HARTCROWSER

Earth and Environmental Technologies

Final Report:
Geotechnical Engineering Study

Milwaukee Waterway Fill Project
Draft EIS Supplement
Appendix E

Prepared for:
Port of Tacoma
Tacoma, Washington

July 1, 1988
Work Order No. 920E
J-2013-02A

1910 Fairview Avenue East Seattle, Washington 98102-3699 206.324.9530

Vicinity Map

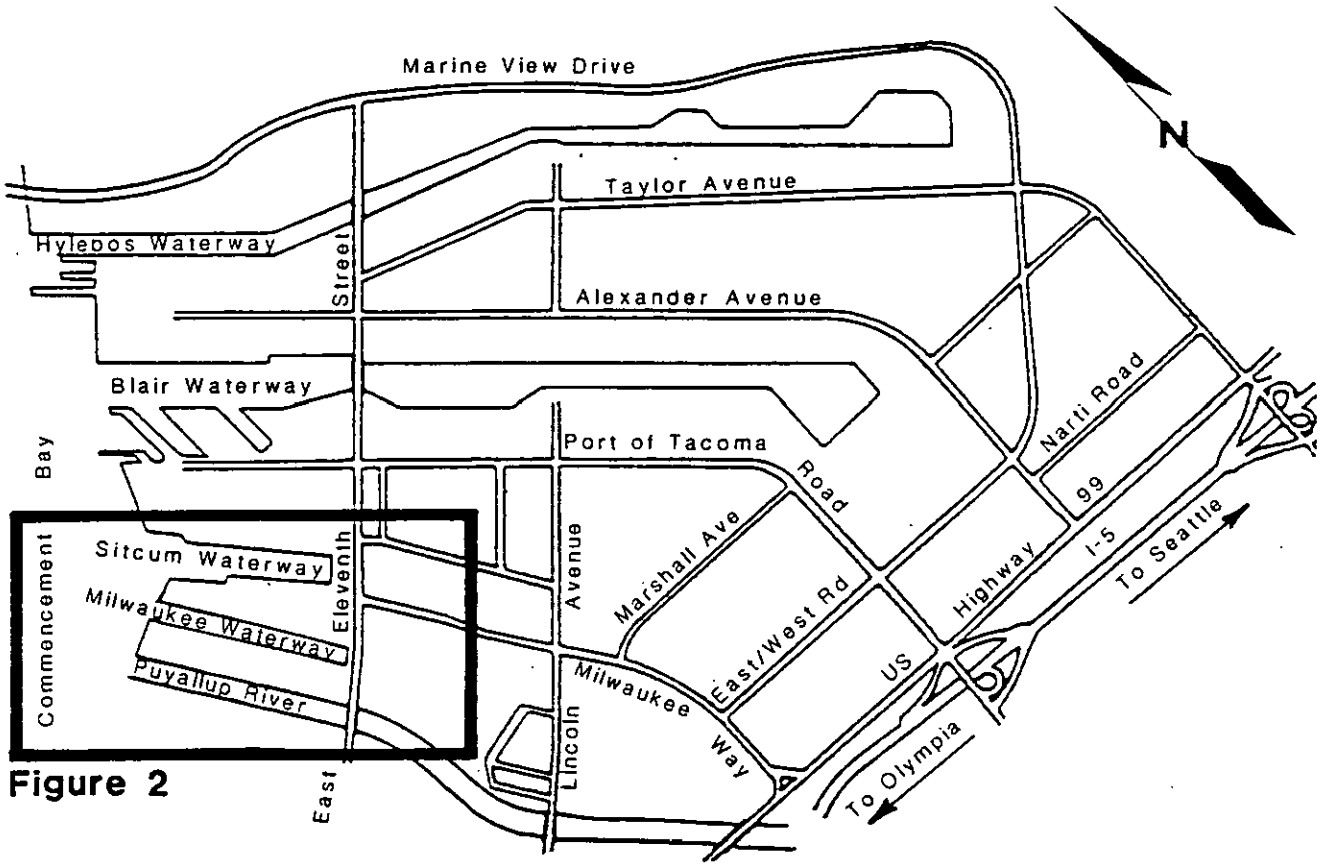

Figure 2

Not to Scale

Regional Map

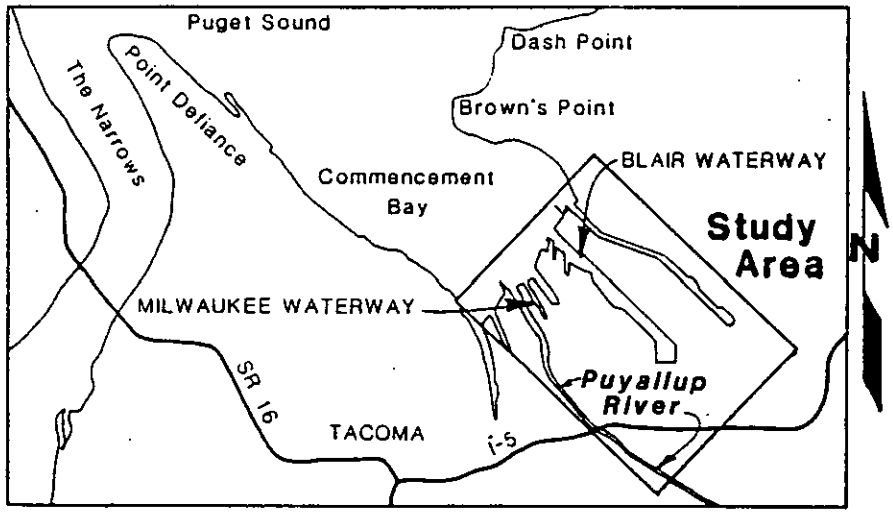

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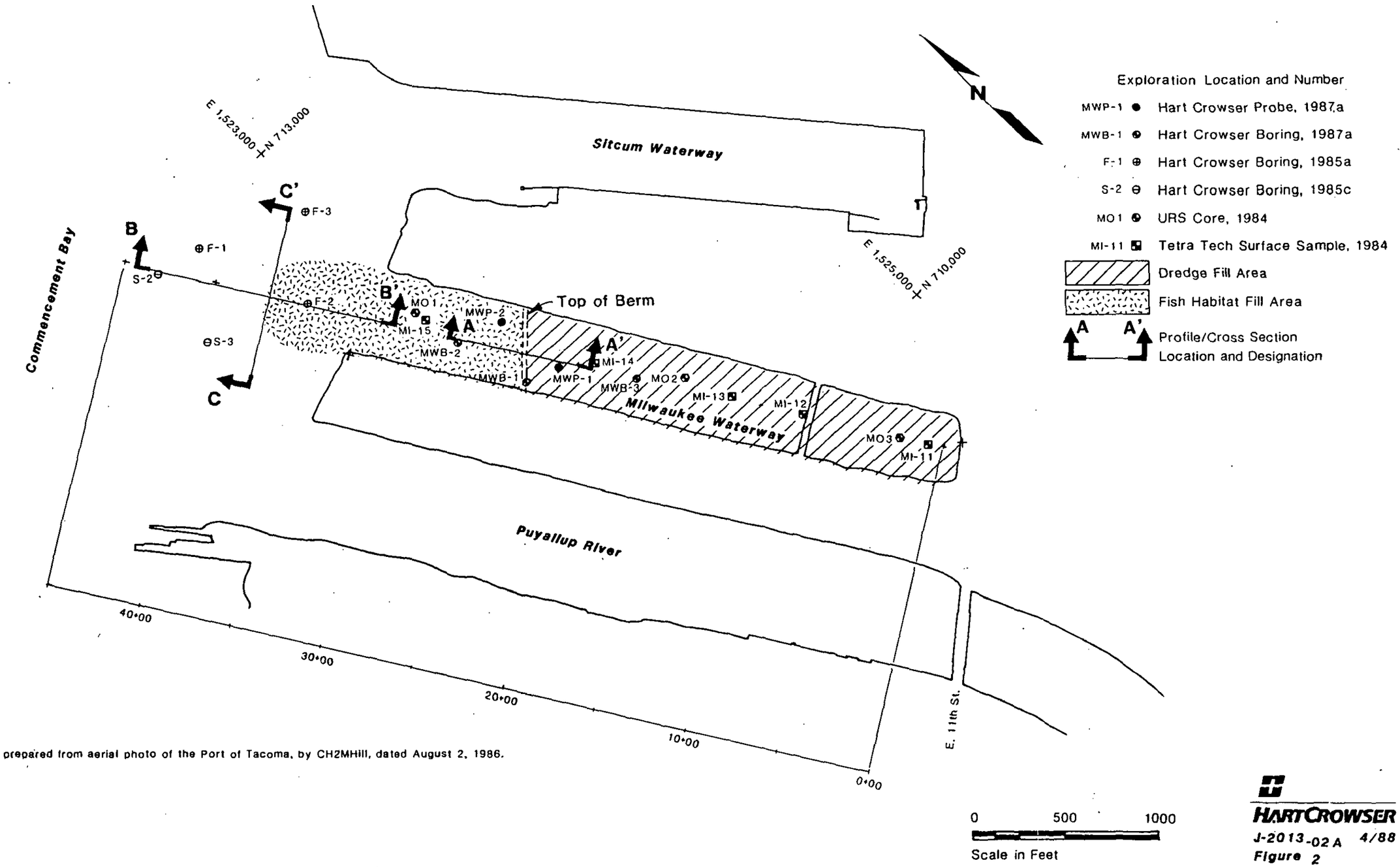
Figure 1

Site and Exploration Plan



Base map prepared from aerial photo of the Port of Tacoma, by CH2MHill, dated August 2, 1986.

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Figure 2

APPENDIX E-I
PREVIOUS EXPLORATIONS

In order to determine the subsurface conditions in the Milwaukee and Blair Waterways for this project, we used information collected in previous studies. In this appendix, we will present copies of the logs or tables showing the results of the previous studies.

Milwaukee Waterway, Hart Crowser, 1987

Hart Crowser advanced three auger borings and two cone penetrometer explorations in the Milwaukee Waterway at the location of the closure berm. These explorations are designated as MWB-1 through MWB-3, MWP-1, and MWP-2. These explorations were done for design level studies of closure berm near its currently proposed location. The actual design of the berm has been postponed until the final location is known. The location of the explorations are shown on Figure 2. The logs of these explorations are included on Figures E-I-2 through E-I-7.

Offshore Milwaukee Waterway, Hart Crowser, 1985

Hart Crowser previously studied the feasibility of constructing a fish habitat north of the Milwaukee Waterway. As part of the study, three borings were drilled in Commencement Bay. These borings are designated F-1 through F-3. The locations of these borings is shown on Figure 2. Logs of the borings are shown on Figures E-I-8 through E-I-10.

Offshore Puyallup Waterway, Hart Crowser, 1985

As a part of a project for a private client, Hart Crowser drilled two borings in the Puyallup River delta, north of the Milwaukee Waterway.

These boring are designated S-2 and S-3, and the locations of these are shown on Figure 2. The logs are shown on Figures E-I-11 and E-I-12.

Blair Waterway, Hart Crowser, 1988

Twelve vibracores were obtained in the Blair Waterway south of the 11th Street Bridge to obtain sediment samples for chemical testing. The logs of these cores provides a visual description of the sediment and the chemical testing included percent solids, which we converted to water content. The location of these cores is shown on Figure 3. Logs of the cores, designated V-1 through V-12, are shown on Figures E-I-13 through E-I-16.

Blair Waterway, Hart Crowser, 1987

Hart Crowser obtained nineteen vibracores from the Blair Waterway, north of the 11th Street Bridge for chemical testing. Although these were primarily obtained for chemical testing, one sample from each core was testing for water content and percent finer than the US No. 200 sieve. Logs showing the sediment visual descriptions were prepared for this project using laboratory notes recorded during the previous work. The location of these cores is shown on Figure 3. Logs of the cores, designated SB-1 through SB-18 and SB-2A, are shown on Figures E-I-17 through E-I-23.

Blair and Milwaukee Waterways, Tetra Tech, 1984

Tetra Tech obtained 21 surface sediment samples in the Blair Waterway and 5 samples in the Milwaukee Waterway for chemical testing. Although they did not include descriptions of the sediments, they did conduct grain size testing, which gives an indication of the type of sediment. The location of the samples are shown on Figure 3 for Blair Waterway (designated BL-11 through BL-32) and Figure 2 for Milwaukee Waterway (designated MI-11 through MI-15). A summary of their testing is shown in Figure E-I-24.

Blair and Milwaukee Waterways, URS, 1984

URS obtained 19 sediment cores in the Blair Waterway and 3 cores in the Milwaukee Waterway for chemical testing. They prepared logs in tabular form that show the descriptions of the sediment. The location of the cores are shown on Figure 3 for Blair Waterway (designated B-01 through B-18 and B-17B) and Figure 2 for Milwaukee Waterway (designated ML-01 through ML-03). A summary of their testing is shown on Figures E-I-25 through E-I-29.

APPENDIX E-III
PREVIOUS LABORATORY ANALYSIS

This appendix presents a selection of representative physical testing data from previous reports. These data were used in the geotechnical engineering for Closure Fill and Fish Habitat Stability, and for filling the Milwaukee Waterway.

The results of the previous testing is summarized on the tables and figures in this appendix. For a complete description of the sampling and testing methodology used, see the references for each test.

Water Contents

Water contents performed by Hart Crowser were done in general accordance with ASTM D 2216 as soon as possible after their arrival in our laboratory. The results of the water contents are shown on the logs of our explorations (Appendix E-I), and with the results of other engineering testing. In addition, water contents calculated from percent solids are shown on Table E-III-1 for samples from the "V" cores and "G" samples.

Grain Size Analysis

Grain size testing performed by Hart Crowser were generally done in accordance with ASTM D 422. The wet sieve analysis method was used for most samples and determined the grain size distribution greater than the U.S. No. 200 mesh sieve. The results from the "G" cores samples are shown on Figures E-III-2 through E-III-4 (Hart Crowser, 1988). The results from the "MWM" borings are shown on Figures E-III-5 and E-III-6 (Hart Crowser, 1987a).

200-Wash

Selected samples were subjected to a modified grain size classification known as a 200-wash. The samples were "washed" through the No. 200 mesh sieve to determine the relative percentages of coarse and fine-grained material in the samples. The tests were performed in general accordance with ASTM D 1140. The results for the "SB" Cores are shown on Table E-III-2 and the results for the "F" borings are shown on Table E-III-3.

Atterberg Limits (Plasticity)

Atterberg Limits are used to test the plasticity of fine-grained soil. Hart Crowser generally conducts the Atterberg limits tests according to ASTM D 423 and D 424 for determining the liquid limit and plastic limit, respectively. The results from the "G" samples are shown on Figure E-III-7 (Hart Crowser, 1988). The results of the "MWB" borings are shown on Figures E-III-8 and E-III-9 (Hart Crowser, 1987a).

Shear Strength Testing

The triaxial unconsolidated undrained compression test was used to estimate the undrained shear strength of the sediment. This test is generally performed in accordance with ASTM D 2850. The results from the "MWM" borings are shown on Figure E-III-10 (Hart Crowser, 1987a).

The direct shear test was used to estimate the drained shear strength of the sediment. This test is generally performed in accordance with ASTM D 3080. The results from the "MWM" boring are shown on Figure E-III-11. The result from the "F" borings are shown on Figure E-III-12 (Hart Crowser, 1985a).

Consolidation Testing

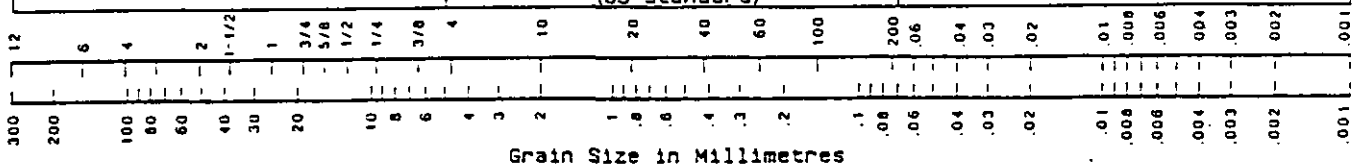
Hart Crowser performed one-dimensional consolidation tests on relatively undisturbed samples of fine-grained sediment. The tests were generally

performed in accordance with ASTM D 2435. The results from the "MWB" borings are shown on Figure E-III-13 (Hart Crowser, 1987a). The results from the "F" borings are shown on Figure E-III-14 (Hart Crowser, 1985a). The results from the "T3B" borings are shown on Figures E-III-15 and E-III-16 (Hart Crowser, 1986); and on Figure E-III-17 (Hart Crowser, 1987b).

Unified Soil Classification (USC) System

Soil Grain Size

Size of Opening in Inches	Number of Mesh per Inch (US Standard)	Grain Size in Millimetres



COBBLES	GRAVEL	SAND	SILT and CLAY
Coarse-Grained Soils			Fine-Grained Soils

Coarse-Grained Soils

G W	G P	G M	G C	S W	S P	S M	S C
Clean GRAVEL <5% fines	*	GRAVEL with >12% fines		Clean SAND <5% fines	*	SAND with >12% fines	
GRAVEL >50% coarse fraction larger than No. 4				SAND >50% coarse fraction smaller than No. 4			
Coarse-Grained Soils >50% larger than No. 200 sieve							

G W and S W $\left(\frac{D_{60}}{D_{10}}\right) > 4$ for G W, $\left(\frac{D_{60}}{D_{10}}\right) > 6$ for S W & $1 \leq \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right) \leq 3$

G P and S P Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M Atterberg limits below A Line with PI <4

G C and S C Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases requiring use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particle diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

Fine-Grained Soils

M L	C L	O L	M H	C H	O H	Pt
SILT	CLAY	Organic	SILT	CLAY	Organic	Highly Organic Soils
Soils with Liquid Limit <50%			Soils with Liquid Limit >50%			
Fine-Grained Soils >50% smaller than No. 200 sieve						

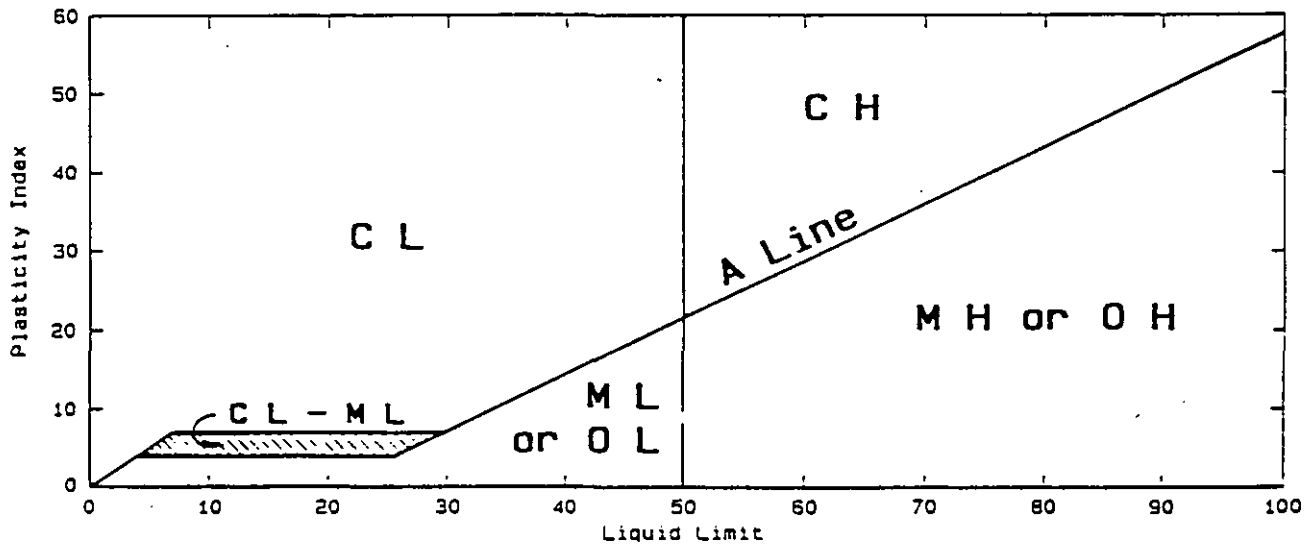


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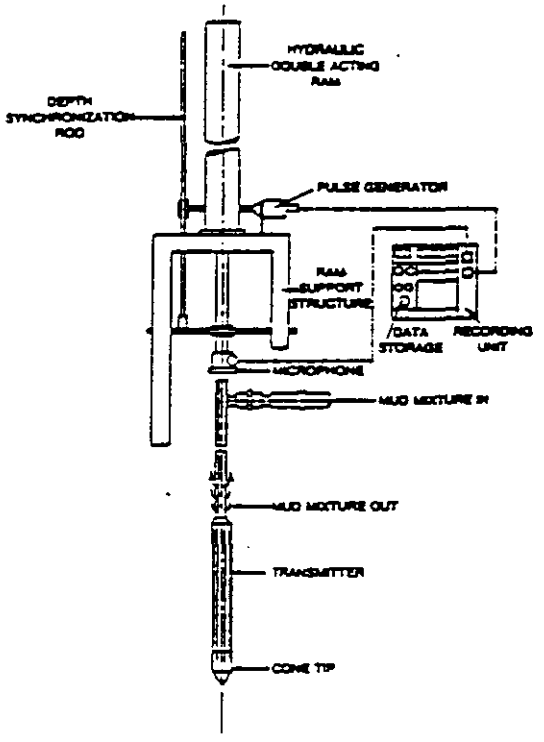
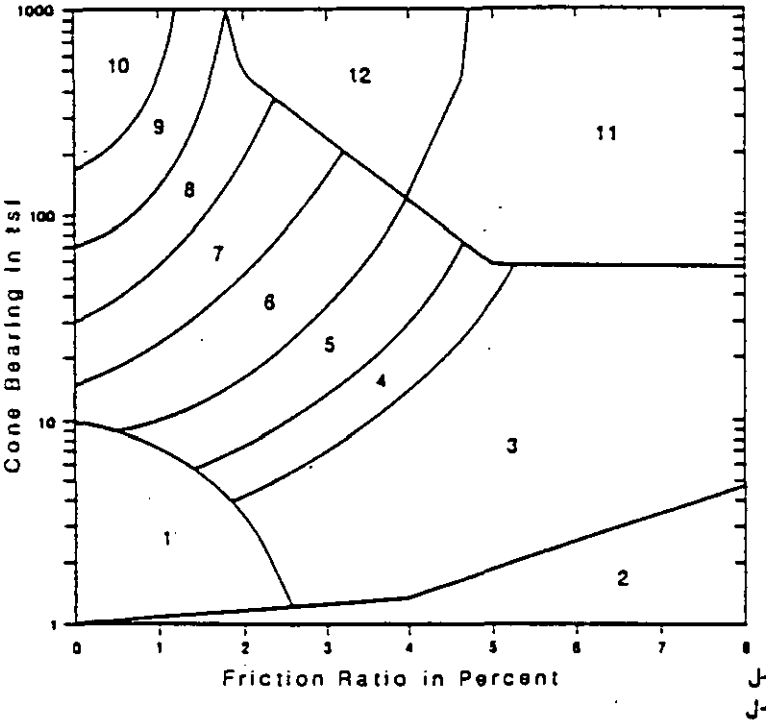
Figure E-III-1

Electric Cone Penetrometer

Schematic



Simplified Classification Chart (Robertson and Campanella, 1984)



1. Sensitive fine-grained
2. Organic material
3. CLAY
4. Silty CLAY to CLAY
5. Clayey SILT to silty CLAY
6. Sandy SILT to clayey SILT
7. Silty SAND to sandy SILT
8. SAND to silty SAND
9. SAND
10. Gravelly SAND to SAND
11. Very stiff fine grained*
12. SAND to clayey SAND*

*Overconsolidated or cemented.

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Figure E-I-5

Boring Log MWB-1

SOIL DESCRIPTIONS

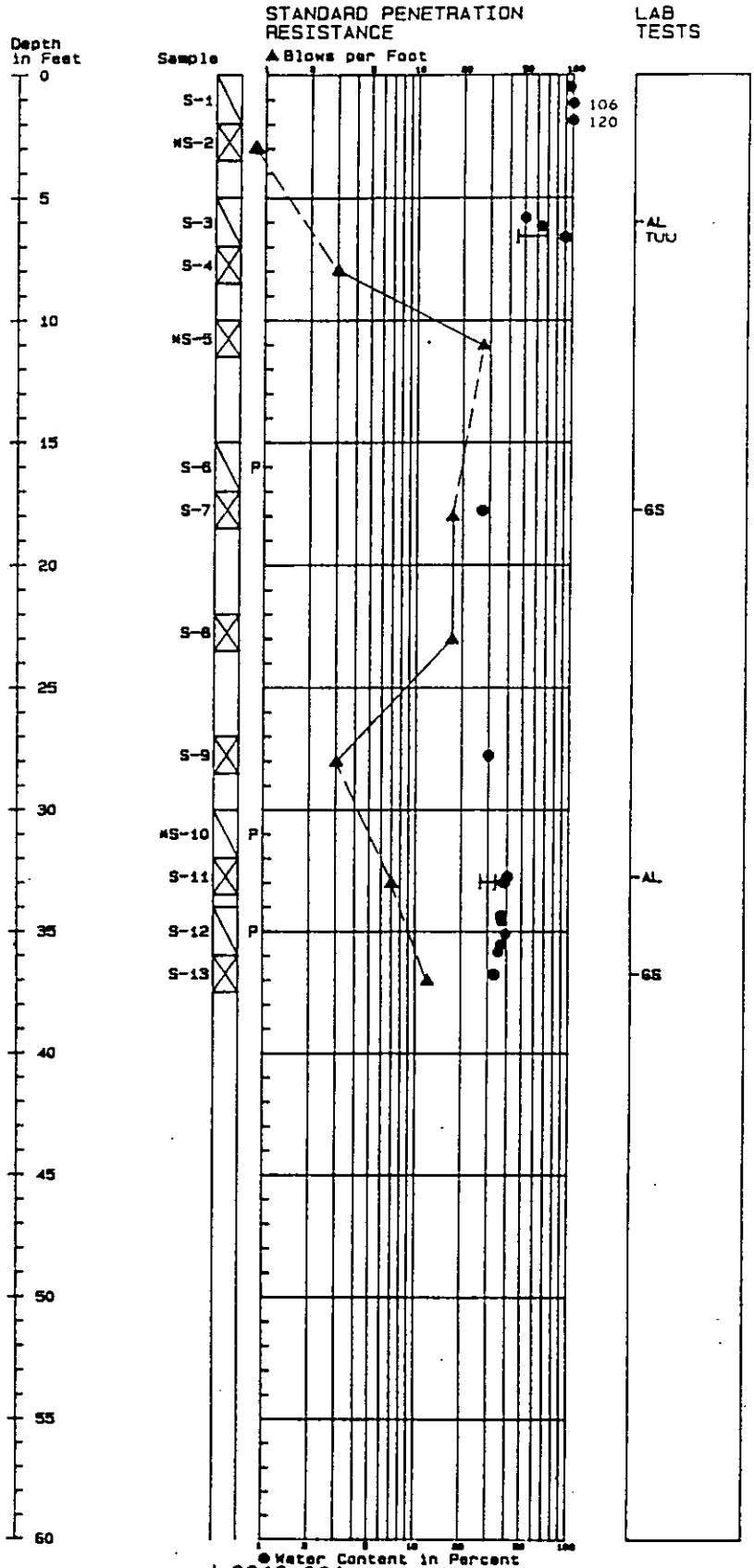
Ground Surface Elevation in Feet -27.5

Very soft to soft, wet, black, clayey SILT with numerous wood and organic fragments, containing crushed rock from 6.5 to 9.5 feet.

Medium dense, wet, black, slightly silty SAND containing gravel from 9.5 to 12 feet.

Soft to stiff, wet, gray, slightly clayey, sandy SILT with interbedded lenses of silty SAND.

Bottom of Boring at 37.5 Feet. Completed 3/18/86.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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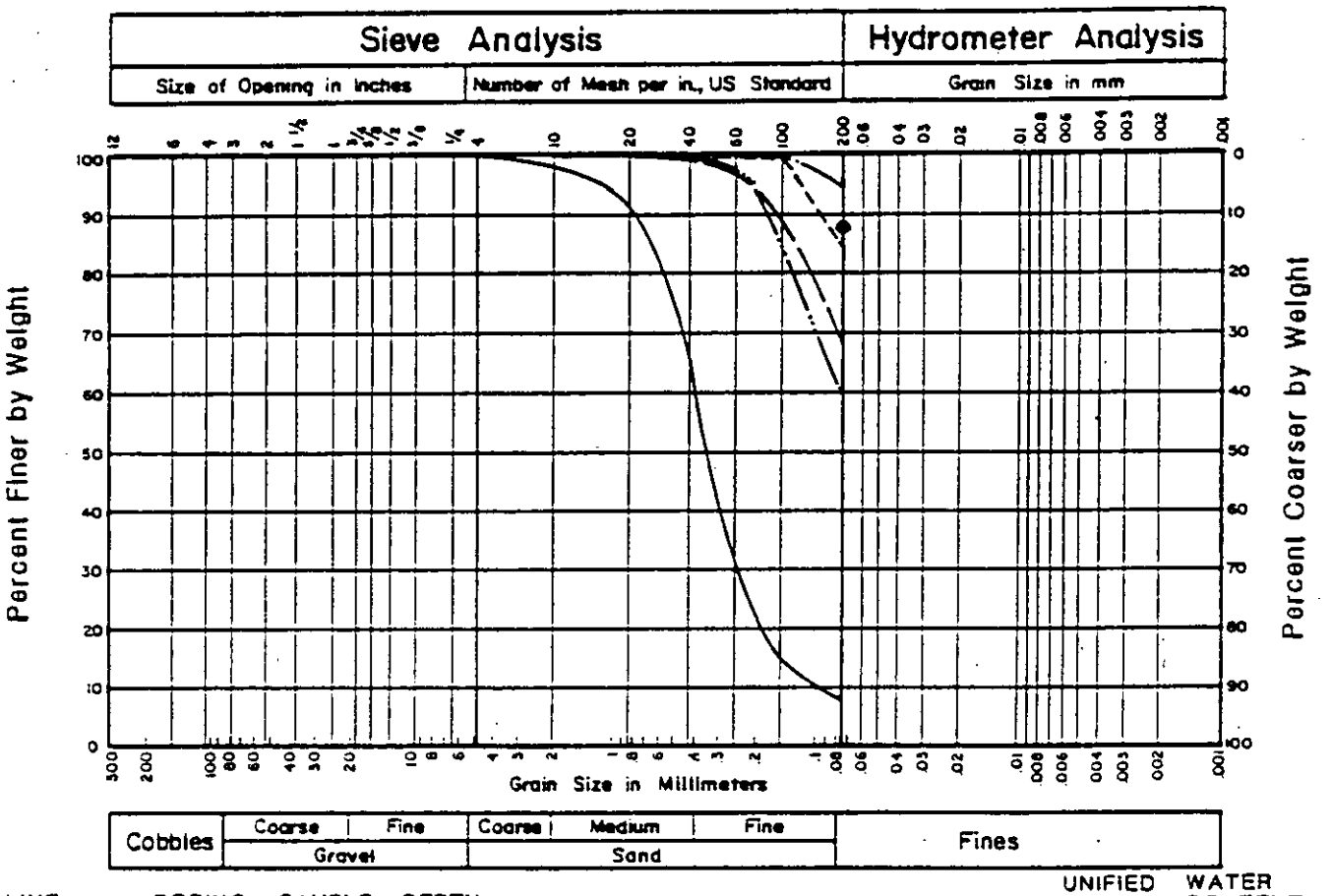
Figure E-I-2

Grain Size Classification



LINE SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	CLASSIFICATION	UNIFIED SOIL CLASS.	WATER CONTENT PERCENT
———	MWB-1	S-7	17.0 - 18.5	Slightly silty, medium to fine SAND	SP - SM	24
— —	MWB-1	S-13	36.0 - 37.5	Very sandy SILT	ML	33
- - - - -	MWB-2	S-5	10.0 - 11.5	Sandy SILT	ML	38
●	MWB-2	S-6	16.2 - 16.3	Slightly sandy SILT	ML	33
—·—	MWB-2	S-7	17.0 - 18.5	Slightly sandy SILT	ML	38
—···—	MWB-2	S-10	27.0 - 28.5	Very sandy SILT	ML	29

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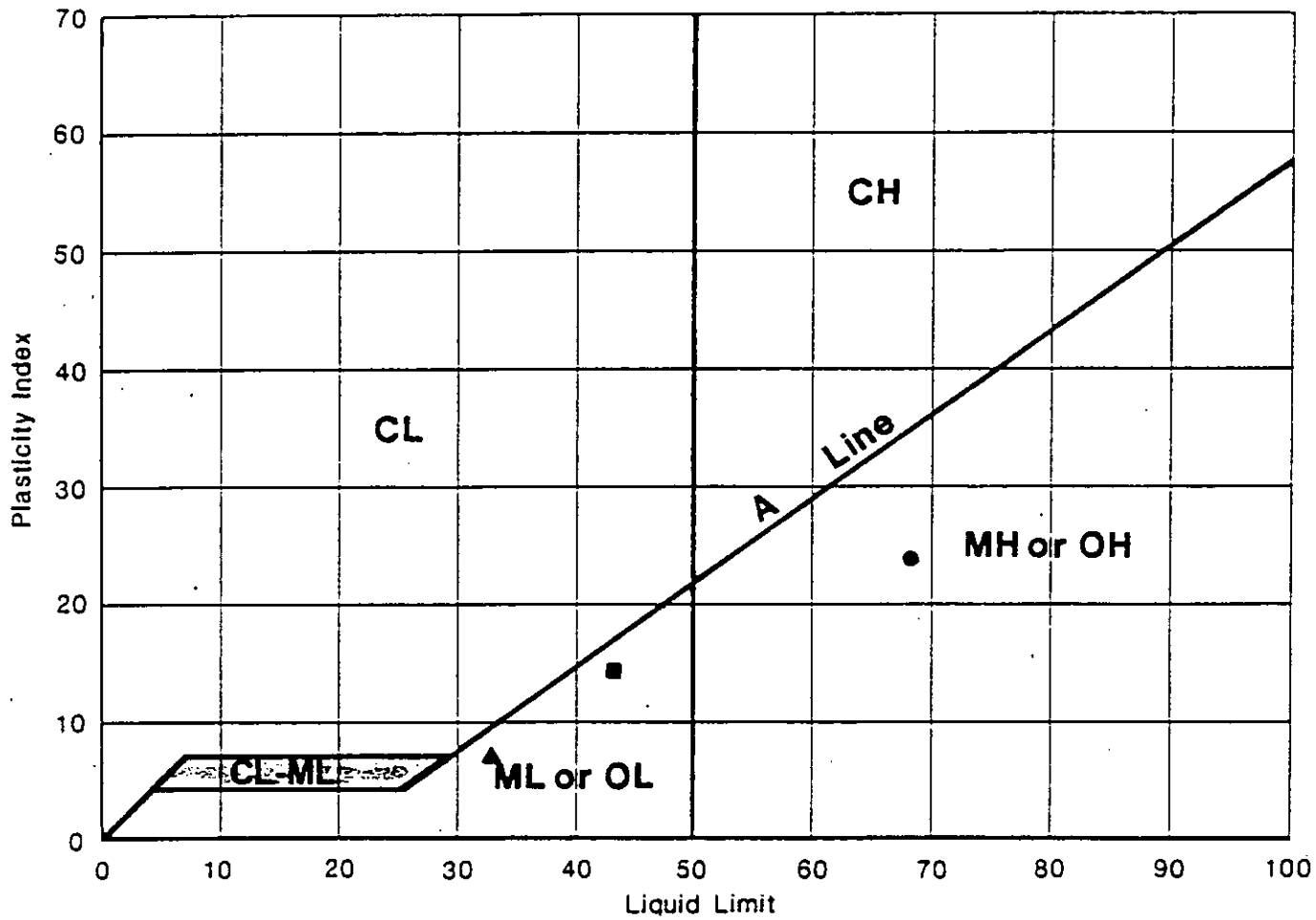
Figure E-III-5

Plasticity Chart



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WATER CONTENT IN PERCENT NAT.	L.L.	P.L.	P.I.	CLASSIFICATION	USC
●	MWB-1	S-3	6.4 - 6.9	90	68	44	24	Clayey SILT	MH
▲	MWB-1	S-11	32.0 - 33.5	38	33	26	7	Sandy SILT	ML
■	MWB-3	S-2	2.0 - 3.5		43	29	14	Clayey SILT	ML

L.L. LIQUID LIMIT
P.L. PLASTIC LIMIT
P.I. PLASTICITY INDEX
USC UNIFIED SOIL CLASSIFICATION

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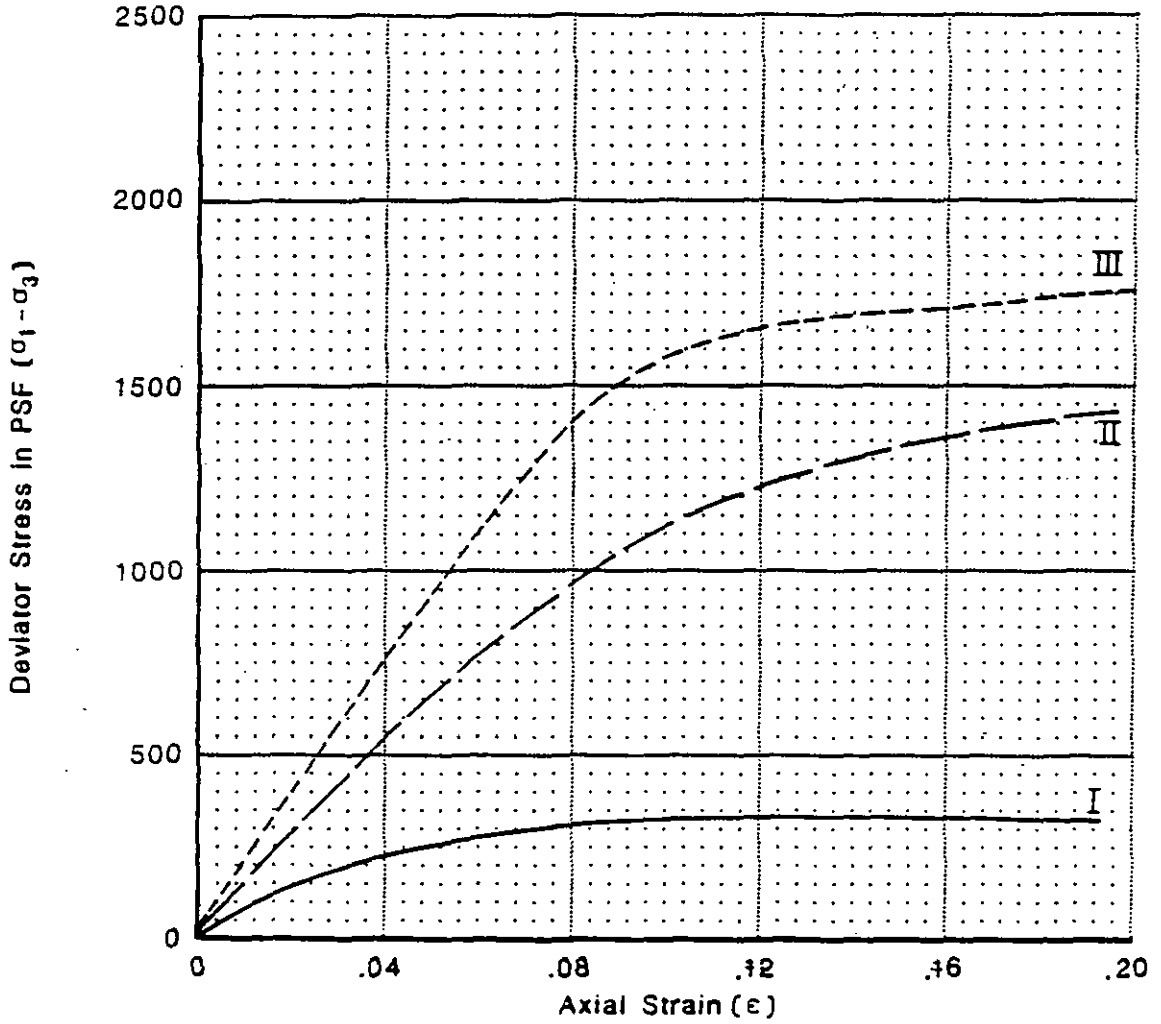
Figure E-III-8

Triaxial Compression Tests
Unconsolidated, Undrained



TEST NUMBER	EXPLOR NUMBER	SAMPLE NUMBER	DEPTH IN FEET	U.S.C.	DESCRIPTION
I	MWB-1	S-3	6.4 - 6.9	MH	Clayey SILT
II	MWB-2	S-3	5.4 - 5.9	ML	Clayey SILT
III	MWB-2	S-3	6.1 - 6.6	ML	Clayey SILT

TEST NUMBER	WATER CONTENT IN PERCENT NAT.	L.L.	P.L.	P.I.	WET UNIT WEIGHT IN PCF	PRESSURE IN PSI CELL	BACK	SHEAR STRENGTH (S_u) IN PSF	STRAIN AT FAILURE (ε_f)
I	90	68	44	24	91	15	0	170	.19
II	34	36	28	8	116	10	0	715	.20
III	36	32	27	5	120	5	0	880	.20

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Figure E-III-10

Boring Log MWB-2

SOIL DESCRIPTIONS

Ground Surface Elevation in Feet -37.5

Very soft to soft, wet, black, clayey SILT with organic debris and shell fragments, containing SAND lenses from 5.0 to 6.8 feet.

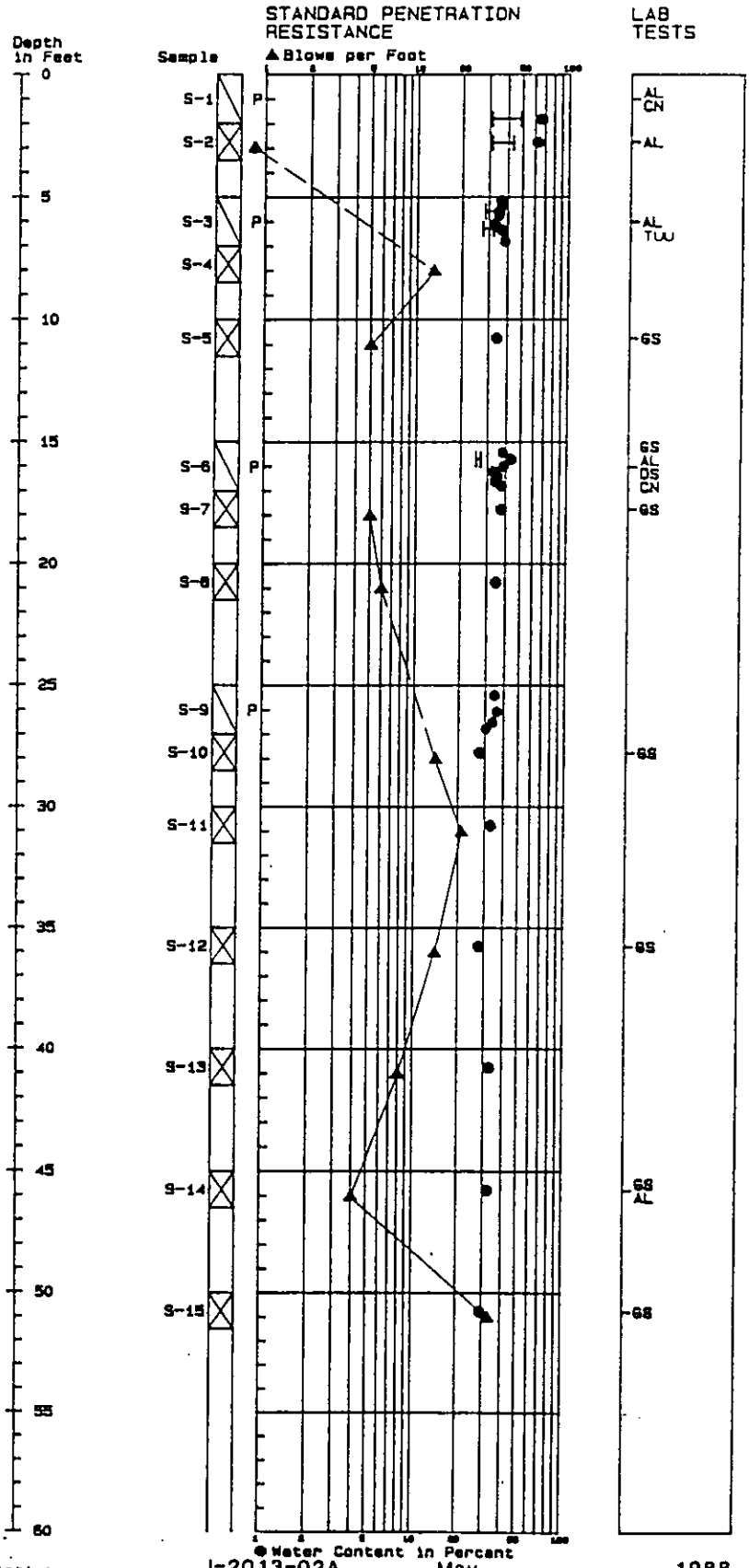
Medium dense, wet, black, silty to very silty SAND.

Medium stiff, wet, gray, slightly sandy to sandy SILT.

Stiff to soft, wet, gray, very sandy to slightly sandy SILT.

Medium dense to dense, wet, gray, silty SAND.

Bottom of Boring at 51.5 Feet. Completed 3/22/86.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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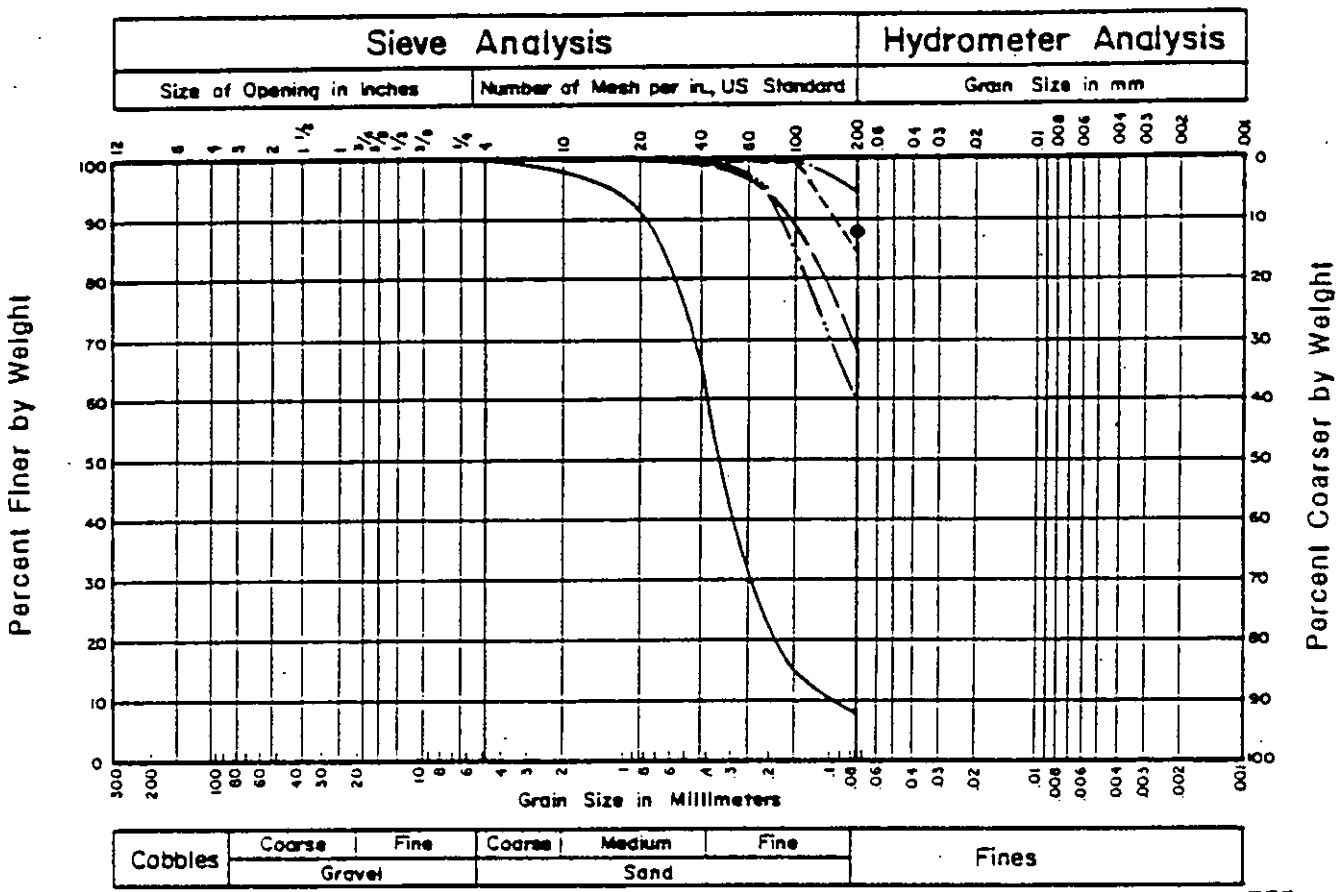
Figure E-I-3

Grain Size Classification



LINE SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	CLASSIFICATION	UNIFIED SOIL CLASS.	WATER CONTENT PERCENT
———	MWB-1	S-7	17.0 - 18.5	Slightly silty, medium to fine SAND	SP - SM	24
—— ——	MWB-1	S-13	36.0 - 37.5	Very sandy SILT	ML	33
- - - - -	MWB-2	S-5	10.0 - 11.5	Sandy SILT	ML	38
●	MWB-2	S-6	16.2 - 16.3	Slightly sandy SILT	ML	33
—·—	MWB-2	S-7	17.0 - 18.5	Slightly sandy SILT	ML	38
—··—	MWB-2	S-10	27.0 - 28.5	Very sandy SILT	ML	29

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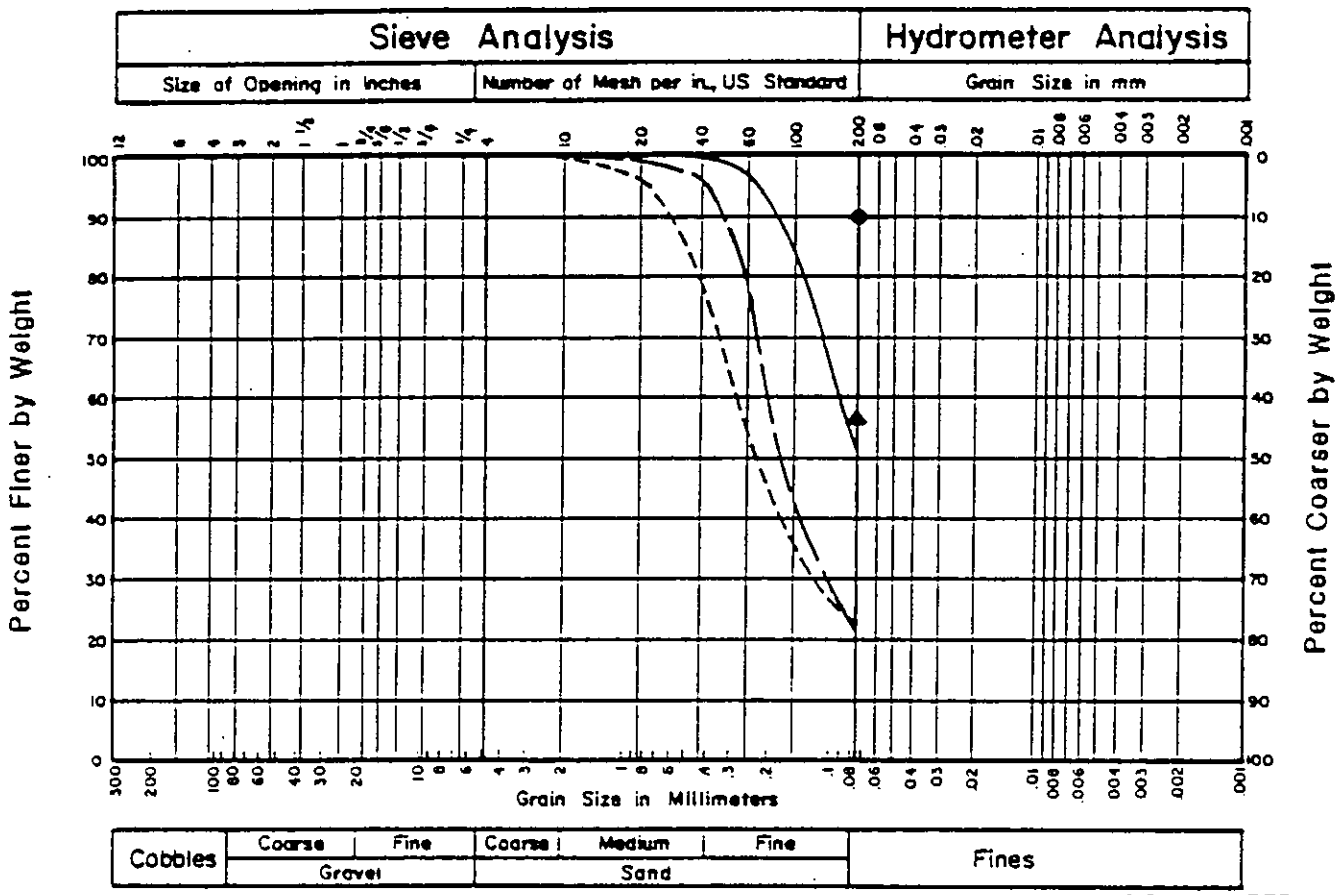
Figure E-III-5

Grain Size Classification



LINE SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	CLASSIFICATION	UNIFIED SOIL CLASS.	WATER CONTENT PERCENT
———	MWB-2	S-12	35.0 - 36.5	Very sandy SILT	ML	31
●	MWB-2	S-14	45.0 - 46.5	Slightly sandy SILT	ML	33
—— ——	MWB-2	S-15	50.0 - 51.5	Silty, fine SAND	SM	29
- - - - -	MWB-3	S-4	7.0 - 8.5	Silty, medium to fine SAND	SM	29
▲	MWB-5	S-7	17.0 - 18.5	Very sandy SILT	ML	30

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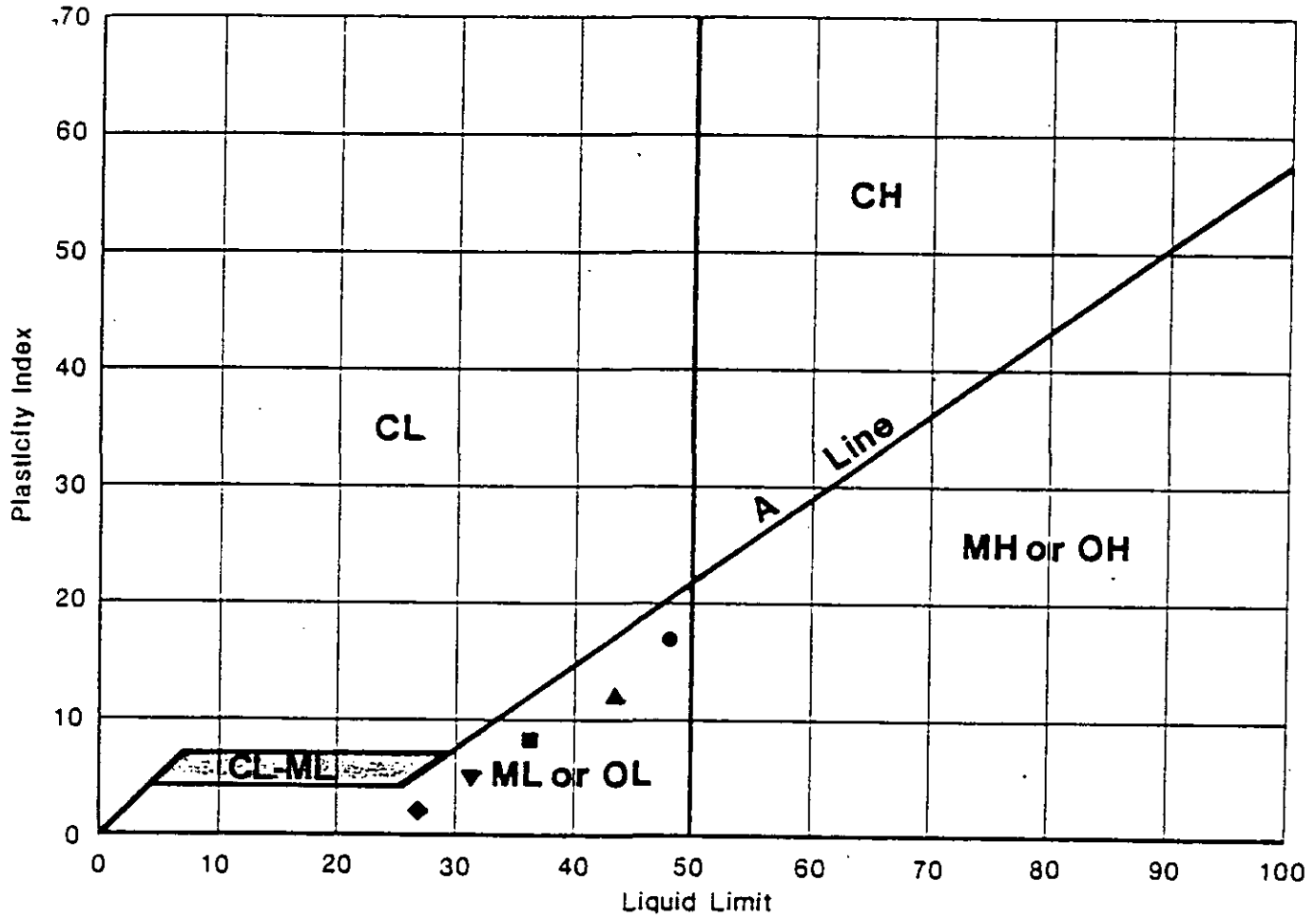
Figure E-III-6

Plasticity Chart



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WATER CONTENT IN PERCENT NAT.	L.L.	P.L.	P.I.	CLASSIFICATION	USC
●	MWB-2	S-1	1.7 - 1.8	66	48	31	17	Clayey SILT	ML
▲	MWB-2	S-2	2.0 - 3.5	64	43	31	12	Clayey SILT	ML
■	MWB-2	S-3	5.4 - 5.9	35	36	28	8	Clayey SILT	ML
▼	MWB-2	S-3	6.1 - 6.6	36	32	27	5	Clayey SILT	ML
◆	MWB-2	S-6	15.8 - 15.9	43	27	25	2	Slightly sandy to sandy SILT	ML
	MWB-2	S-14	45.0 - 46.5	33	GNP			Sandy SILT	ML

L.L. LIQUID LIMIT
P.L. PLASTIC LIMIT
P.I. PLASTICITY INDEX
USC UNIFIED SOIL CLASSIFICATION
GNP GRANULAR NON PLASTIC

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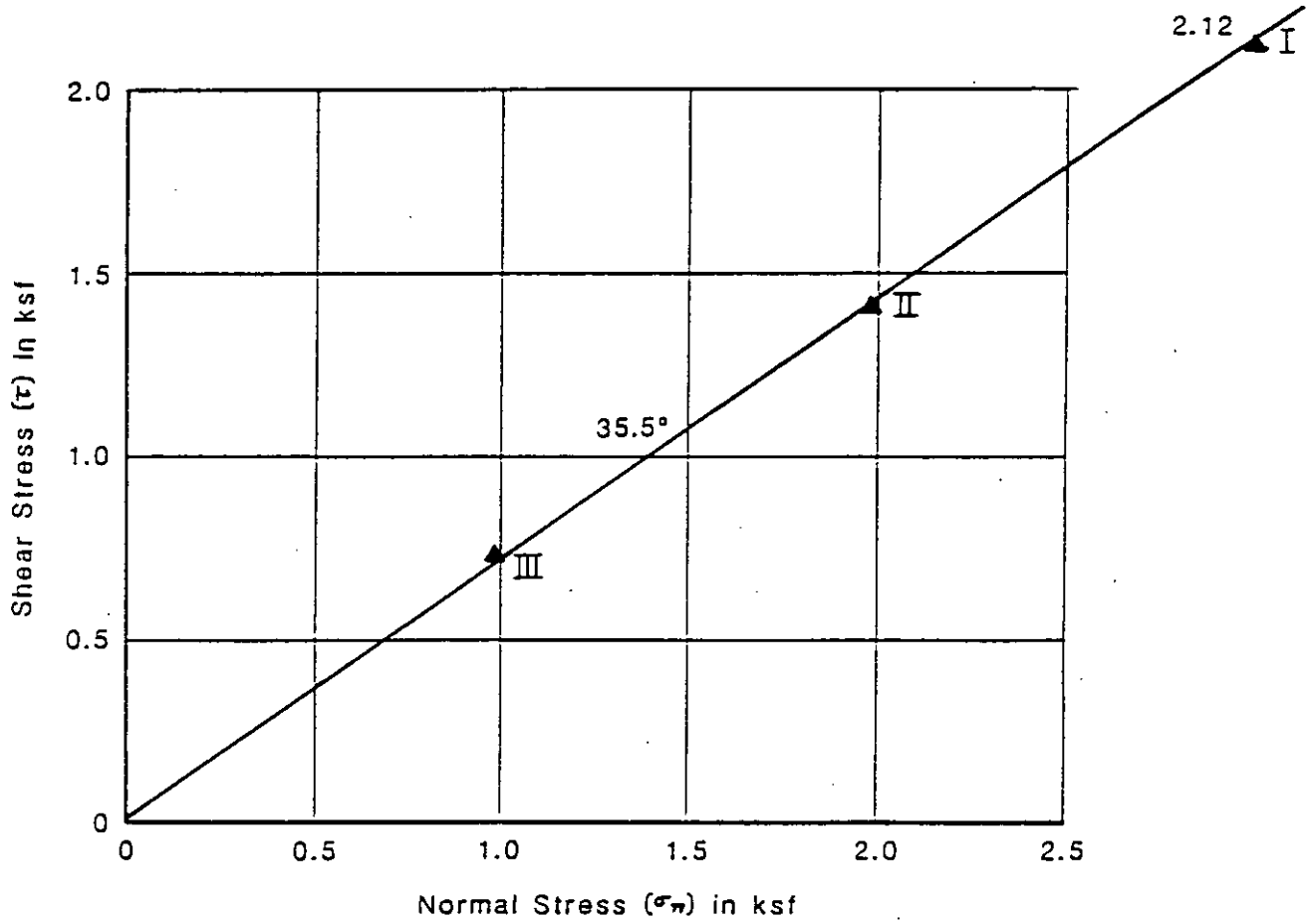
Figure E-III-9

Direct Shear Test Results



TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WET UNIT WEIGHT IN PCF	WATER CONTENT IN PERCENT NAT.	ATTERBERG LIMITS LL	PL	PI	CLASSIFICATION	UNIFIED SOIL CLASS.
I	MWB-2	S-6	16.2 - 16.3	116	33				Slightly sandy to sandy SILT	ML
II	MWB-2	S-6	16.4 - 16.5	116	35				Slightly sandy to sandy SILT	ML
III	MWB-2	S-6	16.6 - 16.7	116	34				Slightly sandy to sandy SILT	ML

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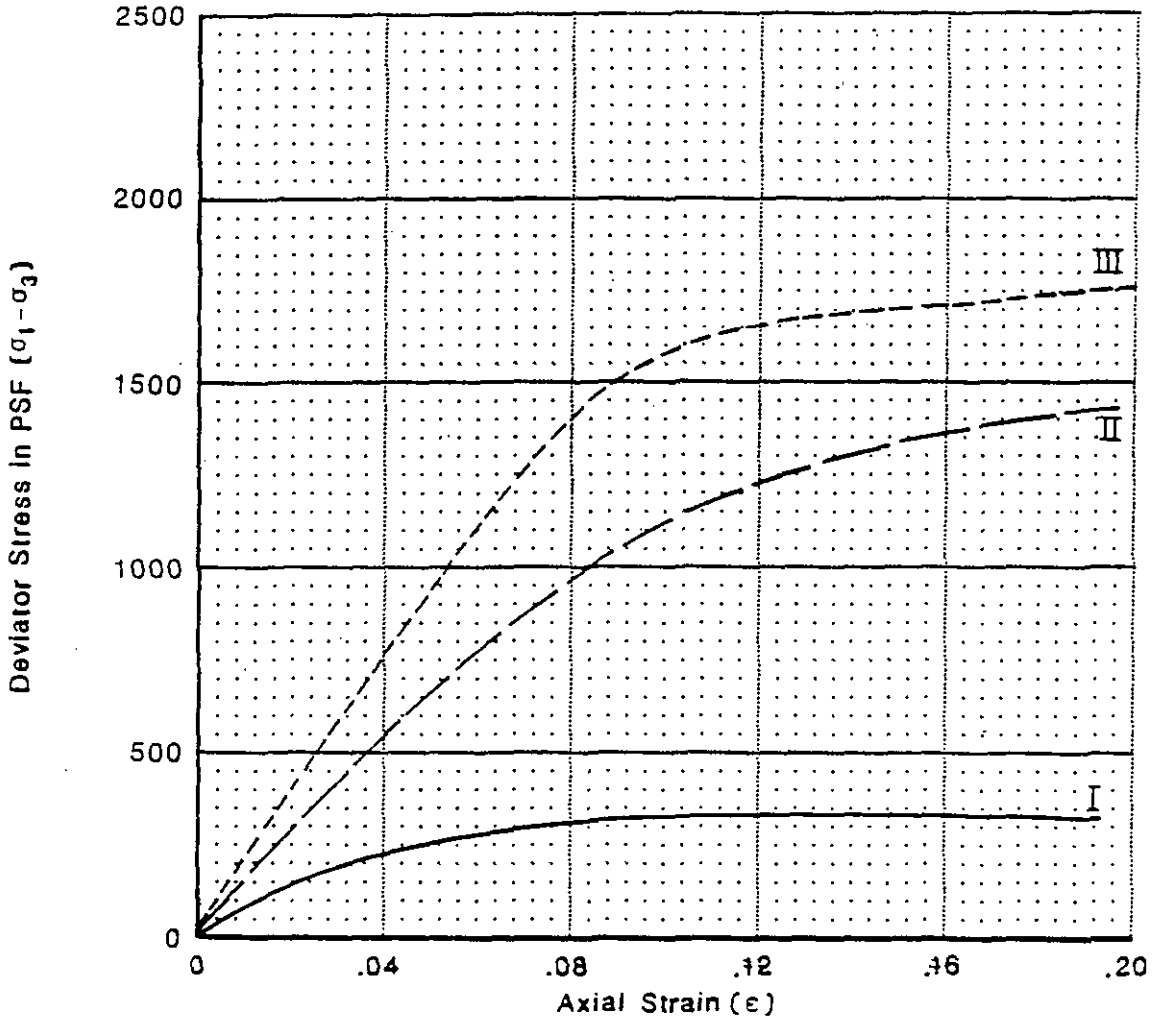
Figure E-III-11

Triaxial Compression Tests
Unconsolidated, Undrained



TEST NUMBER	EXPLOR NUMBER	SAMPLE NUMBER	DEPTH IN FEET	U.S.C.	DESCRIPTION
I	MWB-1	S-3	6.4 - 6.9	MH	Clayey SILT
II	MWB-2	S-3	5.4 - 5.9	ML	Clayey SILT
III	MWB-2	S-3	6.1 - 6.6	ML	Clayey SILT

TEST NUMBER	WATER CONTENT IN PERCENT NAT.	L.L.	P.L.	P.I.	WET UNIT WEIGHT IN PCF	PRESSURE IN PSI CELL	BACK	SHEAR STRENGTH (S_u) IN PSF	STRAIN AT FAILURE (ε_f)
I	90	68	44	24	91	15	0	170	.19
II	34	36	28	8	116	10	0	715	.20
III	36	32	27	5	120	5	0	880	.20

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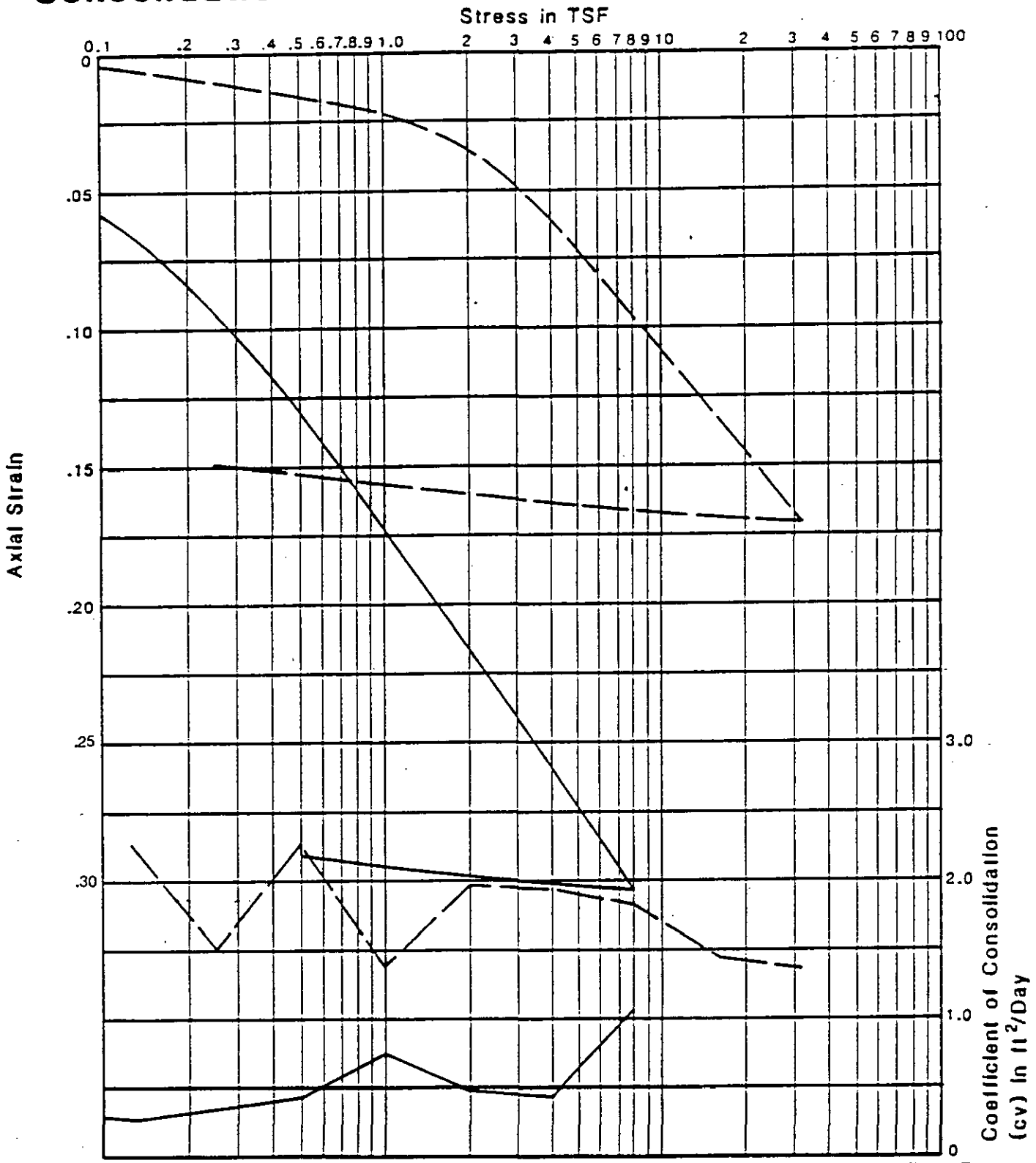
Figure E-III-10

Consolidation Test Results



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WATER CONTENT IN % NAT.	AFTER	LL	PL	PI	CLASSIFICATION	WET UNIT WEIGHT IN PCF
———	MWB-2	S-1	1.7 - 1.8	66	45	48	31	17	Clayey SILT	96
— —	MWB-2	S-6	15.6 - 15.7	43	32	27	25	2	Slightly sandy to sandy SILT	111

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HART-CROWSER & associates inc.

Figure E-III-13

Boring Log MWB-3

SOIL DESCRIPTIONS

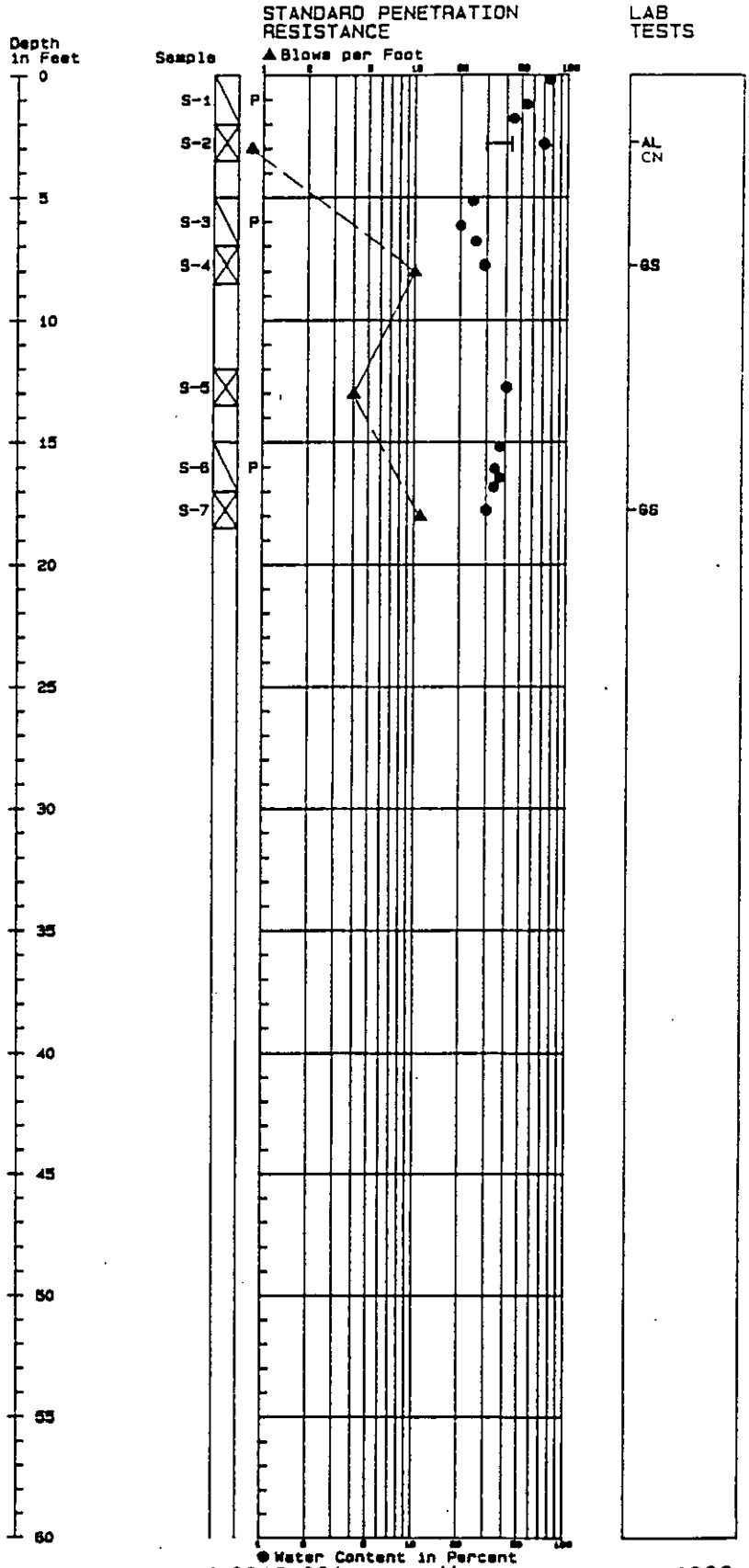
Ground Surface Elevation in Feet -39.5

Very soft, wet, black, clayey SILT with numerous organics.

Loose, wet, gray, silty SAND with occasional shell fragments.

Medium stiff to stiff, wet, gray, sandy to very sandy SILT.

Bottom of Boring at 18.5 Feet. Completed 3/18/86.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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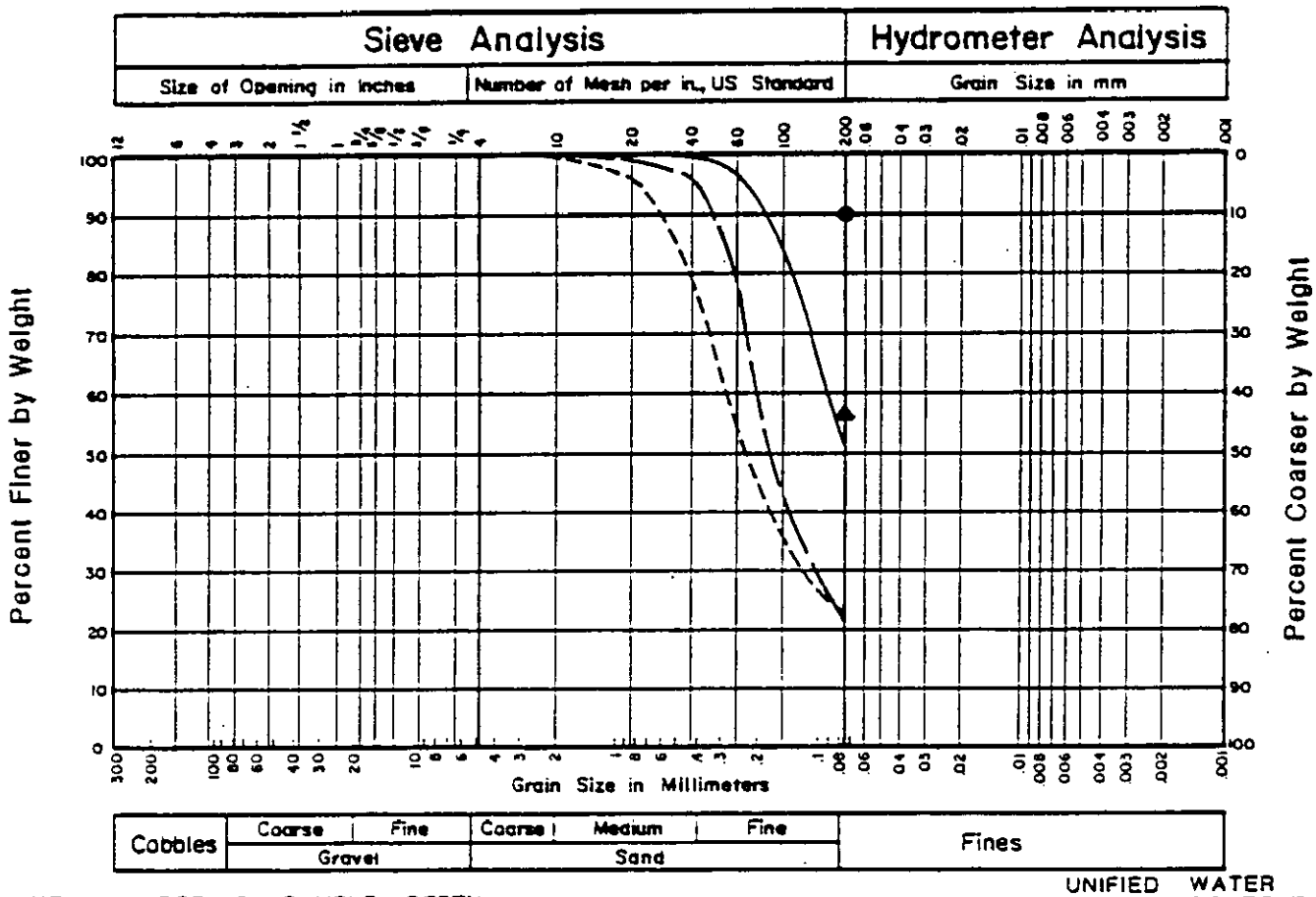
Figure E-I-4

Grain Size Classification



LINE SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	CLASSIFICATION	UNIFIED SOIL CLASS.	WATER CONTENT PERCENT
———	MWB-2	S-12	35.0 - 36.5	Very sandy SILT	ML	31
●	MWB-2	S-14	45.0 - 46.5	Slightly sandy SILT	ML	33
— —	MWB-2	S-15	50.0 - 51.5	Silty, fine SAND	SM	29
- - - - -	MWB-3	S-4	7.0 - 8.5	Silty, medium to fine SAND	SM	29
▲	MWB-5	S-7	17.0 - 18.5	Very sandy SILT	ML	30

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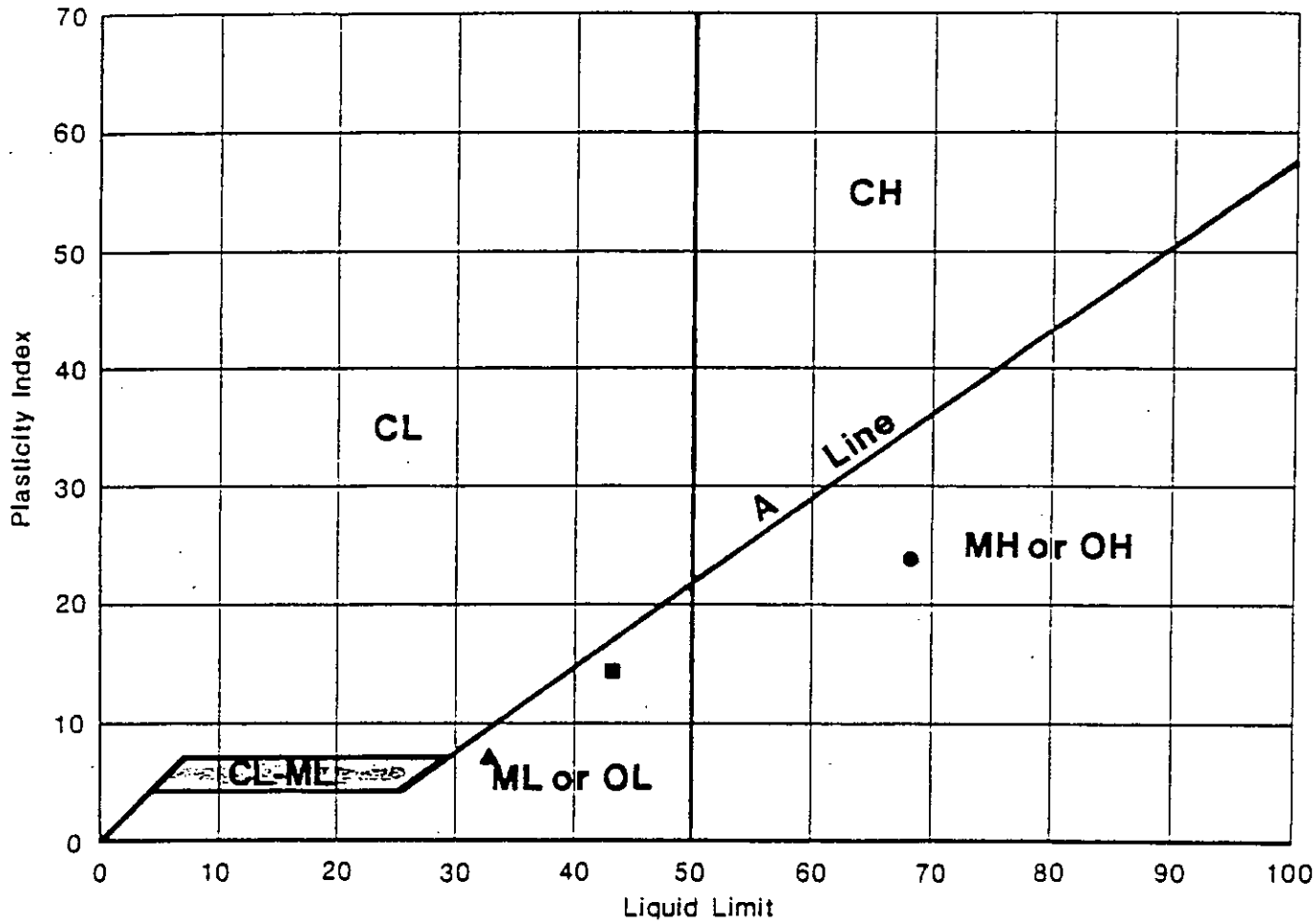
Figure E-III-6

Plasticity Chart



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WATER CONTENT IN PERCENT NAT.	L.L.	P.L.	P.I.	CLASSIFICATION	USC
●	MWB-1	S-3	6.4 - 6.9	90	68	44	24	Clayey SILT	MH
▲	MWB-1	S-11	32.0 - 33.5	38	33	26	7	Sandy SILT	ML
■	MWB-3	S-2	2.0 - 3.5		43	29	14	Clayey SILT	ML

L.L. LIQUID LIMIT
P.L. PLASTIC LIMIT
P.I. PLASTICITY INDEX
USC UNIFIED SOIL CLASSIFICATION

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HART-CROWSER & associates inc.
Figure E-III-8

Boring Log F-1

SOIL INTERPRETATION

Approximate Ground Surface Elevation in Feet -31 MLLW

Depth Feet

Very soft, saturated, dark gray, very sandy SILT.

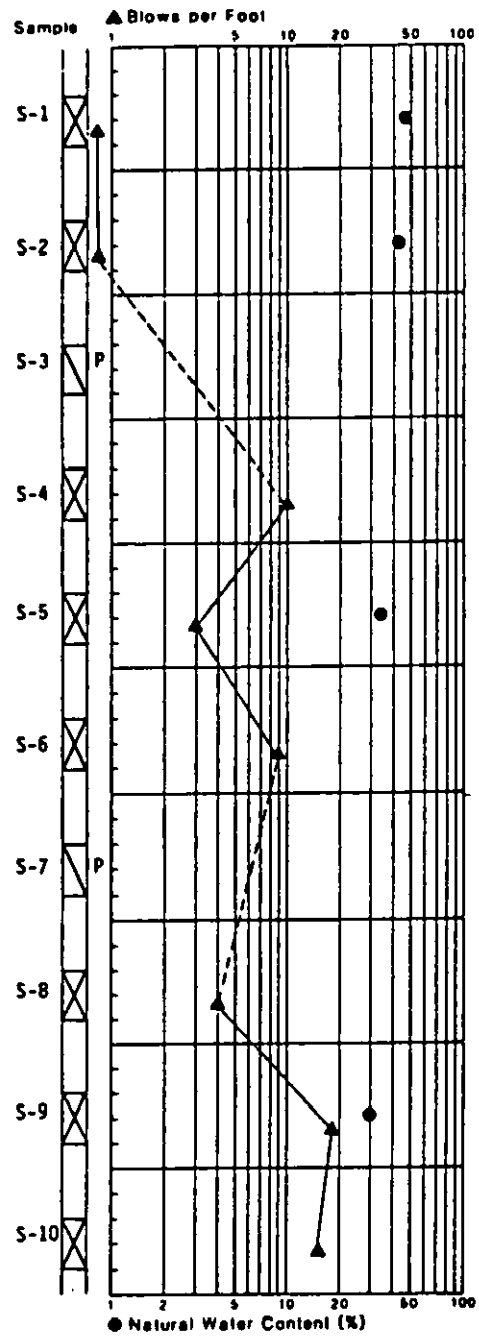
(Chemical odor noticed within upper 15 feet of soil).

Loose, saturated, gray, very silty SAND.

Medium stiff, saturated, dark gray, sandy SILT.

Very stiff, saturated, gray, sandy SILT.

Bottom of Boring at 49.0 Feet.
Completed 12/7/84.



LABORATORY TESTS

200 Wash
200 Wash
200 Wash
200 Wash

Ground Water Level

Bentonite Seal

2/4/83

Water Level (Date) At Time of Drilling

ATD

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

• No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

OU Unconfined Compression

TV Torvane, tsf

PP Pocket Penetrometer, tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year
3. Water content not determined on very small samples nor on samples with significant gravel content.

J-1459-01 December 1984

HART-CROWSER & associates, Inc.

Figure A-1

Table B-1 - Summary of Results From No. 200-Wash Tests

Boring Number	Sample Number	Sample Interval in Feet	Sand Content (% Coarser than No. 200 Sieve)	Silt Content (% Finer than No. 200 Sieve)	Soil Description	U.S.C.
F-1	S-1	2.0 - 4.0	34	66	Very sandy SILT	ML
F-1	S-2	7.0 - 9.0	38	62	Very sandy SILT	ML
F-1	S-5	22.0 - 24.0	36	64	Very sandy SILT	ML
F-1	S-9	42.0 - 44.0	84	16	Silty, fine SAND	SM
F-2	S-1	2.0 - 4.0	14	86	Sandy SILT	ML
F-2	S-3	12.0 - 14.0	67	33	Very silty, fine SAND	SM
F-2	S-8	37.0 - 39.0	90	10	Slightly silty, fine SAND	SP-SM
F-2	S-10	47.0 - 49.0	82	18	Silty, fine SAND	SM
F-3	S-1	2.0 - 4.0	89	11	Slightly silty, fine SAND	SP-SM
F-3	S-4	17.0 - 19.0	24	76	Sandy SILT	ML
F-3	S-6	27.0 - 29.0	9	91	Slightly sandy SILT	ML
F-3	S-9	42.0 - 44.0	80	20	Silty, fine SAND	SM
F-3	S-18	87.0 - 89.0	31	69	Very sandy SILT	ML

Boring Log F-2

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

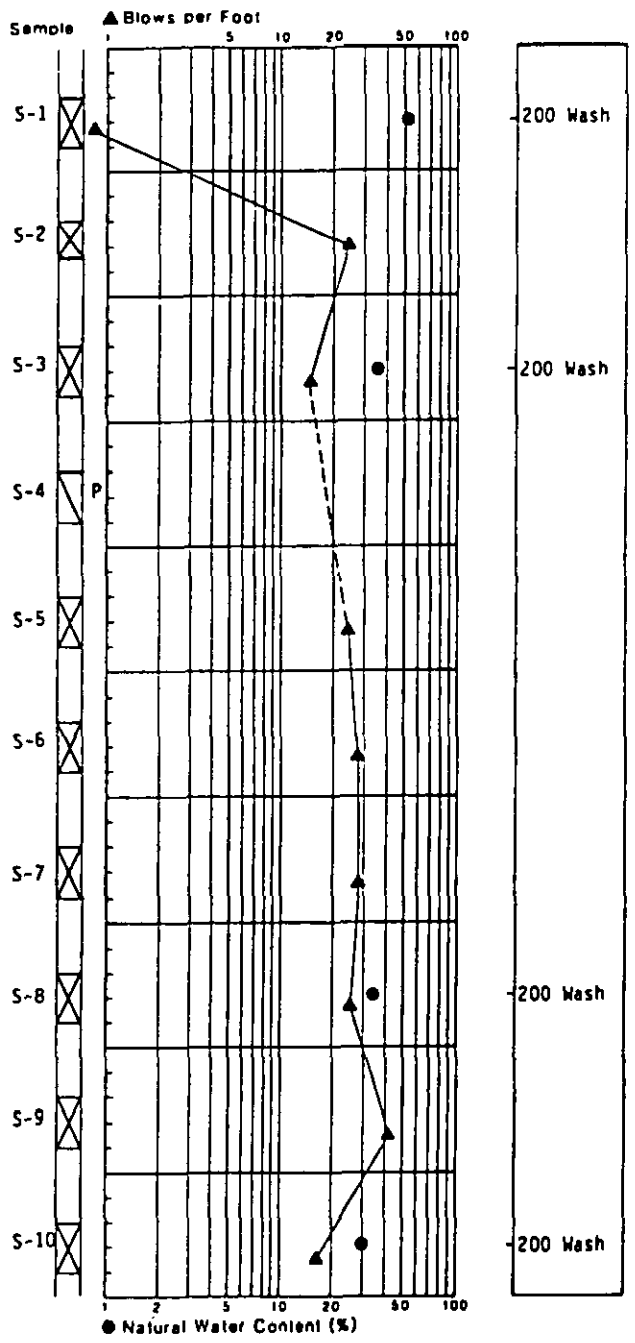
LABORATORY TESTS

Approximate Ground Surface Elevation in Feet -34 MLLW

Very soft to very stiff, saturated, gray, sandy SILT.

Medium dense, saturated, gray to black, slightly silty to silty, fine SAND.

Bottom of Boring at 49.0 Feet.
Completed 12/12/84.



Ground Water Level

Bentonite Seal

Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

DU Unconfined Compression

TV Torvane, tsf

PP Pocket Penetrometer tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level if indicated, is for the date specified and may vary with the time of year
3. Water content not determined on very small samples nor on samples with significant gravel content.

J-1459-01 December 1984

HART-CROWSER & associates, inc.

Figure A-2

Table B-1 - Summary of Results From No. 200-Wash Tests

Boring Number	Sample Number	Sample Interval in Feet	Sand Content (% Coarser than No. 200 Sieve)	Silt Content (% Finer than No. 200 Sieve)	Soil Description	U.S.C.
F-1	S-1	2.0 - 4.0	34	66	Very sandy SILT	ML
F-1	S-2	7.0 = 9.0	38	62	Very sandy SILT	ML
F-1	S-5	22.0 - 24.0	36	64	Very sandy SILT	ML
F-1	S-9	42.0 - 44.0	84	16	Silty, fine SAND	SM
F-2	S-1	2.0 - 4.0	14	86	Sandy SILT	ML
F-2	S-3	12.0 - 14.0	67	33	Very silty, fine SAND	SM
F-2	S-8	37.0 - 39.0	90	10	Slightly silty, fine SAND	SP-SM
F-2	S-10	47.0 - 49.0	82	18	Silty, fine SAND	SM
F-3	S-1	2.0 - 4.0	89	11	Slightly silty, fine SAND	SP-SM
F-3	S-4	17.0 - 19.0	24	76	Sandy SILT	ML
F-3	S-6	27.0 - 29.0	9	91	Slightly sandy SILT	ML
F-3	S-9	42.0 - 44.0	80	20	Silty, fine SAND	SM
F-3	S-18	87.0 - 89.0	31	69	Very sandy SILT	ML

Boring Log F-3

SOIL
INTERPRETATION

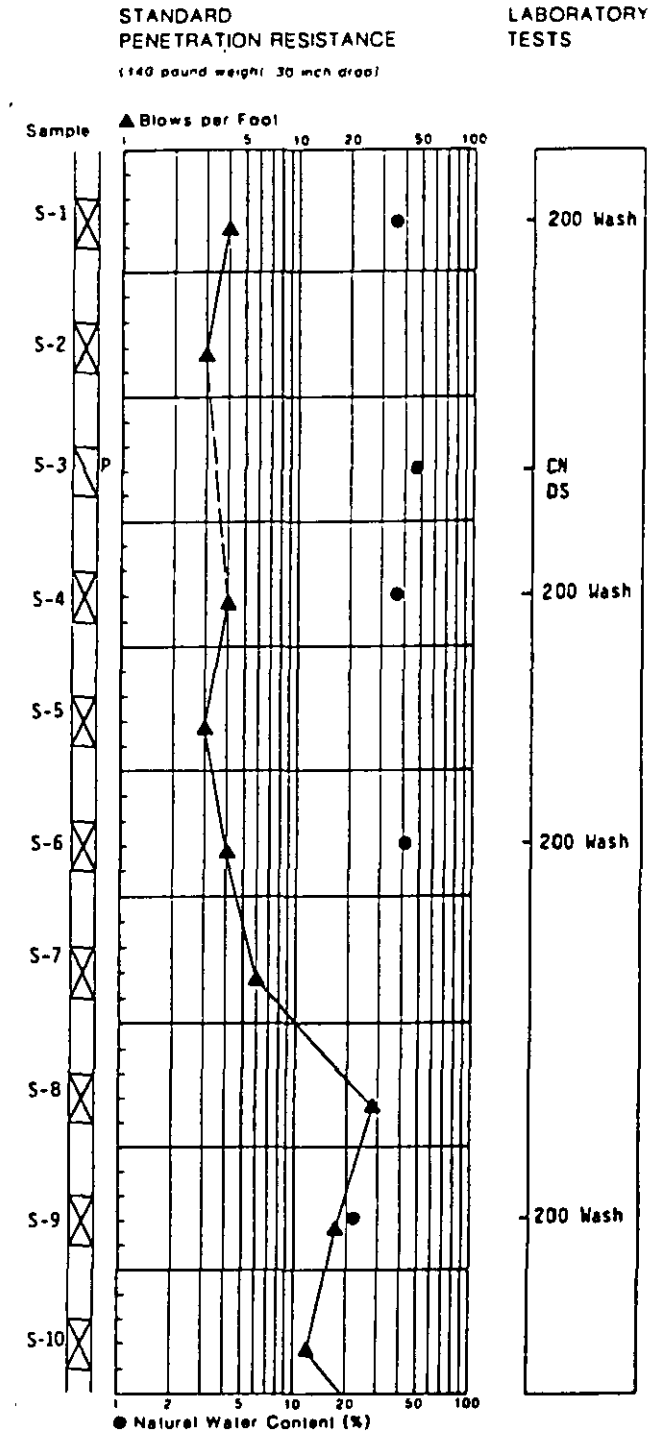
Approximate Ground Surface Elevation in Feet -11 MLLW

Very loose, saturated, dark gray, slightly silty SAND.

Soft, saturated, gray, slightly sandy to sandy SILT with pieces of wood and scattered shell fragments.

Medium dense, saturated, gray to black, slightly silty to silty, fine SAND.

(Strong chemical odor detected during drilling from 38 to 50 feet).



J-1459-01 January 1985
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Sheet 1 of 3 Figure A-3

Boring Log F-3

SOIL
INTERPRETATION

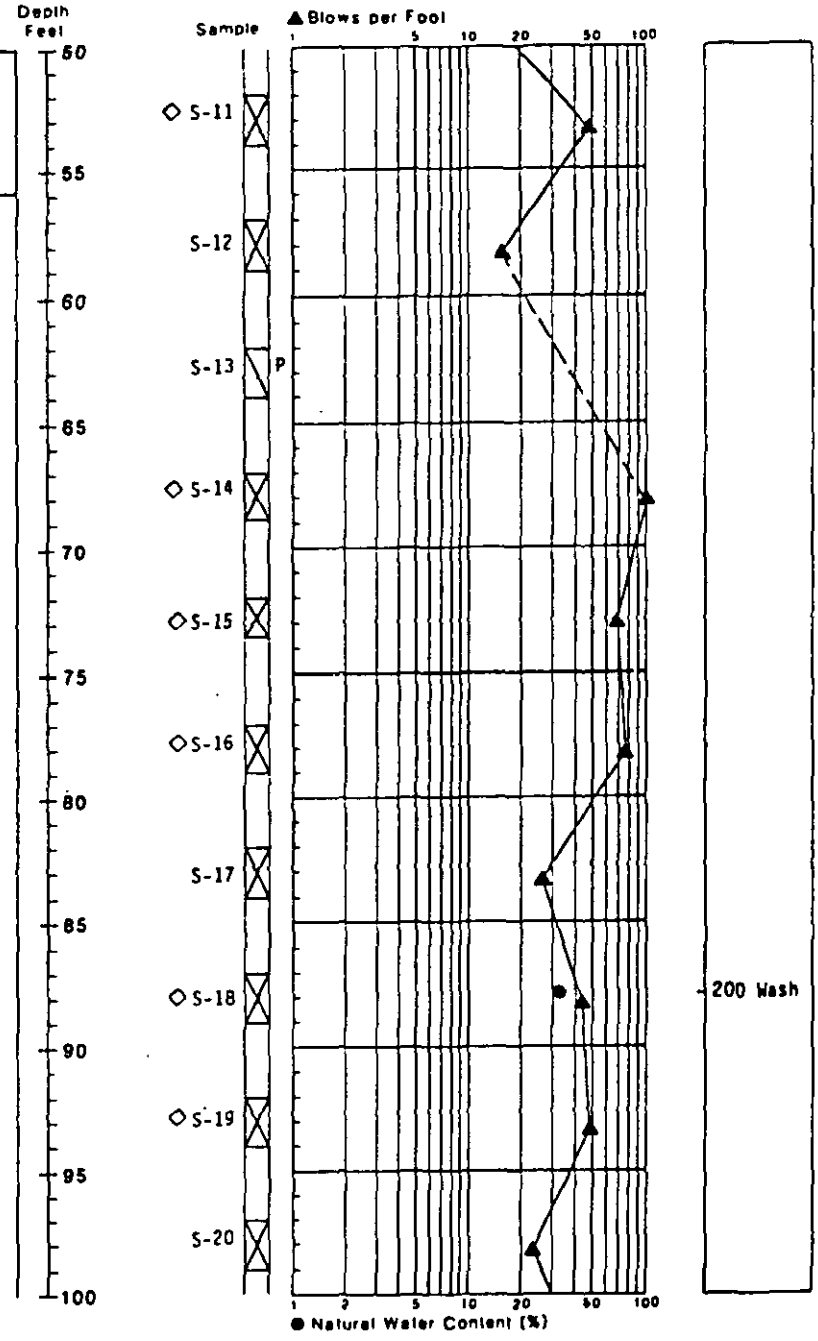
STANDARD
PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY
TESTS

Approximate Ground Surface Elevation in Feet

Medium dense, saturated, gray to black, slightly silty to silty, fine SAND.

Medium dense to dense, saturated, gray to black, slightly silty to silty, fine SAND interlayered with sandy SILT.



J-1459-01 January 1985
HART-CROWSER & associates, inc.
Sheet 2 of 3 Figure A-3

Boring Log F-3

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE (140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet

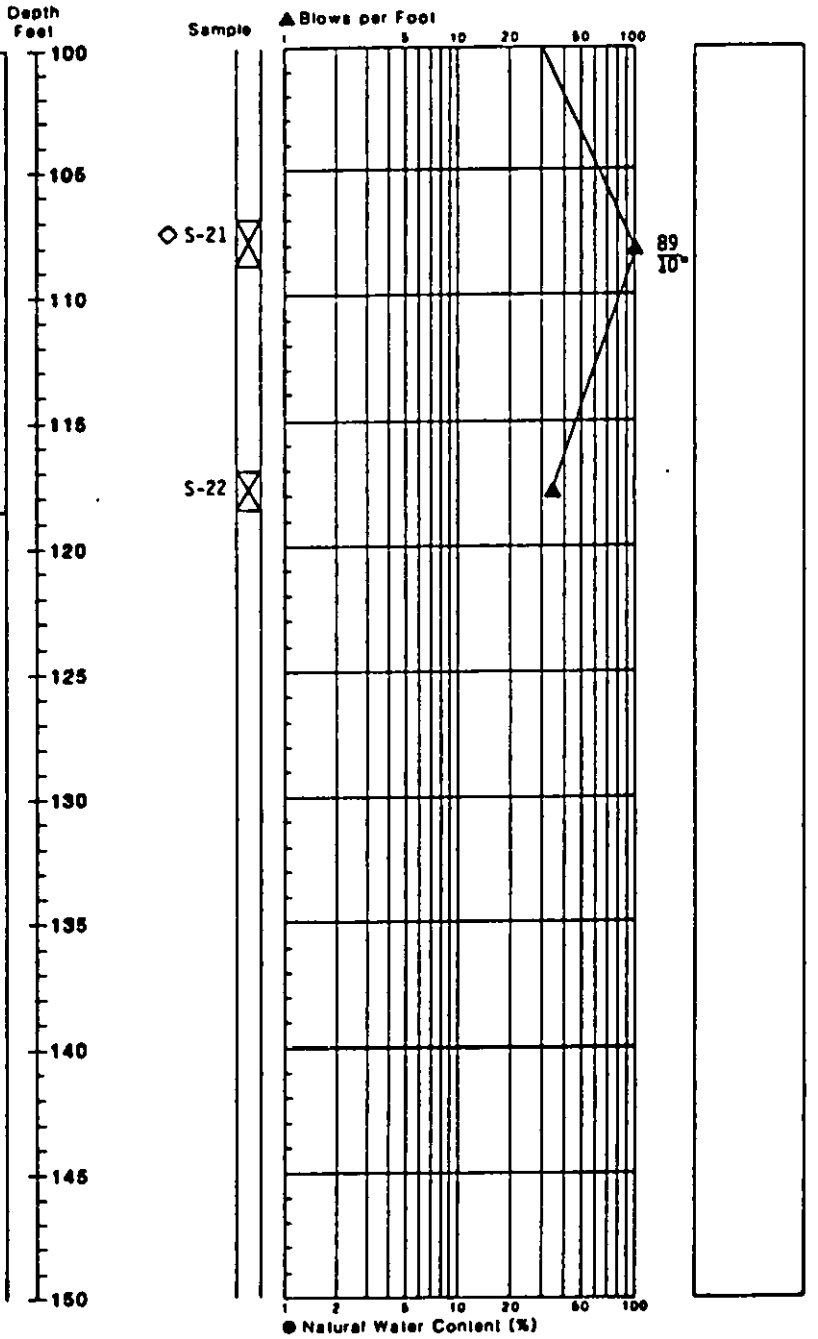
Depth Feet

Sample

▲ Blows per Foot

Medium dense to dense, saturated, gray to black, slightly silty to silty SAND interlayered with sandy SILT.

Bottom of Boring at 118.5 Feet.
Completed 12/14/84.



Ground Water Level

Bentonite Seal

2/4/83

Water Level (Date) At Time of Drilling

ATD

Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- • No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

◇ Blow count not considered representative due to sand heave in auger during drilling.

Laboratory Tests

- GS Grain Size Analysis
- CN Consolidation Test
- K Permeability Test
- DS Direct Shear
- QU Unconfined Compression
- TV Torvane, tsf
- PP Pocket Penetrometer, tsf
- TUU Triaxial Unconsolidated Undrained
- TCU Triaxial Consolidated Undrained
- TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year
3. Water content not determined on very small samples nor on samples with significant gravel content.

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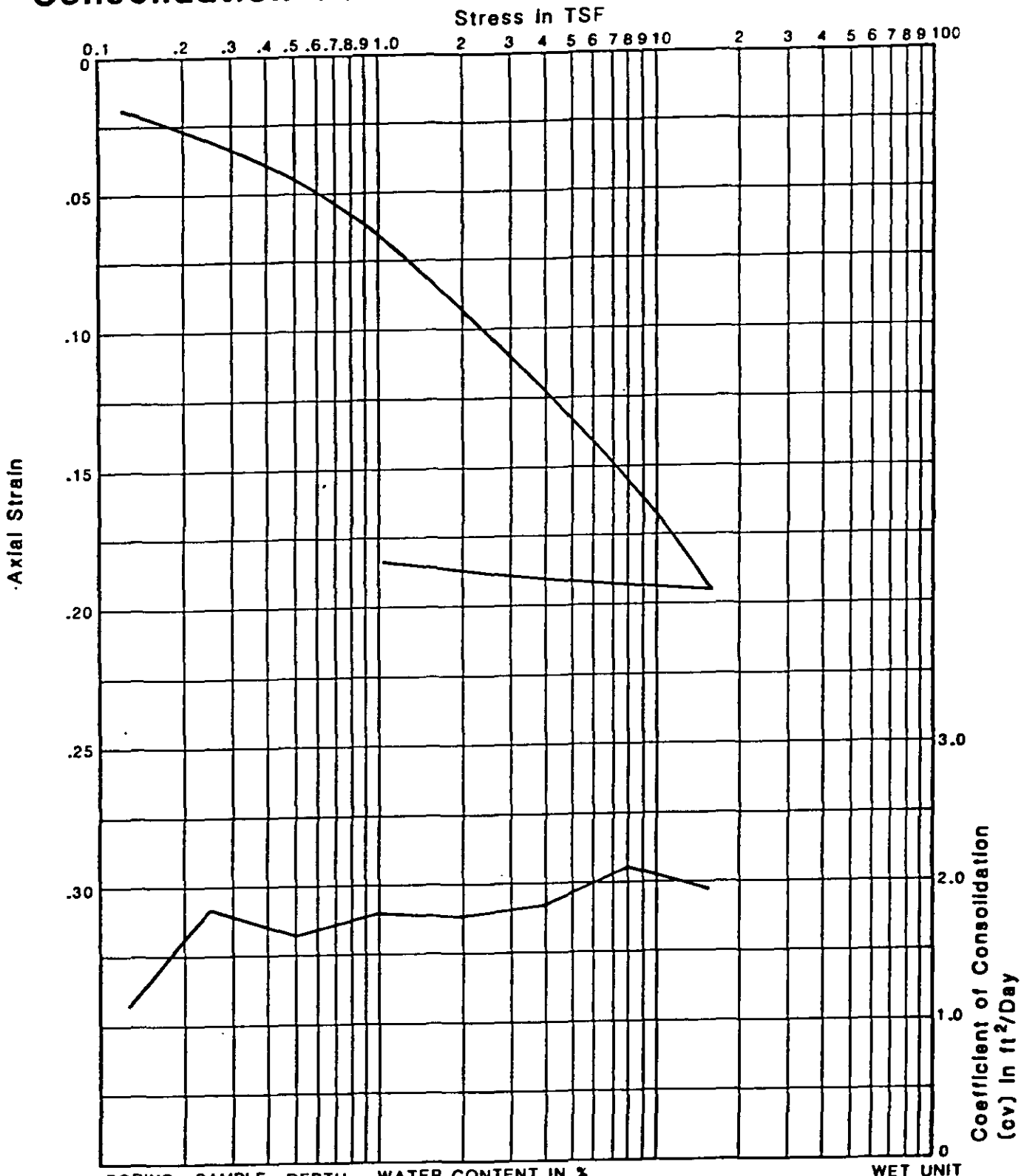
HART-CROWSER & associates, inc.

Sheet 3 of 3 Figure A-3

Table B-1 - Summary of Results From No. 200-Wash Tests

Boring Number	Sample Number	Sample Interval in Feet	Sand Content (% Coarser than No. 200 Sieve)	Silt Content (% Finer than No. 200 Sieve)	Soil Description	U.S.C.
F-1	S-1	2.0 - 4.0	34	66	Very sandy SILT	ML
F-1	S-2	7.0 = 9.0	38	62	Very sandy SILT	ML
F-1	S-5	22.0 - 24.0	36	64	Very sandy SILT	ML
F-1	S-9	42.0 - 44.0	84	16	Silty, fine SAND	SM
F-2	S-1	2.0 - 4.0	14	86	Sandy SILT	ML
F-2	S-3	12.0 - 14.0	67	33	Very silty, fine SAND	SM
F-2	S-8	37.0 - 39.0	90	10	Slightly silty, fine SAND	SP-SM
F-2	S-10	47.0 - 49.0	82	18	Silty, fine SAND	SM
F-3	S-1	2.0 - 4.0	89	11	Slightly silty, fine SAND	SP-SM
F-3	S-4	17.0 - 19.0	24	76	Sandy SILT	ML
F-3	S-6	27.0 - 29.0	9	91	Slightly sandy SILT	ML
F-3	S-9	42.0 - 44.0	80	20	Silty, fine SAND	SM
F-3	S-18	87.0 - 89.0	31	69	Very sandy SILT	ML

Consolidation Test Results



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	WATER CONTENT IN % NAT.	AFTER	LL	PL	PI	CLASSIFICATION	WET UNIT WEIGHT IN PCF
———	F-3	S-3	12.4 - 12.5	46	32				Sandy SILT	109.2

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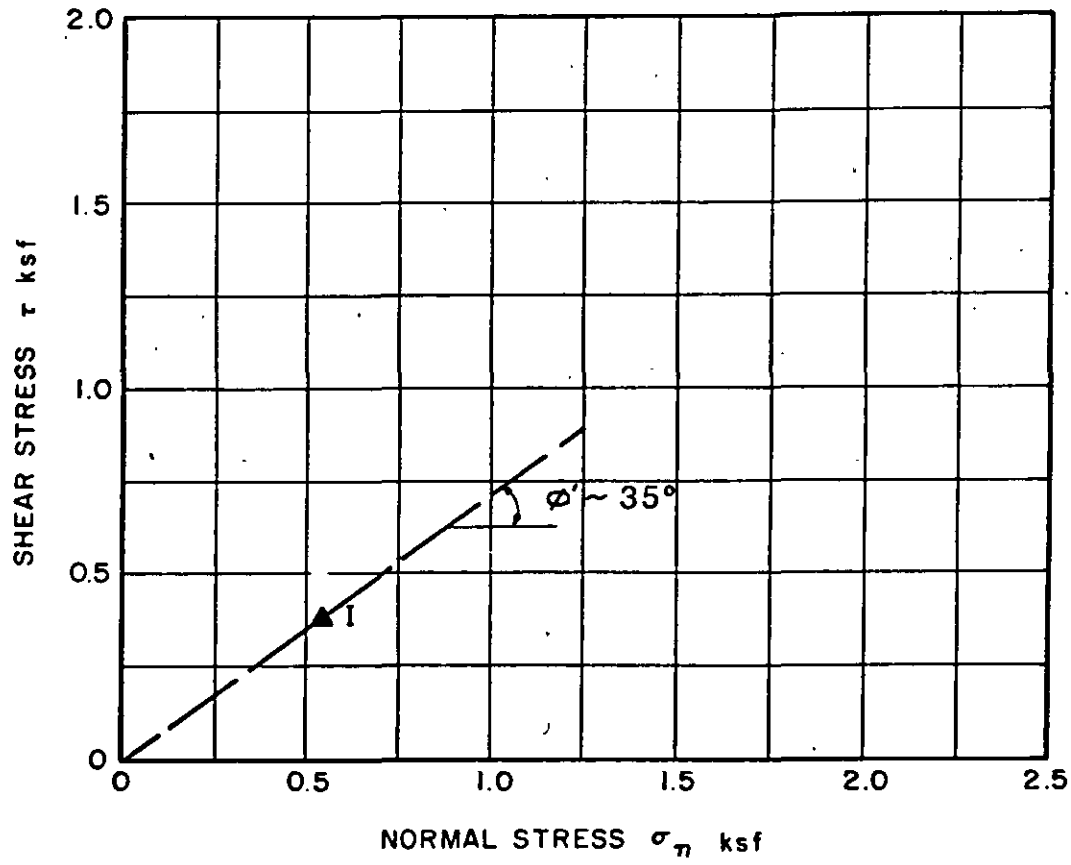
Figure B-2

Direct Shear Test Results



TEST NO	SAMPLE	DEPTH FEET	δ WET (PCF)	%W.C.	ATTERBERG LIMITS LL	PL	PI	CLASSIFICATION
I	F-3, S-3	13.1 - 13.2	110.7	-	-	-	-	Sandy SILT

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Figure B-3

Boring Log S-2

SOIL INTERPRETATION

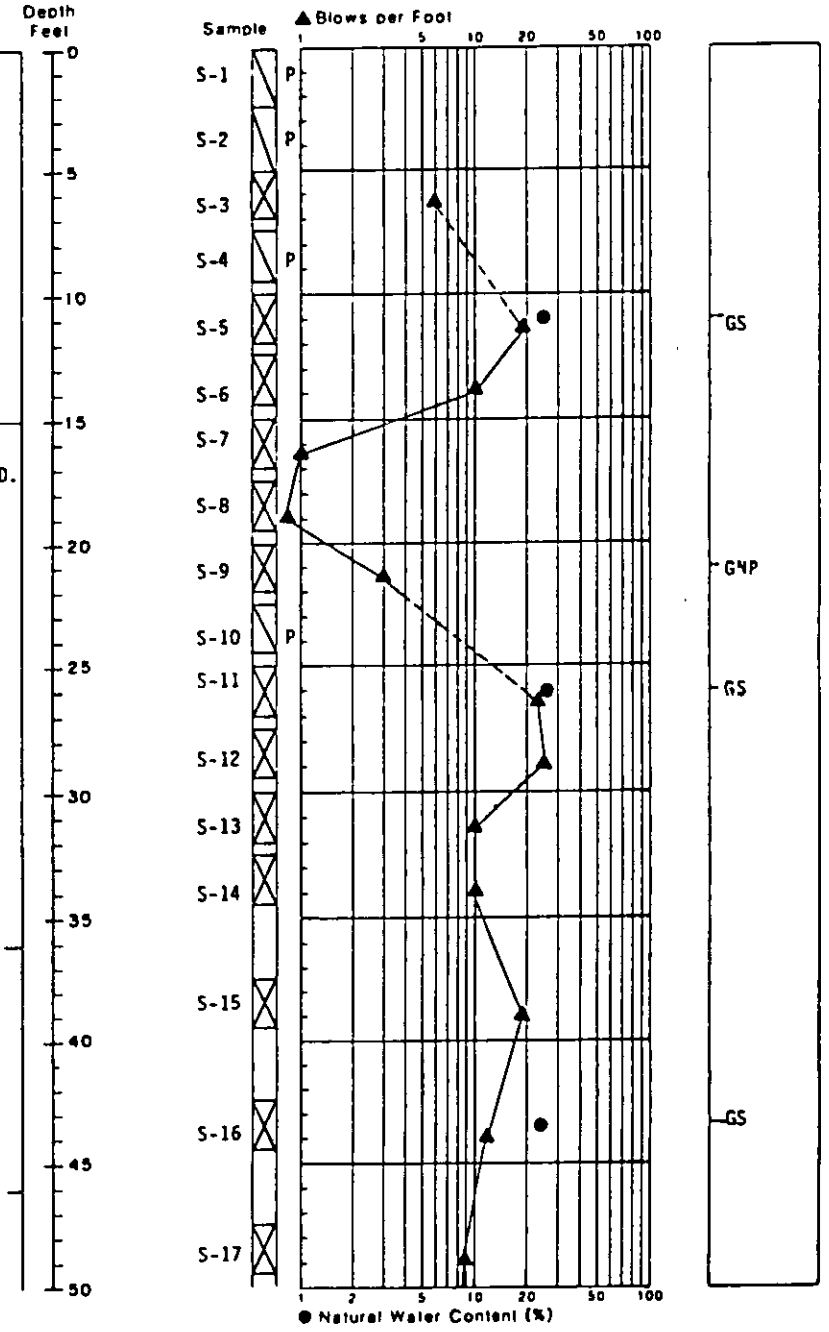
Approximate Mudline Elevation in Feet -44 (MLLW)

Loose, saturated, black, very silty, fine SAND.

Very soft to very stiff, saturated, black, laminated seams of sandy SILT and silty, fine SAND.

Medium dense, saturated, black, silty, fine SAND.

Loose, saturated, black, laminated seams of very silty, fine SAND and sandy SILT.



J-1459-01
J-1455 November 1984
HART-CROWSER & associates, inc.
Sheet 1 of 2 Figure A-4

Boring Log S-2

SOIL INTERPRETATION

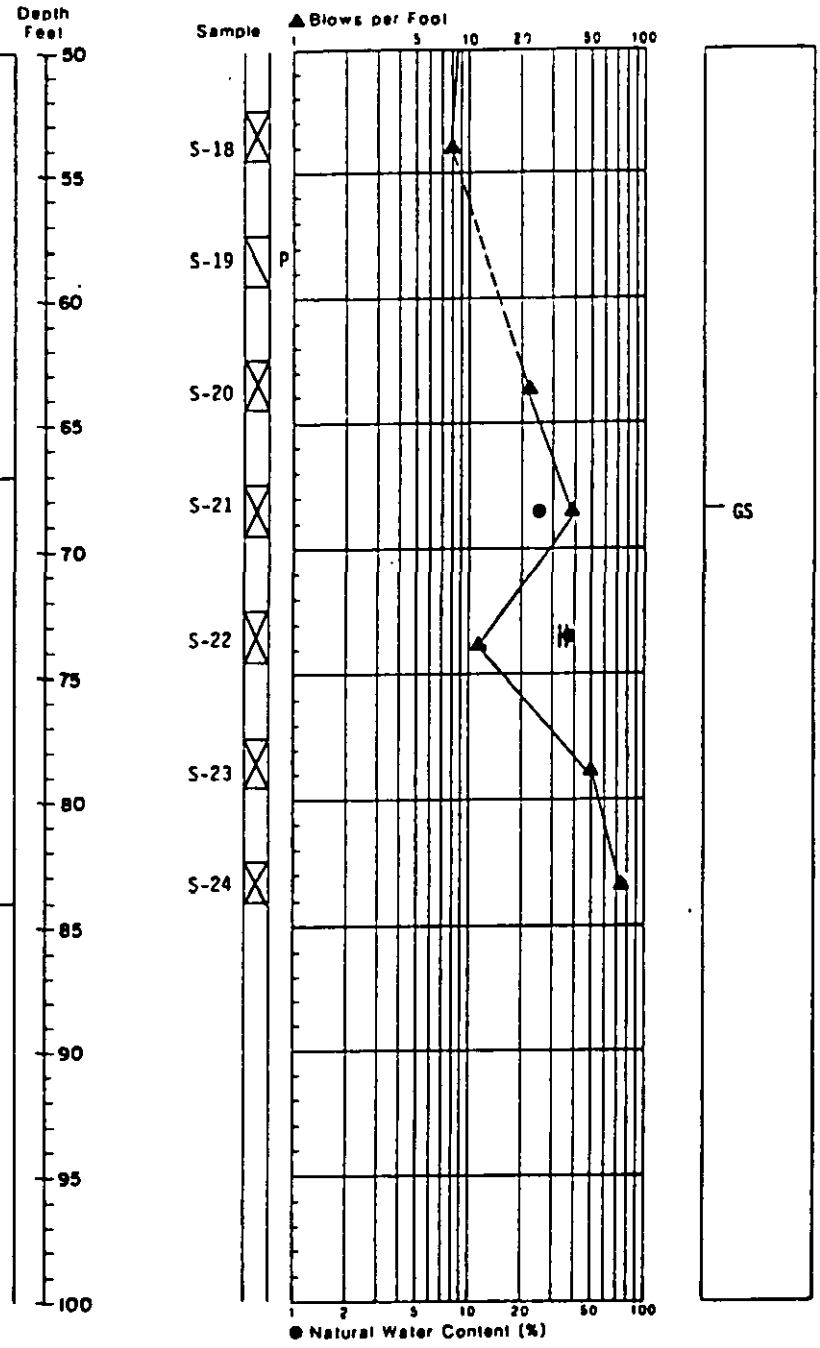
STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Loose to medium dense, saturated, dark gray, laminated seams of very silty, fine SAND and sandy SILT.

Medium stiff to very stiff, saturated, dark gray, very sandy SILT.

Bottom of Boring at 84.0 Feet.
Completed 11/19/84.



Ground Water Level

Bentonite Seal

2/4/83

Water Level (Date)

ATD At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

• No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

QU Unconfined Compression

TV Torvane, tsf

PP Pocket Penetrometer tsf

GNP Granular Non-Plastic

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level if indicated, is for the date specified and may vary with the time of year
3. Water content not determined on very small samples nor on samples with significant gravel content.

J-1459-01
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HART-CROWSER & associates, inc.

Sheet 2 of 2 Figure A-4

Boring Log S-3

SOIL INTERPRETATION

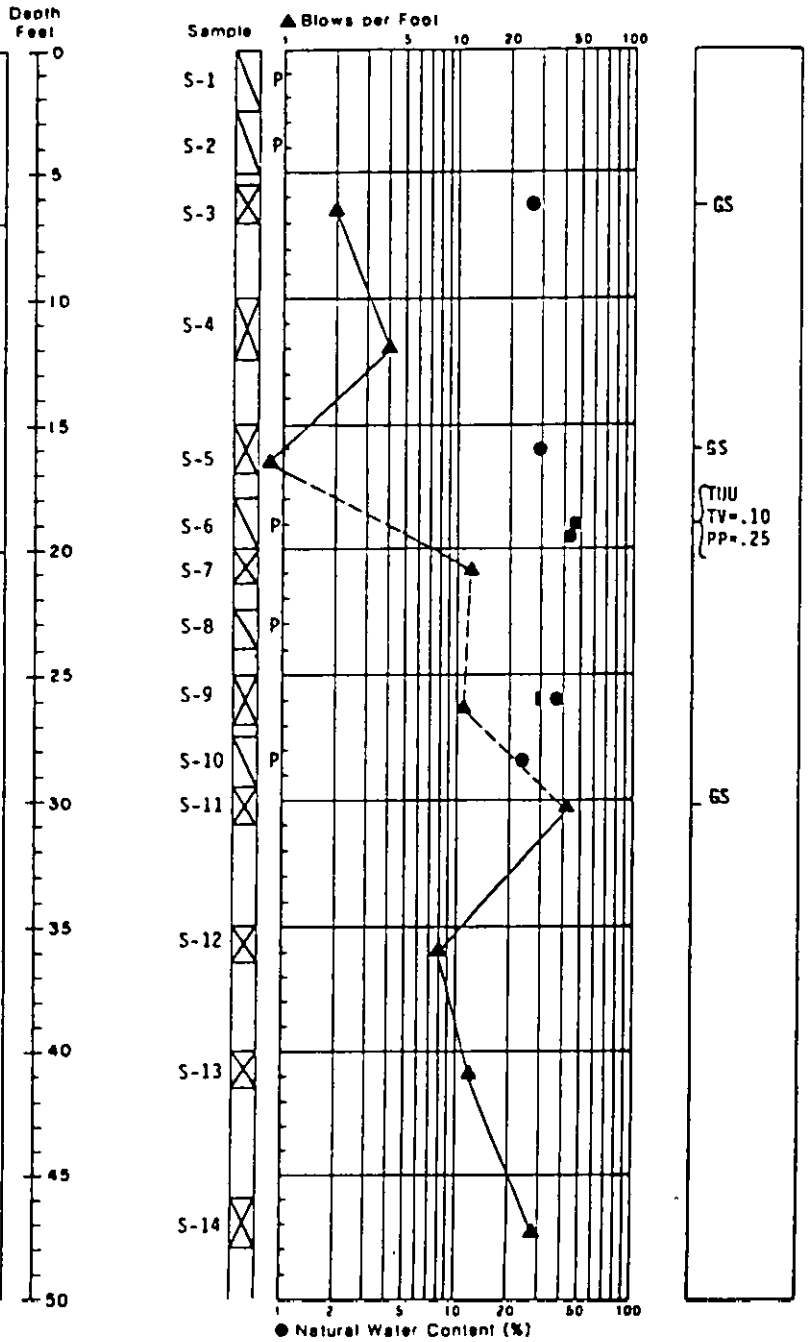
Approximate Mudline Elevation in Feet -28 (MLLW)

Very loose, saturated, black, silty, fine SAND.

Soft to very soft, saturated, black, very sandy SILT with seams of organic SILT.

Loose to medium dense, saturated, black, laminated layers of silty, fine SAND and sandy SILT.

Bottom of Boring at 48.0 Feet.
Completed 11/15/84.



Ground Water Level

Bentonite Seal

3/14/83

Water Level (Date) At Time of Drilling

A10

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

e No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

OU Unconfined Compression

TV Torvane, tsf

PP Pocket Penetrometer tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated is for the date specified and may vary with the time of year
3. Water content not determined on very small samples nor on samples with significant gravel content.

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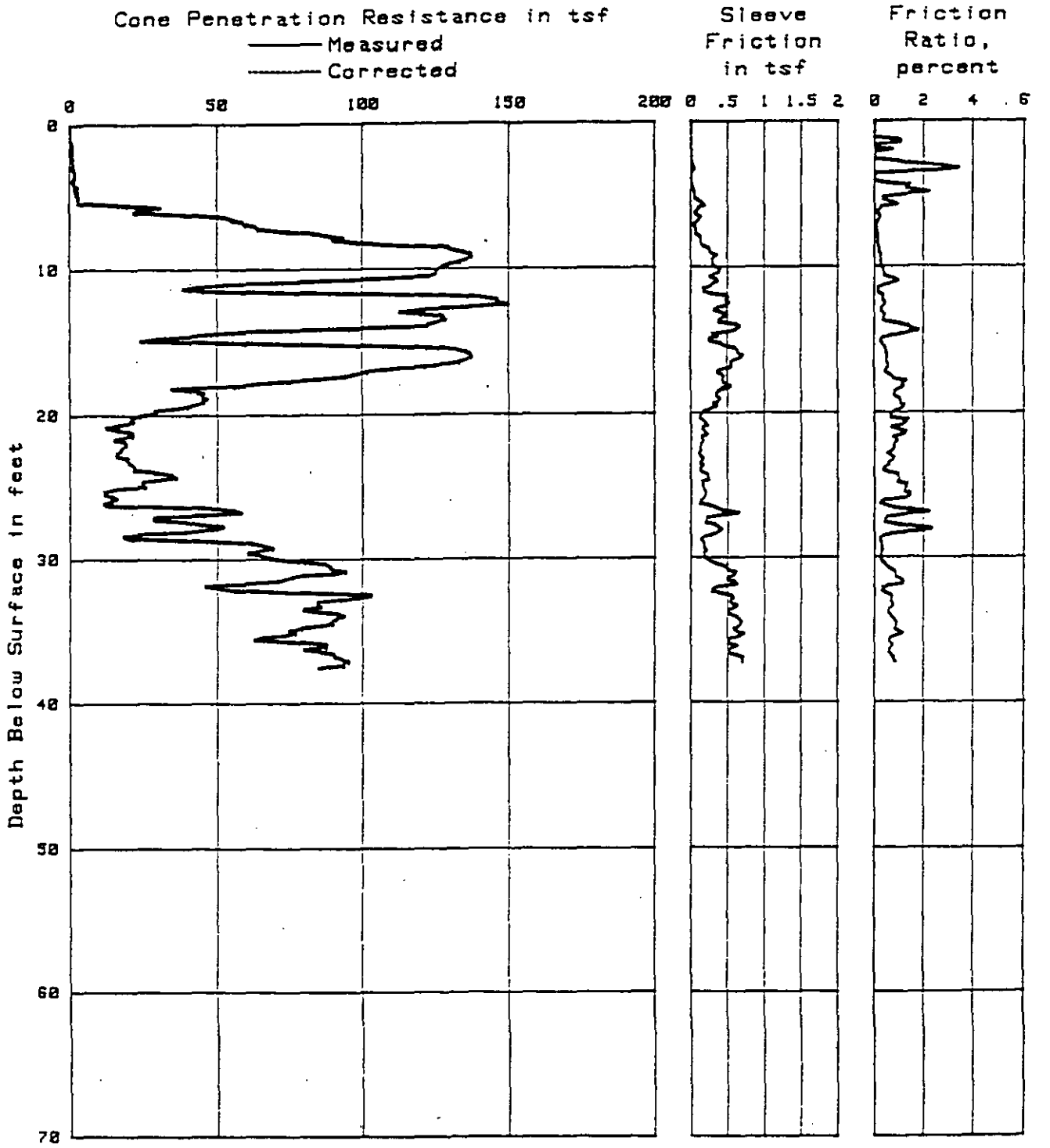
Figure A-5

Probe Log MWP-1

Approximate Surface Elevation in Feet -40
(MLLW=0)



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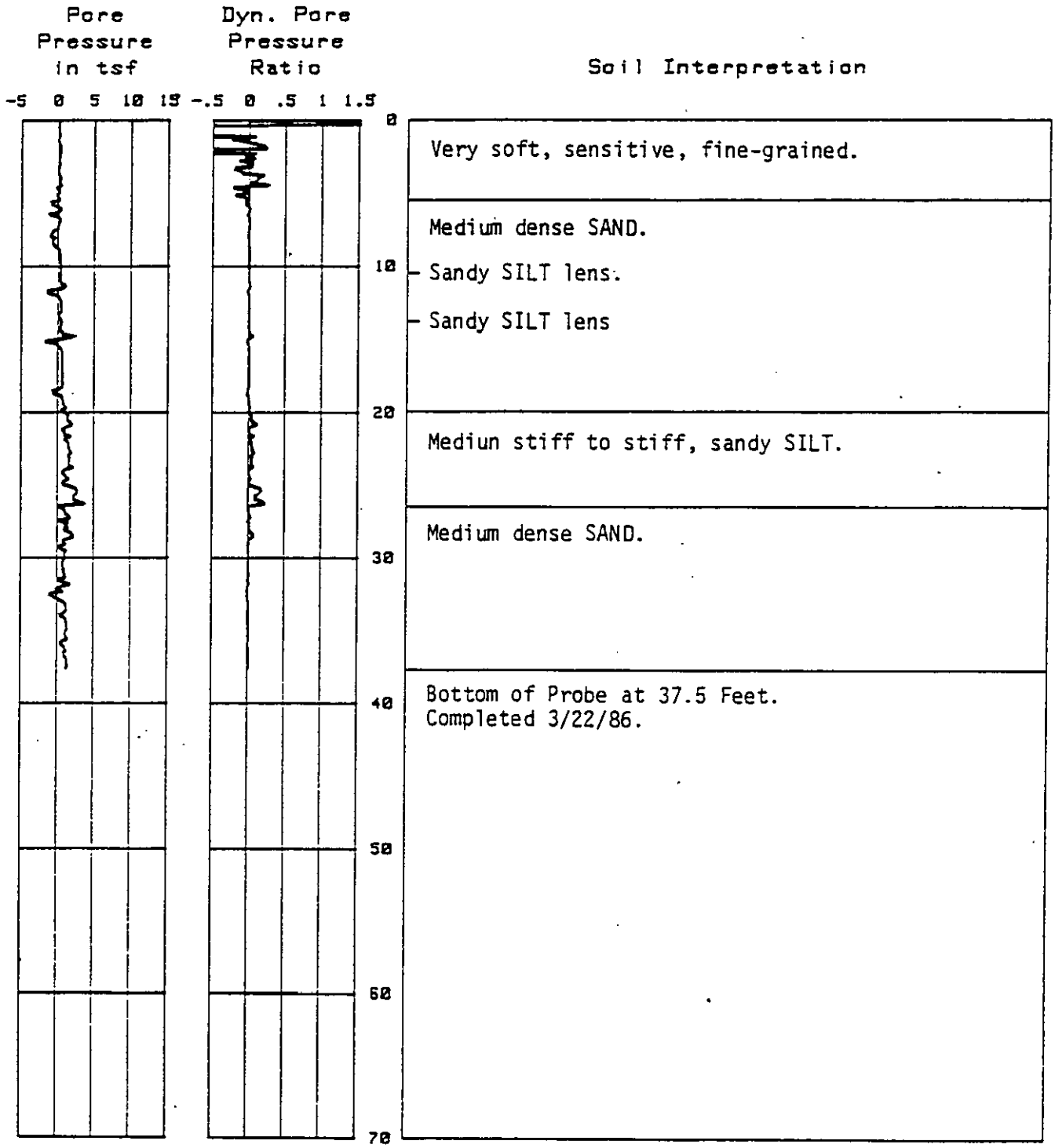
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure E-I-6

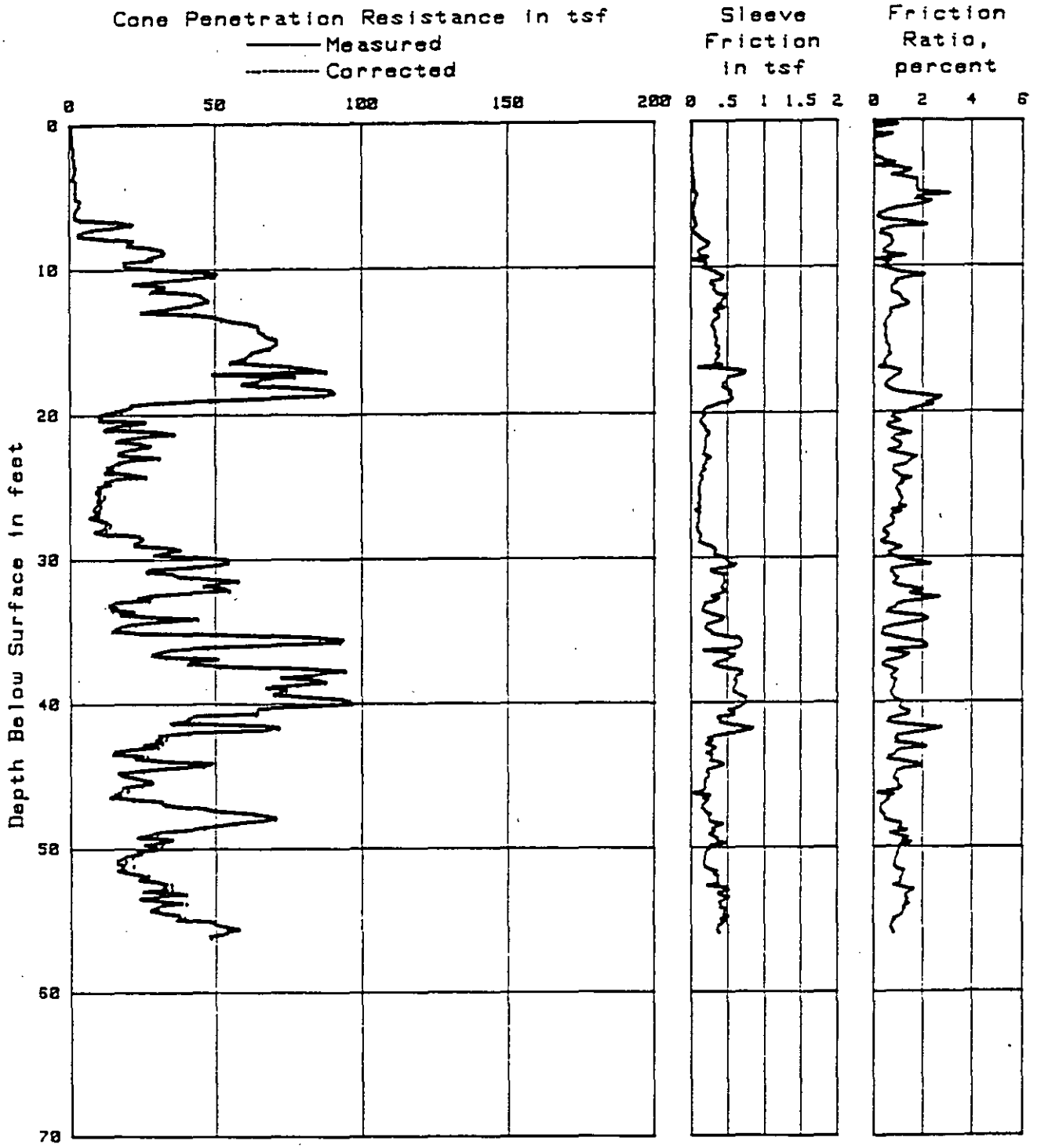
Probe Log MWP-1



J-2013-02A May 1988
J-1684 March 1986
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure E-I-6

Probe Log MWP-2

Approximate Surface Elevation in Feet -36
(MLLW=0)



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J-1684 March 1986
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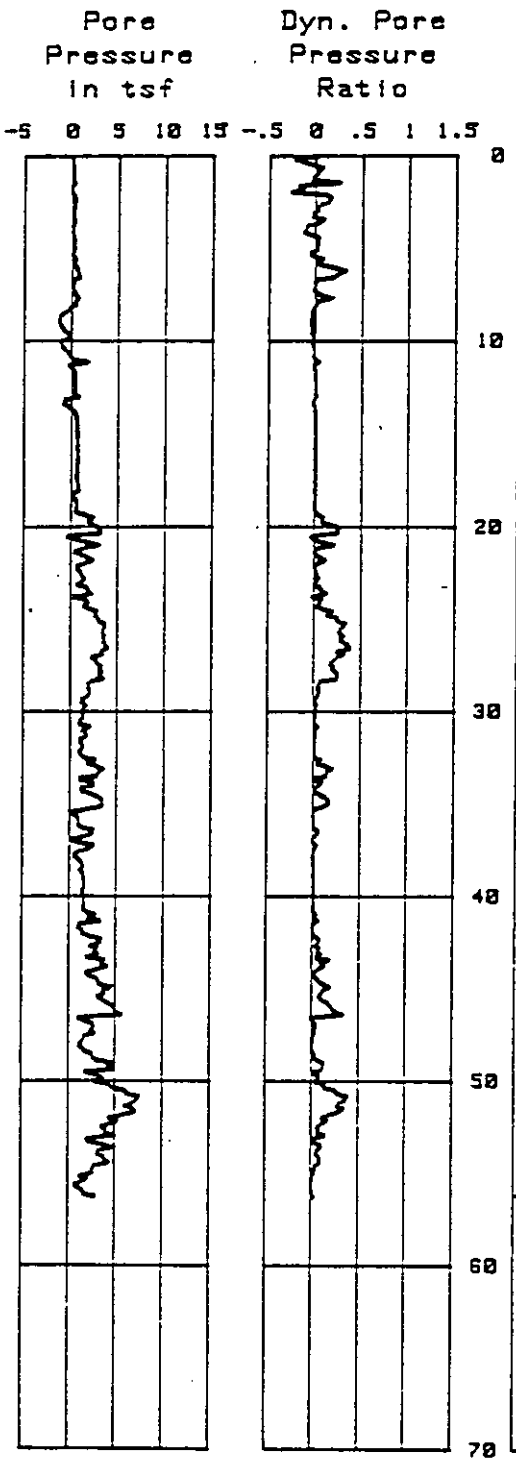
Sheet 1 of 2 Figure E-I-7

Probe Log MWP-2



Soil Interpretation

Very soft, sensitive, fine-grained.

Loose to medium dense SAND.

Medium stiff to stiff, sandy SILT.

Loose to medium dense SAND to silty SAND.

Loose to medium dense, silty SAND to sandy SILT.

Bottom of Probe at 58.0 Feet.
Completed 3/21/86.

J-2013-02A May 1988
J-1684 March 1986
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure E-I-7