.9	-	-	-	-	-	
2	SPT	8-10	SM	N/A	9.1	67.7	23.2	-	-	-	-	5.1	
3	BULK	10-14	SM	N/A	39.5	46.7	13.8	X	Non-Plastic			-	
4	SPT	14-15	SM	N/A	22.3	58.6	19.1	-	-	-	-	6.1	
5	BULK	16-18	SM	N/A	31.3	55.1	13.2	X	Non-Plastic			-	
6	SPT	18-19	SM	N/A	20.5	53.1	26.2	-	-	-	-	7.2	
7	BULK	20-23	GP-GM	N/A	47.2	41.3	11.5	-	-	-	-	-	
8	SPT	24-25	-	N/A	-	-	-	-	-	-	-	5.2	
9	BULK	25-28	SM-SC	N/A	32.4	48.1	19.5	-	-	-	-	-	
10	SPT	28-29	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	32-34	SM	N/A	25.3	47.9	26.8	-	-	-	-	-	
12	SPT	34-35	SM	N/A	1.9	57.4	40.7	-	-	-	-	7.5	
13	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	40-43	SM	N/A	27.4	47.5	25.1	-	16	14	2	-	
15	SPT	44-45	SM	N/A	5.5	57.8	36.7	-	-	-	-	8.2	
16	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
17	SPT	48-49	-	N/A	-	-	-	-	-	-	-	3.6	
18	BULK	50-53	SM	N/A	28.2	44.6	27.2	-	16	14	2	-	
19	SPT	54-55	-	N/A	-	-	-	-	-	-	-	14.1	
20	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PL.	W _c (%)	
21	SPT	52-60	-	N/A	-	-	-	-	-	-	-	8.6	
22	BULK	60-63	SM-SC	N/A	27.6	42.9	29.5	-	18	14	4	-	
23	SPT	64-66	ML-CL	N/A	-	-	-	-	20	15	5	9.4	
24	BULK	66-68	SM	N/A	35.6	41.9	27.5	-	-	-	-	-	
25	SPT	68-69	-	N/A	-	-	-	-	-	-	-	-	
26	BULK	70-73	-	N/A	-	-	-	-	-	-	-	-	
27	SPT	74-75	-	N/A	-	-	-	-	-	-	-	-	
28	BULK	75-77	-	N/A	-	-	-	-	-	-	-	-	
29	BULK	81-83	-	N/A	-	-	-	-	-	-	-	-	
30	BULK	83-86	SC	N/A	21.8	43.5	35.0	-	25	14	11	-	
31	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
32	SPT	88-89	-	N/A	-	-	-	-	-	-	-	-	
33	BULK	90-93	-	N/A	-	-	-	-	-	-	-	-	
34	BULK	95-98	-	N/A	-	-	-	-	-	-	-	-	
35	SPT	98-99	-	N/A	-	-	-	-	-	-	-	6.5	
36	BULK	100-103	SM	N/A	39.6	42.0	18.4	X	Non-Plastic			-	
37	BULK	105-108	-	N/A	-	-	-	-	-	-	-	-	
38	SPT	108-109	-	N/A	-	-	-	-	-	-	-	-	
39	BULK	110-113	-	N/A	-	-	-	-	-	-	-	-	
40	BULK	115-118	SM-SC	N/A	31.1	44.6	24.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	LIMITS				
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.	W _c (%)	
41	BULK	118-120	SM	N/A	33.9	50.2	15.9	-	-	-	-	-	
42	BULK	123-128	-	N/A	-	-	-	-	-	-	-	-	
43	SPT	128-129	SC	N/A	6.4	52.4	41.2	-	31	17	14	9.1	
44	BULK	130-135	SM	N/A	26.4	47.8	25.8	-	Non-Plastic			-	
45	BULK	135-138	-	N/A	-	-	-	-	-	-	-	-	
46	SPT	138-139	CL	N/A	-	-	-	-	34	17	17	7.7	
47	BULK	140-145	SL	N/A	22.4	41.3	36.3	X	26	14	12	-	
48	BULK	150-153	SM	N/A	13.3	67.3	19.4	X	Non-Plastic			-	
49	-	-	-	-	-	-	-	-	-	-	-	-	
50	-	-	-	-	-	-	-	-	-	-	-	-	
51	BULK	155-158	SM	N/A	12.2	68.7	19.1	X	Non-Plastic			-	
52	BULK	160-163	-	N/A	-	-	-	-	-	-	-	-	
53	BULK	165-169	SM	N/A	15.3	70.2	14.5	-	Non-Plastic			-	
54	BULK	170-174	-	N/A	-	-	-	-	-	-	-	-	
55	BULK	175-177	SM	N/A	10.2	64.8	25.0	X	Non-Plastic			-	G _S =2.81
56	BULK	180-181	SW-SM	N/A	40.1	51.8	8.1	X	17	14	3	-	G _S =2.77
57	BULK	185-188	SM	N/A	9.0	72.6	18.4	X	Non-Plastic			-	
58	BULK	190-195	CL-ML	N/A	16.4	31.6	52.0	X	23	17	6	-	G _S =2.82
59	BULK	195-198	-	N/A	-	-	-	-	-	-	-	-	
60	BULK	200-204	CL	N/A	0.0	21.7	78.3	X	29	19	10	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
61	BULK	205-208	SM-SC	N/A	6.3	46.8	-	22	18	4	-		
62	SPT	208-209	SM	N/A	7.4	75.6	17.0	-	-	-	-	13.2	
63	BULK	210-215	SW-SM	N/A	17.5	73.5	9.0	-	Non-Plastic			-	
64	BULK	215-218	SP-SM	N/A	0.7	89.4	9.4	-	-	-	-	-	
65	SPT	218-219	SM	N/A	0.0	86.8	13.2	-	-	-	-	-	
66	BULK	222-225	-	N/A	-	-	-	-	-	-	-	-	
67	BULK	225-228	SM	N/A	13.6	68.1	18.3	-	Non-Plastic			-	
68	SPT	228-229	SM	N/A	0.0	55.5	44.5	-	-	-	-	20.5	
69	BULK	230-235	SM	N/A	14.2	66.7	19.1	-	-	-	-	-	
70	BULK	235-238	-	N/A	-	-	-	-	-	-	-	-	
71	SPT	238-239	SM	N/A	13.8	68.7	17.5	-	-	-	-	6.1	
72	BULK	240-245	SM	N/A	29.5	52.0	18.5	-	-	-	-	-	
73	BULK	245-248	-	N/A	-	-	-	-	-	-	-	-	
74	SPT	248	SM	N/A	37.6	53.6	8.9	-	-	-	-	-	
75	BULK	250-255	SM	N/A	27.8	56.3	15.9	-	-	-	-	-	
76	BULK	255-258	-	N/A	-	-	-	-	-	-	-	-	
77	-	-	-	-	-	-	-	-	-	-	-	-	
78	BULK	258-261	SM	N/A	32.5	45.7	21.8	-	Non-Plastic			-	
79	BULK	261-269	-	N/A	-	-	-	-	-	-	-	-	
80	SPT	268	SM	N/A	23.9	63.8	12.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.	W _c (%)	
81	BULK	268-271	SM	N/A	37.2	50.6	12.2	-	Non-Plastic			-	
82	BULK	274-278	-	N/A	-	-	-	-	-	-	-	-	
83	SPT	278-279	-	N/A	-	-	-	-	-	-	-	-	
84	BULK	278-281	SM	N/A	21.8	64.3	13.9	X	-	-	-	-	G _s =2.74
85	BULK	282-286	-	N/A	-	-	-	-	-	-	-	-	
86	BULK	286-288	SP-SM	N/A	39.4	50.2	10.8	-	Non-Plastic			-	
87	BULK	288-292	-	N/A	-	-	-	-	-	-	-	-	
88	BULK	295-298	SP-SM	N/A	35.3	54.0	10.7	-	-	-	-	-	
89	SPT	298	-	N/A	-	-	-	-	-	-	-	-	
90	BULK	298-302	-	N/A	-	-	-	-	-	-	-	-	
91	BULK	302-307	GP-GM	N/A	47.5	42.1	10.4	X	Non-Plastic			-	
92	BULK	307-308	SM	N/A	31.2	47.7	21.1	X	Non-Plastic			-	
93	SPT	308-309	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-53

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.		
				COBBLE	GRAVEL	SAND	SILT/CLAY					W _c (%)	
1A	BULK	10-19	SM	0.0	13.4	73.2	13.4	-	-	-	-	-	
1	BULK	19-22	SM	0.0	18.3	53.6	28.1	-	16	16	0	-	
2		-	-	-	-	-	-	-	-	-	-	-	
3	BULK	30-32	SC-SM	0.0	27.2	31.9	40.4	X	22	16	6	-	G _S =2.72
4	BULK	36-38	SC	0.0	30.6	33.6	35.8	X	25	15	10	-	
5	SPT	38-39	GC	0.0	39.3	25.7	35.0	X	36	17	19	12.6	
6	BULK	45-47	SC-SM	0.0	28.2	43.5	28.3	X	20	14	6	-	G _S =2.71
7	BULK	57-58	-	-	-	-	-	-	-	-	-	-	
8	BULK	60-62	SC	15.8	26.4	35.4	22.4	-	24	15	9	-	
9	BULK	66-68	-	-	-	-	-	-	-	-	-	-	
10	BULK	70-72	SC	0.0	33.2	40.6	26.2	X	21	13	8	-	
11	BULK	66-68	-	-	-	-	-	-	-	-	-	-	
12	BULK	80-82	SC	0.0	29.3	44.1	26.6	-	19	11	8	-	
13	BULK	86-88	-	-	-	-	-	-	-	-	-	-	
14	BULK	90-92	SC	0.0	40.1	41.8	18.1	-	22	14	8	-	
15	BULK	96-98	-	-	-	-	-	-	-	-	-	-	
16	BULK	100-102	GC	0.0	36.4	34.3	29.3	-	22	14	8	-	
17	BULK	106-108	-	-	-	-	-	-	-	-	-	-	
18	BULK	110-112	GC	0.0	42.4	27.9	29.7	-	25	16	9	-	
19	BULK	116-118	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-53

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-53

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-53

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

WW#3

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	3-5	SM	0.0	20.9	51.6	27.5	-	-	-	-	-	
2	BULK	8-10	SM	0.0	24.6	44.2	31.2	-	-	-	-	-	
3	BULK	13-15	SM	0.0	16.9	44.2	33.9	-	Non-Plastic			-	
4	BULK	18-20	SM	0.0	8.8	48.5	42.7	-	-	-	-	-	
5	BULK	23-25	-	-	-	-	-	-	-	-	-	-	
6	BULK	28-30	SM	4.8	31.3	41.6	22.3	-	-	-	-	-	
7	BULK	33-35	SM-SC	0.0	28.6	43.4	28.0	-	19	14	5	-	
					17.8	49.4	32.8						
8	BULK	38-40	SM-SC	0.0	19.5	47.8	32.7	-	18	14	4	-	G _S =2.72
					16.3	46.8	36.9						
9	BULK	43-45	SM	0.0	15.1	45.8	39.1	-	-	-	-	-	
10	BULK	48-50	SM	0.0	17.1	53.2	29.7	-	-	-	-	-	
11	BULK	50-51	SM	4.0	17.3	39.5	39.2	-	-	-	-	-	
12	BULK	57	SM	0.0	8.2	53.3	38.5	-	-	-	-	-	
13	BULK	60-61	SM	0.0	24.8	45.8	29.4	-	-	-	-	-	
14	BULK	70-71	SM	0.0	12.2	38.8	49.8	-	-	-	-	-	
15	BULK	78-79	ML	0.0	1.1	10.6	88.3	-	-	-	-	-	
16	BULK	82-83	ML	0.0	2.5	26.7	70.8	-	-	-	-	-	
17	BULK	88-89	SM	0.0	23.7	40.1	36.2	-	-	-	-	-	
18	BULK	93-94	SM	0.0	4.4	46.3	49.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

WW#3

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
19	BULK	98-99	SM	0.0	27.2	24.8	43.0	-	-	-	-	-	
20	BULK	103-104	GM	0.0	41.4	38.9	19.7	-	-	-	-	-	
21	BULK	108-109	SM	0.0	25.0	43.7	31.3	-	-	-	-	-	
22	BULK	112-113	SM	0.0	19.8	45.5	34.7	-	-	-	-	-	
23	BULK	118-117	SM	0.0	5.1	61.6	33.3	-	-	-	-	-	
24	BULK	123-124	SM	16.9	18.7	44.8	19.6	-	-	-	-	-	
25	BULK	128-129	GM	0.0	40.4	39.2	20.4	-	-	-	-	-	
26	BULK	134-135	SM	0.0	27.6	53.4	19.0	-	-	-	-	-	
27	BULK	137-138	GP-GM	0.0	64.4	30.3	5.4	-	-	-	-	-	
28	BULK	143-144	CL	-	-	-	-	-	43	23	20	-	
29	BULK	156-157	ML	0.0	1.1	43.5	55.4	-	-	-	-	-	
30	BULK	157 ⁵	ML	0.0	0.3	39.1	57.4	-	-	-	-	-	
31	BULK	159-160	SM	0.0	19.1	72.4	18.5	-	-	-	-	-	
32	BULK	161-162	SM	0.0	17.7	51.0	31.3	-	-	-	-	-	
33	BULK	164-167	GP	0.0	48.3	46.8	4.9	-	-	-	-	-	
			GM	0.0	47.8	37.7	14.7	-	-	-	-	-	
34	BULK	174-175	-	-	-	-	-	-	-	-	-	-	
35	BULK	175-176	-	-	-	-	-	-	-	-	-	-	
36	BULK	176-177	-	-	-	-	-	-	-	-	-	-	
37	BULK	177-178	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

WW# 3

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

3. GRADATION CURVES

3.1 River Channel

3.1.1 Main Dam

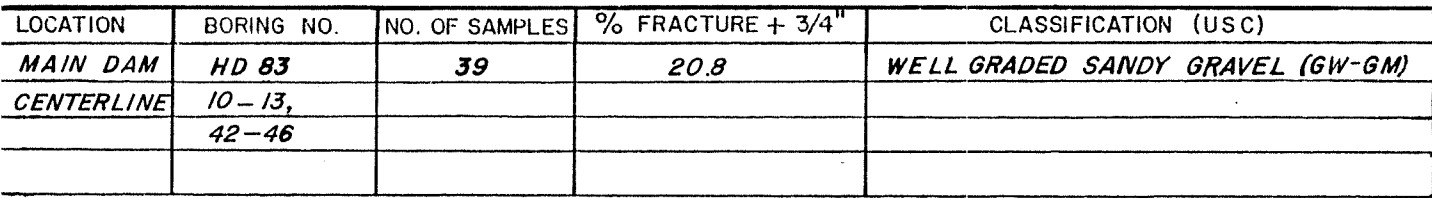
3.1.2 Upstream Cofferdam

3.1.3 Downstream Cofferdam

3.1.4 Portals

3.2 Relict Channel

3.1 RIVER CHANNEL

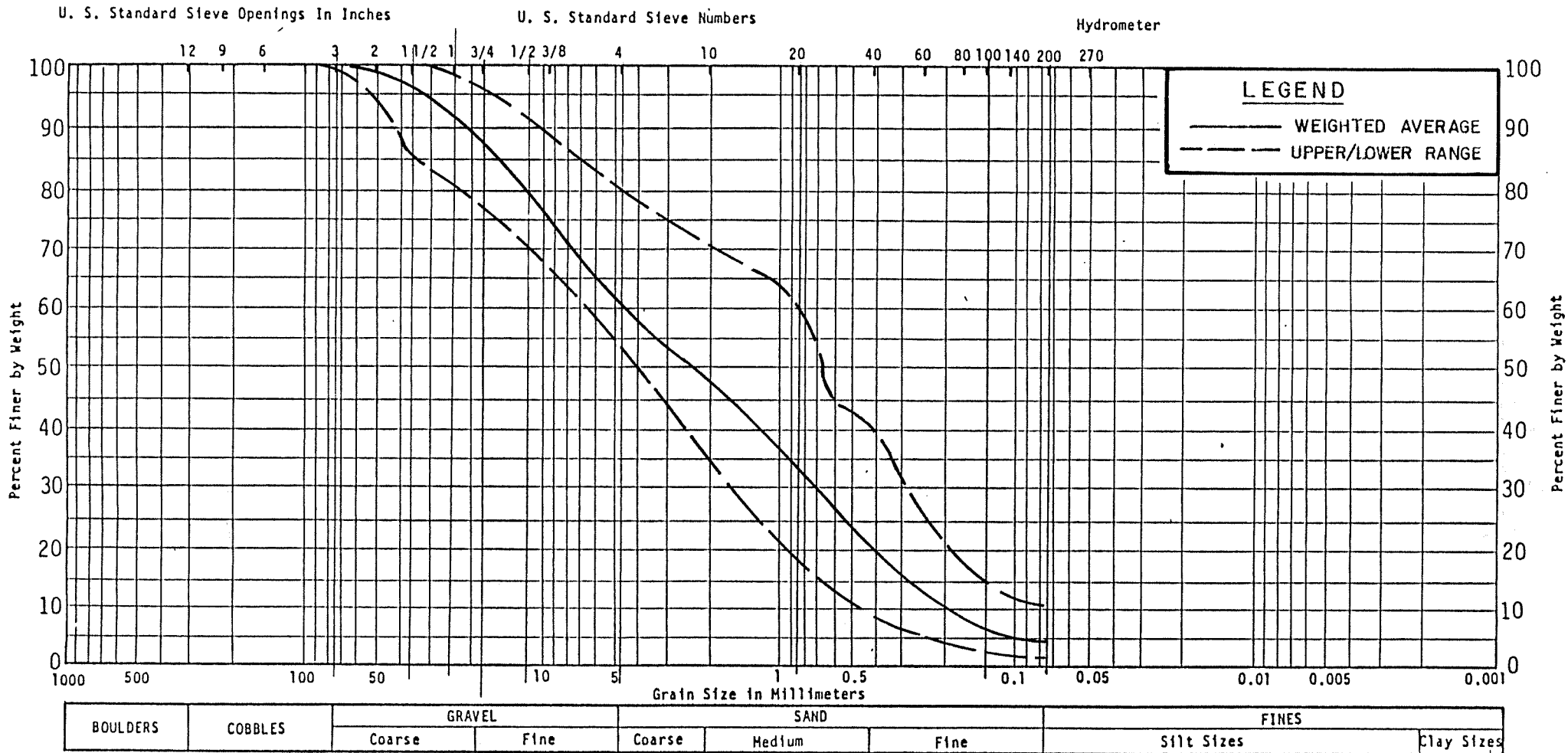


RIVER CHANNEL
DAM AXIS FDN.AREA
SANDY GRAVEL GRADATION

FIGURE
D1

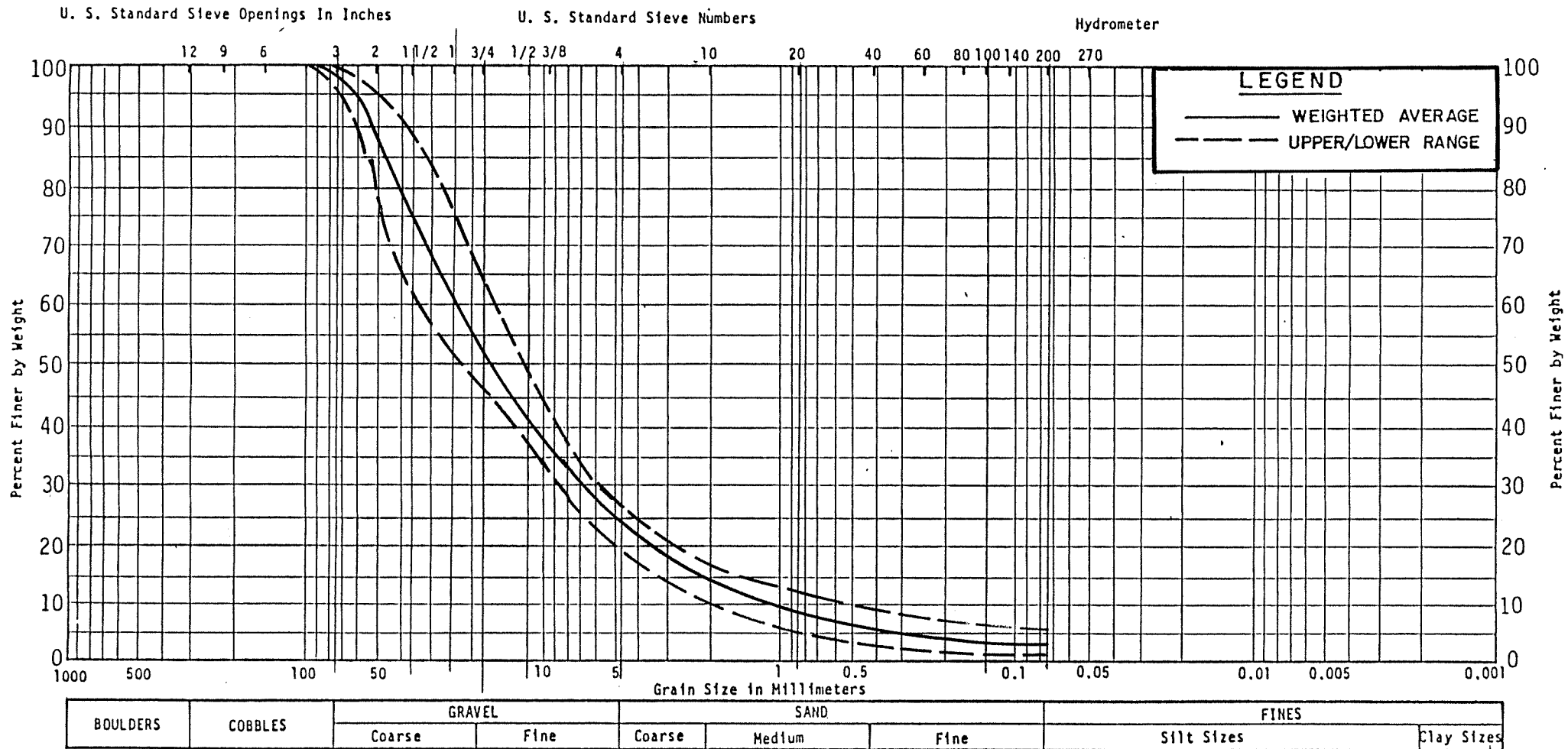
COMMENT: 48' OF SAMPLE

GRADATION SIZE ANALYSIS



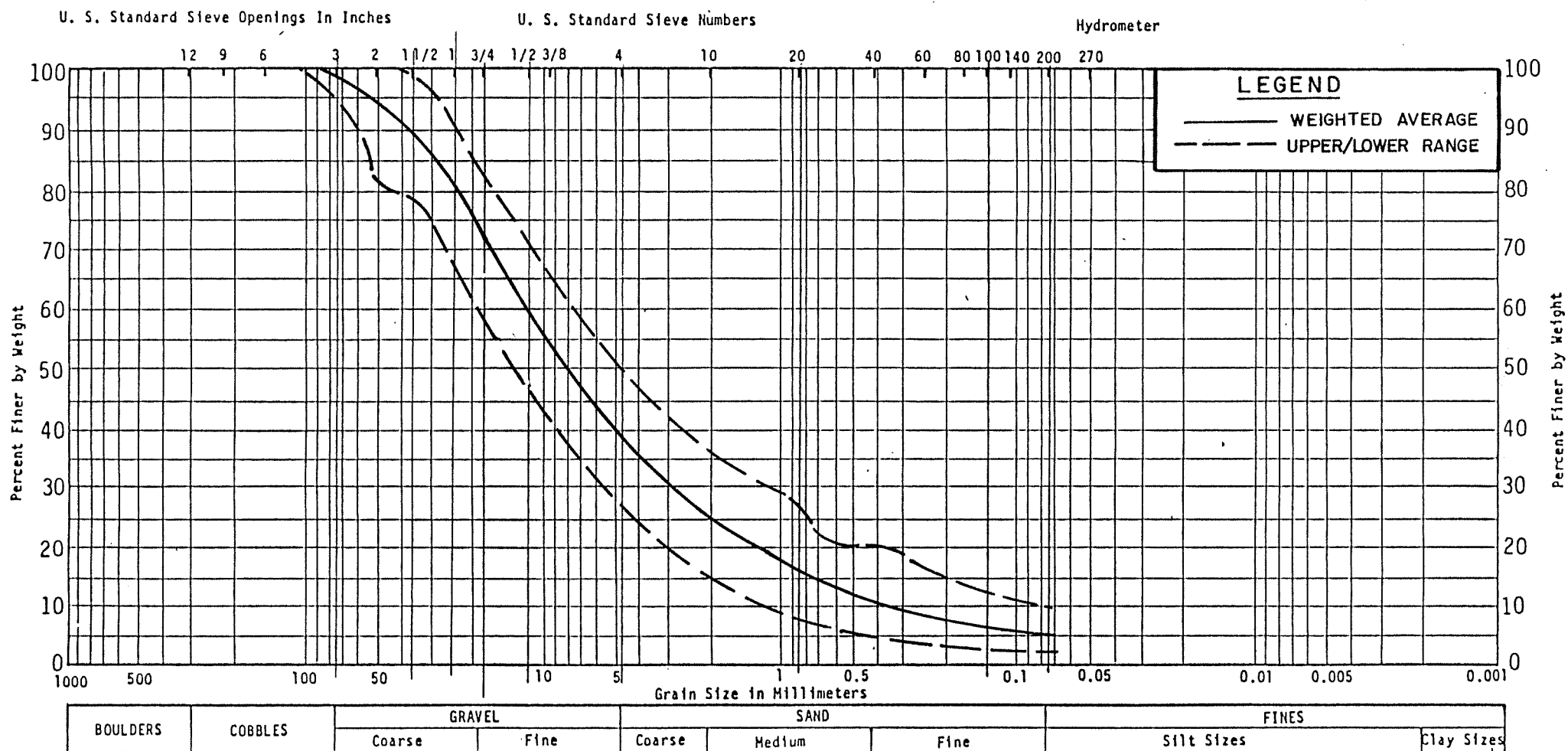
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL DAM AXIS FDN. AREA GRAV. SAND GRADATION		
MAIN DAM	HD 83 10,	18	12.8	POORLY GRADED GRAVELLY SAND,			
CENTERLINE	11, 13, 42-45			(SP-SM)			
COMMENT: 72' OF SAMPLE					HARZA-ERSSCO SUSITNA JOINT VENTURE		
					DATE AUG 1983		
					FIGURE D2		

GRADATION SIZE ANALYSIS



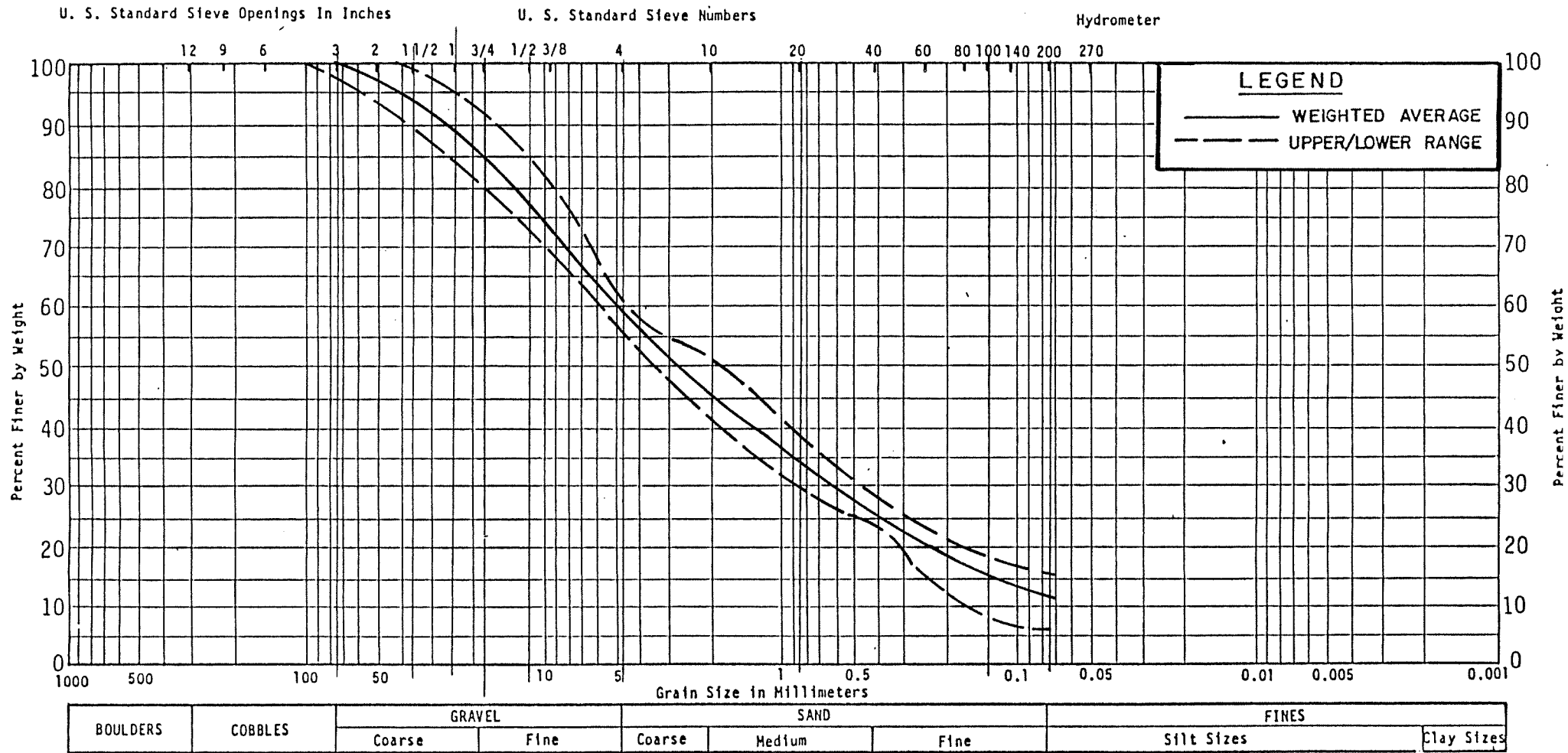
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL AREA U/S OF DAM AXIS GRAVEL GRADATION	
UPSTREAM SHELL	HD 83-37 & 38	10	39.4	WELL GRADED GRAVEL, (GW)		
COMMENT: 41' OF SAMPLE					HARRIS-ERASCO SUSITNA JOINT VENTURE	DATE AUG 1983
					FIGURE D3	

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
UPSTREAM	HD 83-37-39	25	23.5	WELL GRADED SANDY GRAVEL,	SUSITNA HYDROELECTRIC PROJECT		
SHELL				(GW-GM)	WATANA DEVELOPMENT		
					RIVER CHANNEL		
					AREA U/S OF DAM AXIS		
					SANDY GRAVEL GRADATION		
COMMENT: 97' OF SAMPLE					WATANA-EMESCO	DATE AUG 1983	FIGURE D4
					SUSITNA JOINT VENTURE		

GRADATION SIZE ANALYSIS



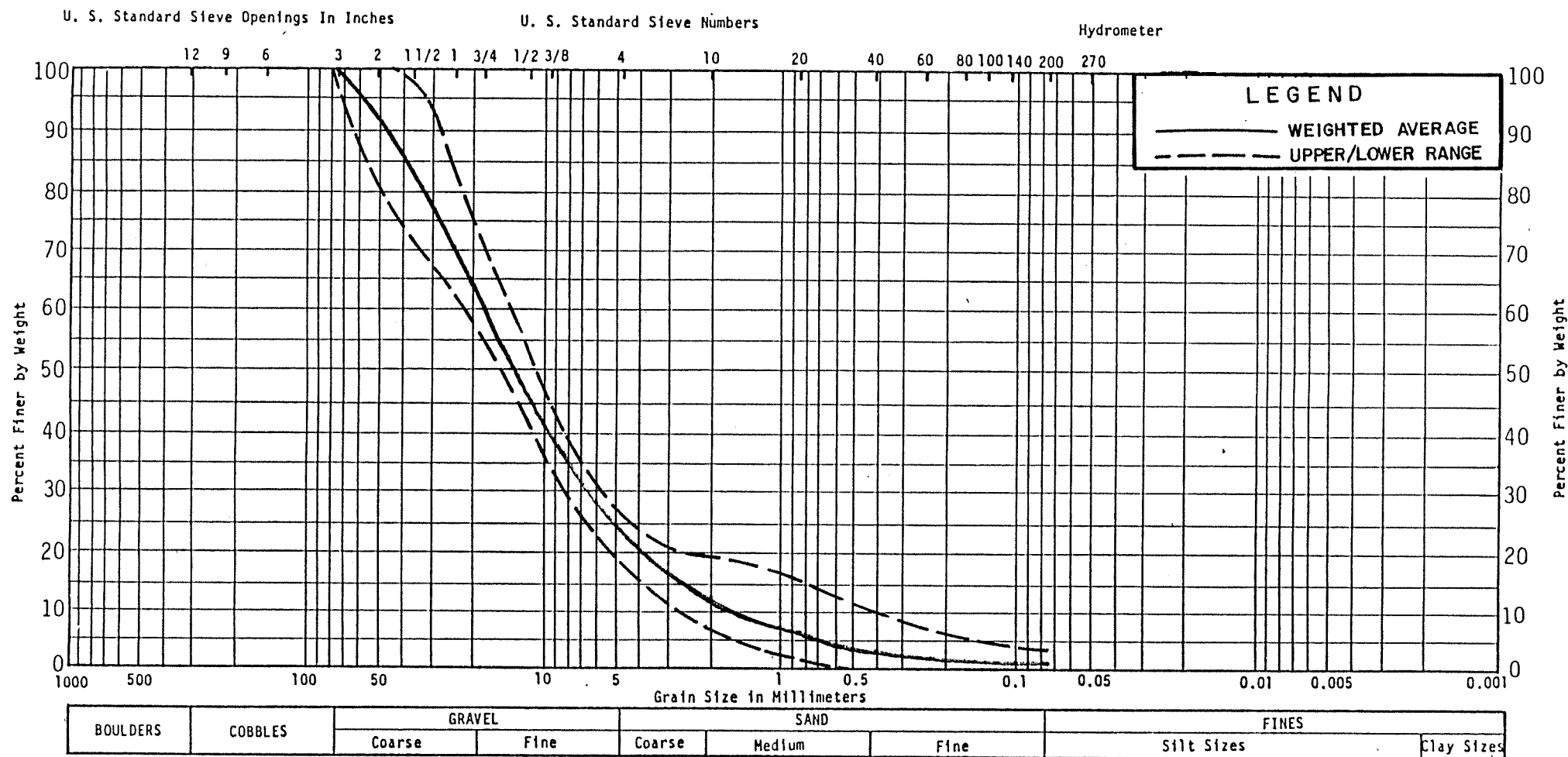
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83- 38, 39	3	15.6	WELL GRADED GRAVELLY SAND,
SHELL				(SM)

COMMENT: 9' OF SAMPLE

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
AREA U/S OF DAM AXIS
GRAVELLY SAND GRADATION

11612A-ECASCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D5
--	------------------	--------------

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83- 17, 19,	7	30.8	WELL GRADED GRAVEL, (GW)
COFFERDAM	20, 21, & 22			

COMMENT: 24' OF SAMPLE

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT

RIVER CHANNEL

U/S COFFERDAM FDN.

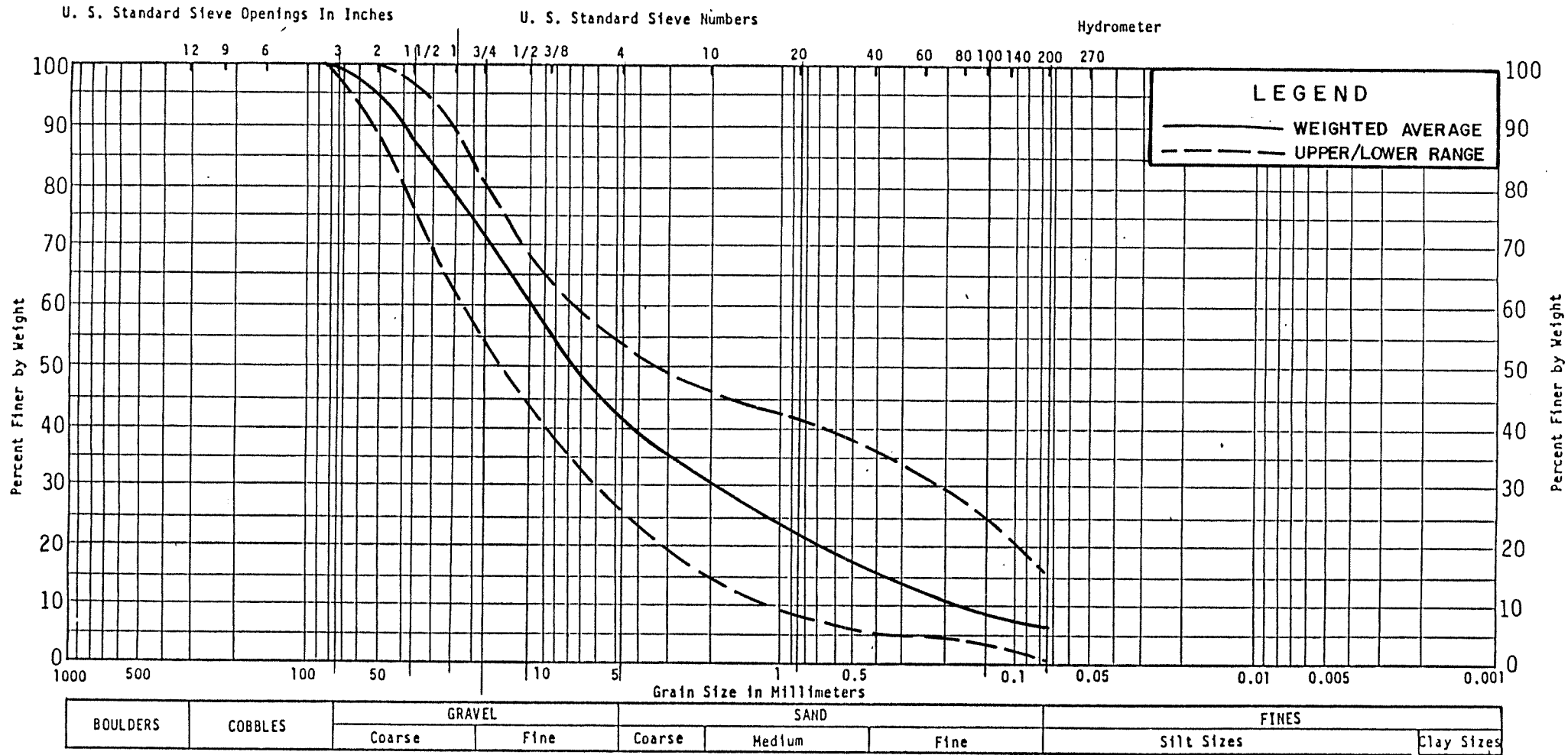
GRAVEL GRADATION

WATANA-EMSCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

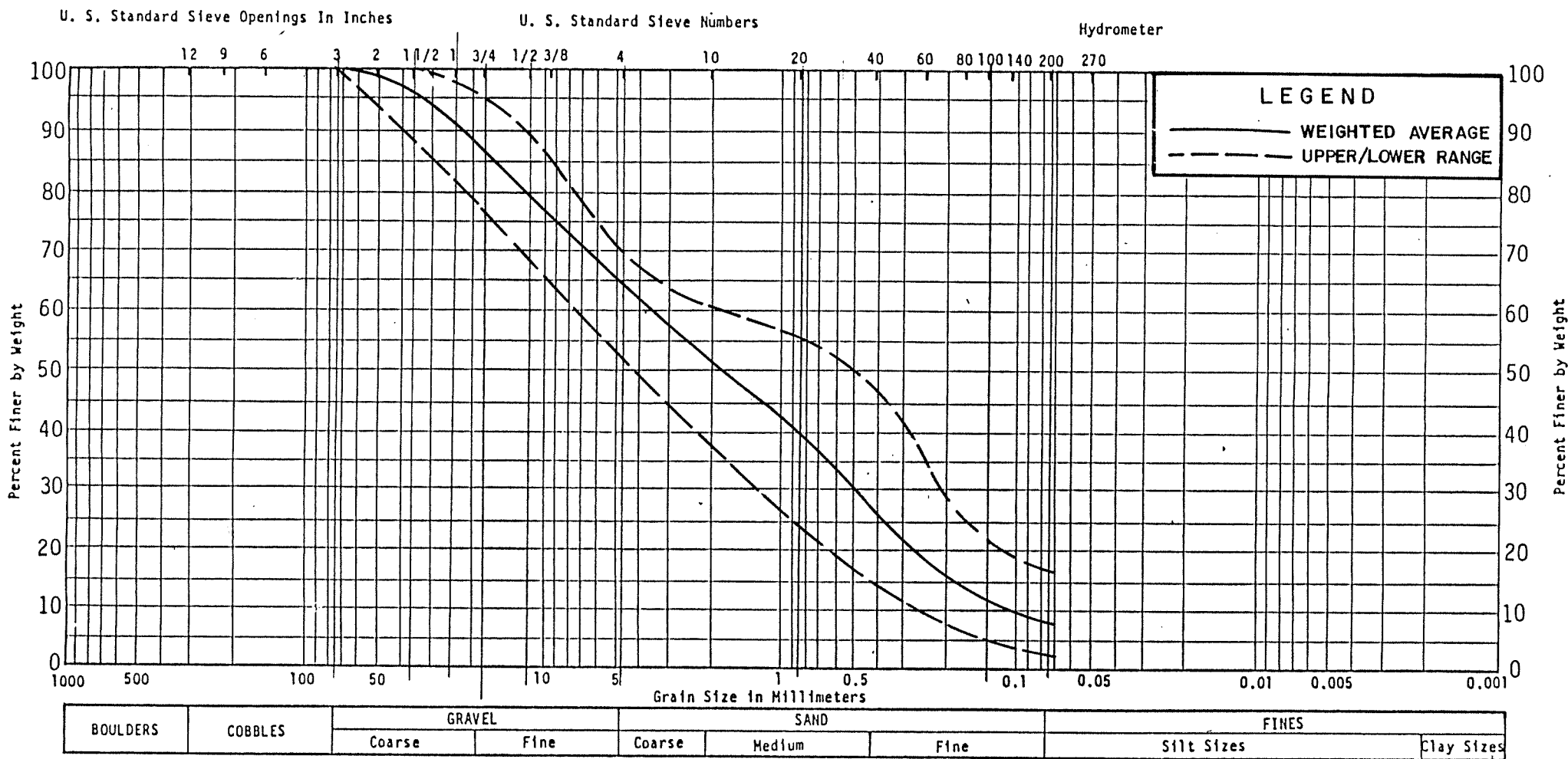
FIGURE
D6

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL U/S COFFERDAM FDN SANDY GRAVEL GRADATION			
UPSTREAM	HD 83-17-23	32	25.1	WELL GRADED SANDY GRAVEL,				
COFFERDAM	41			(GW-GM)				
COMMENT: 99' OF SAMPLE					HAZILA-ERASCO	DATE	FIGURE	
					SUSITNA JOINT VENTURE	AUG 1983	D7	

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83-	18	11.2	POORLY GRADED GRAVELLY SAND
COFFERDAM	17-23, & 41			(SP - SM)

COMMENT: 47' OF SAMPLE

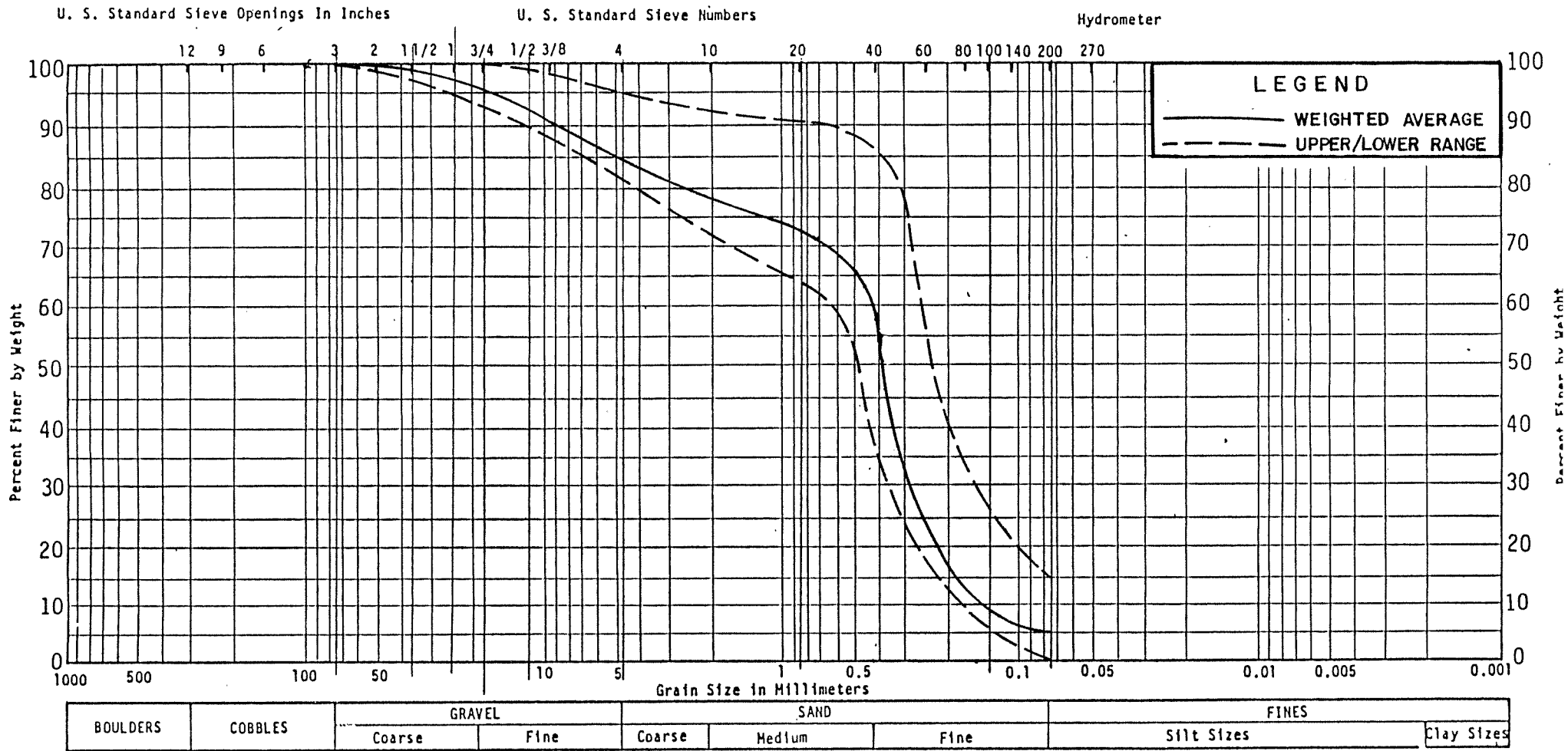
ALASKA POWER AUTHORITY
 SUSITNA HYDROELECTRIC PROJECT
 WATANA DEVELOPMENT
RIVER CHANNEL
U/S COFFERDAM FDN.
GRAVELLY SAND GRADATION

HANNA-ERABCO
 SUSITNA JOINT VENTURE

DATE
 AUG 1983

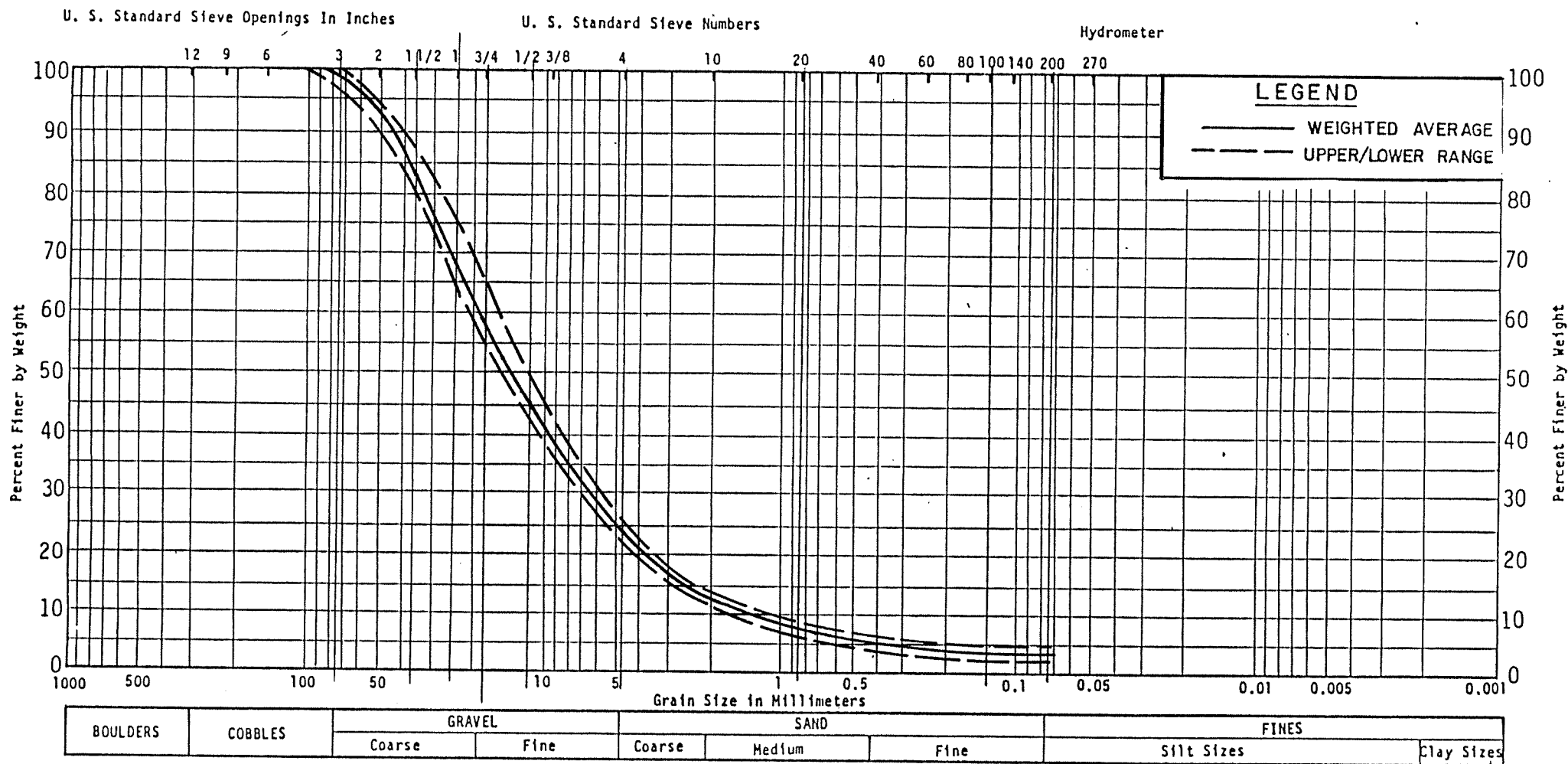
FIGURE
 D8

GRADATION SIZE ANALYSIS



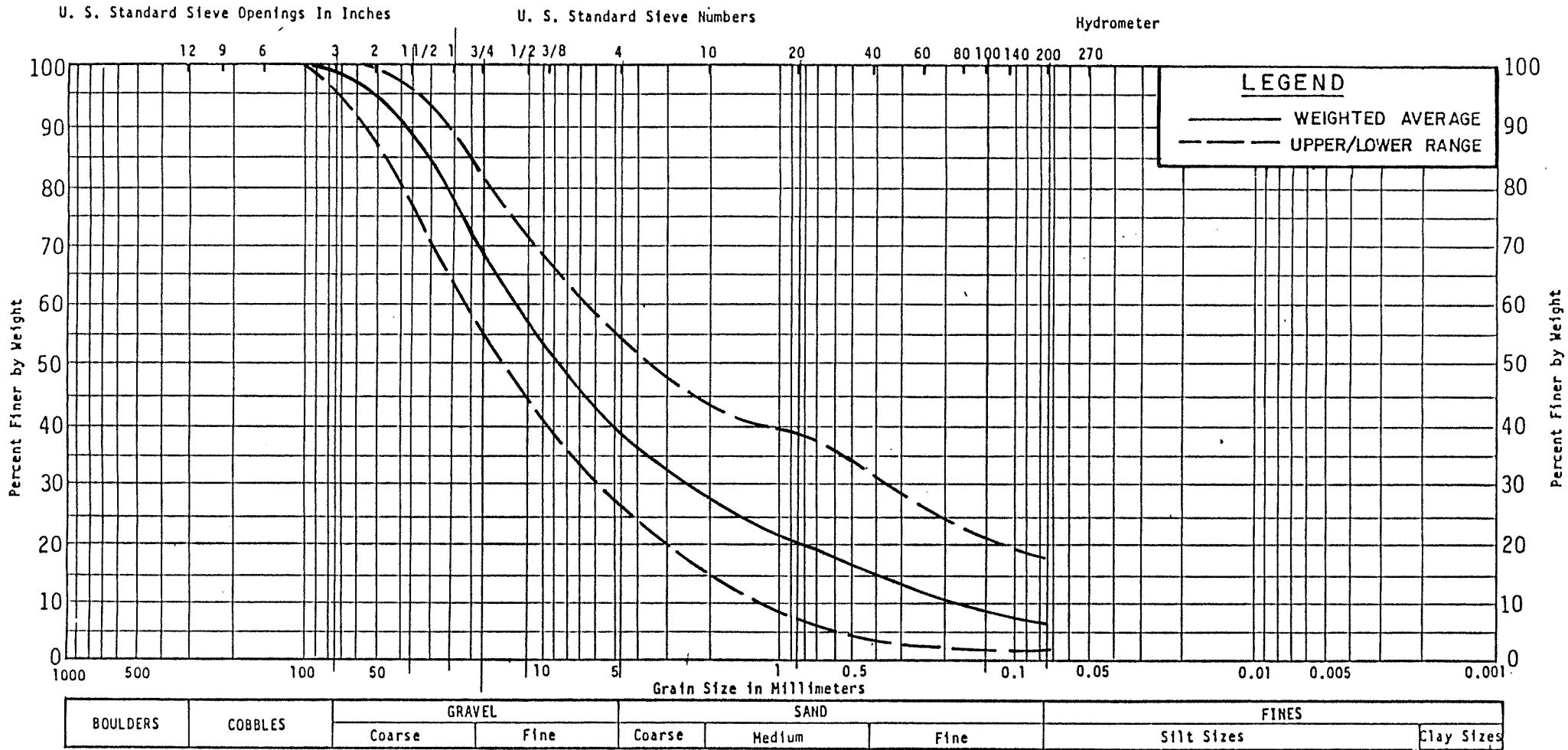
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL U/S COFFERDAM FDN. SAND GRADATION		
UPSTREAM	HD 83-19 & 21	4	3.7	POORLY GRADED SAND, (SP - SM)			
COFFERDAM							
COMMENT: 8' OF SAMPLE							

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL D/S COFFERDAM FDN. GRAVEL GRADATION			
DOWNSTREAM	HD 83-27,	3	37.4	WELL GRADED GRAVEL, (GW)				
COFFERDAM	29, & 31							
COMMENT: 8' OF SAMPLE					HARZA-ERASSCO SUSITNA JOINT VENTURE			
					DATE AUG 1983		FIGURE D10	

GRADATION SIZE ANALYSIS

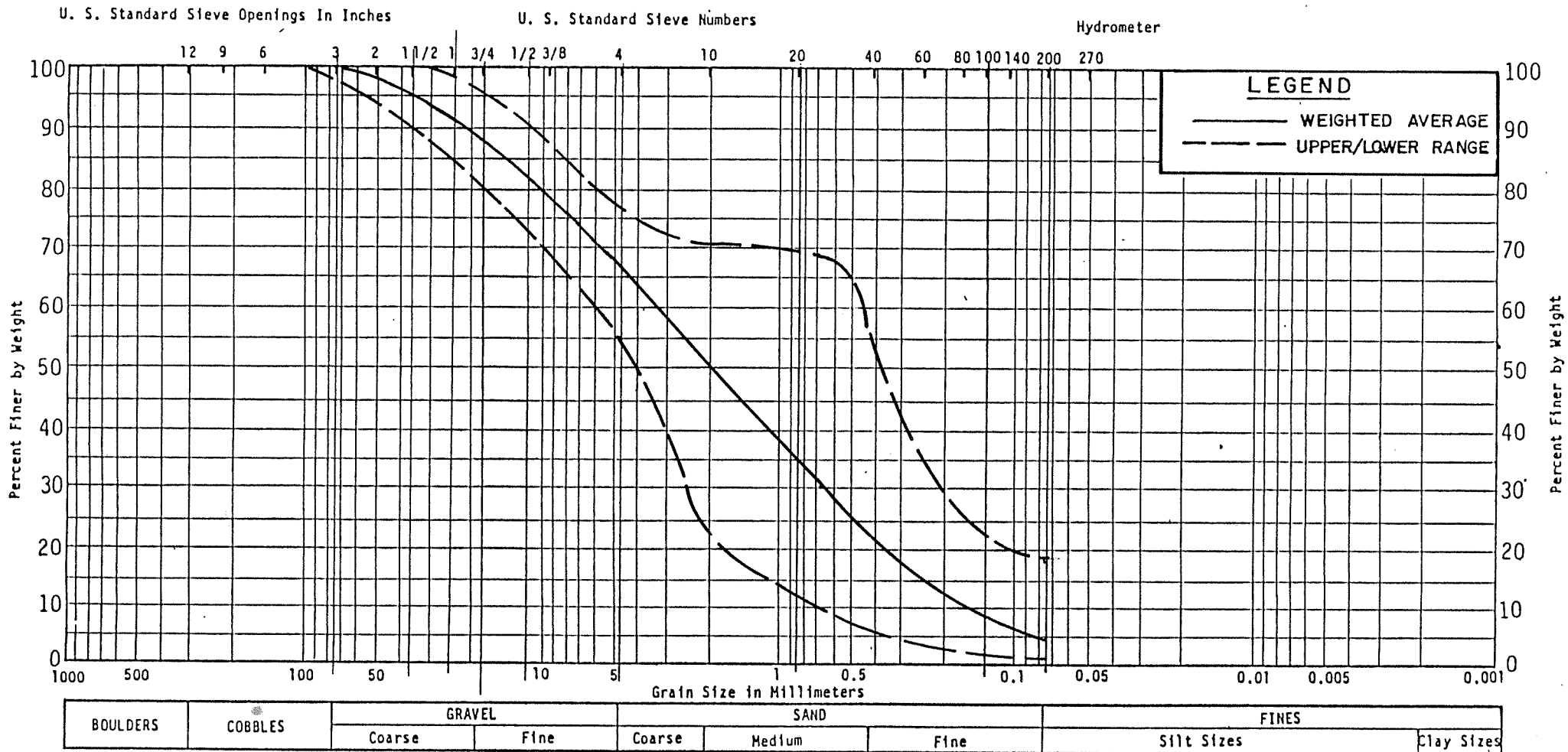


LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-24	40	28.0	POORLY GRADED SANDY GRAVEL,
COFFERDAM	31, & 47			(GW-GM)

COMMENT: 138' OF SAMPLE

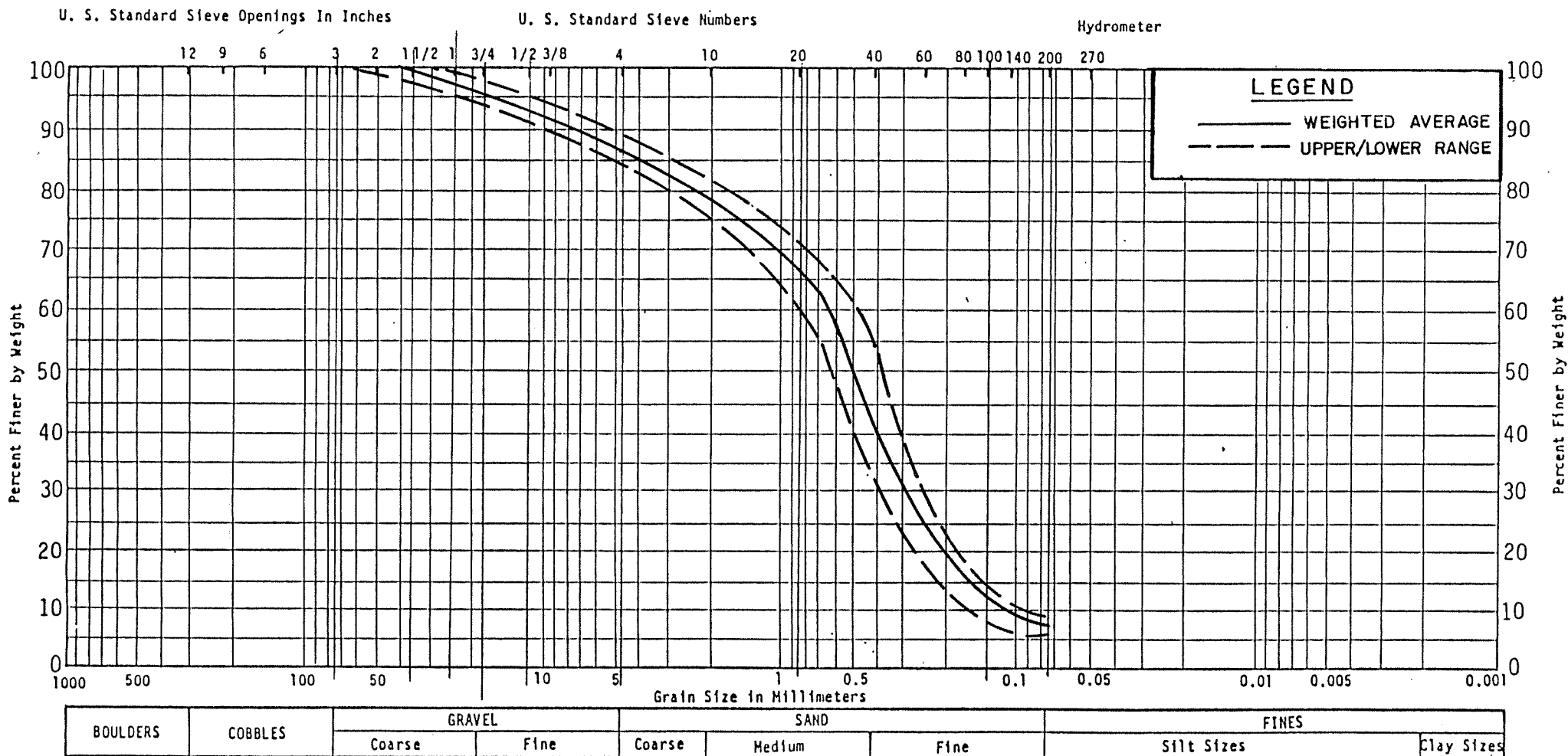
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
D/S COFFERDAM FDN.
SANDY GRAVEL GRADATION
HAZAL-ERASCO SUSITNA JOINT VENTURE
DATE AUG 1983
FIGURE D11

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL D/S COFFERDAM FDN GRAVELLY SAND GRADATION	
DOWNSTREAM	HD 83- 25,	11	8.6	POORLY GRADED GRAVELLY SAND,		
COFFERDAM	26, 28, 30, 31,			(SP - SM)		
	47					
COMMENT: 38' OF SAMPLE					HAZARD-ERASCO	DATE
					SUSITNA JOINT VENTURE	AUG 1983
						FIGURE
						D12

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-28, 47	2	3.8	POORLY GRADED SAND,
COFFERDAM				(SP - SM)

COMMENT: 2' OF SAMPLE

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT

RIVER CHANNEL

D/S COFFERDAM FDN.

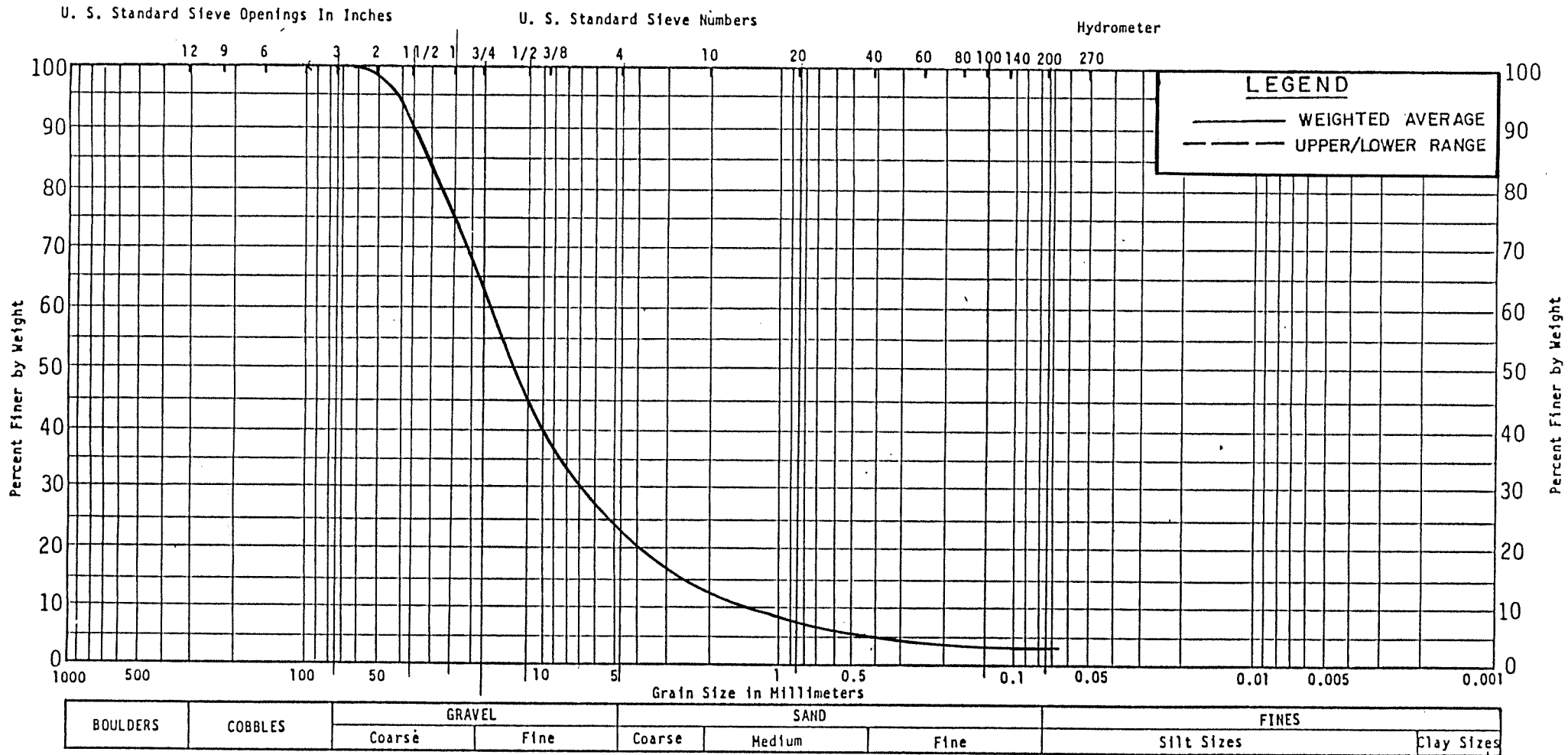
SAND GRADATION

HARZA-ENASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
.D13

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-32	1	29.9	WELL GRADED GRAVEL, (GW)
PORTAL				

COMMENT: 3' OF SAMPLE

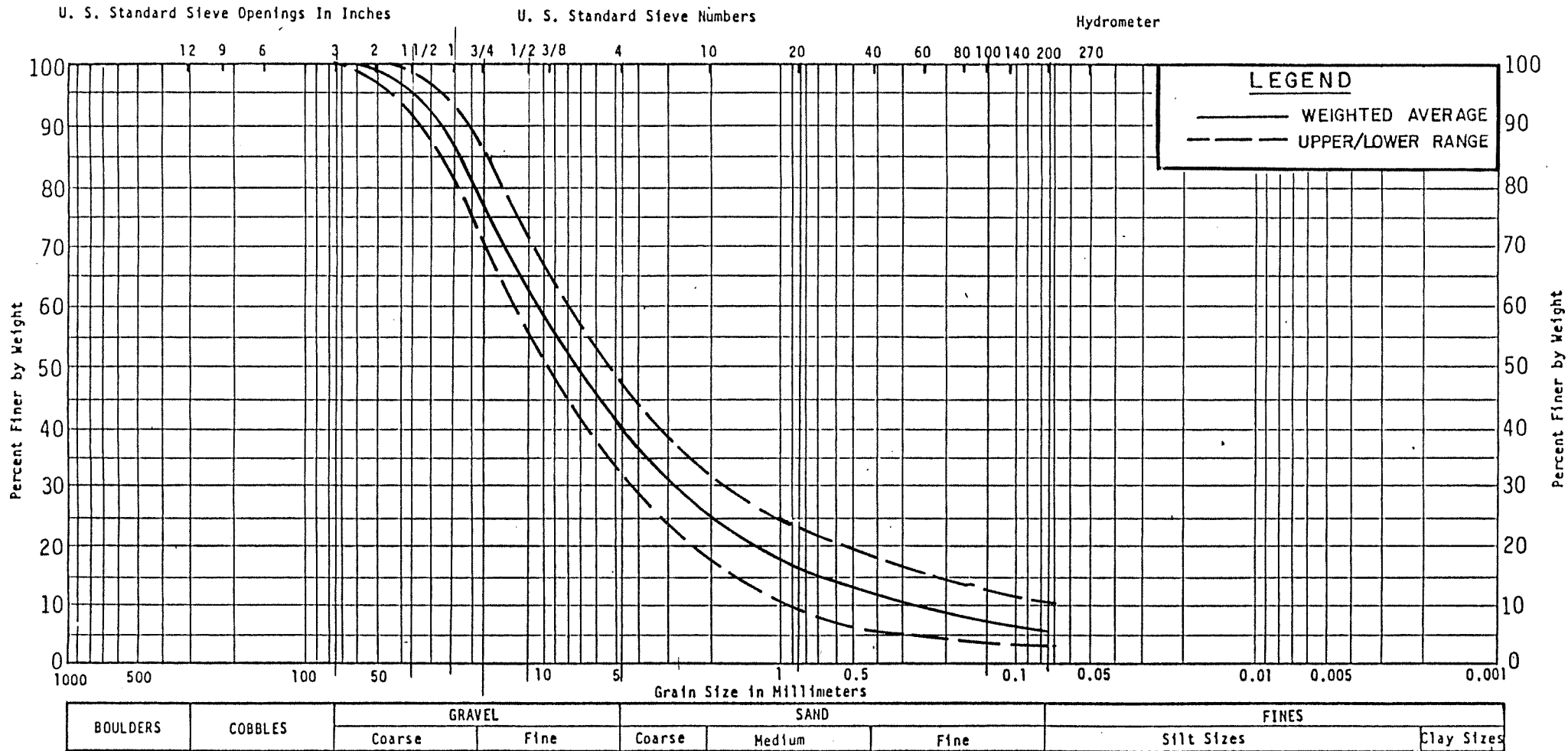
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
D/S PORTAL AREA
GRAVEL GRADATION

HARZA-ESABCO
SUSITNA JOINT VENTURE

DATE
AUG1983

FIGURE
D14

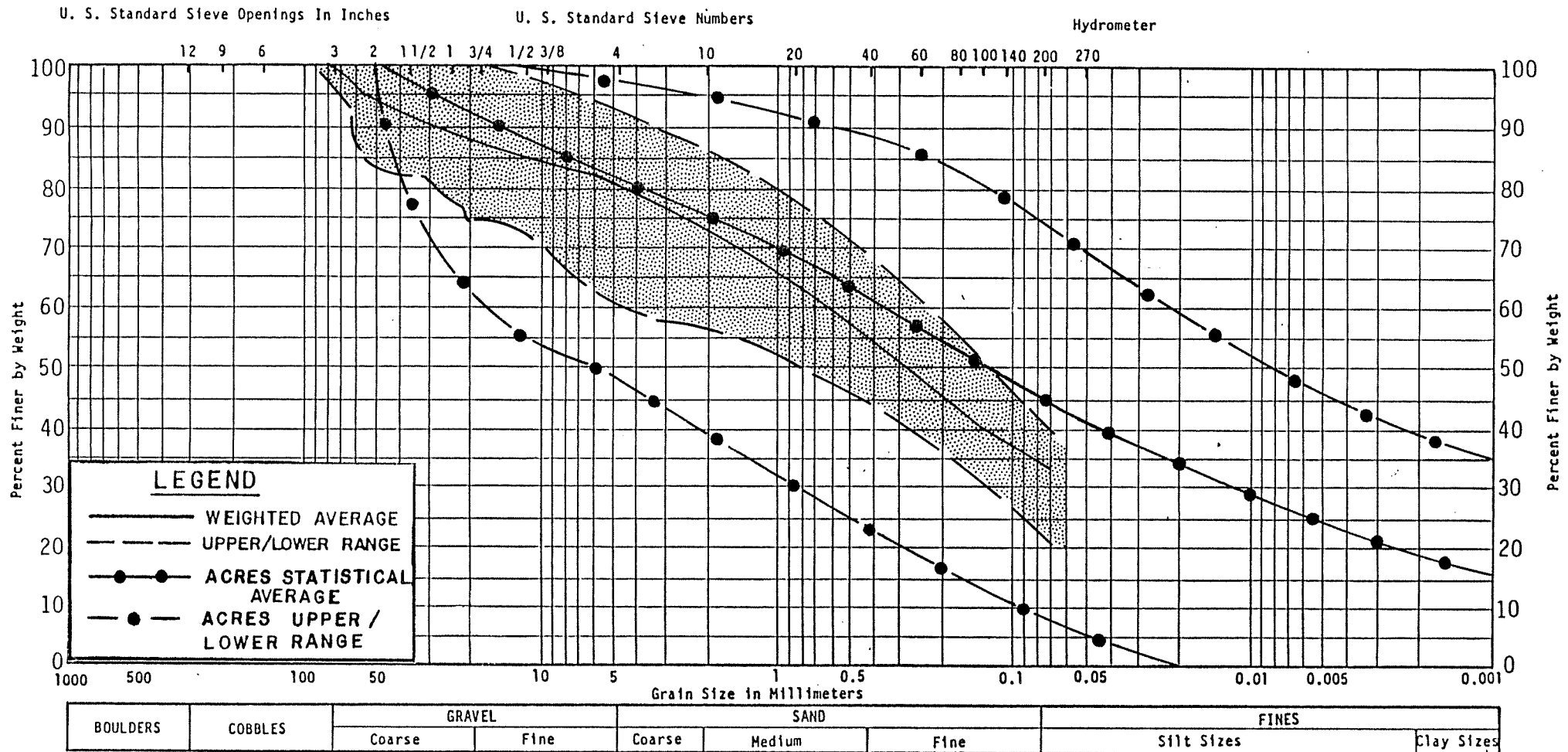
GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL D/S PORTAL AREA SANDY GRAVEL GRADATION	
DOWNSTREAM	HD 83-32-34	5	21.5	WELL GRADED SANDY GRAVEL, (GW-GM)		
PORTAL						
COMMENT: 16' OF SAMPLES					HAZA-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983
					FIGURE D15	

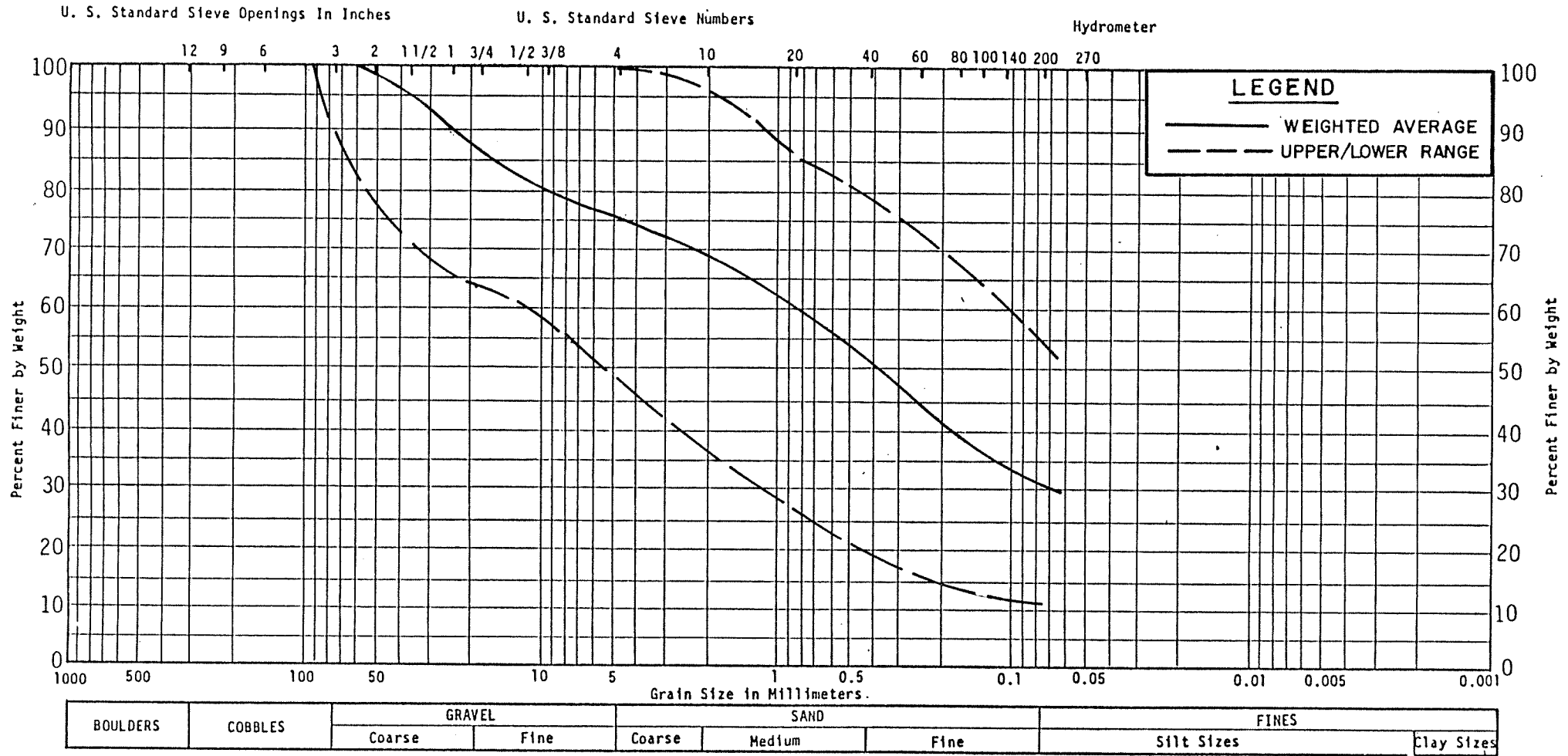
3.2 RELICT CHANNEL

GRADATION SIZE ANALYSIS



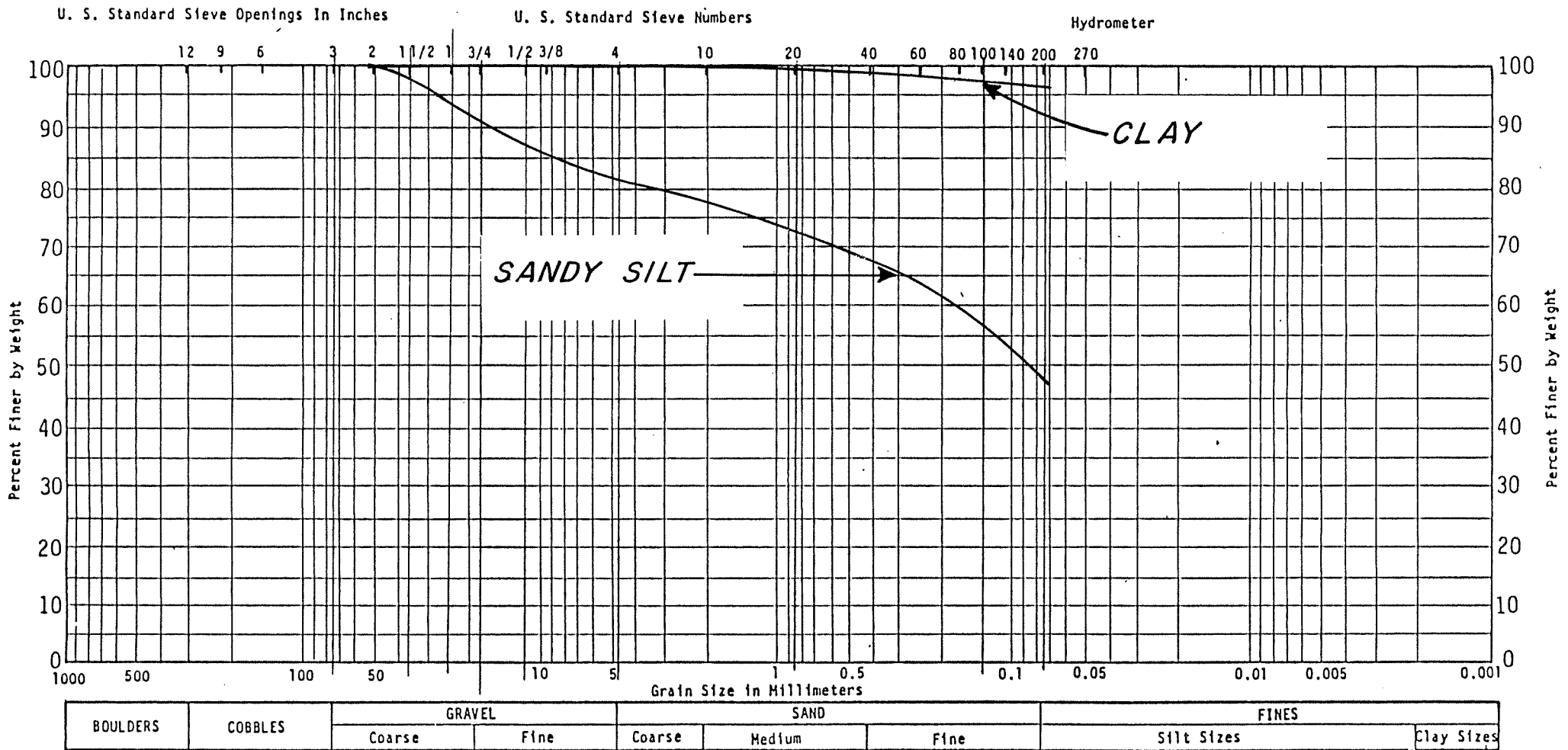
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
WW-3	8	13	SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL.		
				UNIT M GRADATION RANGE		
				SILTY SAND		
				HAZEL-EMSCO	DATE AUG 1983	FIGURE D 16

GRADATION SIZE ANALYSIS



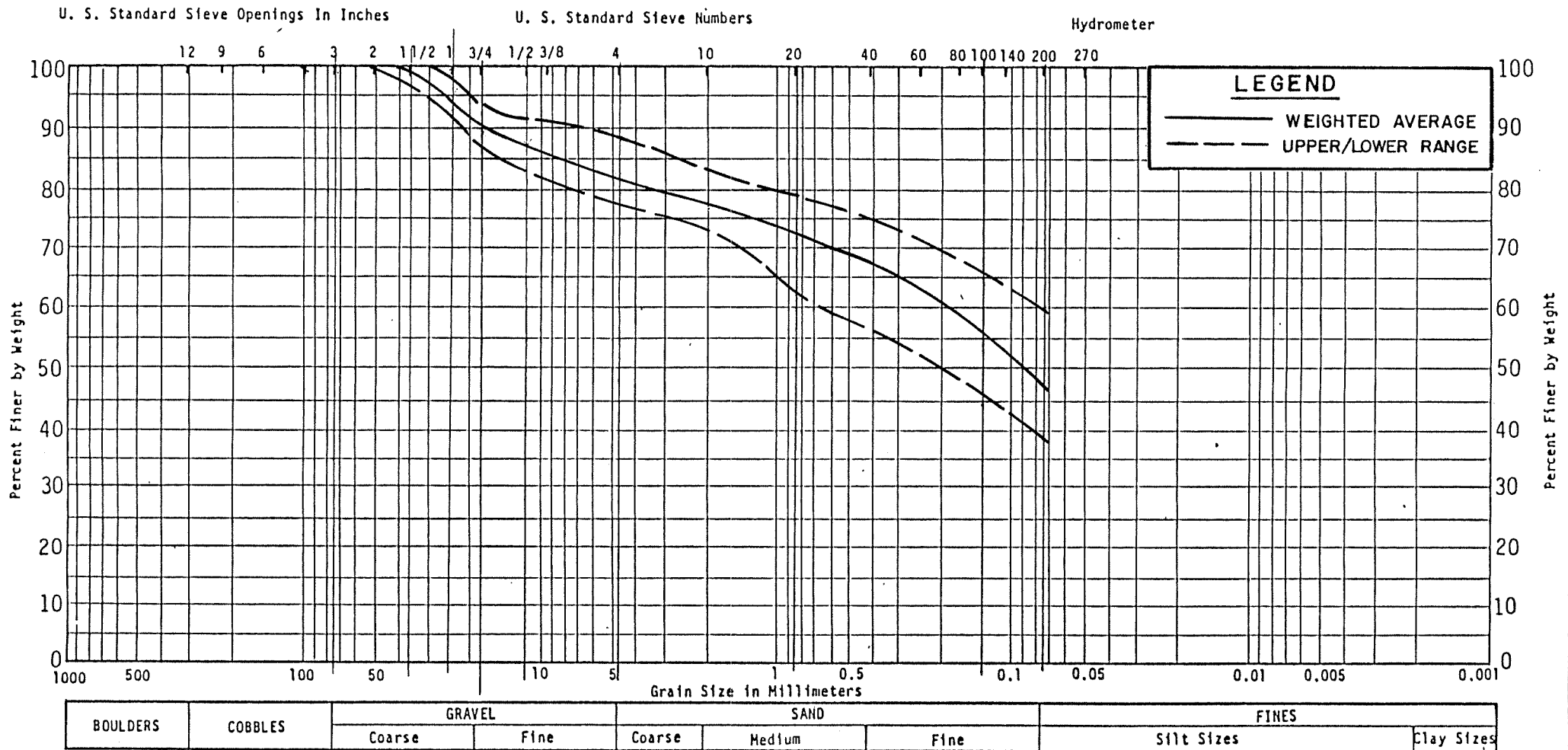
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY				
HD83-1,3,4,6,9	91	223		SUSITNA HYDROELECTRIC PROJECT				
				WATANA DEVELOPMENT				
				RELICT CHANNEL				
				UNIT G GRADATION RANGE				
				SILTY GRAVELLY SAND				
				HAZEL-ERABCO	DATE	FIGURE		
				SUSITNA JOINT VENTURE	AUG 1983	D 17		

GRADATION SIZE ANALYSIS



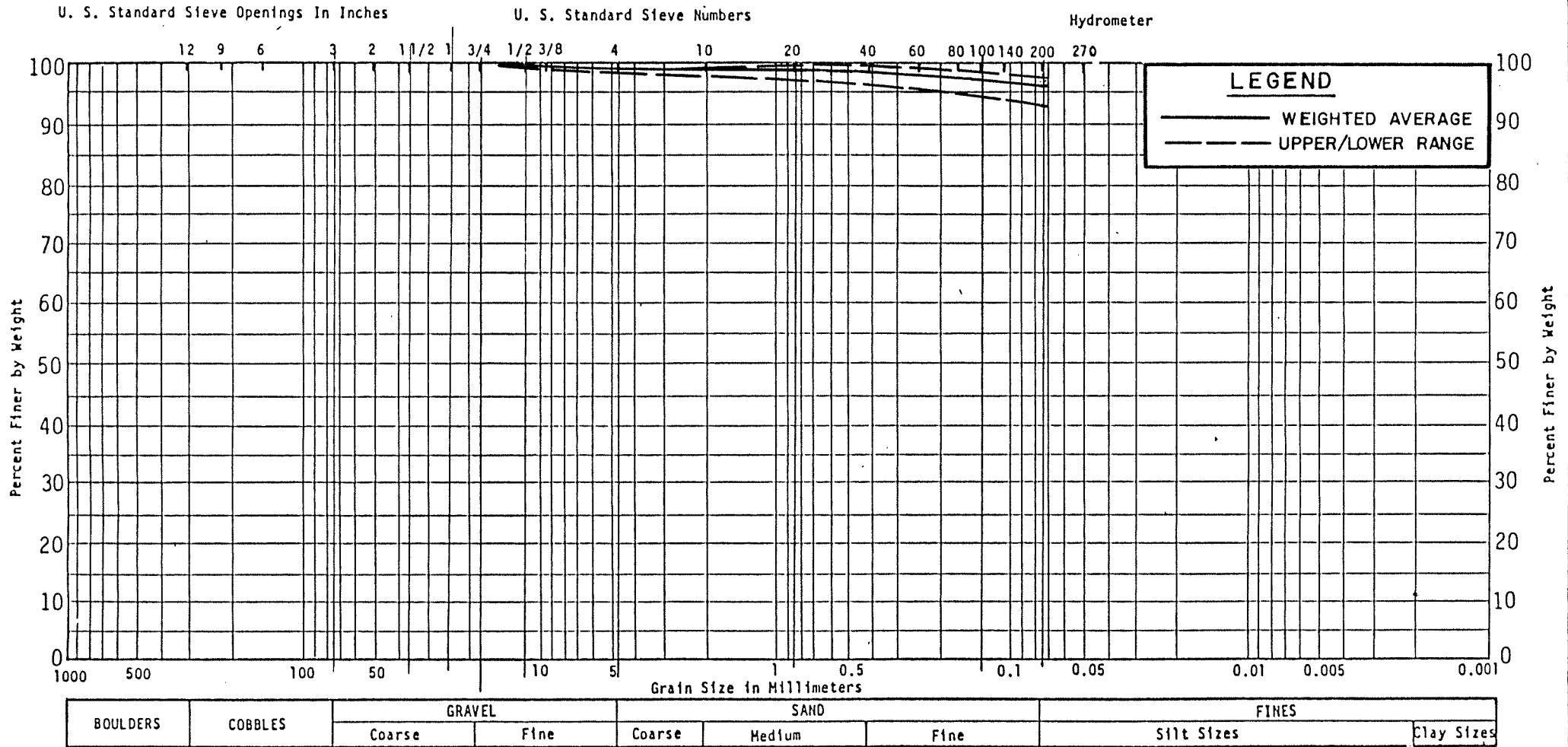
MATERIALS	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY				
SANDY SILT	4	6	50	SUSITNA HYDROELECTRIC PROJECT				
CLAY	4	6	50	WATANA DEVELOPMENT				
TOTALS	8	12	100	RELICT CHANNEL				
				UNIT J GRADATION SUMMARY				
				MARIA-ESABCO				
				DATE				
				AUG 1983				
				FIGURE				
				D18				

GRADATION SIZE ANALYSIS



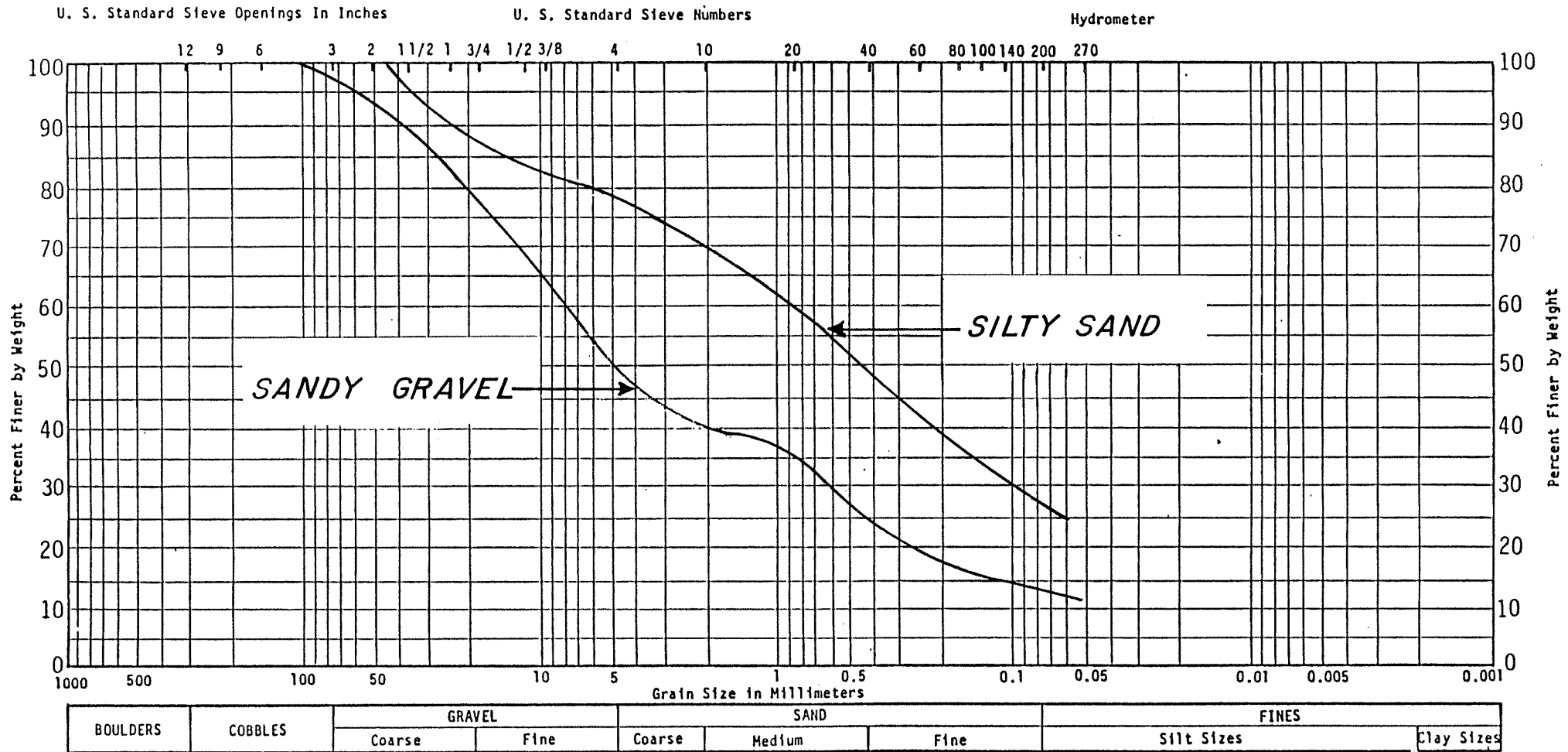
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1	4	6	SANDY SILT, (SM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT J GRADATION RANGE		
				SANDY SILT		
				HAZEL-ESABCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D 19

GRADATION SIZE ANALYSIS

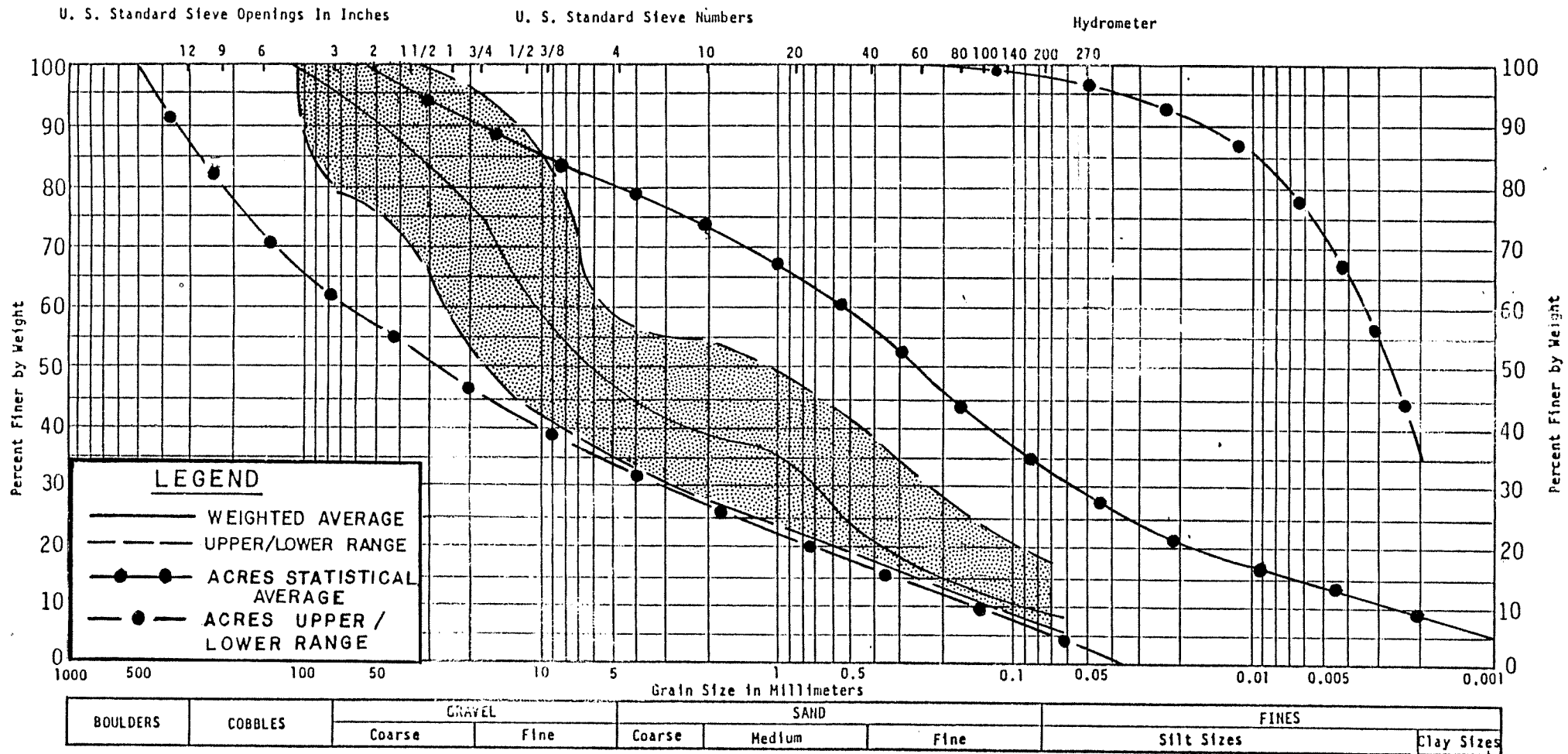


BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY			
HD83-1	4	6	CLAY, (CL)	SUSITNA HYDROELECTRIC PROJECT			
				WATANA DEVELOPMENT			
				RELICT CHANNEL			
				UNIT J GRADATION RANGE			
				LEAN CLAY			
				HEGRI-ERASCO	DATE	FIGURE	
				SUSITNA JOINT VENTURE	AUG 1983	D20	

GRADATION SIZE ANALYSIS

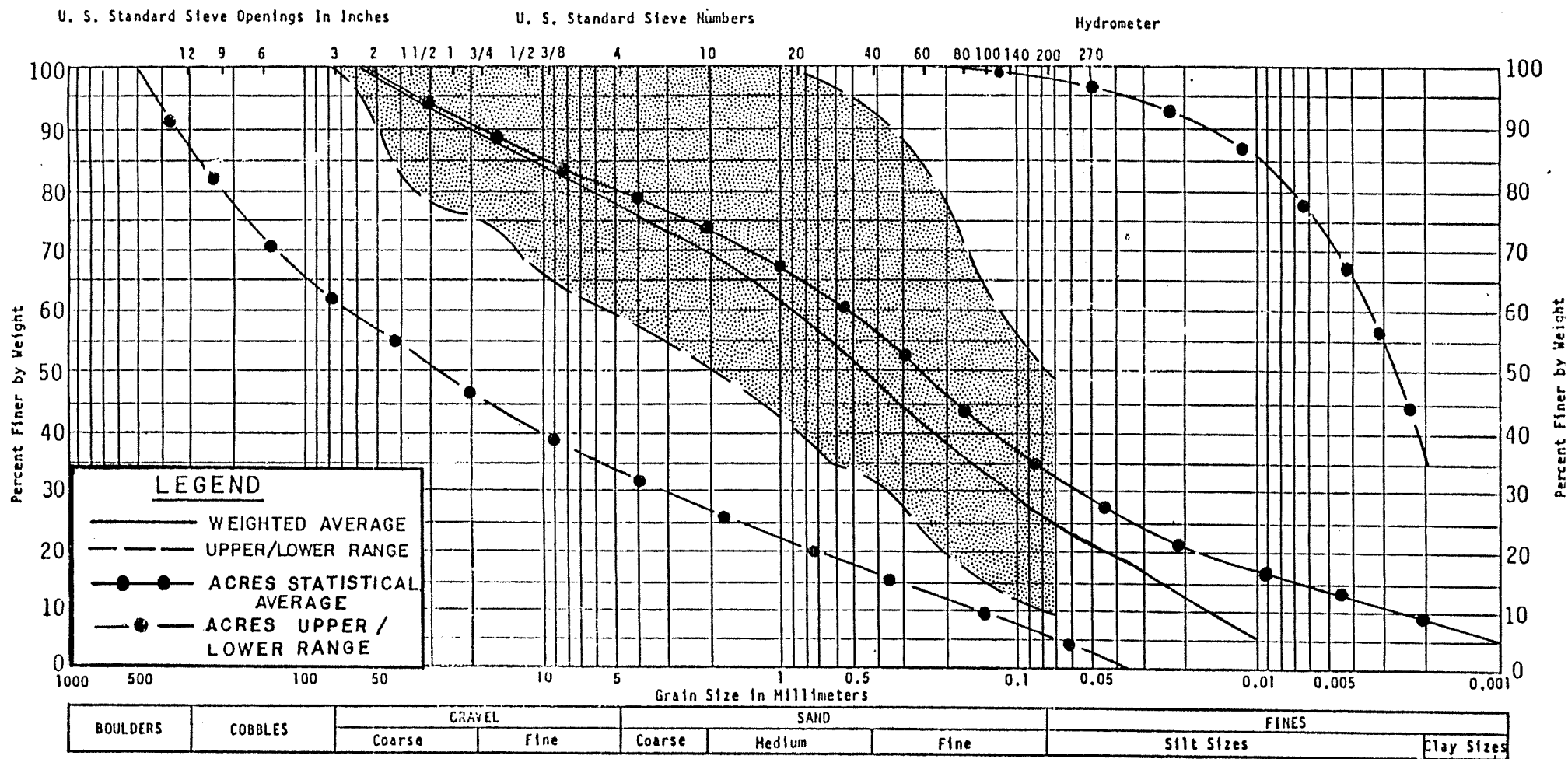


GRADATION SIZE ANALYSIS



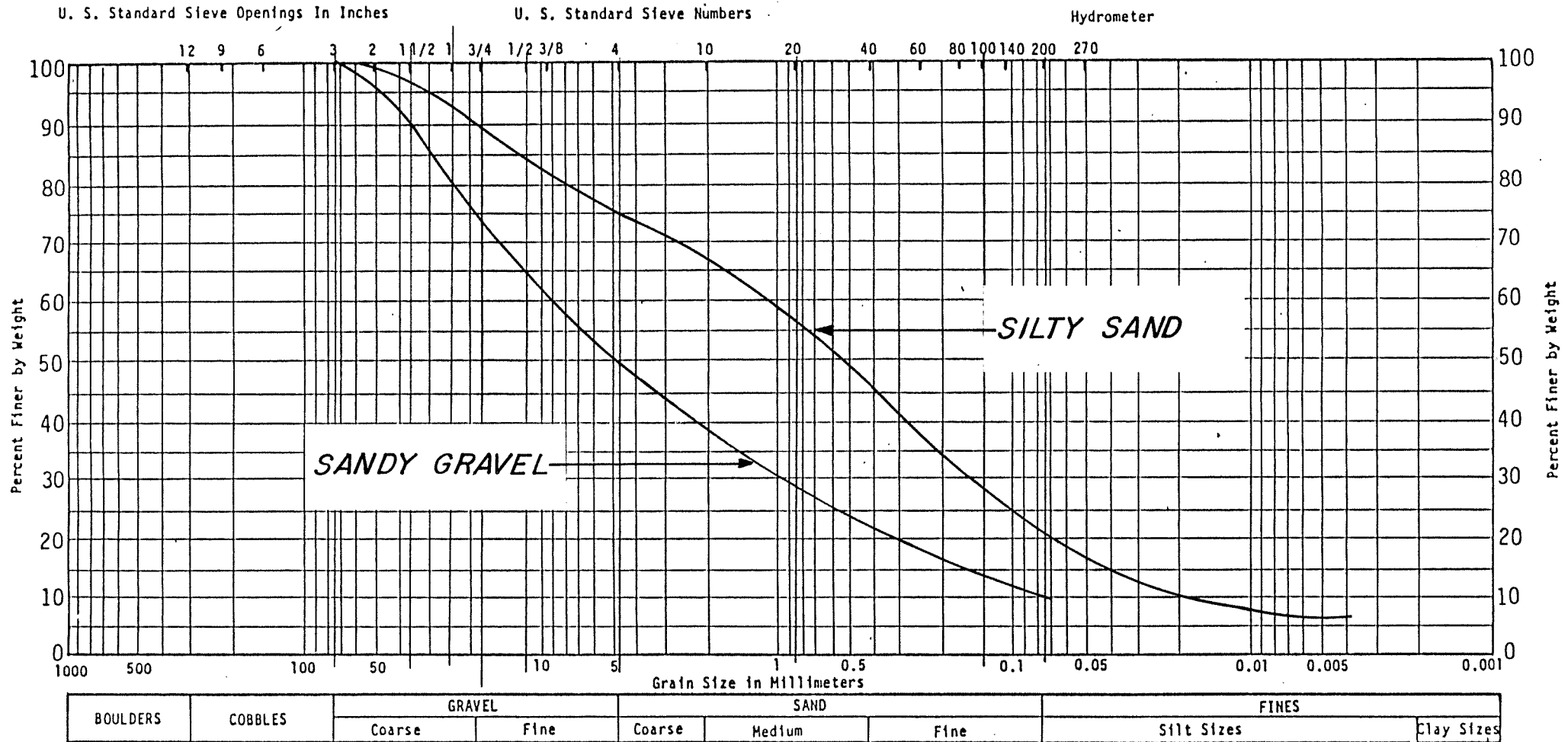
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT E/F GRADATION RANGE SANDY GRAVEL	
H.D. 83-2, 4, 9, 49,	10	26	SANDY GRAVEL (GP/GM)		
52, & WW-3					
				HANZA-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983
					FIGURE D22

GRADATION SIZE ANALYSIS



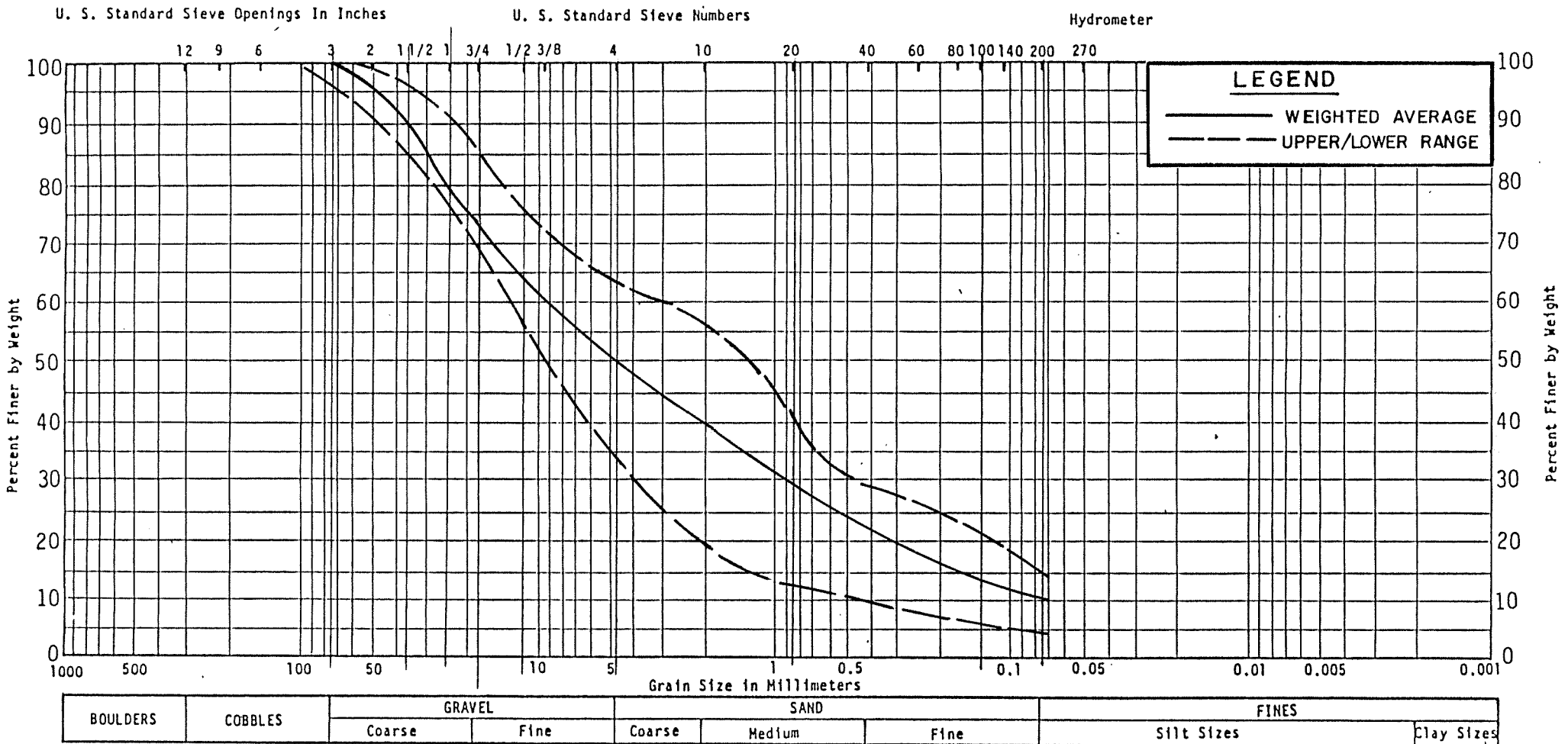
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD 83-1,2,4,5,8,	35	73	SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT		
9,50-52 BW-3				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT E/F GRADATION RANGE		
				SILTY SAND		
				USNIA-EMSCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D23

GRADATION SIZE ANALYSIS



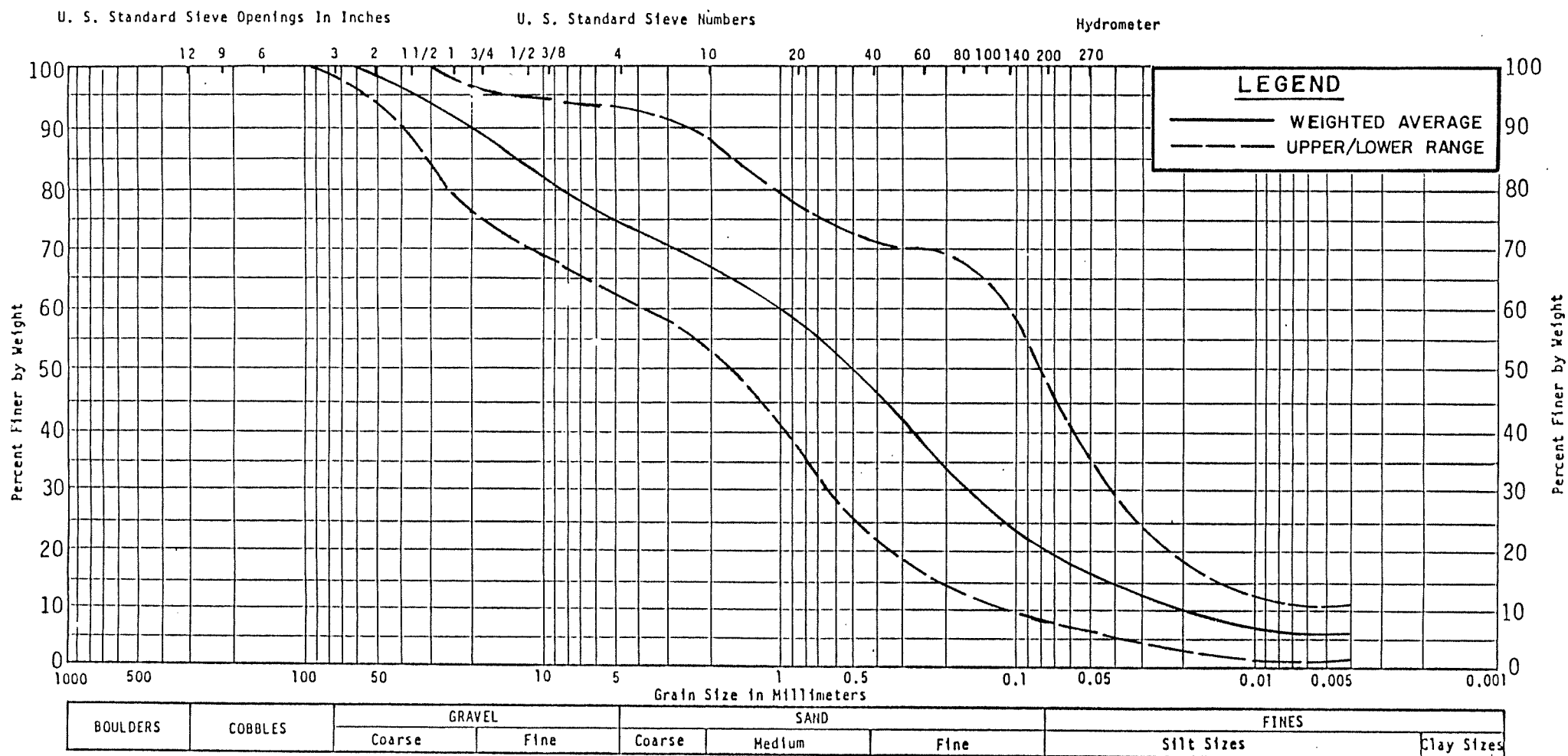
MATERIAL	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT I GRADATION SUMMARY	
WELL GRADED SANDY GRAVEL	5	11	18.7		
WELL GRADED SILTY SAND	17	48	81.3		
TOTALS	22	59	100		
				HANNA-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983
				FIGURE D 24	

GRADATION SIZE ANALYSIS



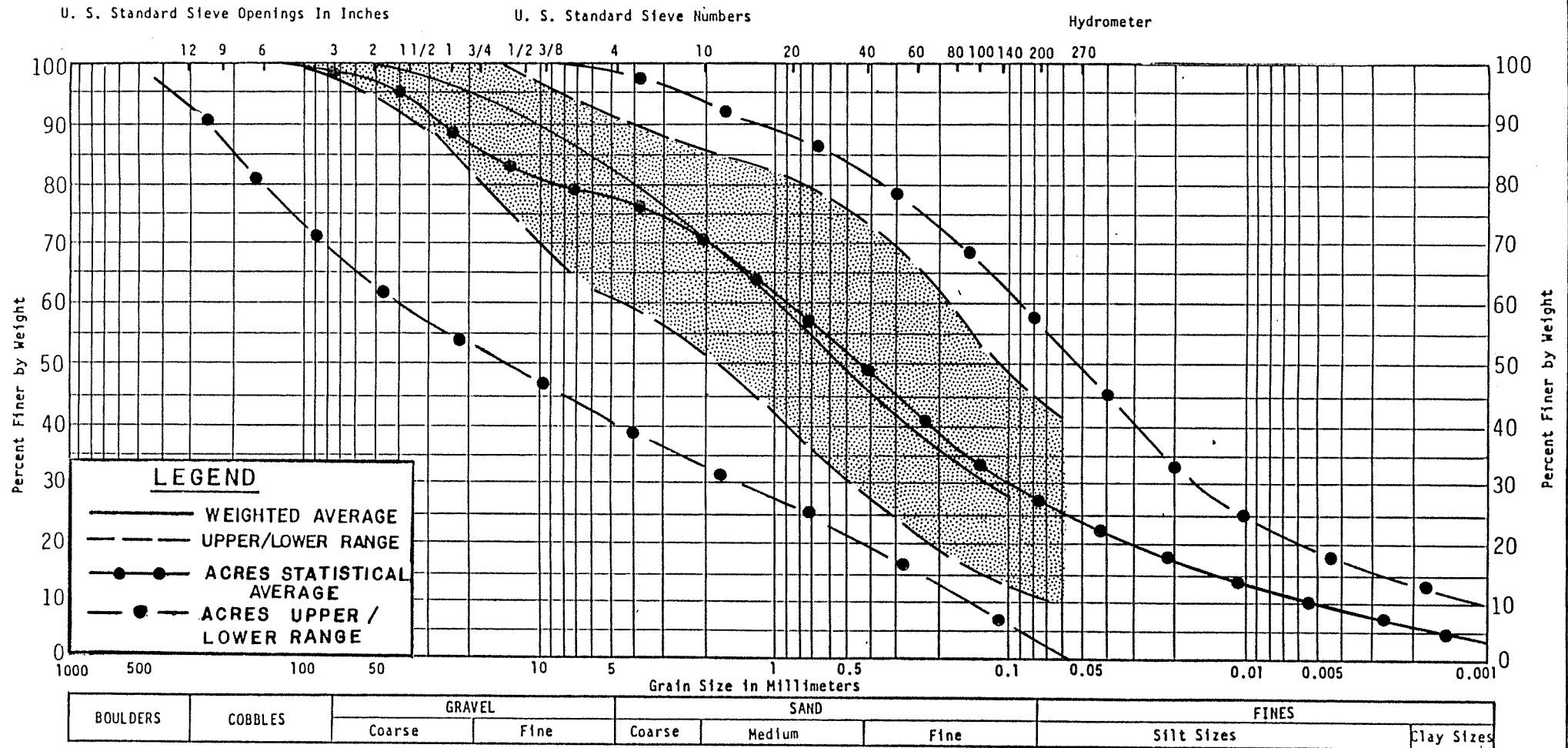
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT I GRADATION RANGE SANDY GRAVEL		
HD83-5,6,52	5	11	WELL GRADED SANDY GRAVEL, (GW-GM)			
				ALASKA-ES&BCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE 025

GRADATION SIZE ANALYSIS



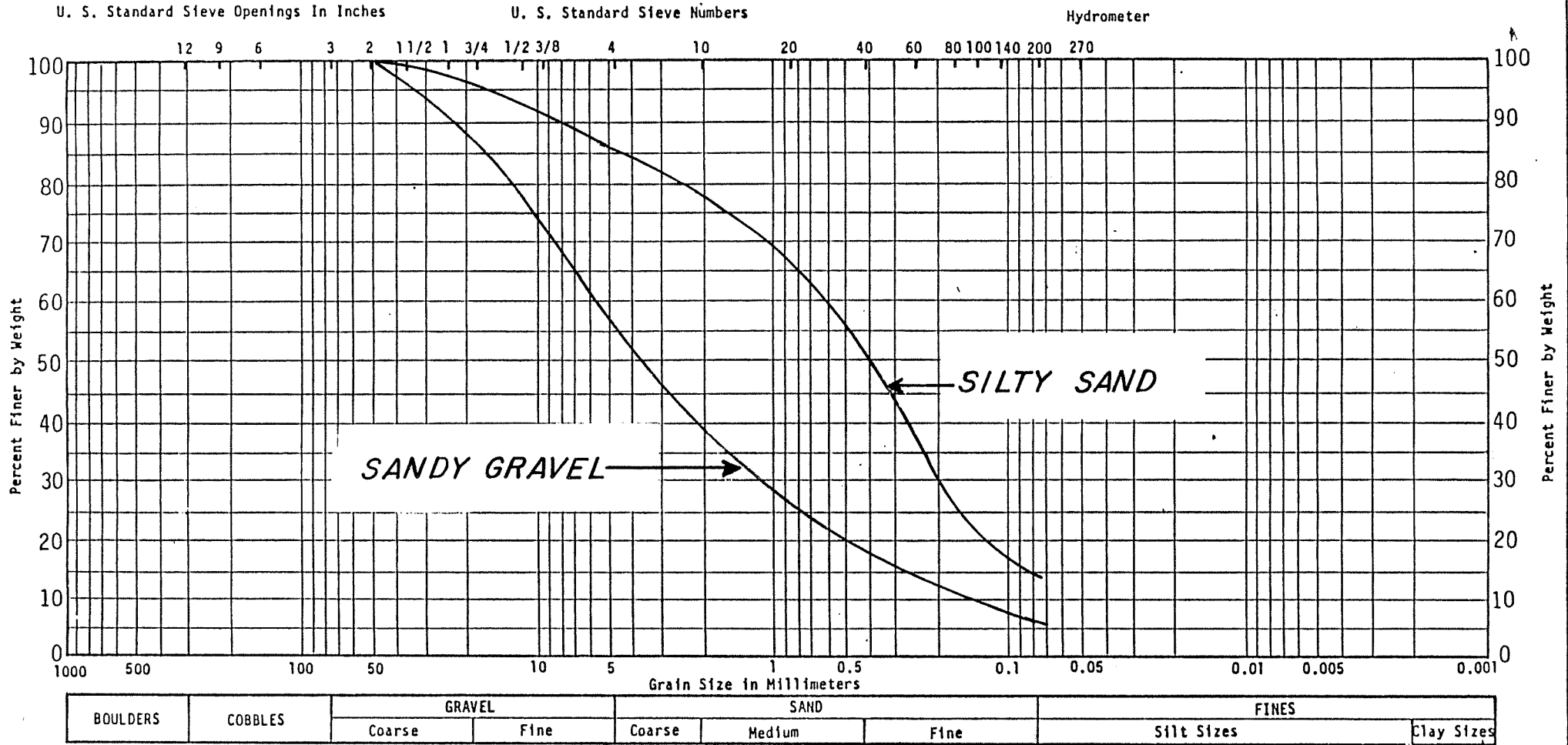
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1,5,6,8,52	17	48	WELL GRADED SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT I GRADATION RANGE		
				SILTY SAND		
				ISSUED - EMBSCO	DATE	FIGURE
				INDIANA JOINT VENTURE	AUG 1983	D 26

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-4, 52, 53,	8	27	SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT		
a WW-3				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT C GRADATION RANGE		
				SILTY SAND		
				HAZARD-ERASCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D27

GRADATION SIZE ANALYSIS



MATERIALS	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY		
WELL GRADED SANDY GRAVEL	6	10	32.3	SUSITNA HYDROELECTRIC PROJECT		
WELL GRADED SILTY SAND	10	21	67.7	WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT H GRADATION		
TOTALS	16	31	100	SUMMARY		
				ALASKA-ESBSCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D 28

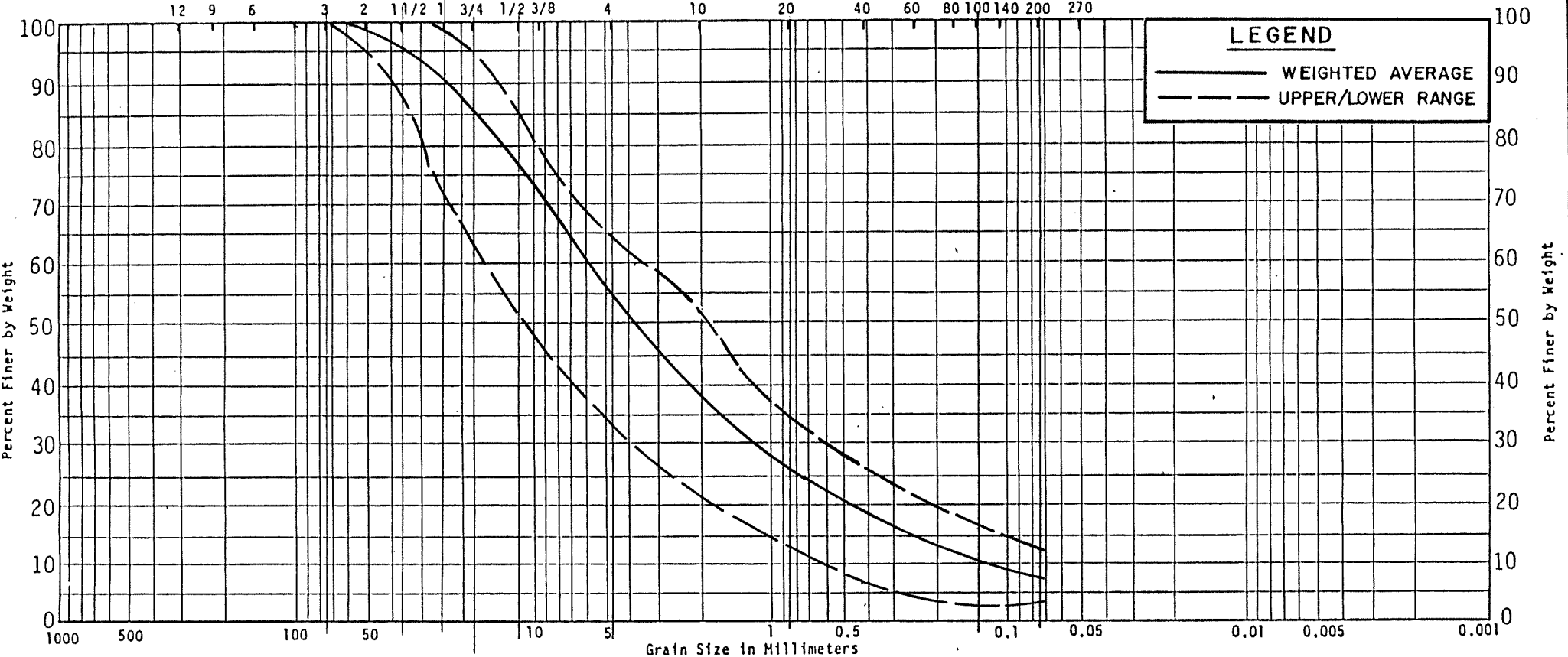
GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

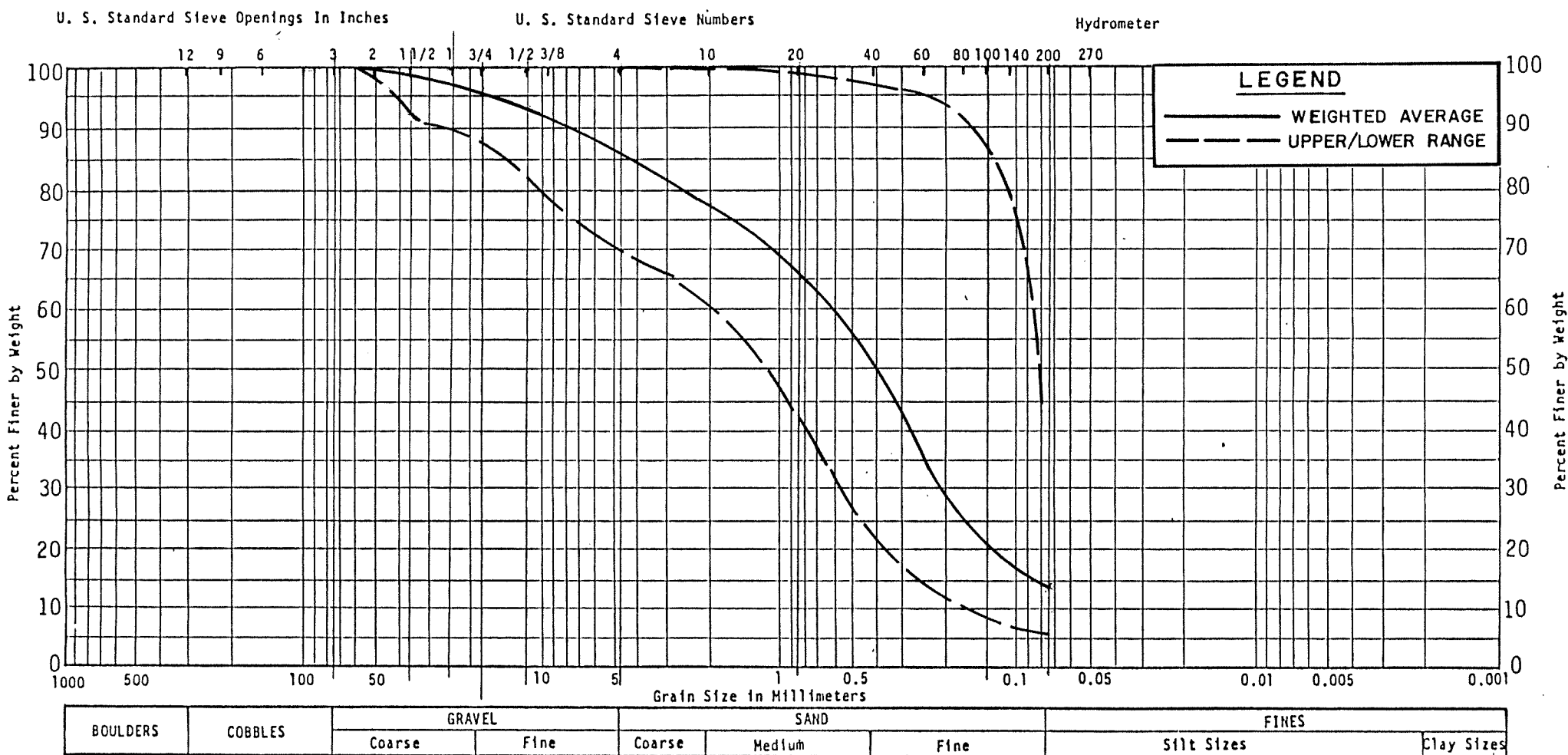
12 9 6 3 2 1 1/2 1 3/4 1/2 3/8 4 10 20 40 60 80 100 140 200 270



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

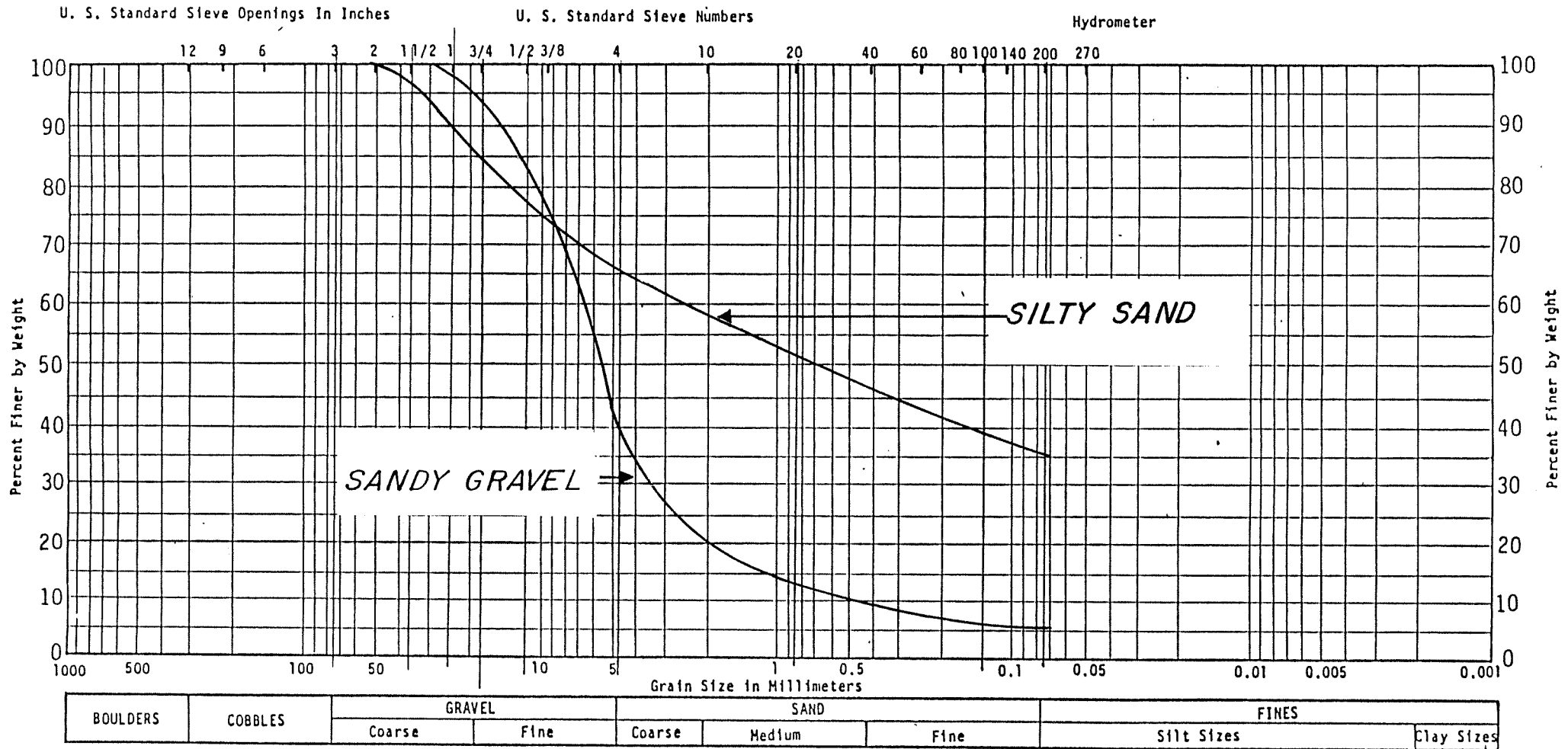
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT H GRADATION RANGE SANDY GRAVEL		
HD83-1, 3, 5	6	10	WELL GRADED SANDY GRAVEL, (GW-GM)			
				HAZARD-ESABCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D29

GRADATION SIZE ANALYSIS



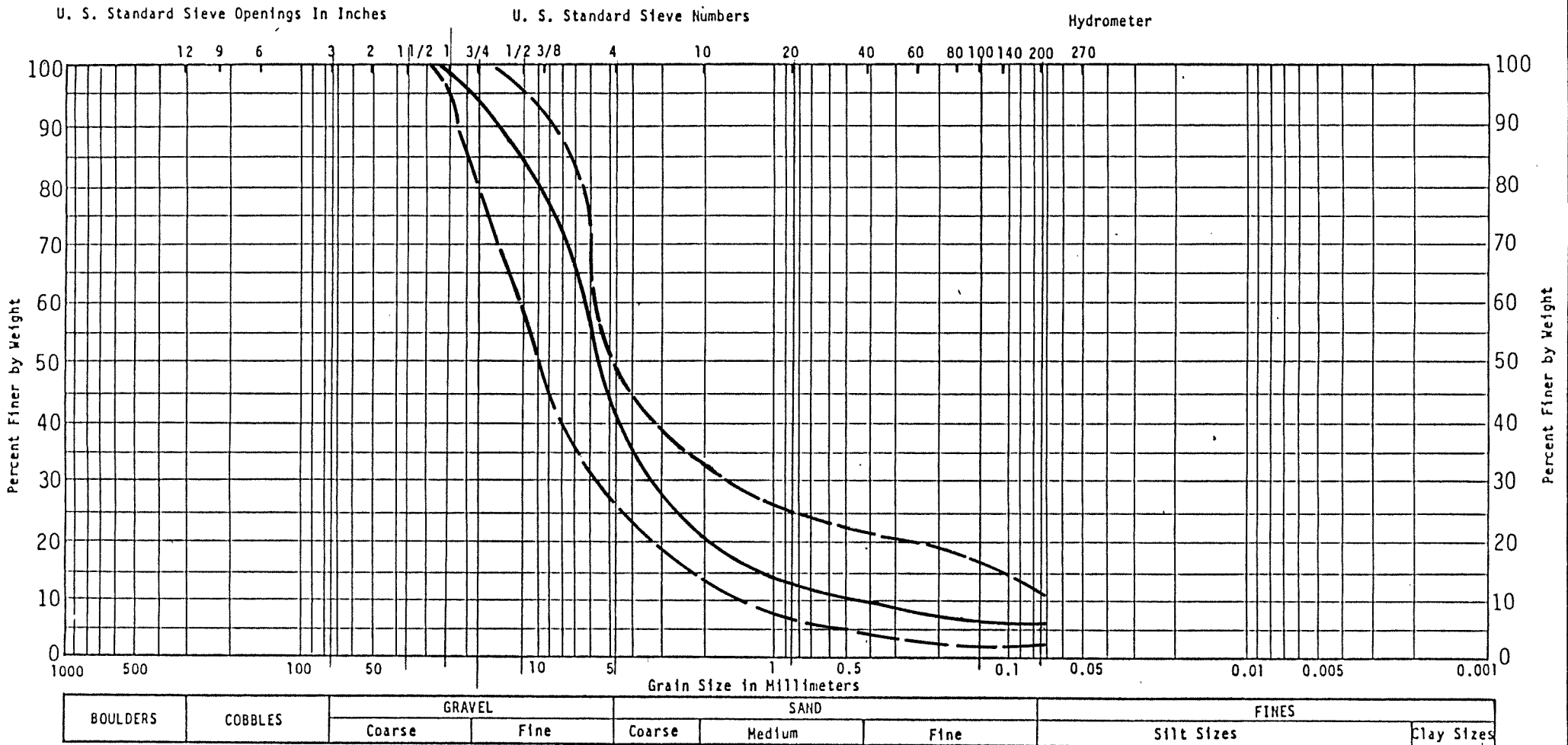
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1,8,52,WW-3	10	21	WELL GRADED SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT K GRADATION RANGE		
				SILTY SAND		
				HAZARD-ESABCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D 30

GRADATION SIZE ANALYSIS



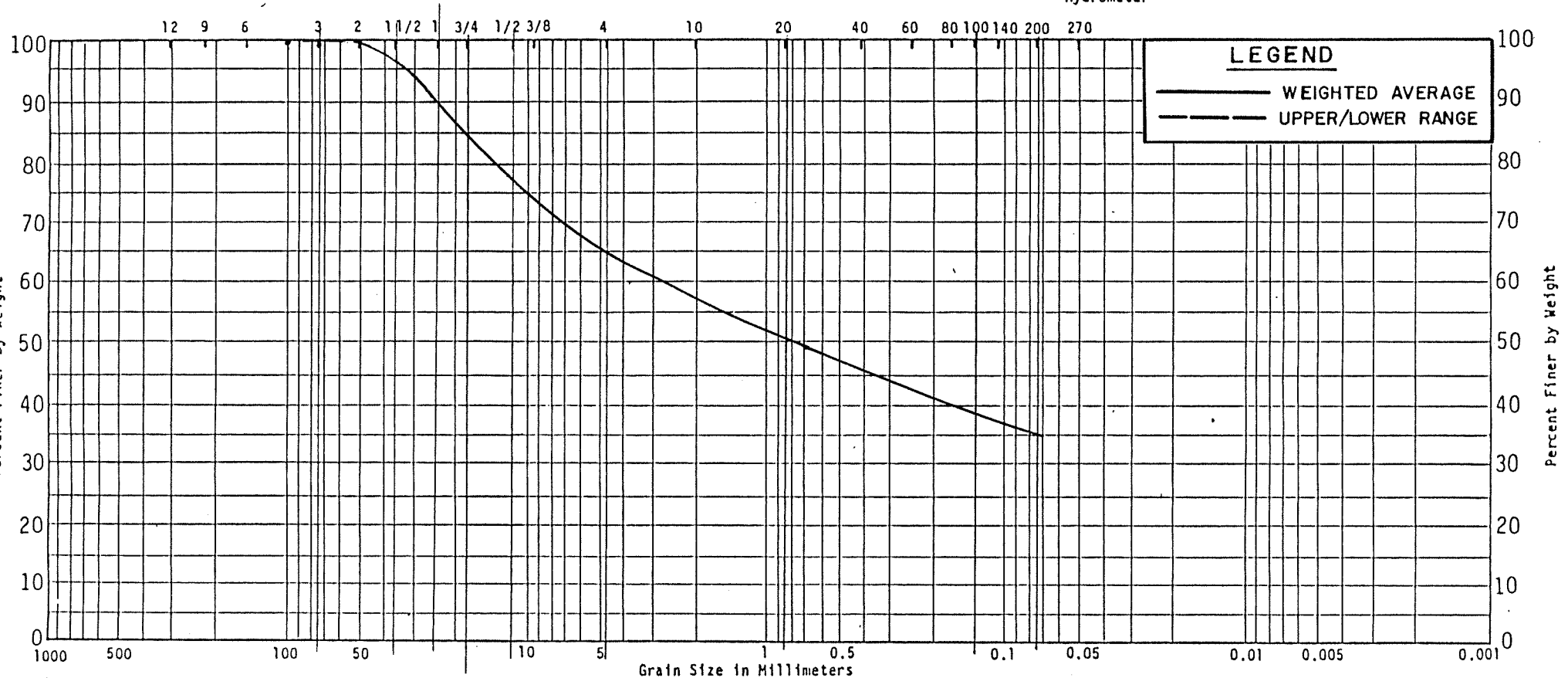
MATERIAL	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY		
POORLY GRADED SANDY GRAVEL	7	7	70	SUSITNA HYDROELECTRIC PROJECT		
SILTY SANDY GRAVEL	2	3	30	WATANA DEVELOPMENT		
				RELICT CHANNEL UNIT K GRADATION SUMMARY		
TOTALS	9	10	100			
				HARRIS-ERASCO SUSITNA JOINT VENTURE	DATE AUG-1983	FIGURE D31

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT K GRADATION RANGE SANDY GRAVEL				
HD83-1	7	7	POORLY GRADED SANDY GRAVEL (GP-GM)					
				ALASKA-EMABCO	DATE	FIGURE		
				SUSITNA JOINT VENTURE	AUG 1983	D32		

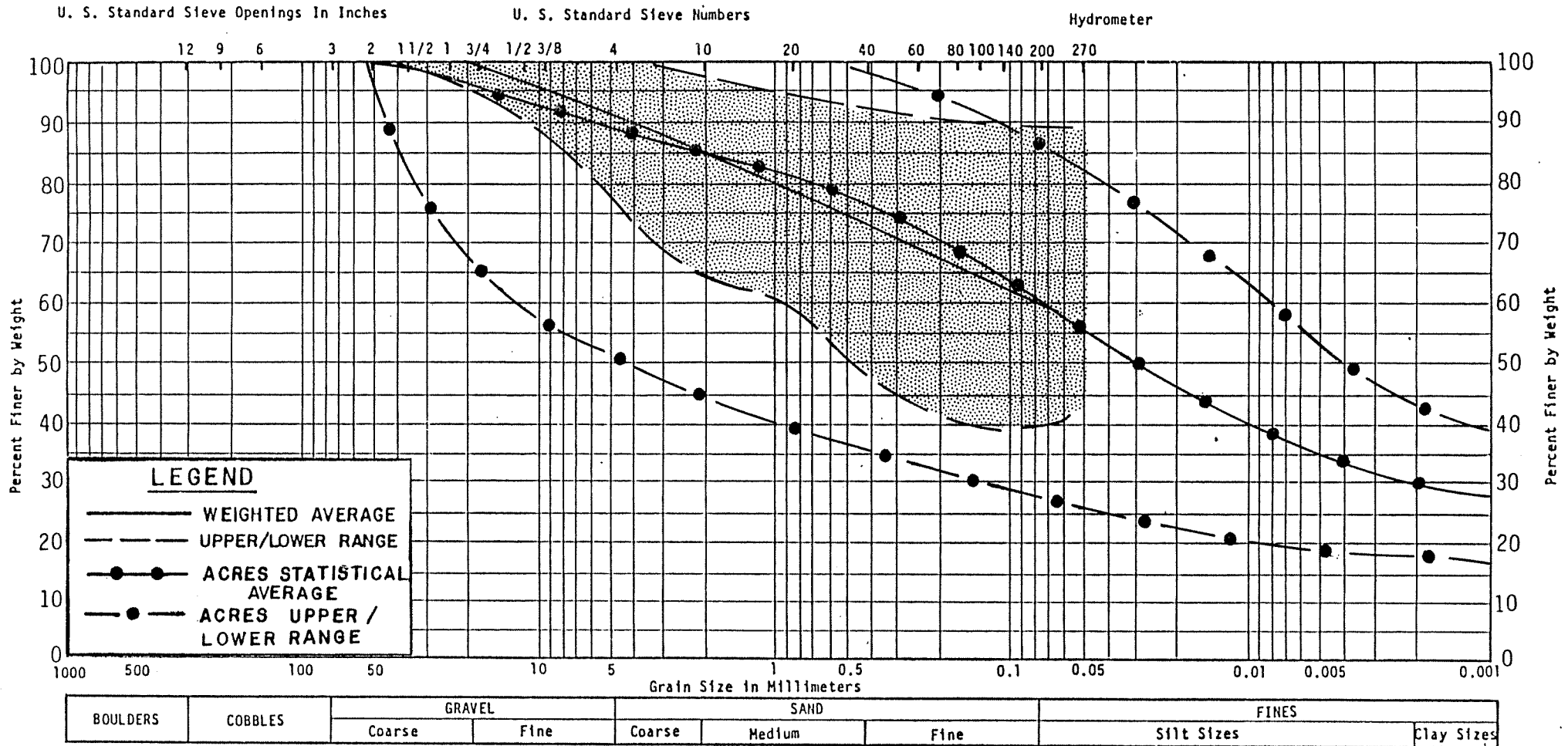
Hydrometer



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

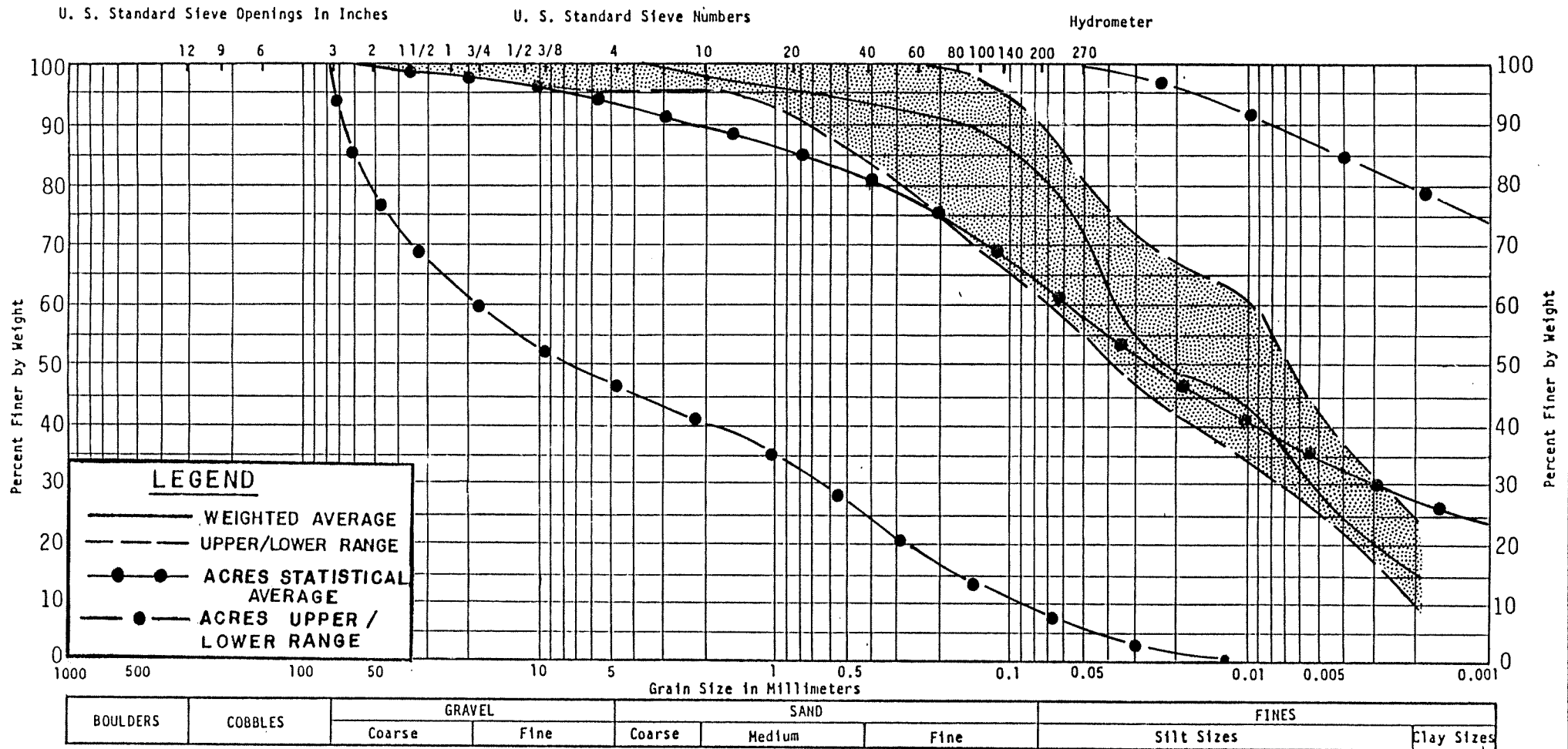
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1	2	3	SILTY SANDY GRAVEL, (GM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT K GRADATION RANGE		
				SANDY GRAVEL		
				HEWLETT-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D33

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY			
WW-3	4	4	SANDY SILT, (ML)	SUSITNA HYDROELECTRIC PROJECT			
				WATANA DEVELOPMENT			
				RELICT CHANNEL			
				UNIT D' GRADATION RANGE			
				SANDY SILT			
				11/02/83	DATE	FIGURE	
				11/02/83	AUG 1983	D 34	

GRADATION SIZE ANALYSIS



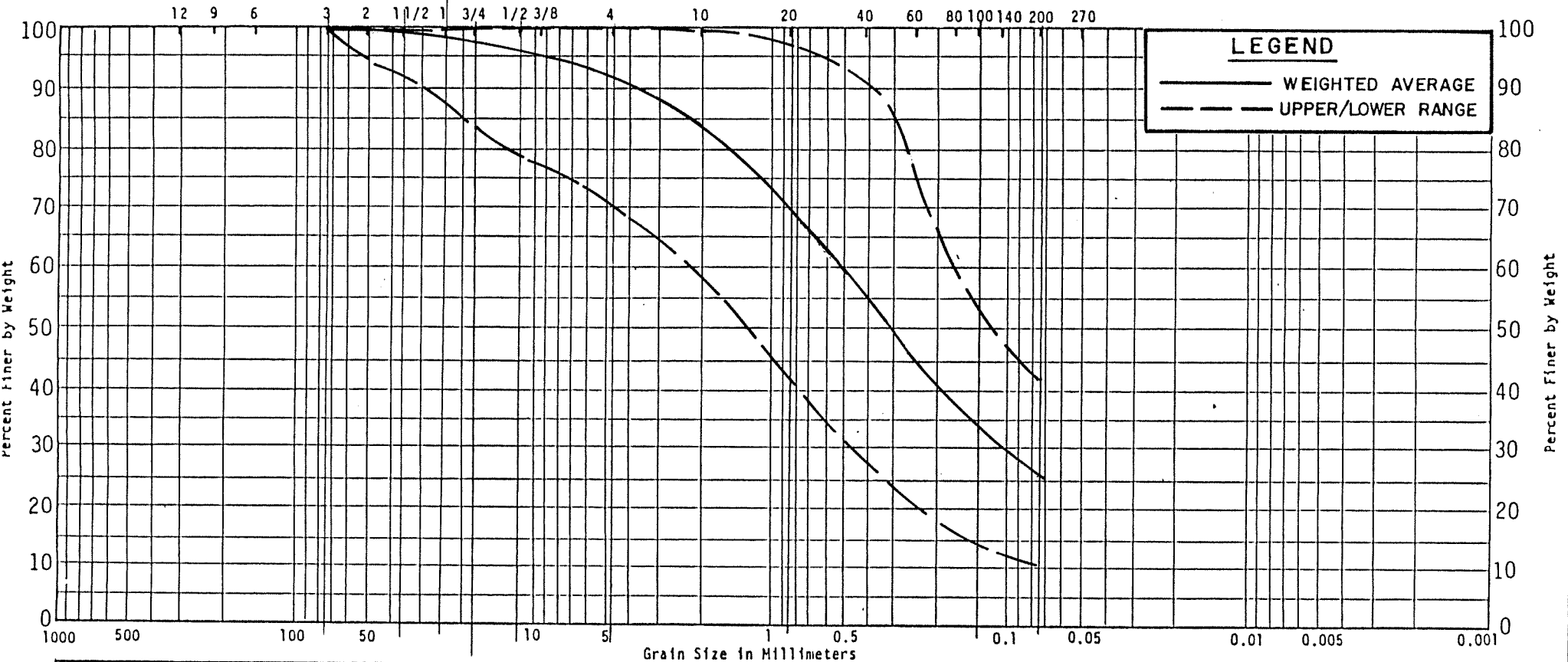
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-4-6, 49	9	17	SILTY CLAY, (ML/CL)	SUSITNA HYDROELECTRIC PROJECT		
8 WW-3				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT G GRADATION RANGE		
				SILTY CLAY		
				HSRIA-EMASCO	DATE AUG 1983	FIGURE D 35

GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

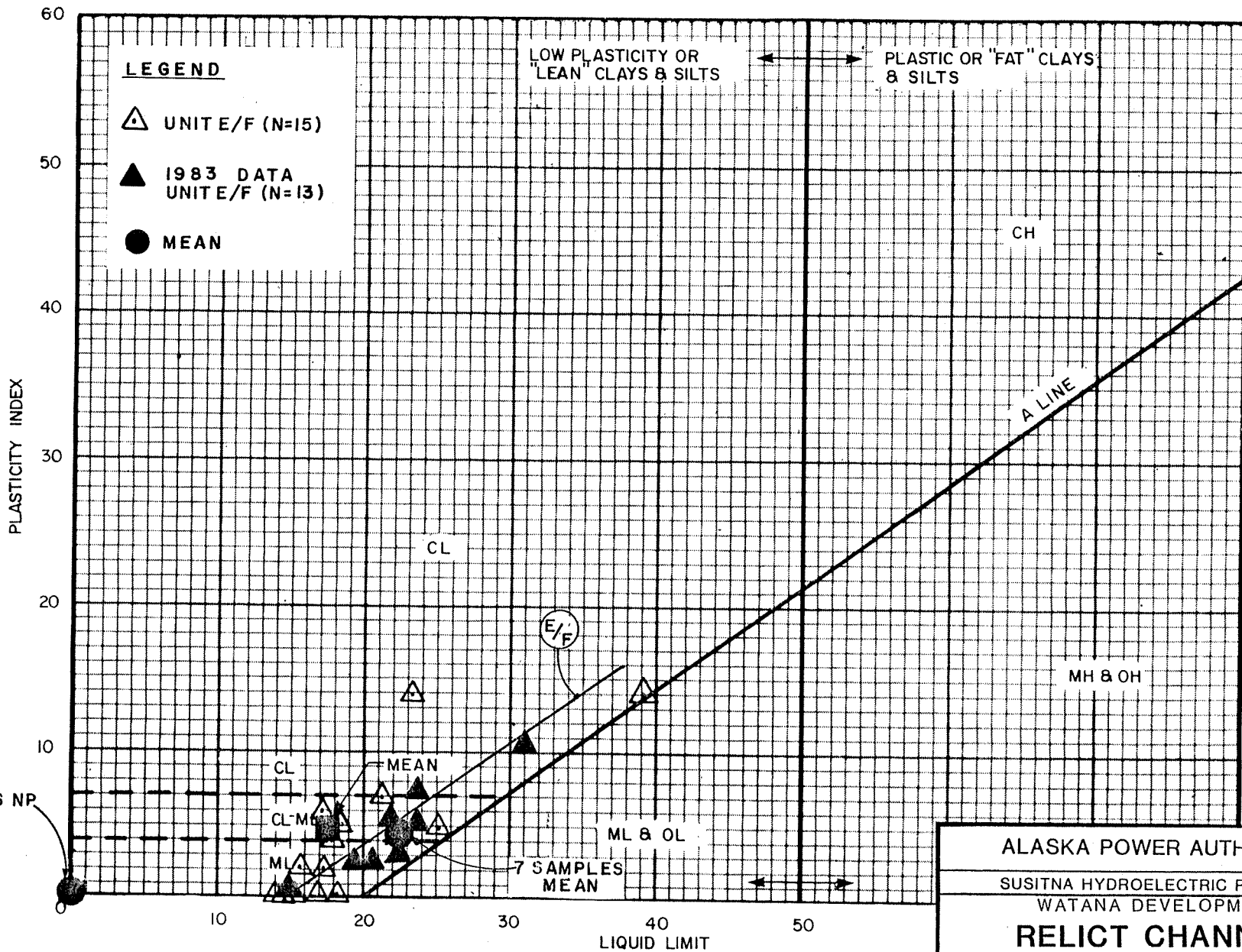
Hydrometer



LEGEND
 ——— WEIGHTED AVERAGE
 - - - UPPER/LOWER RANGE

BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT E GRADATION RANGE SILTY SAND	
HD83-2,5,6	18	23	WELL GRADED SILTY SAND, (SM/SM-SC)		
MARIA-ESABCO				DATE AUG 1983	FIGURE D 36



TEST PERFORMED ON MATERIAL PASSING
NO. 40 SIEVE IN ACCORDANCE WITH
ASTM D423-66 (1972) AND D424-59 (1971)

(INCLUDES ALL TESTS 1978-1982)

ALASKA POWER AUTHORITY

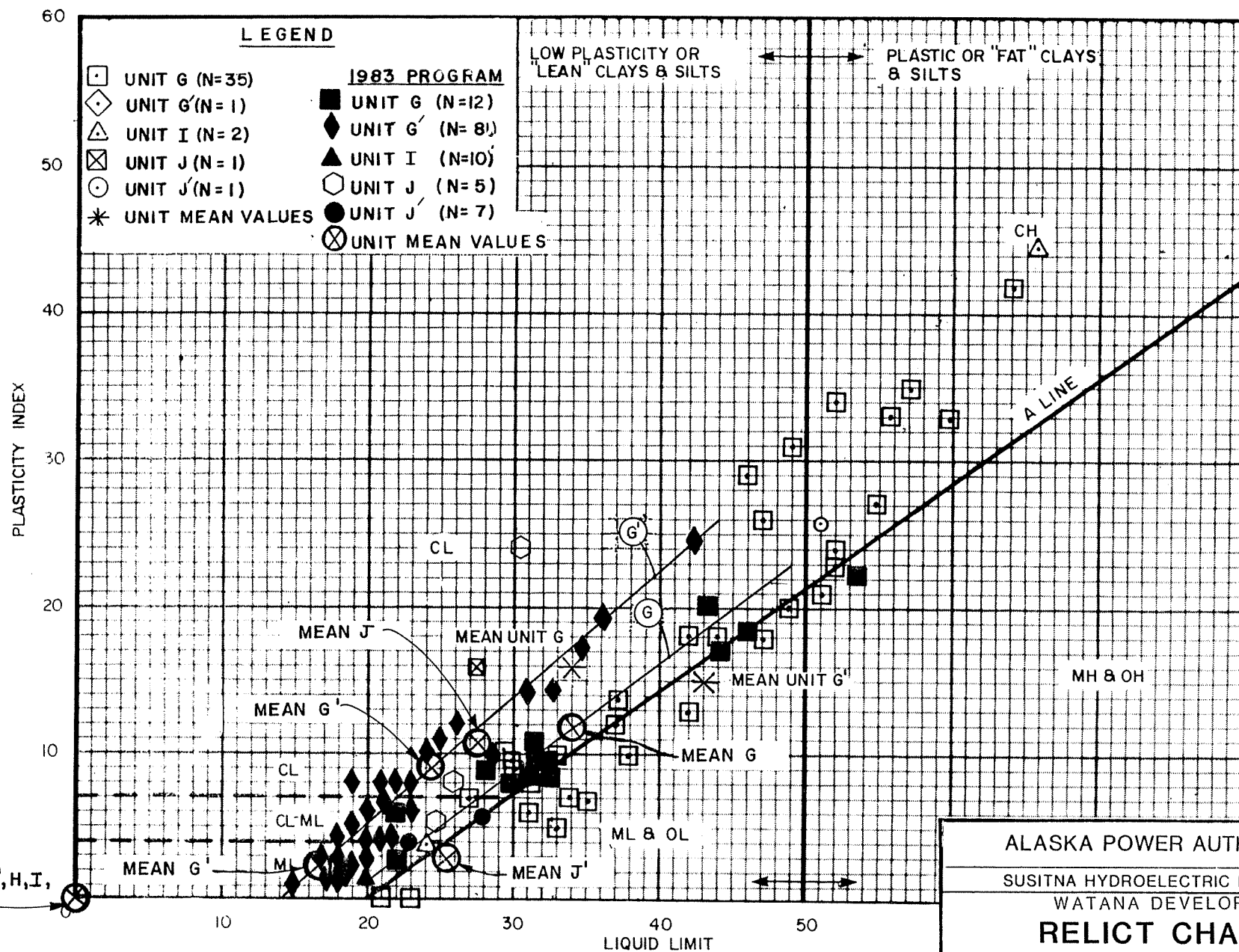
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT

**RELICT CHANNEL
RANGE OF PLASTICITY
UNITS E/F**

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D38



TEST PERFORMED ON MATERIAL PASSING
NO. 40 SIEVE IN ACCORDANCE WITH
ASTM D423-66 (1972) AND D424-59 (1971)

(INCLUDES ALL TESTS 1978-1982)

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RELICT CHANNEL
MATERIALS BELOW UNIT E/F
PLASTICITY SUMMARY

WARZA-EDASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D39

