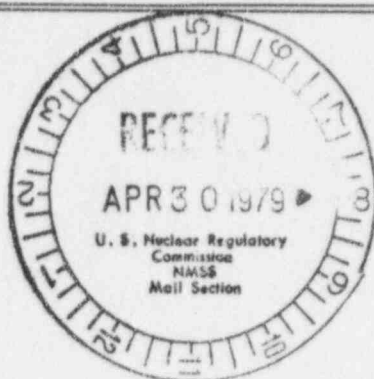


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F.M. FOX & ASSOCIATES, INC.
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SUPPLEMENTAL GEOTECHNICAL INVESTIGATION

AND

STABILITY ANALYSIS

FOR THE

PROPOSED TAILING DAM NO. 2

FEDERAL-AMERICAN PARTNERS

GAS HILLS PROJECT, GAS HILLS MINING DISTRICT

FREMONT COUNTY, WYOMING

Prepared For

Federal-American Partners

Job No. 1-1371-3765-01
April 1979

9706120313 790430
PDR ADOCK 04004492
C PDR

12690

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		NO ACTION NECESSARY <input type="checkbox"/>		COMMENT <input type="checkbox"/>		BY	
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Supplemental Geotechnical Investigation and Stability Analysis for Proposed Tailing		Reg File Cy		5/1			
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WHEAT RIDGE, COLORADO 80033
(303) 424-5578 — FMFOX

March: 30, 1979

Federal-American Partners
Gas Hills Star Route
Riverton, Wyoming 82501

Job No. 1-1371-3765.01

Subject: Supplemental Geotechnical Investigation and Stability Analysis
for the Proposed Tailing Dam No. 2, Federal-American Partners Gas
Hills Project, Gas Hills Mining District, Fremont County, Wyoming.

- Reference: 1. Our Geotechnical Investigation for the Proposed Extensions
of Tailing Dam No. 1 and No. 2., Job No. 1-1371-3454.01,
Revision Date June 16, 1978.
2. Our Revision of the Design for the Proposed Tailing Dam No.
2, Job No. 1-1371-3765.
3. Our Stability Analysis for the Revised Design for the Proposed
Tailing Dam No. 2, Job No. 1-1371-3963, Dated November 20,
1978.

Dear Mr. Jackson:

At your request, we have completed the supplemental geotechnical investigation and stability analysis for the Tailing Dam No. 2 extension. This report presents results from our supplemental field and laboratory investigation along with our geotechnical evaluations, recommendations and additional stability analysis. Also included are answers to specific Nuclear Regulatory Commission questions.

We are prepared to offer technical support for the reviewing agencies to expedite project approval as needed.

If further consultation or assistance regarding the contents of this report is required, do not hesitate to contact us.

F. M. FOX & ASSOCIATES, INC.

Donald L. Taylor, Jr.

Donald L. Taylor, Jr.
Staff Engineer

DLT/cae

Reviewed by:

Donald R. Clark

Donald R. Clark, P.E.
Division Manager

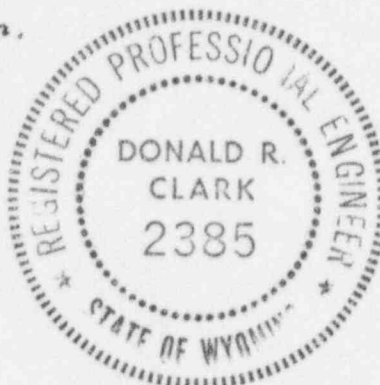


TABLE OF CONTENTS

1.0 GENERAL	Page	1
2.0 FIELD INVESTIGATION	Page	1
Foundation Cross Section	Figure	2.0-1
Embankment Cross Section	Figure	2.0-2
3.0 LABORATORY INVESTIGATION	Page	1
4.0 GEOTECHNICAL EVALUATION	Page	2
4.1 SUBSOIL CONDITIONS	Page	2
4.2 STABILITY ANALYSIS	Page	2
Stability Analysis Sections	Figure	4.2-1
with Calculations	Figure	4.2-2
4.3 LIQUEFACTION POTENTIAL	Page	3
5.0 SUPPLEMENTAL CONSTRUCTION RECOMMENDATIONS	Page	3
5.1 FOUNDATION PREPARATION	Page	3
5.2 TAILING SAND DIKES	Page	4
5.0 SUPPLEMENTAL PERFORMANCE MONITORING RECOMMENDATIONS	Page	4
6.1 SETTLEMENT MONITORING	Page	4
6.2 PIEZOMETRIC SURFACE MONITORING	Page	5
6.3 GROUND WATER MONITORING	Page	5
7.0 NRC QUESTIONS AND RESPONSES	Page	5
Borrow Material Gradations	Figures through and through	B1-7 B1-9 D-4 D-7
Borrow Boring Logs	Figures through	A-3 A-5
8.0 REVIEW AND CONSULTATION	Page	11
APPENDIX A - LITHOLOGICAL BORING LOGS	Figures through	A-1 A-11

TABLE OF CONTENTS

(continued)

APPENDIX B - LABORATORY TESTS RESULTS	Figures through	B-1 B-17
SAGEBRUSH-TABLESTAKES EXTENSION PIT LIMITS	Plate	1*
TEST PIT, BORING AND CROSS SECTION LOCATION MAP	Plate	2*
PERFORMANCE MONITORING LOCATIONS	Plate	3*

* in pocket at rear of report

1.0 GENERAL

At your request and in compliance with Nuclear Regulatory Commission (NRC) requirements, this supplemental report is being submitted. This report includes additional geotechnical data relative to the proposed extension of the Tailing Dam No. 2 embankment. Special consideration has been given to determining site specific strength parameters for additional stability analysis.

Field and laboratory data along with geotechnical evaluations and recommendations are included in this report. In addition, Section 7.0 addresses specific NRC questions received during an on-site inspection on March 21, 1979.

2.0 FIELD INVESTIGATION

A total of thirty-six borings were drilled in the foundation area along the downstream toe of the existing structure. Seven borings were drilled along the crest of the existing embankment. Refer to Plate 2 for boring locations. All borings were advanced with a CME 55 drill rig capable of auger drilling and sampling. Borings D-1 through D-36 were sampled with a two inch diameter California Barrel Sampler. Borings C-1 through C-7 were sampled with both a two inch diameter California Barrel Sampler and a Thin-Wall Tube Sampler. Detailed lithological logs can be found in Appendix A. Refer to Figures 2.0-1 and 2.0-2 for generalized sections of the foundation and embankment along with sample types and depths.

In addition to the drilling program, five tailing samples were obtained from the mill discharge for laboratory analysis.

3.0 LABORATORY INVESTIGATION

Upon completion of the field investigation, the samples were returned to our Denver laboratory for inspection by the project engineer. Field

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classifications were checked and the testing program formulated.

The testing program was divided into two sections. The first section includes sieve analysis and Atterberg Limit tests to determine material classifications. The second section includes unconfined compression tests to determine strength parameters. Special consideration was given to the material in the existing Tailing Dam No. 2 embankment. Refer to Appendix B for laboratory tests results. All testing was done in accordance with appropriate ASTM specifications.

4.0 GEOTECHNICAL EVALUATION

4.1 Subsoil Conditions

Foundation soils consist of 0 to 3 feet of stiff clay over generally medium dense to dense mixtures of silty and clayey sands and stiff to very stiff clays. An isolated loose sand "pocket" was encountered in the area of boring D-23 at a depth of 6 feet. Sandstone bedrock was encountered in the area of boring D-26 at a depth of 18 feet. No free water was encountered in the foundation borings. Refer to Figure 2.0-1 for foundation soils section.

The existing embankment consists of erratic mixtures of clayey, silty sands and clays with highly variable moisture contents, and densities. Very moist, soft embankment zones were encountered in Borings C-2 and C-4. Free water was encountered in borings C-1, C-3 and C-6 at depths of 54, 72 and 54 feet, respectively. The water appears to be confined to a thin zone of gravelly, silty, clayey sand at the base of the existing structure. The fluid surface was not encountered in the foundation borings to the north of the dam. Refer to Figure 2.0-2 for embankment soils section.

4.2 Stability Analysis

A horizontal translation stability analysis was conducted on critical sections to determine the factor of safety against foundation failure.

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Minimum factors of safety of 1.5 and 4.5 were obtained from this analysis. Refer to Figures 4.2-1 and 4.2-2 for sections analyzed and calculations. The strength parameters used in the analysis were obtained from the laboratory investigation results presented in Appendix B.

4.3 Liquefaction Potential

For saturated, fine to medium grained, loose sands, the potential for liquefaction exists. Liquefaction of these materials is generally caused by seismic disturbances or shock loads which can reduce the shear strength of saturated soils through an increase in the pore water pressure caused by the event. For this reason, tailing which are placed hydraulically and remain saturated in a loose condition are generally prone to liquefaction as a result of cyclic earthquake loading or progressive unidirectional shearing strains. Since a tailing liquefaction potential must be considered, the embankment which will retain the tailing must be designed and constructed to provide an adequate factor of safety against failure assuming that the shear strength of the retained tailing has been reduced to zero by liquefaction. The horizontal translation analysis discussed above satisfies this criteria by assuming that the retained tailing material has no strength.

5.0 SUPPLEMENTAL CONSTRUCTION RECOMMENDATIONS

The following construction recommendations are presented as a supplement to the recommendations found in our report entitled "Revision of Design for the Proposed Tailing Dam No. 2", dated July 19, 1978, Job No. 1-1371-3765.

5.1 Foundation Preparation

Foundation sands with Standard Penetration resistance values less than 10 blows for 12 inches should be removed and recompact to 95% of ASTM D-698. Boring data indicates that loose sands exist in the area of boring D-23 and should be removed and recompact. In addition, a hand Cone Penitrometer will be used subsequent to foundation stripping to delineate any

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additional loose sand areas not encountered in this investigation that should be removed prior to fill placement. Calibration tests have been conducted in the field to correlate the Standard Penetration test results from the California Sampler with that of the penetrometer. A minimum of 85 blows for 6 inches with the Cone Penetrometer is equivalent to a penetration resistance of 10 blows for 12 inches with the California Sampler. Cone Penetrometer tests should be conducted at a minimum spacing of one for every 5,000 square feet of foundation area.

5.2 Tailing Sand Dikes

Tailing sand dikes will be constructed within the existing tailing impoundment on both the east and west sides of the structure. Refer to Plate 2 for dike locations. These dikes are required for solids retention and will not be in contact with any mill fluids. The sand dikes will be constructed of existing tailing material within the impoundment area. Gradations indicate that approximately 50 percent of the tailing material is finer than a #200 sieve (refer to Appendix B). Therefore, Standard Proctor curves will be used to determine embankment compaction. The tailing material placed in the embankment should be placed in 6 to 8 inch lifts and compacted to a minimum of 95% of ASTM D-698. The upstream and downstream faces of the dikes should be constructed with 3:1 side slopes. A minimum crest width of 15 feet is recommended. Prior to construction, the existing tailing surface should be scarified and compacted to a depth of 12 inches.

6.0 SUPPLEMENTAL PERFORMANCE MONITORING RECOMMENDATIONS

6.1 Settlement Monitoring

Settlement monuments should be located at three points along the crest of the dam and at three points along the midpoint of the downstream face. These monuments should be evenly spaced to include the entire downstream face of the extension. Refer to Plate 3 for proposed monument locations.

Monitoring should be done monthly for the first year and quarterly thereafter. Records should be kept for future reference. If any abnormalities should arise, we should be contacted immediately to evaluate the conditions and recommend any necessary remedial action.

6.2 Piezometric Surface Monitoring

Piezometric surface monitoring within the embankment should be done with eight open check wells, three in each sand tailing dike and two in the maximum section along the downstream face of the extension. Refer to Plate 3 for proposed well locations. Monitoring should be done monthly for the first year and quarterly thereafter and records kept for future reference. If any abnormalities should arise, we should be contacted immediately to evaluate the conditions and recommend any necessary remedial action.

6.3 Ground Water Monitoring

Ground water monitoring devices TP2-1 and TP2-2 have already been installed. Their locations can be found on Plate 3. Water sampling should be conducted monthly for the first year of operations and quarterly thereafter for the life of the project. If any abnormalities should arise, we should be contacted immediately to evaluate the conditions and recommend any necessary remedial action.

7.0 NRC QUESTIONS AND RESPONSES

(Round One Geotechnical Engineering Questions, March 21, 1979)

Question 1:

The raising of Tailing Dam No. 2 from El. 6495 to El. 6510 will provide storage for an estimated 1.5 million tons of tailings, based on an assumed in-place dry density of 100 pcf for the tailings (Ref. 3). Field test results (Ref. 2, Table A-2) are less than the assumed dry density values. Provide additional field test data which justify the assumed dry density of 100 pcf

for in-place tailings. Alternatively, provide revised capacity estimates based on a lower dry density value.

Response 1:

The average dry density calculated from density tests 9 through 11 is 94.09 pcf. Refer to our report Geotechnical Investigation for the Proposed Extensions of Tailing Dam No. 1 and 2, Job No. 1-1371-3454, Table A-2. The available capacity at elevation 6505, allowing for a 5 foot freeboard, is approximately 625 acre-feet. This will allow for a total capacity of approximately 1.3 million tons of tailing material.

Question 2:

Provide details of the proposed borrow materials to be used for embankment construction. Include:

- a. A location plan showing areal extent of borrow area.
- b. Justification that adequate quantity of suitable material is available for embankment construction.
- c. The results of subsurface exploration of the borrow area. Include test boring and test pit logs.
- d. The results of laboratory tests on representative samples showing the soil properties and strength parameters for compacted fill materials as they will be used in embankment construction. Include identification tests, compaction and/or maximum-minimum density tests, permeability tests or estimates, strength tests.
- e. A comparison of the laboratory test results with the values assumed in design stability analyses. Provide revised stability analyses if the laboratory values are not compatible with the design criteria.

Response 2:

The original borrow material was to be removed from the western half of Impoundment No. 2, refer to Section 9.3 of our report Geotechnical Investigations for the Proposed Extensions of Tailing Dams No. 1 and 2, Job No. 1-1371-3454. The proposed borrow area is now designated as the Sagebrush-Tablestakes Pit. As we discussed in our meeting with the NRC, it would be sufficient to show that the now proposed borrow has similar mechanical

properties as that of the original borrow. In comparing the original borrow area material with that from the Sagebrush-Tablestakes extension area, both materials were found to be similar and suitable for use as embankment material. Refer to the enclosed sieve analysis, Figures B1-7 through B1-9 from our original report Geotechnical Investigation for the Proposed Extensions of Tailing Dams No. 1 and 2, Job No. 1-1371-3454, and Figures D-4 through D-7 along with our lithological logs A-3 through A-5 from our report Geotechnical Investigation and Design for the Subsurface Disposal of Millwaste, Job No. 1-1371-3771.

The estimated required volume of suitable borrow material for Tailing Dam No. 2 extension is approximately 1 million cubic yards. The available volume of suitable borrow material from the Sagebrush Tablestakes Pit exceeds this requirement, (i.e., the total volume of the pit is in excess of 12 million yards). Refer to Plate 1 of this report from our Geotechnical Investigation and Design of the Subsurface Disposal of Millwaste, Job No. 1-1371-3771, for existing and proposed Sagebrush Tablestakes pit limits.

Question 3:

Clarify and correct the apparent inconsistency in design parameters as provided in:

- a. Reference 1, pages 2-29 through 2-31
- b. Reference 1, page 3-17
- c. Reference 2, Figure C-2
- d. Reference 4, Figure 2

Response 3:

Refer to Appendix B in this report for the most recent detailed laboratory strength test results. Also, refer to Figures 4.2-1 and 4.2-2 for our revised stability analysis conducted with the strength data presented in this report.

GRADATION ANALYSIS

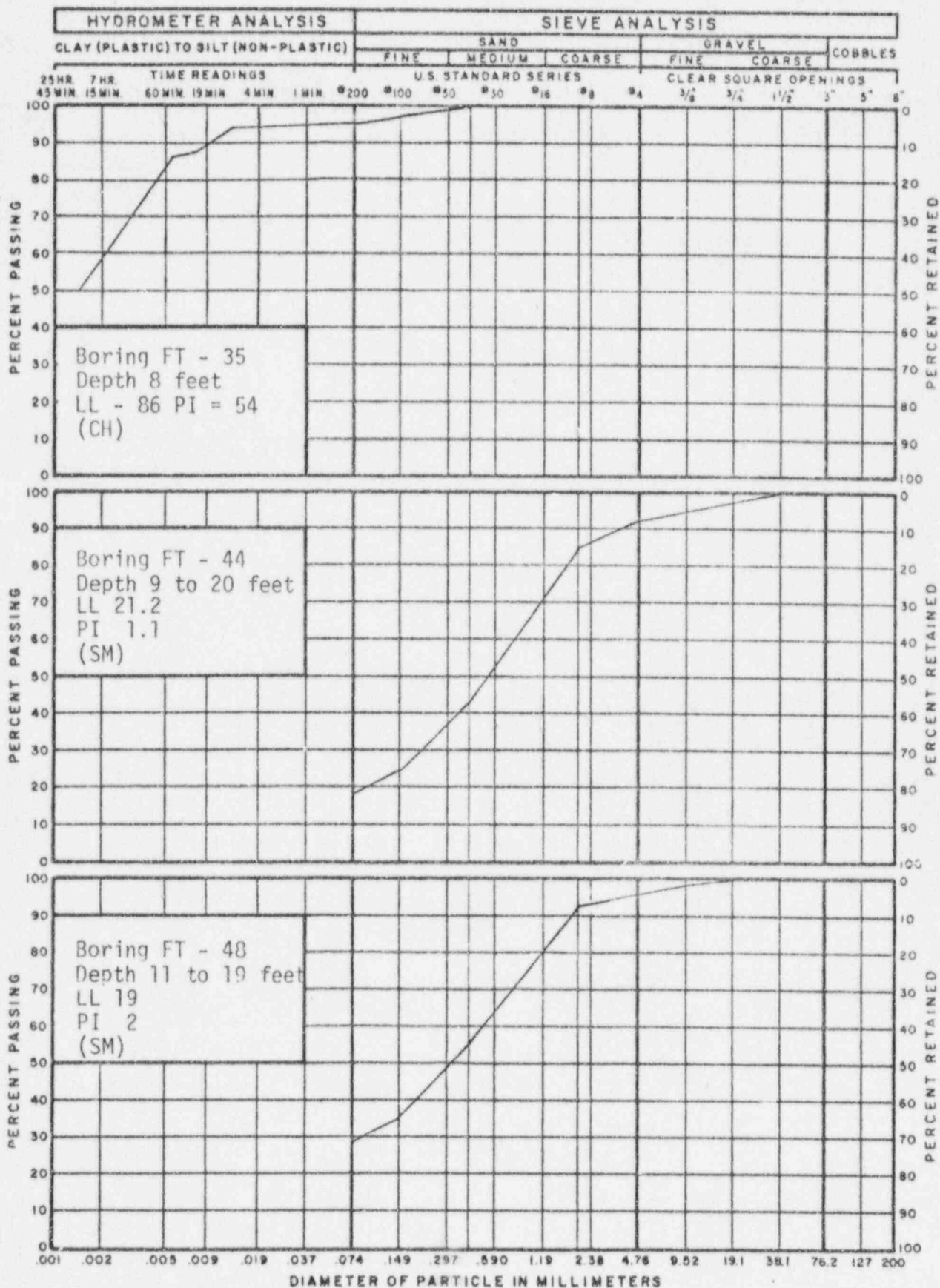


FIG. B1-7

GRADATION ANALYSIS

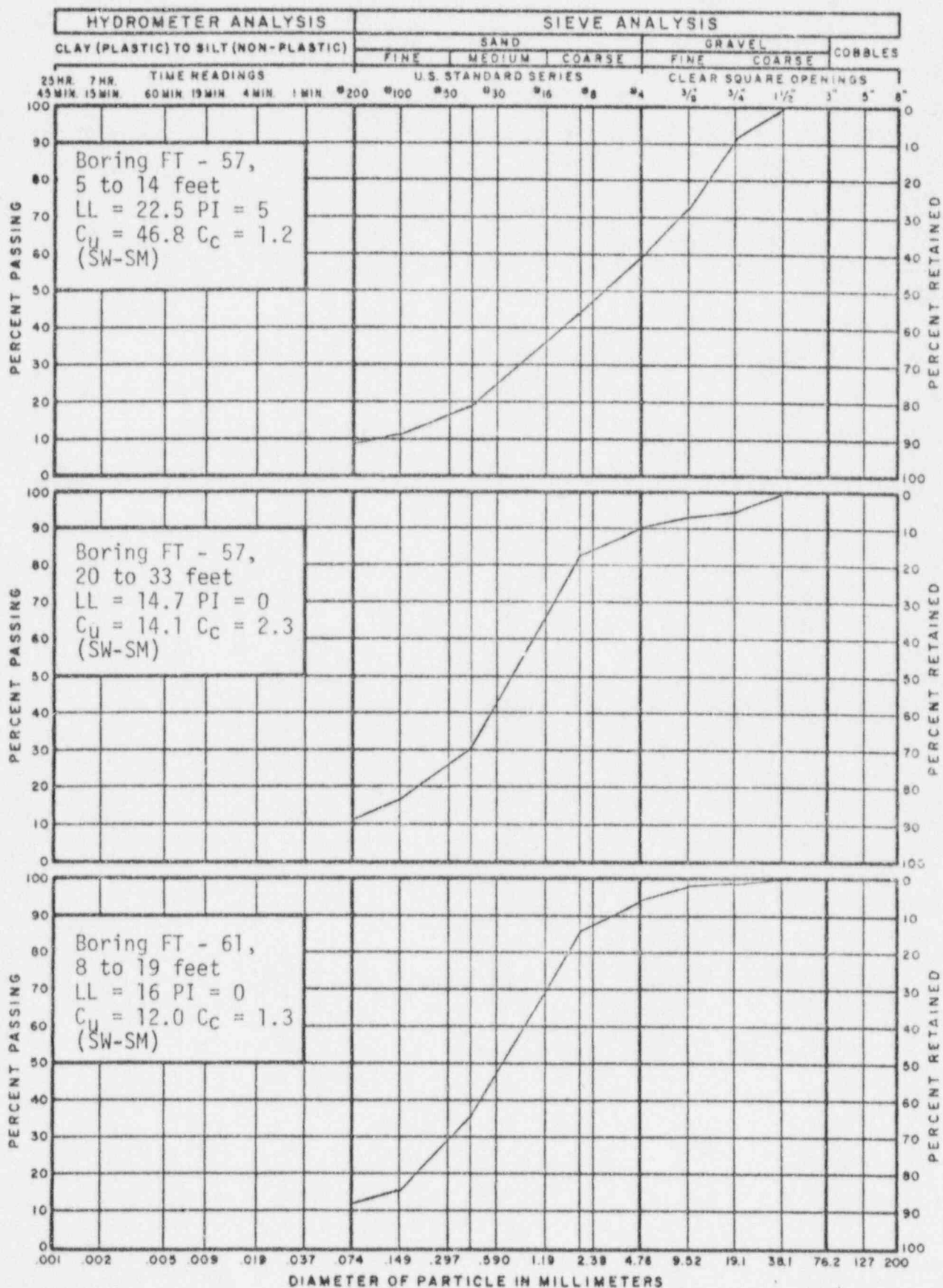


FIG. B1-8

GRADATION ANALYSIS

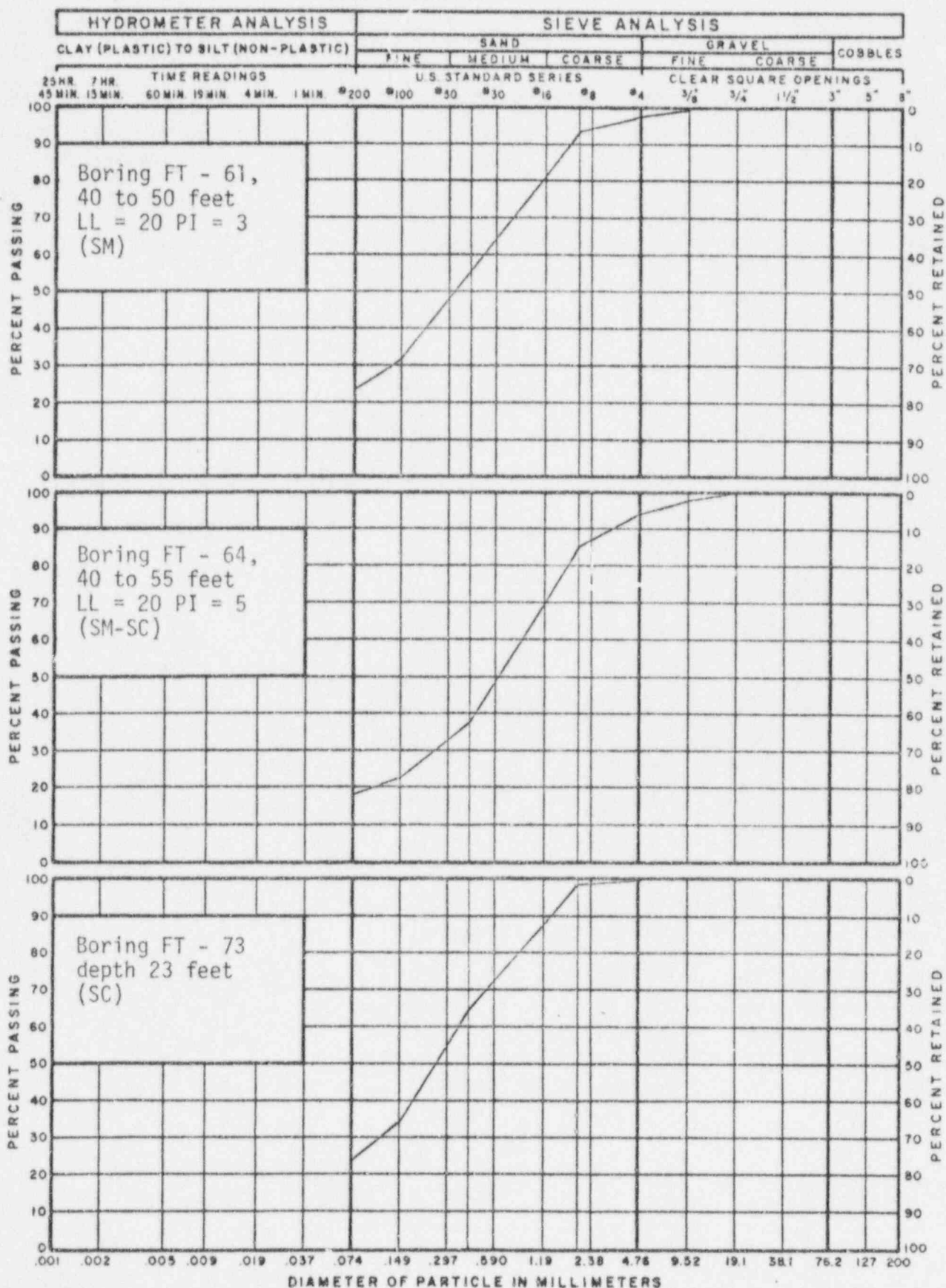


FIG. B1-9

GRADATION ANALYSIS

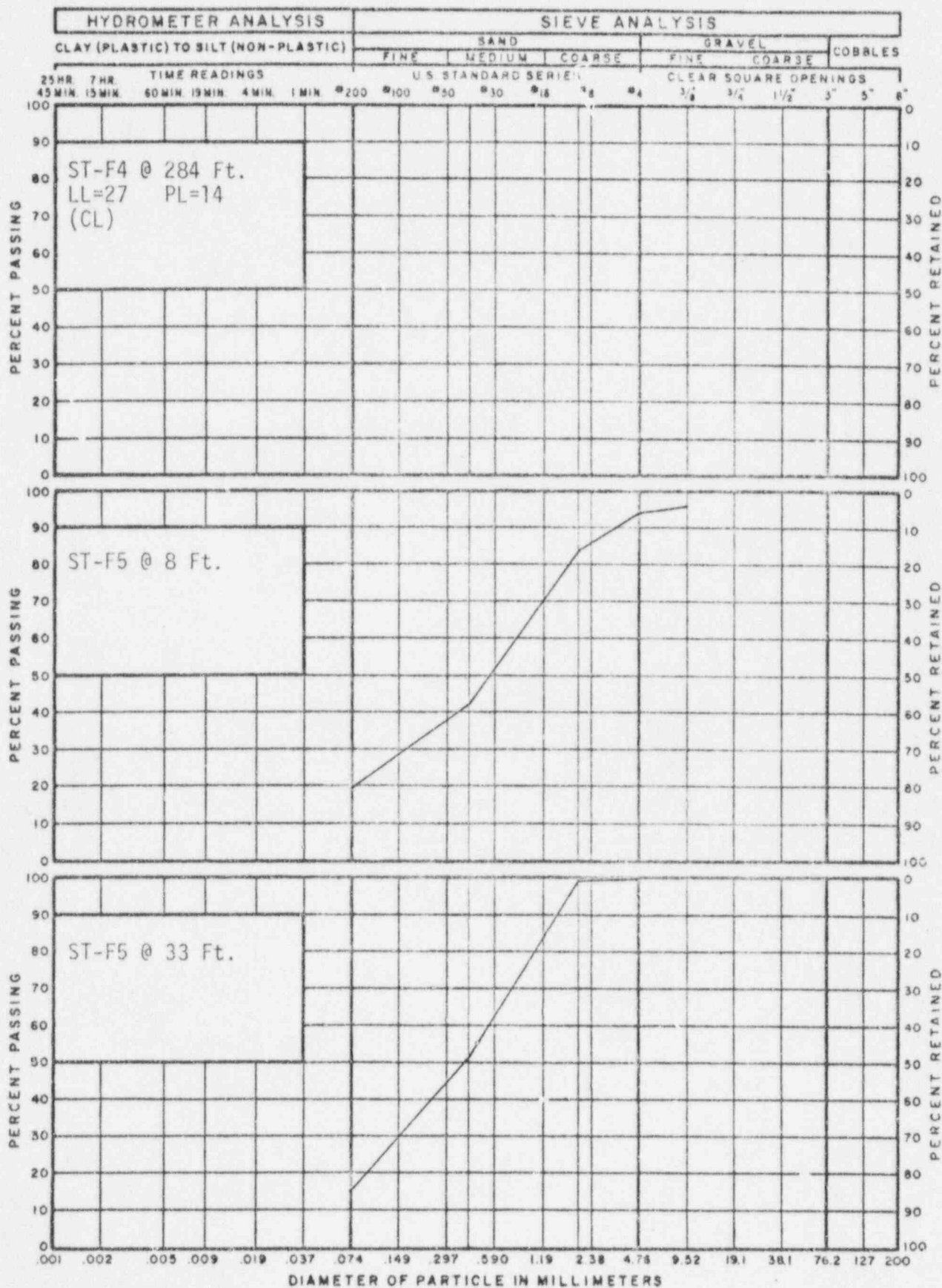


FIG. D-4

GRADATION ANALYSIS

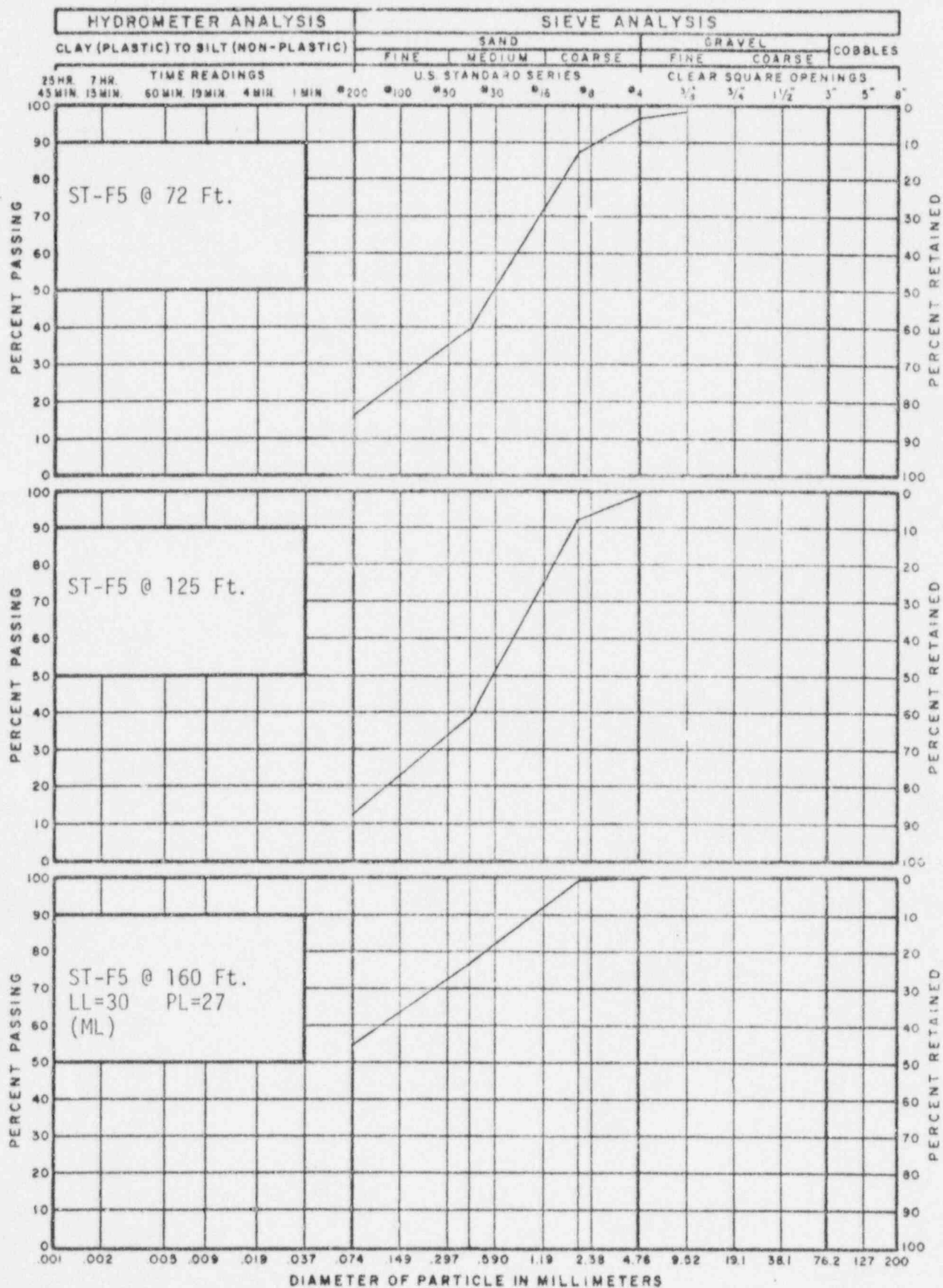


FIG. D-5

GRADATION ANALYSIS

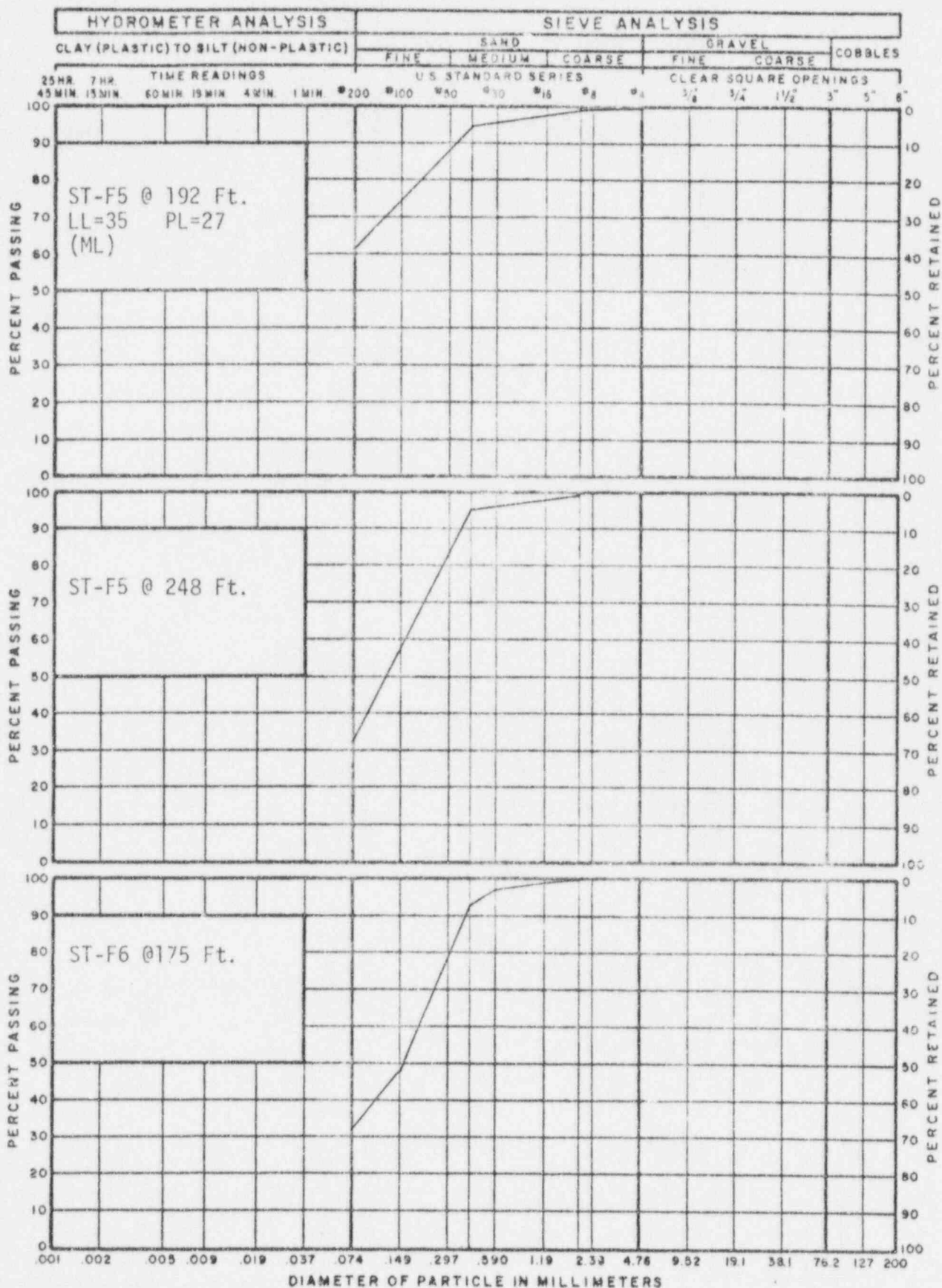


FIG. D-6

GRADATION ANALYSIS

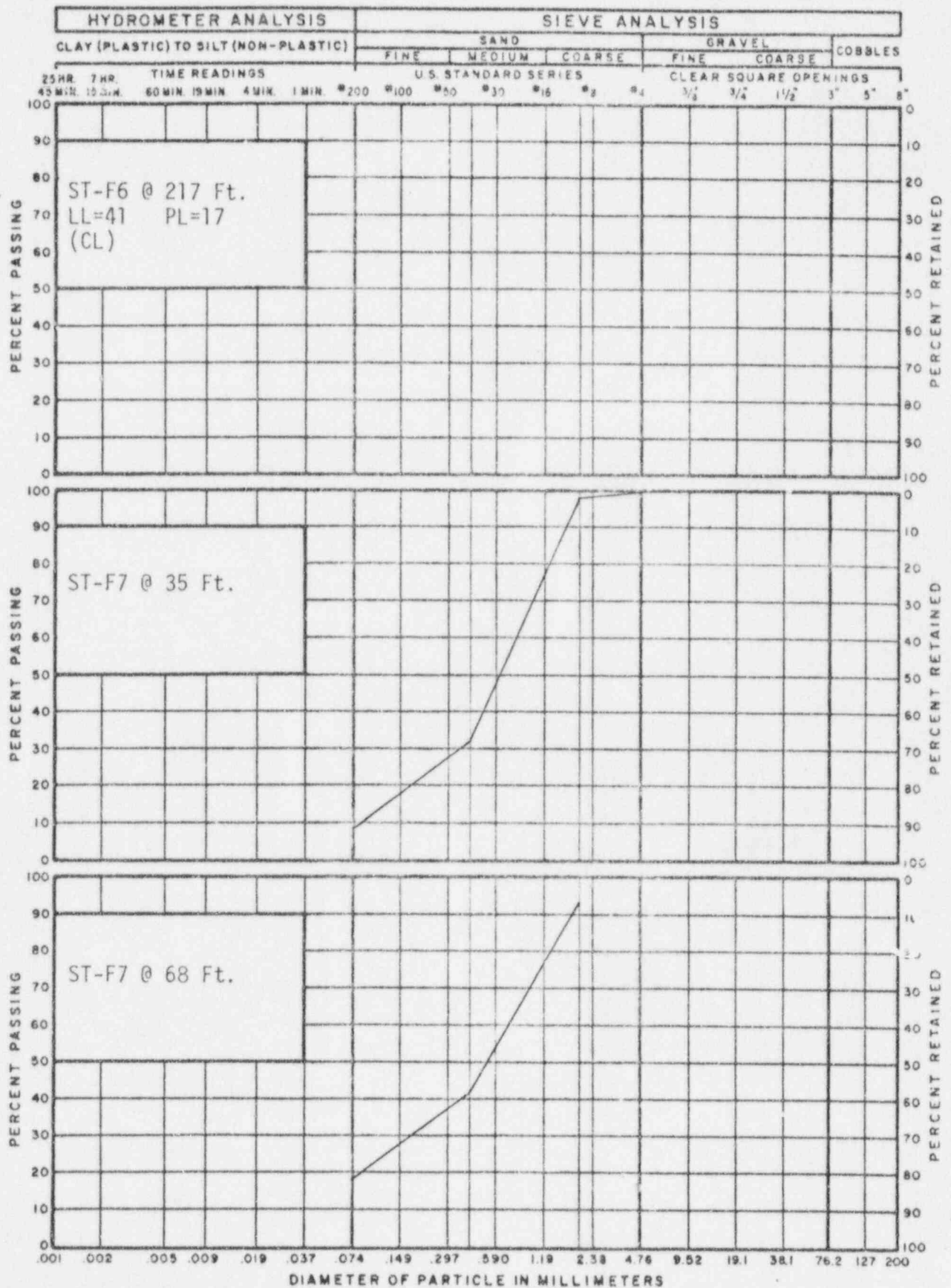


FIG. D-7

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-5

COLLAR ELEVATION: 6589 feet TOTAL DEPTH: 249.25 feet

DATE BEGUN: September 29, 1978 DATE FINISHED: October 8, 1978 LOGGED BY: Don Taylor REVIEWED BY: RAH

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE	R.O.D. (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					FILL, SAND, fine to coarse grained with traces of gravel, silty and clayey in part, loose to medium dense, medium moist, green to brown	10/12										
	6579	10				48/12					6.0x10 ⁻⁴	20			103.3	
	6578	13			White to yellow brown, fine to coarse grained, poorly to moderately cemented (clay), quartz sandstone, with traces of silt and gravel	37/12										
	6569	20			18' - 23' Traces of gravel with some iron staining	50/8										
	6559	30			28' - 42' Trace of pyrite and iron staining	50/8										
	6559	30				50/6.5					7.4x10 ⁻⁴	18			109.2	
	6549	40				50/5.5										
	6549	40				50/5										
	6539	50				50/4.75										Started coring at 45' using revert, 100% circulation
	6539	50					37	41			1.2x10 ⁻⁶					
	6529	60					0	3								59' - drilled faster pushed casing down 3 more feet
	6519	70			more coarse grained and iron staining towards end of zone		0	0								
	6518	74					30	30								
	6509	80			Light to dark green, fine to medium grained, silty, poorly to well sorted, very weakly to moderately cemented (clay), quartz sandstone, with coarse grained sandstone and mudstone lenses		48	60			4.9x10 ⁻⁵	16			110.0	72' - drilling firmed up 75.5' drilled faster 76' - water pressure up
	6499	90			83' - 91' Coarse grained lense		100	100								86' - 95% circulation drilling firmed up and water pressure up
	6489	100			91' - 119' Fine grained, silty, slightly argilla-ceous, moderately to well cemented lense		100	100								91.5' - water pressure surge and drilling firmed up

EXPLANATION

HOLE TYPES

- A - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE

INDICATES CORE RECOVERY

INDICATES CORE LOSS

INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:
BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES. REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 2 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771 BORING NO. ST F-5

COLLAR ELEVATION: 6589 feet TOTAL DEPTH: 249.25 feet

DATE BEGUN: September 29, 1978 DATE FINISHED: October 8, 1978 LOGGED BY: Don Taylor REVIEWED BY: pat

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
C	6479	110					100	100								102' - drilling firmed up 104' - getting water back flow up hole
							82	100								
	6479	110					92	100								114.5' - drilled faster
							100	100								119' - water pressure up and bit trying to plug
	6469	120					100	100								
					127' - 134.5' Traces of gravel		90	90			7.7x10 ⁻⁸	13			115.3	127' - water pressure surge and drilling firmed up
	6459	130					89	100								
							100	100								
	6449	140					100	100								
							100	100								
	6439	150					100	100								150' - drilled faster 10% circulation lost 380 gallons water level 83' down from top of collar
					158' - 162' Slightly arenaceous (fine grained), mudstone lense		80	80								155' - lost all circu. lost 140 gallons lost 200 gallons
	6429	180		11/19			93	100					54	27	30	128.8
				11/1			100	100								162' - drilled faster lost 200 gallons
	6419	170			169' - 185.5' Coarse grained lense		10	10								168' - barrel started to freeze lost 240 gallons 170' - used some borax lost 190 gallons
							60	60								
	6409	180					100	100								lost 220 gallons
					185.5' - 191' Traces of gravel		100	100								
	6399	190					58	58					61	27	35	lost 480 gallons lost 350 gallons
	6389	200			191' - 249.5' Slightly arenaceous (fine grained), mudstone lense		60	100								

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE

- INDICATES CORE RECOVERY
- INDICATES CORE LOSS

- INDICATES WATER LEVEL AND DATE RECORDED

*** STANDARD PENETRATION TEST:**

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG


SHEET 3 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-5

COLLAR ELEVATION: 6589 feet TOTAL DEPTH: 249.25 feet



DATE BEGUN: September 29, 1978 DATE FINISHED: October 8, 1978 LOGGED BY: Don Taylor REVIEWED BY: RAH


TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
NO. 1	6379	210			200' With secondary pyrite and more sand with depth		100	100								204' - water pressure surge and bit trying to plug 209' - running straight water - no revert
	6374	215					100	100								
	6369	220				Light to dark green, fine to medium grained, silty, poorly to well sorted, very weakly to moderately cemented (clay), quartz sandstone, with coarse grained sandstone and mudstone lenses	60	80								
	6359	230					100	100								
	6349	240					100	100								
	6339.75	249.25				Bottom of hole		100	100			7.5x10 ⁻⁷	32		116.9	

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
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-  INDICATES CORE LOSS

-  INDICATES WATER LEVEL AND DATE RECORDED

- * STANDARD PENETRATION TEST:
 BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-6

COLLAR ELEVATION: 6604 feet

TOTAL DEPTH: 217 feet

DATE BEGUN: October 26, 1978

DATE FINISHED: October 30, 1978

LOGGED BY: Don Taylor

REVIEWED BY: RAJ

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"	6594	10			White to yellow brown, fine to coarse grained, poorly to moderately cemented (clay), quartz sandstone, with traces of silt and gravel											
					0' - 10' Sandstone conglomerate with clean lenses	50/5										
	6584	20			18' - 32' Fine grained, silty lense with some iron staining											
R 3"	6574	30			iron stained with depth	50/7.5										started rotary at 28' 100% circulation using quick gel
	6564	40				50/7.5										43' - drilling firmed up using standard barrel
	6554	50														
	6544	60			58.5' - 68' Traces of gravel	50/4.75										
	6534					50/4										
	6524	80														
	6514	90				50/3										88' - drilling firmed up
	6508	96														
	6504	100			see next page for sample description											

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE

- INDICATES CORE RECOVERY
- INDICATES CORE LOSS

- INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

12650

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 2 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-6

COLLAR ELEVATION: 6604 feet

TOTAL DEPTH: 217 feet

DATE BEGUN: October 26, 1978

DATE FINISHED: October 30, 1978

LOGGED BY: Don Taylor

REVIEWED BY: RAH

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	COPE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
C	6494	110			Light to dark green, fine to medium grained, silty, poorly to well sorted, very weakly to moderately cemented (clay), quartz sandstone, with coarse grained sandstone and mudstone lenses	50/4	100	100								started coring with revert at 103', 95% circulation
	6484	120			116' - 147' Coarse grained lense		43	43								119.5' - lost circulation
	6474	130					0	0								samples being washed out
	6464	140					0	0								129.5' - drilling firmed up
	6454	150			155' - traces of pyrite		15	15								139' - drilled faster
	6444	160			161' - 188' Coarse grained lense		0	0								144.5' - drilling firmed up
	6434	170					50	50								164.5' - drilled faster
	6424	180					0	0								174.5' drilling firmed up
	6414	190					82	100								175' smell of gas noted
	6404	200					10	20								189.5' - 10/29/78 no water in hole
							0	0								193' started rotary
							25	30								
							65	55								
							68	68								
							100	100								
							100	100								

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE

- INDICATES CORE RECOVERY
- INDICATES CORE LOSS

- INDICATES WATER LEVEL AND DATE RECORDED

*** STANDARD PENETRATION TEST:**

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG



SHEET 3 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-6

COLLAR ELEVATION: 6604 feet TOTAL DEPTH: 217 feet



DATE BEGUN: October 26, 1978 DATE FINISHED: October 30, 1978 LOGGED BY: Don Taylor REVIEWED BY: RAN


TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
	6394	210			215' - 217'	50/1.5										
	6389	215			Slightly arenaceous (fine grained) mudstone lense								17	41	126.5	
	6387	217			Bottom of hole											

EXPLANATION

HOLE TYPES

SA - INDICATES SOLID AUGER
 HA - INDICATES HOLLOW AUGER
 C - INDICATES CORE HOLE
 R - INDICATES ROTARY HOLE

 INDICATES CORE RECOVERY
 INDICATES CORE LOSS

 INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:
 BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3271

SHEET 1 OF 3

COLLAR ELEVATION: 6608 feet

TOTAL DEPTH: 219 feet

BORING NO. ST F-7

DATE BEGUN: September 12, 1978

DATE FINISHED: November 7, 1973

LOGGED BY: Don Taylor

REVIEWED BY: JPH

[illegible]

HOLE TYPES

SA - INDICATES SOLID AUGER
HA - INDICATES HOLLOW AUGER
C - INDICATES CORE HOLE
R - INDICATES ROTARY HOLE

EXPLANATION

INDICATES
CORE RECOVERY

INDICATES
CORE LOSS

INDICATES WATER
LEVEL AND DATE
RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER
OF BLOWS WITH A 140 POUND HAMMER,
FALLING 30 INCHES, REQUIRED TO DRIVE
A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 2 OF 3

PROJECT: F.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771 BORING NO. ST F-7

COLLAR ELEVATION: 6608 feet TOTAL DEPTH: 219 feet

DATE BEGUN: September 12, 1978 DATE FINISHED: November 7, 1978 LOGGED BY: Don Taylor REVIEWED BY: Field

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA	6498	110			Light to dark green, fine to medium grained, silty, poorly to well sorted, very weakly to moderately cemented (clay), quartz sandstone, with coarse grained sandstone and mudstone lenses		100	100					24	27	127.4	
					102' - 104.5'		100	100								116.5' - water pressure up
					Slightly arenaceous (fine grained), mudstone lense		100	100								
	6488	120			trace of pyrite		100	100								119.5' - drilled faster
					125' - 140'		90	100			3.9x10 ⁻⁴				104.2	lost circulation
					Fine grained, silty, slightly argillaceous, moderately to well cemented lense		100	100								
	6478	130					100	100								135' - lost circulation put borax down hole
					140' - 187.5'		100	100								lost 150 gallons
	6468	140			Coarse grained lense		100	100								lost 360 gallons
							100	100								lost 90 gallons
	6458	150					30	30								lost 180 gallons
							0	0								lost 135 gallons
	6448	180					35	35								lost 135 gallons
							50	50								lost 135 gallons
	6438	170					100	100								lost 225 gallons
							22	22								lost 180 gallons
	6428	180					10	10								lost 230 gallons
							38	38								did not use revert
	6418	190					90	90								lost 135 gallons
							20	20								lost 250 gallons mixed more revert
	6408	200														

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE

- INDICATES CORE RECOVERY
- INDICATES CORE LOSS

- INDICATES WATER LEVEL AND DATE RECORDED

- * **STANDARD PENETRATION TEST:**
BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES. REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 3 OF 3

PROJECT: E.A.P. Millwaste Subsurface Disposal Investigation PROJECT NO. 1-1371-3771

BORING NO. ST F-7

COLLAR ELEVATION: 6608 feet TOTAL DEPTH: 219 feet

DATE BEGUN: September 12, 1978 DATE FINISHED: November 7, 1978 LOGGED BY: Dnn Taylor REVIEWED BY: PRH

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
C NX					202' - 209' Coarse grained lense trace of pyrite		40	40								lost 90 gallons
					11/1 1044		20	20								lost 320 gallons
	6398	210			210' - 214' Fine grained, silty, slightly argilla- ceous, moderately to well cemented lense		22	22				46	22	27	114.8	207' - drilling firmed up, did not use revert
	6394	214			214' - 219' Slightly arenaceous (fine grained), mudstone lense		100	100			5.8x10 ⁻⁷					lost 190 gallons
	6380	219			Bottom of hole								24	32	103.5	

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES CORE RECOVERY
- INDICATES CORE LOSS



- INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

Question 4:

The height of the raised Dam No. 2 is to be about 82 feet at the maximum section according to the contours shown on Ref. 3, Fig. 1. What was the height at the maximum section for the original design which led to the statement (ref. 4, page 1) that the "revised" maximum section height is approximately 10 feet less than the original No. 2 design height?

Response 4:

The height of this section can be clarified by designating the final crest elevation for Tailing Dam No. 2 at 6510 feet.

Question 5:

The soil materials and conditions beneath the new embankment and within the existing embankment have not been adequately investigated. Provide field test data and laboratory test data which justify the design assumptions. If necessary, provide new stability analyses based on new information obtained.

Address your response to the following aspects:

- a. Density, shear strength parameters and permeability of the existing fill.
- b. Relative density and shear strength parameters of the foundation sand materials. Field Density Tests #1 and #2 indicate that some of the shallow sands may have a very low relative density.
- c. The nature, extent and shear strength of any cohesive layers below the new embankment.
- d. Liquefaction potential of loose sands
- e. Densification, improvement or undercutting of foundation soils expected to be necessary during construction. The investigation should be performed in accordance with Geosciences Branch Position on Design Features for Tailings Dams, dated September 28, 1978, as attached.

Response 5:

Refer to Figures 4.2-1 and 4.2-2 included in this report for our revised stability analysis with existing embankment and foundation strength parameters. Also, refer to Appendix A for lithological boring logs along with

Figures 2.0-1 and 2.0-2 for cross sections through both of these areas. Any loose foundation material will be removed and recompact, refer to Section 5.2 of this report.

The liquefaction potential of loose sands is addressed in Section 4.2 of this report.

Question 6:

At what locations are settlement monuments to be provided? The applicant must provide a commitment to monitor monuments monthly for the first year and annually thereafter. The readings must be evaluated by a competent engineer who must notify the Fuel Processing and Fabrication Branch, NMSS, NRC, by phone, if any unusual behavior is observed. All records must be available at the site for NRC inspectors.

Response 6:

Refer to Section 6.1 of this report. All data will be reviewed by this office after acquisition.

Question 7:

At what locations are Norton Porous stone piezometers (Ref. 5) to be provided? The applicant must provide a commitment to monitor and record piezometric levels monthly. The readings must be evaluated by a competent engineer who must notify the Fuel Processing and Fabrication Branch, NMSS, NRC, by phone if any unusual behavior is observed. All records must be available at the site for NRC inspectors.

Response 7:

As we discussed at our meeting, the porous stone piezometers will be eliminated and replaced with open check wells. Refer to Section 6.2 of this report.

Question 8:

Groundwater monitoring devices numbers TP-2A and TP-2B are to be installed

downstream of the existing Dam No. 2. Identify the locations of these devices.

Response 8:

Refer to Section 6.3 of this report for the locations of the previously installed wells.

Question 9:

Provide the field criteria to be used during construction for approval of subgrade materials. Provide details of the proposed inspection and testing of compacted fill.

Response 9:

Refer to Section 5.0 of this report for supplemental construction recommendations. We have been contracted by Federal-American Partners to conduct the field density testing and subgrade material inspections during construction of the Tailing Dam No. 2 extension.

NRC REFERENCES

1. Tailings Dike Information, Federal American Partners, October, 1977.
2. Geotechnical Investigation for the Proposed Extension of Tailing Dam Numbers 1 and 2, F. M. Fox & Associates, Inc., June 18, 1978, prepared by F. M. Fox & Associates, Inc., Denver, Colorado.
3. Revision of Design for the Proposed Tailing Dam No. 2, Federal American Partners, July 19, 1978, prepared by F. M. Fox & Associates, Inc., Denver, Colorado.
4. Stability Analyses for the Revised Design of Tailing Dam No. 2, Federal American Partners, November 24, 1978, prepared by F. M. Fox & Associates, Inc., Denver, Colorado.
5. Gas Hills Wyoming Tailings Retention Dam, SER Input Geotechnical Engineering, U.S. Army Engineers, Omaha District, July 13, 1978, transmitted by letter to W. Gammill, NRC, from R. Burnett, U.S. Army Engineers.

8.0 REVIEW AND CONSULTATION

This report contains supplemental geotechnical data and analysis for the proposed Tailing Dam No. 2 extension. Also included are answers to questions submitted by the Nuclear Regulatory Commission regarding the above subject.

If there are any questions regarding this report, our responses to NRC questions, or if you desire further consultation in this matter do not hesitate to contact us.

F. M. FOX & ASSOCIATES, INC.

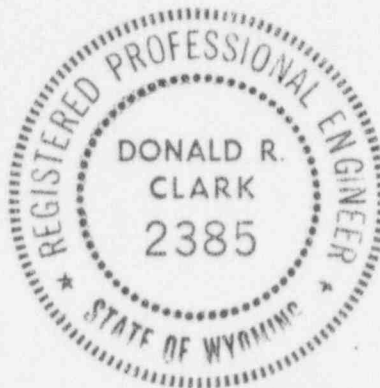
Donald L. Taylor, Jr.
Donald L. Taylor, Jr.
Staff Engineer

DLT/cae

Copies: 13

Reviewed by:

Donald R. Clark
Donald R. Clark, P.E.
Division Manager



APPENDIX A
LITHOLOGICAL BORING LOGS

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

Supplemental Stability Analysis and Investigation
 for Proposed Tailing Dam No. 2

PROJECT: _____

PROJECT NO. 1-1371-3755.01

BORING NO. C-1

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 60 feet

DATE BEGUN: March 10, 1979

DATE FINISHED: March 10, 1979

LOGGED BY: Don Taylor

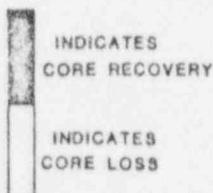
REVIEWED BY: BWT

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA	6495	0			0 - 2' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SH)	24										
	6485	10			2' - 8' FILL, SAND, silty to SILT, sandy, fine grained, with traces of iron staining, medium dense, medium moist to moist, brown to green to yellow brown (SH-ML)	21										
	6475	20			8' - 18' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SH)	38										
	6465	30			18' - 24' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	28										
	6455	40			24' - 29' FILL, SAND, slightly silty, fine to coarse grained, with traces of iron staining, dense, medium moist to moist, light brown to brown (SP)	28										
	6445	50			29' - 40' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist brown to light brown (SP-SC)	23										
	6435	60			40' - 44' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	72										
					44' - 47' FILL, SAND, slightly silty, fine to coarse grained, with traces of iron staining, dense, medium moist to moist, light brown to brown (SP)											
					47' - 57' SAND, fine to coarse grained, clayey, slightly silty, loose to dense, slightly moist to very moist, yellow brown to brown (SC)											
					57' - 60' CLAY, silty to SILT, clayey, slightly sandy (fine grained), stiff to hard, medium moist to very moist, dark brown, yellow brown to green (CL-ML)											
					60' - Bottom of Hole											

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



INDICATES WATER LEVEL AND DATE RECORDED

*** STANDARD PENETRATION TEST:**

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

12690

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

PROJECT: Supplemental Stability Analysis and Investigation
 for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-2

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 60 feet

DATE BEGUN: March 10, 1979

DATE FINISHED: March 10, 1979

LOGGED BY: Don Taylor

REVIEWED BY: *STH*

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE *	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					0' - 6' FILL, SAND, slightly silty, fine to coarse grained, with traces of iron staining, dense, medium moist to moist, light brown to brown (SP)											6' - 24' weak zone
	6485	10			6' - 14' FILL, SAND, clayey, slightly silty, with traces of iron staining, loose, moist to very moist, brown to light brown (SP-SC)	6										
	6475	20			14' - 24' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, medium stiff to stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	12										
	6465	30			24' - 27' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist, brown to light brown (SP-SC)	19										
	6455	40			27' - 48' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	20										
	6445	50			48' - 59' SAND, fine to coarse grained, poorly to well graded, medium dense to dense, very moist to wet, brown (SP-SH)	24										
	6435	60			59' CLAY, silty to SILT, clayey, slightly sandy (fine grained), stiff to hard, medium moist to very moist, dark brown, yellow brown to green (CL-ML)	36										
					60' - Bottom of Hole											

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES CORE RECOVERY
- INDICATES CORE LOSS



- INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 2

PROJECT: Supplemental Stability Analysis and Investigation
for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-3

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 109.5 feet

DATE BEGUN: March 7, 1979

DATE FINISHED: March 7, 1979

LOGGED BY: John Dietzler

REVIEWED BY: *[Signature]*

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					0 - 7' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SM)	29										
	6485	10			7' - 29' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist, brown to light brown (SP-SC)	19										
	6475	20				20										
	6465	30			29' - 39' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining and mudstone chips, medium dense to dense, medium moist to moist, brown (SP-SM)	30										
	6455	40			39' - 59' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	23										
	6445	50				32										
						31										
	6435	60			59' - 82' SAND, fine to coarse grained, poorly to well graded, medium dense to dense, very moist to wet, brown (SP-SH)	48										
	6425	70				63										
	6415	80				40										
	6405	90			82' - 96' SAND, fine to medium grained, silty, poorly graded with traces of iron staining, medium dense to dense, slightly moist to moist, yellow brown to white (SP-SH)	28										
	6395	100			96' - 109' see next page for description	38										

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES CORE RECOVERY
- INDICATES CORE LOSS



- INDICATES WATER LEVEL AND DATE RECORDED

*** STANDARD PENETRATION TEST:**

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 2 OF 2

PROJECT: Supplemental Stability Analysis and Investigation
for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-3

COLLAR ELEVATION: 6495 feet


TOTAL DEPTH: 109.5 feet

DATE B'GUN: March 7, 1979

DATE FINISHED: March 7, 1979

LOGGED BY: John Dietzler

REVIEWED BY: *gfh*

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION * RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					96' - 109' CLAY, silty to SILT, clayey, slightly sandy (fine grained), stiff to hard, medium moist to very moist, dark brown, yellow brown to green (CL-ML)											
	6385.110				109.5' - Bottom of Hole	105										

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES
CORE RECOVERY
- INDICATES
CORE LOSS



- INDICATES WATER
LEVEL AND DATE
RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER
OF BLOWS WITH A 140 POUND HAMMER,
FALLING 30 INCHES, REQUIRED TO DRIVE
A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

Supplemental Stability Analysis and Investigation
 PROJECT: for Proposed Lilling Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-4

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 69.5 feet

DATE BEGUN: March 7, 1979

DATE FINISHED: March 7, 1979

LOGGED BY: John Dietzler

REVIEWED BY: RAH

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION * RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"	6485	10			0 - 17' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	40										
	6475	20			17' - 24' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist, brown to light brown (SP-SC)	26										
	6465	30			24' - 42' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SM)	24										
	6455	40				61										
	6445	50			42' - 69.5' SAND, fine to medium grained, silty, poorly graded with traces of iron staining, medium dense to dense, slightly moist to moist, yellow brown to white (SP-SM)	171										
	6435	60				109										
	6425	70			69.5' - Bottom of Hole	120										

EXPLANATION

HOLE TYPES

SA - INDICATES SOLID AUGER
 HA - INDICATES HOLLOW AUGER
 C - INDICATES CORE HOLE
 R - INDICATES ROTARY HOLE

INDICATES CORE RECOVERY
 INDICATES CORE LOSS

INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

PROJECT: Supplemental Stability Analysis and Investigation
 for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-5

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 59.5 feet

DATE BEGUN: March 7, 1979

DATE FINISHED: March 7, 1979

LOGGED BY: John Dietzler

REVIEWED BY: *SAH*

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION RESISTANCE *	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					0 - 10' FILL, SAND, silty to SILT, sandy, fine grained, with traces of iron staining, medium dense, medium moist to moist, brown to green to yellow brown (SM-ML)	29										
	6485	10			10' - 23' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	22 24										
	6475	20														
	6465	30			23' - 32' SAND, fine to medium grained, silty, poorly graded with traces of iron staining, medium dense to dense, slightly moist to moist, yellow brown to white (SP-SM)	37 38										
	6455	40			32' - 37' SAND & GRAVEL, medium graded, slightly clayey, medium moist to moist, medium dense to dense, yellow brown (SP-GP)	62										
					37' - 59.5' SANDSTONE BEDROCK, medium hard to very hard, fine to coarse grained, weakly cemented, slightly silty, with traces of iron staining, medium moist to moist, yellow brown to white	100 109 171 171										
	6435	60			59.5' - Bottom of Hole	240										

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES
CORE RECOVERY
- INDICATES
CORE LOSS



- INDICATES WATER
LEVEL AND DATE
RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER
 OF BLOWS WITH A 140 POUND HAMMER,
 FALLING 30 INCHES, REQUIRED TO DRIVE
 A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

PROJECT: Supplemental Stability Analysis and Investigation
for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-6

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 60 feet

DATE BEGUN: March 10, 1979

DATE FINISHED: March 10, 1979

LOGGED BY: Don Taylor

REVIEWED BY: SPH

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	PENETRATION* RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					0 - 10' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SM)											
	6485	10			10' - 23' FILL, silty, slightly sandy, with mudstone chips and traces of iron staining, very stiff, moist to very moist, brown to brown to yellow brown (CL-ML)	15										
	6475	20			23' - 32' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SM)	16										
	6465	30			32' - 42' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist, brown to light brown (SP-SC)	20										
	6455	40			42' - 48' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	21										
	6445	50			48' - 52' SAND, fine to coarse grained, clayey, slightly silty, loose to dense, slightly moist to very moist, yellow brown to brown (C)	21										
	6435	60			52' - 56' SAND & GRAVEL, medium graded, slightly clayey, medium moist to moist, medium dense to dense, yellow brown (SP-GP)	60										
					56' - 60' SAND, fine to medium grained, silty, poorly graded with traces of iron staining, medium dense to dense, slightly moist to moist, yellow brown to white (SP-M)											
					60' - Bottom of Hole											

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



- INDICATES CORE RECOVERY
- INDICATES CORE LOSS



- INDICATES WATER LEVEL AND DATE RECORDED

* STANDARD PENETRATION TEST:

BLOWS/FOOT: RECORDED AS, NUMBER OF BLOWS WITH A 140 POUND HAMMER, FALLING 30 INCHES, REQUIRED TO DRIVE A 2 INCH DIAMETER SAMPLER ONE FOOT.

F. M. FOX & ASSOCIATES, INC.
SUBSURFACE EXPLORATION LOG

SHEET 1 OF 1

PROJECT: Supplemental Stability Analysis and Investigation
for Proposed Tailing Dam No. 2

PROJECT NO. 1-1371-3765.01

BORING NO. C-7

COLLAR ELEVATION: 6495 feet

TOTAL DEPTH: 44 feet

DATE BEGUN: March 9, 1979

DATE FINISHED: March 9, 1979

LOGGED BY: Don Taylor

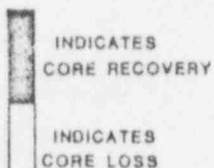
REVIEWED BY: *D.H.*

TYPE AND SIZE OF HOLE	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	WATER LEVEL	LITHOLOGY AND PHYSICAL CONDITION	* PENETRATION RESISTANCE	R Q D (%)	CORE RECOVERY (%)	TEST SECTIONS	FIELD PERMEABILITY CM./SEC.	LAB PERMEABILITY CM./SEC.	% PASSING 200	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	DRY DENSITY (PCF)	NOTES
SA 4"					0 - 12' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	21										
	6485	10			12' - 22' FILL, SAND, silty, slightly clayey, fine to medium grained, with traces of iron staining, medium dense to dense, medium moist to moist, brown (SP-SH)	15										
	6475	20			22' - 30' FILL, silty, clayey, slightly sandy, with mudstone chips and traces of iron staining, very stiff, medium moist to very moist, brown to green brown to yellow brown (CL-ML)	19										
	6465	30			30' - 44' FILL, SAND, clayey, slightly silty, with traces of iron staining, very stiff, moist to very moist, brown to light brown (SP-SC)	33										
	6455	40														
	6445	50			44' SAND, fine to coarse grained, clayey, slightly silty, loose to dense, slightly moist to very moist, yellow brown to brown (SC)	26										
					44' - Bottom of Hole											

EXPLANATION

HOLE TYPES

- SA - INDICATES SOLID AUGER
- HA - INDICATES HOLLOW AUGER
- C - INDICATES CORE HOLE
- R - INDICATES ROTARY HOLE



INDICATES WATER
LEVEL AND DATE
RECORDED

*** STANDARD PENETRATION TEST:**

BLOWS/FOOT: RECORDED AS, NUMBER
OF BLOWS WITH A 140 POUND HAMMER,
FALLING 30 INCHES, REQUIRED TO DRIVE
A 2 INCH DIAMETER SAMPLER ONE FOOT.

TEST HOLE

D-1

D-2

D-3

D-4

D-5

D-6

D-7

D-8

D-9

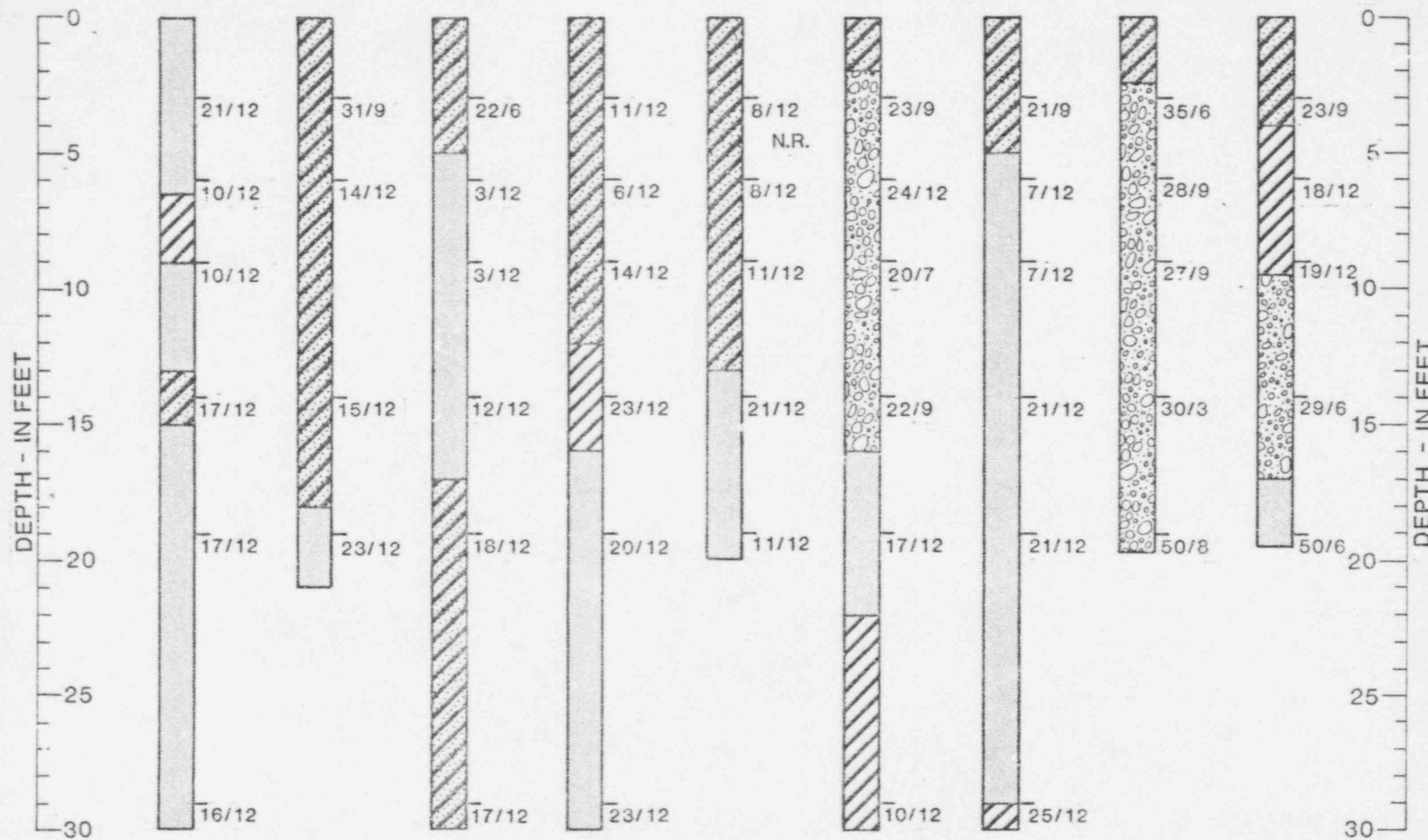


FIGURE A-8

REFER TO FIGURE A-11 FOR LEGEND AND NOTES

LOGS OF TEST HOLES

TEST HOLE D-10

D-11

D-12

D-13

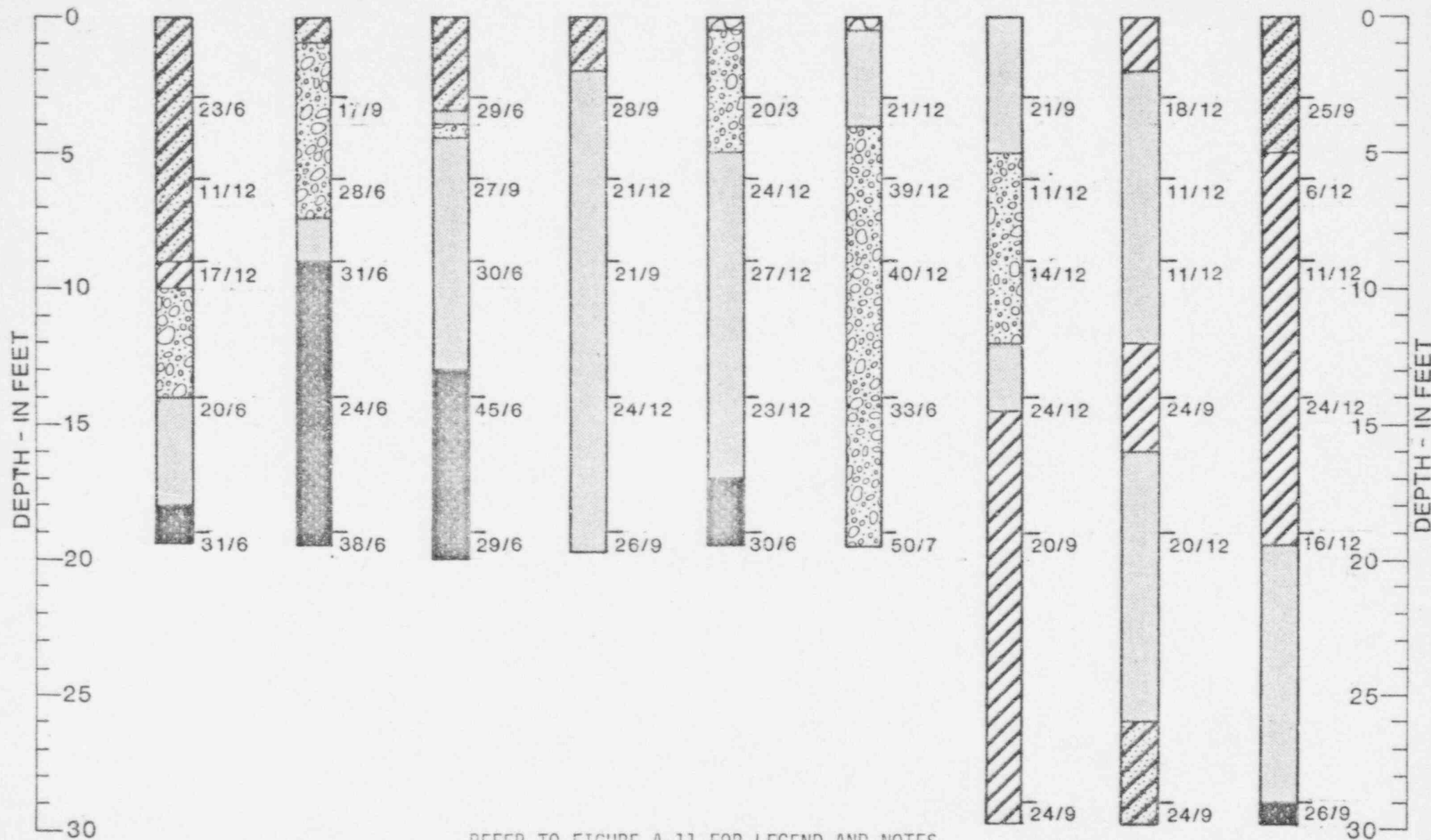
D-14

D-15

D-16

D-17

D-18



REFER TO FIGURE A-11 FOR LEGEND AND NOTES

LOGS OF TEST HOLES

FIGURE A-9

TEST HOLE D-19

D-20

D-21

D-22

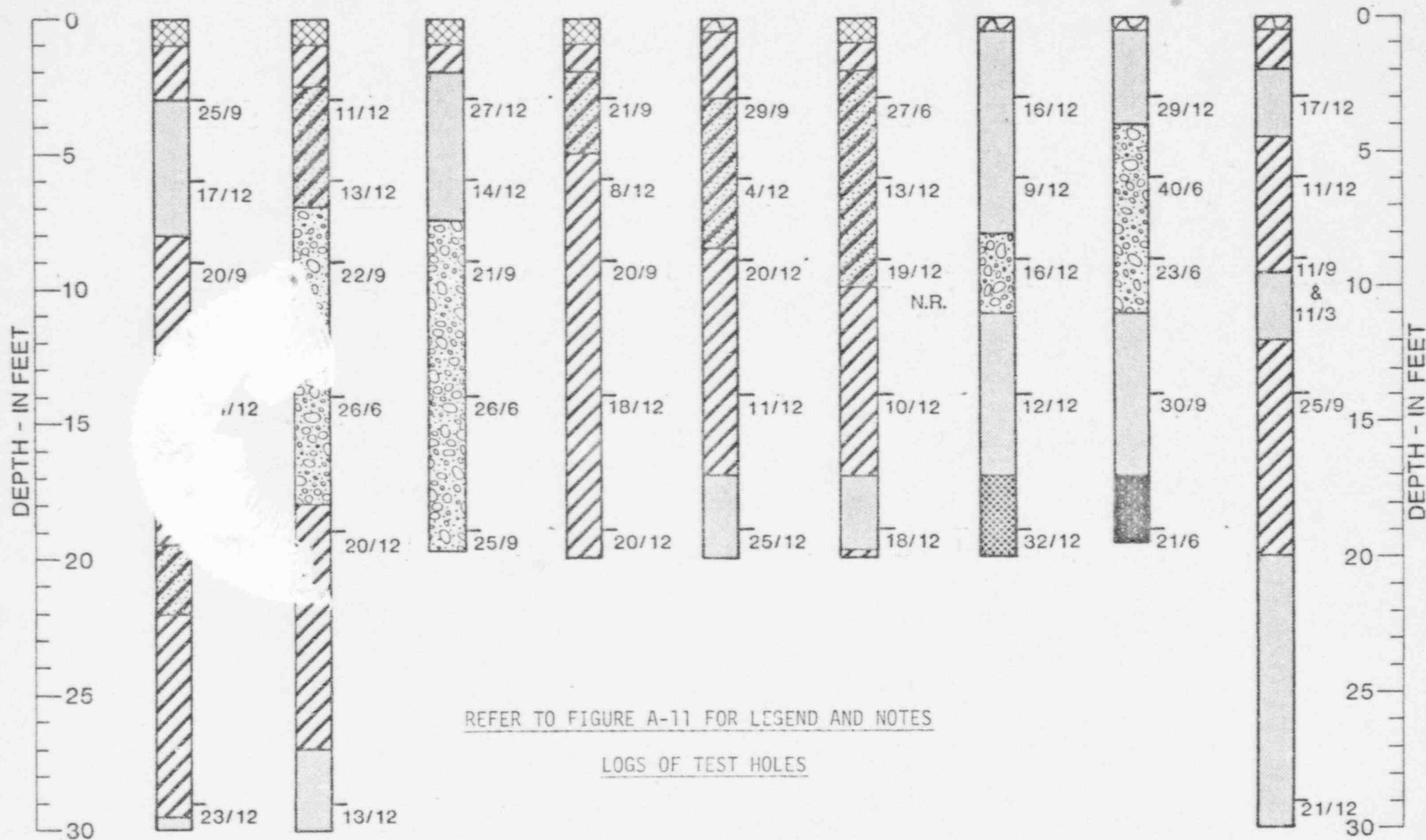
D-23

D-24

D-25

D-26

D-27

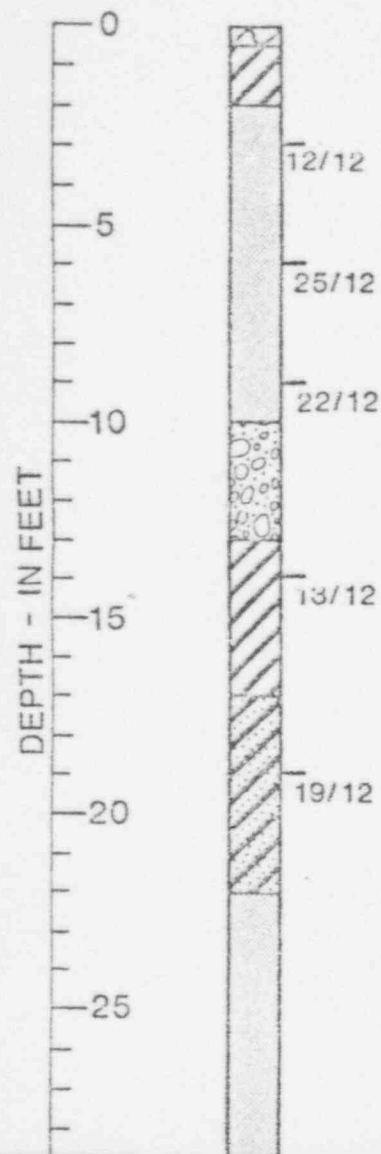


REFER TO FIGURE A-11 FOR LEGEND AND NOTES

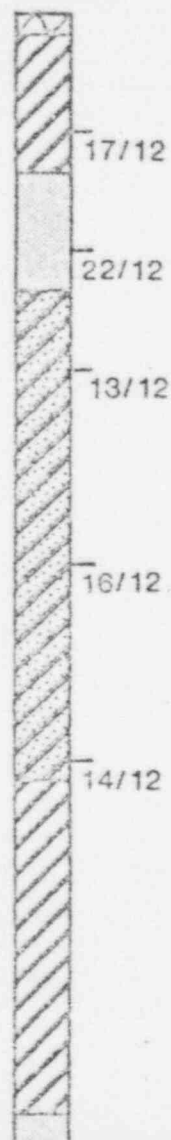
LOGS OF TEST HOLES

FIGURE A-10

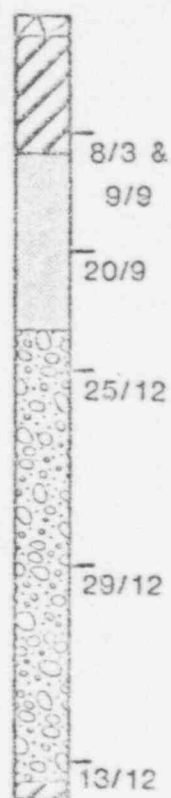
TEST HOLE D-28



D-29



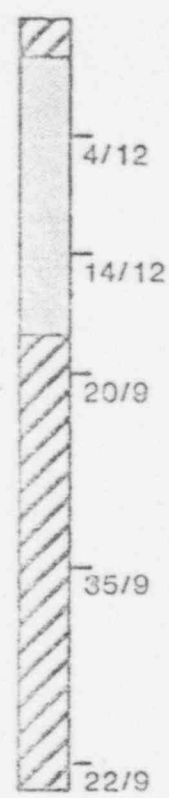
D-30



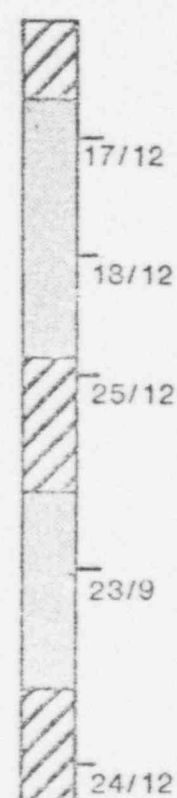
D-31



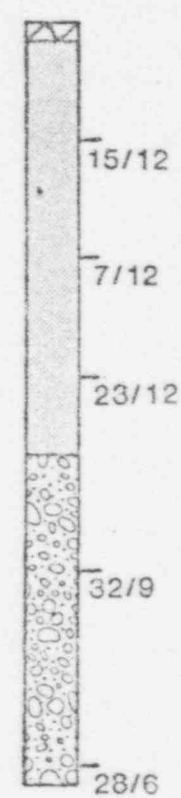
D-32



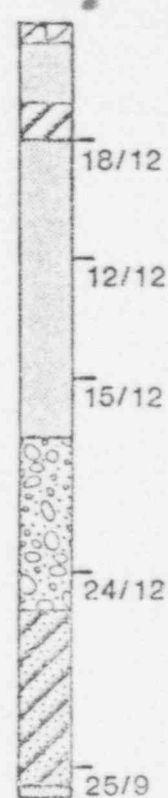
D-33



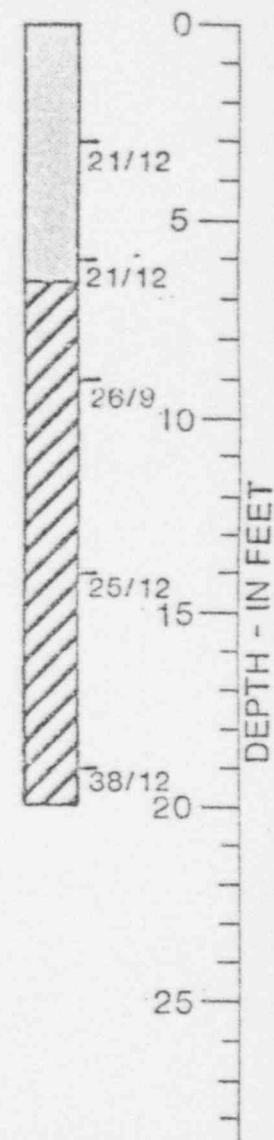
D-34



D-35



D-36



LEGENDTOPSOIL

MAN-MADE FILL, erratic moisture and compaction

CLAY, silty to SILT, clayey, slightly sandy (fine grained), stiff to hard, medium moist to very moist, dark brown, yellow brown to green (CL-ML)

SAND, fine to coarse grained, clayey, slightly silty, loose to dense, slightly moist to very moist, yellow brown to brown (SC)

SAND, fine to medium grained, silty, poorly graded with traces of iron staining, medium dense to dense, slightly moist to moist, yellow brown to white (SP-SM)

SAND, fine to coarse grained, poorly to well graded, medium dense to dense, very moist to wet, brown (SP-SW)

SANDSTONE BEDROCK, medium hard to very hard, fine to coarse grained, weakly cemented, slightly silty, with traces of iron staining, medium moist to moist, yellow brown to white (SP-SM)

CLAYSTONE BEDROCK, slightly silty and sandy, medium hard, medium moist - iron staining noted in fractures, brown (CL-CH)

SILTSTONE, slightly sandy, hard to very hard, medium moist, light brown to white (ML)

SAND & GRAVEL, medium graded, slightly clayey, medium moist to moist, medium dense to dense, yellow brown (SP-GP)

LOGS OF TEST HOLES

ANSTEC
APERTURE
CARD
Also Available on
Aperture Card

9706120313-05

APPENDIX B
LABORATORY TEST RESULTS

12690

SUMMARY OF LABORATORY TESTING

Hole No.	Depth of Sample (ft)	Percent Passing No. 200 Sieve	Atterberg Limits LL (%)	PI	Unconfined Compressive Strength (psf)	Unified Classification	Remarks
C-1	4	53.1	--	--	6,392	SM-ML	Refer to Figures B-1 and B-4
C-1	59	9.1	--	--	--	SP	Refer to Figure B-1
C-2	19	--	36	18	1,421	CL	Refer to Figure B-5
C-2	39	--	16	20	2,613	CL	Refer to Figure B-6
C-3	14	40.6	--	--	3,370	CL-SC	Refer to Figures B-1 and B-7
C-3	24	--	--	--	2,582	SC	Refer to Figure B-8
C-3	34	46.9	--	--	8,135	SM-ML	Refer to Figures B-2 and B-9
C-3	59	--	--	--	723	SC	Refer to Figure B-10
C-4	9	63.7	--	--	2,190	SM-ML	Refer to Figures B-2 and B-11
C-4	39	41.2	--	--	7,569	SP-SC	Refer to Figures B-2 and B-12
C-5	4	--	--	--	3,140	CL-ML	Refer to Figures B-13
C-6	9	28.8	--	--	954	SC	Refer to Figures B-3 and B-14

SUMMARY OF LABORATORY TESTING

Hole No.	Depth of Sample (ft)	Percent Passing No. 200 Sieve	Atterberg Limits LL (%)	PI	Unconfined Compressive Strength (psf)	Unified Classification	Remarks
C-6	39	--	--	--	1,895	SC	Refer to Figure B-15
C-7	14	33.9	--	--	956	SM-SP	Refer to Figure B-3 and B-16
D-18	9	--	--	--	1,502	SC-SM	Refer to Figure B-17
Mill Tailing #1		53	26	2	--	ML	Refer to Figure D-1
Mill Tailing #2		45	26	4	--	SM	Refer to Figure D-1
Mill Tailing #3		48	26	5	--	SM	Refer to Figure D-1
Mill Tailing #4		52	26	4	--	ML	Refer to Figure D-2
Mill Tailing #5		49	27	5	--	SM	Refer to Figure D-2

SECTION 1
CLASSIFICATION TESTS

GRADATION ANALYSIS

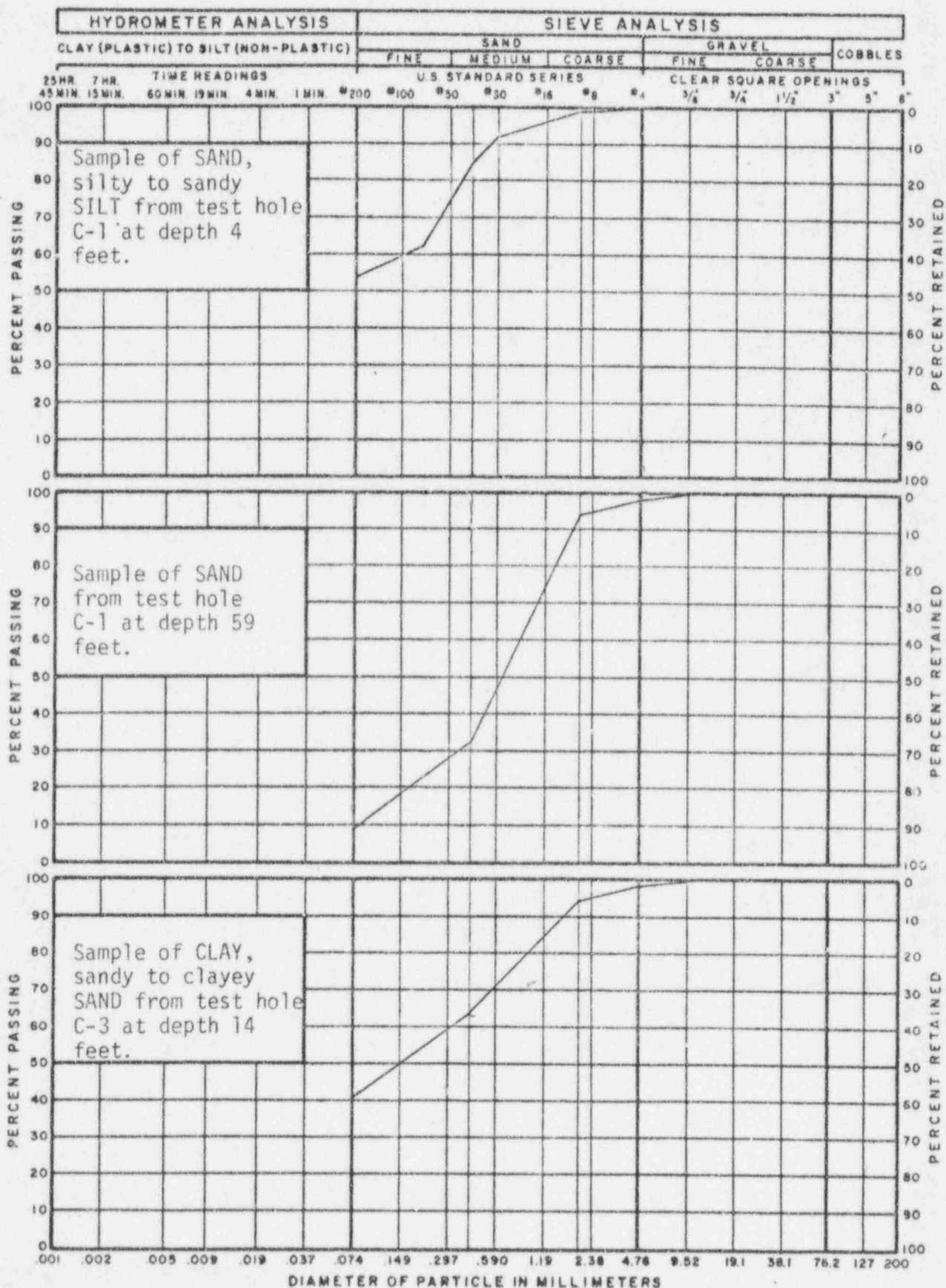


FIG. B-1

GRADATION ANALYSIS

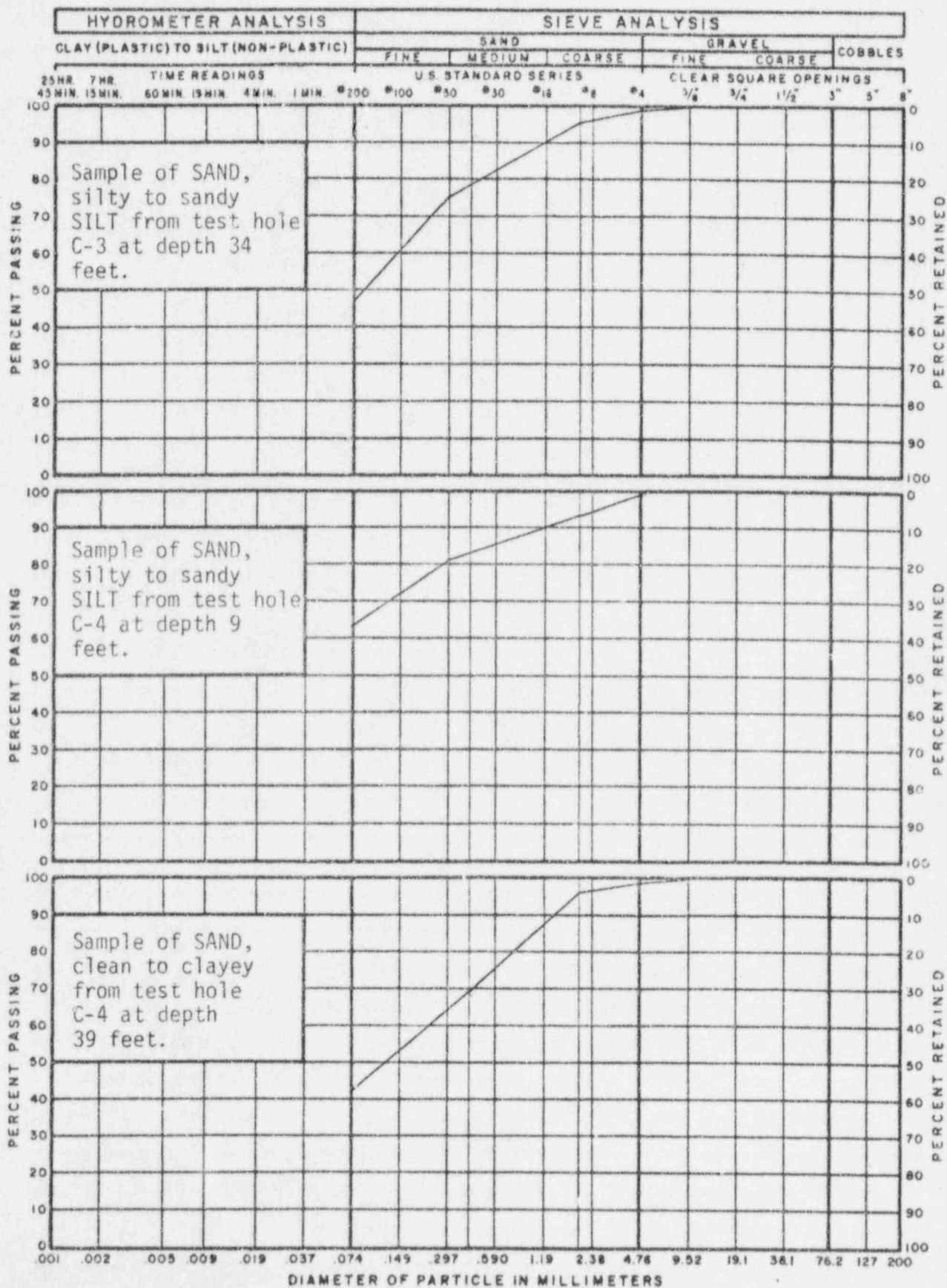


FIG. B-2

GRADATION ANALYSIS

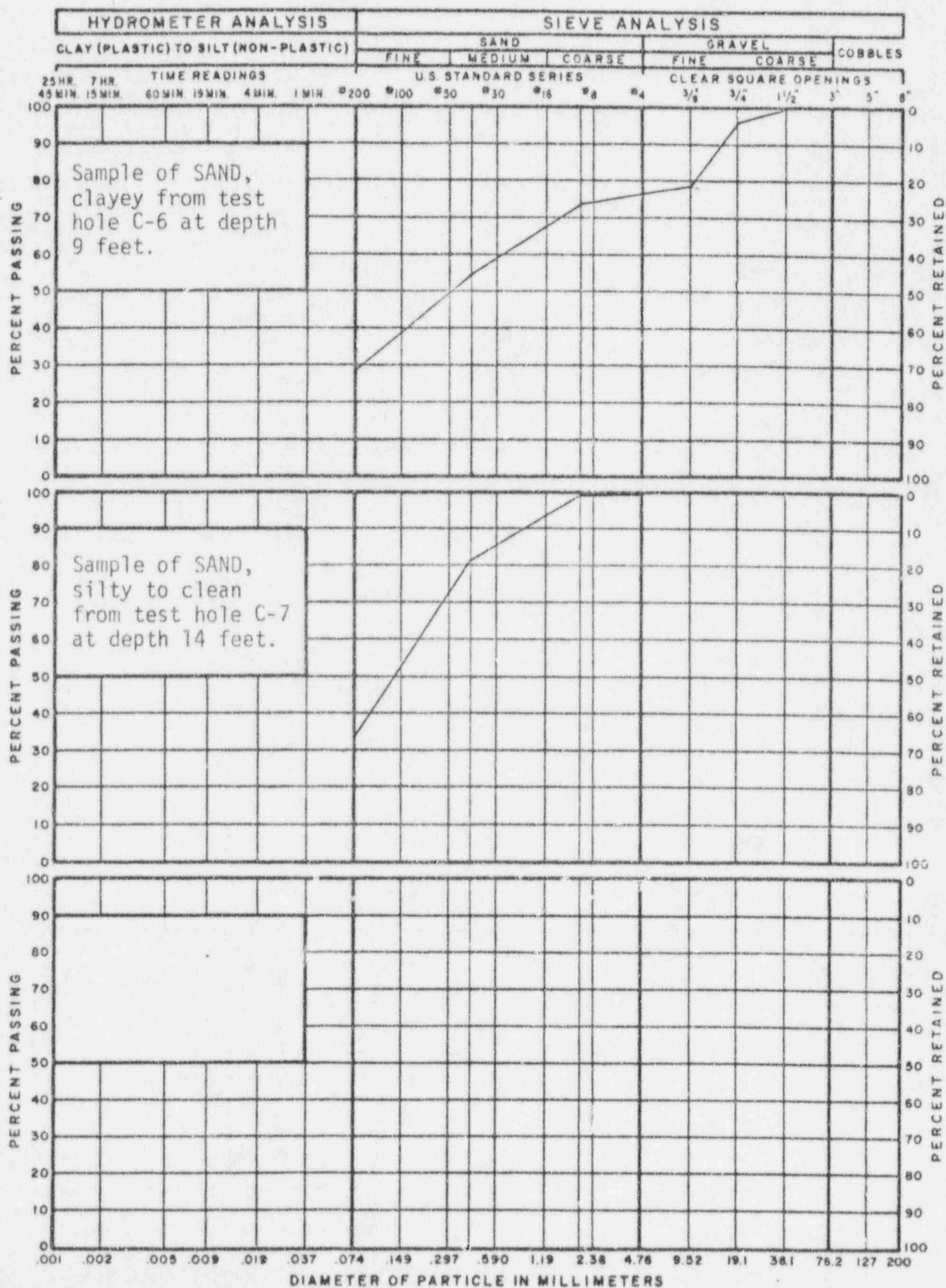


FIG. B-3

GRADATION ANALYSIS

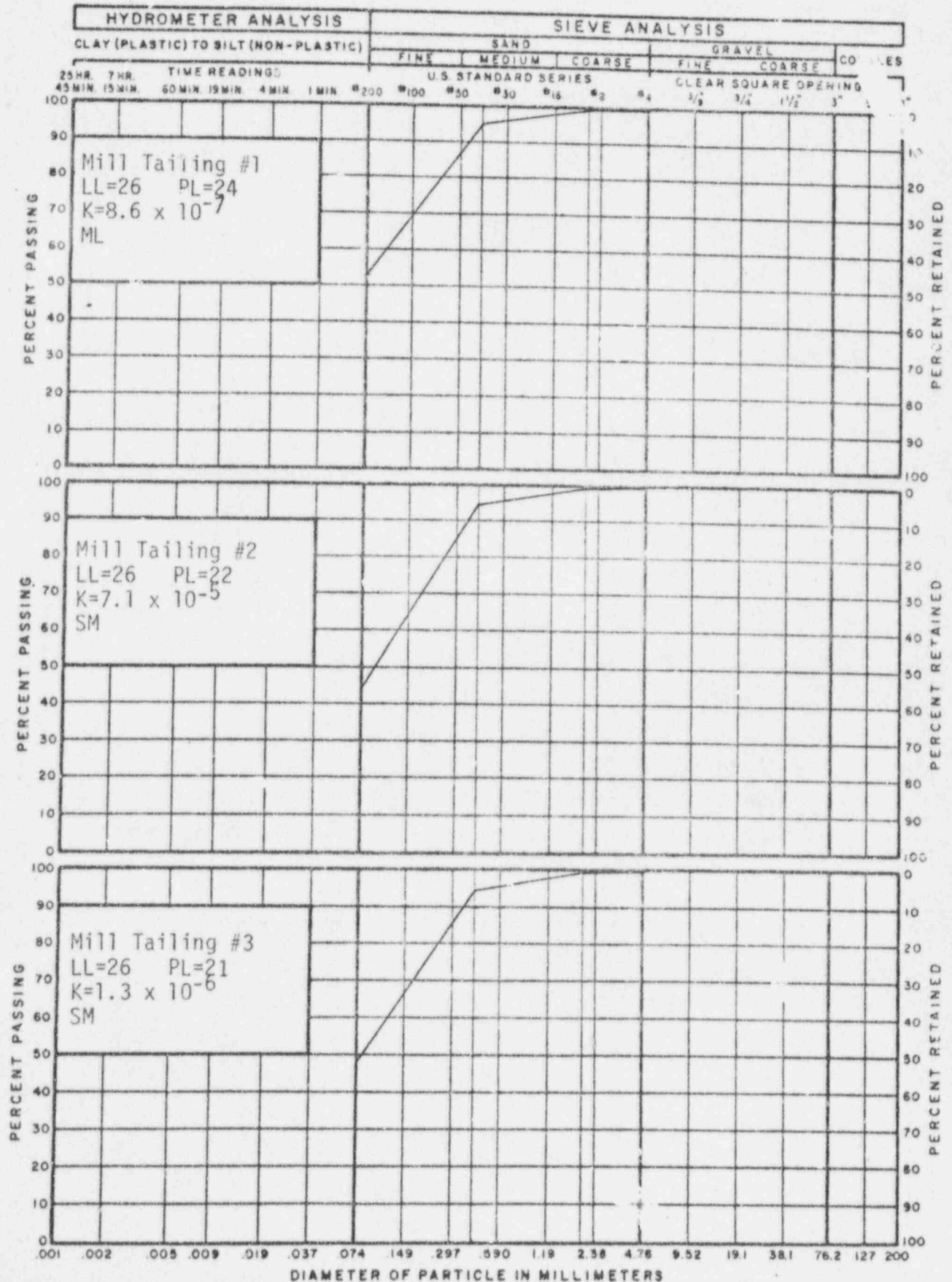


FIG. D-1

GRADATION ANALYSIS

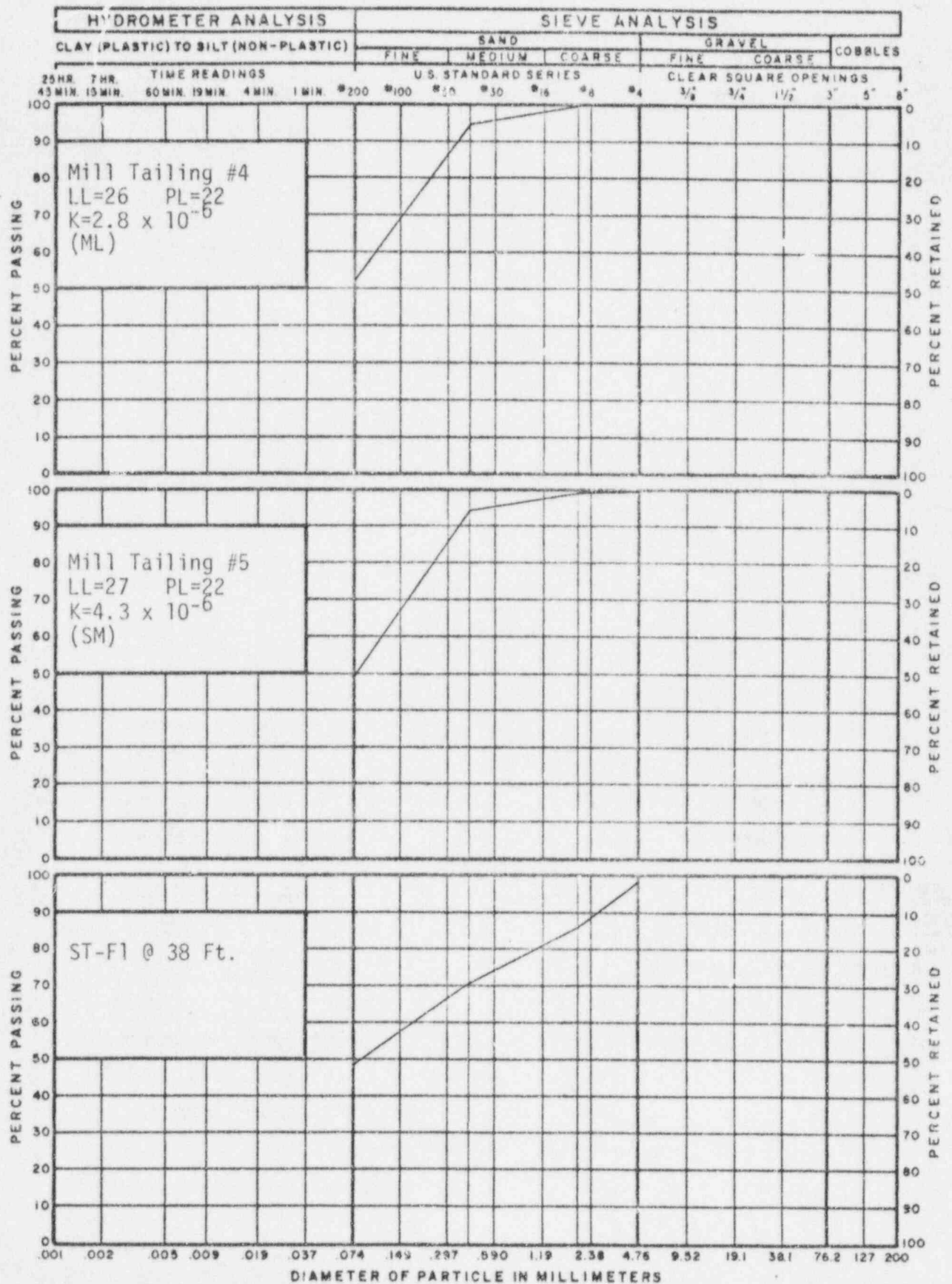
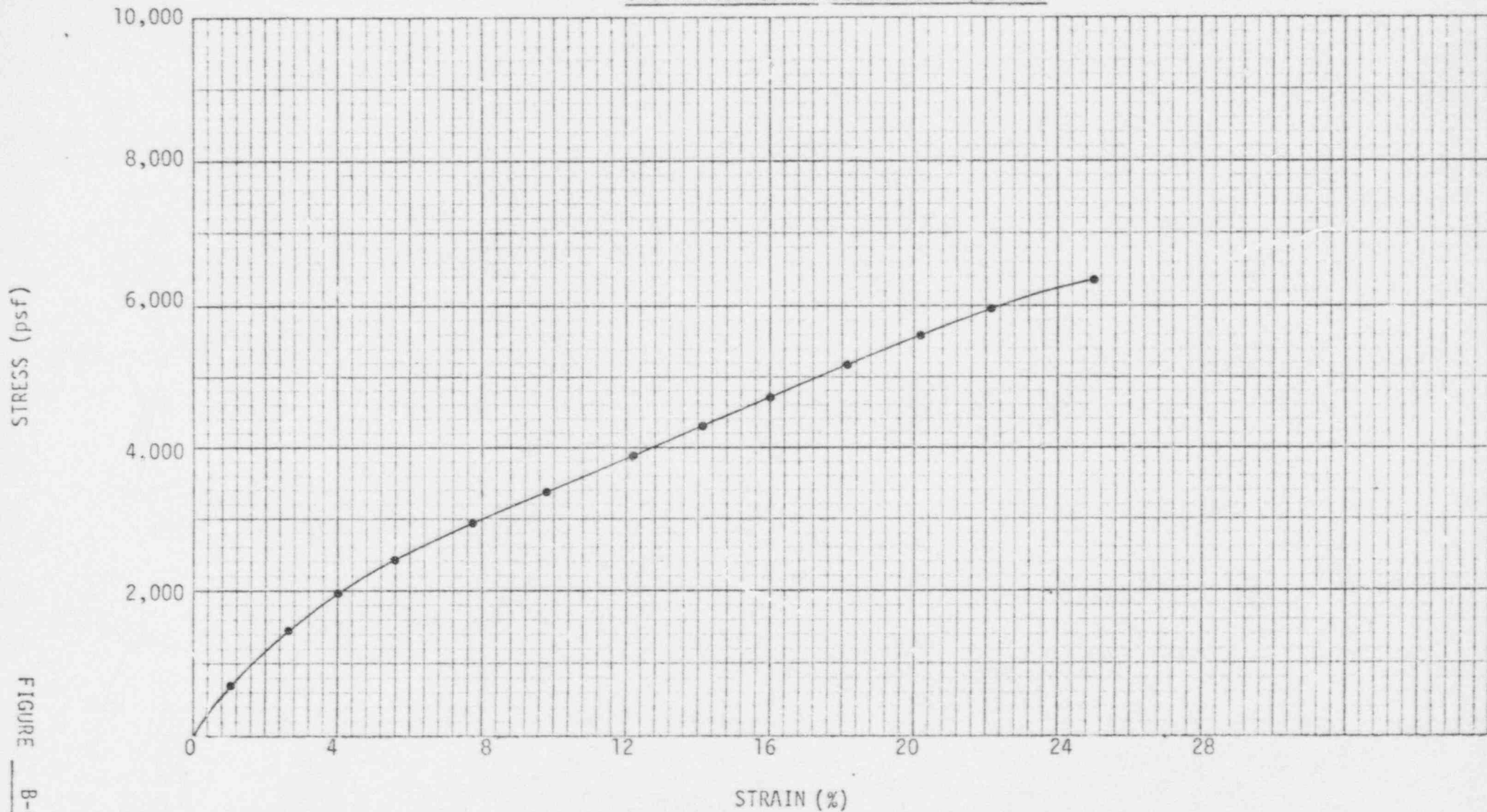


FIG. D-2

SECTION 2
STRENGTH PARAMETER TESTS

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

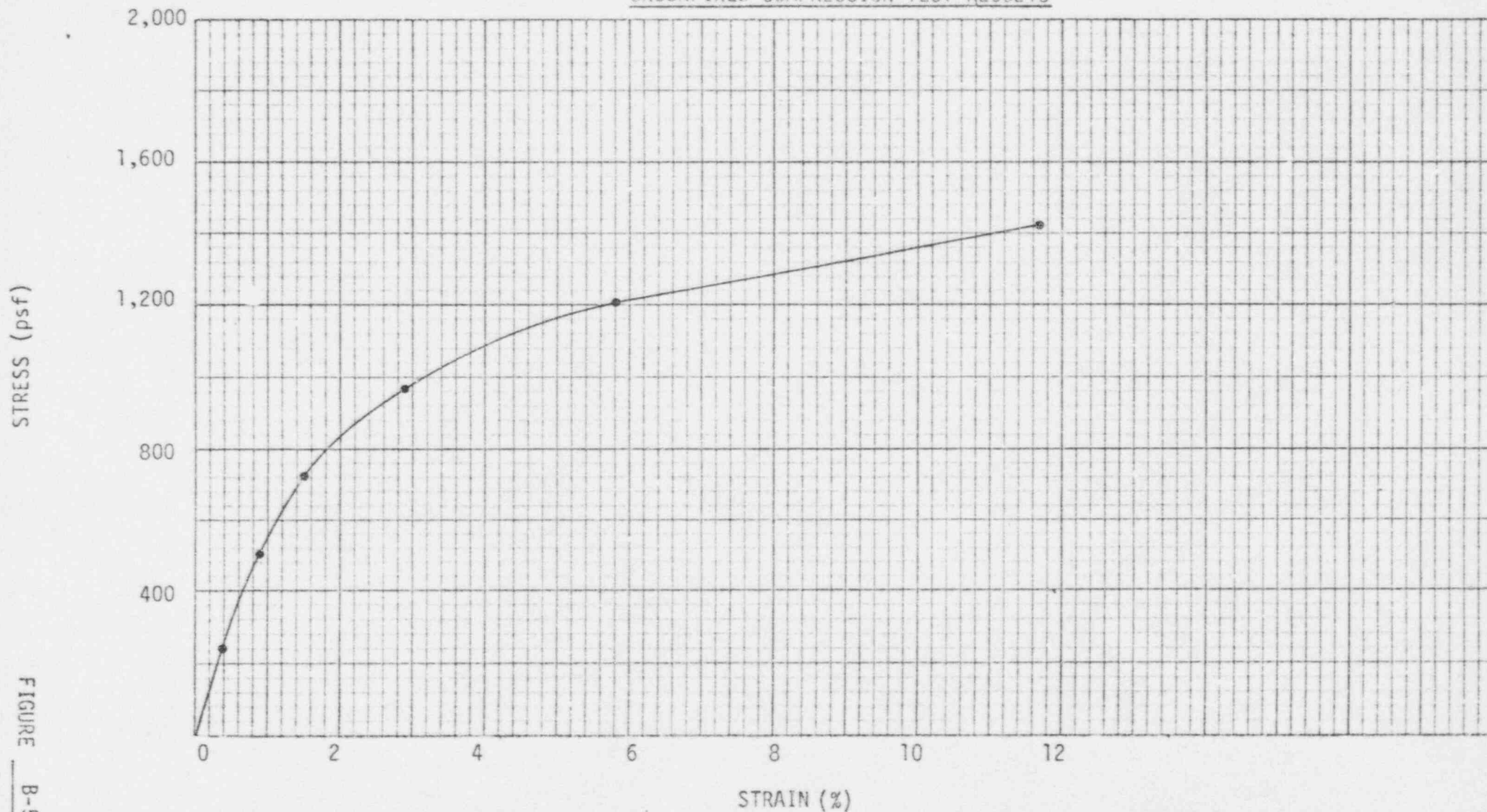


Sample of FILL (SM-ML) from hole C-1 at depth 4' Moisture Content 12.5 %

Unconfined Compressive Strength 6,392 psf Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

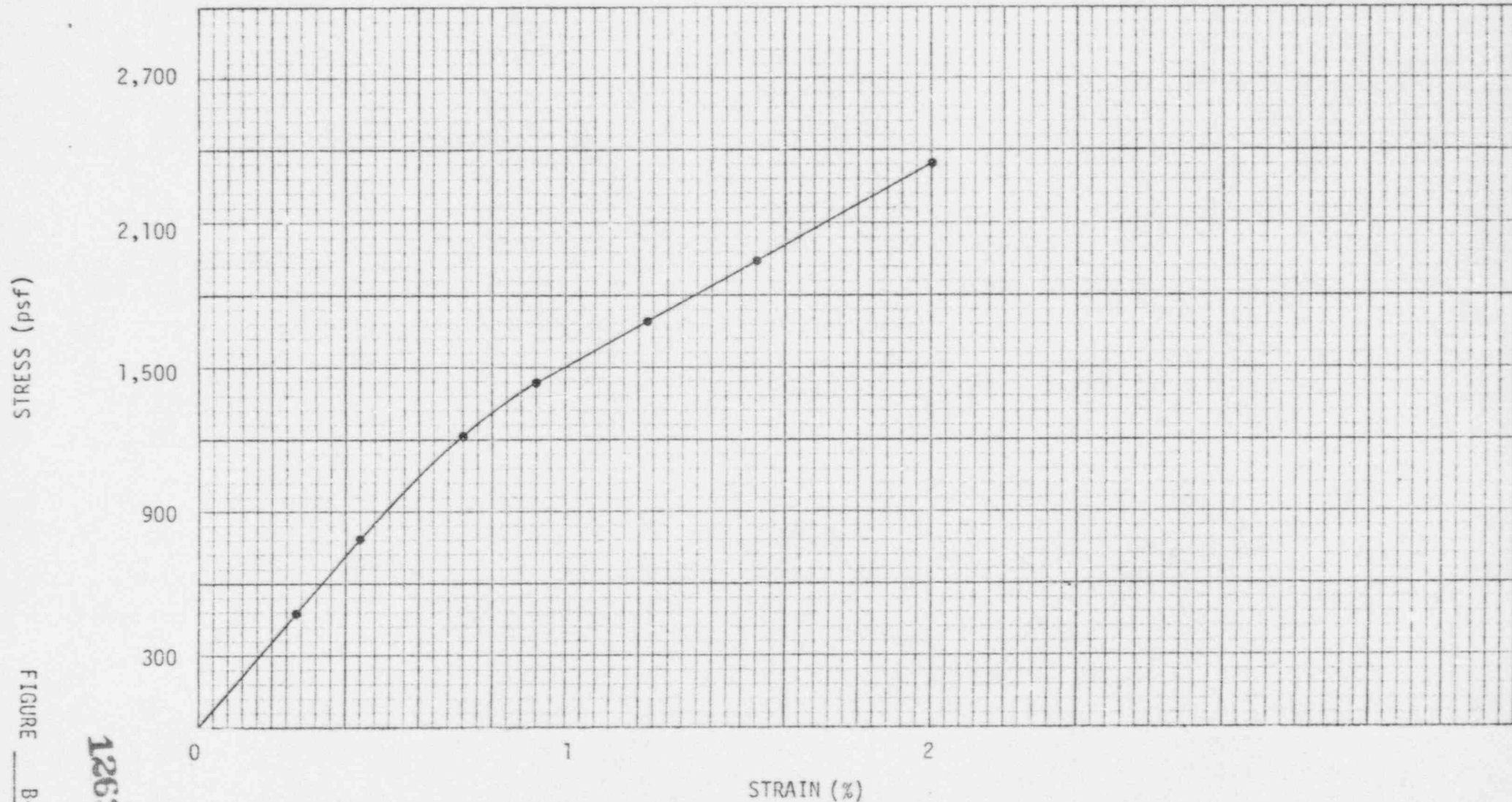


Sample of FILL (CL) from hole C-2 at depth 19. Moisture Content 23.9 %

Unconfined Compressive Strength 1,421 psf Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

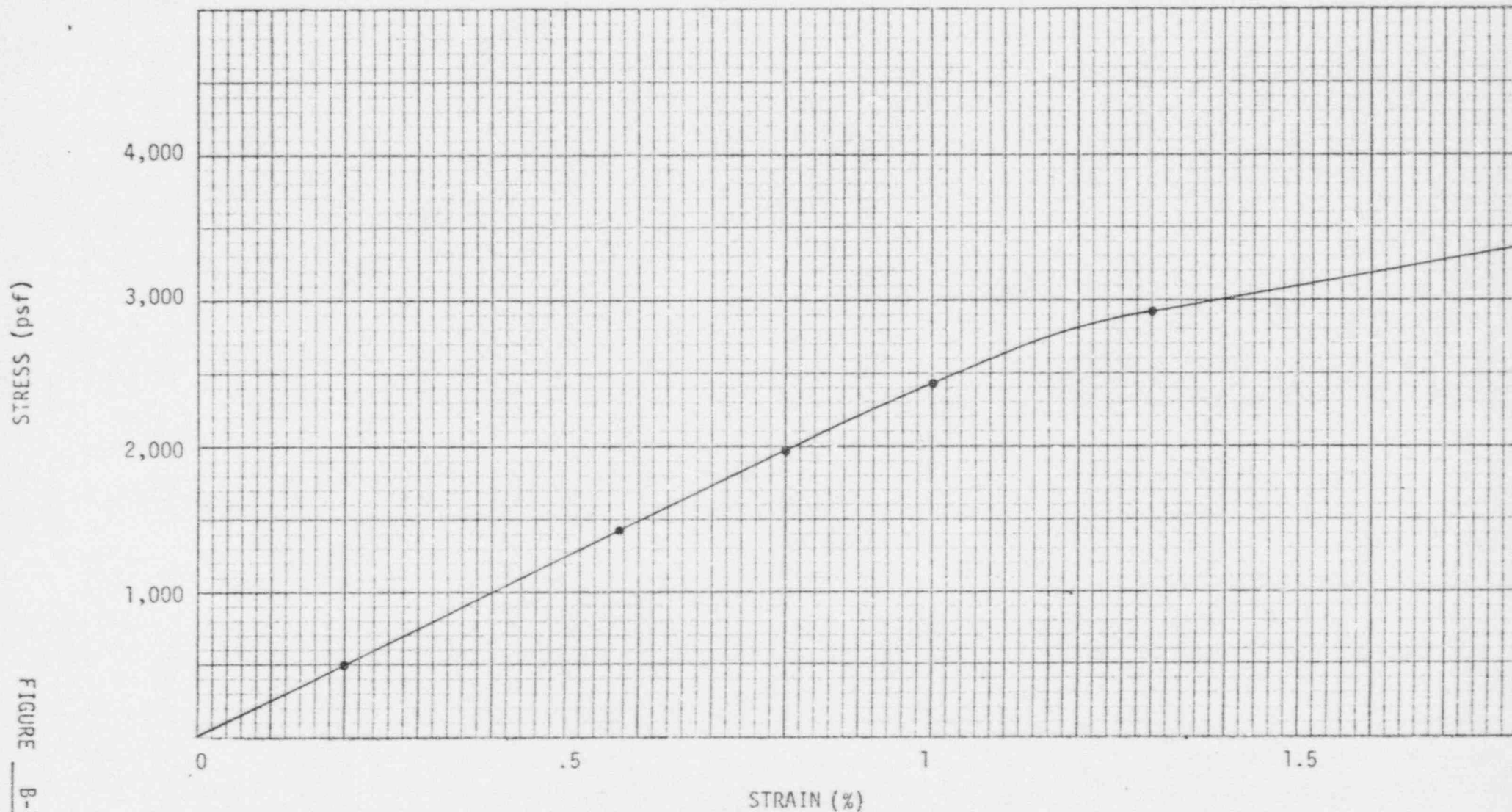
UNCONFINED COMPRESSION TEST RESULTS



Sample of FILL (CL) from hole C-2 at depth 39'. Moisture Content 18 %
Unconfined Compressive Strength 2,613 psf Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

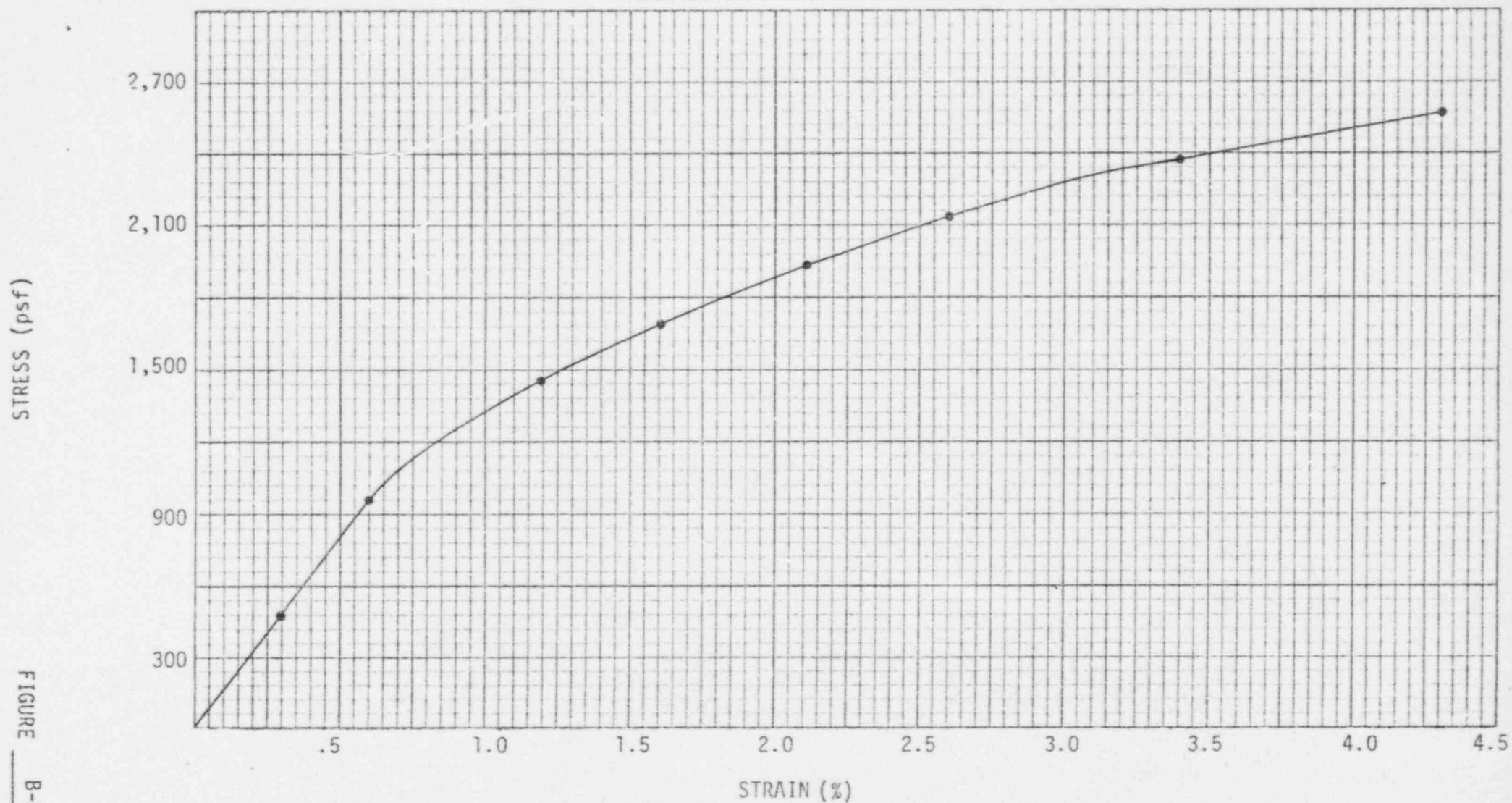


Sample of FILL (SC) from hole C-3 at depth 14'. Moisture Content 15.1 %

Unconfined Compressive Strength 3,370 psf Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS



Sample of FILL (SC) from hole C-3 at depth 24' Moisture Content %

Unconfined Compressive Strength 2,582 psf

Natural Wet Density pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

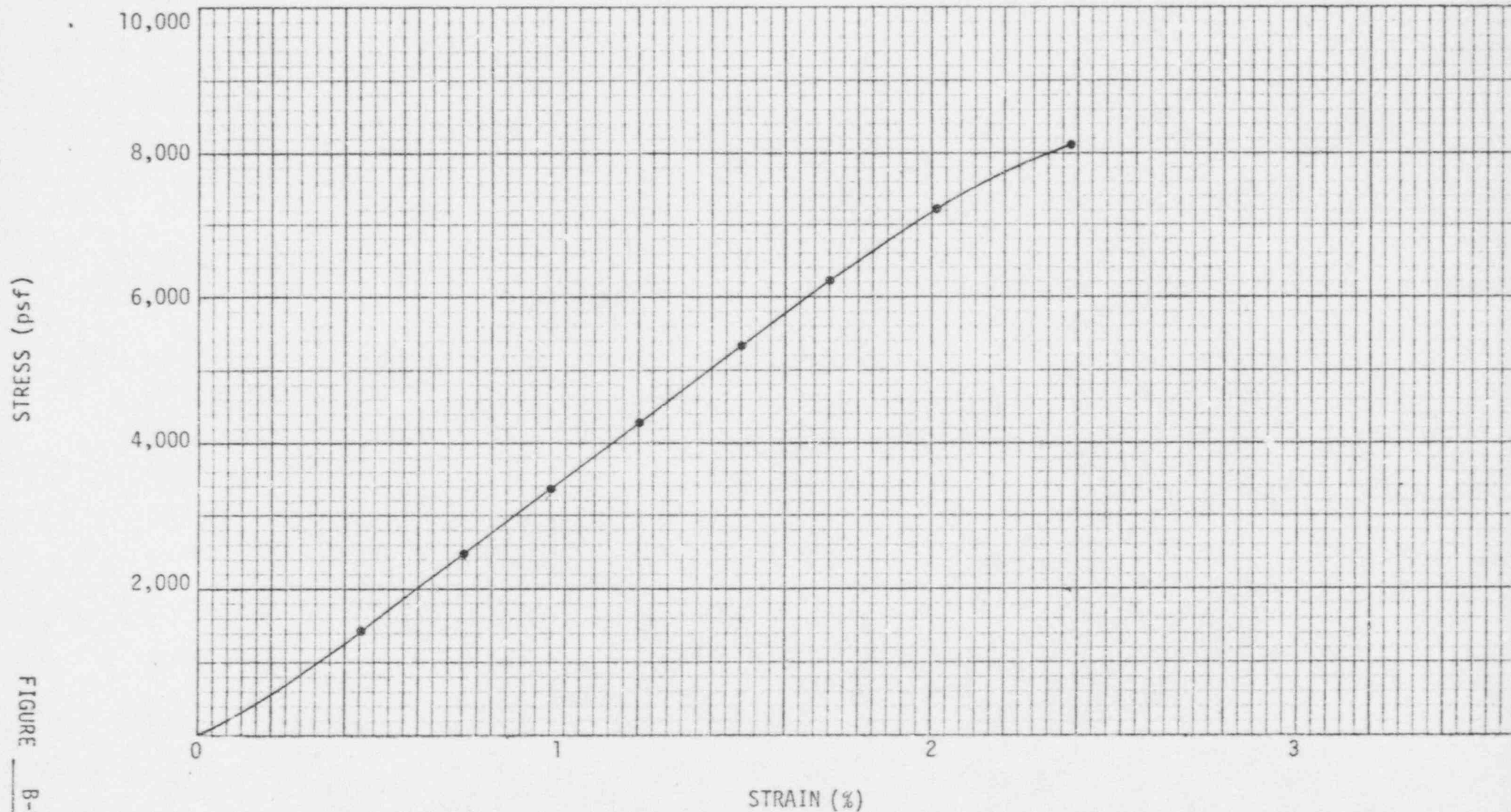


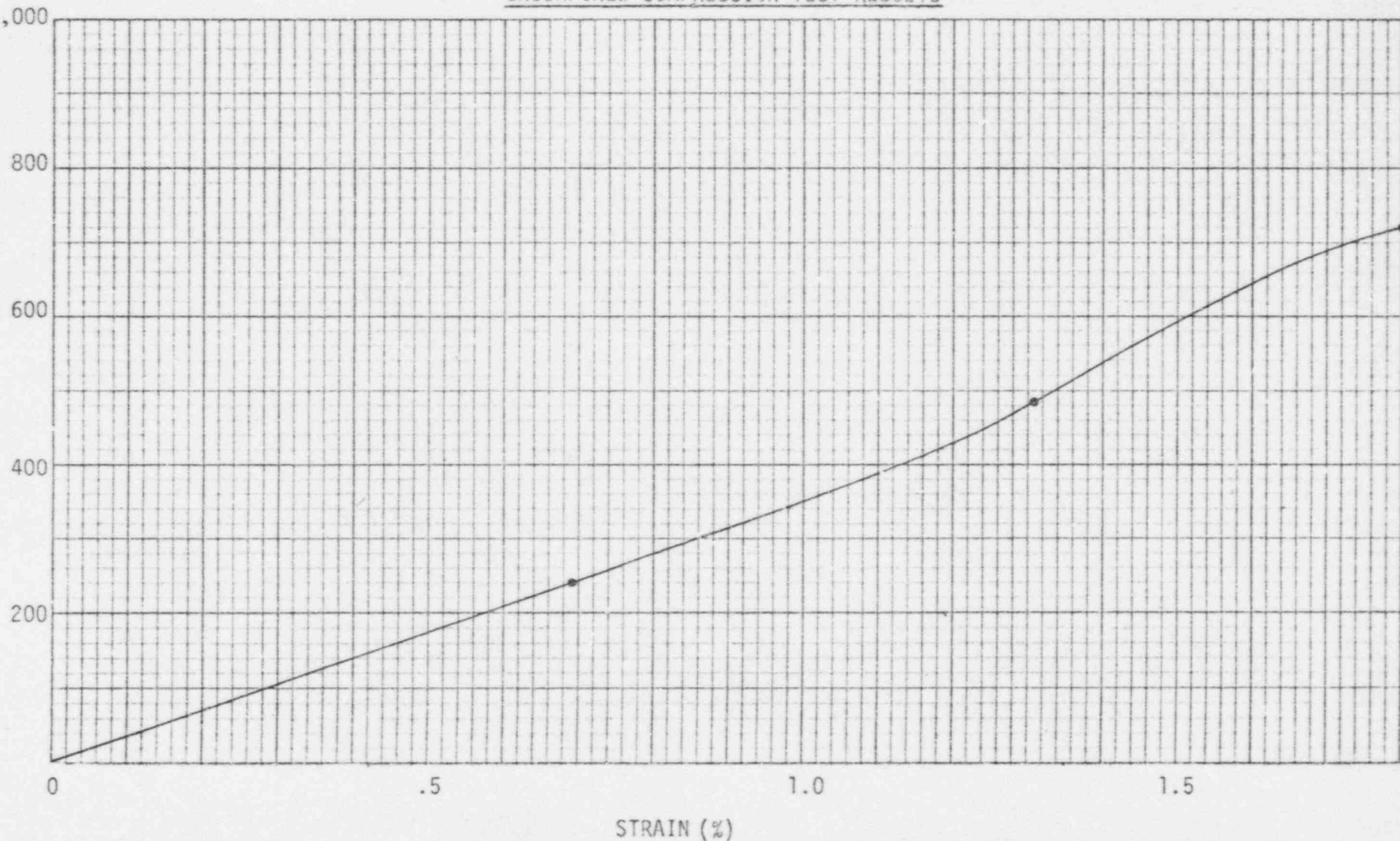
FIGURE B-9

Sample of FILL (SM-ML) from hole C-3 at depth 34'. Moisture Content 12.1 %
Unconfined Compressive Strength 8,135 psf Natural Wet Density pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

STRESS (psf)



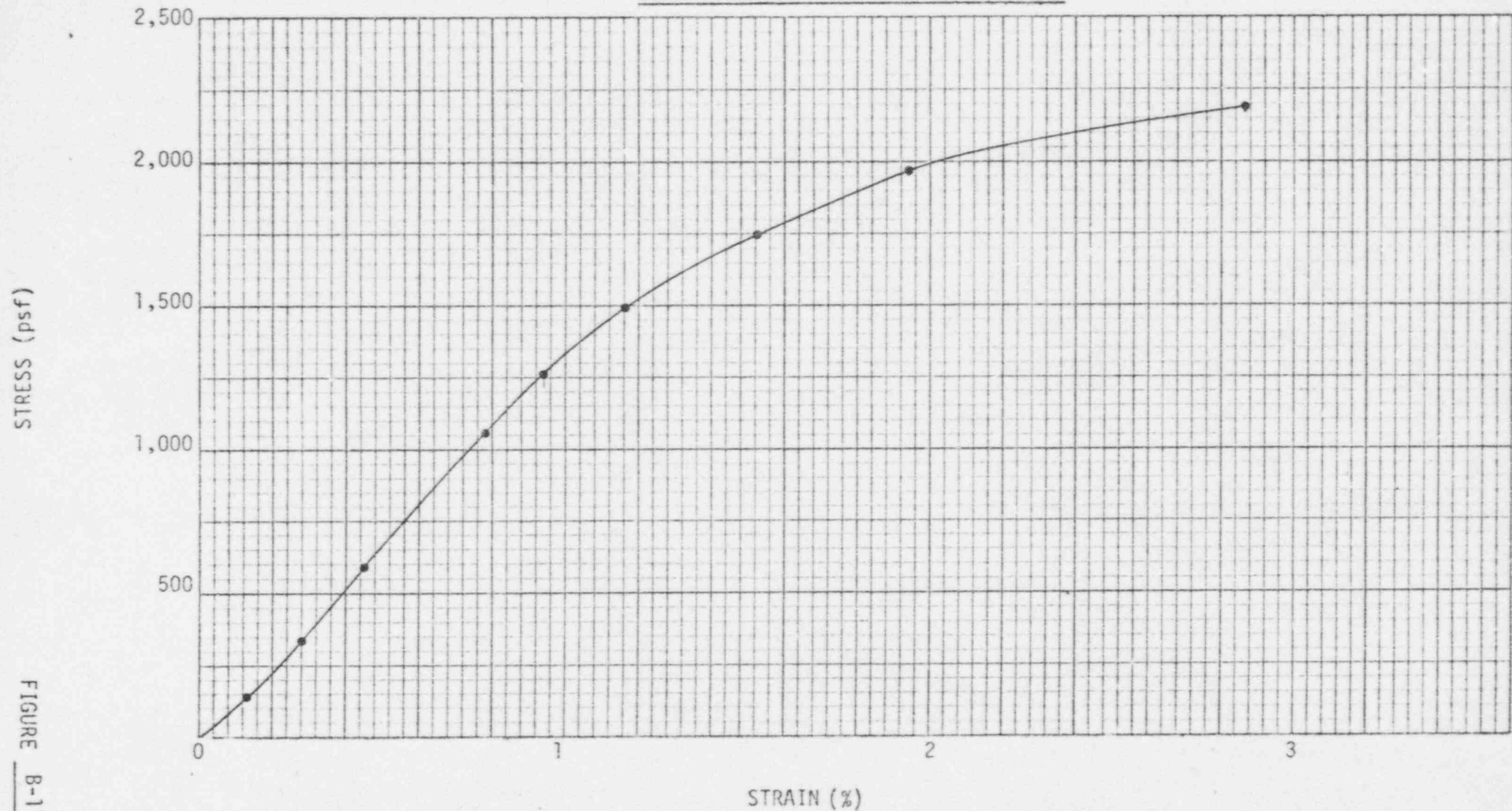
Sample of _____ (SC) _____ from hole C-3 at depth 59'. Moisture Content _____ %

Unconfined Compressive Strength 723 psf Natural Wet Density _____ pcf

FIGURE B-10

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

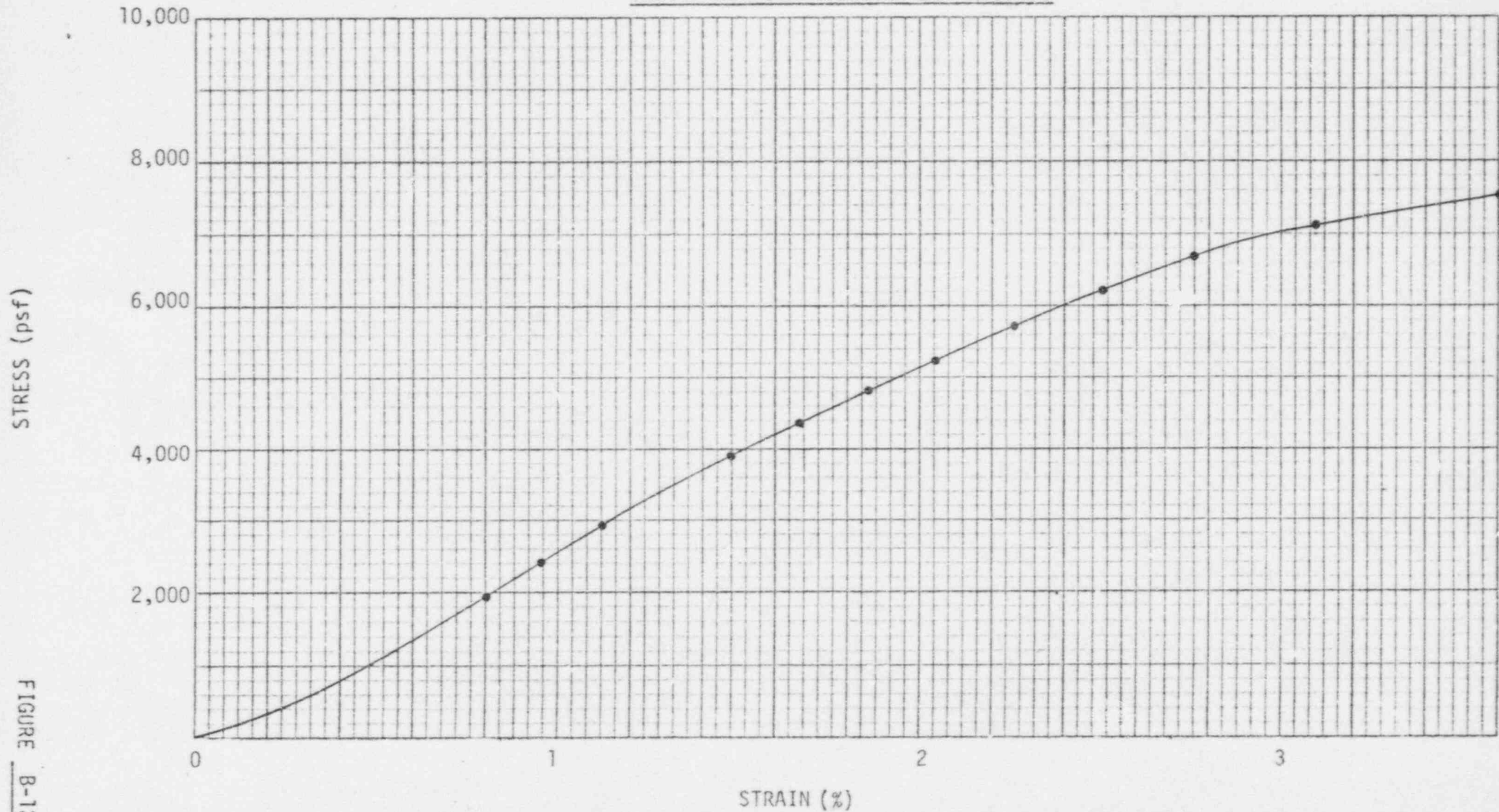


Sample of FILL (ML-CL) from hole C-4 at depth 9'. Moisture Content 12.7 %

Unconfined Compressive Strength 2,190 Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

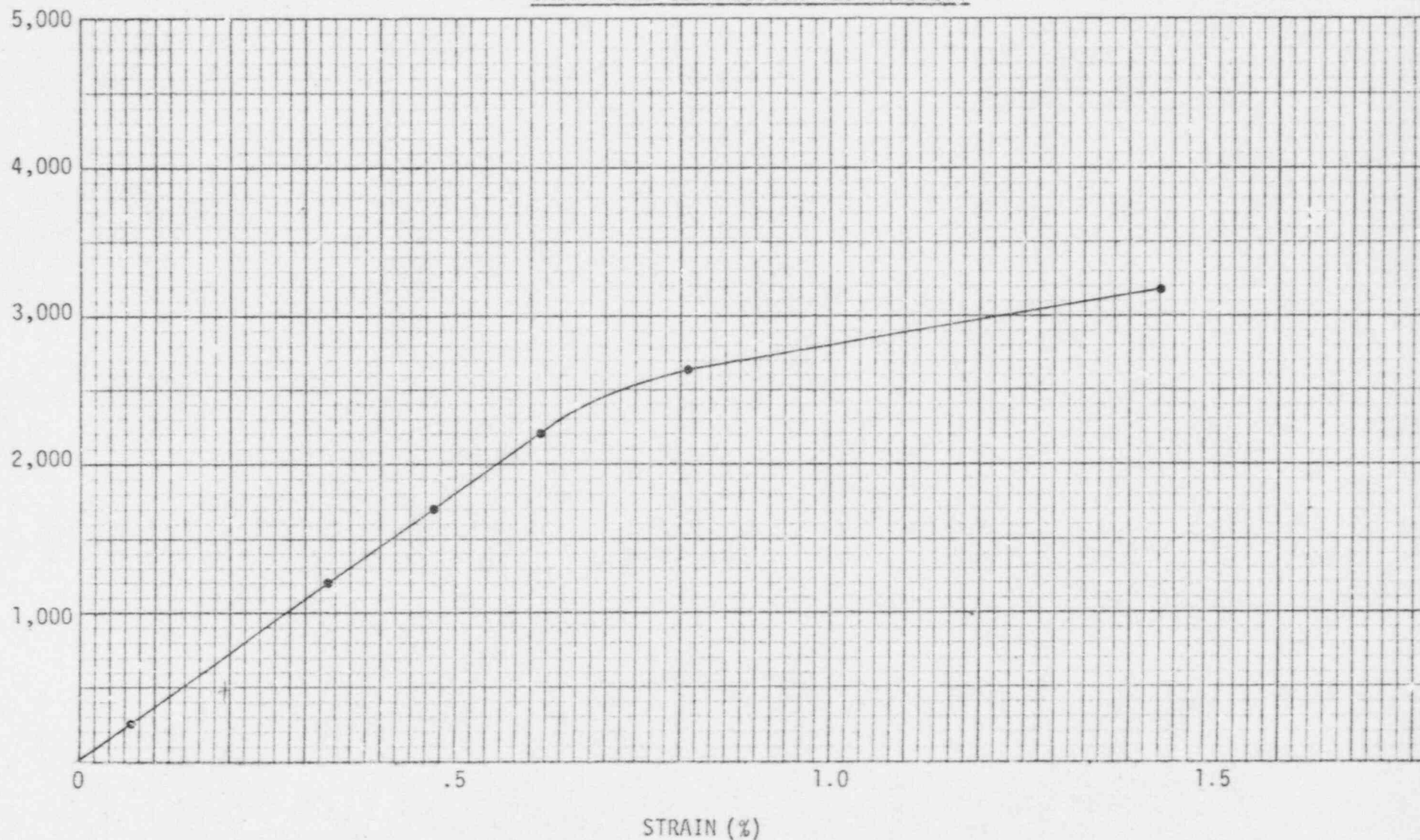
UNCONFINED COMPRESSION TEST RESULTS



Sample of FILL (SP-SC) from hole C-4 at depth 39'. Moisture Content 12.0 %
Unconfined Compressive Strength 7,562 psf Natural Wet Density pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

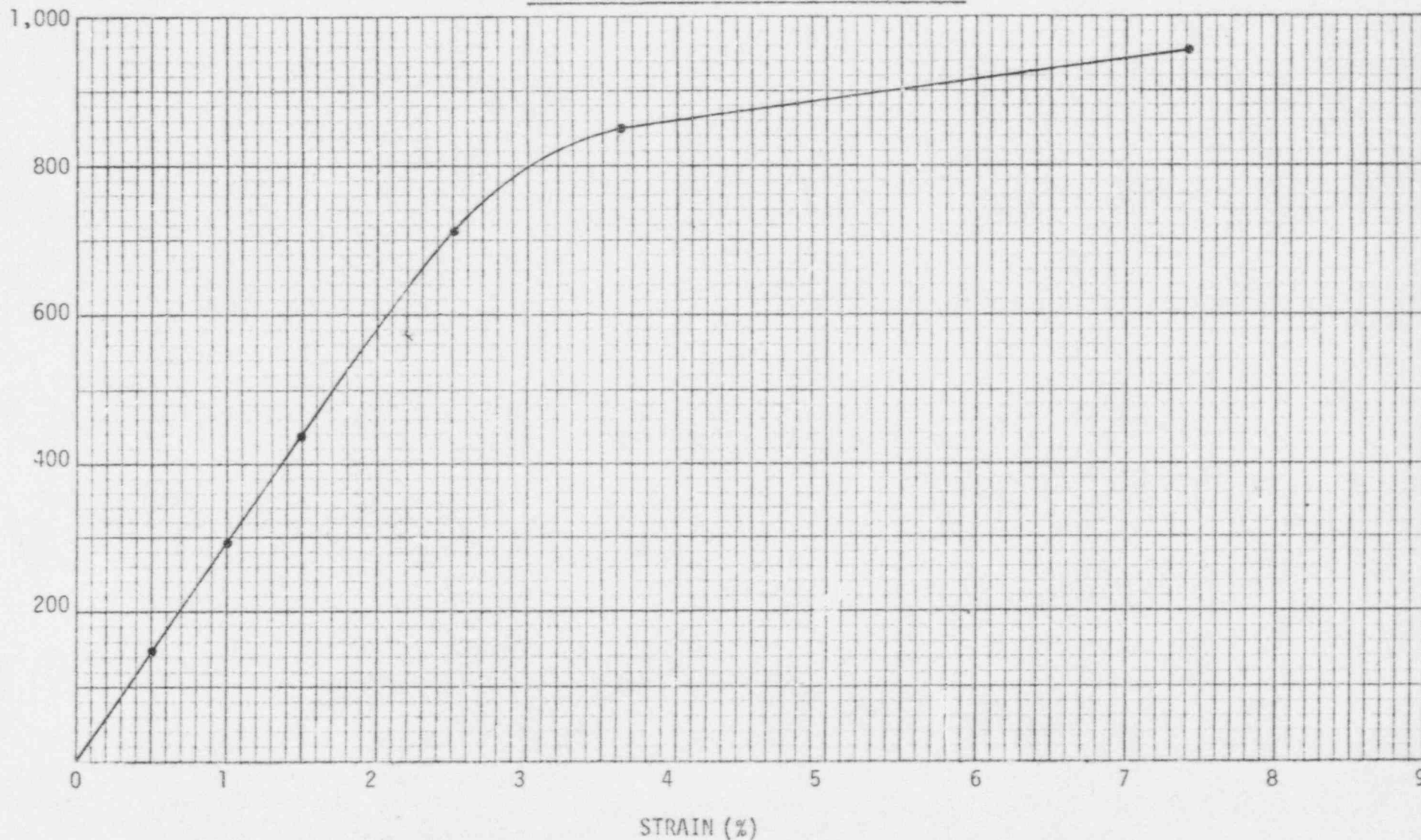
UNCONFINED COMPRESSION TEST RESULTS



Sample of FILL (ML-CL) from hole C-5 at depth 4'. Moisture Content %
Unconfined Compressive Strength 3,140 psf Natural Wet Density pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS

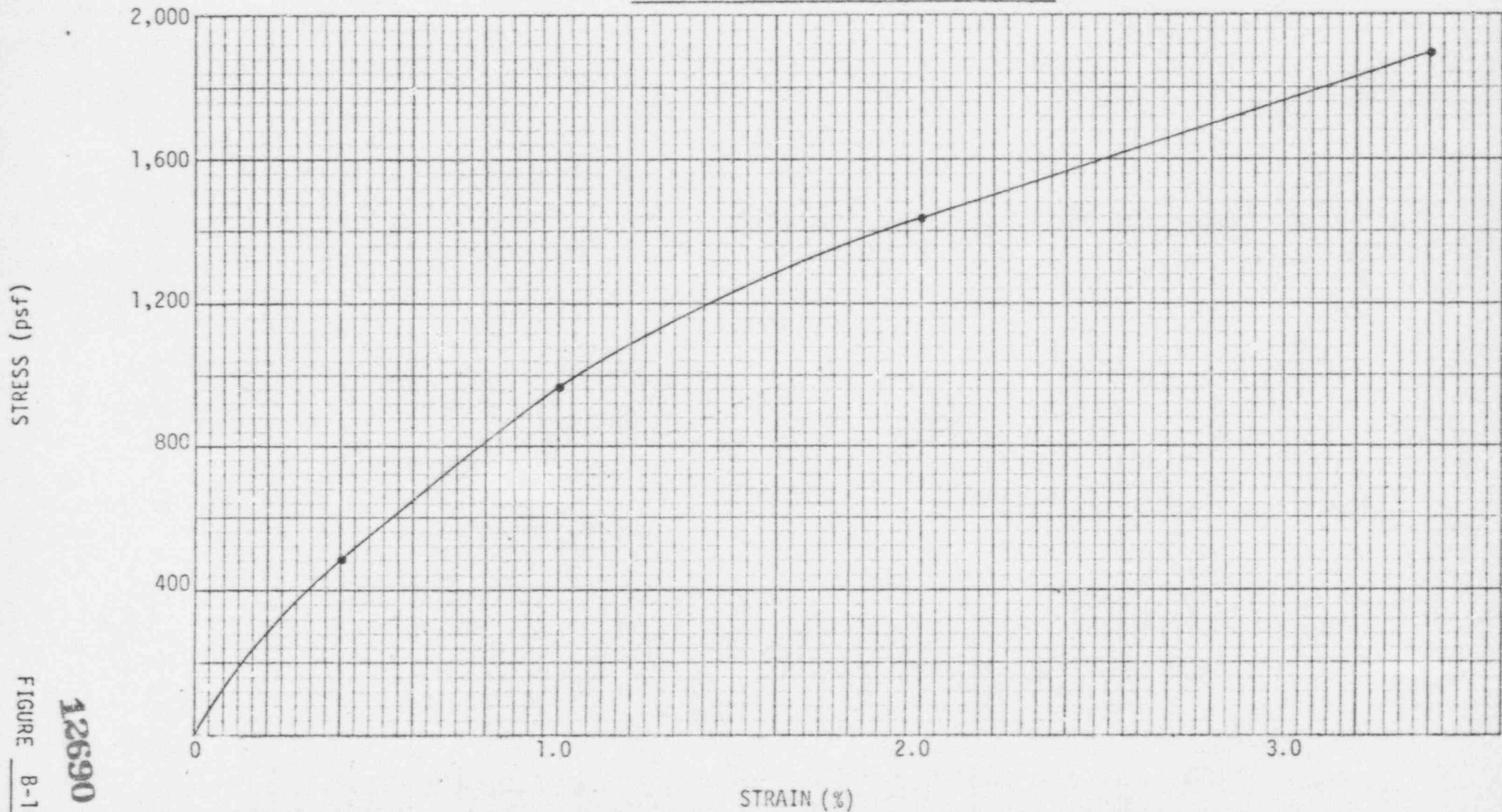


Sample of FILL (SC-SM) from hole C-6 at depth 9'. Moisture Content 16.0 %

Unconfined Compressive Strength 954 psf Natural Wet Density _____ pcf

F. M. FOX & ASSOCIATES, INC.
Consulting Engineers and Geologists

UNCONFINED COMPRESSION TEST RESULTS



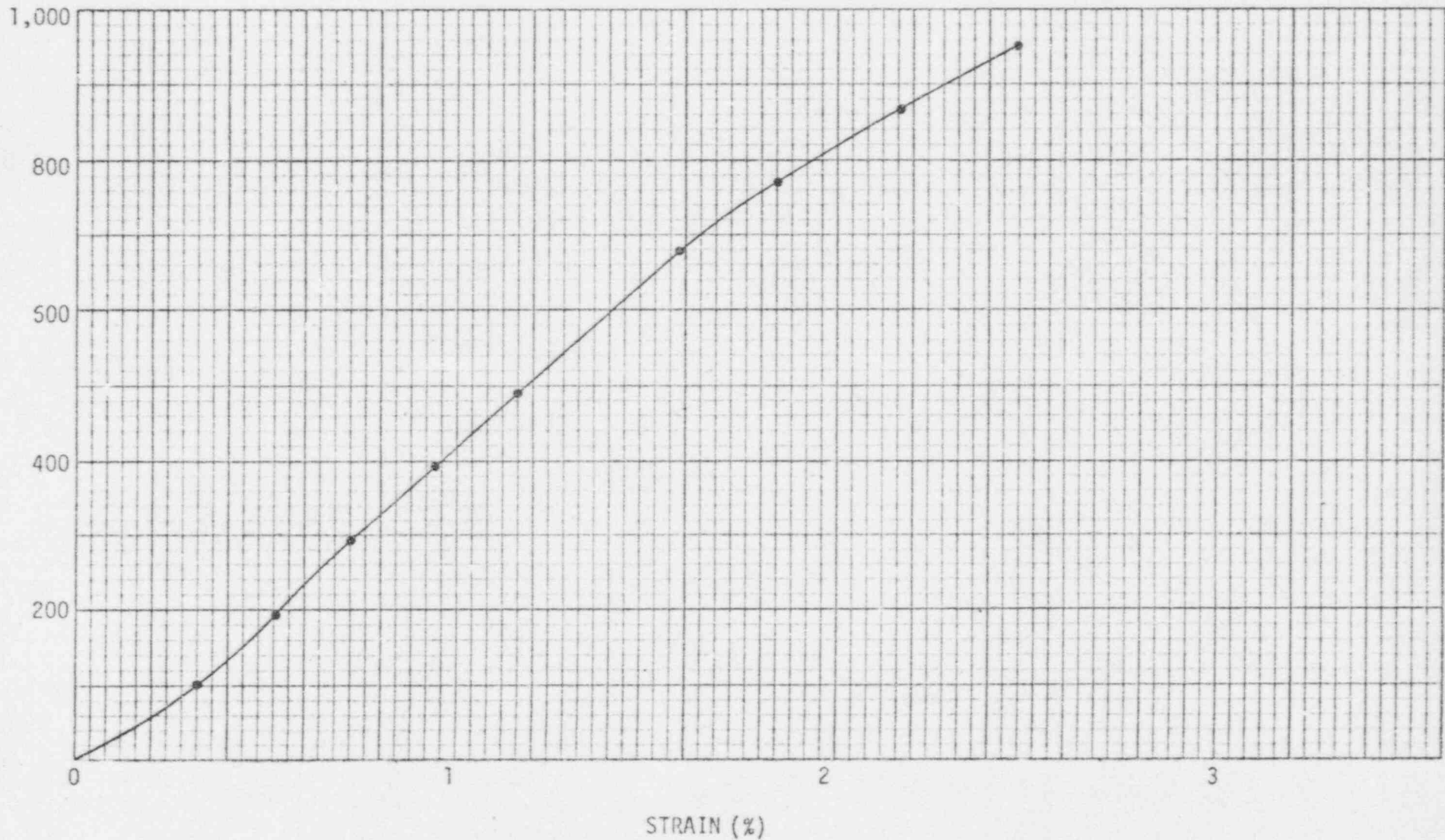
Sample of FILL (SC) from hole C-6 at depth 39'. Moisture Content %

Unconfined Compressive Strength 1,895 psf Natural Wet Density pcf

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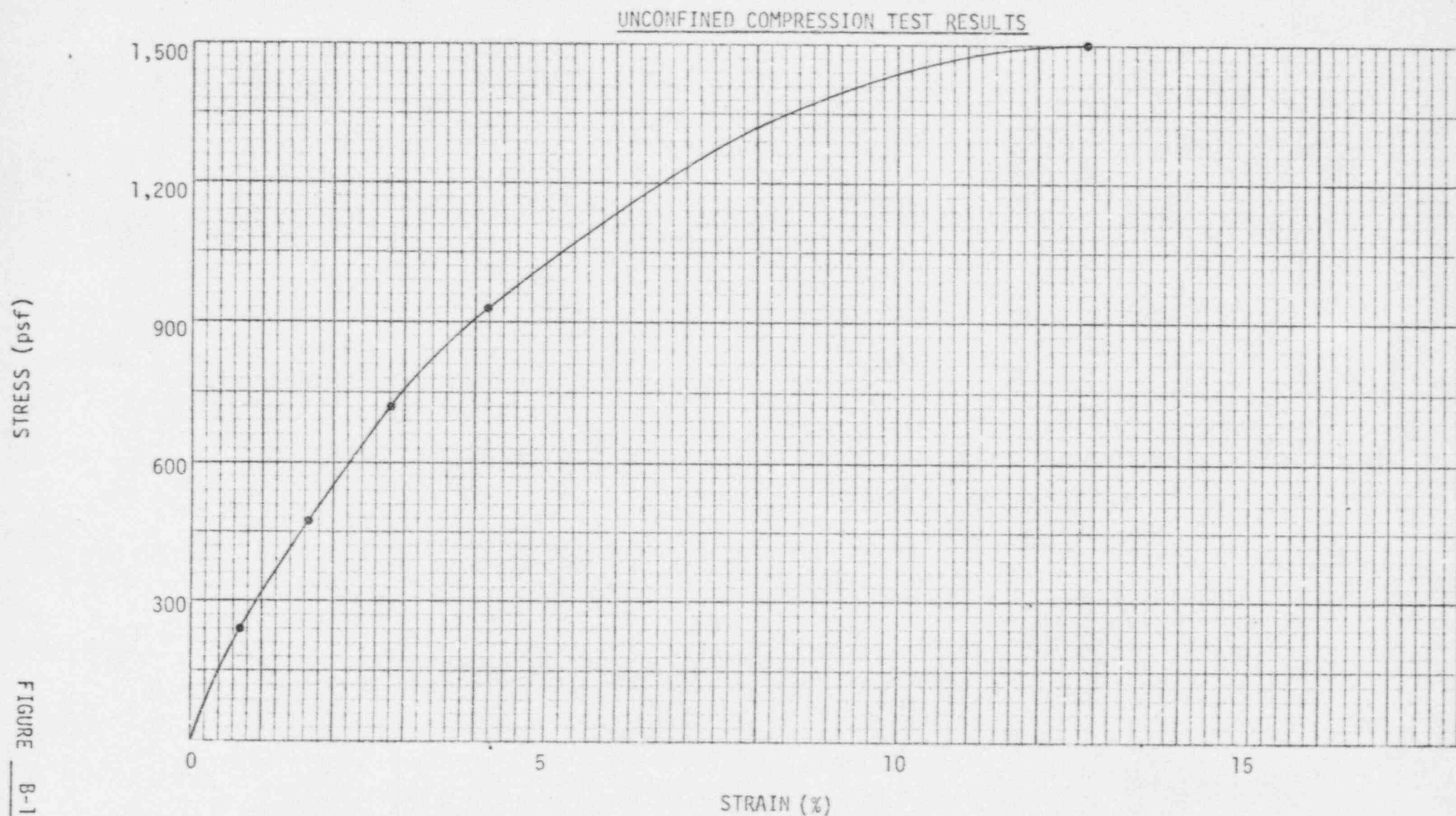
UNCONFINED COMPRESSION TEST RESULTS

STRESS (psf)



Sample of FILL (SP-SM) from hole C-7 at depth 14'. Moisture Content 16.3 %
Unconfined Compressive Strength 956 psf Natural Wet Density _____ pcf

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Sample of (SC-SM) from hole D-18 at depth 9'. Moisture Content %

Unconfined Compressive Strength 1,502 psf Natural Wet Density pcf

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APERTURE CARD/PAPER COPY AVAILABLE THROUGH NRC FILE CENTER

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This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.