ADDITIONAL CHEMICAL ENGINEERING INVESTIGATIONS FOR ARIZONA'S MARIOCPA SSC SITE

Edward A. Nowatzki, Eugene Muller, Jay S. DeNatale,
German A, Ibarra-Encinas, Abdul-Hakim M. F. AlGhanem (1)
and John Welty (2)

TABLE OF CONTENTS

page

1.0 DESCRIPTION OF SURFACE STUDIES 1

1.1 In-Place Testing: Field Slope Testing

2.0 LABORATORY TESTING 3

2.1 Sieve Analyses
2.2 Atterberg Limits Analyses
2.3 Soil Classifications
2.4 Direct Shear Testing
2.5 Triaxial Testing
2.6 Analyses of Collapse Potential

3.0 FINDINGS 5

3.1 Results of Drilling (Fanglomerate Boreholes Logs)
3.2 Results of Field Slope Testing
3.3 Results of Laboratory Testing
3.4 Comparability of Fanglomerate Strength Data
3.4.1 Lab Data Versus Dilatometer Data
3.4.2 Lab Data Versus Field Slope Data
3.4.3 SPT Blow-Count Data Versus Seismic Survey Data
3.5 Open Cut Construction -- Stability Analyses for 90 degree, 60 degree, and 45 degree side slopes

4.0 CONSTRUCTION REQUIREMENTS 22

5.0 REFERENCES 23

APPENDIX A: FIELD BORING LOGS

APPENDIX B: FIELD SLOPE TEST FAILURE LOADS AND GEOMETRIES

APPENDIX C: LABORATORY DATA SHEETS AND CURVES

1.0 DESCRIPTION OF SURFACE STUDIES

1.1 In-Place Testing: Field Slope Testing

Much of the basin fill and fanglomerate is lightly to moderately cemented, and it is very difficult to acquire undisturbed specimens from standard field sampling techniques. Disturbed and undisturbed test specimens will exhibit nearly identical internal friction angles ϕ, provided that the specimens possess similar void ratios. However, the material's apparent cohesion c generally decreases as the degree of sampling-induced disturbance increases. For this reason, laboratory testing may significantly underestimate the shear strength of the material in it's natural, undisturbed state. A novel program of field slope testing was therefore conducted to identify the shear strength of the basin fill in it's natural state. A 10-foot deep, 35-foot long benched trench was dug in the material with a steam shovel, and several separate slope failures were then induced by applying a surface loading at the crest of the newly created vertical slope.

A one-inch thick, square steel plate, 8 inches or 15 inches in length, was placed near the crest of the slope, as shown in Figure 1.1.1. A uniform load of increasing intensity was then applied to the plate by means of a 50-ton hydraulic jack. The rear-end of the steam shovel provided the reaction support for the hydraulic jack. The surface surcharge was gradually increased until the slope failed, and the failure load and slip surface geometry were then recorded. Ten separate tests were performed -- five on the upper slope and five more on the lower slope (see Appendix A). The shear strength parameters of the undisturbed basin fill were then back-calculated by means of an accepted analytical procedure (described in detail in Section 3.2).

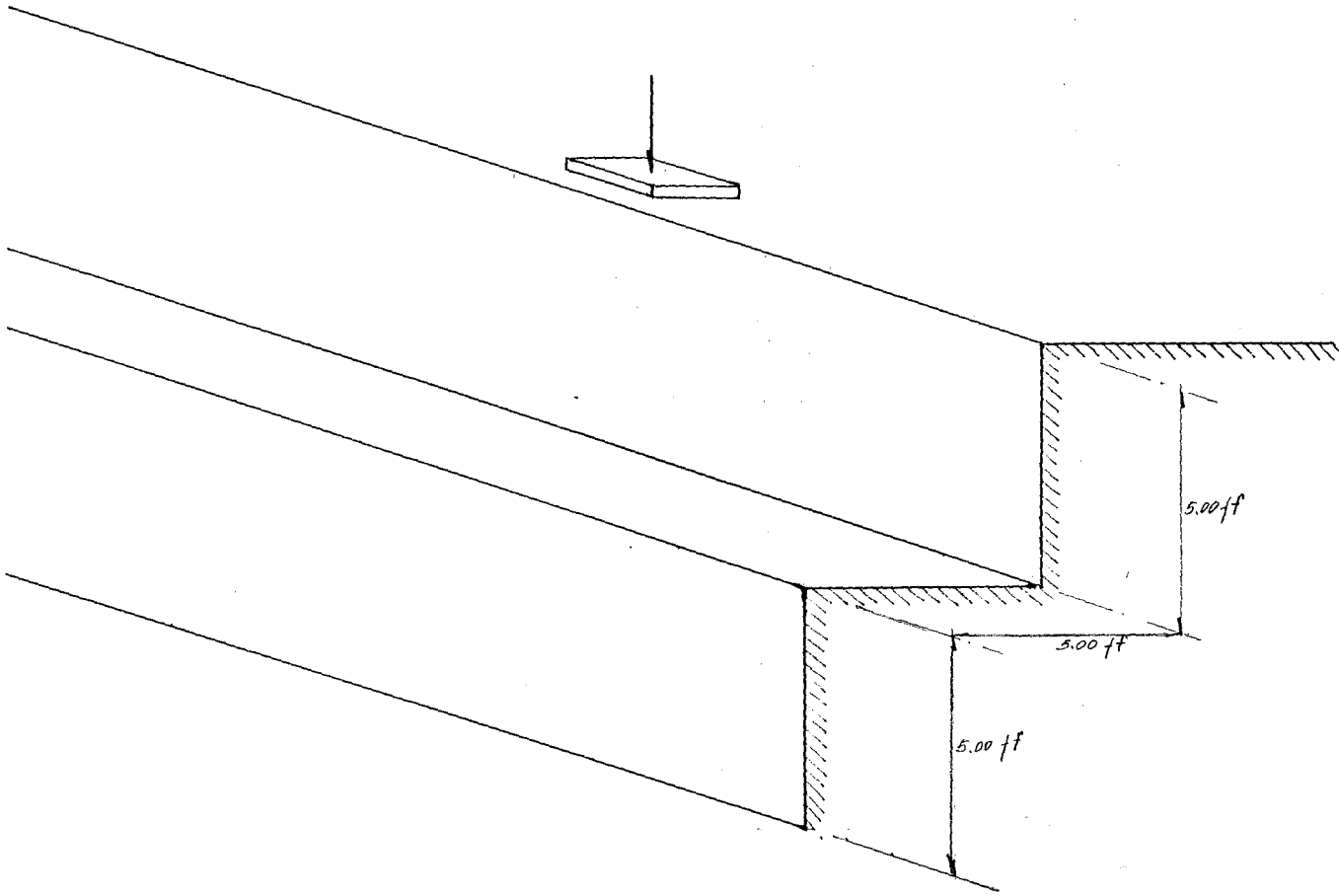


Figure 1.1.1

Sketch of Field Slope Testing Set-up, Maricopa Site

TABLE OF CONTENTS

page

1.0 DESCRIPTION OF SURFACE STUDIES 1

1.1 In-Place Testing: Field Slope Testing

2.0 LABORATORY TESTING 3

2.1 Sieve Analyses
2.2 Atterberg Limits Analyses
2.3 Soil Classifications
2.4 Direct Shear Testing
2.5 Triaxial Testing
2.6 Analyses of Collapse Potential

3.0 FINDINGS 5

3.1 Results of Drilling (Fanglomerate Boreholes Logs)
3.2 Results of Field Slope Testing
3.3 Results of Laboratory Testing
3.4 Comparability of Fanglomerate Strength Data
3.4.1 Lab Data Versus Dilatometer Data
3.4.2 Lab Data Versus Field Slope Data
3.4.3 SPT Blow-Count Data Versus Seismic Survey Data
3.5 Open Cut Construction -- Stability Analyses for 90 degree, 60 degree, and 45 degree side slopes

4.0 CONSTRUCTION REQUIREMENTS 22

5.0 REFERENCES 23

APPENDIX A: FIELD BORING LOGS

APPENDIX B: FIELD SLOPE TEST FAILURE LOADS AND GEOMETRIES

APPENDIX C: LABORATORY DATA SHEETS AND CURVES

1.0 DESCRIPTION OF SURFACE STUDIES

1.1 In-Place Testing: Field Slope Testing

Much of the basin fill and fanglomerate is lightly to moderately cemented, and it is very difficult to acquire undisturbed specimens from standard field sampling techniques. Disturbed and undisturbed test specimens will exhibit nearly identical internal friction angles ϕ, provided that the specimens possess similar void ratios. However, the material's apparent cohesion c generally decreases as the degree of sampling-induced disturbance increases. For this reason, laboratory testing may significantly underestimate the shear strength of the material in it's natural, undisturbed state. A novel program of field slope testing was therefore conducted to identify the shear strength of the basin fill in it's natural state. A 10-foot deep, 35-foot long benched trench was dug in the material with a steam shovel, and several separate slope failures were then induced by applying a surface loading at the crest of the newly created vertical slope.

A one-inch thick, square steel plate, 8 inches or 15 inches in length, was placed near the crest of the slope, as shown in Figure 1.1.1. A uniform load of increasing intensity was then applied to the plate by means of a 50-ton hydraulic jack. The rear-end of the steam shovel provided the reaction support for the hydraulic jack. The surface surcharge was gradually increased until the slope failed, and the failure load and slip surface geometry were then recorded. Ten separate tests were performed -- five on the upper slope and five more on the lower slope (see Appendix A). The shear strength parameters of the undisturbed basin fill were then back-calculated by means of an accepted analytical procedure (described in detail in Section 3.2).

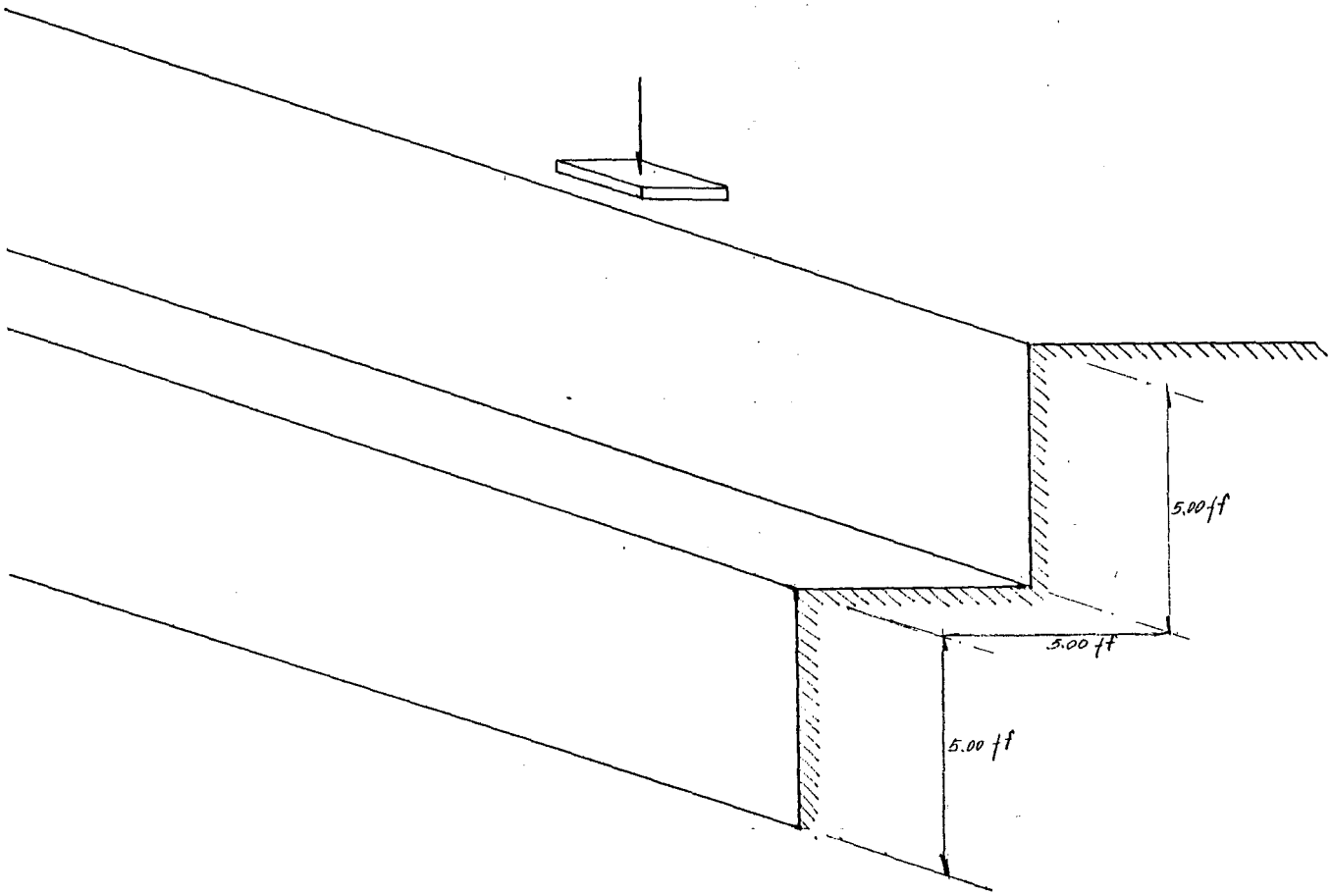


Figure 1.1.1

Sketch of Field Slope Testing Set-up, Maricopa Site

2.0 LABORATORY TESTING

2.1 Sieve Analyses

Sieve analyses were performed on samples acquired from different depths within the various boreholes. All analyses were conducted in accordance with ASTM D421 and D422 standards for sample preparation and testing. A sample weighing between 100 and 500 grams was oven-dried and then placed in a sieve stack consisting of #20, #40, #60, #140, and #200 sieves. The stack was vibrated in a mechanical sieve shaker for about ten minutes, and the percentage (by weight) of material passing each sieve was recorded. The sample's grain size distribution curve was constructed from the five data points obtained by means of the sieve analysis. The in situ moisture content of each sample was also measured.

2.2 Atterberg Limits Analyses

Atterberg Limits analyses were performed on remolded samples acquired from different depths within the various boreholes. All analyses were conducted in accordance with ASTM 4318 standards.

2.3 Soil Classifications

The borehole samples were classified according to the Unified Soil Classification System (USCS) using the standard ASTM D2487 procedure. The results of the sieve analyses and Atterberg Limits testing provided the necessary numerical data relating to grain size and plasticity.

2.4 Direct Shear Testing

Direct shear testing was performed on intact CME and diamond drill core samples from boreholes MA-12 and MD-12. All testing was conducted in accordance with ASTM D3080 standards. Tests were run at several different normal (vertical) stresses, and continuous measurement was made of both shear stress and shear deformation. Vertical displacement during shear was not recorded.

2.5 Triaxial Testing

Unconsolidated Undrained (UU) triaxial testing was performed on intact diamond drill core samples from borehole MD-12, in accordance with ASTM D2850 standards. Each 2-inch (50 mm) diameter, 4.5-inch (114 mm) high cylindrical sample was tested at it's natural moisture content. The testing was all strain-controlled, with an axial deformation rate of 0.40 in/hr (10 mm/hr). Each test was carried beyond the point of peak deviator stress and to an axial strain of at least 5%.

2.6 Analysis of Collapse Potential

The procedure followed in determining the collapse potential of near-surface soils at the Maricopa Site is described in detail by Nowatzki (1980) and is referred to as the "one-dimensional pseudo-consolidation test." The test is called a pseudo-consolidation test because the sample in the oedometer is not saturated prior to load application, as is the case in a conventional consolidation test. Instead, a series of tests is performed in which undisturbed samples, approximately two inches in diameter and one inch thick, are placed at in-situ moisture content in an oedometer. Following application of a 200 psf seating load, each sample is loaded in a sequence of vertical stress increments until a predetermined maximum stress is reached. The applied stress increments generally double the magnitude of the existing stress. Following application of a given stress increment, displacement readings are taken periodically (usually 15 minutes apart for the first hour and then once every hour) until the difference between two successive readings is less than 0.001 inches. When the vertical stress on the sample has been incremented to a level approximately equal to the anticipated allowable foundation pressure, the sample is saturated while still under load, and displacement readings are taken in the same manner as described above. The anticipated allowable foundation pressure is predetermined on the basis of design loads, the foundation soil's strength properties, and the type and size of foundation system that is most economical. In general, the pseudo-consolidation test as described above can be completed within 24 hours. The results are usually reported in terms of total applied stress and percent compression (strain). The following loading sequences were used in this study:

1. 200 psf, 1200 psf, saturation.
2. 200 psf, 2400 psf, saturation.
3. 200 psf, 1200 psf, 2400 psf, saturation.
4. 200 psf, 1200 psf, 2400 psf, 4800 psf, saturation.
5. 500 psf, 1000 psf, 2000 psf, 4000 psf, 8000 psf, 16000 psf, 32000 psf, 4000 psf, 32000 psf, saturation.

3.0 FINDINGS

3.1 Results of Drilling (Fanglomerate Borehole Logs)

Thirteen new test borings were conducted as part of the most recent geotechnical investigations. The actual field boring logs are contained, for reference, in Appendix A. The borings were taken to a depth of up to 200 feet. A wide range of materials were encountered, ranging from boulders and cobbles, to clayey gravels (GC soils, according to the Unified Soil Classification System), to well- and poorly-graded sands, silty sands, and clayey sands (SW, SP, SM and SC soils), to silts, sandy silts, clays, and sandy clays of low plasticity (ML and CL soils). No silts or clays of high plasticity were encountered. Standard penetration testing was done at boreholes MA-1, MA-3, MA-3A, MA-4, MA-6, MA-10, MA-11, MA-12, and MA-13, and all blow count information is contained on the respective boring logs (see Appendix A).

3.2 Results of Field Slope Testing

Disturbed and undisturbed test specimens exhibit nearly identical internal friction angles ϕ, provided that the specimens possess similar void ratios. Hence, the friction angle of the basin fill in its natural state may be fixed at $\phi = 32$ -- the value that was measured by direct shear laboratory testing on intact samples extracted from borehole MA-12.

A slope failure is associated with a safety factor of F = 1. Since the applied surface surcharge, failure surface geometry, and in situ unit weight were measured for each of the ten individual field slope tests, the cohesive component of shear strength becomes the only relevant unknown. Stability analyses of the slopes may therefore be used to back-calculate the basin fill's undisturbed cohesion c. The relatively small loaded surface area led to the development of a roughly wedge-shaped slip surface (Figure 3.2.1), and conventional two-dimensional plane strain slope stability procedures, such as Bishop's Modified Method (Bishop, 1955), Janbu's Method (Janbu, 1973), or the Morgenstern-Price Method (Morgenstern and Price, 1965), would overestimate the cohesion associated with a given safety factor. The method of Hovland (1977), on the other hand, accounts for the "end-effects" associated with a truly three-dimensional failure surface, and this procedure was therefore used to analyze the field test data.

The cohesion c is calculated from the equation (Hovland, 1977):

$$c = \left[\frac{\gamma b' \sin i}{3B}\right]\left[F_3 - \frac{\tan \phi}{B \tan i}\right]$$

where:

$$B = \left\{\left[\frac{2b'}{w} \sin i\right]^2 + 1\right\}^{1/2}$$

ϕ = internal friction angle = 32
i = angle of inclination of the slip surface (measured)
b'= maximum depth of the failure surface perpendicular to the crest of the slope (measured)
w = maximum length of the failure surface parallel to the crest of the slope (measured)
γ = equivalent unit weight (which accounts for the unit weight of the soil plus the applied surface surcharge)
F_3= the three-dimensional safety factor = 1 (at failure)

A complete record of the field slope testing is included, for reference, in Appendix B. An example of the back-calculation procedure is also provided. The cohesion values associated with the various tests are presented in Table 3.2.1. As may be observed, the cohesion values for the uppermost five feet of soil (Tests #1-#5) are significantly lower than the values corresponding to failure surfaces within the five-to ten-foot depth range (Tests #6-#10). These results should be expected, since normal exposure and weathering reduces the cohesive particle bonding in the uppermost few feet of material. The value of c = 2430 psf, which is the average value for the lower-bench failures (Tests #6-#10), may therefore be regarded as a conservative lower estimate of the undisturbed cohesion of the basin fill material.

3.3 Results of Laboratory Testing

The data obtained from the laboratory sieve and Atterberg Limits analyses, and the direct shear, triaxial, and consolidation testing are included for reference in Appendix C. The results of the sieve and Atterberg Limits analyses are summarized in Table 3.3.1, and the results of the strength testing program are summarized in Table 3.3.2.

The results of the pseudo-consolidation tests are summarized in Table 3.3.3 and shown graphically in Figure 3.3.1. Jennings and Knight (1975) regard the strain occurring at a saturation stress of 4000 psf as an index of collapse called the "Collapse Potential". They define the following critical values for the Collapse Potential (C_p):

C_p (%)	Severity
0 - 1	No problems
1 - 5	Moderate problems
5 -10	Problems
10 -20	Severe problems
>20	Very severe problems

As can be seen from Table 3.3.3 and Figure 3.3.1, the data obtained from pseudo-consolidation tests performed on soils from the Maricopa Site suggest a Collapse Potential of approximately 9%. This indicates that there is a potential for settlement problems as a result of collapse. However, the field samples were not retrieved directly into oedometer rings, as is usually the case. Thus, pseudo-consolidation test specimens had to be prepared in the laboratory by extruding them from the field sampler into the oedometer rings. This dual handling procedure undoubtedly resulted in sample disturbances which caused the specimens to have greater values of C_p than conventional "undisturbed" samples would have had. For this reason, the severity of the collapse problem is expected to be less than that suggested by the laboratory test data. This interpretation is consistent with the evaluation of collapse susceptibility made on the basis of the Gibbs criterion as shown in Figure 3.3.2. Therefore, methods typically recommended by geotechnical engineering consultants in Arizona for stabilizing such soils (e.g. excavation and recompaction under controlled conditions) are expected to be effective for collapse susceptible soils at the Maricopa site.

The pseudo-consolidation tests in this study were performed on samples retrieved from depths of from 30 to 60 feet. Ali (1987) has shown that the probability of encountering collapse susceptible soils decreases with depth. Therefore, soils exhibiting a high degree of collapse potential are not expected to occur below a depth of about 30 feet, and probably more shallow. Since the potential for collapse settlement is such an important consideration in the design of foundations for surface structures, and since the results of laboratory pseudo-consolidation tests are susceptible to sample disturbance, full scale field tests should be performed at the site of the main campus to verify the existence of collapse-susceptible soils and determine their severity with depth.

3.4 Comparability of Fanglomerate Strength Data

3.4.1 Lab Data Versus Dilatometer Data : The results of the field dilatometer testing program have not yet become available.

3.4.2 Lab Data Versus Field Slope Data : Direct shear testing was performed on intact specimens of basin fill material extracted from borehole MA-12 at depths of 30 to 65 feet. As mentioned previously in Section 3.3, this direct shear testing yielded minimum shear strength parameters of $\phi = 32$ and $c = 2160$ psf. By comparison, the field slope testing on the unweathered lower bench (involving material at depths of 5 to 10 feet) yielded an average cohesion of $c = 2430$ psf. As a consequence of sampling-induced disturbance, the laboratory specimens should be expected to have a cohesion which is lower than that for the material in its natural (undisturbed) state. Indeed, it appears as though the process of sampling reduces the material's cohesion by at least 10%. The results of the laboratory and field testing are consistent, and minimum strength parameters of $\phi = 32$ and $c = 2430$ psf may be assigned, with confidence, to the cemented basin fill material.

3.4.3 SPT Blow-Count Data Versus Seismic Survey Data : A comparison is made between elastic moduli determined from SPT blow counts obtained from boreholes on or near the ring alignment with moduli values computed from velocity data obtained from seismic surveys performed at or in the vicinity of the borehole locations. The seismic data were correlated to modulus by the relationship:

$$E = V_C^2 \, [(1+\nu)(1-2\nu)/(1-\nu)][\gamma/g]$$

where:

E = modulus of elasticity
V_C = compression wave velocity
ν = Poisson's ratio
γ = unit weight of soil or rock
g = acceleration due to gravity

This expression can be rewritten as:

$$E = V_C^2 K$$

where :

K = a material constant

For the materials at the Maricopa site the following values of the material parameters were found to be appropriate:

$\nu = 0.33$
$\gamma = 125$ pcf

If these values are used with $g = 32.2$ ft/sec/sec to evaluate K, and V_C is expressed in ft/sec then:

$$E(tsf) = 0.00131V_C^2$$

The SPT blow count data were correlated to modulus by the following relationship developed for sands and gravels by Wrench and Nowatzki (1987):

$$E(tsf) = 22.2\ N_a^{0.888}$$

Table 3.4.1 shows that although the moduli do not appear to correlate well numerically at shallow depths, there is consistency between the results regarding an increase of modulus with depth. Both sets of data suggest that the material within approximately 20 feet of the surface has a much lower modulus than the alluvial fanglomerate below that depth. At shallow depths the modulus is generally less than 1000 tsf, whereas at depths greater than approximately 20 feet the modulus is generally greater than 3000 tsf and in some locations greater than 7000 tsf. This agrees with results reported elsewhere (see, for example, DeNatale et al, 1987 and Beckwith et al, 1988).

It should be noted that seismic data give an integrated value for velocity and modulus over a range of depths, whereas blow counts are taken at specific depths. With the seismic data, discrete changes of strata density are recorded by discrete changes in compression wave velocity. SPT blow counts, on the other hand, are non-integrative and pertain only to the depth at which they are taken. It would not be correct to average blow counts over a range of depths and use the average value as representative of the stratum. In addition, for this study, the SPT blow counts were recorded for three 6-inch increments with the reported N-value (N_a) being the sum of the blows over the last two 6-inch increments. If the full 6-inch penetration was not reached after 50 hammer blows in any increment, the test was discontinued, and the count was reported as 50 blows for the actual penetration obtained in that increment. In those cases the SPT blow count was increased by linear proportion to the full 6-inch penetration, so that a value of N_a could be computed for use in the equation above. This extrapolation can significantly underestimate the actual 6-inch penetration that would have occurred had the test been continued. Therefore the moduli reported in Table 3.4.1 for depths greater than 10-20 feet represent lower limits of the in situ moduli that can be expected. In all cases, data were used from the seismic survey conducted closest to the borehole for which SPT data were available.

3.5 Open-Cut Construction -- Stability Analyses For 90 Degree, 60 Degree, And 45 Degree Side Slopes

The primary component of the SSC project is the 52-mile long collider ring that will be housed in a 10-foot diameter concrete tunnel placed 30 feet or more below the ground surface. The most economical way to construct an underground tunnel of this type in Arizona is by the cut-and-cover method. In this approach, a tunnel is formed by excavating downward from the ground surface. Precast cylindrical concrete tunnel segments are placed in the open trench with cranes, and the trench is then backfilled with the excavated soil. At the Maricopa

site, about half of the underground accelerator ring can be placed by the cut-and-cover method. Since the amount of material to be excavated decreases as the sides of the excavation become more steep, the cut-and-cover method becomes most economical when an unsupported vertical excavation profile can be used.

Bishop's Modified Method (Bishop, 1955) provides a conservative relationship between the safety factor F and the excavation depth H in a homogeneous deposit where circular slip surfaces are expected. If the cohesion and friction angle of the alluvial material are conservatively fixed at $c = 2430$ psf and $\phi = 32$, a computer-aided stability analysis based on Bishop's Modified Method indicates that it is possible to excavate vertically downward to a depth of 100 feet and still have a safety factor against slope failure in excess of one. Table 3.5.1 presents a summary of safety factors for heights of up to 100 feet and slope angles of 45 , 60 , and 90 . It should be pointed out that vertical slope faces are actually preferable to inclined ones, since vertical faces are less susceptible to weakening due to water infiltration, in the event that precipitation occurs before the excavation has been backfilled.

TABLE 3.2.1: VALUES OF COHESION AS BACK-CALCULATED FROM FIELD SLOPE TESTING.

Test #	Bench	Cohesion (in psf)
1	Upper	---
2	Upper	1393
3	Upper	1203
4	Upper	738
5	Upper	469
6	Lower	---
7	Lower	2619
8	Lower	2657
9	Lower	---
10	Lower	2007
Average Cohesion For Upper-Bench Failures		**950**
Average Cohesion For Lower-Bench Failures		**2430**

TABLE 3.3.1: RESULTS OF LABORATORY SIEVE AND ATTERBERG LIMITS ANALYSES.

Borehole	Depth (ft)	% < #200 Sieve	Moisture Content %	Atterberg Limits LL	PL	PI
MA-10	0.5 - 2.0	29	3.4			
	3.5 - 5.0	26		21	20	1
	8.5 - 9.0	14	4.3			
	13.5 -13.9	17				
	19.5 -23.5	24				
	30.0 -30.5	13		23	19	4
	40.0 -40.3	19				
	55.0 -55.4	22				
	60.0 -60.5		5.7			
	65.0 -65.4	30				
	68.5 -73.0	7				
	80.0 -80.2	35				
	85.0 -85.4		7.0			
	90.0 -90.4	37				
MA-11	0.5 - 2.0	31	3.8			
	10.0 -10.4	14	6.7			
	20.0 -20.3	35	6.2			
	30.0 -31.5	14	4.2	19	18	1
	40.0 -40.3	23	5.5			
	55.0 -55.2	21	6.4			
	65.0 -65.5	19	3.4			
	73.5 -73.8	11	6.3			
MA-12	0.5 - 2.0	12	2.0	22	9	13
	15.0 -15.7	22	7.1			
	25.0 -25.8	38	7.6			
	30.0 -32.8			38		
	33.5 -34.9	16	3.7			
	48.5 -48.9	41	7.4			
	53.5 -54.2	34	8.0			
	61.0 -62.0	27	7.1	37		
	68.5 -69.1	38	12.6			
	73.5 -73.9	28	9.2			

TABLE 3.3.1: RESULTS OF LABORATORY SIEVE AND ATTERBERG LIMITS ANALYSES.
(Continued)

Borehole	Depth (ft)	% < #200 Sieve	Moisture Content %	Atterberg Limits LL	PL	PI
MR-1	5 - 10	10	2.4	28	19	9
	15 - 20	13	7.4	44	22	22
	25 - 30	22	2.4	26	22	4
	35 - 40	14	4.3	31	17	14
	45 - 50	14	3.1			
	55 - 60	5	4.0			
	65 - 70	6	4.9			
	75 - 80	11	4.8			
MR-2	5 - 10	11	6.2	54	50	4
	15 - 20	21	4.3	32	22	10
	25 - 30	4	2.9	35	27	8
	35 - 40	17	3.6	37	20	17
	45 - 50	17	0.9			
	55 - 60	19	2.5			
	65 - 70	19	3.6			
	75 - 80	13	2.8			

TABLE 3.3.2: RESULTS OF LABORATORY STRENGTH TESTING

Source of Specimens	Type of Material	Laboratory Test	Cohesion c (psf)	Friction Angle ø
MA-12	Basin Fill	Direct Shear	2160	32°
MD-12	Fanglomerate	Direct Shear	9000	27°
MD-12	Fanglomerate	Triaxial (Peak Value)	11400	26°
MD-12	Fanglomerate	Triaxial (at 5% Strain)	2000	39°

TABLE 3.3.3: SUMMARY OF RESULTS OF PSEUDO-CONSOLIDATION TESTS FOR BOREHOLE MA-12

Sample Depth	Applied Stress (psf)	Strain (%)
30'3" - 32'9"	1200	2.38
	1200 S	11.59
		C_p = **9.21**
30'3" - 32'9"	2400	5.87
	2400 S	13.01
		C_p = **7.14**
30'3" - 32'9"	1200	1.85
	2400	4.70
	2400 S	11.45
		C_p = **6.75**
30'3" - 32'9"	1200	1.78
	2400	4.38
	4800	7.36
	4800 S	16.68
		C_p = **9.32**
61'0" - 63'6"	500	0.50
	1000	1.42
	2000	2.61
	4000	3.49
	8000	4.91
	16000	6.89
	32000	8.44
	4000	7.20
	32000	8.68
	32000 S	25.00
		C_p = **16.32**

TABLE 3.4.1: COMPARISON OF ELASTIC MODULI OBTAINED FROM SPT BLOW COUNTS WITH MODULI OBTAINED FROM SEISMIC SURVEYS.

	SPT Blow Count Data		Seismic Survey Data	
Boring	Depth (ft)	Maximum Modulus (tsf)	Depth (ft)	Modulus (tsf)
MA-1	0 - 11	< 500	0 - 57	5694
	11 - 75	>4000		
MA-3	0 - 11	<1000	0 - 6	838
	11 - 60	>4000	6 -300	20522
MA-4	0 - 11	< 500	0 - 5	1500
	11 -100	>3000	5 - 36	23784
			36 -509	78357
MA-6	0 - 5	< 500	0 - 15	2046
	5 - 70	>5000	15 -260	24481
MA-10	0 - 9	< 500	0 - 44	5909
	9 - 65	>3000	44 -106	16379
	65 -150	>7000	106 -319	56202
MA-11	0 - 20	<1000	0 - 8	258
MA-11	20 - 40	>3000	8 - 29	7470
	40 - 74	>7000	29 -221	14798
MA-12	0 - 10	< 500	0 - 9	247
MA-12	10 - 74	>4000	9 -130	10926
MA-13	0 - 22	<2000	0 - 97	327
	22 - 75	>5000	97 -161	16583

TABLE 3.5.1: SAFETY FACTORS AS A FUNCTION OF SLOPE HEIGHT AND SLOPE ANGLE.

Slope Height (feet)	Safety Factor Values: Slope Angle of 45 Degrees	Slope Angle of 60 Degrees	Slope Angle of 90 Degrees
40	4.05	3.35	2.17
50	3.47	2.87	1.81
60	3.08	2.53	1.57
70	2.80	2.28	1.40
80	2.59	2.09	1.27
90	2.41	1.94	1.17
100	2.29	1.82	1.09

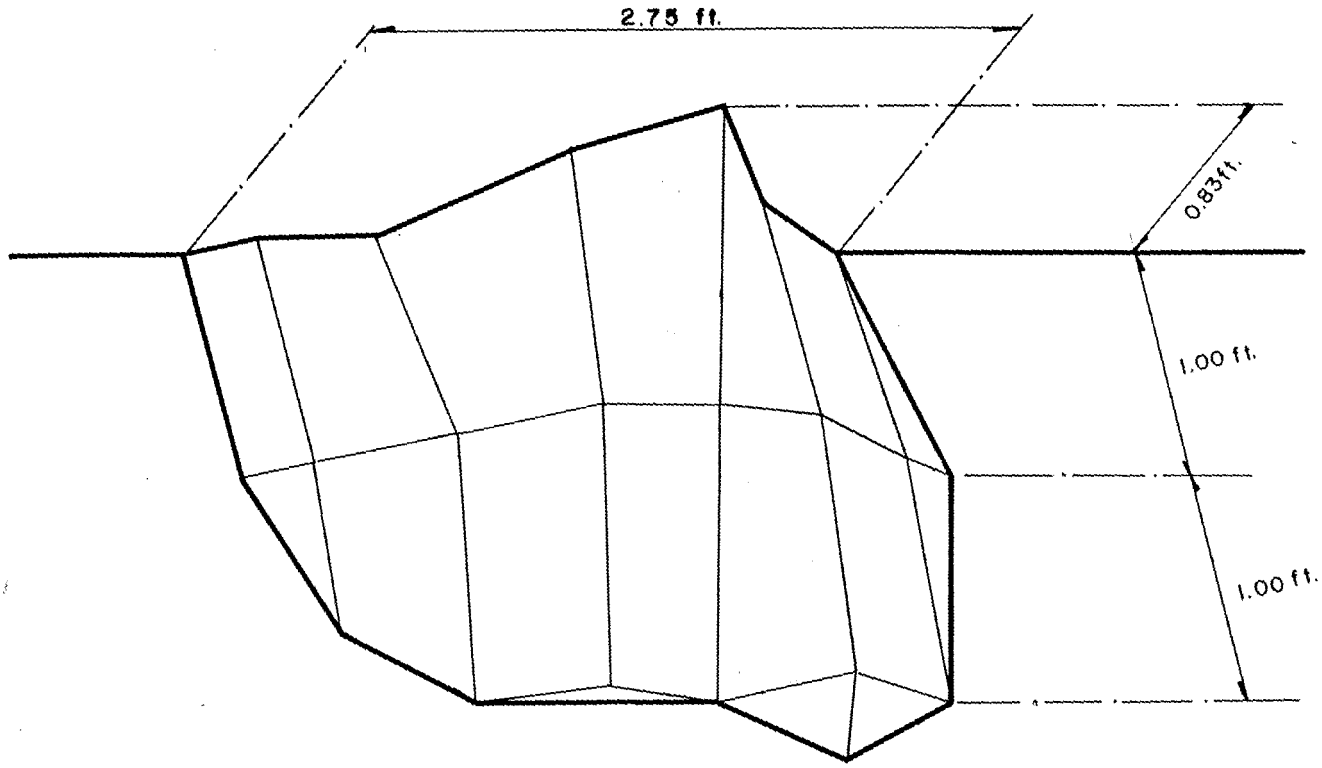


Figure 3.2.1

A Typical Field Slope Failure Surface Geometry

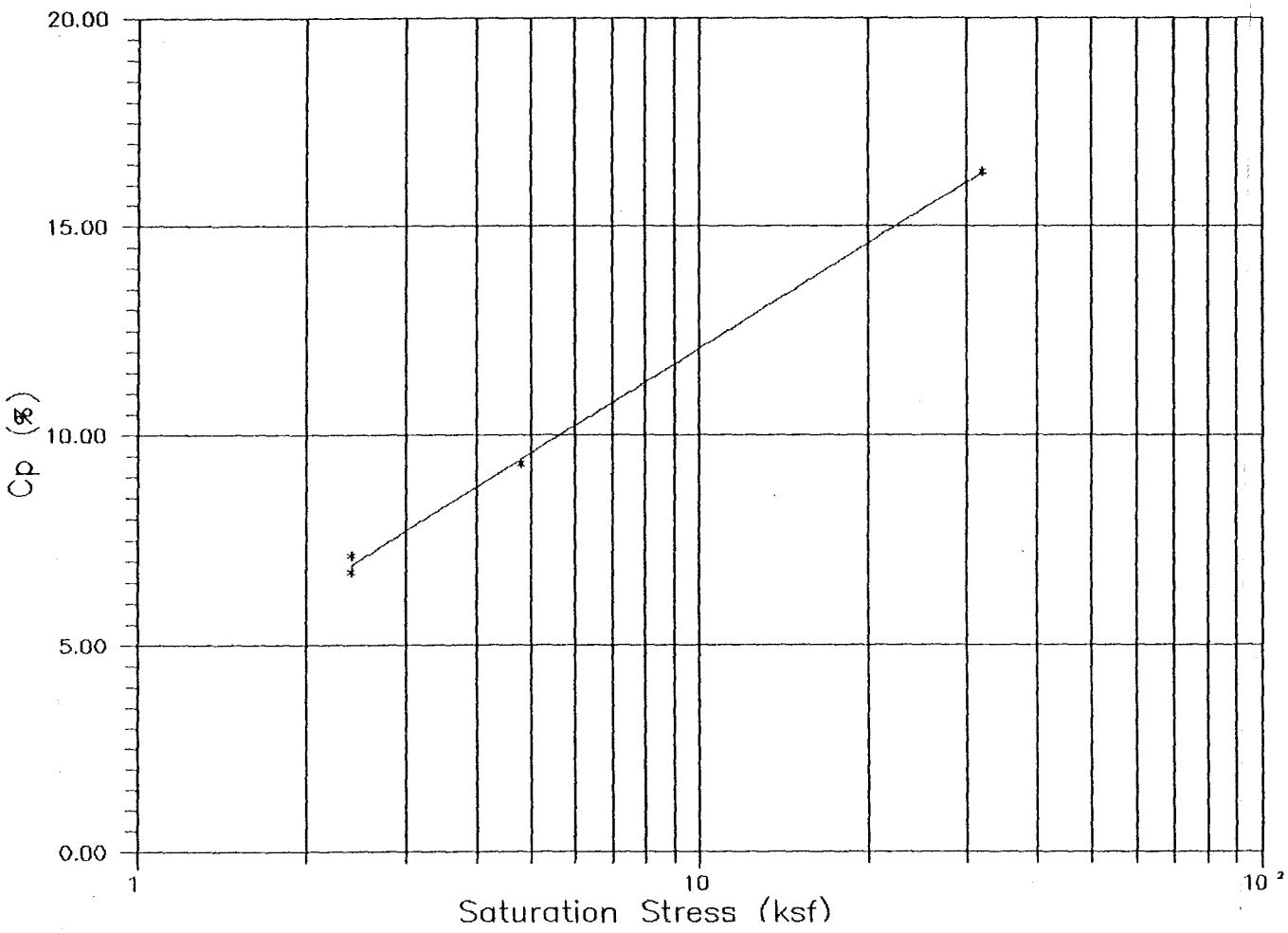


Figure 3.3.1

Collapse Strain (%) versus Saturation Stress (ksf)
Maricopa SSC Site - Borehole MA-12
Collapse Potential = Collapse Strain at Saturation Stress = 4 ksf (Jennings & Knight, 1979)

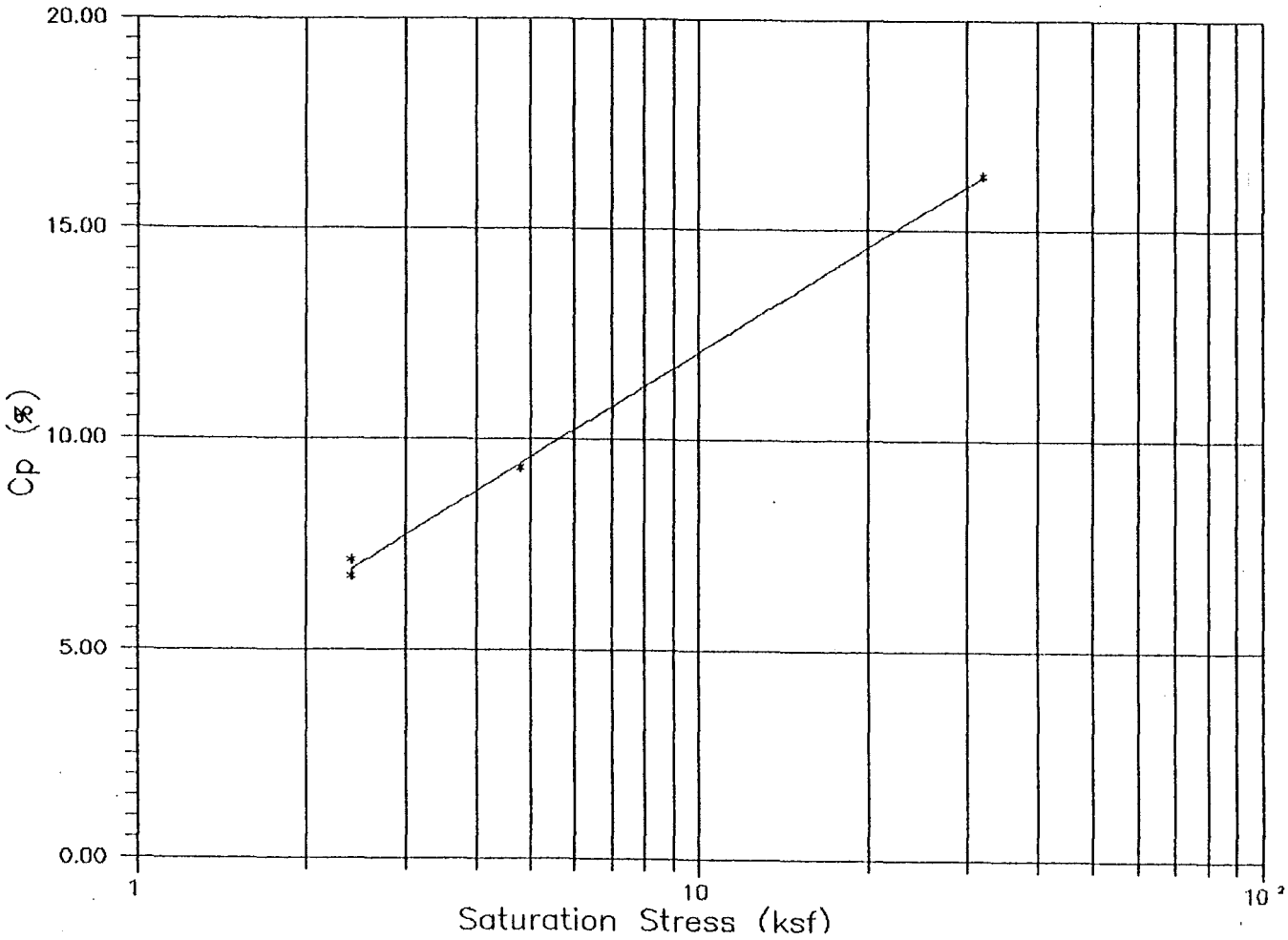


Figure 3.3.1

Collapse Strain (%) versus Saturation Stress (ksf)
Maricopa SSC Site - Borehole MA-12
Collapse Potential = Collapse Strain at Saturation
Stress = 4 ksf (Jennings & Knight, 1979)

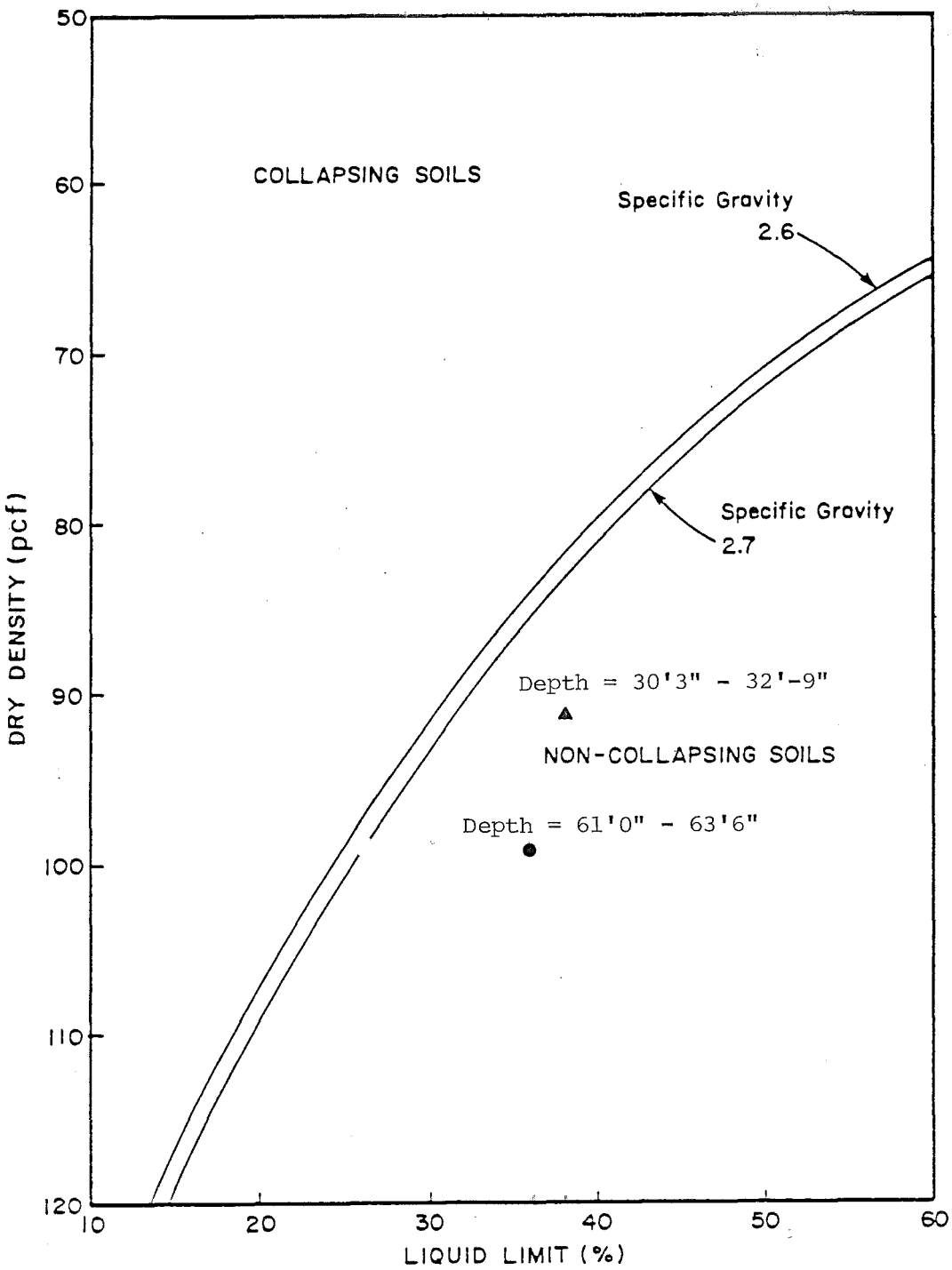


Figure 3.3.2

Collapse-Susceptibility Diagram (After Gibbs,1961)
Maricopa SSC Site - Borehole MA-12

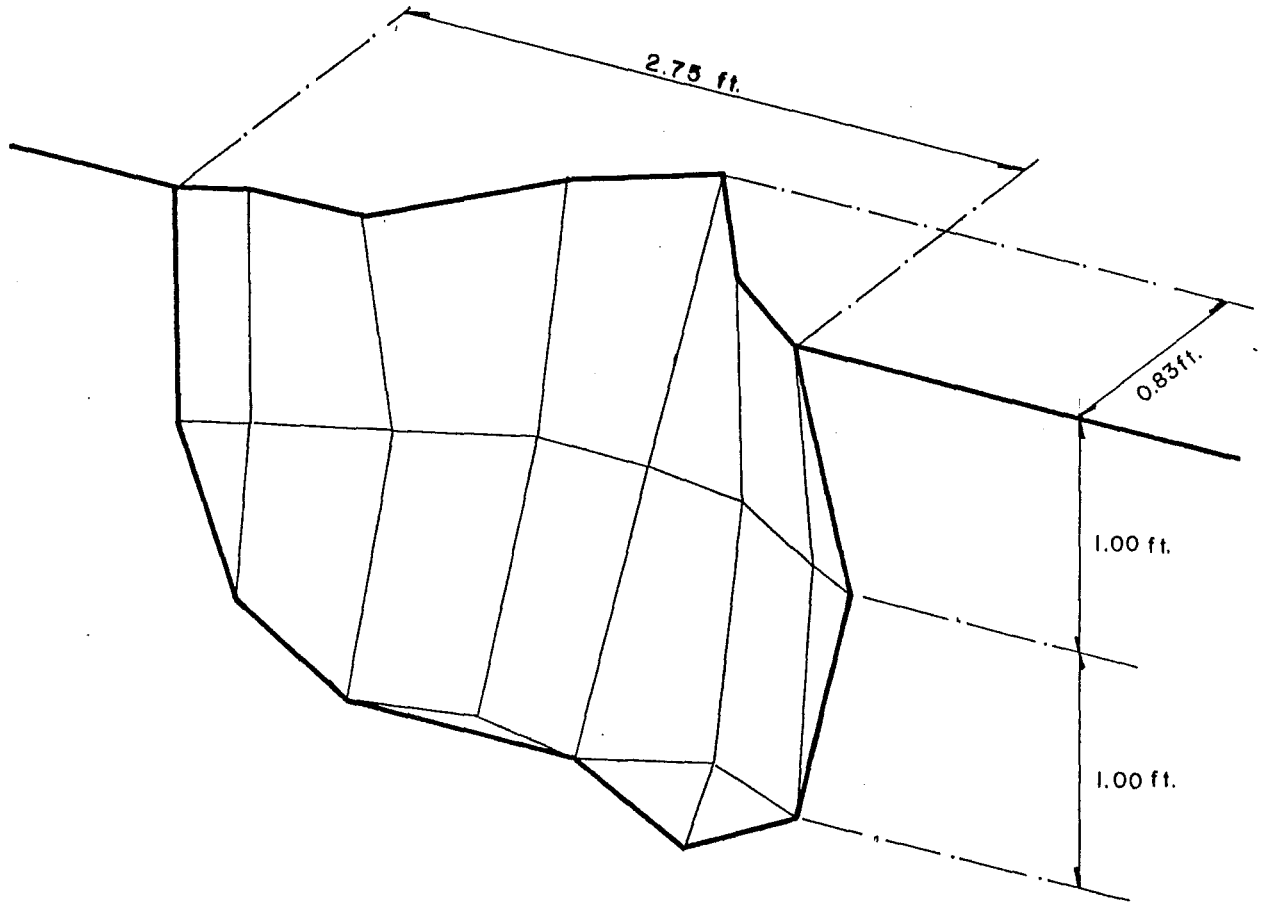


Figure 3.2.1

A Typical Field Slope Failure Surface Geometry

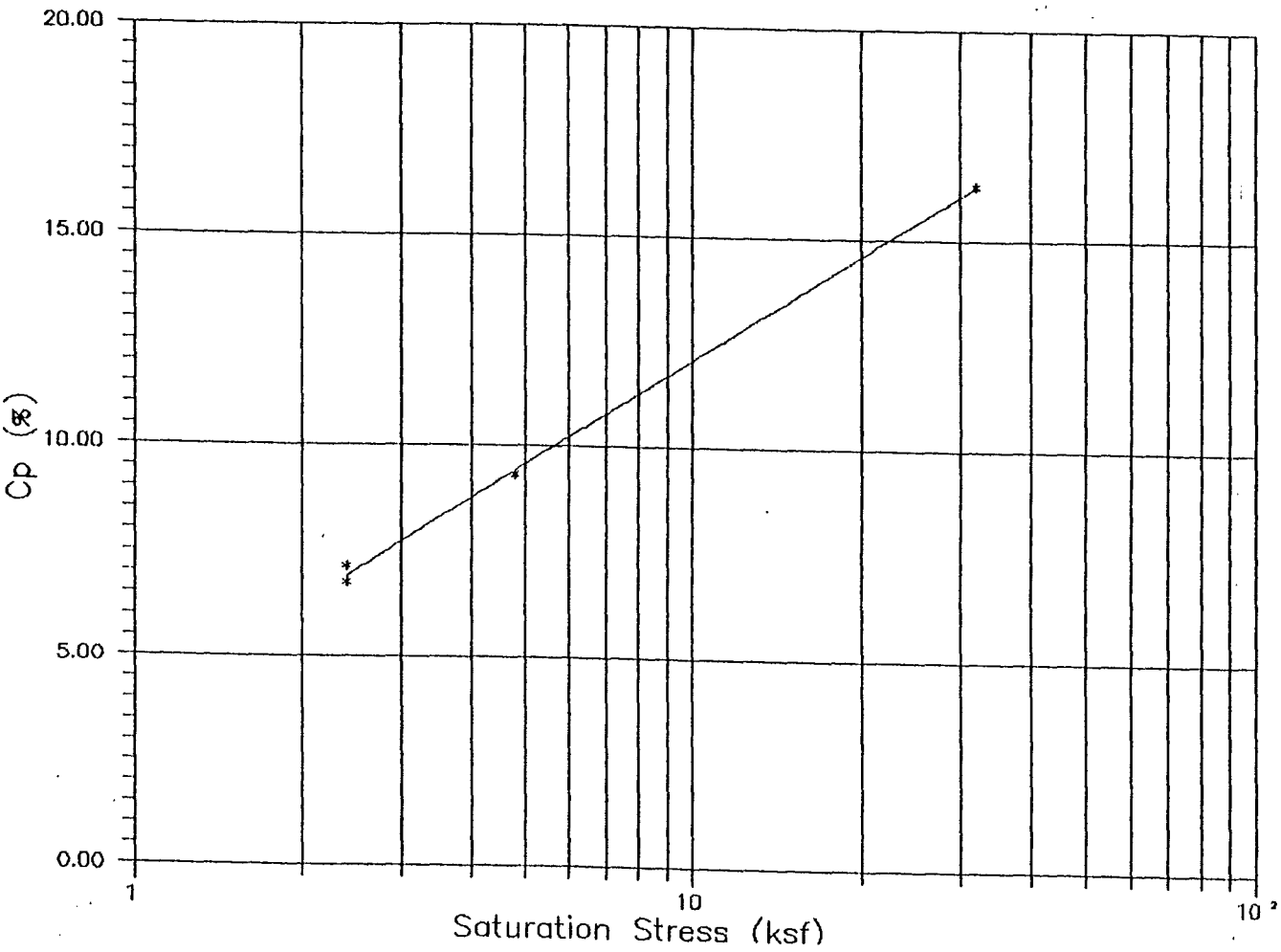


Figure 3.3.1

Collapse Strain (%) versus Saturation Stress (ksf)
Maricopa SSC Site - Borehole MA-12
Collapse Potential = Collapse Strain at Saturation
Stress = 4 ksf (Jennings & Knight, 1979)

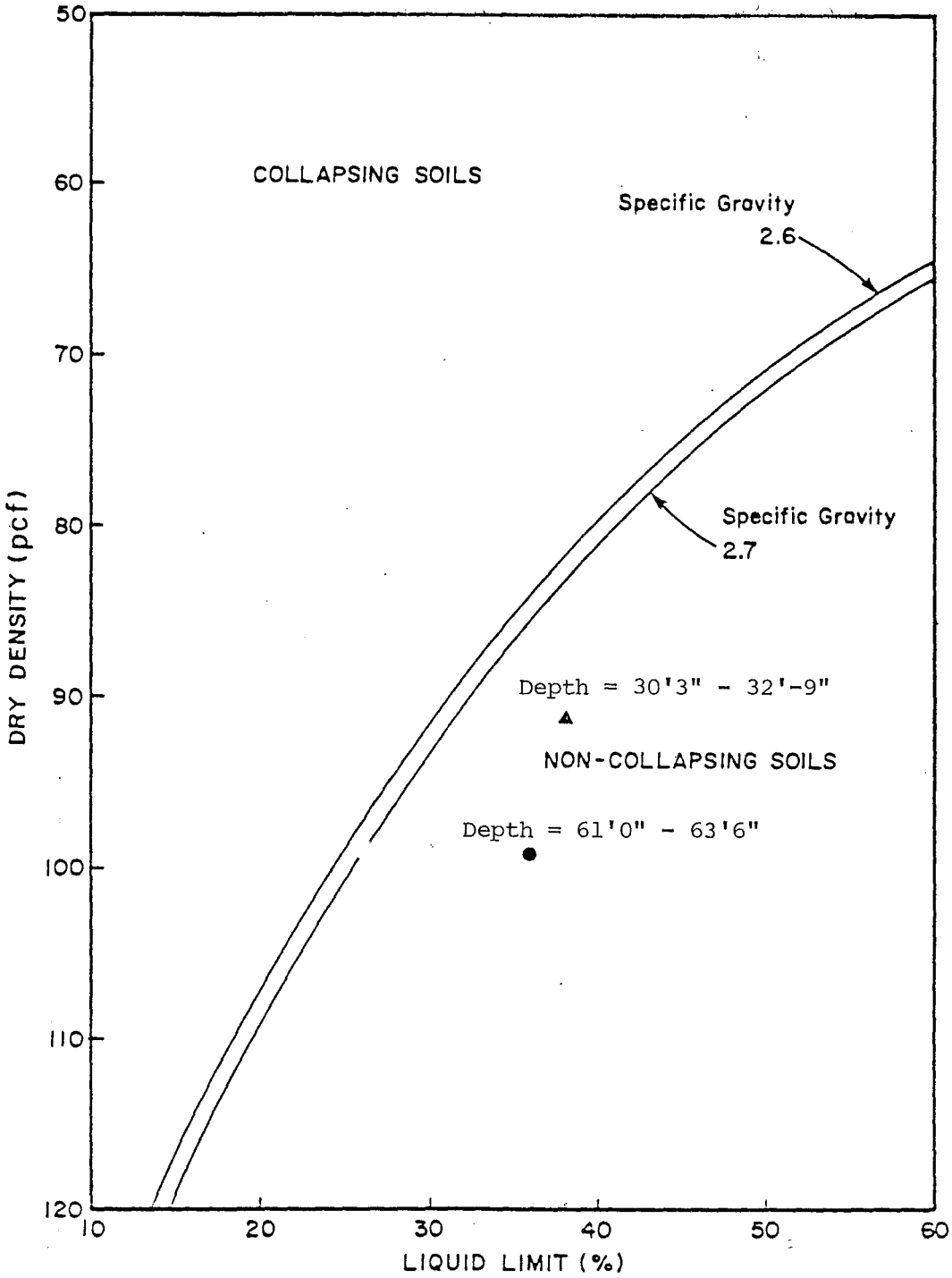


Figure 3.3.2

Collapse-Susceptibility Diagram (After Gibbs,1961)
Maricopa SSC Site - Borehole MA-12

4.0 CONSTRUCTION REQUIREMENTS

Construction requirements for the injector complex, experimental chambers, and campus building area, as well as analyses for foundation bearing capacity, settlement, and swell/collapse potential are discussed in detail by Beckwith et al (1988). Details of these analyses need not be repeated herein.

5.0 REFERENCES

1. Ali, M.M. (1987), "A Probabilistic Analysis of the Distribution of Collapsing Soil in Tucson Using Kriging Method", **PhD. Dissertation**, The University of Arizona, Department of Civil Engineering and Engineering Mechanics.

2. Beckwith, G.H., Weeks, R.E., and Cheng, S.S. (1988), "The Preliminary Geotechnical Investigation -- Main Campus Area, Maricopa SSC Site," **Technical Report**, SHB Consulting Geotechnical Engineers, Phoenix, Arizona.

3. Bishop, A.W. (1955), "The Use of the Slip Circle in the Stability Analysis of Slopes," **Geotechnique**, Vol. 5, pp. 7-17.

4. DeNatale, J.S. (1986), "Program CSLIP1: For Slope Stability Analysis by Bishop's Modified Method, with a Search Routine Based on the Simplex Method of Nelder and Mead," **Technical Report**, The University of Arizona, Department of Civil Engineering and Engineering Mechanics.

5. DeNatale, J.S., Nowatzki, E.A., and Welty, J.W. (1987), "Geotechnical Engineering Investigations for Arizona's SSC Sites", **Arizona Bureau of Geology and Mineral Technology Open-File Report 87-7**.

6. Gibbs, H.J. (1961), "Properties which Divide Loose and Dense Uncemented Soils," **U.S. Bureau of Reclamation Report No. EM-608**.

7. Hovland, H.J. (1977), "Three-Dimensional Slope Stability Analysis Method," **Journal of Geotechnical Engineering, ASCE**, Vol. 103, No. GT-9, pp. 971-986.

8. Janbu, N. (1973), "Slope Stability Computations," **Embankment Dam Engineering, Casagrande Volume**, pp. 47-86.

9. Jennings, J.E. and Knight, K. (1975), "A Guide to Construction on or with Materials Exhibiting Additional Settlement Due to Collapse of Grain Structure," **Proceedings of the 6th Regional Conference for Africa on Soil Mechanics and Foundation Engineering**, Vol. 1, pp. 99-105.

10. Morgenstern, N.R. and Price, V.E. (1965), "The Analysis of the Stability of General Slip Surfaces," **Geotechnique**, Vol. 15, No. 1, pp. 79-93.

11. Nowatzki, E.A. (1980), "Settlement Estimates in Collapse-Susceptible Soils," **Journal of Civil Engineering Design**, Vol. 2, No. 2, pp. 121-148.

APPENDIX A: FIELD BORING LOGS

SERGENT, HAUSKINS & BECKWITH

Memo from Paul Smith

To JOHN WELTY, STEVE BROOKS

Date 1/30/88

Attached are edited logs, field logs and work orders for the samples from MR-1 and MR-2.

In MR-1 there was a change from what I called "Basin-Fill Sediments (Recent?)" to "Fanglomerate" at about 135' which may correspond to the change in seismic velocity noted by Steve.

There may be a zone of weathered bedrock from

Consulting Geotechnical Engineers

SERGENT, HAUSKINS & BECKWITH

Memo from Paul Smith

To JW, SB

Date 1/30/88

about 180' – 205', and a possible bedrock contact hard, fresh at about 205'. The bedrock is a fn-med grnd., greyish white, qtz-fldsprs-biot granite w/ a salt and pepper texture.

Groundwater, probably in perched zones, may be present from 150'-200'.

Consulting Geotechnical Engineers

PROJECT Superconducting Super Collider

JOB NO. E87-113 DATE ~5/8/87

LOG OF TEST BORING NO. MA-1

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-3-4 (7)			SM	S. moist Soft to Firm	SILTY SAND Pred fine grained non plastic to low P.I. l. brown Note: Some clay & w. lime cem. below 4'
5				S	7-9-14 (23)					
10				S	17-32-42 (74)			SC-CL	S. moist hard	CLAYEY SAND Fine grained weak to mod. lime cem. Low to Medium P.I. l. brown
15				S	23-50/5" small rec					
20				S	28-40-48 (88)			CL	S. moist hard	SANDY CLAY Fine grained weak to mod. lime cem. Low-Med P.I. l. brown
25				S	22-33-45 (78)			SM	S. moist hard	SILTY SAND some clay w. lime cem. Low P.I. l. brown
30				S	43-50/4"			CL	S. moist hard	SILTY CLAY some fine sand w to mod lime cem. Low to Med P.I. l. brown
35				S	50/6" v. small rec					
40				S	45-50/4" small rec.			SC	S. moist hard	CLAYEY SAND some silt Fine to medium grained mod. lime cem. Low-Med P.I. l. brown Note: Trace to some fine gravel
45				S	50/4" v. small rec.					
50								CL	S. moist hard	SANDY CLAY some silt Pred. fine grained mod. lime cem, Low to Med P.I, l. brown

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT Superconducting Super Collider

JOB NO. _____ DATE _____

LOG OF TEST BORING NO. MA-1

RIG TYPE _____

BORING TYPE _____

SURFACE ELEV. _____

DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X		37-50/2"			CL	S. moist hard	SANDY CLAY Pred fine grained mod. lime cem. Low to Med P.I. l. brown Note: Consid. poorly gr. gravels (angular) in lenses below 51'. (Poss. GC)
55				S	50/2½" N.R.					
60				S	50/5" N.R.					
								SC	S. moist hard	CLAYEY SAND fine gravel Fine to med grained mod to strong lime cem. Low to Med P.I. l. brown
65				S	50/3" small rec.					
70				S	50/3" small rec.			GC-	S. moist hard	CLAYEY SAND & GRAVEL Pred. fine to med. gr. " " gravel angular strong lime cem. Low-Med P.I. l. brown - l. grayish br.
75				S	50/3" v. small rec.					
80										Auger refused on strongly cemented gravels or cobbles @ 76'. Sampler refused @ 74'9" Hole caved to 58'. Covered hole with plywood 5/8.
85										
90										
95										
100										

MA-1

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT [illegible] SITE

JOB NO. E67-112 DATE MAY 6 67

LOG OF TEST BORING NO. MA-2

RIG TYPE TEXOMA TADPOLE

BORING TYPE 42" AUGER

SURFACE ELEV. DIA.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SP	sl moist soft to mod. firm	SAND considerable silt pred. fine-grained subangular to subrounded uncemented to wkly lime cemented nonplastic grayish brown
				D						
5									sl. moist	
				D				SM		
10									firm	SILTY SAND trace to some clay pred. fine-grained subangular to subrounded wkly. ~~cemented to~~ modly lime cemented low P.I. grayish brown to brown Note: some well-graded sand Note: contains considerable mica Note: occasional isolated gravel and cobbles. Note: increase of silt with depth, some fine-grained sandy silt lenses.
				D						
15								ML		
				D						
20									sl. moist	
				D				SC CL		
25									very firm	
				D					sl. moist	
30									hard	SILT some fine-grained sand some clay modly lime cemented low P.I. brown Note: considerable mica Note: increase of clay with depth.
				D						
35								SM	sl. moist	
				D						
40									hard	
				D						
45										SANDY CLAY (CL) considerable silt wkly to modly lime cemented low to med. P.I. brown Note: fine-grained sand lens from about 25 to 26 ft
				D				ML	Note: considerable rocks of carbonaceous matt, decayed roots	
50										

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT SCC - MARICOPA SITE

JOB NO. F87-112 DATE MAY 6, 87

LOG OF TEST BORING NO. MA-7

RIG TYPE TEXOMA TADPOL

BORING TYPE 42" AUGER

SURFACE ELEV. DIA

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50								ML	sl. moist	SILTY SAND (SM) some clay pred. fine-grained subangular to subrounded modly lime cemented low P.I. brown Note: considerable mica Note: trace clayey fine-grained sand lenses Note: some fine-grained sand lenses from 25 ft to 38 ft Note: increased cementation below 41 ft, occuring in pods or pockets
				D				ML	sl moist	
55									hard	
				D				ML	hard	
60								SW	sl moist	
				D						
65								SM	sl. moist	SILT (ML) some fine-grained sand trace to some clay modly. lime cemented low P.I. brown Note: very micaceous ~~Note: increase of clay below 51 ft. has a med. P.I.~~ Note: considerable carbonaceous mat'l, decayed roots?
				D				ML	hard	
70									sl. moist	CLAYEY SILT (ML) considerable fine-grained sand modly to strongly lime cemented low to med. P.I. brown Note: decrease in amount of clay below 54 ft Note: very micaceous Note: considerable carbonaceous mat'l, decayed roots
									hard	
									sl. moist	
									hard	
									sl. moist	
									hard	SILT (ML) some fine-grained sand some clay modly. lime cemented low P.I. brown

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT SCE - MEDICOPA SITE

JOB NO. E67-113 DATE MAY 6, 87

LOG OF TEST BORING NO. M-2

RIG TYPE TEXOMA TAURUS

BORING TYPE 42" ϕ AUGER

SURFACE ELEV. DIA.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										Note: very micaceous Note: trace to some carbonaceous mat'l, probably decayed roots.
									sl. moist hard	SAND (SW) considerable gravel some cobbles well-graded subangular to rounded wkly to modly lime cemented nonplastic brown Note: decrease of gravel and cobbles below 62 ft.
									sl. moist hard	SILTY SAND (SM) trace to some clay pred. fine-grained subangular to subrounded modly lime cemented low P.I. brown Note: some well-graded sand lense.
									sl. moist hard	SILT (ML) some fine-grained sand trace clay modly to strongly cemented low P.I. brown to grayish brown Note: increase of fine-grained sand and clay below 67 ft. Note: trace fine-gravel below 68 ft. Note: trace carbonaceous mat'l
										Stopped drilling at 70 ft. Cased hole with 36" casing Monitored seismicity at depths of 10, 33, and 64 ft. Pulled casing and back-filled hole with native soil

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

HD

page [illegible] of 1

PROJECT Superconducting Super Collider

JOB NO. E87-113 DATE 3/6/87

LOG OF TEST BORING

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFIC
0			X	S	2-5-8 (13)			ML	S. moist M. firm	SANDY SILT trace fine gravel poorly graded w. lime cem. Low P.I - N.P l. brown
5			X	S	17-21-28 (49)			SP	S. moist dense	SAND some silt trace to some fine gap graded non plastic to Low l. brown
10			X	S	14-38-44 (82)			SP-SC	S. moist hard	CLAYEY SAND trace fine gravel pred. med to coars no lime to w. lime c med-high P.I. light reddish brow Note: Alt. lenses c SC. Note: Low-Med P.I consid. mineralizat present and pred. m med. grained M'-
15			X	S	38-47-46 (93)					
20			X	S	46-50/4"					
25			X	S	21-23-31 (54)			SP	S. moist Very dense	GRAVELLY SAND some to consid. silt gap graded subr-ang. non plastic - low F l. brown
30			X	S	21-31-31 (62)			SP-SC	S. moist hard Note: Pulled Auger @ 32' to check teeth.	CLAYEY SAND, trace- Pred. med to coarse med-Low P.I l. brown - l. reddish Note: Some "mineraliz present (gold colore biotites)?
35										
40									Note: Moved boring MA-3A ≈300' W of MA-3.	Auger refused on cob boulder @ 32'. Hole caved to 21'. Backfilled hole. Moved to boring MA-
45										
50										

GROUND WATER

DEPTH	HOUR	DATE
	none.	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample

SERGENT, HAUSKINS & BE

KHD

PROJECT Superconducting Super Collider

JOB NO. E87-113 DATE 5/6/87

LOG OF TEST BORING NO. MA-3A

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									S. MOIST	Note: See log MA-3 0-32'.
5										Note: Consid. poorly graded gravel 8½'-10'.
10										Note: Slight increase in gravels from MA-3 to MA-3A.
15										
20										
25										
30								SP-SC	S. MOIST hard	CLAYEY SAND, trace fine gravel Pred. med to coarse grained med.-low P.I. l. brown - l. reddish brown
35			S		42-50/4"					Note: some angular fine gravel 35'-40'
40			S		50/5½"					Note: Med-high P.I below 34'- with increase in clay (SC).
45			S		50/5½"					
50			S		50/5"					

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

PROJECT Superconducting Super Collider

JOB NO. E87-113 DATE 5/6/87

LOG OF TEST BORING NO. MA-3A

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50								SP-SC	S, moist hard	CLAYEY SAND trace fine gravel Pred. med to coarse gr. med-high P.I. l. brown - l. reddish br.
55			S		50/5"			CL	Note: Tight drilling below 55, S, moist hard	SILTY CLAY trace to some fine sand mod to strong lime cem. mod P.I. l. brown Note: Some fine to med. gr. sand below 59½'. Note: Some manganese oxide (black) cementation present
60			S		50/3"					Stopped Auger @ 59½'. Sampler refused @ 59'9" Hole caved to 55' Left hole open and covered with plywood.

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample

SERGENT, HAUSKINS & BECKWITH

PROJECT Superconducting Super Collider

JOB NO. E87-113 DATE 5/7/87

LOG OF TEST BORING NO. MA-4

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	4-3-3 (6)			SM	s. moist soft to m. firm	SILTY SAND some to consid. fine gravel gap graded subr-ang., w. lime cem. non plastic to low P.I. l. brown Note: Dec. in silt from 7-10'. ~~Prob. grd to SP~~
5				S	3-5-6 (11)					
10				S	11-27-50/5"			~~SP-~~ SC	s. moist hard	CLAYEY SAND trace to some fine gravel Pred. med to coarse grained no lime to weakly lime cemented medium P.I. l. brown - l. reddish br.
15				S	50/5"					
20				S	31-42-50/5"			SP	s. moist hard	GRAVELLY SAND some clay & silt gap graded Pred. fine gravel subr-ang w. lime cem. Low P.I - N.P. l. brown
25				S	50/5"			CL	s. moist hard	
30				S	50/5"			~~SP-~~ SC	s. moist hard	SANDY CLAY consid. silt Fine to medium grained med. lime cem. Low P.I. l. brown
35				S	50/4"			GP	s. moist hard	CLAYEY SAND consid. fine gravel poorly graded subr-ang. Low to medium P.I. l. brown
40				S	31-50/4"					SILTY SAND & GRAVEL poorly gr. sand pred. fine gravel subr-ang. non plastic - low P.I. l. brown
45				S	33-50/4" N.R.					
50				S	50/4" sample			SP	s. moist	Note: Matl. consists of dec. sand and gravel size granitics.

next page →

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT Superconducting Super Collider

JOB NO. FE7-113 DATE 5/7/87

LOG OF TEST BORING NO. MA-4

RIG TYPE CME 55

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50								SP	S. moist Note: Added H_2O @ 51' & 56'	GRAVELLY SAND some silt poorly graded fine gravel subang-ang. non plastic - low P.I. l. brown
55				S	20-23-39 (62)				hard	Note: Consid. silt from 58-62'. ~~Grades to SM.~~
60				S	12-28-50/5"				Note: Added H_2O @ 61' & 66' & 71' & 76'	
65				S	16-36-50/5"					Note: consid. poorly grd. gravel from 66-69'.
70				S	25-50/4"					SILTY SAND some to consid fine gravel trace clay poorly graded weak to mod lime cem. Low P.I l. brown
75				S	24-50/5½"			~~SP~~-SM	s. moist hard	
80				S	50/5½"			SC	s. moist hard Note: Added H_2O @ 81' & 86'	CLAYEY SAND some fine gravel poorly graded, angular weak to mod lime cem. med-high P.I. l. brown - l. reddish br.
85				S	50/5"					Note: Some to consid. fine gravel from 84'-87' Note: Fred fine to med gr. below 87'
90				S	35-50/5"					Note: GRAVELLY SAND lens with some silt from 89'9"-90'2" Note: Med-low P.I below 90'2"
95				S	50/5"					Note: Dec clay @ 99½'. ~~Rec. grd. to SP~~
100				S	50/6" small rec.					Stopped Auger @ 99½'. Sampler refused @ 100'0" Hole caved to 91'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT SCC - MARICOPA SITE

JOB NO. F87-115 DATE MAY 7, 87

LOG OF TEST BORING NO. MA-5

RIG TYPE TEXOMA TAURUS

BORING TYPE 42" DIA. AUGER

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	sl moist mod. firm	SILTY SAND some fine-gravel pred fine-grained subangular to subrounded wkly lime cemented to modly. lime cemented nonplastic to low P.I. brown to grayish brown
				D						
5								SW	sl. moist	
				D						
								SW		
10									firm	SAND considerable silt some fine gravel trace to some clay well-graded subangular to subrounded modly lime cemented nonplastic to low P.I. brown to grayish brown Note: trace subangular cobbles
				D						
15									sl. moist	
				D						
20									very firm to hard	
				D						
25										GRAVELLY SAND trace silt and clay well-graded gravel pred. fine subangular to subrounded wkly lime cemented nonplastic brown to reddish brown Note: some nodules of mod. cementation Note: soil appears to be derived from granitic parent rock Note: slight decrease in gravel with depth Note: trace subangular cobbles
				D				SW		
30									sl. moist	
				D						
35									very firm to hard	
				D						
40										
				D						
45										
				D						
50										SAND considerable gravel some clay trace silt well-graded

MA-5

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT SCC - MARICOPA SITE

JOB NO. E87-113 DATE MAY 7 87

LOG OF TEST BORING NO. MA-5

RIG TYPE TEXOMA TAURUS

BORING TYPE 42" DIA AUGER

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50									sl. moist very firm to hard	subangular mostly lime cemented nonplastic to low P.I. brown to grayish brown Note: some moisture is strong cementation Note: mat'l appears to be derived pred. from granitic parent rock Note: the major in clay from 13 ft. to 40' ~~(consecutive clay) lens~~
55								SW		
60									continued	
65								SM		Note: decrease in gravel below 15 ft ~~(trace gravel)~~. Note: sands are angular to subangular below 15 ft Note: some gravel from 18-22 ft. about 50% of gravel appears quite fresh the other 50% is decomposed and breaks down upon handling to clayey sand. Note: ~~trace~~ occasional ~~well graded~~ clayey sand lenses ~~P.I.~~
70									sl. moist hard	Note: reddish brown below 16 ft. Note: occasional cobble. Note: wkly lime cemented but indurated below 30 ft ~~- held together~~ with clays. Note: trace clay and some silt from 40 ft. to 51 ft. Note: cobbles below 35 ft. consist pred. of quartzite. Note: sands are slightly finer and decrease in gravel below 53 ft. Note: considerable silt and clay below 58 ft.
										SILTY SAND some clay trace fine-gravel well-graded

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT SCC - MARICOPA SITE

JOB NO. F87-113 DATE MAY 7, 87

LOG OF TEST BORING NO. MA-5

RIG TYPE TEXOMA TAURUS

BORING TYPE 42" DIA. PUSER

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
									sl. moist hard	angular to subangular modtylime cemented low P.I. brown to grayish brown Note: some pockets of strong cementation

STOPPED AUGER AT 70 FT
CASED HOLE WITH 36" CASING
OBTAINED SEISMICITY READINGS AT DEPTHS OF 10, 35 and 66? ft
PULLED CASING AND BACKFILLED HOLE WITH NATIVE SOIL

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT Superconducting Super Collider

JOB NO. 587-117 DATE 5/19/87

LOG OF TEST BORING NO. MA-6

RIG TYPE CME 55

BORING TYPE 6¼" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	3-5-6 (11)			ML	S. MOIST M. Firm	SANDY SILT trace fine gravel Pred fine grained sand w. lime cem. Low P.I. l. brown
5				S	50/5"			SC	S. MOIST hard	CLAYEY SAND trace to some fine gravel gap graded mod-weak lime cem. med P.I. l. brown
10				S	50/4"					
15				S	50/6"			GP	S. MOIST V. dense	SAND & GRAVEL ~~MIX~~ some silt gap graded sand Pred fine gravel subr-ang no lime-w. lime cem. N.P-Low P.I. tan Note: Some cobbles 16-18'
20				S	50/3" SMALL REC.					
25				S	50/1½" V. SMALL REC.			GC	S. MOIST hard	
30				S	50/5"			GP	S. MOIST hard	CLAYEY SAND & GRAVEL gap graded sand Pred fine gravel subang-ang. mod-strong lime cem. Med-low P.I. l. brown Note: Dec. in amount of clay ~~to same~~ with depth below 25'
35				S	50/4" SMALL REC			SC	S. MOIST hard	SAND & GRAVEL ~~MIX~~ some to consid clay. poorly gr. sand, fine gravel, subr-subang, mod lime cem. Low-Med P.I., l. brown
40				S	50/5"					
45				S	50/3"					CLAYEY SAND some to consid. fine gravel gap graded, subang-ang mod. lime cem. Med. P.I. l. brown
50				S	50/5"					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT Superconducting Super Collider

JOB NO. 527-113 DATE 5/9/87

LOG OF TEST BORING NO. 114-6

RIG TYPE CME 55

BORING TYPE 6" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50								SC	S. moist hard Note: Added H2O @ 50'	CLAYEY SAND (cont'd) some fine gravel gap graded subang. med dense cont. med P.I. l. brown Note: Some silt @ 60'. Increase to consid @ 69½'. Prob. grds to SM.
55				S	50/5"					
60				S	50/5"					
65				S	50/5½"					
70				S	50/5"					Stopped Auger @ 69½'. Sampler refused @ 69'11" Hole caved to 60½'. Covered hole with plywood 5/9.

GROUND WATER

DEPTH	HOUR	DATE
	1 DAY	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT Maricopa SSC

JOB NO. E98-11 DATE 20 JAN 98

LOG OF TEST BORING NO. MA-1

RIG TYPE CME-75

BORING TYPE 6 1/2" - H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
			X	S	24.7 11			SC	Slightly Moist to Dry	Clayey SAND, Fine to Medium Grained, Wkly limecemented to Moderately Low PI Lt Brown
5			X	S	6.10.15 25					
								CL	Dry Hard	SANDY CLAY Sand is Fine Moderately Lime cemented Low PI Lt Brown
10				S	50(5 1/2")					
								SC	Dry Hard	CLAYEY SAND Fine to Medium Grained Moderately lime cmtd Low PI Lt Brown
15				S	50(5")					
20		19'6" CME-Sample	X		# 43 N.R. Sandstone					SILTY SAND Fine to Medium Grained Wkly lime cmtd N.P. Lt Brown
		23'6"								
25					Marzyzyn					
								SM	Dry Hard	SANDY CLAY Trace fine gravel Sand is Fine to Med Grained Modly lime cmtd Low PI Lt Brown
30			X	S	23 42 50 92					
								CL	Dry Hard	CLAYEY SAND Fine to Medium Grained, Moderately lime cmtd Low Plasticity Lt Brown
35				S	50(3") NR Sampler Empty					
40				S	50(3 1/2")				Dry Hard	
		43'6"						SC	21 JAN 98 22 JAN 98	
45		CME sampler	X		1' Sand					
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PAS

PROJECT MARICOPA SSC

JOB NO. F88-11 DATE 21 JAN 88

LOG OF TEST BORING NO. MA

RIG TYPE CME-75

BORING TYPE 6 1/2" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
								SC	Dry Hard	
55			☒	S	50(4 1/2")					
										note: Sand is predom. fine after 60'
60			☒	S	50(5")					Strongly cmtd zone from 77'-80'6"
65			☒	S	50(4 1/2")					
										SANDY CLAY, Consid S Pred Fine SAND Modly → Strongly Low → Mod FE cmtd
				U	100(2 1/2")	NR				
70		No recovery								
75								CL	Dry Hard	note: modely line cmtd after 80'6".
80			☒	S	50(2")					
85			☒	S	50(4 1/2")					
									Boring Suspended 21 JAN 88 22 JAN 88	
90				S	50(4 1/2")					
95				S	50(2")					
100										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKW

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY

PROJECT MARICOPA SSC

JOB NO. E9R-1 DATE 22 JAN 98

LOG OF TEST BORING NO. MA-

RIG TYPE CME-75

BORING TYPE 6 1/2" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
				S	50(2")			CL	Dry Hard	
105				S	50(1 1/2")					
110				S	50(3")					
115				S	50(4")					
120				S	50(2 1/2")					
125				S	50(2")					
130				S	50(2 1/2")					
135				S	50(2")				Boring Suspended 22 JAN 98 Boring Resumed 26 JAN 98	
140				S	50(2 1/2")					
145				S	50(3 1/2")			SC	Dry Hard	
								SC	Dry Hard	
150				S	50(3")					

note: grading to Clayey SAND in zones after 105'

CLAYEY SAND Predominantly Fine to Medium Grained Modly lime cmtd Low Plasticity Lt Brown

CLAYEY SAND, Consid: Pred Fine grained Modually lime cmtd Low Plasticity Lt Brown

H.S.A. Stopped 150 Sampler refusal 150' 3"

GROUND WATER

DEPTH	HOUR	DATE
	None	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWIT

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL

PROJECT Maricopa SSC
JOB NO. E89-11 DATE 26 JAN 89

LOG OF TEST BORING NO.

RIG TYPE CME-75
BORING TYPE 6 1/2" H.S.A.
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
			X	S	3.6.9 15			SC	Slightly moist Medium firm	CLAYEY SAND Fine grained Lime present Low Plasticity Brown
5			X	S	14.22.29 71			CL	1.7 Hard	SANDY CLAY Sand is fine grained Moderately lime cemented Low to mod PI Lt Brown
10			X	S	50(4 1/2")					
								SP/SC	Dry Firm	CLAYEY SAND Fine grained Lime present Low → N.P. Lt Brown
15			X	S	11.11.12 23					
								CL	Dry Hard	SANDY CLAY Sand is fine grained Moderately lime cemented Low
20			X	S	50(4")					CLAYEY SILT Some fine sand Lime present Low PI Lt Brown
25			X	S	50(3")	NR	sampler empty		Suspended 26 JAN 88 resumed 27 JAN 88	SANDY CLAY Some silt Sand is predominantly ~~fine~~ Modly lime cm Low PI Lt Brown
								ML	Dry Hard	
30			X	S	15.27.30 57					
								CL	Dry Hard	
35			X	S	50(4")	NR	sampler empty			
40				S	50(3")					
45			X	U	100(4")	Rec				
	CME sample tube mitted sampled		X	CME THRE						
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & I

CONSULTING GEOTECHNICAL ENGI
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • S

PROJECT Maricopa SSC

JOB NO. F88-11 DATE 27 JAN 88

LOG OF TEST BORING NO. MA-11

RIG TYPE CME-75

BORING TYPE 6 7/8" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
								CL	Dry Hard	
55				S	50(2")					CLAYEY SAND Fine to medium grained mostly lime carbonate → N.P. & Brown
								SC	Dry Hard	
60				S	50(2")	N.P.	Sandy			
65				S	50(2")					CLAYEY SAND Med Medium Grained Small amount fine gravel Mostly carbonate Med Pl Reddish Brown
				U	100(2")	N.P.				
70										
								SC	Dry to Slightly moist Hard	
75				U	100(3")	Bag only				H.S.A. Stopped at 73'6", Sampler refused 73'9" Caved to 64.5'

GROUND WATER

DEPTH	HOUR	DATE
	NONE	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT Superconducting Super Collider

JOB NO. E99-11 DATE 19 JAN 89

LOG OF TEST BORING NO. M

RIG TYPE CME-75

BORING TYPE 6 1/2" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
			X	S	2.4.5 9			SM	Slightly moist Soils generally firm	SILTY SAND Trace Clay Fine to medium Grained N.P. Brown
5			X	S	12.20.16 36			SC	Slightly moist to Dry Very Firm	CLAYEY SAND Sand is Fine to medium Gr. Wkly lime cmtd Low Pl Lt Brown
10			X	S	48.50(3")			CL	Dry Hard	SANDY CLAY Sand is Med Fine gr. Moderately lime cmtd Low Pl Lt Brown
15			X	S	41.50(2 1/2")					
20			X	S	34.50(3")					CLAYEY SAND Fine to Medium Grained Wkly lime cmtd to Modly cmtd, Low Pl Lt Brown
25		Sand 30'-32' Sand 32'-33'6" Auger Refusal	X	S	43.50(3")					
30		30'3"	X	U	100 (9") N.R.				Fine sand Med Hard	SANDY CLAY Considerable silt Sand is Fine Grained Modly lime cmtd Low Pl Lt Brown
35	CAVE IN	33'6"	X	S	40.46.50(5")			SC	Dry Hard	
								CL	Dry Hard	
40			X	S	28.50(5")					
45			X	S	50(4 1/2")					
50			X	S	50(5")					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BEC

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LA

MA-1C Page

PROJECT Superconducting Super Collider

JOB NO. ESB-11 DATE 19 JAN 85

LOG OF TEST BORING NO. MA-

RIG TYPE CME-75

BORING TYPE 6½" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
55			☒	S	41-50(3")					CLAYEY SAND Fine to Medium Grained Wkly → Modly lime cmtd Low PI Lt Brown
								SC	Dry Hard	
60		59'4" CME Sample 63'6"	☒	U	100(10")				Boring Suspended 1950 hrs Boring Resumed 20 JAN 85 note added water to Assist Drilling at 60' used about 15 gallons	SANDY CLAY Sand is fine Modly lime cmtd. Low → Medium PI Lt Brown
			☒ A							
65			☒	S	45-50(2")			CL	Dry Hard	
70			☒	S	49-50(1½")					
			☒	S	50(5½")					
75										H.S.A. Stopped 73'6" Sampler refused >73'11½" Caved to 66'

GROUND WATER

DEPTH	HOUR	DATE
	None	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PROJECT MARICOPA SSC

JOB NO. E98-11 DATE 28 JAN 98

LOG OF TEST BORING NO. MA-

RIG TYPE CME-75

BORING TYPE 6 1/2" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
			X	S	2.4.6 10			CL	Dry Modly Firm	SANDY CLAY Fine to Medium Grained Lime present Low PI Lt Brown
5			X	S	19.21.26 47			CL	Dry Very Firm	
10			X	S	31.50(6")					SANDY CLAY Med Fine Grained Modly lime cmtd Medium ~~Low~~ PI Lt Brown → Br Note: increasing Sand content after 10'
15				S	50(5 1/2")			SC	Dry, Hard	CLAYEY SAND Fine to Medium Grained Moderatly cmtd Med Plasticity Lt Brown
20			X	S	23.30.38 68			SM-SP	Dry, Hard	Silty Sand Med Fine to Medium Grained Lime present N.P. Lt Brown Note: coarse gravel pres at 21'6"-22'
25		CME-Sample tube method		U	100(3") Bag Sample			SC	Dry Hard	CLAYEY SAND Med Fine to medium Moderatly cmtd Low PI → Brown to Reddish Br Note: coarse sand included after 35' to 42' Note: decreasing Sand after 47' to 52'
30										
35				S	50(4 1/2")					
40				S	50(2")					
45				S	50(2 1/2")					
50				S	50(5")					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWIT

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • El

PROJECT MARICOPA SSC

JOB NO. EER-11 DATE 22 JAN 84

LOG OF TEST BORING NO. MA

RIG TYPE CME-75

BORING TYPE 6 1/4" H.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
								SC	Dry Hard note: added aprox 15 gallon water to assist in drilling	
55			X	S	50(4")					
										Silty Sand (small amt clay) Med Fine Modly cmtd Low → M.C. Lt Brown
60			X	S	50(5")	Sampler empty		SM	Dry Hard note: aprox 10 gallon water added to assist drilling	
65			X	S	50(6")	Poor recovery				
								CL	Dry Hard note: added 5 gallon water to assist drilling	SANDY CLAY Sand is Med Fine Modly → Strongly cmtd Low PI Lt Brown
70			X	S	50(1 1/2")					
75			X	S	50(2")					
										H.S.A. Stopped 75 Sampler refused 50' 2"

GROUND WATER

DEPTH	HOUR	DATE
	None	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWI

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY •

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. M

RIG TYPE GARDNER-DENVER 140

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1480 ± 10'

DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance *	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	A					SI. MOIST TO MOIST 0-5'	SAND, pred. fn-grnd., var. to SAND SILT & SILTY SAND, occas. med-coarse sand & gravel, subang-sbrnd, md-st lime cmtd NP-low PI, lt. br. to lt. rdsh br.
5			X	A				ML	V. SI. MOIST BELOW 5'	
10	1 FT / 2 minutes		X	A				SP		
15	0.3 minutes		X	A						Some to cons.
20			X	A				ML		note ~~Cons~~ med-Granular coarse sand ~~& fn~~ w/ occ gravel, 10-15', 30-45, var. ign. & met. rock types,
25	2 FT / 1 minute		X	A						
30			X	A						note: caliche veinlets & concret. common
35	0.4 minutes		X	A				SP		
40			X	A						
45	3 FT / 1 minute		X	A				ML	* Drill rate in minutes/foot	
50	0.2 minutes		X							

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECK

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE C

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1480 ± 10'

DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance *	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X							SAND, var. to SANDY SILT & SILTY SAND, (cont'd.)
	0.2 minutes/ft.		X	A					V. SL. MOIST	
55			X							
	0.2 minutes		X	A						
60			X					SP		note: Granular med to coarse sand w/ occas. fn. gravel, 50-70', 85-90', 95-100'.
			X	A						
65			X							
	0.5 minutes/ft.		X	A						
70			X							note. Stopped drilling on 1/28/88 @ 100' Encountered difficulty due to excessive caving at 95'.
	0.5 minutes		X	A						
75			X							
	0.5 minutes		X	A				ML		
80			X							
			X	A						note: Recent basin-fill sediments
85			X							
	0.6 minutes/ft.		X	A				SP		
90			X							note: Borehole diameter may be irregular due to caving below 90', esp. from 90'-100'.
	0.6 minutes		X	A				ML		
95			X							
			X	A				SP	* Drill rate in minutes/foot	
100										

GROUND WATER

DEPTH	HOUR	DATE
NONE	8AM	1/29/88*

* DEPTH [illegible]

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/29/88

LOG OF TEST BORING NO. MR

RIG TYPE GARDNER-DENVER 140

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1480 ± 10'

DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance *	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
100			X	A						SAND, var. to SILTY SAND & SAND SILT (cont'd)
			X	A						
105			X	A					V. SL. MOIST (?)	note: Added water and poly-foam to stiffen borehole walls and floor cuttings @ 100'
	0.75 minutes/ft.		X	A						
110			X	A				SP		
			X	A						note: Bedding not very found few inches to a few feet; irregular contacts
115			X	A						
			X	A						note: Some to cons. med-coarse grad sand to fn gravel, 100'-135', var. igneous metrock types.
120			X	A						
	1.9 minutes/ft.		X	A						
125			X	A						
			X	A						note: Contact w/ underlying Fang. unit @ about 135', approxim. located, probably variable
130			X	A						
			X	A						
135			X	A						
	1.75 minutes/ft.		X	A					* Drill rate in minutes/foot	FANGLOMERATE (cont'd.)
140			X	A						
145										
150										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/29/88

LOG OF TEST BORING NO. MR-1

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1480±10'

DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance *	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
150	1.75 mins/ft.		X	A						Fanglomerate (Late Tertiary-Quat) Boulders - cobbles of granite (salt-and-pepper, gra-Feldspars - Bot. [illegible] fn-med grnd (?)) in fnr.-grnd., clay-rich matrix, sl. lime cmtd., pinkish brown to br.
155			X	A						
160			X	A						
165			X	A						
170			X	A						note: Contact w/ overlying basin-fill sediments approx. located, prob. irregl.
175			X	A						
180			X	A					POSSIBLE TOP OF WEATHERED BEDROCK (?)	note: Contact w/ underlying bdrk. approx. loctd., prob. irregl.
185	1.05 mins/ft.		X	A						
190			X	A						note: Possible perched zones of groundwater
195			X	A					* Drill rate in minutes/foot	
200										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/29/88

LOG OF TEST BORING NO. MR-1

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1480 ± 10'

DATUM USGS TOPO

Depth in Feet	* Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
200				A						FANGLOMERATE (cont'd.)
205				A						BEDROCK (?) GRANITE, fn.-med grnd., gray-wt., pk. feldspar - bot.
210										

REFUSED ON BEDROCK OR LARGE BOULDER @ 206'.

LEFT BOREHOLE OPEN FOR INSTRUMENTATION (DILATOMETER)

NOTE: POSSIBLE GROUNDWATER BETWEEN ABOUT 150 AND 200 FEET

* Drill rate in minutes/foot

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PROJECT A2, SSC
JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-

RIG TYPE GARDNER-DENVER 1400
BORING TYPE 5 3/4" AIR ROTARY
SURFACE ELEV. 1480 ± 10'
DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
4:48 0			X	A				ML		SAND, some silt, pred. fn-med grnd., w/rndd-subang., sl. lime cmtd., NP-low PI, lt. rdsh br.-br.
5			X	A						
10	0.3		X	A				SP	DRY to V. Sl. moist.	note: Ver. to SILTY SAND, pred fn-grnd, 0-10', 15'-20', 45'-50',
15			X	A				ML		note: Occas coarse sand to fn gravel, 25'-40',
7:54 4:58 20			X	A				SP		
25			X	A						
30	0.4		X	A						
35			X	A						
.06 40 08:30			X	A						
45	0.2		X	A				ML		
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PY7

PROJECT AZ SSC

JOB NO. E 88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-1

RIG TYPE

BORING TYPE

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50									MOIST 0-5'	
	4 MINS / 20 FT = 0.2 MINS/FT			A				SP	DRY to V. Sl. moist	
55										
				A						
60										
				A						SAND, pred. v fn-fn grnd, some silt, some med grnd sand, w/ mdd-subang, sl. lime-cmtd, NP, lt. br.
65										
				A						
	0.3									
70										
				A				SP	Dry to V. sl moist	note: Ver. to pred fn-grnd., 85'-90'
75										
				A						
80										note: temporarily hole caved or blocked at 95'. ~~Driller says pr. 95. moisture (sample dry)~~ poss. coarse sand or gravel?
				A						
85										
				A						
	0.6									
90										
				A						
95										
				A						
100										

GROUND WATER

DEPTH	HOUR	DATE
NONE	8AM	1/29/88

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT Az. SSC

JOB NO. EEE-11 DATE 1/29/88

LOG OF TEST BORING NO. MR-1

RIG TYPE

BORING TYPE

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
100									1/29/88 START	note: Difficulty advancing drill stem below 120'; apparently due to sloughing, caving & sticking. No evident change in materials.
								SP		
105										
110										note: Unable to advance beyond 100' on V26. Pulled out at 7PM to return on 1/29. Started drilling again 1/29 at 100'
115										note: lenses of fn-med sand, 90'-100'.
120										note: Started drilling with ~~mud~~ poly-foam at 100'.
125										note: Probable cavity at about 90'-100' caused by caving ~~end~~.
130										note: Diff. drlng. from 140'-; changed bit at 145'.
135										note: Driller indicates poss. water at ~160'.
140										SAND, pred. med-gmd, some fn sand, some coarse sand-fn gravel, subang-subrnd., NP, br.
145										note: Occas. beds of fn sand & silty sand, esp. from 135'-140'.
150										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT Az SSC

JOB NO. E88-11 DATE 1/29/88

LOG OF TEST BORING NO. MR-1

RIG TYPE

BORING TYPE

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
150										FANGLOMERATE, Granitic clasts, st. cmtd., v. hard
155										
160										
165										
170										
175										
180										
185										
190										
195										
200										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

...DER FOR SOIL & FOUNDATION INVESTIGATION SAMPLES (SOIL)

WO #

DATE WORK ASSIGNED

TARGET DATE FOR COMPLETION

PROJECT A2. SSC

Tab. Date 1/29/88

Job No. E88-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	MR-2 0-5'	A																			
	5-10'	A																			
	10-15'	A																			
	15-20'	A																			
	20-25'	A																			
	25-30'	A																			
	30-35'	A																			
	35-40'	A																			
	40-45'	A																			
	45-50'	A																			
	50-55'	A																			
	55-60'	A																			
	60-65'	A																			
	65-70'	A																			
	70-75'	A																			
	75-80'	A																			
	80-85'	A																			
	85-90'	A																			
	90-95'	A																			
	95-100'	A																			

REV. 10-10-80
TAB

NO 20376

Code No. 40

SERGENT, HAUSKINS & BECKWITH

PROJECT AZ SSC

JOB NO. E88-11 DATE 1/29/88

LOG OF TEST BORING NO. 1-5G MR.

RIG TYPE

BORING TYPE

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
200										
205										BEDROCK Fn-med grained granite, hard gray to white
210										
215										REFUSED ON BEDROCK @ 206' PROBABLE WATER TABLE ELEV. 150'-200' (DRILLER'S EST.)
220										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-2

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1355 ± 5'

DATUM USGS TOPO

Depth in Feet	* Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	A					V. Sl. MOIST	SILTY SAND, pred. v. fn. – fin. grnd, ver. to SANDY SILT, md-st. lime cmtd, NP Subang. – subrnd to lowl Pl, lt. br., ver. to lt. rdsh-br.
5			X	A				SM		
10	0.6 min/ft		X	A						
15			X	A				ML		note: Occas. gravel sized clasts, subang.-subrnd, various ign. & met. rock types;
20			X	A						
25	0.5 min/ft		X	A				SM		note: Bedding may vary from a few inches to a few feet, irreg. contacts.
30			X	A						
35			X	A				ML		note: Probable Recent basin-fill sediments.
40	0.4 min/ft		X	A						
45			X	A					* Drill rate in minutes/foot	
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT ARIZONA SSC

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-2

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. 1355 ± 5'

DATUM USGS TOPO

Depth in Feet	Continuous Penetration Resistance *	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X							
			X	A						SILTY SAND, VER. to SANDY SILT (cont'd.)
			X					ML		
55			X						V. SL. MOIST	
			X	A						
60			X							note: common caliche veinlets & concretions
			X	A				SM		
65			X							
			X	A						
70			X							
			X	A						
75			X					ML		
			X	A						
80			X							
			X	A						
85			X							
			X	A						
90			X							STOPPED DRILLING @ 100' BOREHOLE CAVED TO 99' LEFT OPEN FOR INSTRUMENTATION (GEOPHONES)
			X	A						
95			X						* Drill rate in minutes/foot	
			X	A						

GROUND WATER

DEPTH	HOUR	DATE
	NONE	1/28/88

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PV-

PROJECT AZ 55C

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-2

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV. ~~1360~~ 1355 ± 5'

DATUM USGS TOPO

Depth in Feet	* ~~Continuous Penetration Resistance~~	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2:00 0			X	A				SM	* DRILL RATE MINS/FT	4'6" FROM BASE OF KELLY TO GROUND 24' KELLY BAR ~~ABOVE B.H.~~ (60' FROM SWITCH RAIL) 20' PIPES (PLUS 1'8" BIT
5			X	A					Dry to V. sl. moist	
10	11½ Mins / 20 Ft = 0.6 min/ft 0-20'		X	A						SILTY SAND, pred. fn-grnd., some med grnd sand, ver. to sandy silt, md-st. lime cmtd, NP-low Pl, lt. br. subang-subrnd note: Ver. to ~~slt~~ sandy silt from 15'-20', 35'-60', 65-
15			X	A				ML	— COLOR CHANGE TO REDSH	
2:11 30 20			X							
2:26 30			X	A						note: Color change to lt. rdsh br. @ 20'
25			X	A				SM		note: Color change to lt. br. @ 35'
30	9½ / 20 = 0.45 min/ft		X	A						
35			X	A				ML		
3:? 40 4:1			X	A						
45			X	A						
50										

GROUND WATER

DEPTH	HOUR	DATE
	NONE	1/28/88

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX · TUCSON · ALBUQUERQUE · SANTA FE · SALT LAKE CITY · EL PASO

PROJECT AZ. SSC

JOB NO. E88-11 DATE 1/28/88

LOG OF TEST BORING NO. MR-2

RIG TYPE GARDNER-DENVER 1400

BORING TYPE 5 3/4" AIR ROTARY

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X							(SANDY SILT)
	8½/20 = 0.43		X	A					DRY TO V. SL. MOIST	
55	MIN/FT		X					ML		
			X	A						
49:30										
60			X							
55			X	A				SM		
65	5 MINS = 20 FT 0.25 M/F		X	A				ML		
70			X	A						
75			X	A						
80			X	A						
85	5 MINS / 20 FT = 0.25 MIN/FT		X	A						
90			X	A						
95			X	A						
00										

STOPPED DRILLING @ 100'. BOREHOLE LEFT OPEN FOR INSTRUMENTATION (GEOPHONES) CAVED TO 99'

GROUND WATER

DEPTH	HOUR	DATE
	NONE	1/28/88

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

WORK ASSIGNED BY _____

DATE WORK ASSIGNED _____

TARGET DATE FOR COMPLETION _____

WORK ORDER FOR SOIL & FOUNDATION INVESTIGATION SAMPLES

(SOIL)

WO # _____

Tab. Date 23 JAN 88

PROJECT Maricopa SSC Site

Job No. E39-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	Boring MA-10 6"-2'	S																			
	3'6"-5'	S																			
	8'6"-8'11½"	S																			
	13'6"-13'11"	S																			
	19'6"-23'6"	S																			
	30'-31'6"	S																			
	40'-40'3½"	S																			
	55'-55'4½"	S																			
	60'-60'5"	S																			
	65'-65'4½"	S																			
	68'6"-73'6"	*																			
	80'-80'2"	S																			
	85'-85'4½"	S																			
	90'-90'4½"	S																			
	95'-95'2"	S																			
	100'-100'2"	S																			
	105'-105'1½"	S																			
	110'-110'3"	S																			
	115'-115'4"	S																			
	120'-120'2½"	S																			

REV. 10-10-80
TAB

NO 30373

S - Spoon Samples
* - Bulk Sample remains

Code No. 40 _____

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

PROJECT ENGINEER REW
WORK ASSIGNED BY
DATE WORK ASSIGNED
TARGET DATE FOR COMPLETION

WORK ORDER FOR SOIL & FOUNDATION INVESTIGATION SAMPLES

(SOIL)

WO #
Tab. Date 28 JAN 89
PROJECT Maricopa SSC Site
Job No. E89-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	Information missing																				
	120'-120'2½"	S																			
	135'-135'2"	S																			
	140'-140'2½"	S																			
	145'-145'3½"	S																			
	150'-150'2"	S																			
	Boring MA-11																				
	6"-2'	S																			
	4'6"-6'	S																			
	10'-10'4½"	S																			
	15'-15'6"	S																			
	20'-20'4"	S																			
	30'-31'6"	S																			
	40'-40'3"	S																			
	43'6"-43'10"	S																			
	47.0-48.5	X																			
	55'-55'2"	S																			
	65'-65'5"	S																			
	73'6"-73'9"	S																			

REV. 1 10-80
TAB

CME-

Code No. 40

SERGENT, HAUSKINS & BECKWITH

FOR SOIL & FOUNDATION INVESTIGATION SAMPLES (SOIL)

WO #

DATE WORK ASSIGNED

TARGET DATE FOR COMPLETION

PROJECT Maricopa SSC Site

Tab. Date 28 JAN 89

Job No. E89-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	Boring MA-12																				
	6"-2'	S																			
	4'6"-6'	S																			
	9'6"-10'3"	S																			
	15'-15'8½"	S																			
	20'-20'8½"	S																			
	25'-25'9"	S																			
	32'9"-33'2"	S																			
	33'6"-34'11"	S																			
	38'6"-39'5"	S																			
	43'6"-44'1½"	S																			
	48'6"-48'11"	S																			
	53'6"-54'3"	S																			
	58'6"-59'4"	U																			
	61'-62'	S																			
	63'6"-64'2"	S																			
	68'6"-69'1½"	S																			
	73'6"-73'11½"	S																			

REV. 10-10-80
TAB

Code No. 40

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

NO 30375

... ORDER FOR SOIL & FOUNDATION INVESTIGATION SAMPLES (SOIL)

WO #

DATE WORK ASSIGNED

TARGET DATE FOR COMPLETION

PROJECT Az. SSC

Tab. Date 1/29/88

Job No. E88-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	MR-1 0-5'	A																			
	5-10'	A																			
	10-15'	A																			
	15-20'	A																			
	20-25'	A																			
	25-30'	A																			
	30-35'	A																			
	35-40'	A																			
	40-45'	A																			
	45-50'	A																			
	50-55'	A																			
	55-60'	A																			
	60-65'	A																			
	65-70'	A																			
	70-75'	A																			
	75-80'	A																			
	80-85'	A																			
	85-90'	A																			
	90-95'	A																			
	95-100'	A																			

EV. 10-10-80
AB

Code No. 40

SERGENT, HAUSKINS & BECKWITH

NO 30377

WORK ORDER FOR SOIL & FOUNDATION INVESTIGATION SAMPLES

WO #

DATE WORK ASSIGNED

TARGET DATE FOR COMPLETION

PROJECT Az. SSC (SOIL)

Tab. Date 1/29/89

Job No. E88-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	MR-2 100-105'	A																			
	105'-110'	A																			
	110-115'	A																			
	115-120'	A																			
	120-125'	A																			
	125-130'	A																			
	130-135'	A																			
	135-140'	A																			
	140-145'	A																			
	145-150'	A																			
	150-155'	A																			
	155-160'	A																			
	160-165'	A																			
	165-170'	A																			
	170-175'	A																			
	175-180'	A																			
	180-185'	A																			
	185-190'	A																			
	190-195'	A																			
	195-200'	A																			

REV. 10-10-80
TAB

Code No. 40

SERGENT, HAUSKINS & BECKWITH

NO 30378

... FOR SOIL & FOUNDATION INVESTIGATION SAMPLES (SOIL)

WO #

DATE WORK ASSIGNED

TARGET DATE FOR COMPLETION

PROJECT Az. SSC

Tab. Date 1/30/88

Job No. E88-11

LAB NO.	BORING NO. AND DEPTH SAMPLED	TYPE OF SAMPLE	SIEVE ANALYSIS (SA)	PLASTICITY INDEX (PI)	MOISTURE CONTENT	DENSITY	CONSOLIDATION: MAXIMUM LOAD	CONSOLIDATION: SATURATE @	CONSOLIDATION: CURVE DESIGNATION	DIRECT SHEAR: NUMBER OF POINTS	DIRECT SHEAR: SATURATE OR IN SITU	DIRECT SHEAR: NORMAL FORCES	EXPANSION/ @ SURCHARGE	EXPANSION CURVE DESIGNATION	HYDROMETER	PERMEABILITY	OTHER	MOISTURE-DENSITY CALCULATIONS: WET WEIGHT (GMS.)	DRY WEIGHT (GMS.)	PERCENT MOISTURE	DENSITY (PCF)
	MR-2 200-205'	A																			
	205-206'	A																			
	MA-13 6"-2'	S																			
	5'-6'6"	S																			
	10'-11'	S																			
	15'-15'5½"	S																			
	20'-21'6"	S																			
	23'6"-23'9"	S																			
	33'6"-33'10½"	S																			
	43'6"-43'8½"	S																			
	38'6"-38'8"	S																			
	48'6"-48'11"	S																			
	55'-55'4"	S																			
	65'-65'6"	S																			
	70'-70'1½"	S																			
	75'-75'2"	S																			

REV. 10-10-80
TAB

Code No. 40

SERGENT, HAUSKINS & BECKWITH

NO. 20270

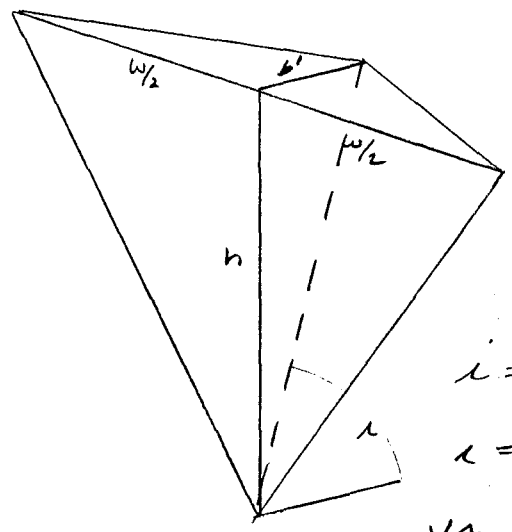
APPENDIX B: FIELD SLOPE TEST FAILURE LOADS AND GEOMETRIES

Failure load = 9200 #

$\omega = 2.7'$
$h = 2.2'$
$b' = 10''/12'' = 0.83'$

$\phi = 32°$

Approximated Failure Volume



slope crest

$$i = 90 - \tan^{-1}\left(\frac{b'}{h}\right)$$

$$i = 90 - \tan\left(\frac{.83}{2.2}\right) = 69°$$

$$V \approx \frac{1}{3}(h)(b')(\omega/2)$$

$$V = \frac{1}{3}(2.2)(.83)(1.35) = 0.822\ ft^3$$

$$\gamma_T = \frac{V(\gamma_{soil}) + \text{Failure load}}{V}$$

$$\gamma_T = \frac{(.822)(100\,pcf) + 9200\#}{.822} = 11292\ pcf$$

$$B = \left[4\left(\frac{b'}{\omega}\right)^2 \sin^2 i + 1\right]^{1/2} = \left[4\left(\frac{.83}{2.7}\right)\sin^2 69 + 1\right]^{1/2} = 1.15$$

$$F_3 = \frac{3c}{\gamma_t b'}\,\frac{B}{\sin i} + \frac{1}{B}\,\frac{\tan\phi}{\tan i} = 1$$

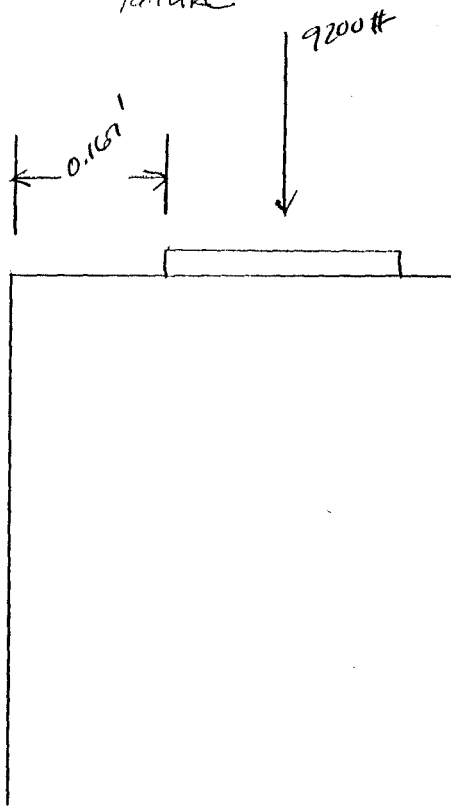
$$C = \left[1 - \frac{\tan\phi}{(\tan i)(B)}\right]\left[\frac{\gamma b' \sin i}{3B}\right] = \left[1 - \frac{\tan 32}{1.15 \tan 69}\right]\left[\frac{(11292)(.83)(\sin 69)}{3B}\right]$$

$$\underline{C = 2007\ psf}$$

Test #10

D = 2.0 | Plate #1 | Bench Lower

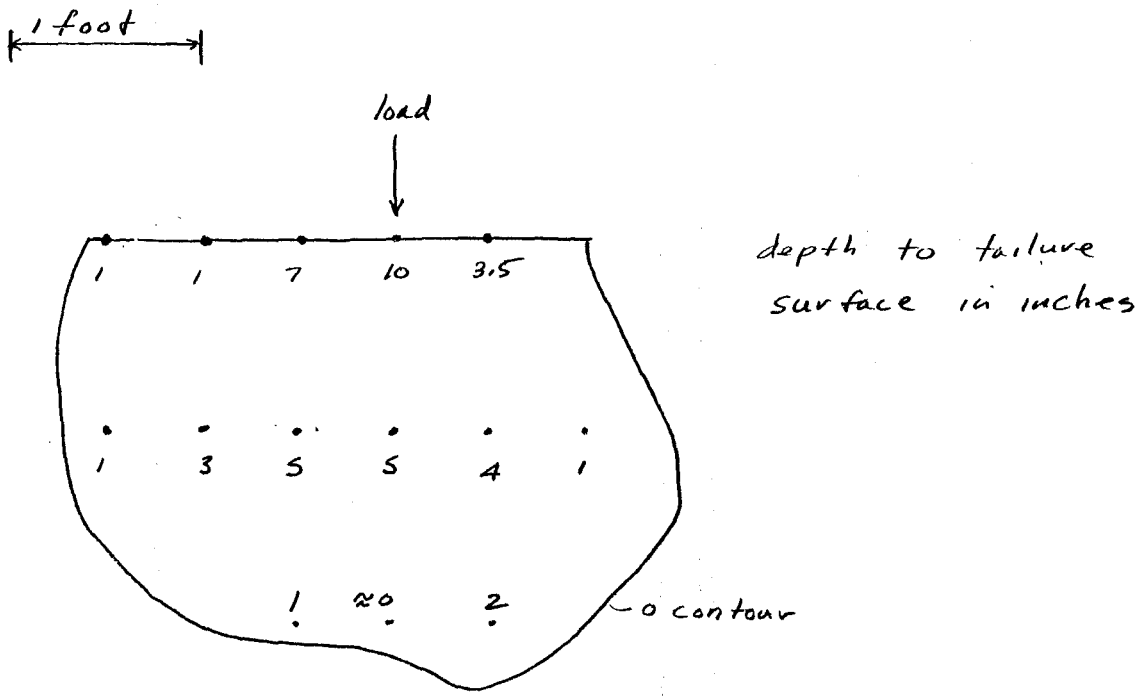
Load Units		Displacement	Comm
1.5	1025	10	
2	1040	17	
2.5	1750	17	
3	2100	18	
		19	
4	2800	20	
		22	
5	3500	25	
		27	
6	4200	28	
		32	
7	4900	33	
		35	Tension Cracks
8	5600	38	
		38	
9	6400	38	
		38	
10	7000	39	
		40	
11	7800		
12	8500	40	
		45	
13	9200	55	failure



$$\sigma_{n_f} = \frac{9200\#}{0.449} \quad 20.49 \text{ ksf}$$

$$\text{Plate} = 0.67' \times 0.67'$$

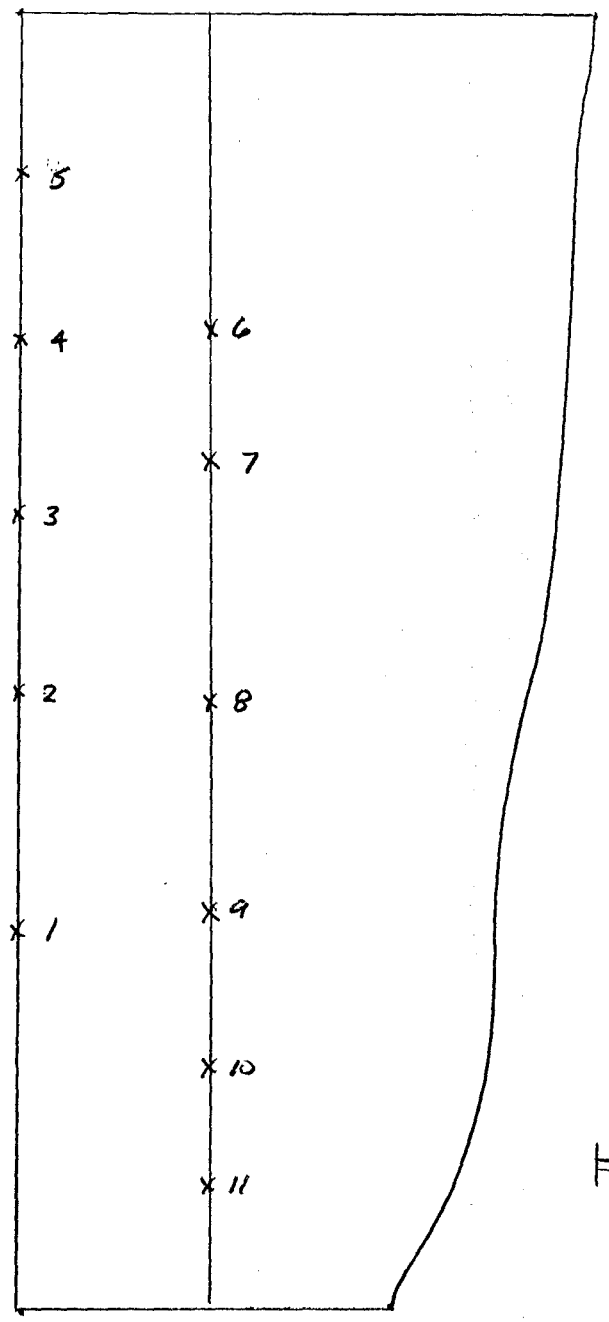
$$= .449 \text{ ft}^2$$


1 foot
load
1
1
7
10
3.5
1
3
5
5
4
1
1
≈0
2
0 contour
depth to failure surface in inches

SSC Project	Sample locations	2/12/88	GM

Plan view

1" = 5'

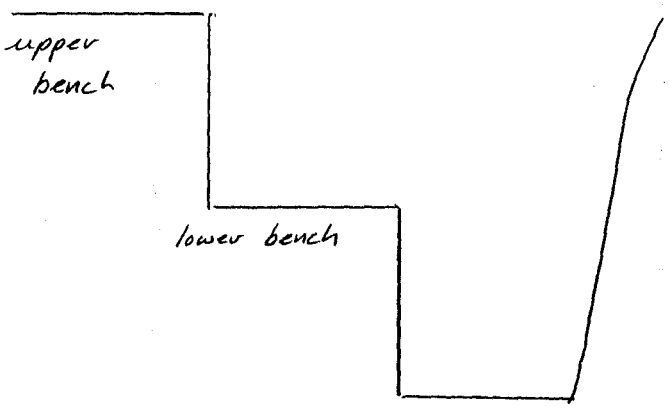


N 40° W

Trench Location
T5S, R1E
Sec 17
CCD

5'

X-section



Definitions

Plate 1

$0.67' \times 0.67' = 0.449\ ft^2$

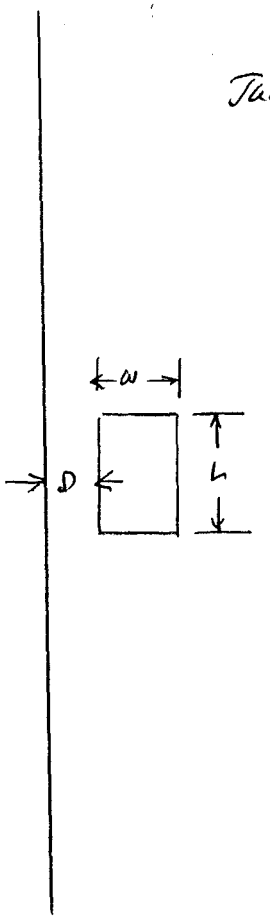
Plate 2

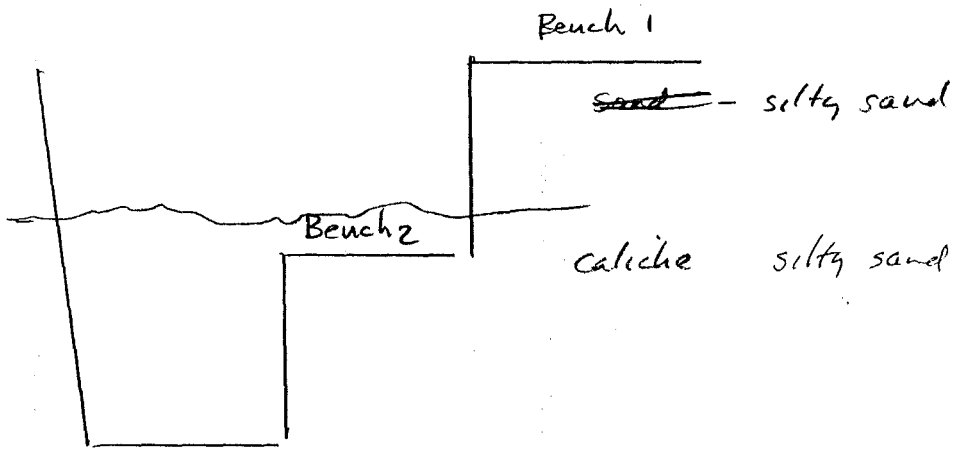
$1.25 \times 1.0 = 1.25\ ft^2$

Jack Capac

1 10 ton UA# A023070
model Simplex R106
A 1890

2 30 Ton UA# A023108
Simplex R306





Field Testing

Sample #	W_m	W_d	W_w	w%
CT# 1	733.1	711.5		3.04
CT#2	726.2	703.1		3.28
CT#3	662.1	643.2		2.94
CT#4	877.5	838.5		4.65
CT#5	877.8	804.3		2.98
CT#6	496.5	479.1		3.63
CT#7	779.4	745.5		4.55
CT#8	439.9	418.3		5.16
CT#10	747.8	716.9		4.31
CT# 11	814.5	784.9		3.77
CS# 1	1185	1134.0		4.50
CS#2	1172	1133.1		3.43

Data Sheet

Test # 1

Bench

D, 0.5

W,

L,

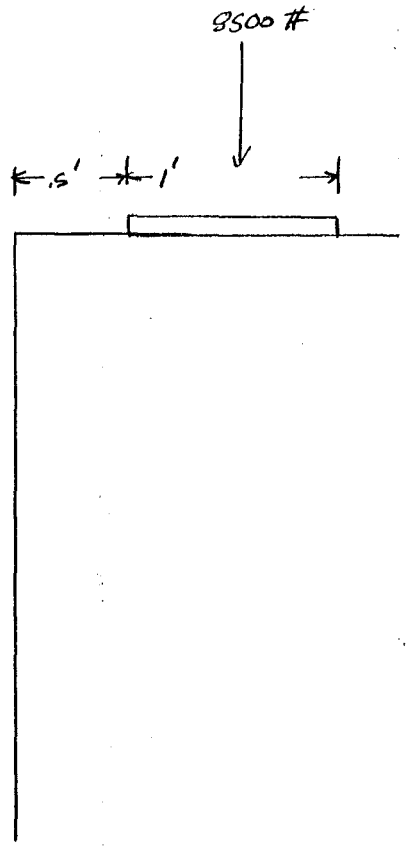
Plate AREA = 1.25 ft²

long axis parallel slope face

10 ton jack

Load UNITS	Load (#)	displacement	comments
1.5 ~~0.5~~	1025	10.0	
2.0 ~~1.0~~	1040	18.0	
3.0 ~~2.0~~	2100	35.0	
4.0	2800	45.0	
4.5	3150	47.0	
5.0	3500	50.0	
5.5	3900	60.0	
6.0	4200	65.0	
6.5	4550	70.0	
7.0	4900	80.0	
7.5	5300	90.0	
8.0	5600	95.0	
8.5	5950	100.0	
9.0	6400	105.0	
10.0	7000	115.0	
→ 11.0	7800	130.0	← failure Cracks forming
12.0	8500	200.0	

$\sigma_{n_{failure}}$ = 6800 psf



Data Sheet

Test # 2

Bench

D, 5"

W,

L,

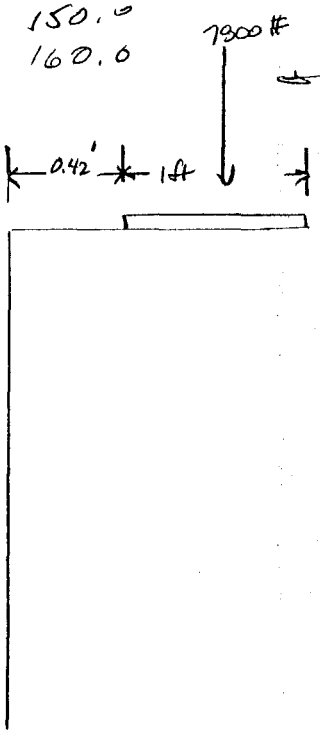
Plate 1.25 x 1.0 = 1.25 ft^2

Long axis parallel slope

10 ton Jack

Load UNITS		Displacement	Comments
2	1400	18.0	
2.5	1750	22.0	
3.0	2100	27.0	
3.5	2450	30.0	
4.0	2800	35.0	
4.5	3150	45.0	
5.0	3500	50.0	moving
5.5	3900	60.0	
6.0	4200	70.0	
6.5	4550	80.0	
7.0	4900	105.0	Cracks forming
7.5	5300	130.0	
8.0	5600	135.0	
8.5	5950	140.0	
9.0	6400	145.0	
9.5	6700	148.0	
10.0	7000	150.0	
11.0	7800	160.0	failure

$\sigma_{n\ failure} = \frac{7800}{1.25} = 6240$ psf



Date Sheet | Test # 3 | Bench

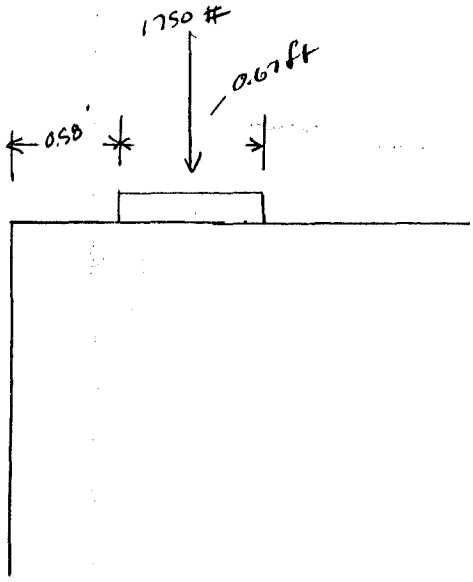
D, 7" | Plate No. 1 | area = 0.449 ft²

W, | 10 ton Jack

L,

Load UNITS	load #	Displacement	Comments
2.0	1400	15.0	
2.5	1750	17.0	σ_u failure = 3890 psf

(131) from Corner



Data Sheet | Test # 4 | Bench #1 (Upper)

D, 7"

W, 1.0

L, 1.25

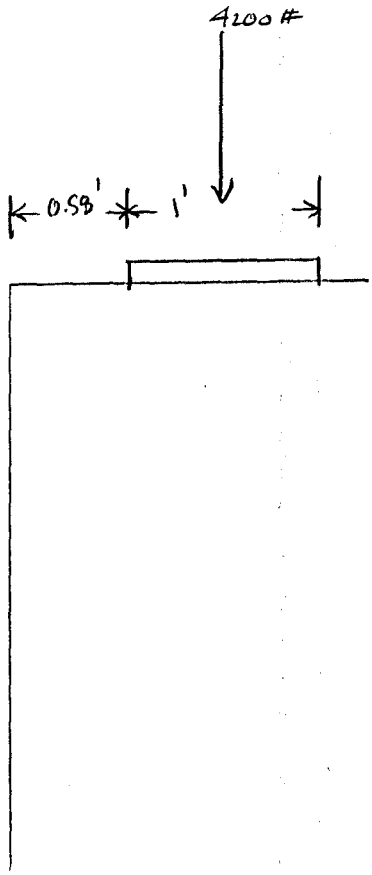
Plate No. 2 | Area = 1.25 ft²

long axis ∥ slope face

10 ton Jack

Load UNITS		Displacement	Comments
2.0	1040	30.0	
2.5	1750	35.0	
3.0	2100	37.0	
3.5	2450	42.0	
4.0	2800	47.0	
4.5	3150	55.0	Start
5.0	3500	64.0	
5.5	3900	75.0	
6.0	4200	85.0	Cracking
6.0	4200	95.0	failure
6.5			

$$\sigma_{n\,failure} = \frac{4200}{1.25} = 3360 \text{ psf}$$



Data Sheet

Test # 5 Bench 1 (Upper)

D, 6"

W, 1.0

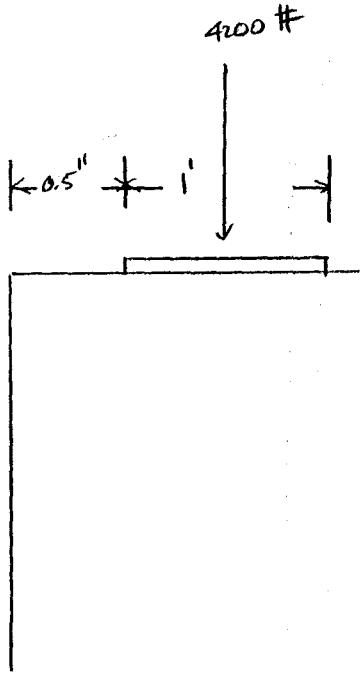
L, 1.25

Plate No 2 Area = 1.25 ft²

long axis parallel slope face

Load UNITS		Displacement	Comment
0.5		15.0	
1.0		22.0	
1.5		25.0	
3.0		30.0	
3.5		33.0	
4.0		37.0	
4.5		44.6	
5.0	3500	50.0	
5.5	3900	65.0	
6.0	4200	90.0	Cracks forming
6.5	4550	250.0	failure

$$\sigma_{n\,failure} = \frac{4200}{1.25} = 3360 \text{ psf}$$



Data Sheet

Test # 6

Plate No. 1

Area = 0.449 ft²

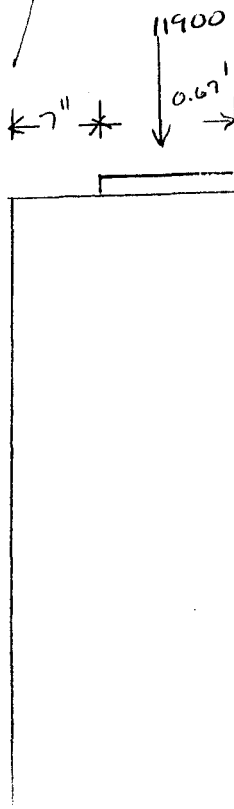
1 Bench lower

D, 7"

W, 0.67

L, 0.67

Load UNITS		Displacement	Comments
1.5	1025	14.0	
2.0	1640	33.0	
3.0	2100	40.0	
3.5	2450	50.0	
5.0	3500	60.0	
5.5	3900	65.0	
6.0	4200	75.0	
7.0	4900	85.0	
7.5	5300	90.0	
8.0	5600	100.0	
10.0	7000	117.0	← failure ??? Cracks forming
11	7900	140	
12	8500	150	
13	9200	160	
13 1/2	9500	175	
15	10500	180	
17	11900	190	
17	11900	200	← failure
16 1/2	11600		



$$\sigma_{n_{failure}} = \frac{11900}{0.449} = 26.5 \text{ ksf}$$

Defz Sleet Test # 7 Bench (lower)

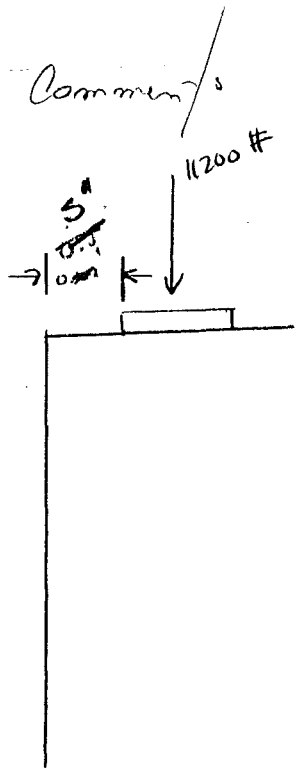
D, 5" Plate No. 1

W, 0.67

10 ton Jack

L, 0.67

Load UNITS	Load #	Displacement	Comments
0.5			
1.0			
1.5		19.0	
2.0		24.0	
2.5		29.0	
3.0		30.0	
3.5		34.0	
4.0		35.0	
4.5		38.0	
5.0	3500	41.0	
5.5	3900	44.0	
6.0	4200	48.0	
6.5	4550	50.0	Cracks
7.0	4900	53.0	start moving
7.5	5300	60.0	
8.0	5600	67.0	
8.5	5950	71.0	
9.0	6400	75.0	Cracking moving
9.5	6700		
10.0	7000	85.0	
10 1/2	7400	95.0	
11	7800	100.0	
11 1/2	8100	107.0	
12	8500	115.0	
12 1/2	8900	119.0	
13	9200	123.0	
13 1/2	9500	127.0	
14	9800	132.0	



$\sigma_{n\,failure} = 25.94$ ksf

15 10500 145
15 1/2 10900 155
16 11200 160 ← failure
16 1/2 11500

Data Sheet | Test # 8 | Bench

D, 2.5"

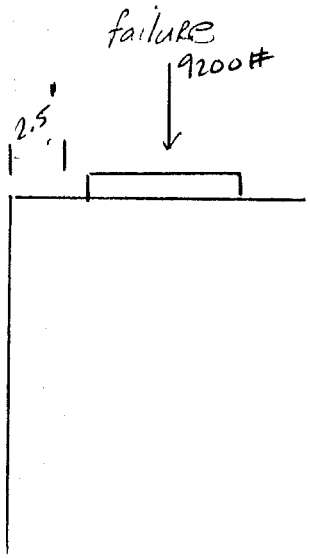
W, 0.67

L, 0.67

Plate No. 1

Load	UNITS	Displacement	Comments
~~0.5~~			
~~1.0~~			
1.5	1025	4	
2.0	1040	5	
2.5	1750		
3.0	2100		
3.5	2450		
4.0	2800	9	
4.5	3150		
5.0	3500	14	
5.5	3900	16	
6.0	4200		CRACKS forming
6.5	4550		
7.0	4900	20	
7.5	5300		
8.0	5600		
8.5	5950	40	
9.0	6400	50	
9.5	6700		
10.0	7000	65	
10.5	7400	75	
11	7800	75	
.5	8100	80	
12	8500	85	
.5	8800	92	
13	9200	97	
.5	9500		

$\sigma_{n_{failure}} = 20.49$ ksf



Test #9

Bench Lower

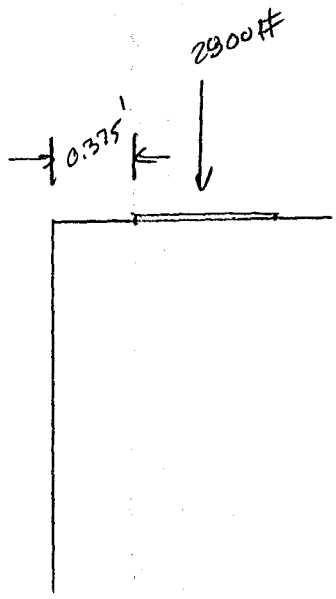
D 4.5"
Area = 0.449 ft^2

Plate #1
10 ton Jack

Load units		Displacement	
1.5	1025	30	
2	1400	55	cracks forming
.5	1750	80	
3.5	2450		
4.0	2900		failure

* may not be representative due to loose material

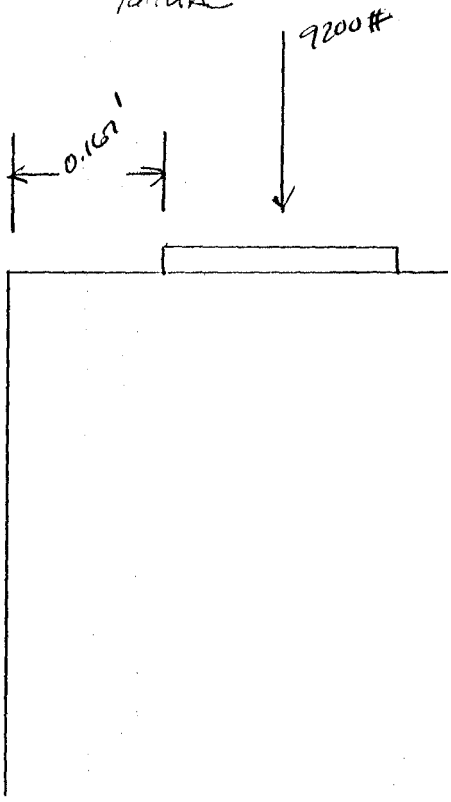
$$\sigma_f = \frac{2900}{0.449} = 6.24 \text{ ksf}$$



Test #10

D = 2.0 | Plate # 1 | Bench Lower

Load	Units	Displacement	Comm
1.5	1025	10	
2	1040	17	
2.5	1750	17	
3	2100	18	
		19	
4	2800	20	
		22	
5	3500	25	
		27	
6	4200	28	
		32	
7	4900	33	
		35	Tension Cracks
8	5600	38	
		38	
9	6400	38	
		38	
10	7000	39	
		40	
11	7800		
12	8500	40	
		45	
13	9200	55	failure



$$\sigma_{r_f} = \frac{9200\#}{0.449} \quad 20.49 \text{ ksf}$$

Plate = 0.67' x 0.67'

= .449 ft²

TEST #11

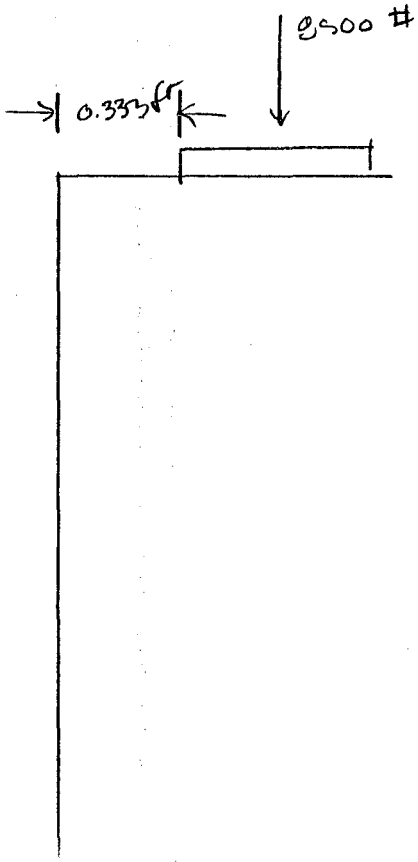
D = 4.0"

10 ton jack

plate area = 0.449 ft²

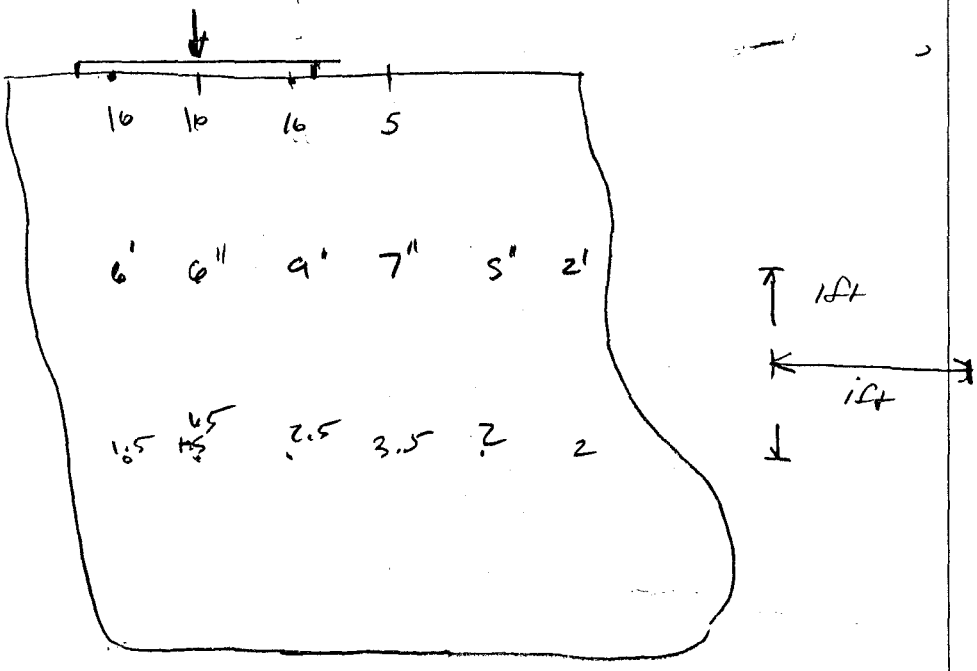
Dial Units		displac
1.5	1025	4
2	1040	5
		5
3	2100	5
		5
4	2900	5
		5
5	3500	5
6	4200	5
7	4900	|
8	5600	6
		10
9	6400	12
		17
10	7000	20
		38
11	7800	45
		47
12	8500	57
13	9200	
14	9800	
15	10500	

failure ?

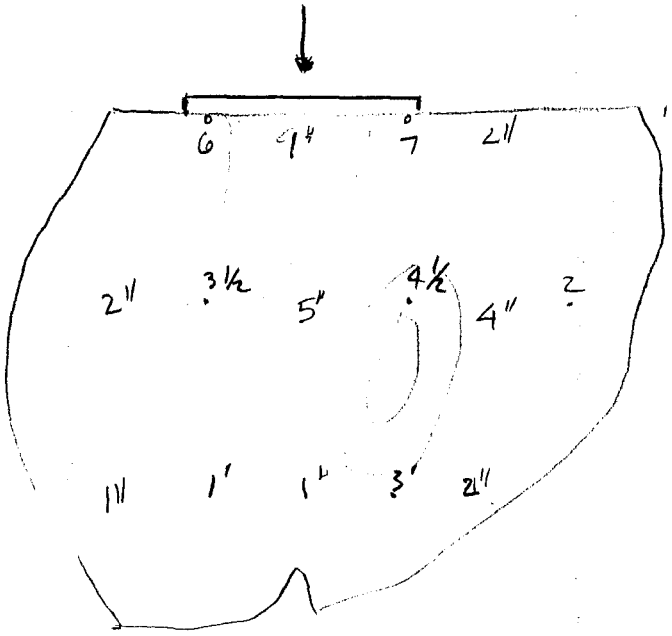


$$\sigma_f = \frac{8500}{0.449} = 18{,}93 \text{ ksf}$$

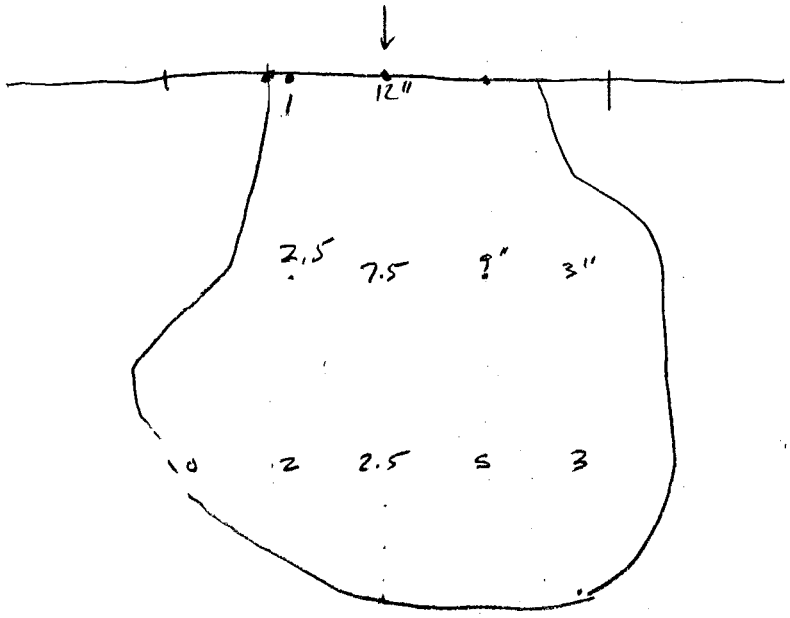
CT #1



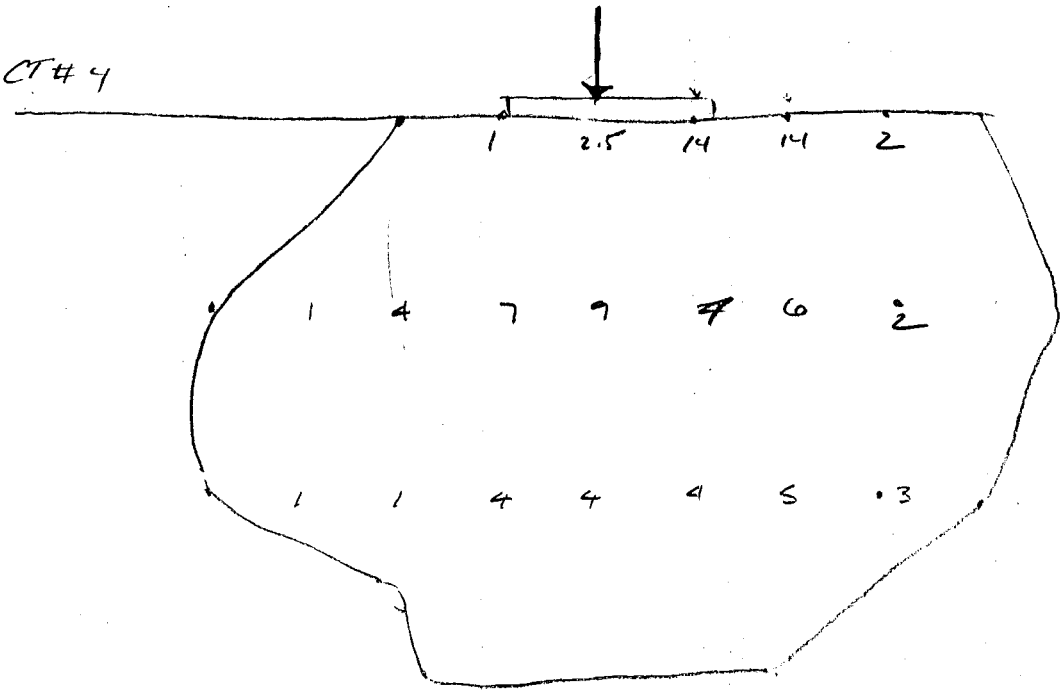
CT #2



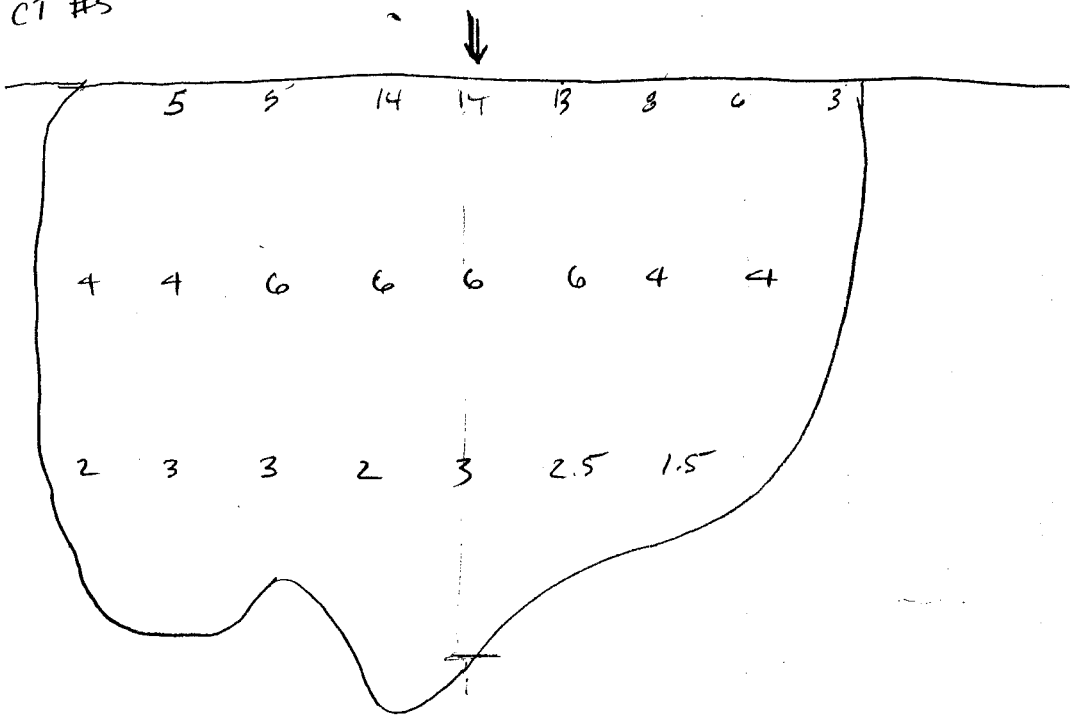
CT#3



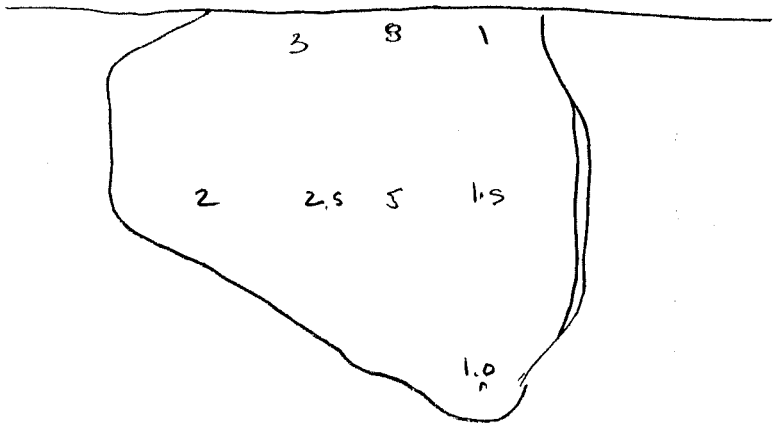
CT#4



CT #5

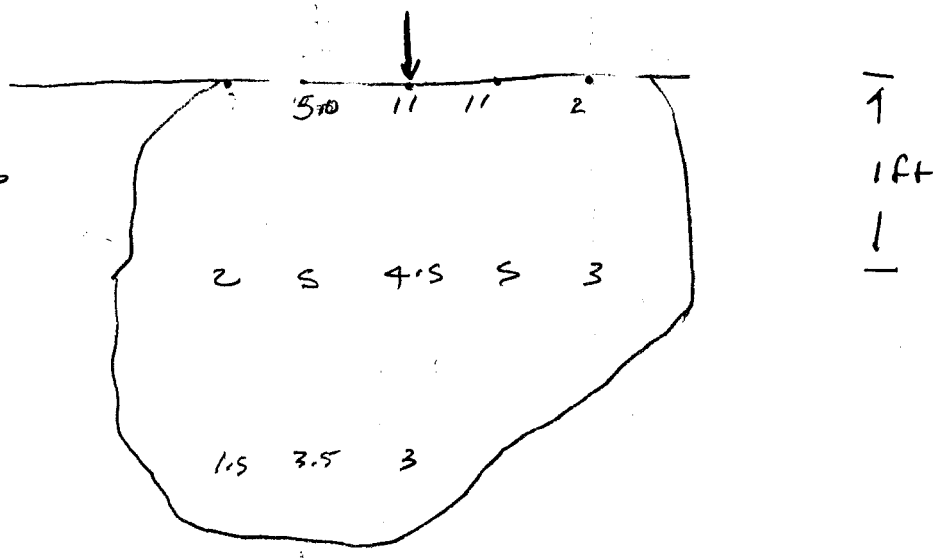


CT #6

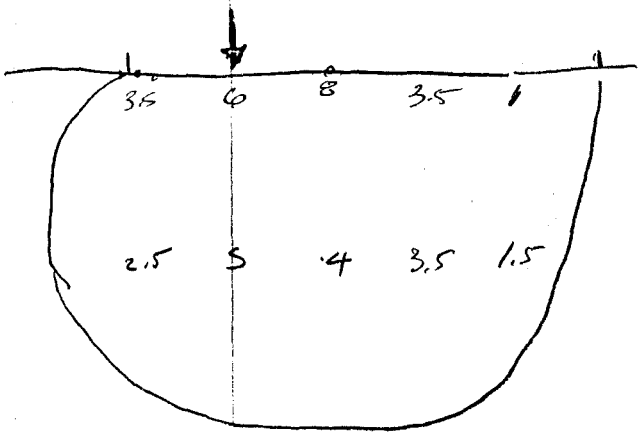


CT#7

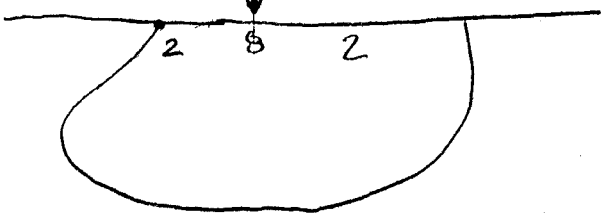
= inches



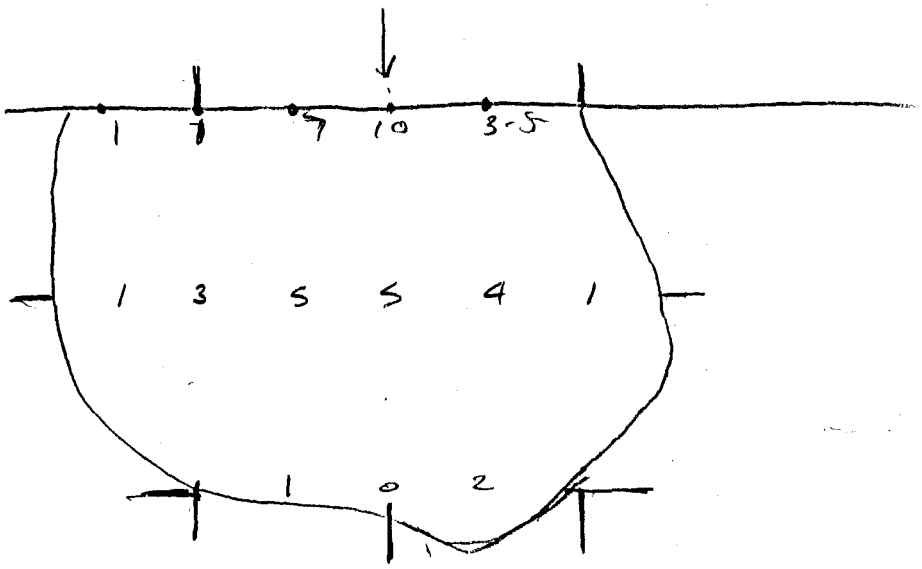
CT#8



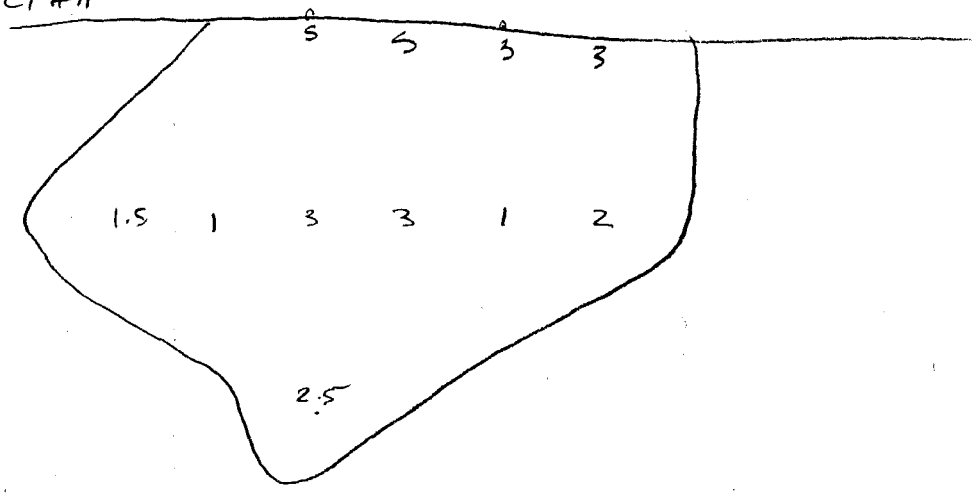
CT#9



CT #10



CT#11



APPENDIX C: LABORATORY DATA SHEETS AND CURVES

C.1 -- Sieve Analysis and Atterberg Limits Test Data

2-10-88 1/

Summary of Sieve Size (-200) and Moisture Content Data Maricopa Site

Boring MA-12

Depth	-200 fraction	In-Situ Moisture Content (%) Dry Weight Basis	PI
6" → 2'	12	2.0	13
15' → 15'-8½"	22	7.1	
25' → 25'-9"	38	7.6	
33'-6" → 34'-11"	16	3.7	
48'-6" → 48'-11"	41	7.4	
53'-6" → 54'-3"	34	8.0	
61' → 62'	27	7.1	
68'-6" → 69'-1½"	38	12.6	
73'-6" → 73'-11½"	28	9.2	

Boring MA-10

6" → 2'	29	3.4	
3'-6" → 5'	26	NT = not taken	1
8'6" → 8'-11½"	14	4.3	
13'6" → 13'-11"	17	Bad value	
19'6" → 23'-6"	24	NT	
30'-0" → 30'-6"	13	NT	4
40'0" → 40'-3½"	19	NT	
55'0" → 55'4½"	22	NT	
60'0" → 60'-5"	NT	5.7	
65'-0" → 65'-4½"	30	NT	
68'-6" → 73'-0"	7	NT	
80'-0" → 80'-2"	18/35 Wash	NT	

Boring MA-10 (cont)

Depth	-200 fraction	In Situ Moisture Content (%) Dry Weight Basis	PI
85' → 85'-4½"	NT	17	
90' → 90'4½"	37	NT	

Boring MA-11

6" → 2'	31	3.8	
10' → 10'-4½"	14	6.7	
20' → 20'-4"	35	6.2	
30' → 31'-6"	14	4.2	1
40' → 40'-3"	23	5.5	
55' → 55'-2"	21	6.4	
65' → 65'-5"	19	3.4	
73'-6" → 73'-9"	11	6.3	

Boring MR-1 (To be done)

Boring MR-2 (To be done)

42-381 50 SHEETS 5 SQUARE
42-382 100 SHEETS 5 SQUARE
42-389 200 SHEETS 5 SQUARE
Made in U.S.A.
NATIONAL

Boring MR-1

Depth	-200 fraction (%)	In Situ Moisture Content (%) Dry Weight Basis	PI
5'-10'	10	2.4	6
15'-20'	13	7.4	26 19
25'-30'	22	2.4	4
35'-40'	14	4.3	14
45'-50'	14	3.1	
55'-60'	5	4.0	
65'-70'	6	4.9	
75'-80'	11	4.8	

Boring MR-2

Depth	-200 fraction (%)	In Situ Moisture Content (%) Dry Weight Basis	
5'-10'	11	6.2	4
15'-20'	21	4.3	10
25'-30'	4	2.9	
35'-40'	17	3.6	
45'-50'	17	0.9	
55'-60'	19	2.5	
65'-70'	19	3.6	
75'-80'	13	2.8	

NATIONAL 42-381 50 SHEETS 5 SQUARE 42-382 100 SHEETS 5 SQUARE 42-389 200 SHEETS 5 SQUARE

Inventory 2/6 | J.M. | Rotary Drill Holes

MR-1	MR-2
0-5	0-5
5-10	5-10
10-15	10-15
15-20	15-20
20-25	20-25
25-30	25-30
30-35	30-35
35-40	35-40
40-45	40-45
45-50	45-50
50-55	50-55
55-60	55-60
60-65	60-65
65-70	65-70
75-80	70-75
80-85	75-80
85-90	80-85
90-95	85-90
95-100	90-95
100-105	95-100
105-110	
110-115	
115-120	
120-125	
125-130	
130-135	
135-140	
140-145	
145-150	
150-155	
155-160	
160-165	
165-170	
170-175	
175-180	
180-185	
185-190	
190-195	
195-200	
200-205	
205-206	

MD-12

125 pcf

15-16 broken

18.5-19 broken

freeze 19.5-20 broken

21'3" to 22'3"

freeze for 24'8" to 25'2" broken

26.0 to 26.5

29'11" to 30'7"

32'3" to 32'6" falling apart

34'9" to 35'3" ITRX

37'7" to 38' ITRX - split but maybe ok

40'6" to 40'11" DS1

42'11" to 43'4" IDS DS1

Done 2-12-88 $\sigma_3 = 274$ kPa → 44'10" to 45'4" - IDS, ITRX DS1

$\sigma_3 = 500$ kPa → 47'6" to 47'11" ITRX

$\sigma_3 = 1000$ kPa → 49'5" to 49'10" ITRX

51'9" to 52'5" ITRX IDS

54'5" to 55'1" ✓ IDS ITRX

59'10" to 60'4" ITRX

62'3" to 62'10" ITRX DS

64'6" to 65' IDS ITRX

67'8" to 68'2" +

72'2" to 72'9"

75'3" to 75'10"

80' to 80'6"

85'6" to 87'1"

96 to 96.75

96.75 to 97.5

99 to 99.75

102.5 to 103.5

105.5 to 106.25

110' to 111'

40 psi
20 psi
σ_n for DS

115' to 115.75

122.75 to 123.25

124 to 124.5

131.5 to 132

140'10" to to 141'5"

151'7" to 152'1"

165.25 to 166.0

174.5 to 175.5

185.5 to 185.75

203.5 to 204

228'3" to 228'9"

250 to 250.6

271.25 to 272

297.5 to 298

315.25 to 316

360'8" to 361'2"

$125 - 40 = 85$

$\frac{5000}{144} = 30$ psi

$85 \times 125 = \frac{5000}{144}$ psf

250 psf

92.5

250 psf

9p

$1.25 - 20 = 105$

20 psi

$\frac{2500}{144}$ psf

Hole MD-12 Coarse Gravel 2" OD core

✓ 165.25 to 166.0	s-m to w/ coarse gravel
✓ 64'6" to 65'	coarse gravel conglomerate
✓ 49'5" to 49'10"	s, m - fine gravel
✓ 54'5" to 55'1"	s, m - fine - med gravel
✓ 75' 3" 75'10'	coarse grave
✓ 59'10" - 60'4"	s, m - to coarse gravel
✓ 67' 8" 68'2"	med - coarse grave'
✓ 43'3" 40'11"	fine - med gravel
✓ 62'3" to 62'10'	Sand, m. pec gravel
✓ 44'10" 45'4"	Sand, Silt
✓ 51'9" to 52'5"	s-m grades to gravel
✓ 47'6" to 47'11"	s-m minor gravel
✓ 24'8" to 25'2"	s-m - gravel 2 3" pieces
✓ 29'11" to 30'7"	conglom - gravel
19.5 to 20.0	fine conglomerate 2 3" pieces
✓ 26'0" to 26'5"	med conglomerate
✓ 34'9" to 35'3"	fine - med conglomerate
✓ 32'3" to 32'6"	med conglom
✓ 21'8" to 22'2"	ss-m to fine congl 1/3" 1/4"
✓ 42'11" to 43'4"	med congl
✓ 37'7" to 39'	fine - med congl
✓ 140'10" 141'5"	M-C conglom
✓ 72'2" 72'9"	m conglom
✓ 151.7 152.1	m - Conglom
✓ 80 80'6"	m - conglom
✓ 85.6 87'[illegible]1"	s-m to fine conglom
✓ 124.0 to 124.5	m - conglom
✓ 96.75 to 97.5	s, m w (fine grading to med conglo. gravel) minor
✓ 115 to 115.75	m to c conglom
✓ 122.75 to 123.5	m congl
✓ 110 to 111	m to c conglom
✓ 18.5 - 19	m congl broken 2/3"
✓ 105.5 106.25	s-m with minor m congl
✓ 174.5 to 175.5	s+m locally conglom
✓ 96.0 to 96.75	m - congl
✓ 102.5 to 103.5	m - congl
✓ [illegible] to 99.75	s-m

✓ 15-16'	M-C conq	broken 3 pcs.
✓ 131.5 to 132.0	S/M	
✓ 185 to 185.75	M congl	
✓ 203.5 to 204	M congl	
✓ 250 to 250.6	S-M broken	2/3"
✓ 228' 3" to 228' 9"	M-congl	
350.'8" 351' 5"	M-cgl	
315.25 to 316	S/M	
✓ 297.5 to 298	M-C congl	
✓ 271.25 to 272'	C congl	

MA-10 CME Sampler

46' to 45.6'	S/M	disturbed
61.0 to 63.5	S/M	1" to 6" pieces semi-undisturbed

Add'l MD-12 Samples

185 - 185.75
250 - 250.6"
271.25 - 272
203.5 - 204
174.5 - 175.2
102.5 - 103
350'8" - 351.5
228'3" - 228'9"
315.25 - 316.0

MA-10

No.	Depth	% Passing 0.03 mm
1	3'6" - 5'	0.00
2	19'6" - 23'6"	0.00
3	30' - 30'6"	1.00
4	40' - 40'3.5"	0.00
5	55' - 55'4.5"	4.61
6	65' - 65'4.5"	10.00
7	68'6" - 73'	0.00
8	80' - 80'2"	3.07
9	90' - 90'2"	10.00
10	90' - 90'4.5"	16.92

MA-11

1	6" - 2'	0.00
2	10' - 10'4.5"	13.07
3	20' - 20'4"	10.00
4	30' - 31'6"	0.00
5	40' - 40'3"	4.61
6	55' - 55'2"	1.00
7	65' - 65'5"	7.69
8	73'6" - 73'9"	1.23

MA-12

1	4'6" - 6'	0.00
2	15' - 15'8.5"	3.84
3	25' - 25'9"	16.92
4	33'6" - 34'11"	1.00
5	48'6" - 48'11"	18.46
6	53'6" - 54'3"	12.30
7	61' - 62'	10.00
8	68'6" - 69'1.5"	14.61
9	73'6" - 73'11"	10.00

MA -10	Moisture content		Wo (g)	Wf (g)
6"-2'	MC = 3.36%	sieve	313.4	303.2
8'6" – 8'11.5"	MC = 4.29%	sieve	138.6	132.9
13'6" – 13'11"	MC = 0.33%	sieve	122.0	121.6
60-60'5"	MC = 5.70%		194.7	184.2
88-88' 4.5"	MC = 6.96%		144.4	135.0

MA -10

13'6" – 13'11"

Wo = 122.2g

20	34.5
40	29.9
60	13.1
140	16.0
200	7.9
Pan	20.0
	121.4 ok

→ 16.5%

6" – 2'

Wo = 305.5g

20	44.9
40	53.9
60	44.8
140	43.9
200	30.0
Pan	87.8
	305.3 ok

→ 28.75%

8'6" – 8'11.5"

Wo = 133.3g.

20	46.5g.
40	29.4g
60	16.2
140	15.6
200	7.7
Pan	17.9
	132.4

→ 13.5%

MA-10		EM	
Interval	Moisture Content	% -200	
6"–2'	3.4	29 %	
3'6"–5'		~~25.8~~ %	26 %
8'6"– 8'11.5"	4.3	14	
13'6" to 13'11"		17 %	
19'6"– 23'6"		24.4 %	
30' – 30'6"		13.X %	
40' – 40'3.5"		19.X %	
55'– 55'4.5"		22.3 %	
60'– 60'5"	5.7		
65–65'4.5"		~~29.7~~ %	30
68'6"– 73'		6.25 %	caliche
80'– 80' 2"		18.4 %	/34.7 wash
85'– 85' 4.5"	7.0		
90'–90'4.5"		37.2 %	
95– 95' 2"			
100'–100'2"			
105'– 105'1.5"			
110– 110'3"			
115–115'4"			
120–120'2.5"			
130– 130'2.5"			
135– 135'2"			
140–140'3.5"			
145'– 145'3.5"			
150 – 150'2"			
CME			
46'– 48.5	dist – semi dist		

MA - 11

Interval	WC	% -200
6"-2'	3.8%	~~30.9~~ 31
4'6" 6'		
10' - 10'4.5'	6.7%	~~14.1~~
15' - 15'6"		
20' - 20'4"	6.2%	~~34.5~~ 35
30' - 31'6"	4.2%	~~13.6~~ 14
40' - 40'3"	5.5%	~~23.1~~
43' 43' 10'		
55' - 55'2"	6.4%	~~20.5~~ 21 %
65' - 65'5"	3.4%	~~19.1~~
73'6' - 73'9"	6.3%	~~11.4~~

CMF 47'6" - 48'5" v disturbed

Hole MA - 12

Interval	Moisture content	-200 fraction
6" - 2'	1.96 % 2	-200 < 12 % (11.0 %) 12
4'6" to 6'		
9'6" to 10'3"		
15' to 15'8.5"	7.07 % 7.1	22.0 % 22
20' to 20'8.5"		
25' to 25'9"	7.56 % 7.6	38.2 % 38
32'9" to 33'2"		
33'6" to 34'11"	3.69 % 3.7	15.9 % 16
38'6" to 39'5'		
43'6" to 44'1.5"		
48'6" to 48'11"	7.4 7.38 %	41.0 %
53'6" to 54'3'	7.97 % 8.0	34.4 %
61' to 62'	7.11 % 7.1	26.8 % 27
63'6" to 64'2"		
68'6" to 69'1.5"	12.58 % 12.6	38.4 %
73'6" to 73'11.5"	9.18 % 9.2	28.2 %

Intact CME Sample

58'6" to 59'4"

30'5" to 33'9" Semi Undisturbed

61.0' to 63.5" several undisturbed samples (D.S.)

MR-1

No.	Depth	% Passing 0.03 mm
1	5-10'	0.00
2	15-20'	0.00
3	25-30'	0.00
4	35-40'	0.00
5	45-50'	0.00
6	55-60'	1.00
7	65-70'	1.00
8	75-80'	0.00

MR-2

1	5-10'	0.00
2	15-20'	0.00
3	25-30'	1.00
4	35-40'	0.00
5	45-50'	0.00
6	55-60'	0.00
7	65-70'	1.00
8	75-80'	0.00

Moisture content.

MR-1

	W_o	W_s	M_c
5-10	564.4	551.2	2.4%
15-20	548.5	510.7 ~~526.9~~	7.4% ~~4.2%~~
25-30	476.7	465.6	2.4%
35-40	536.4	514.4	4.3%
45-50	581.4	563.9	3.1%
55-60	591.5	568.8	4.0%
65-70	554.7	528.7	4.9%
75-80	594.7	567.3	4.8%

MR-1 5'-10'

W_o = 551.2g

20	195.	
40	127.2	
60	80.8	
140	64.1	
200	34.1	
Pan	49.2	8.9%
	550.4	

MR-1 35'-40'

W_o = 527.4

20	169.9	
40	120.9	
60	74.1	
140	59.9	
200	31.0	
Pan	71.1	13.5%
	526.9	

MR 15'-20'

W_o = 526.4g

20	171.9	
40	120.5	
60	72.	
140	62.9	
200	32.7	
Pan	66.9	12.7%
	526.9	

MR-1 45'-50'

W_o = 577.4g

20	198.5	
40	124.3	
60	73.5	
140	66.9	
200	34.5	
Pan	80.	13.8%
	577.7 ok	

MR 25'-30'

W_o = 465.9

20	158.6	
40	77.4	
60	40.6	
140	41.5	
200	45.4	
Pan.	101.8	21.9%
	465.3 ok	

MR-1 55'-60'

W_o = 577.1 (possible error in reading)

20	259.6	
40	161.4	
60	70.4	
140	45.4	
200	15.0	
Pan	30.0	5.2%
	581.8	(.8% diff).

MR-1 65'-70'

w_o = 542.6.

20	201.2	
40	165.6	
60	70.4	
140	54.1	
200	18.1	
Pan	33.2	~~6.2%~~ 6.1%
	542.6	

MR-1 75'-80'

w_o = 568.2

20	140.0	
40	158.1	
60	89.0	
140	84.6	
200	35.0	
Pan.	61.0	10.8 %
	567.1 ok	

Manc use

MR-2	Original data		MR-1	
-10	370.0	348.5		
-20	394.6	378.4		
-30	~~476.7~~ 528.5	~~514.9~~ 513.7	-30	476.7 — 465.6
-40	431.19	416.09		
-50	545.3	540.3		
-60	526.2	513.6		
-70	427.5	412.8		
-80	440.6	428.8		

MR-2	MC
5-10	6.2%
~~15-20~~	4.3%
25-30	2.9%
35-40	3.6%
45-50	0.9%
55-60	2.5%
65-70	3.6%
75-80	2.8%

Moisture Contents MR-2

JM

Sieve analysis MR-2

5-10 w_o = 349.2

20	98.8	
40	72.2	
60	51.9	
140	58.5	
200	28.5	
Pan	38.3	11.0%
	348.2	

15-20 w_o = ~~360.8~~ 376.5

20	34.8	
40	45.3	
60	56.7	
140	86.0	
200	74.9	
Pan	78.3	20.8%
	376.0	

25-30 w_o = 516.1

Black

20	246.9	
40	141.2	
60	62.6	
140	32.6	
200	12.6	
Pan	20.0	3.9%
	515.4	

35-40 w_o = 416.0

Light Black

20	133.6	
40	68.5	
60	52.5	
140	55.1	
200	36.7	
Pan	69.5	16.7%

45-50 w_o = 540.5

20	131.2	
40	87.7	
60	76.2	
140	96.2	
200	55.8	
Pan	92.6	17.2%
	539.7	

55-60 w_o = 514.9

20	132.5	
40	88.5	
60	70.5	
140	83.8	
200	43.3	
Pan	95.7	18.6%
	514.3	

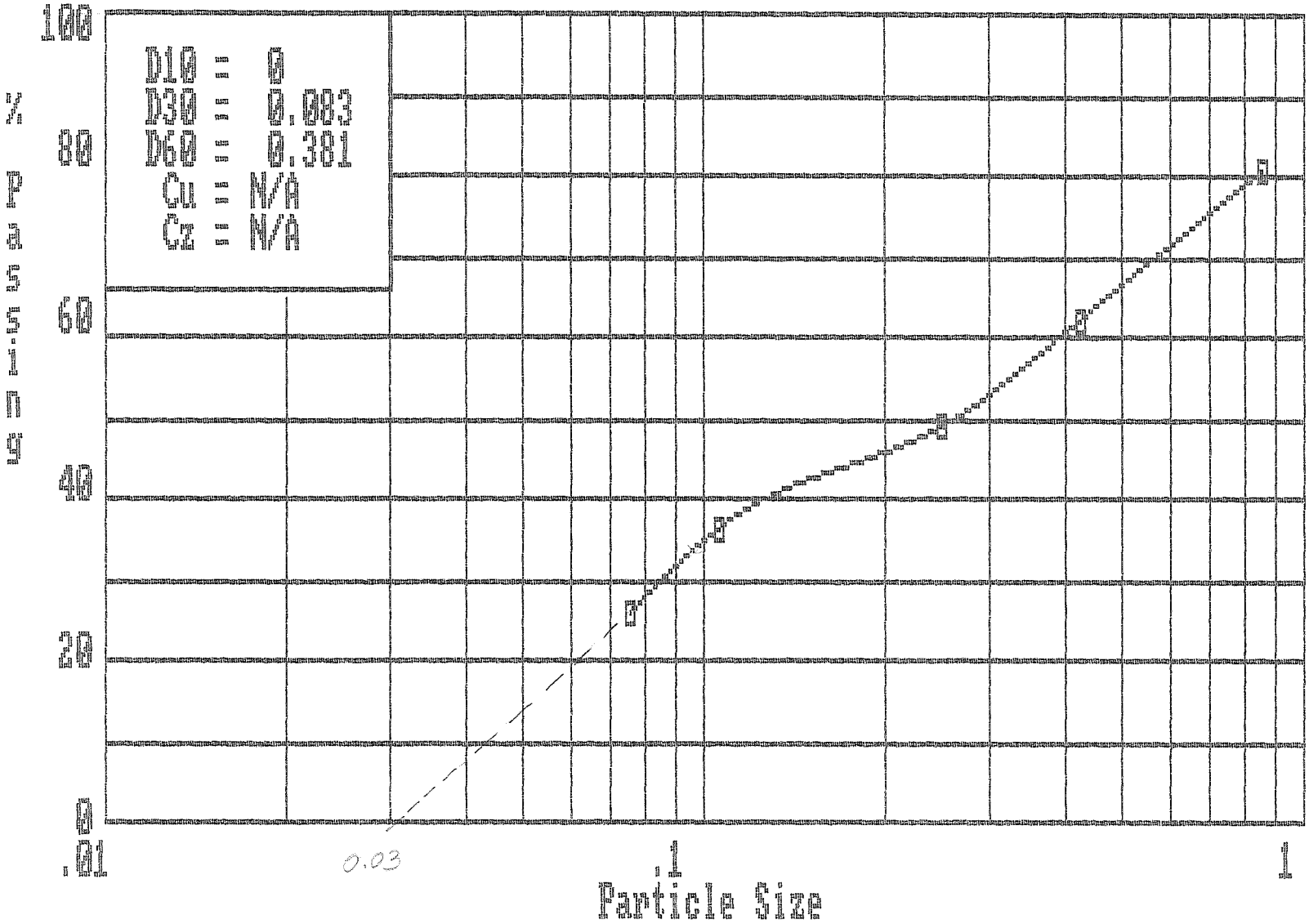
65-70 w_o = 412.9

20	101.7	
40	82.1	
60	65.3	
140	55.5	
200	28.7	
Pan	79.3	19.2%
	412.6	

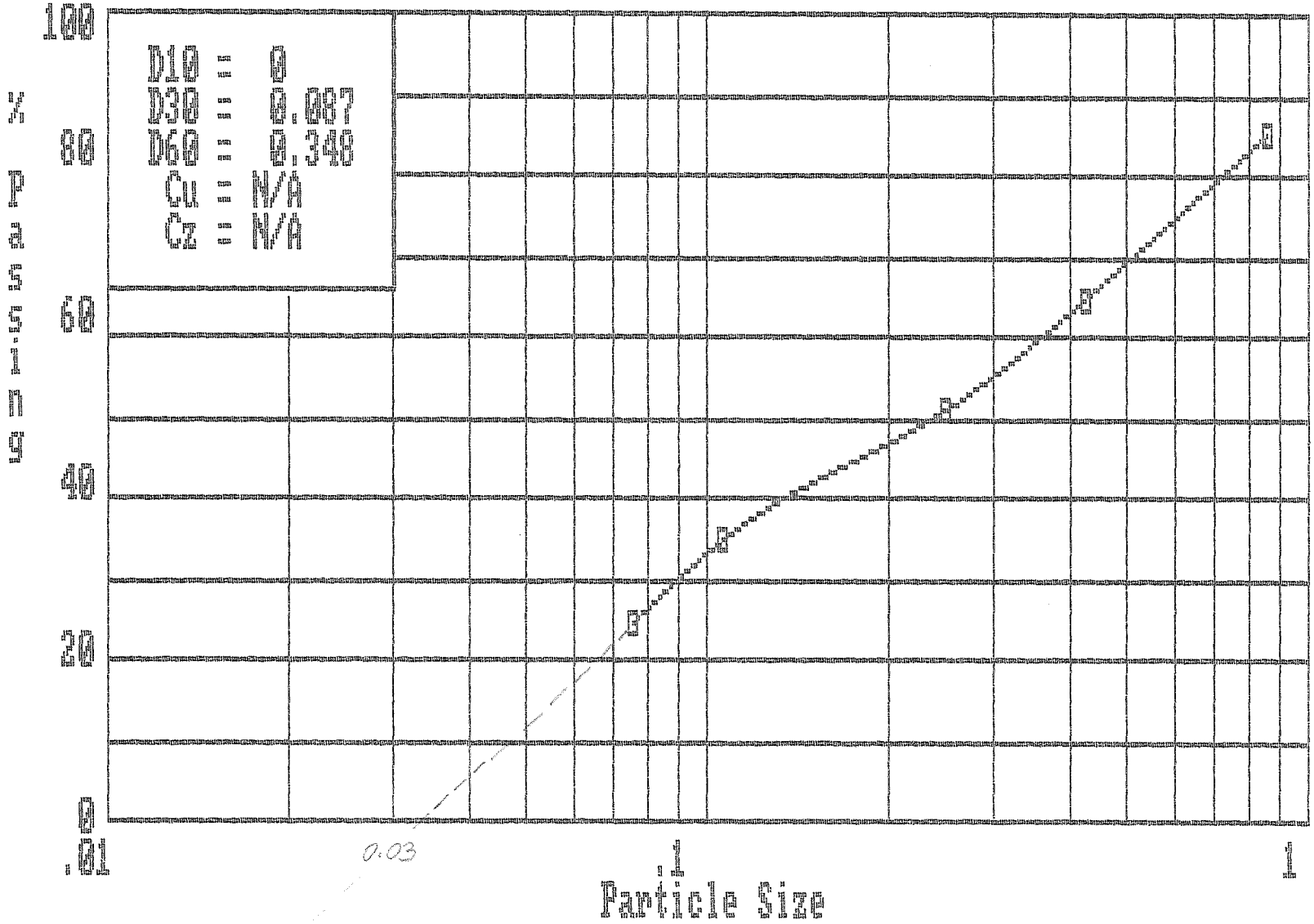
75-80 w_o = 429.0

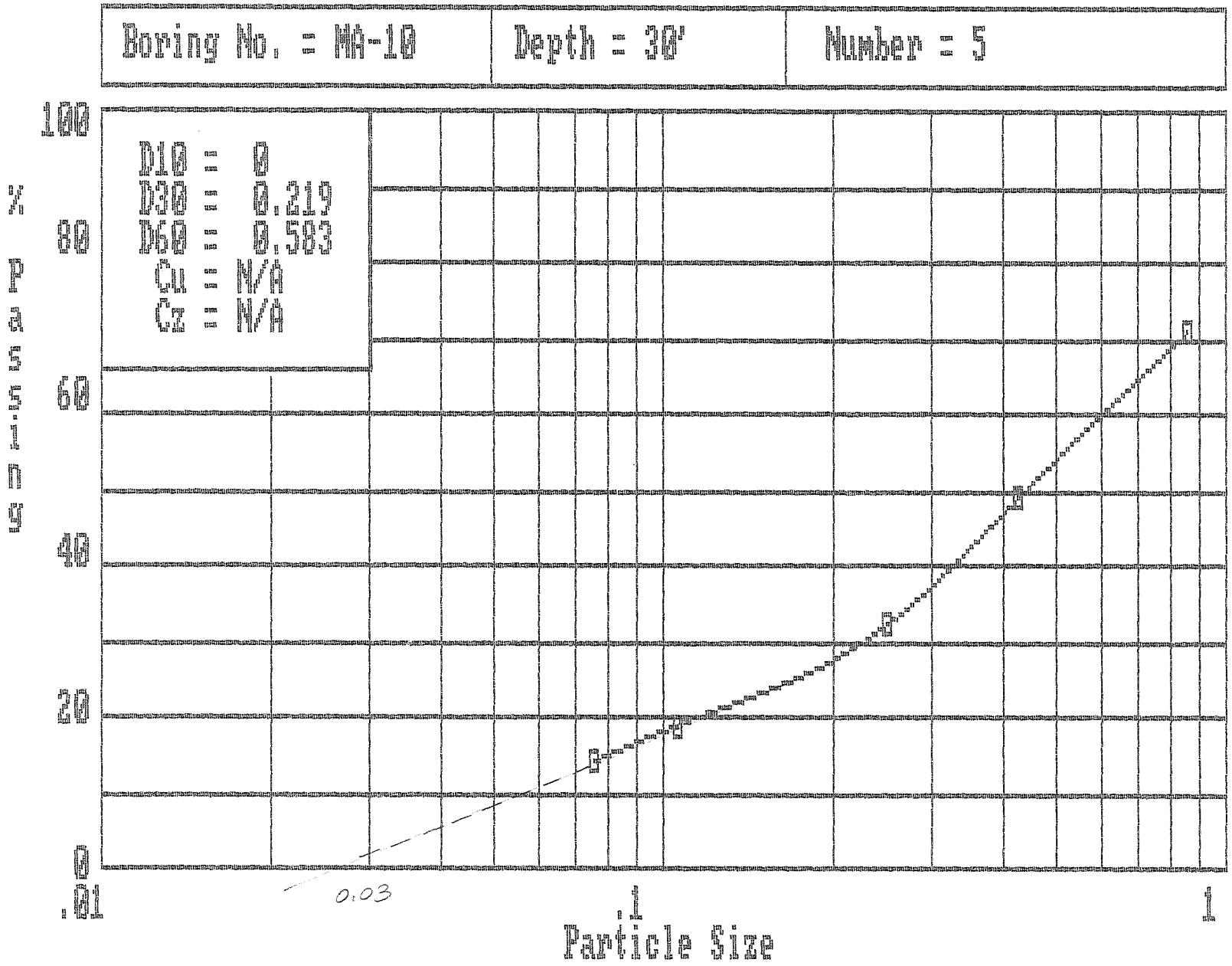
20	92.6	
40	97.5	
60	83.2	
140	69.1	
200	27.7	→ 13.4
Pan	57.3	427.4

Boring No. = MA-10	Depth = 3-5'	Number = 4

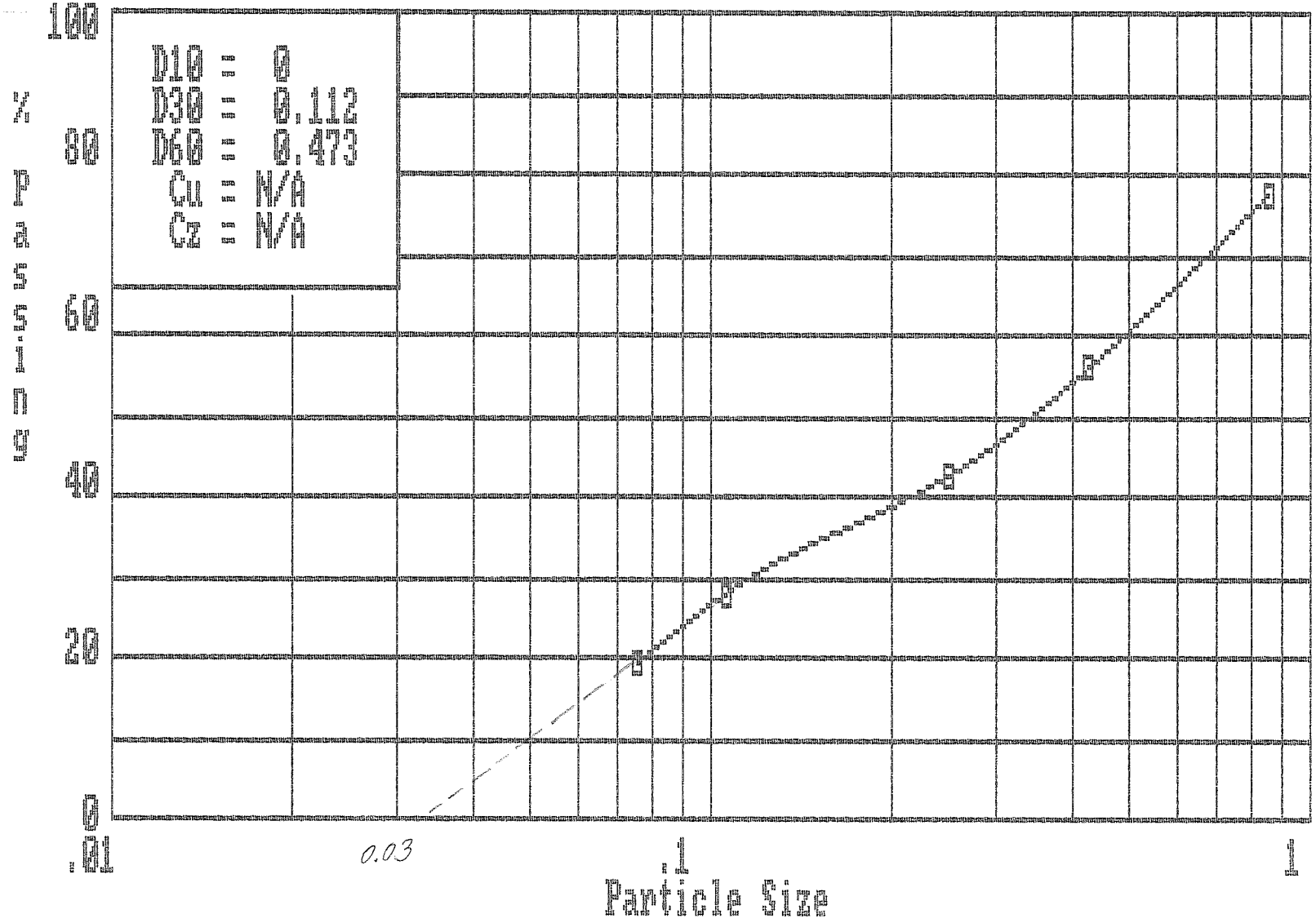


Boring No. = MA-10	Depth = 19-23'	Number = 1

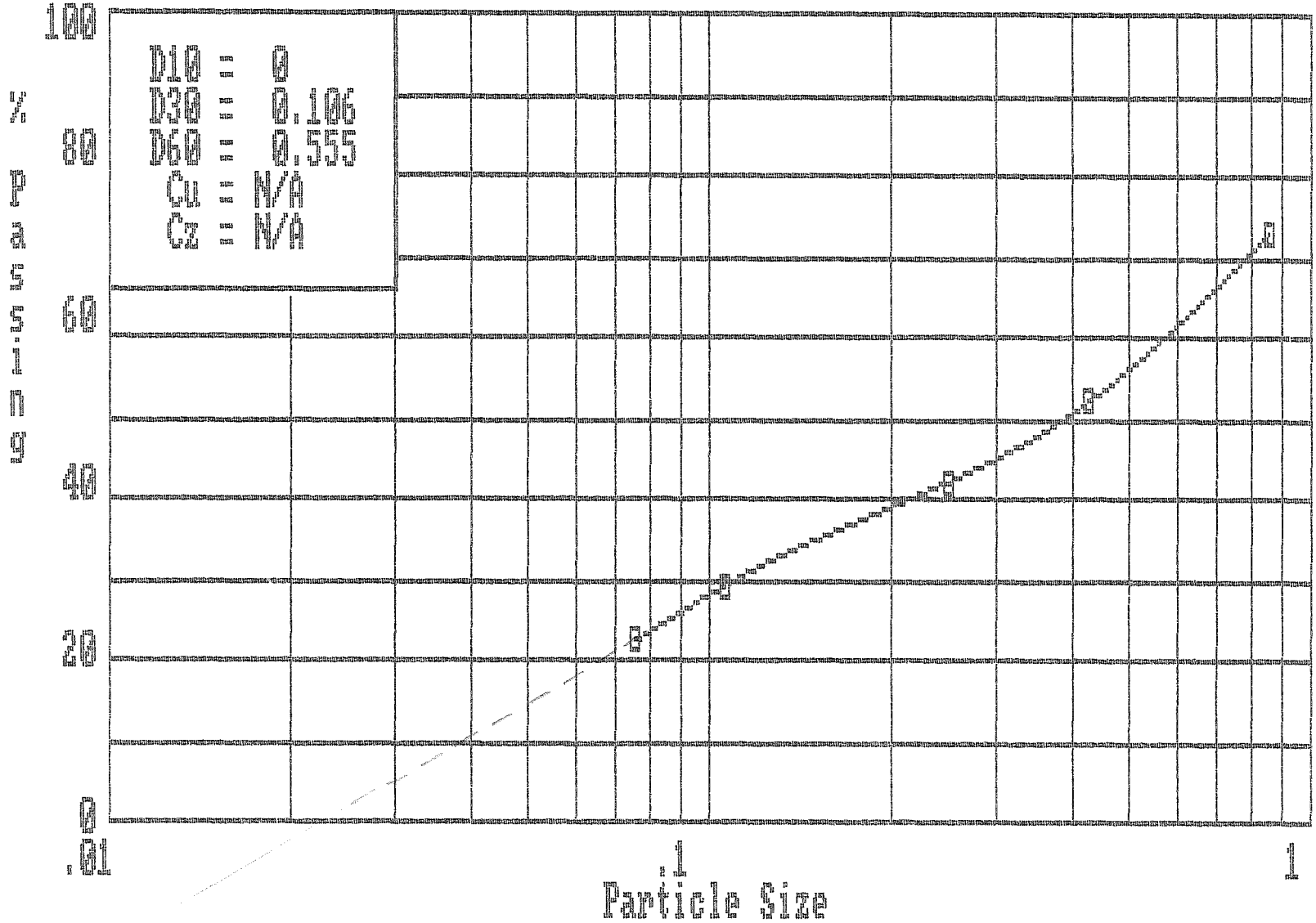



Boring No. = MA-10
Depth = 30'
Number = 5
D10 = 0
D30 = 0.219
D60 = 0.583
Cu = N/A
Cz = N/A
100
80
60
40
20
0
% Passing
.01
.1
1
0.03
Particle Size

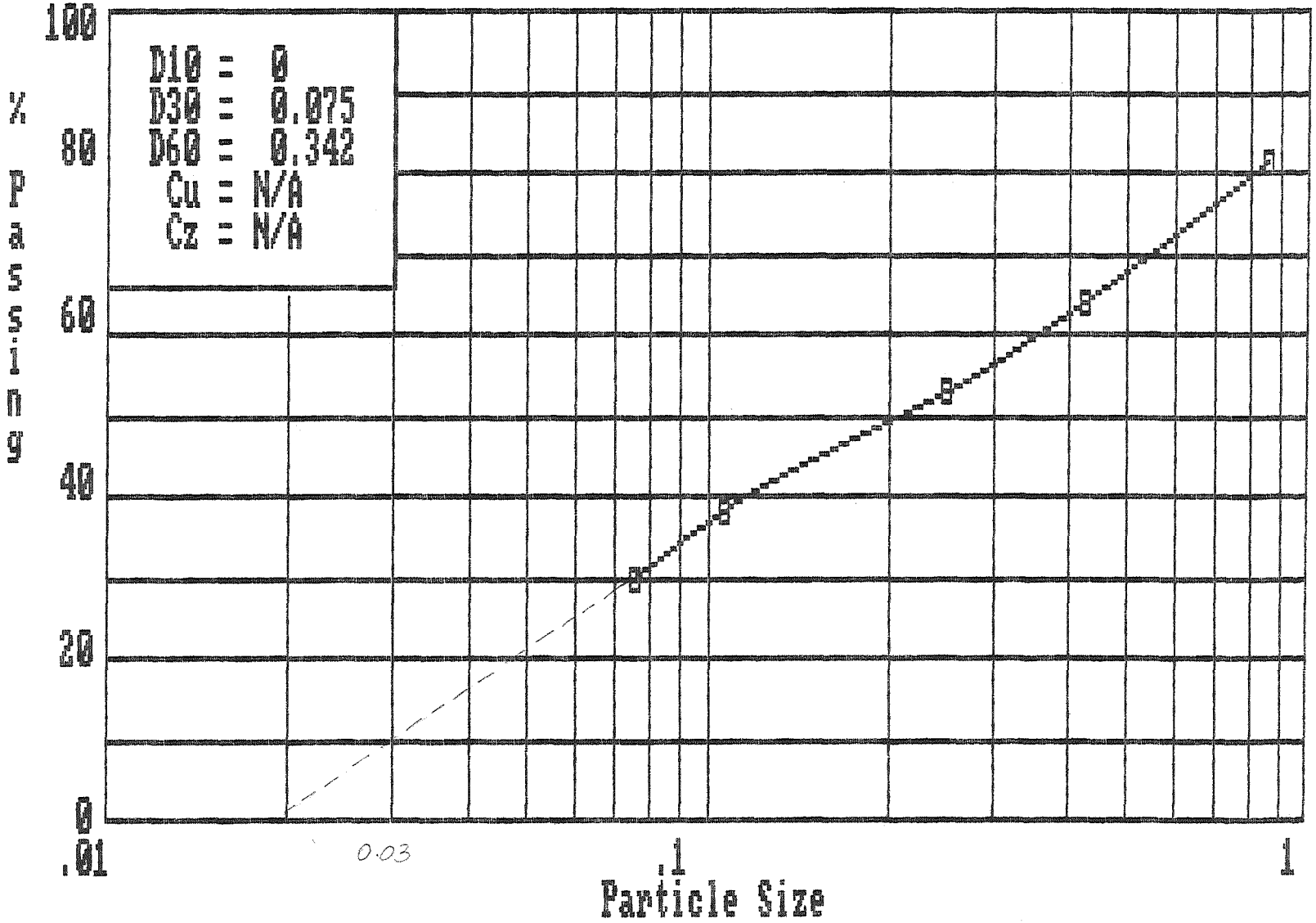
Boring No. = MA-10	Depth = 40'	Number = 2



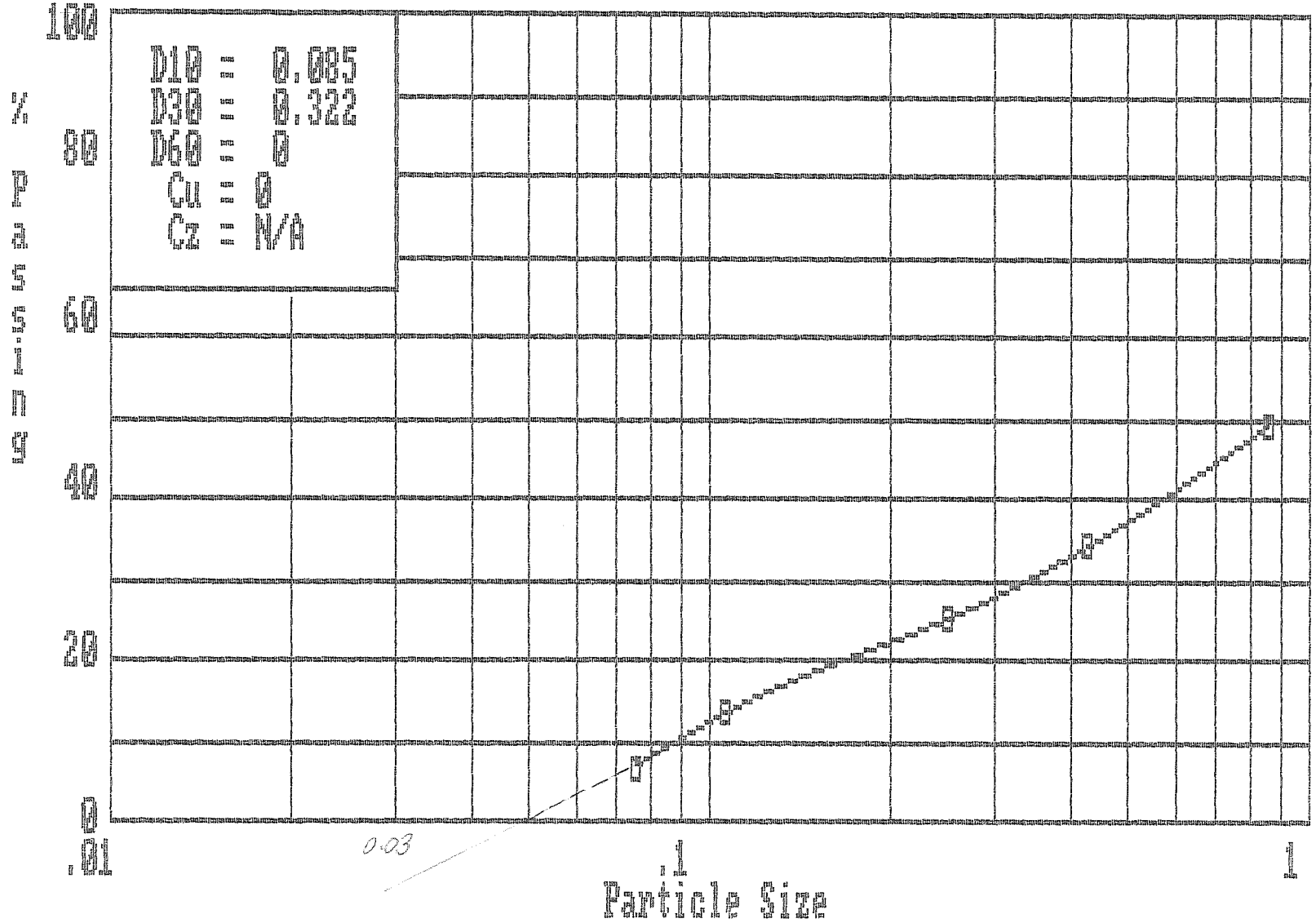
Boring No. = MA-10	Depth = 55'	Number = 3



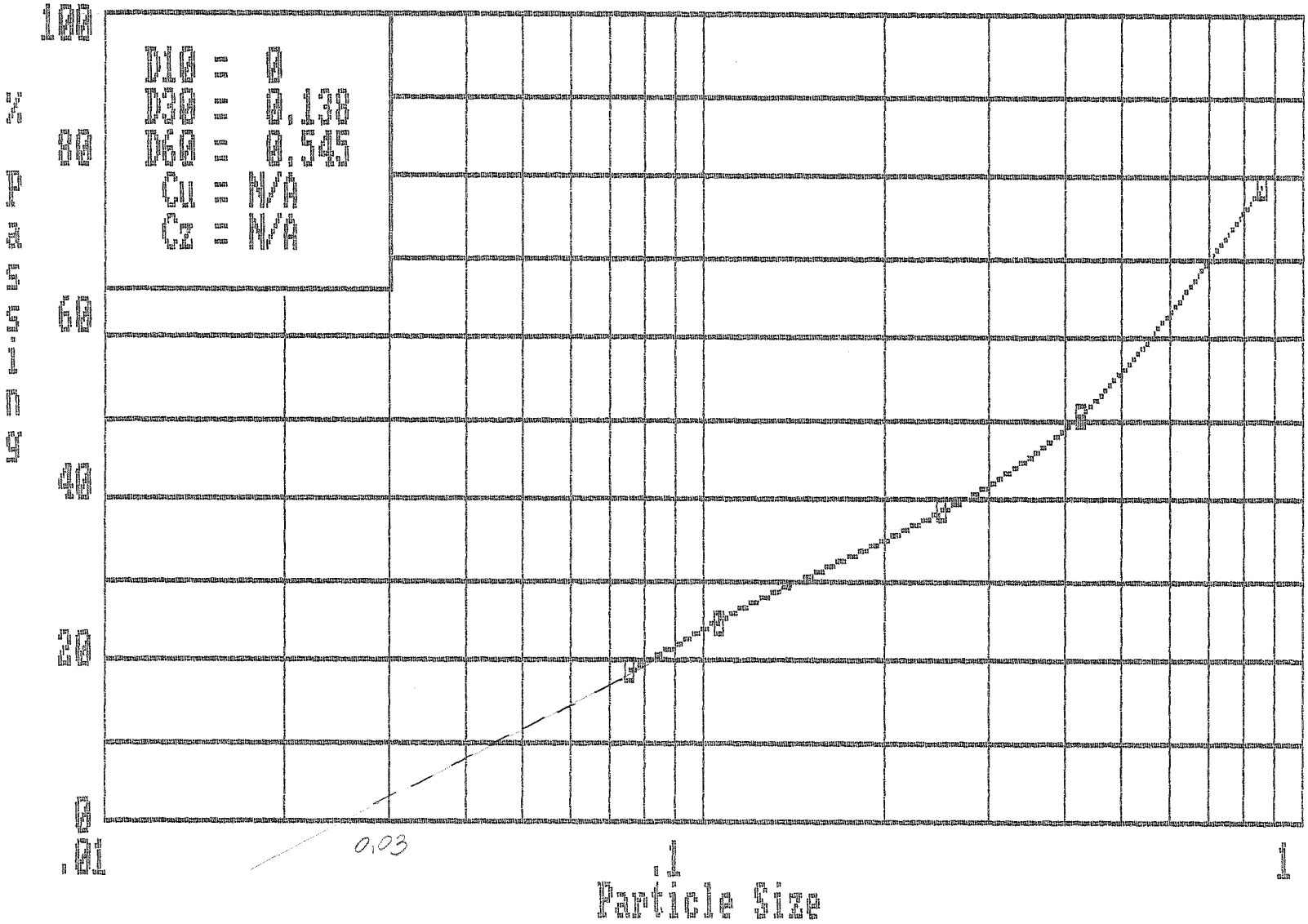
Boring No. = MA-10	Depth = 65'	Number = 10



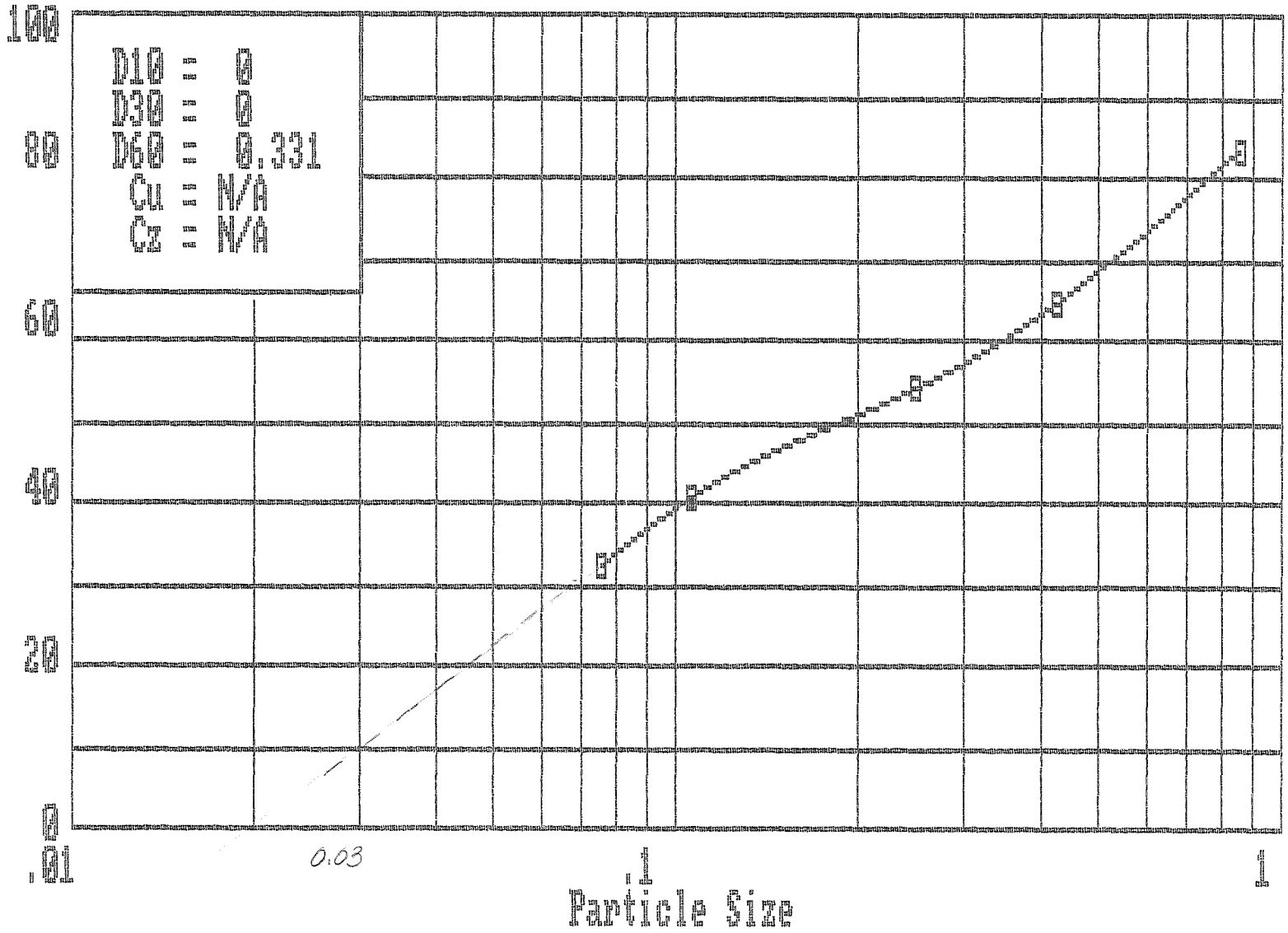
Boring No. = MA-10	Depth = 68-73'	Number = 6



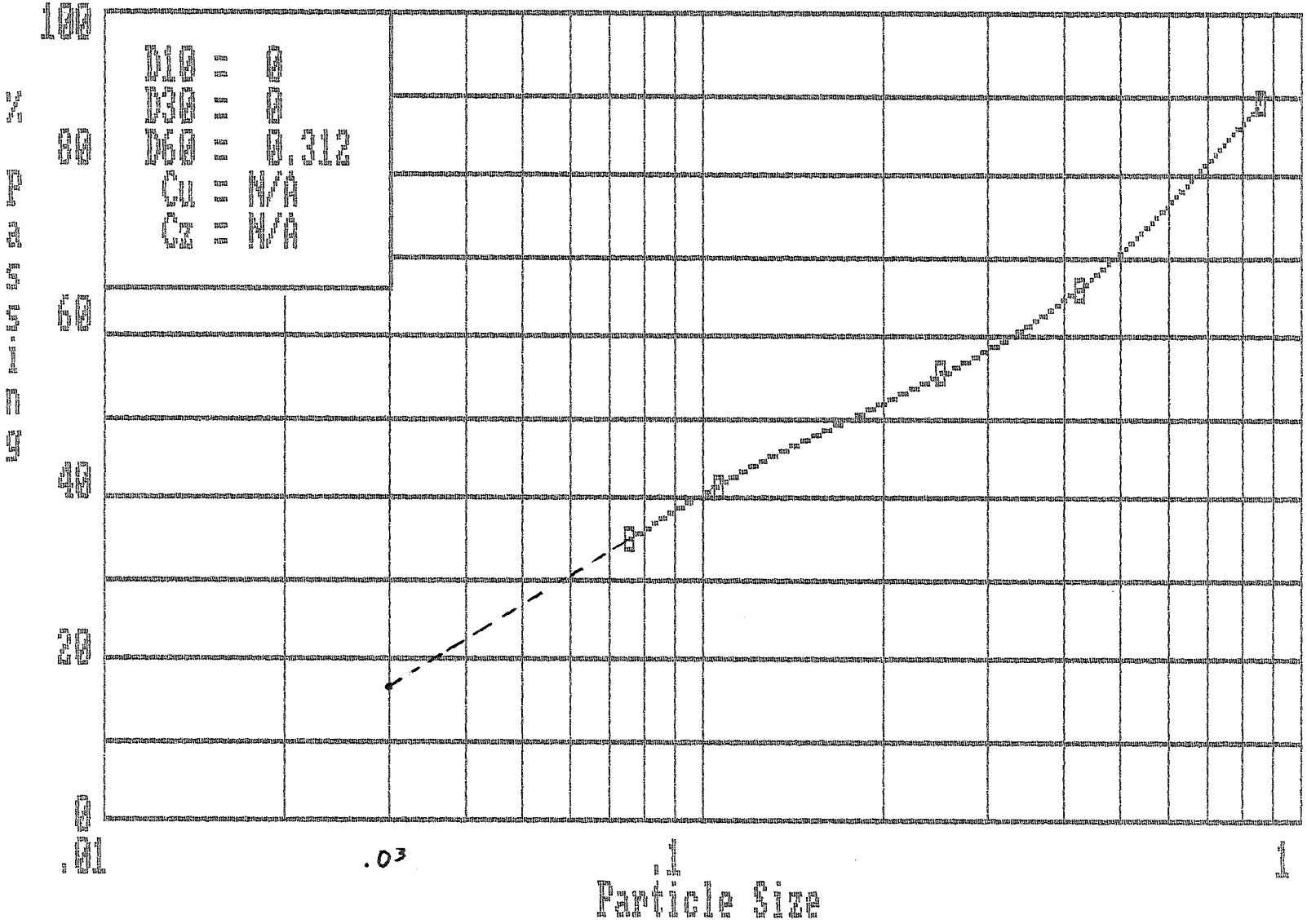
Boring No. = MA-10	Depth = 80'	Number = 8



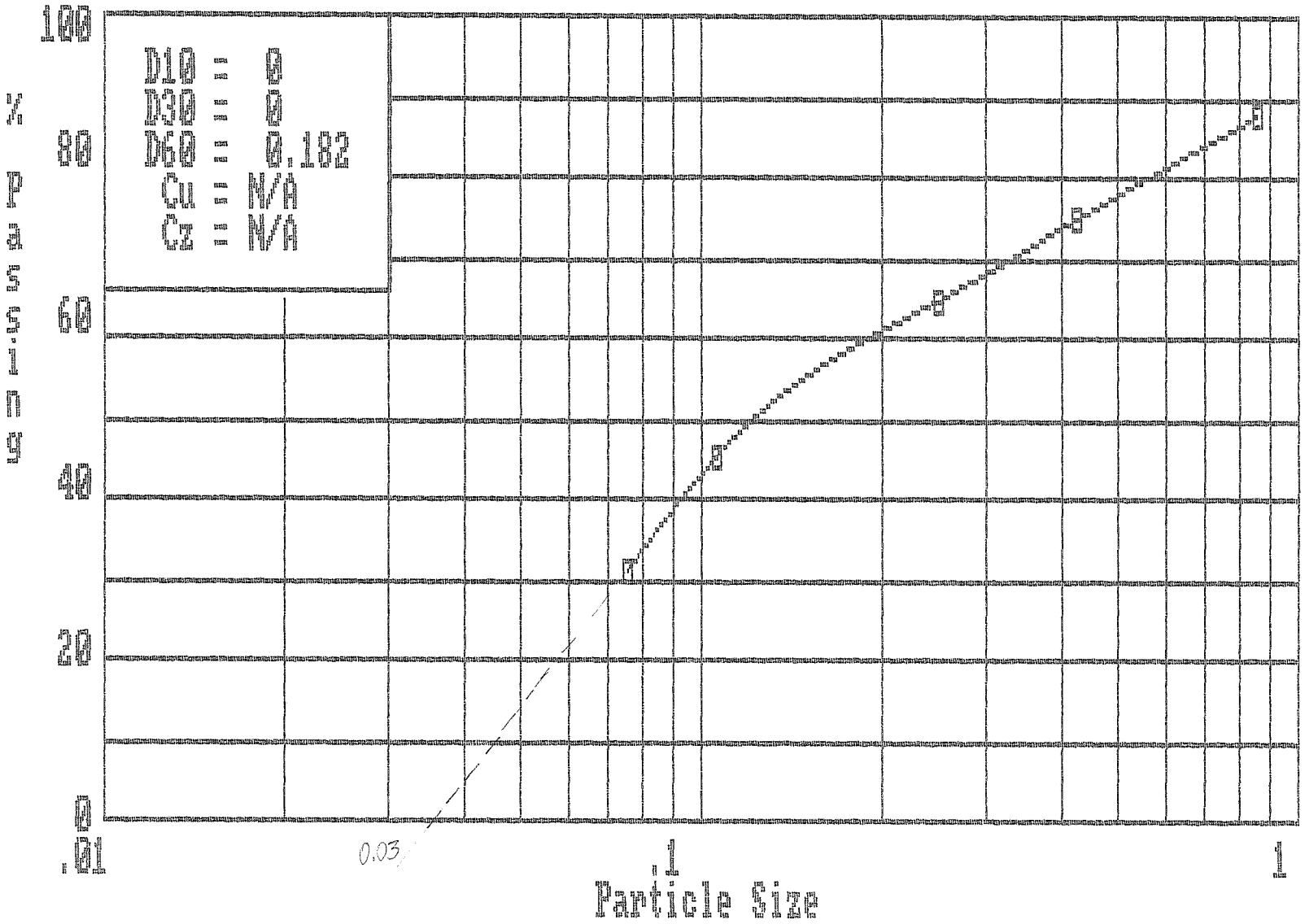
Boring No. = MA-10	Depth = 90'	Number = 7



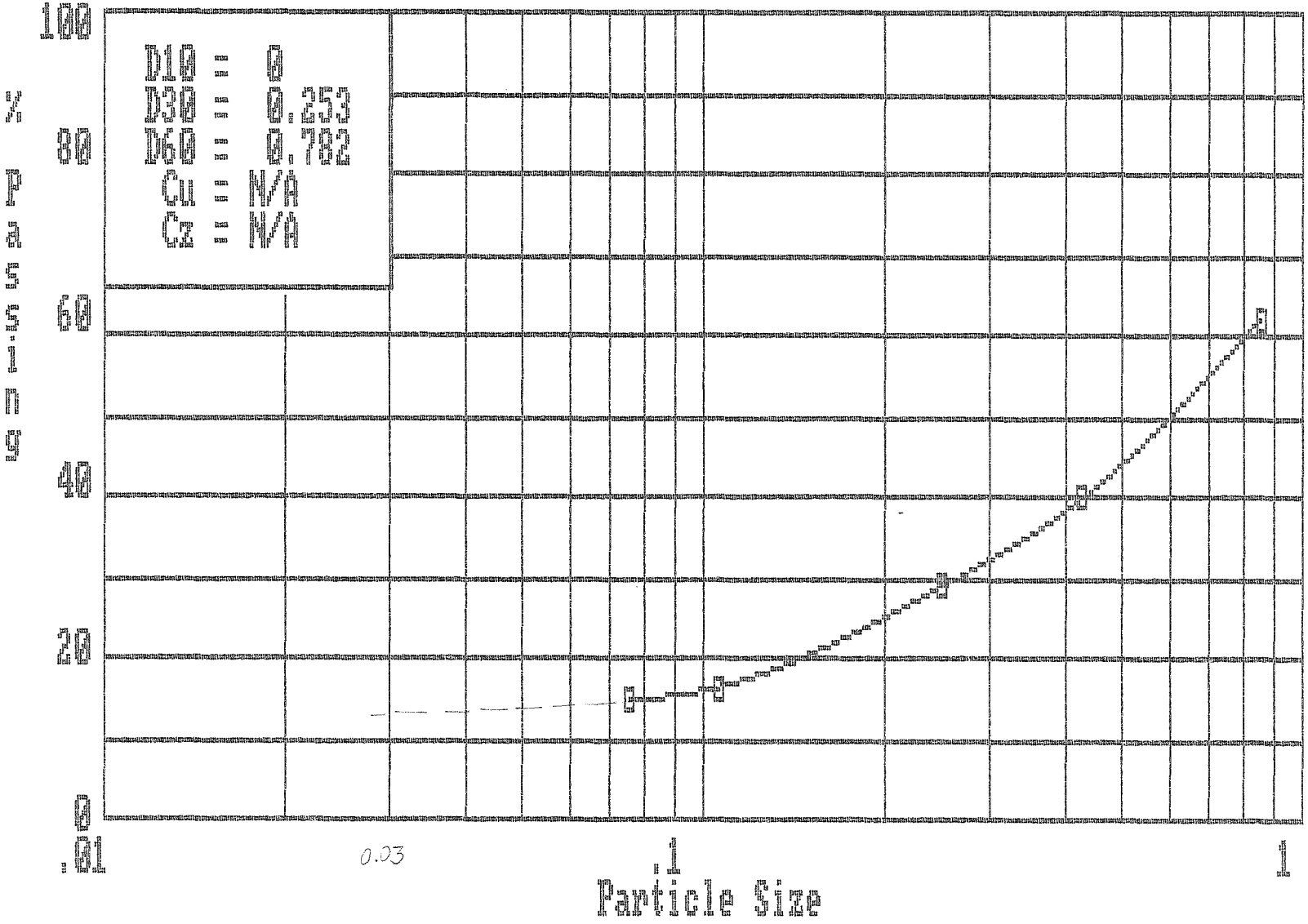
Boring No. = MA-10	Depth = 90'	Number = 9



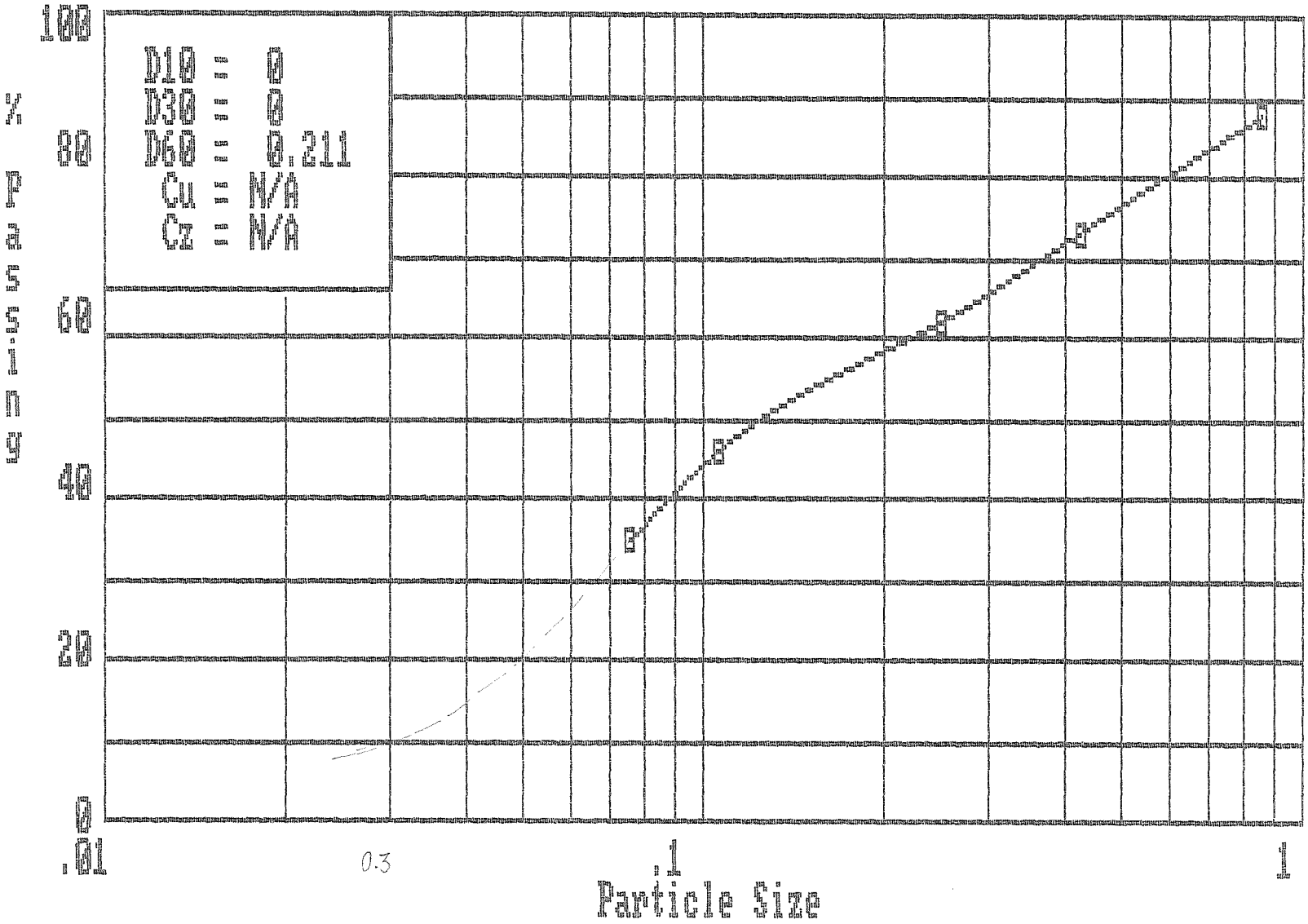
Boring No. = MA-11	Depth = 6'-2'	Number = 5



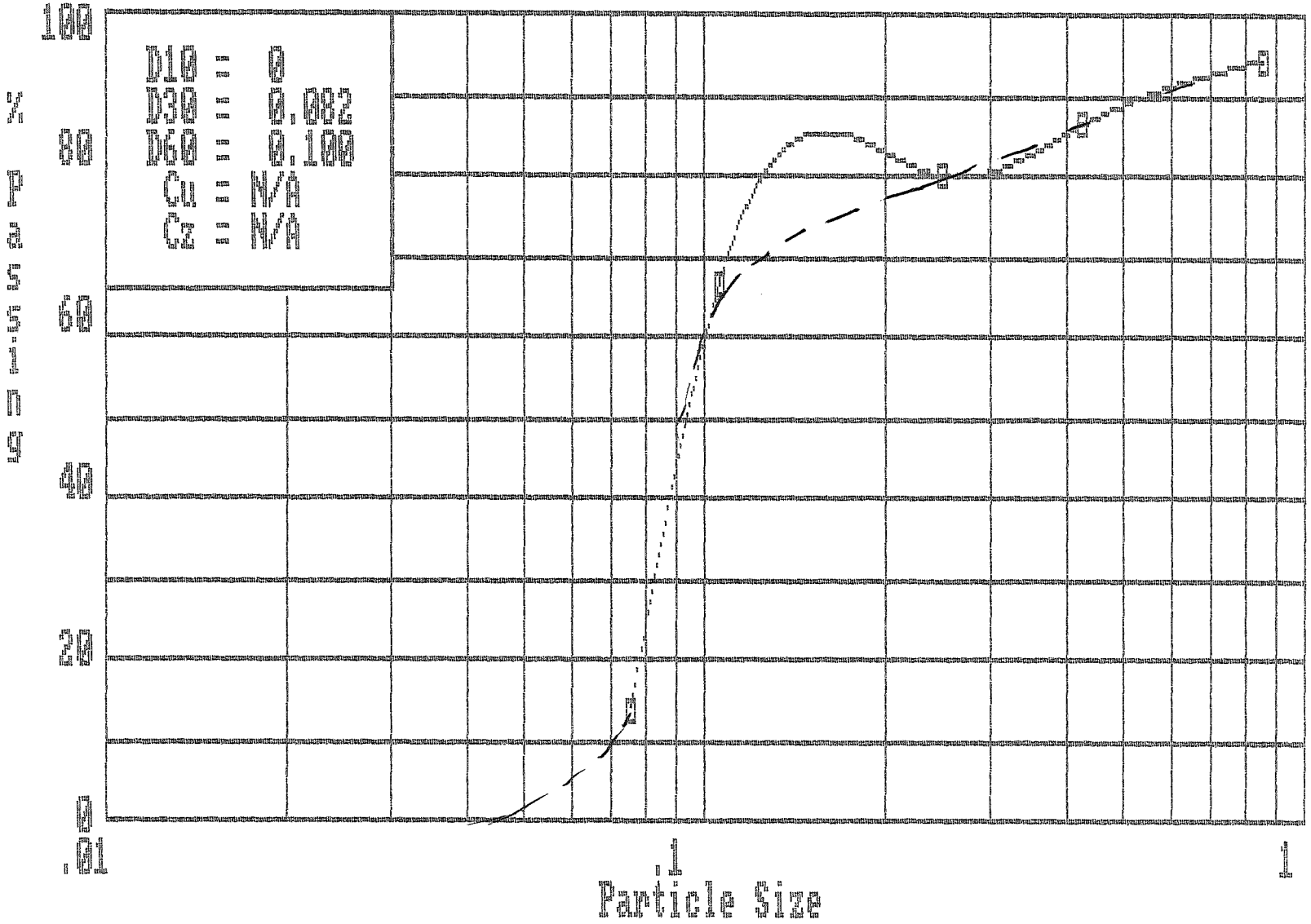
Boring No. = MA-11	Depth = 10'	Number = 4



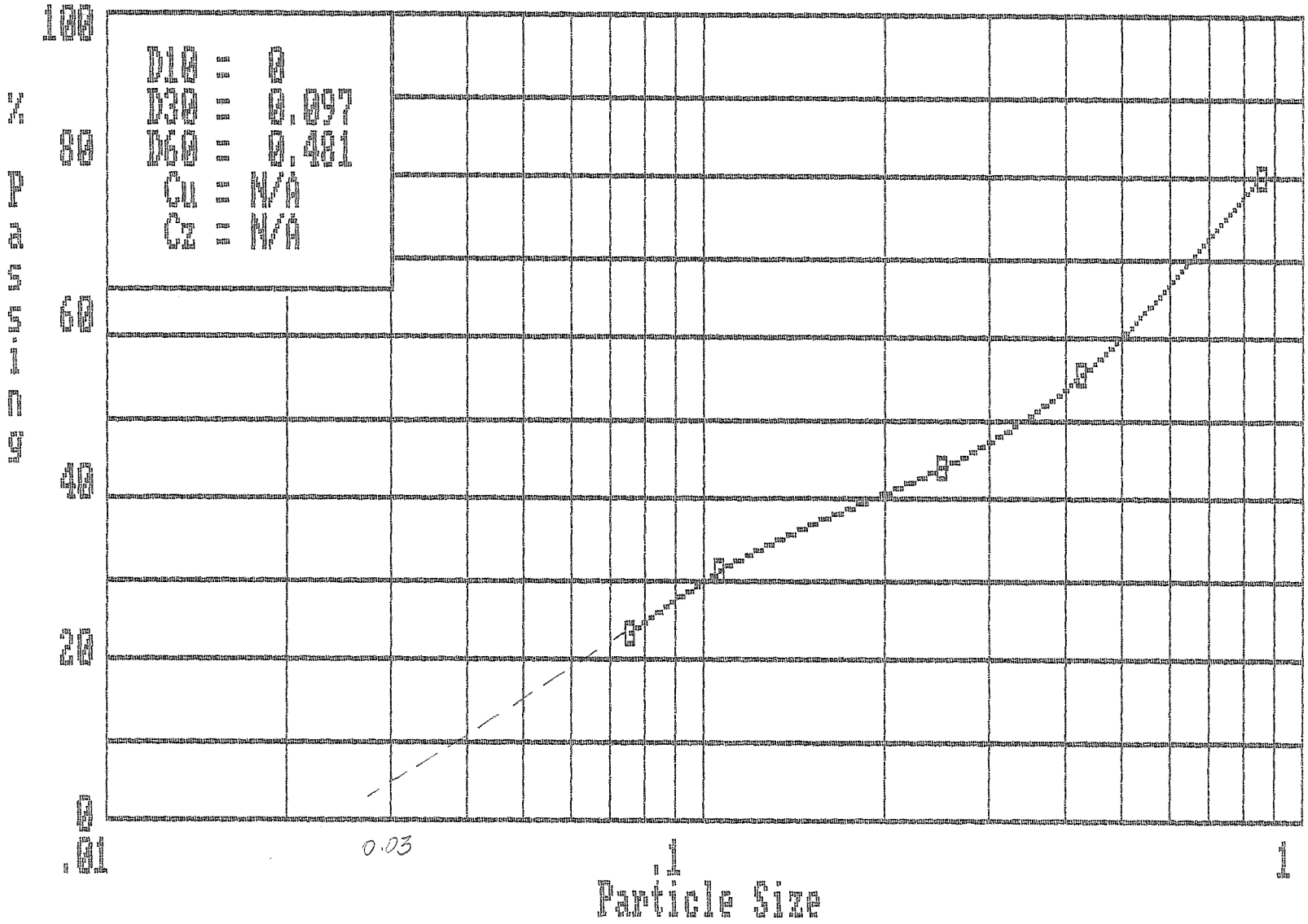
Boring No. = 2	Depth = 20'	Number = MA-11



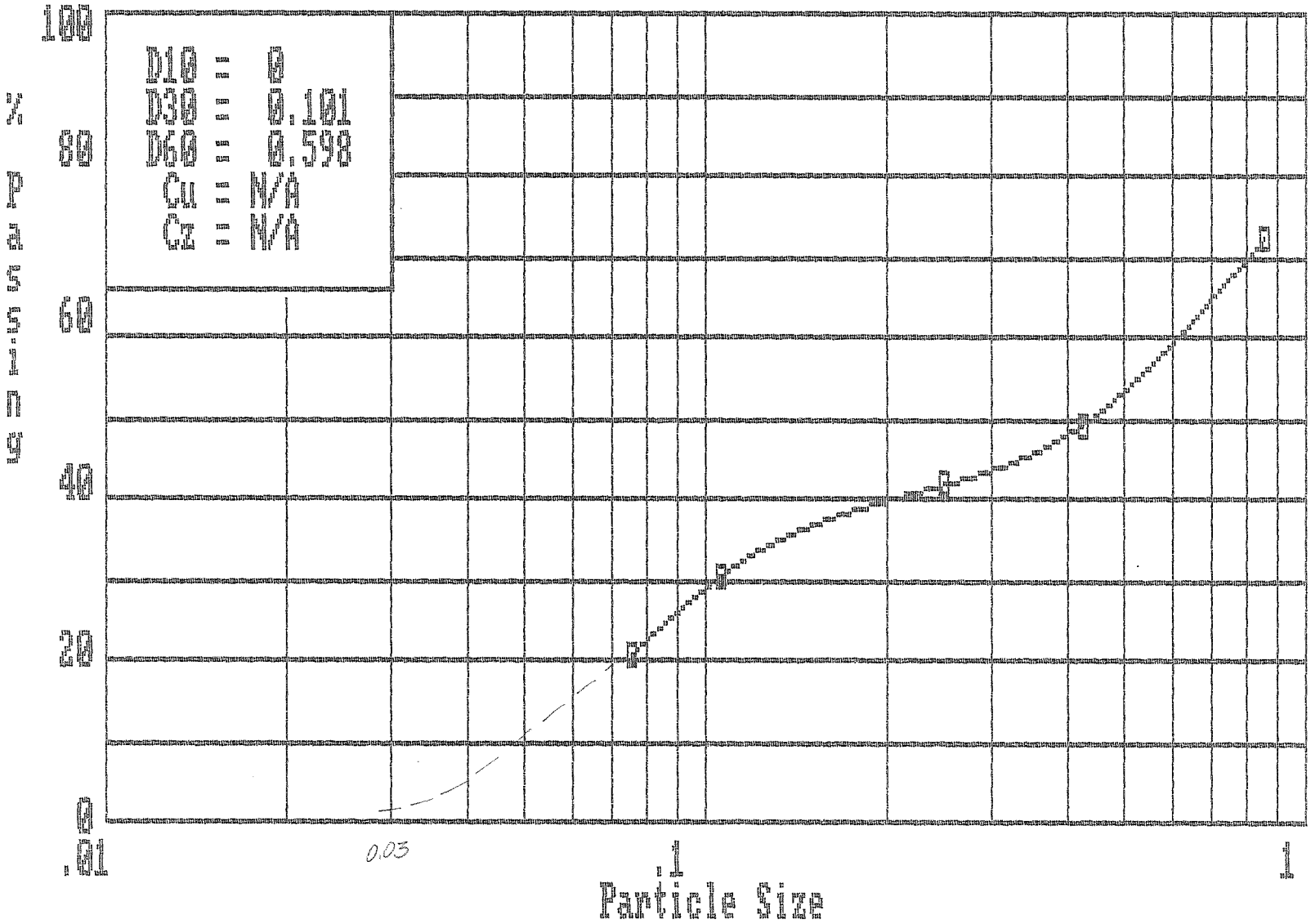
Boring No. = MA-11	Depth = 30-31'	Number = 6



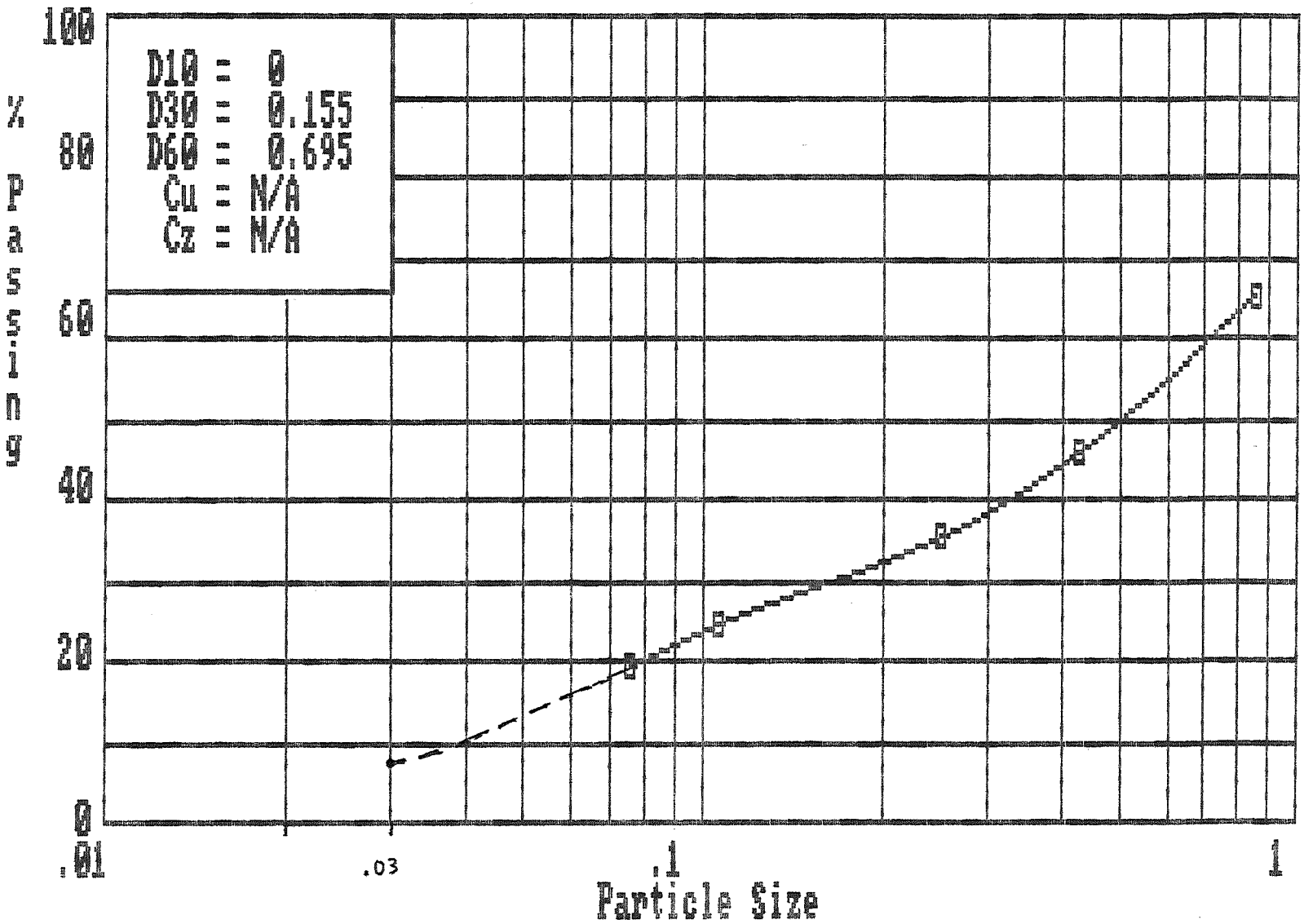
Boring No. = MA-11	Depth = 40'	Number = 8



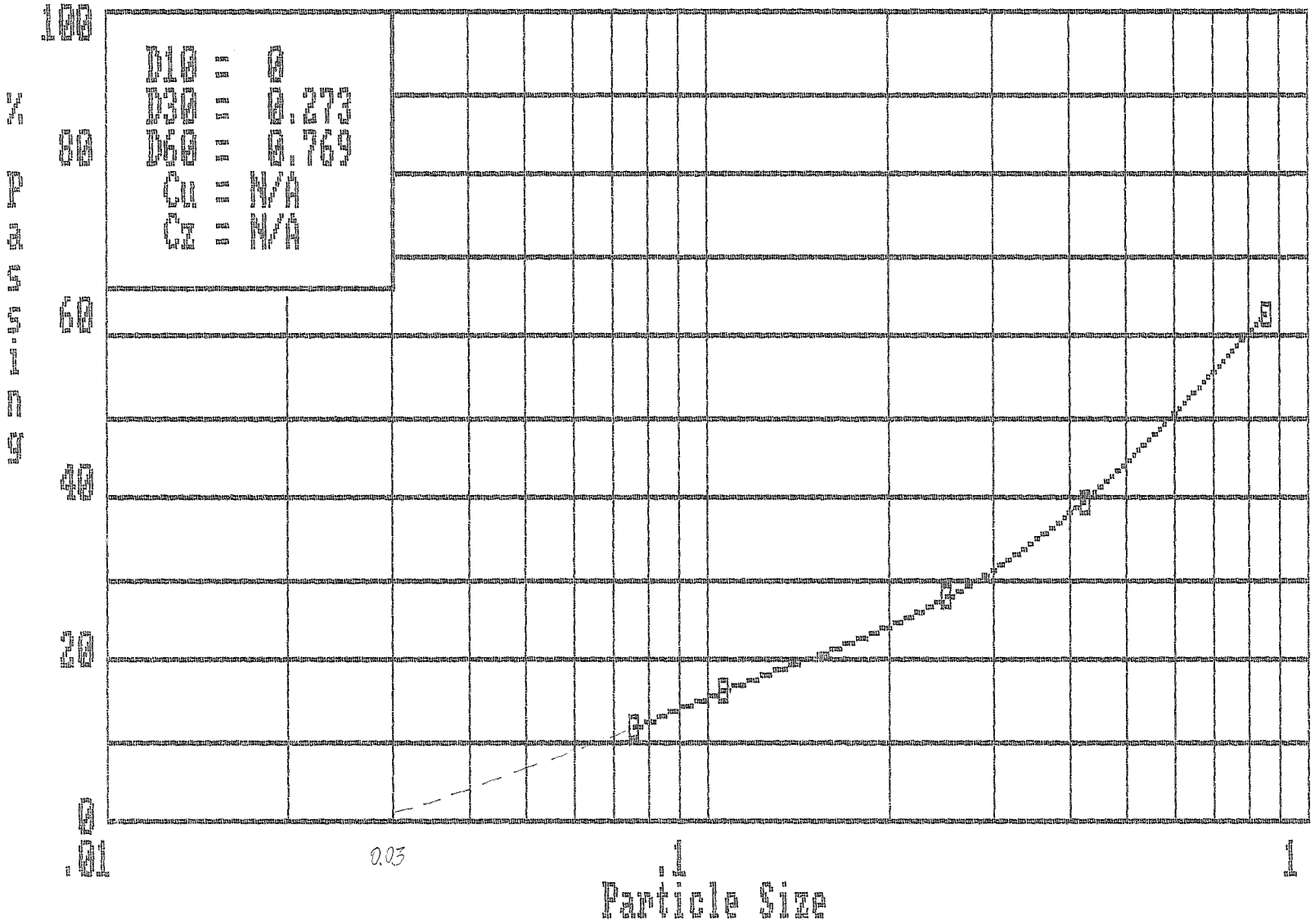
Boring No. = MA-11	Depth = 55'	Number = 7



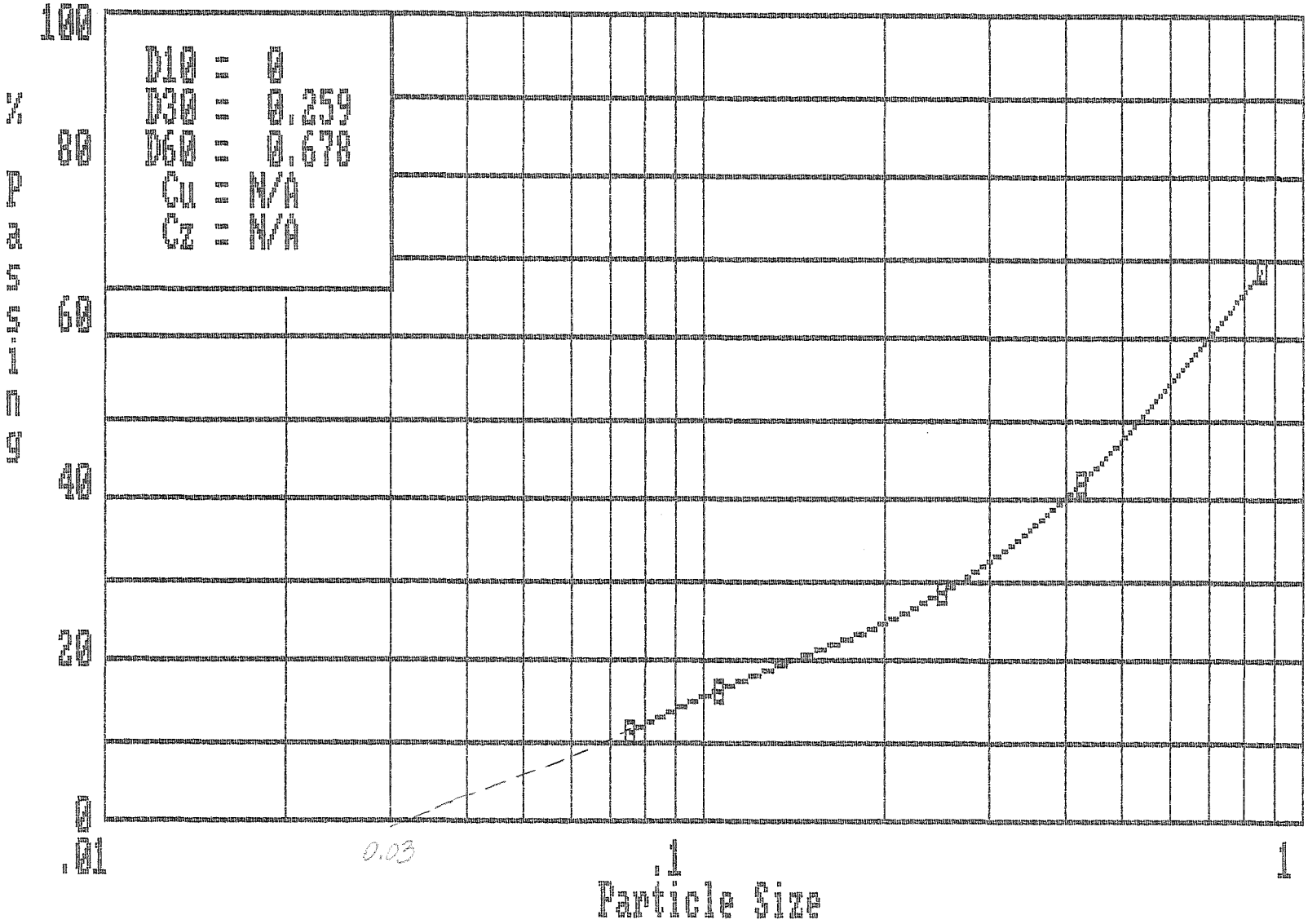
Boring No. = MA-11	Depth = 65'	Number = 1



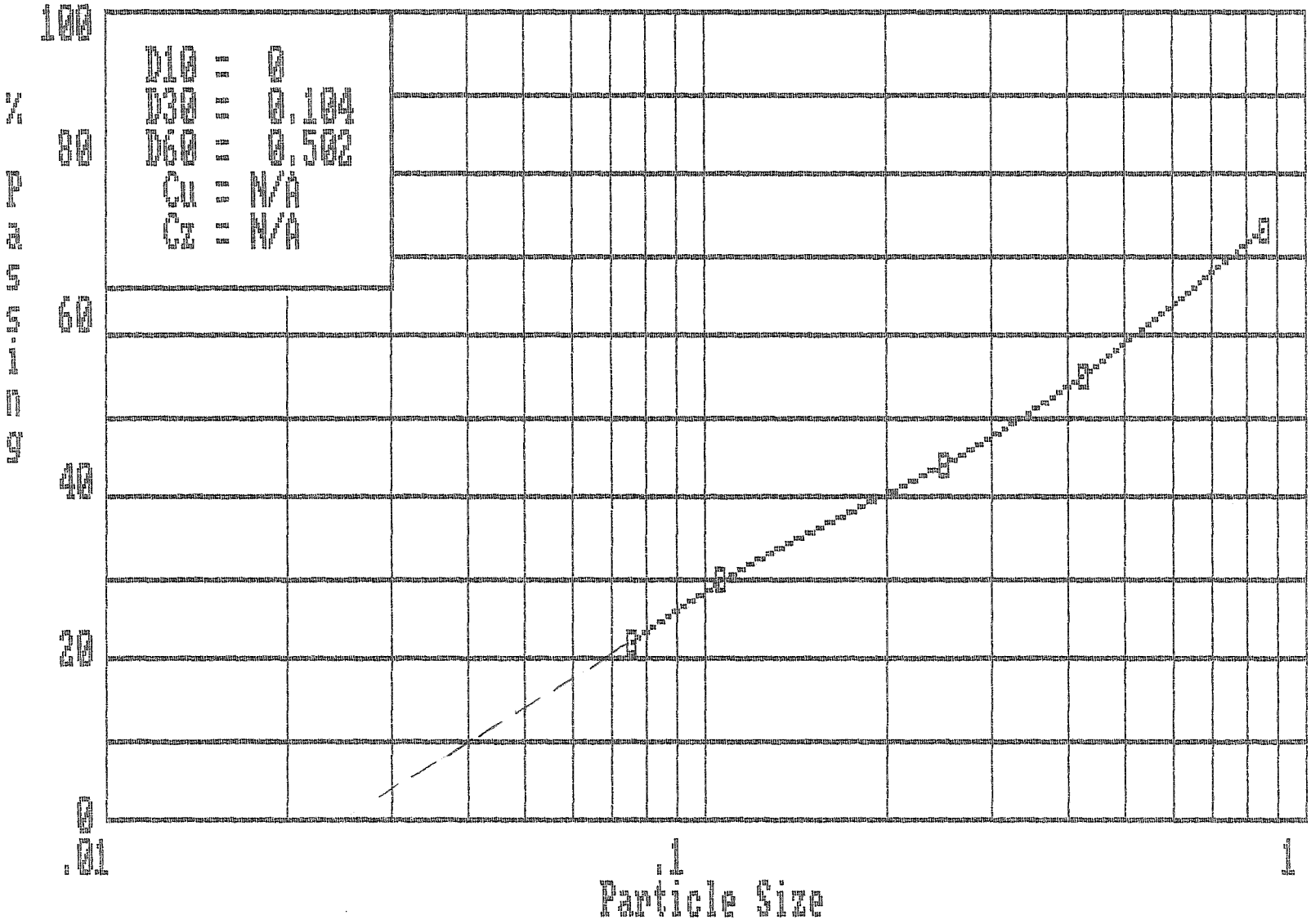
Boring No. = MA-11	Depth = 73'	Number = 3



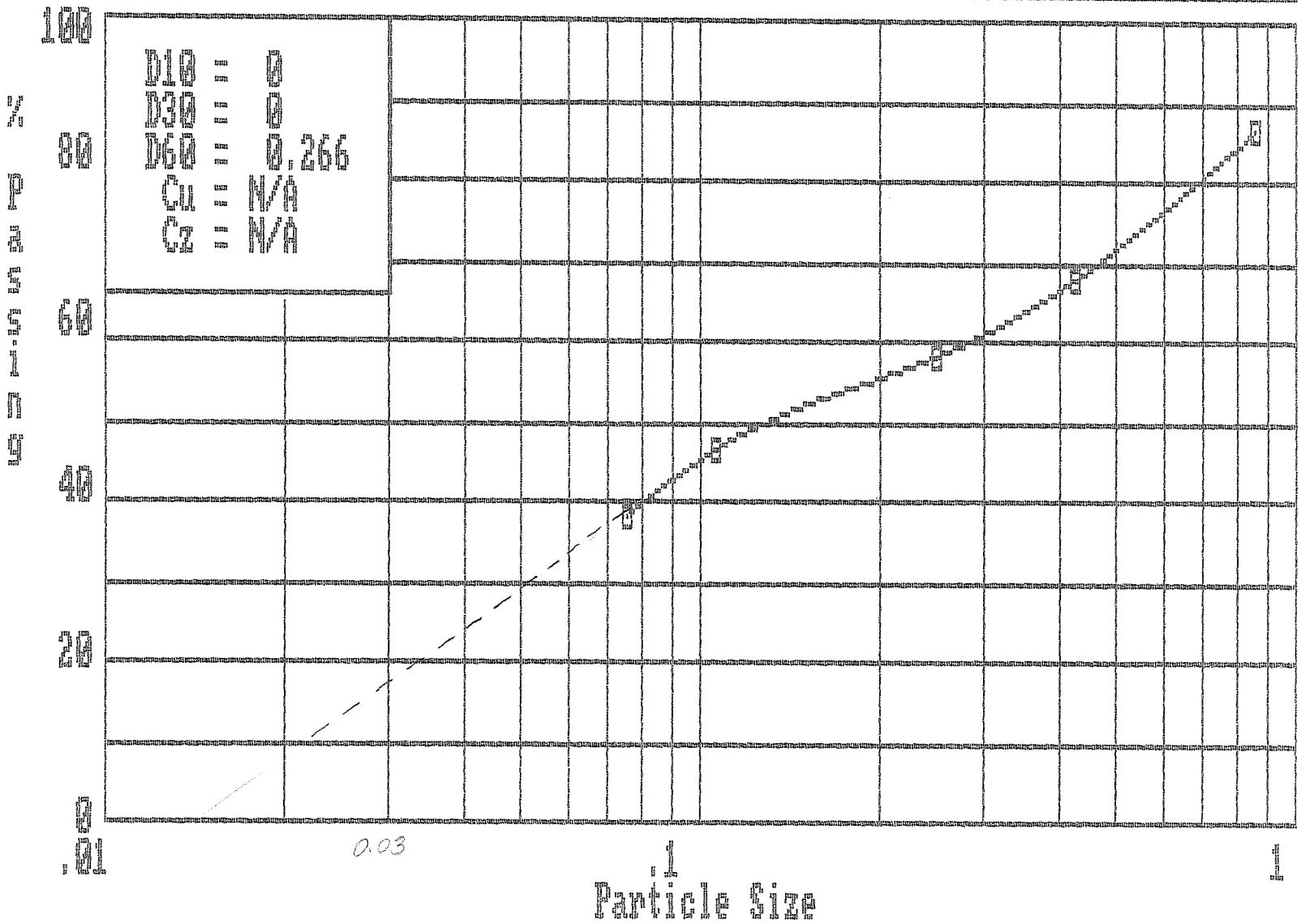
Boring No. = MA-12	Depth = 4-6'	Number = 6



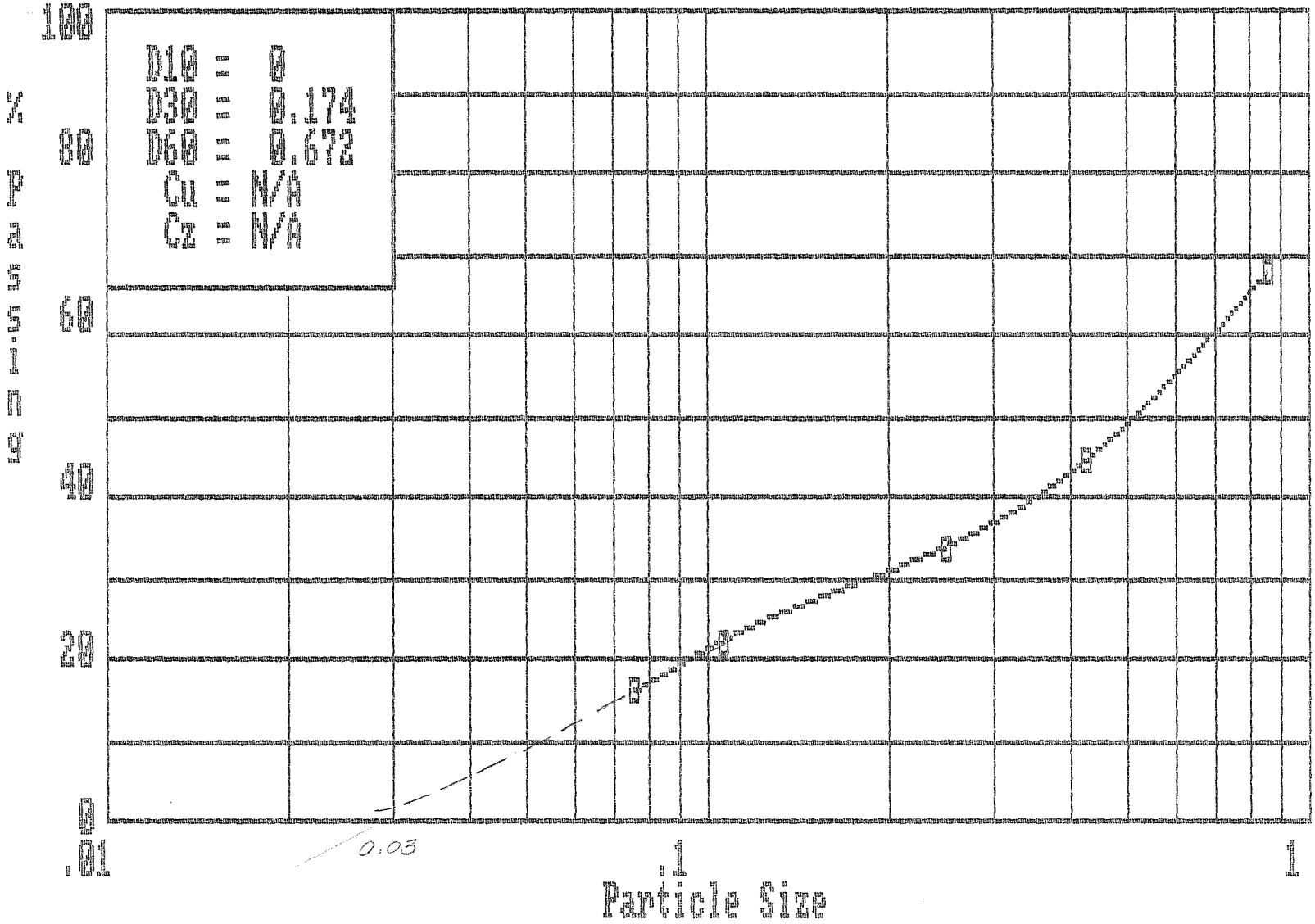
Boring No. = MA-12	Depth = 15'	Number = 9



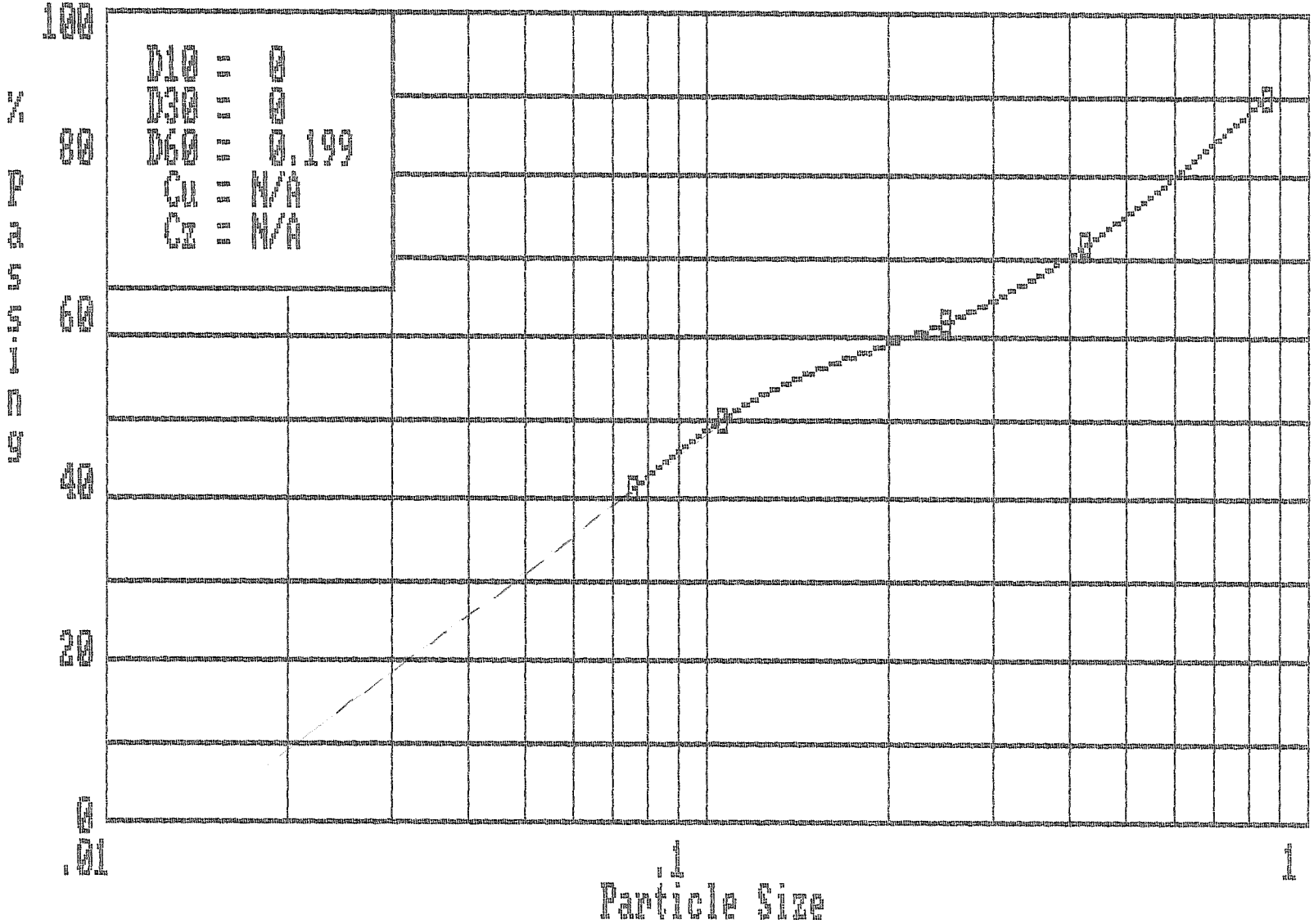
Boring No. = MA-12 | Depth = 25-26' | Number = 4



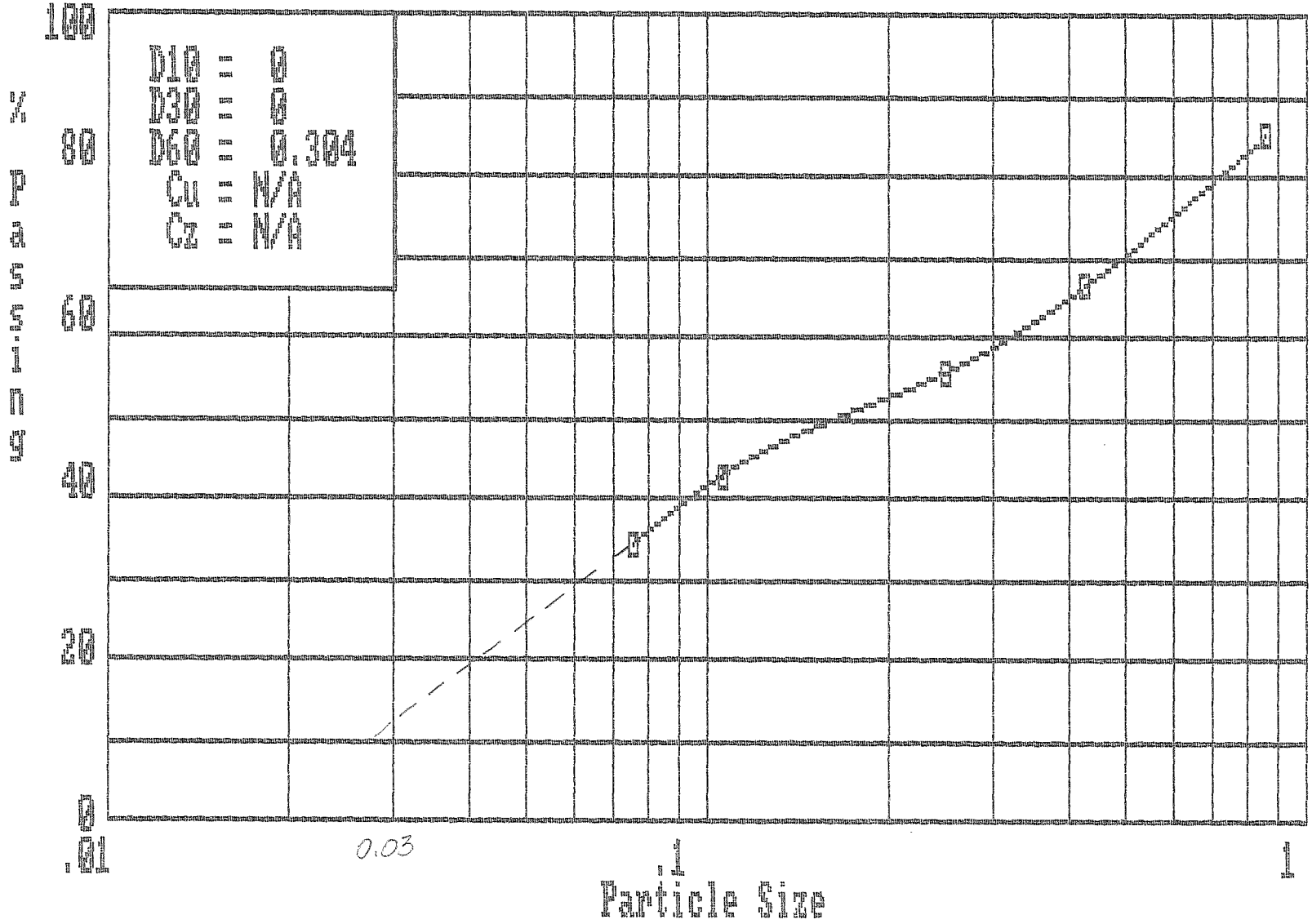
Boring No. = MA-12	Depth = 33-34'	Number = 8



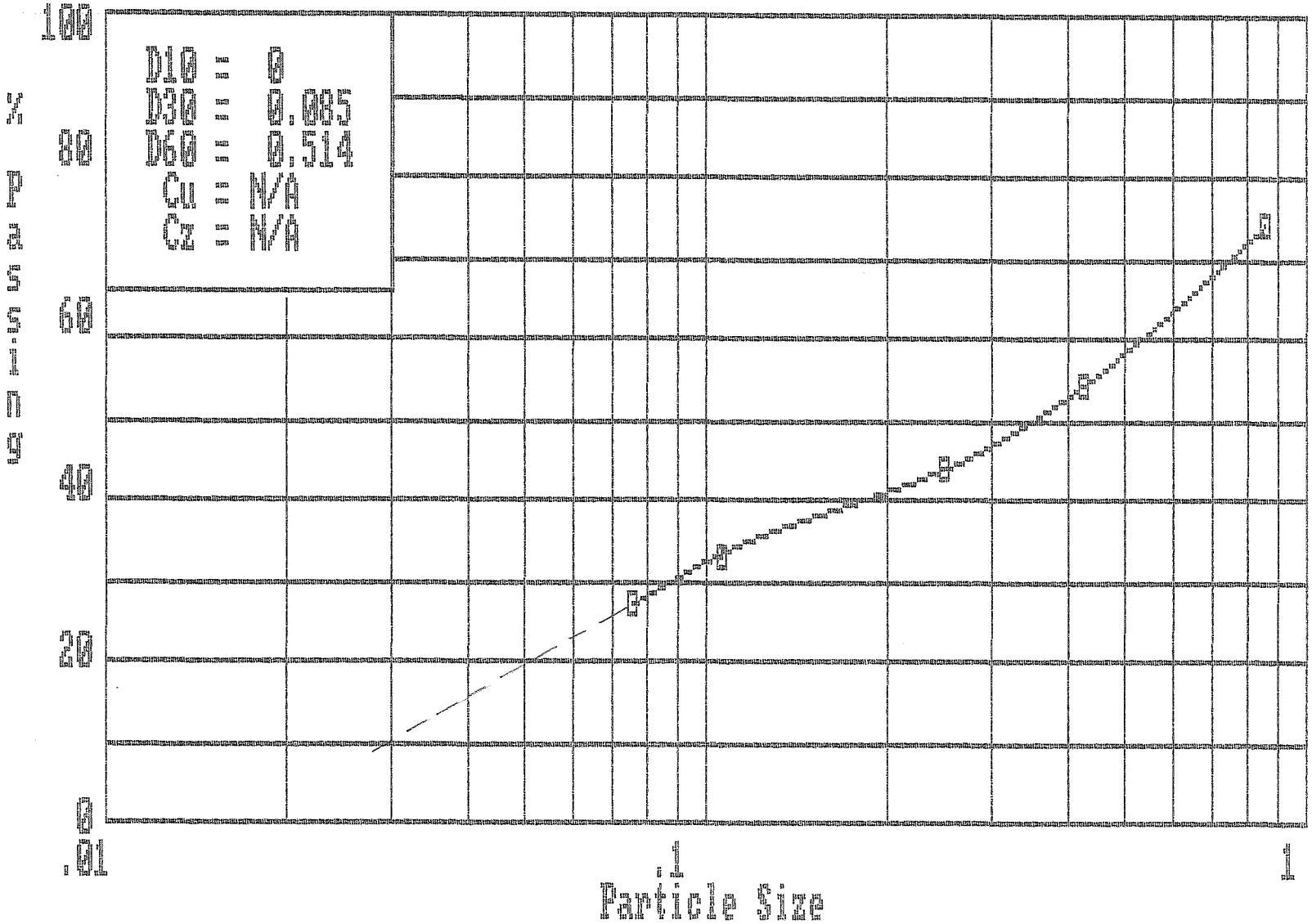
Boring No. = MA-12	Depth = 48'	Number = 5



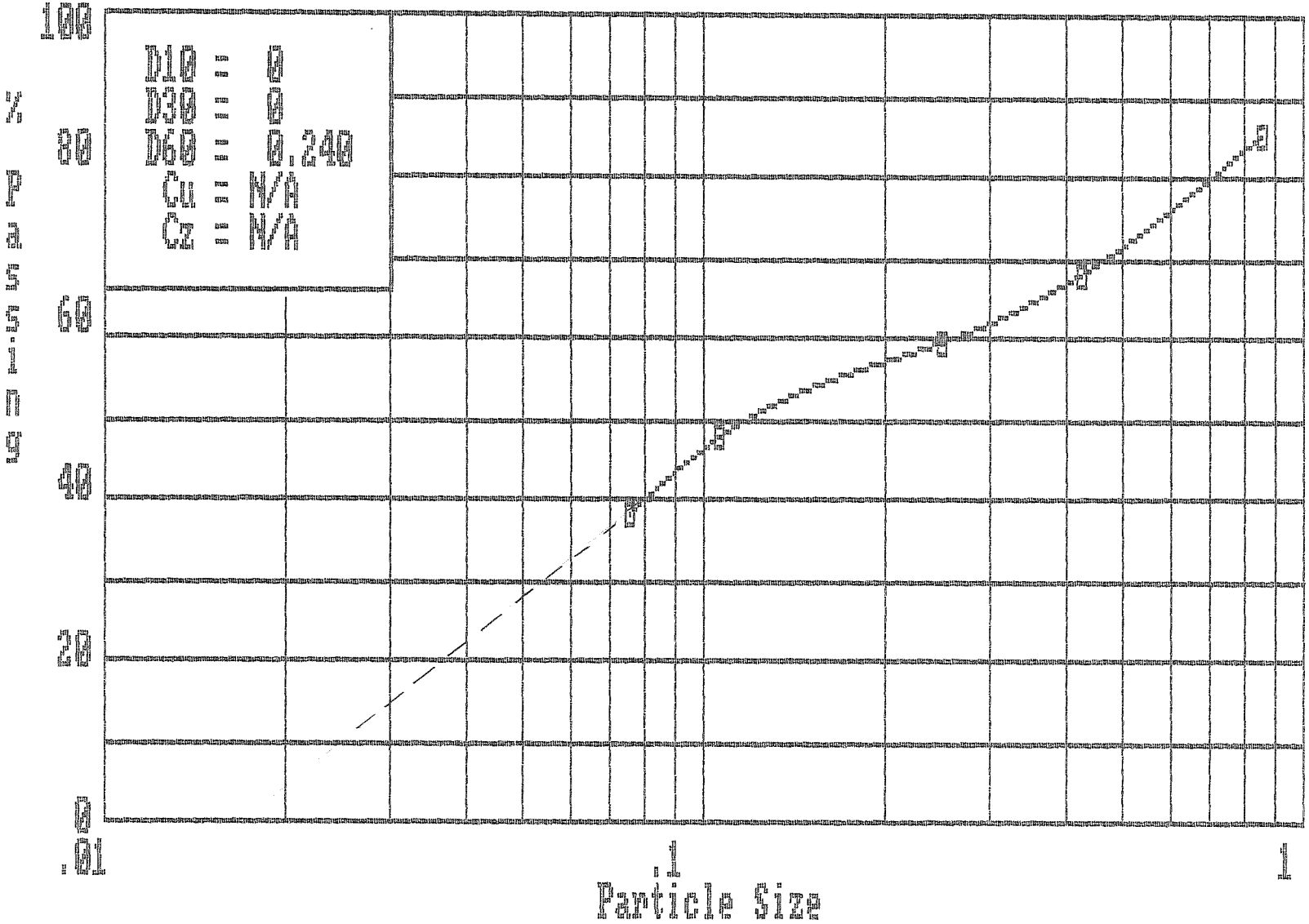
Boring No. = 1	Depth = 53'-54'	Number = MA-12



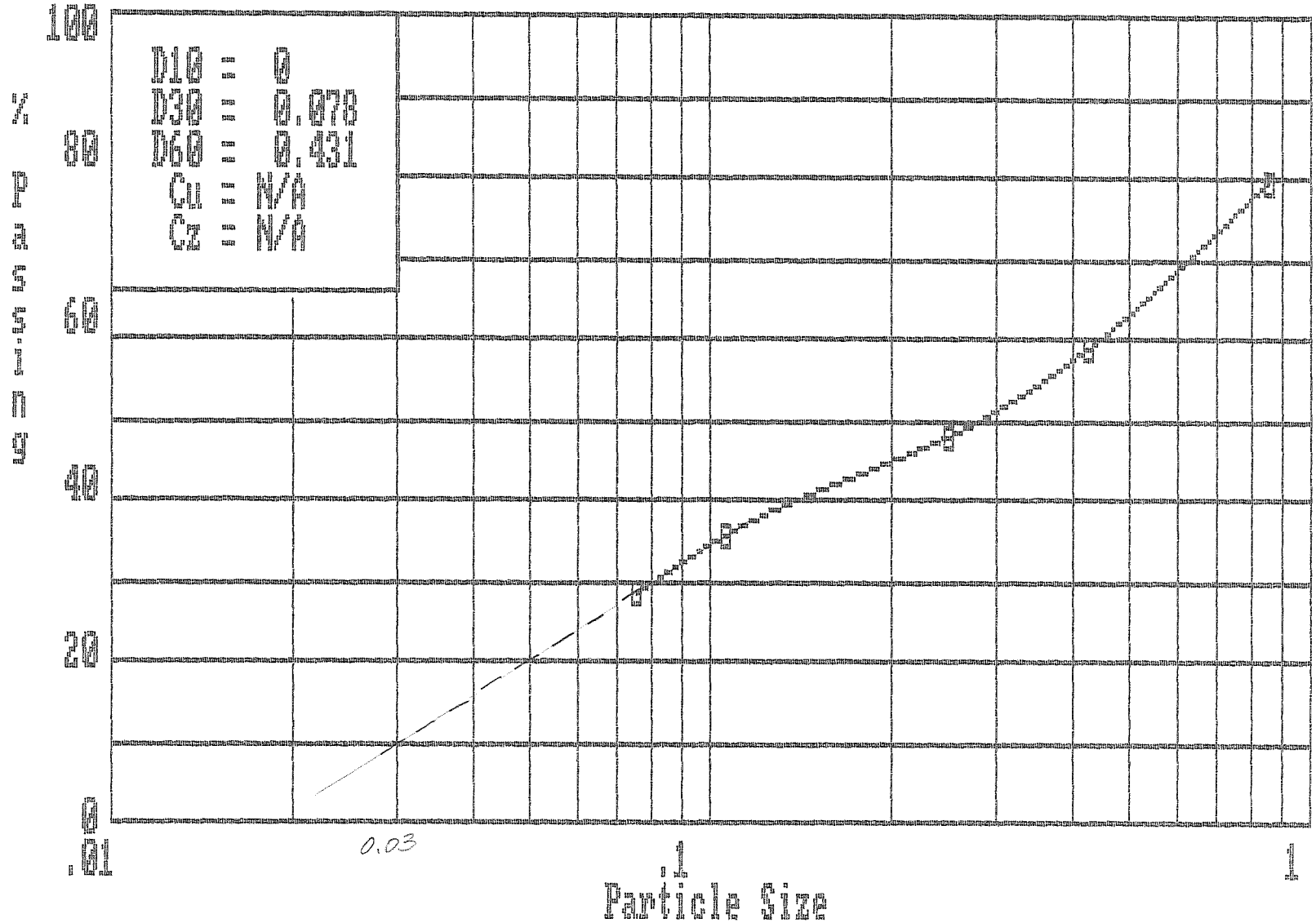
Boring No. = MA-12	Depth = 61-62'	Number = 3



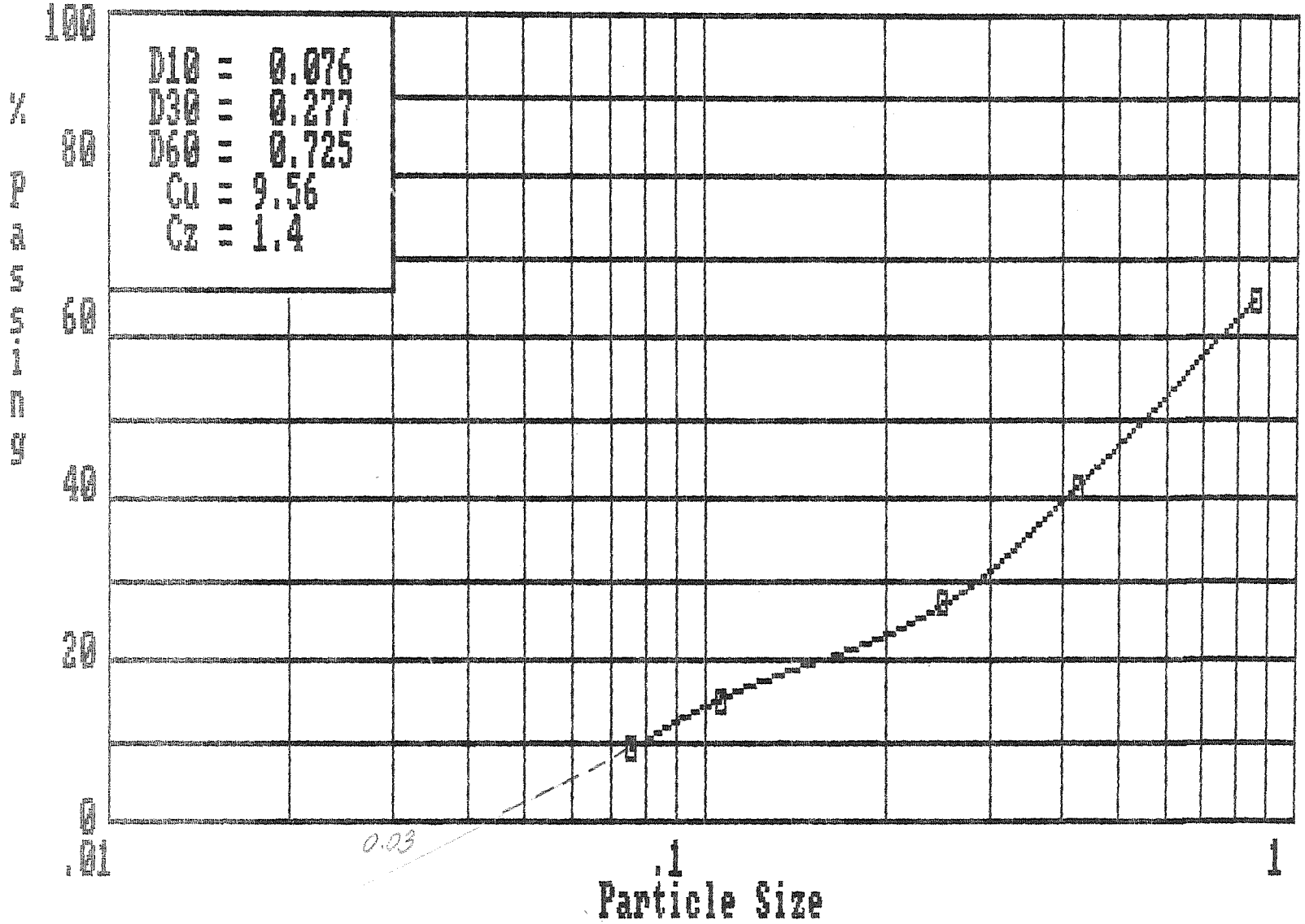
Boring No. = MA-12	Depth = 68-69'	Number = 7



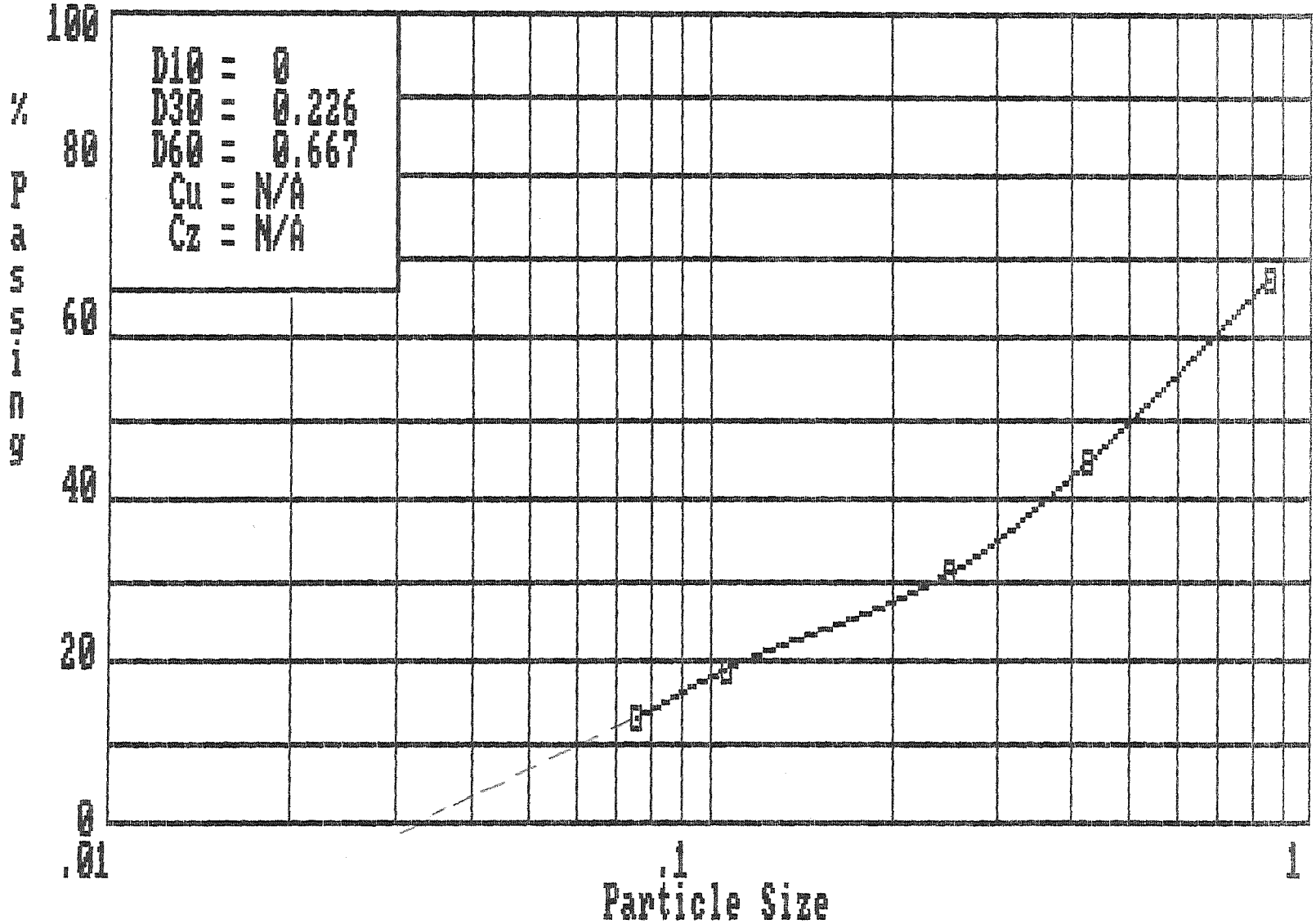
Boring No. = MA-12	Depth = 73'	Number = 2



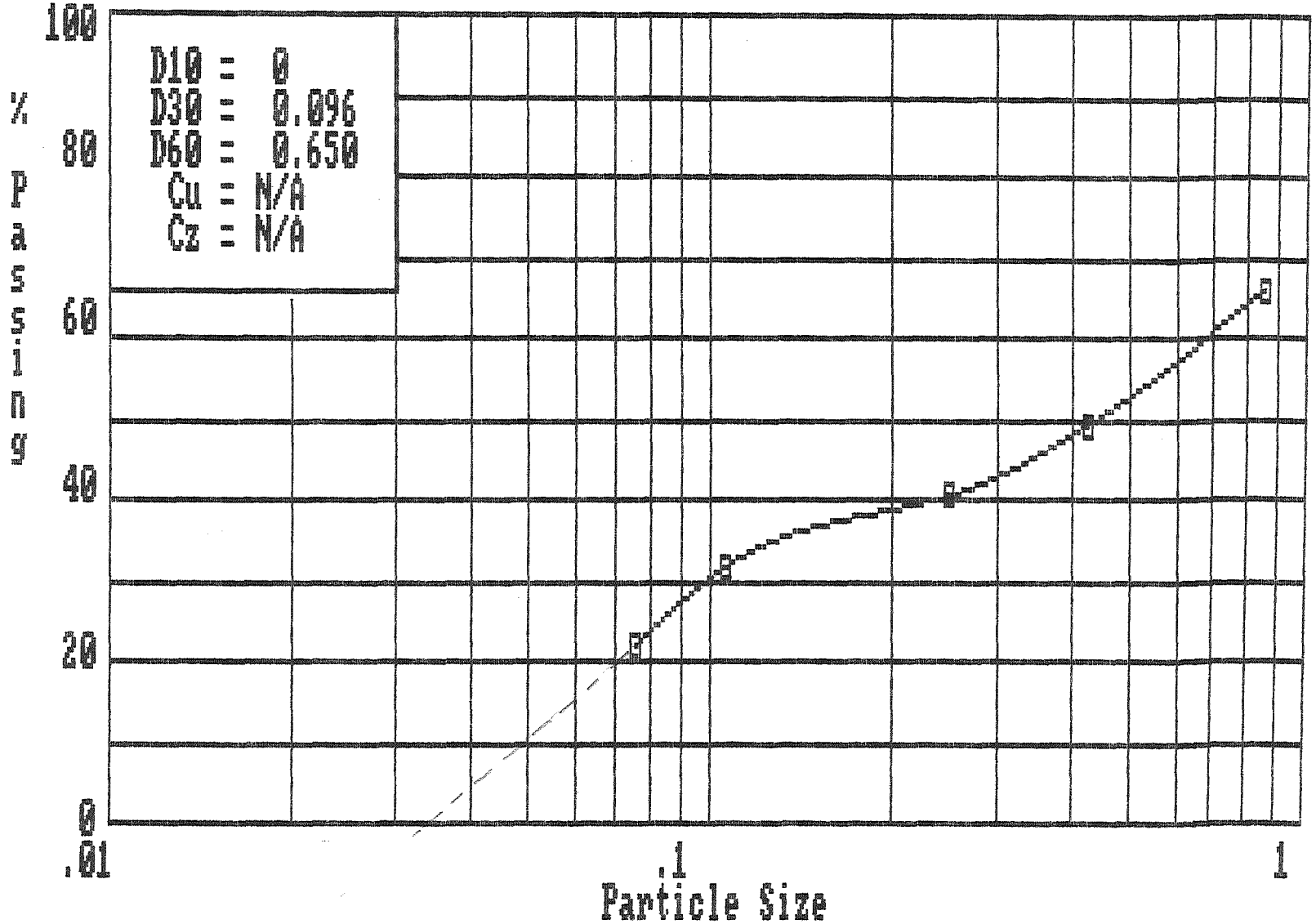
Boring No. = MR-1	Depth = 5-10'	Number = 1



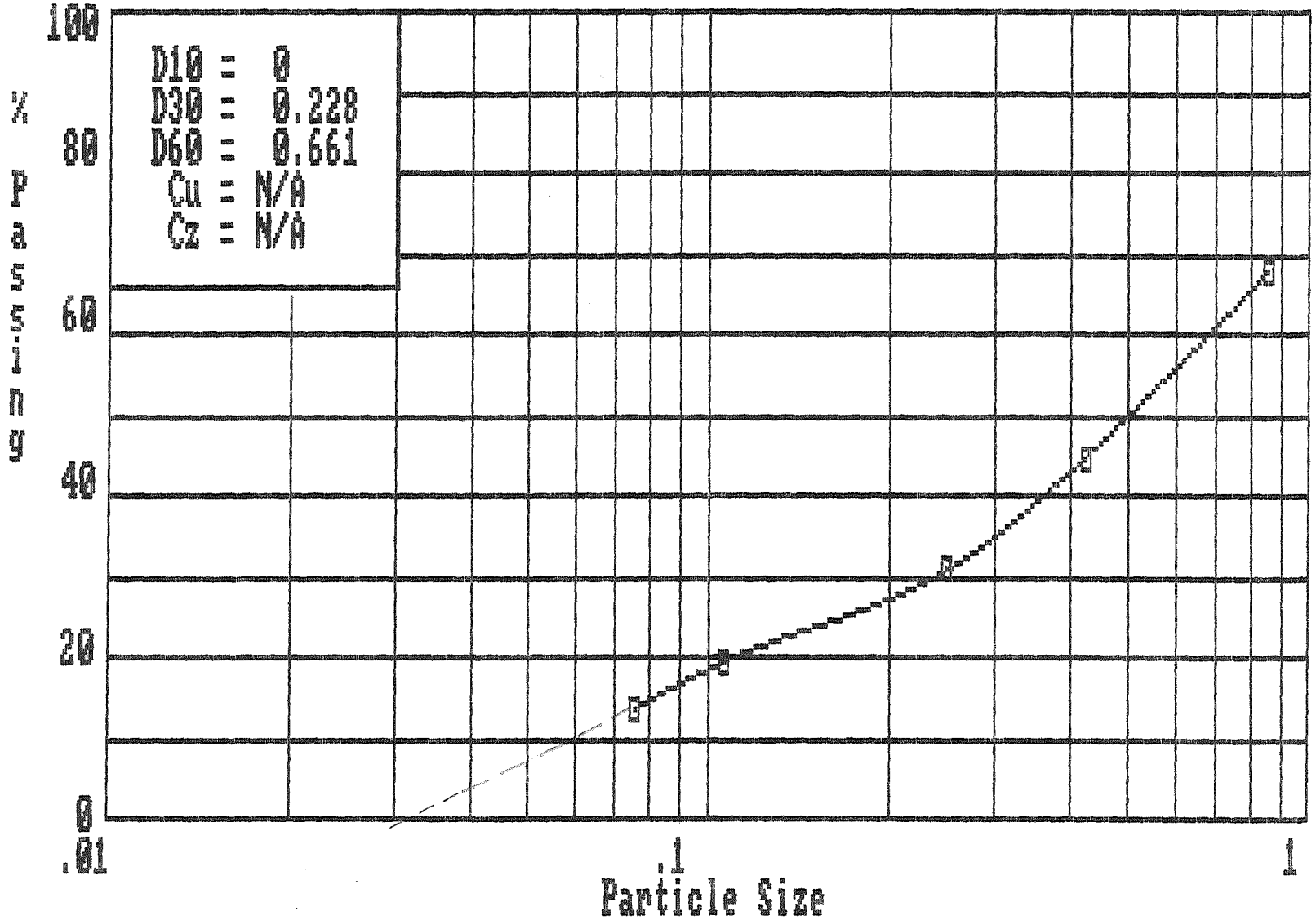
Boring No. = MR-1	Depth = 15-20'	Number = 2



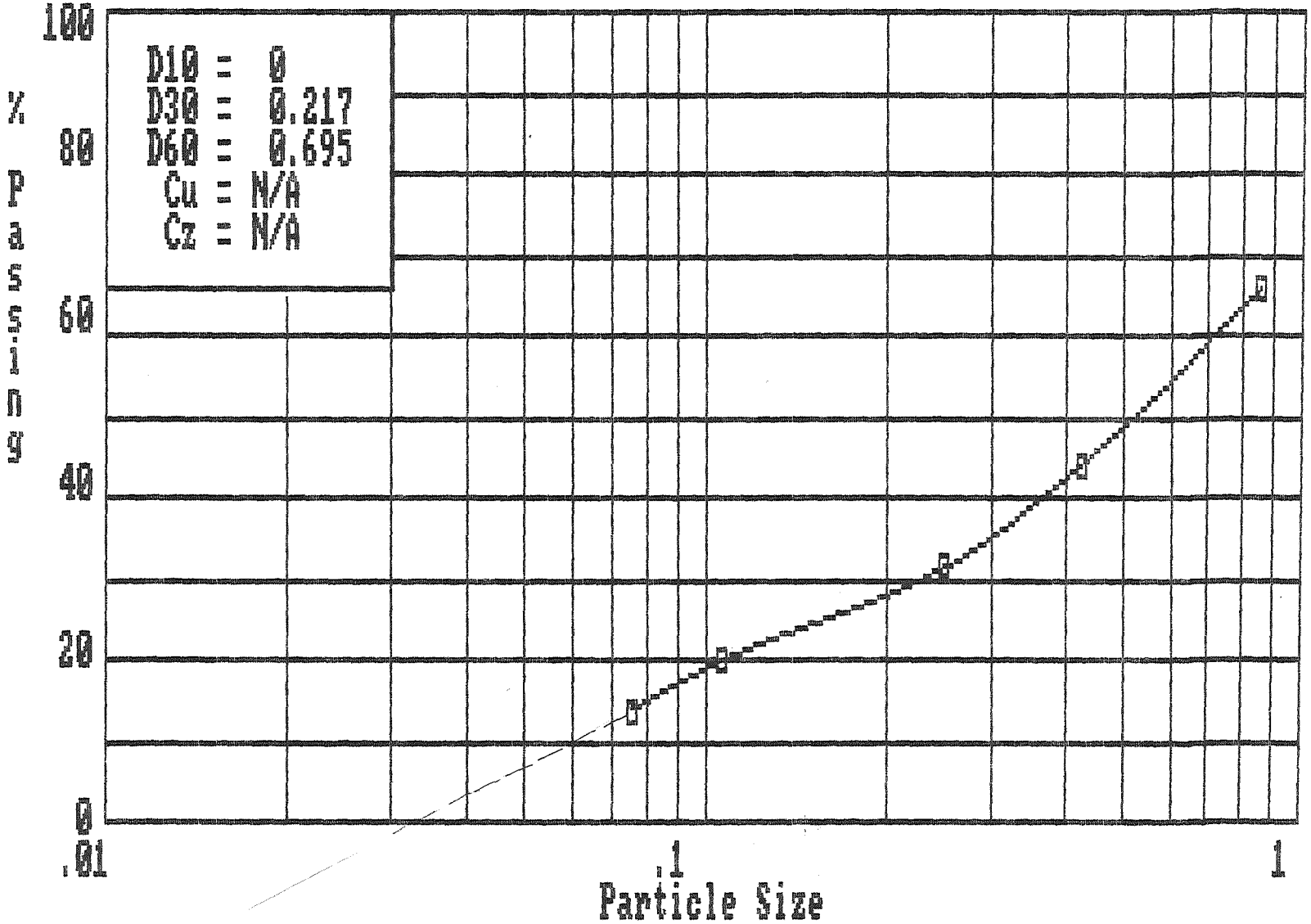
Boring No. = MR-1	Depth = 25-30'	Number = 3



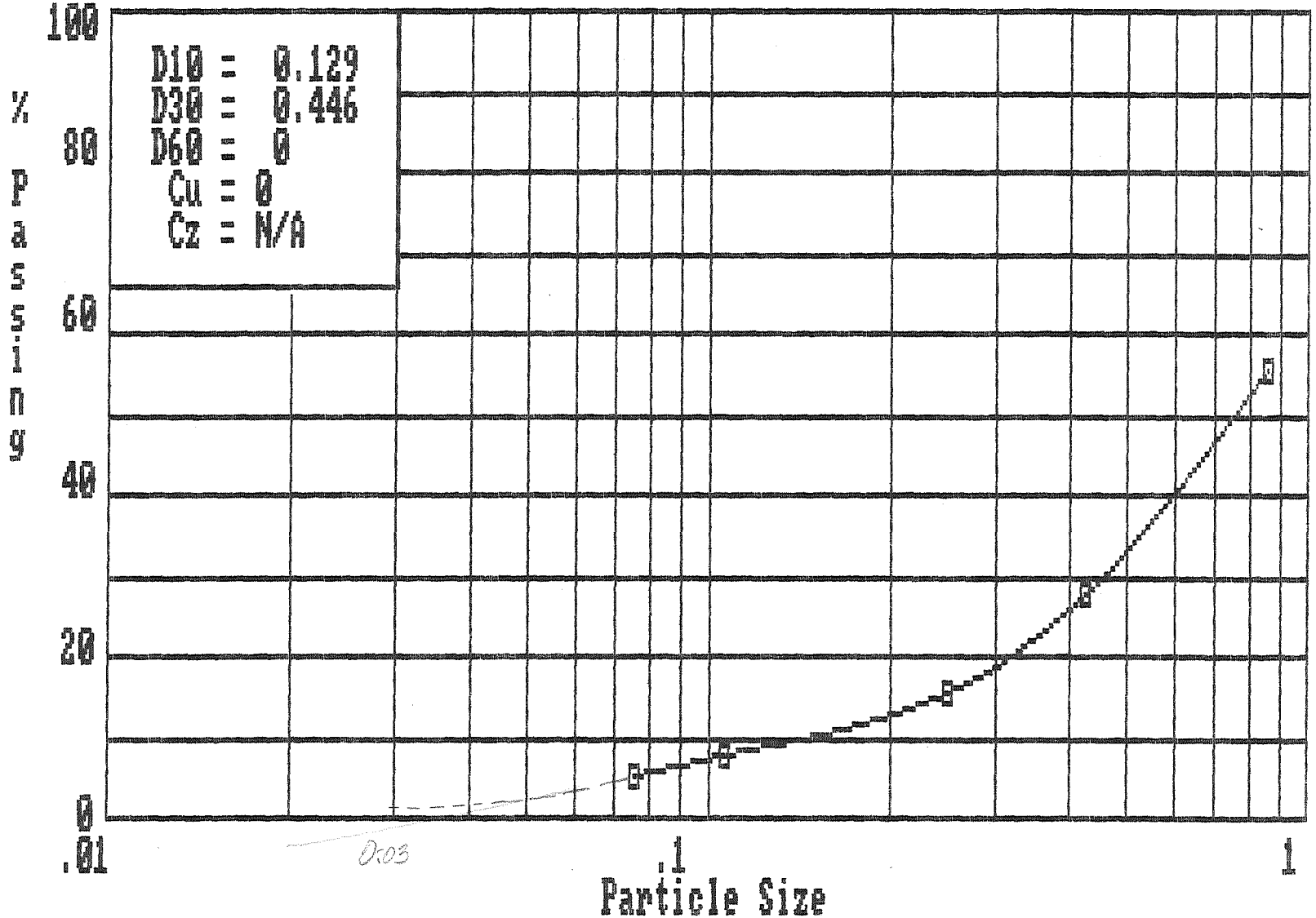
Boring No. = MR-1	Depth = 35-40'	Number = 4



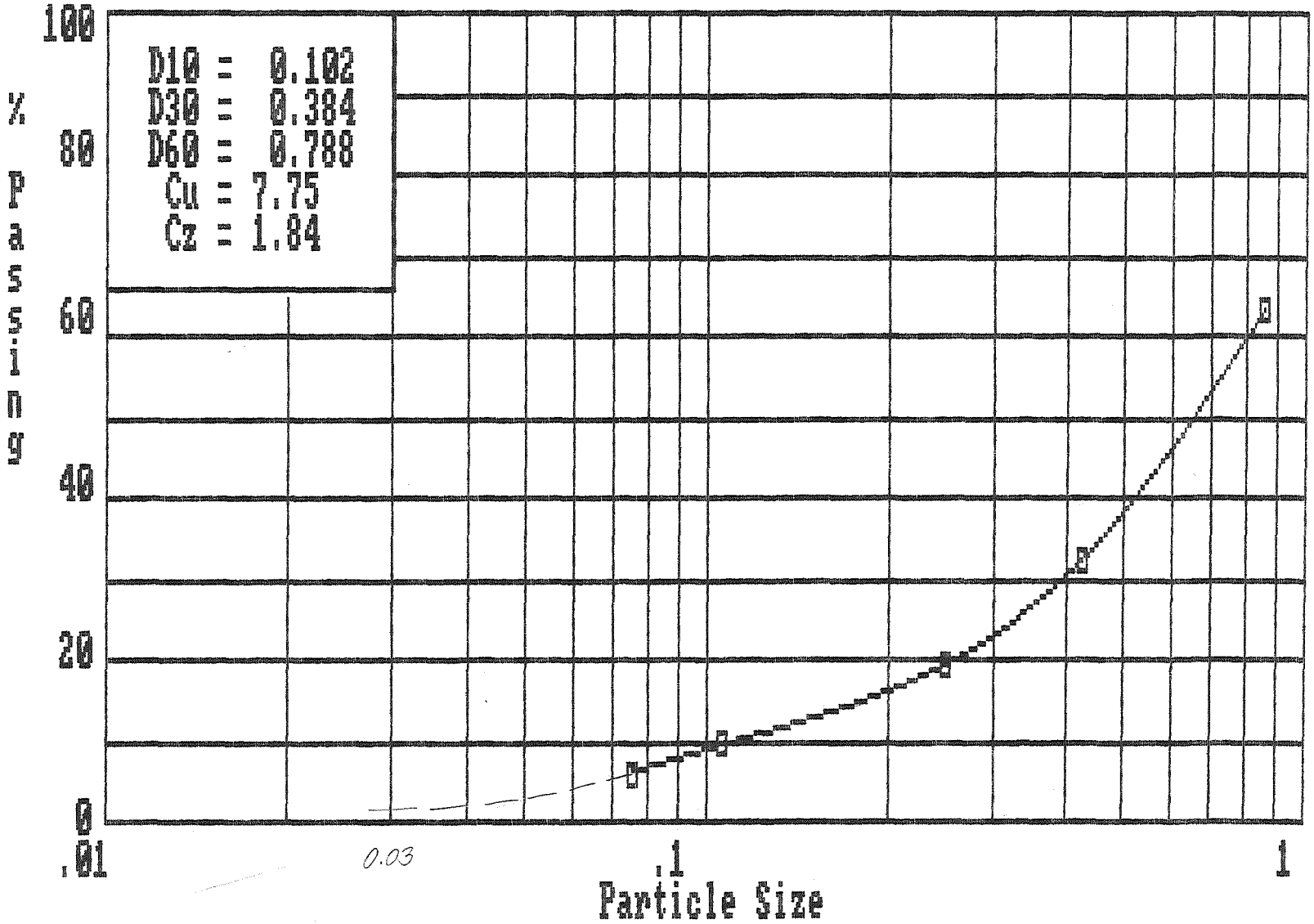
Boring No. = MR-1	Depth = 45-50'	Number = 5



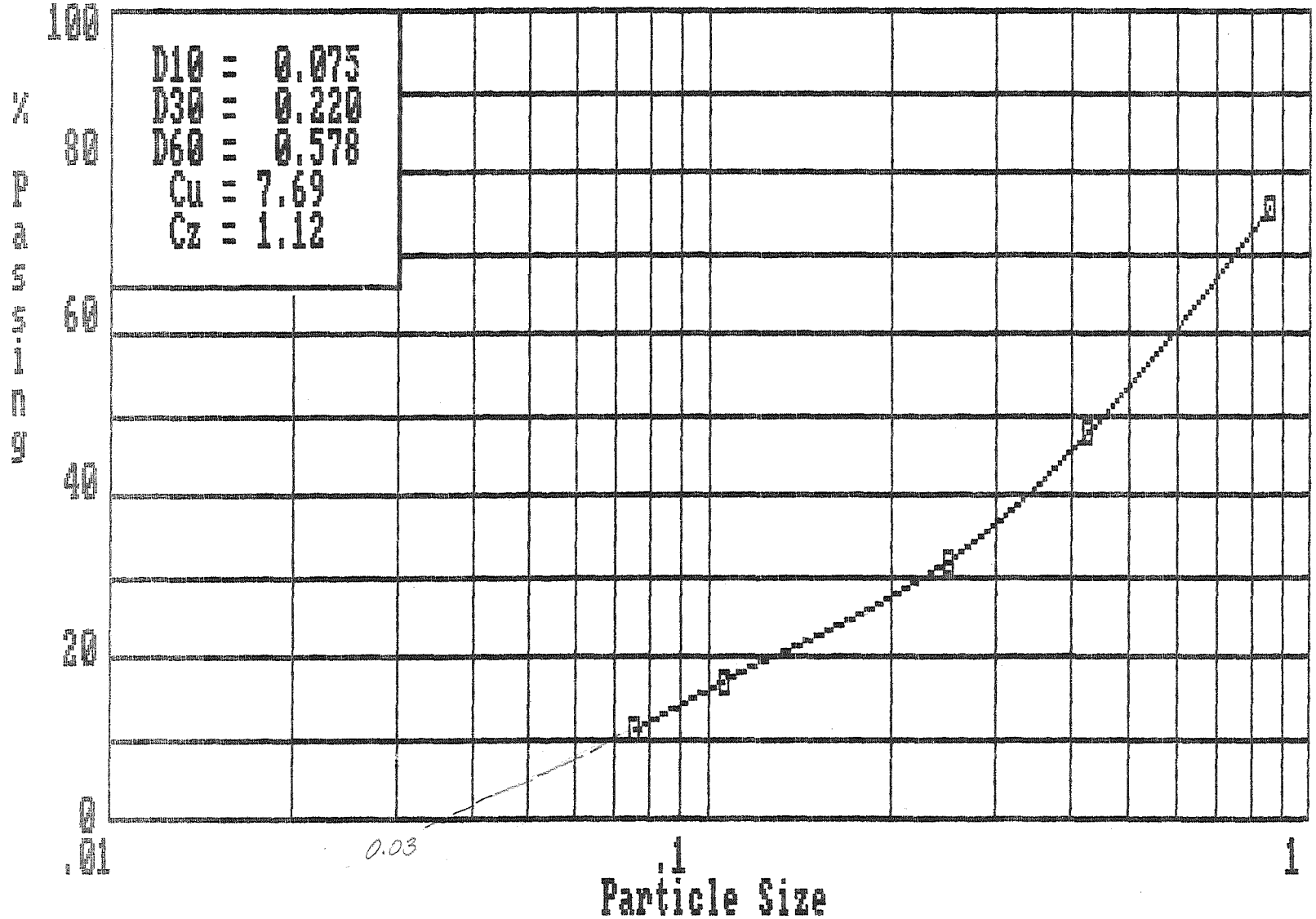
Boring No. = MR-1	Depth = 55-60'	Number = 6



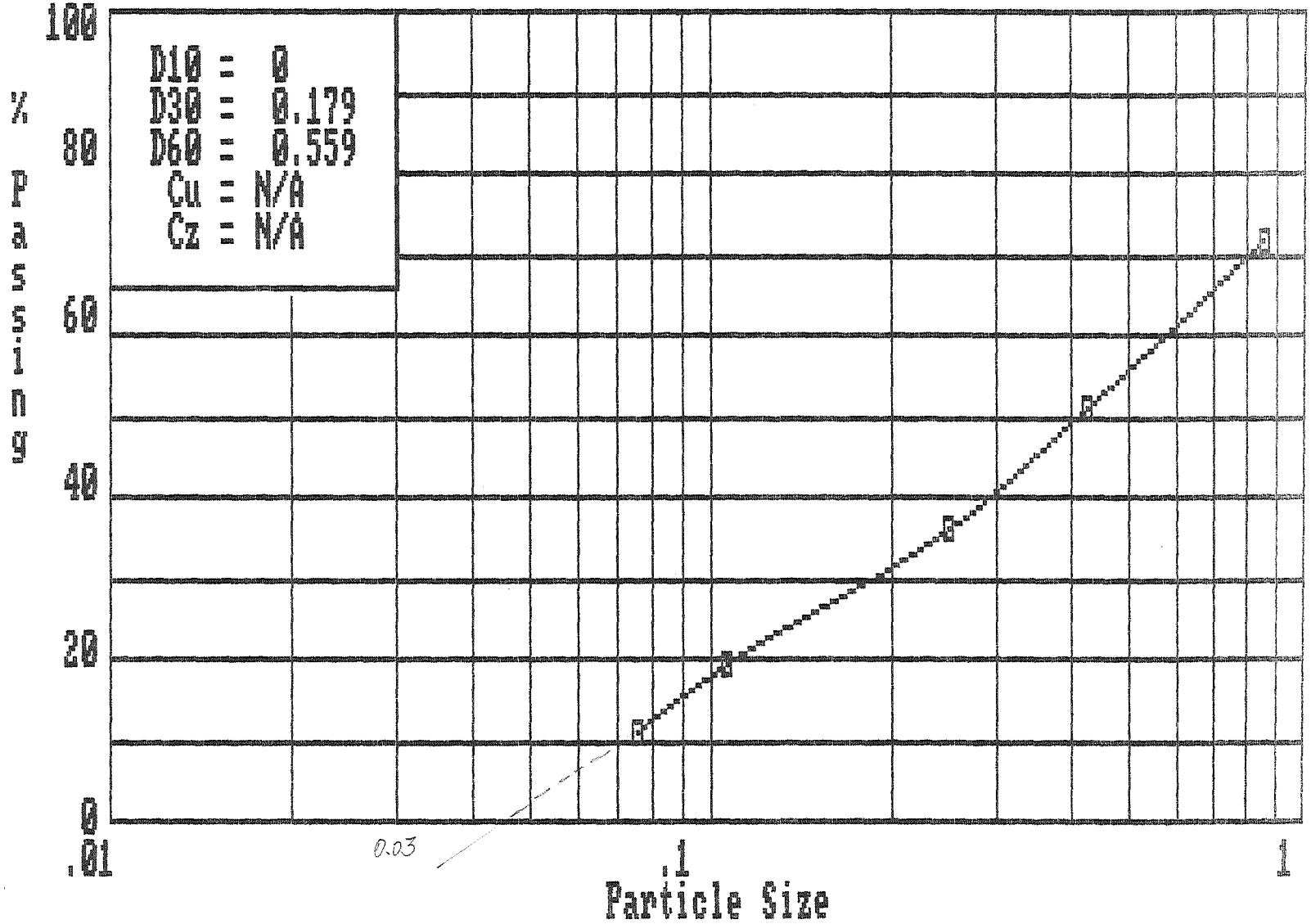
Boring No. = MR-1	Depth = 65-70'	Number = 7



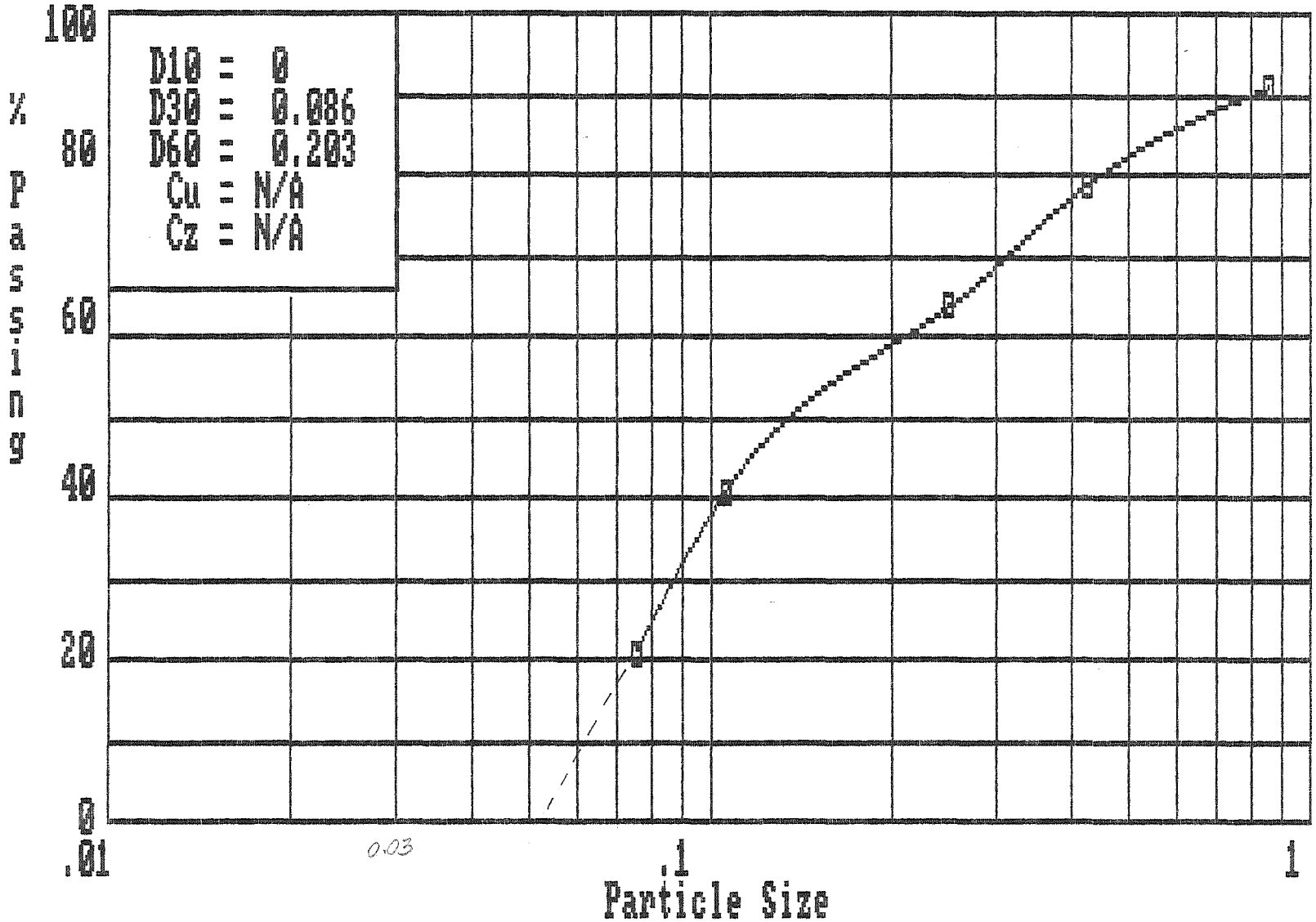
Boring No. = MR-1	Depth = 75-80'	Number = 8



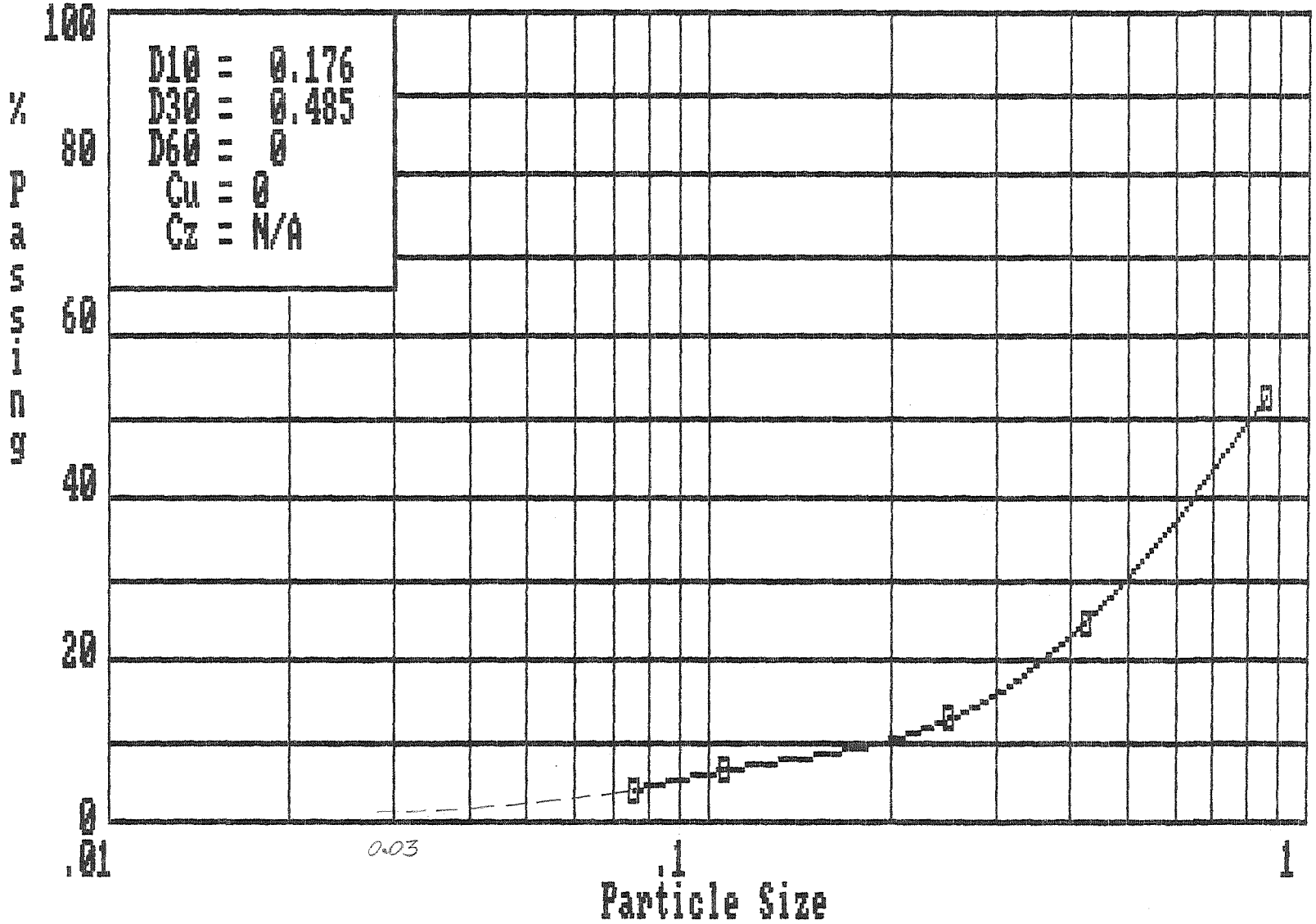
Boring No. = MR-2	Depth = 5-10'	Number = 1



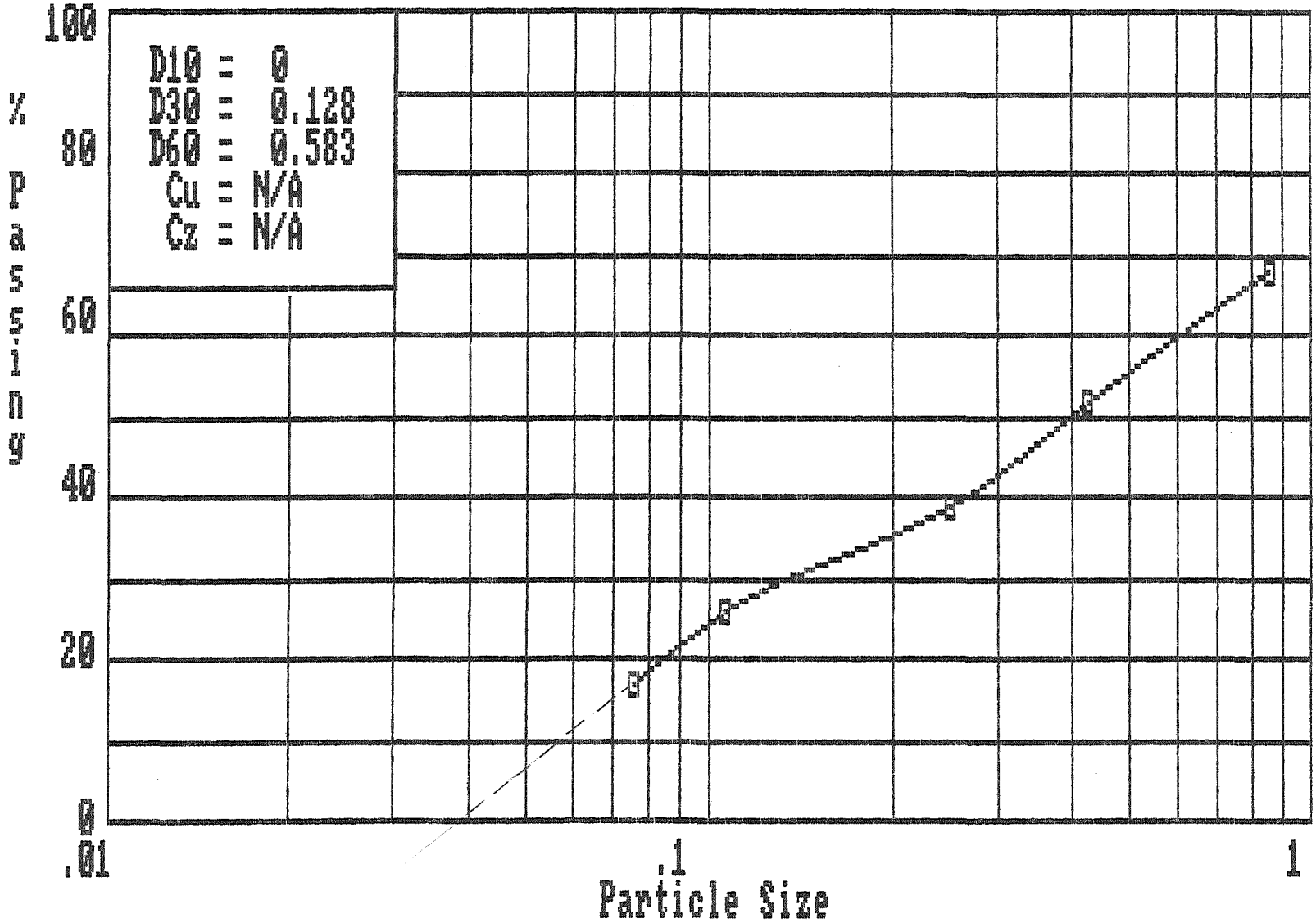
Boring No. = MR-2	Depth = 15-20'	Number = 2



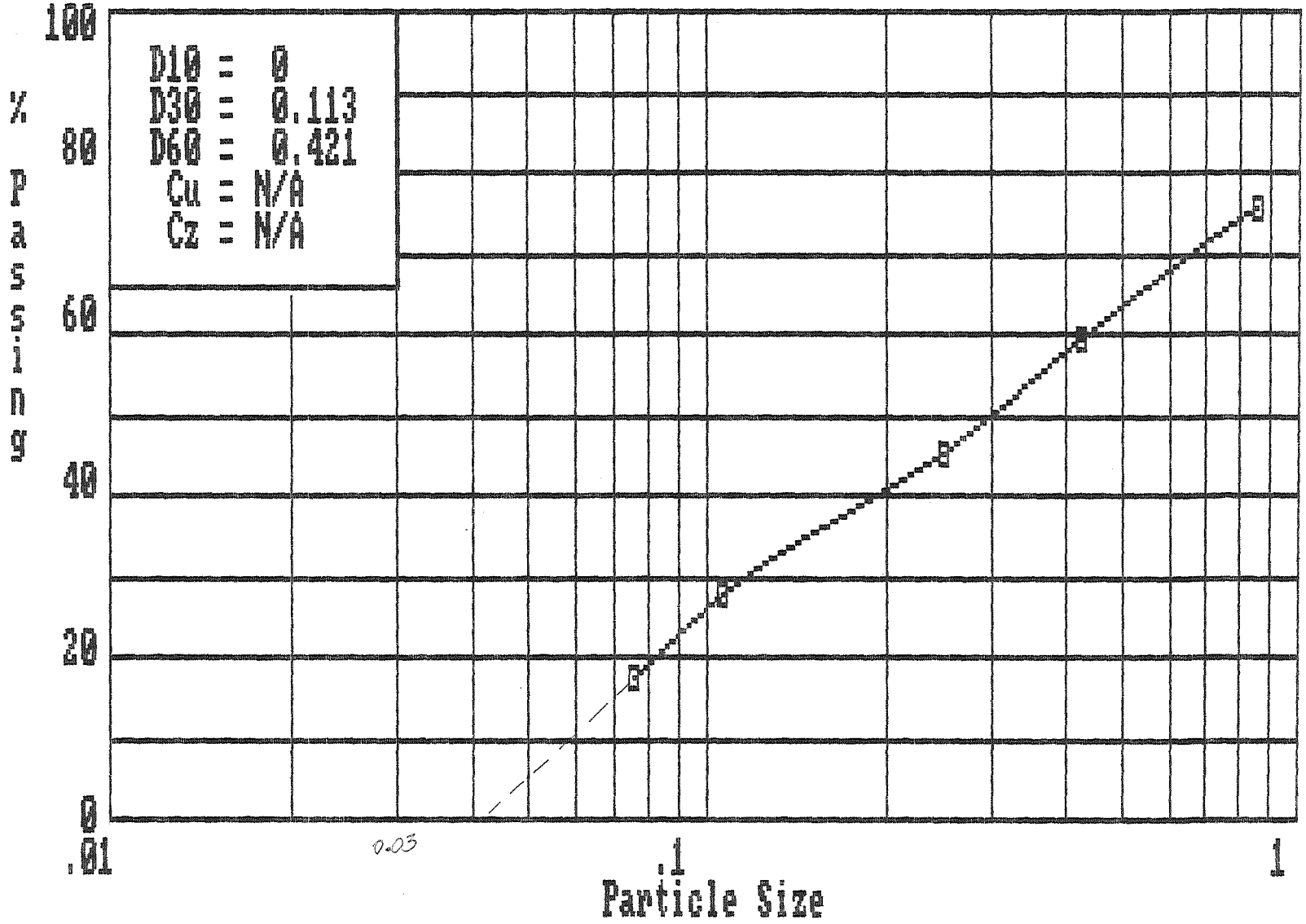
Boring No. = MR-2	Depth = 25-30'	Number = 3



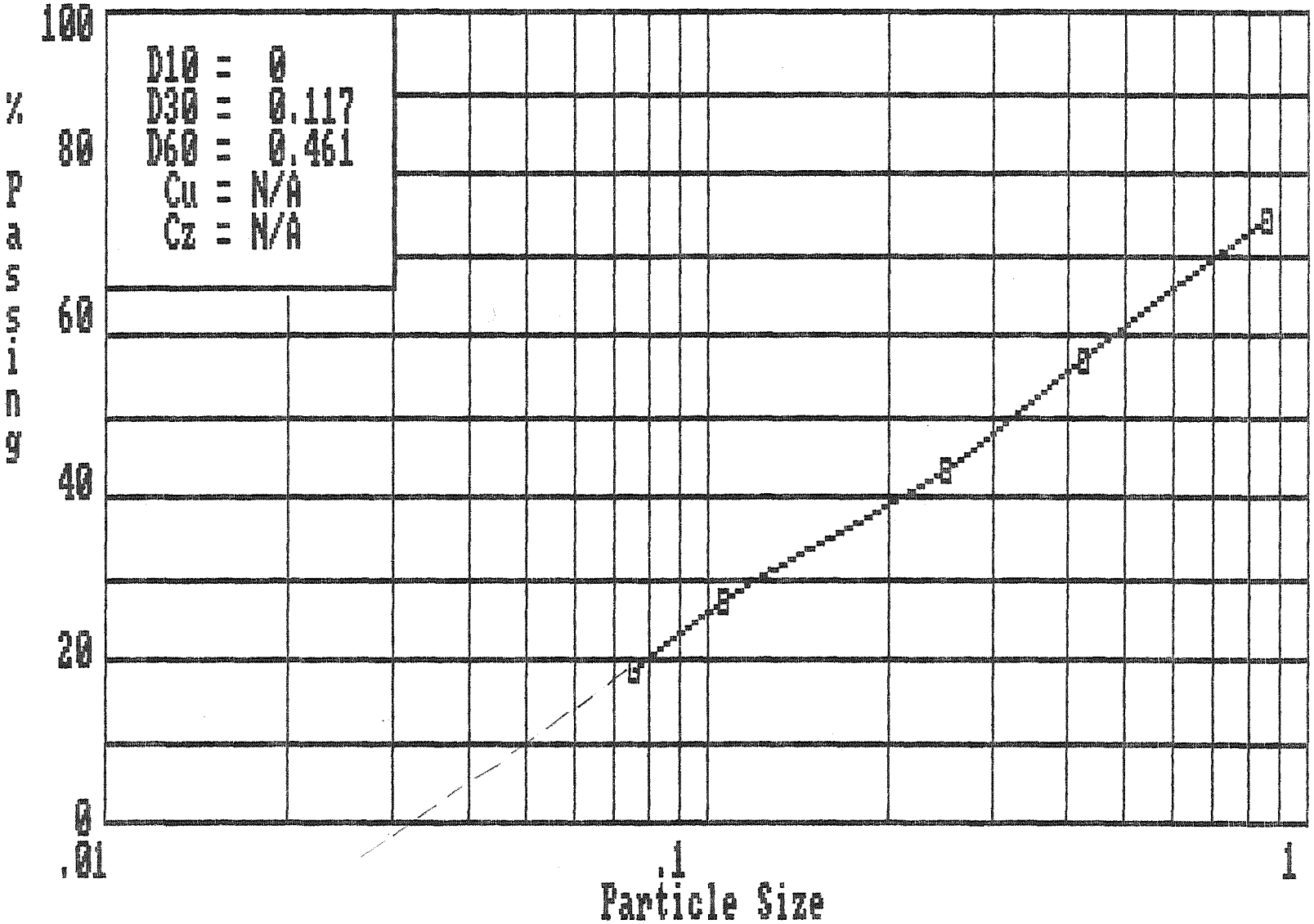
Boring No. = MR-2	Depth = 35-40'	Number = 4



Boring No. = MR-2	Depth = 45-50'	Number = 5

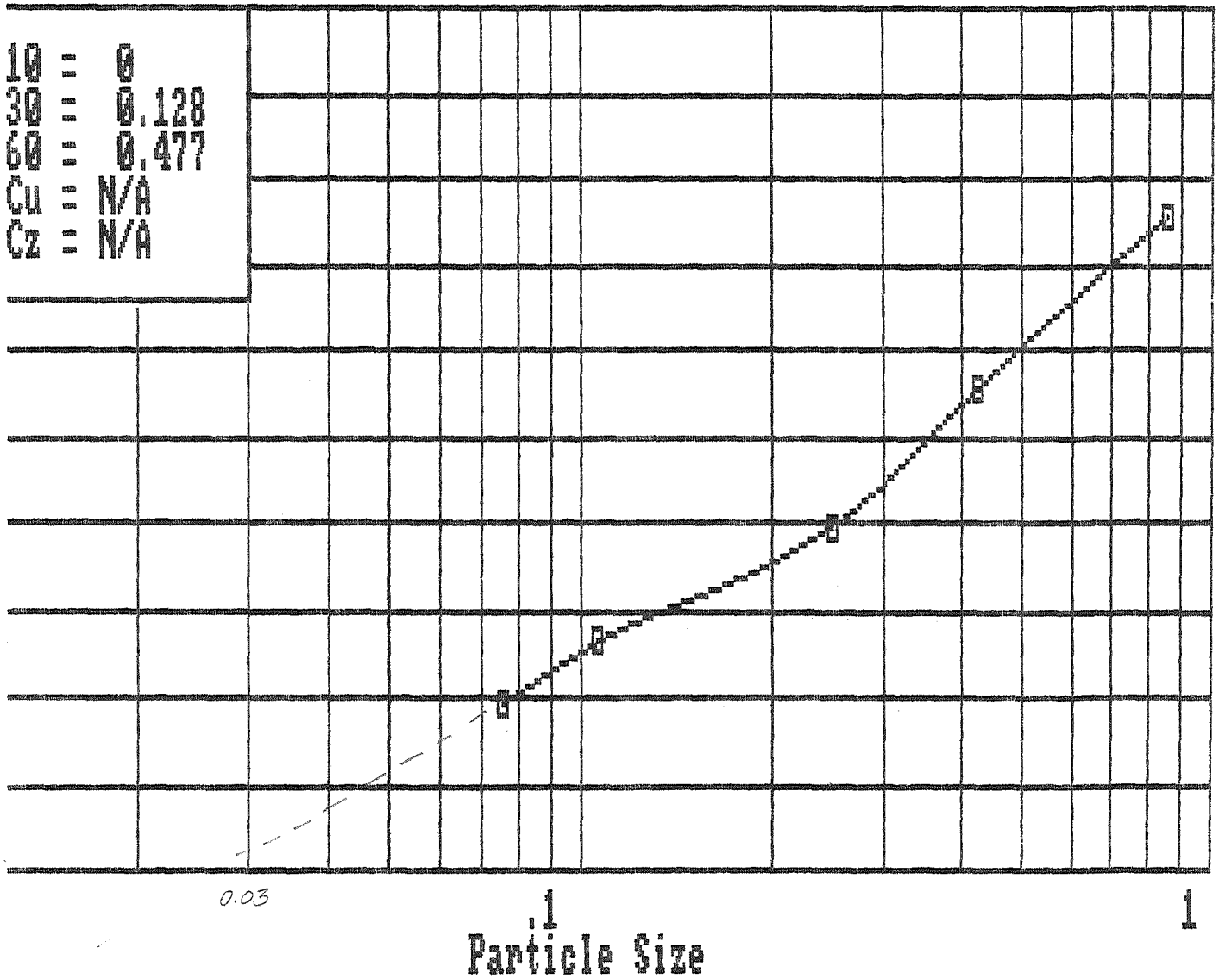


Boring No. = MR-2	Depth = 55-60'	Number = 6

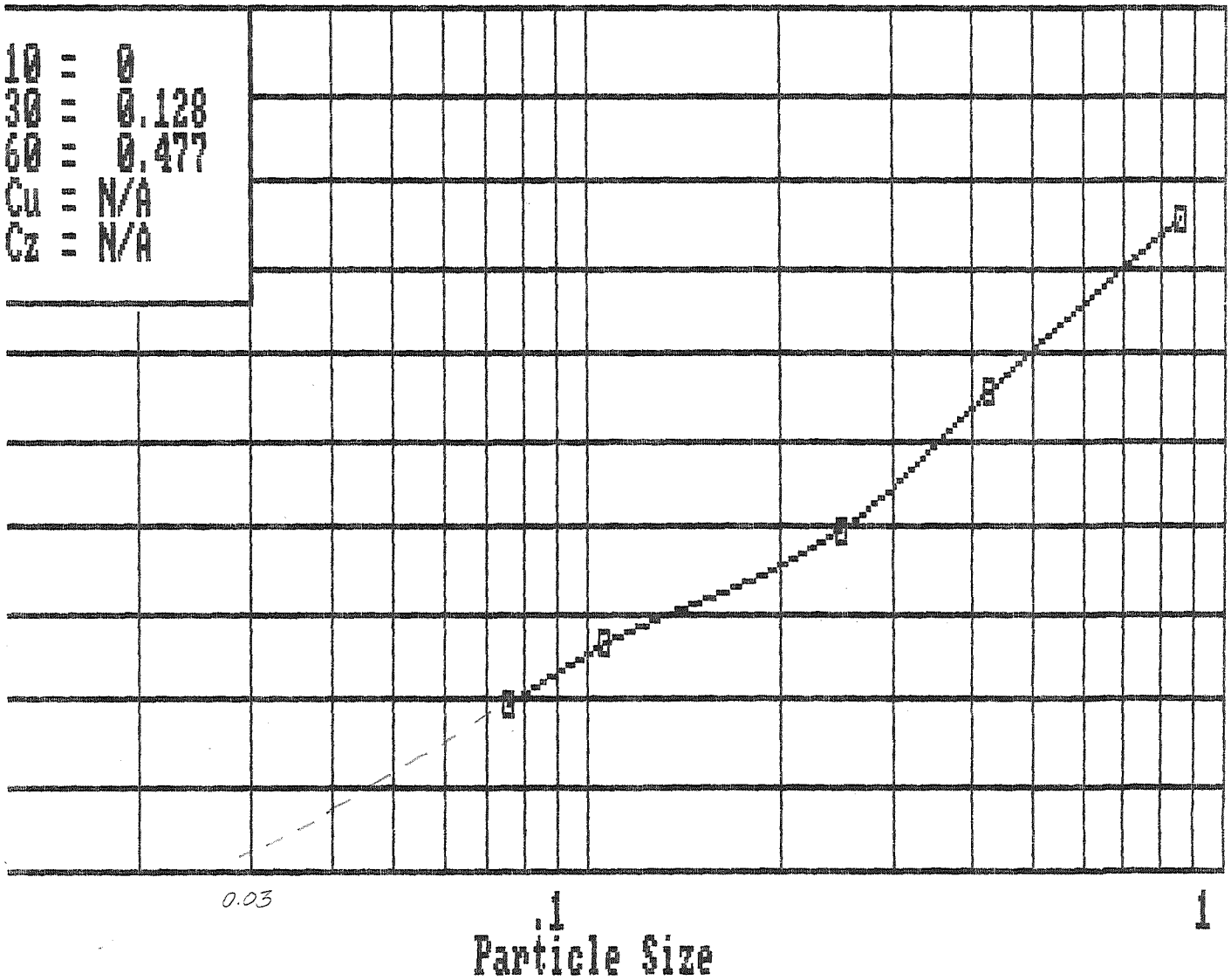


ring No. = MR-2	Depth = 65-70'	Number = 7

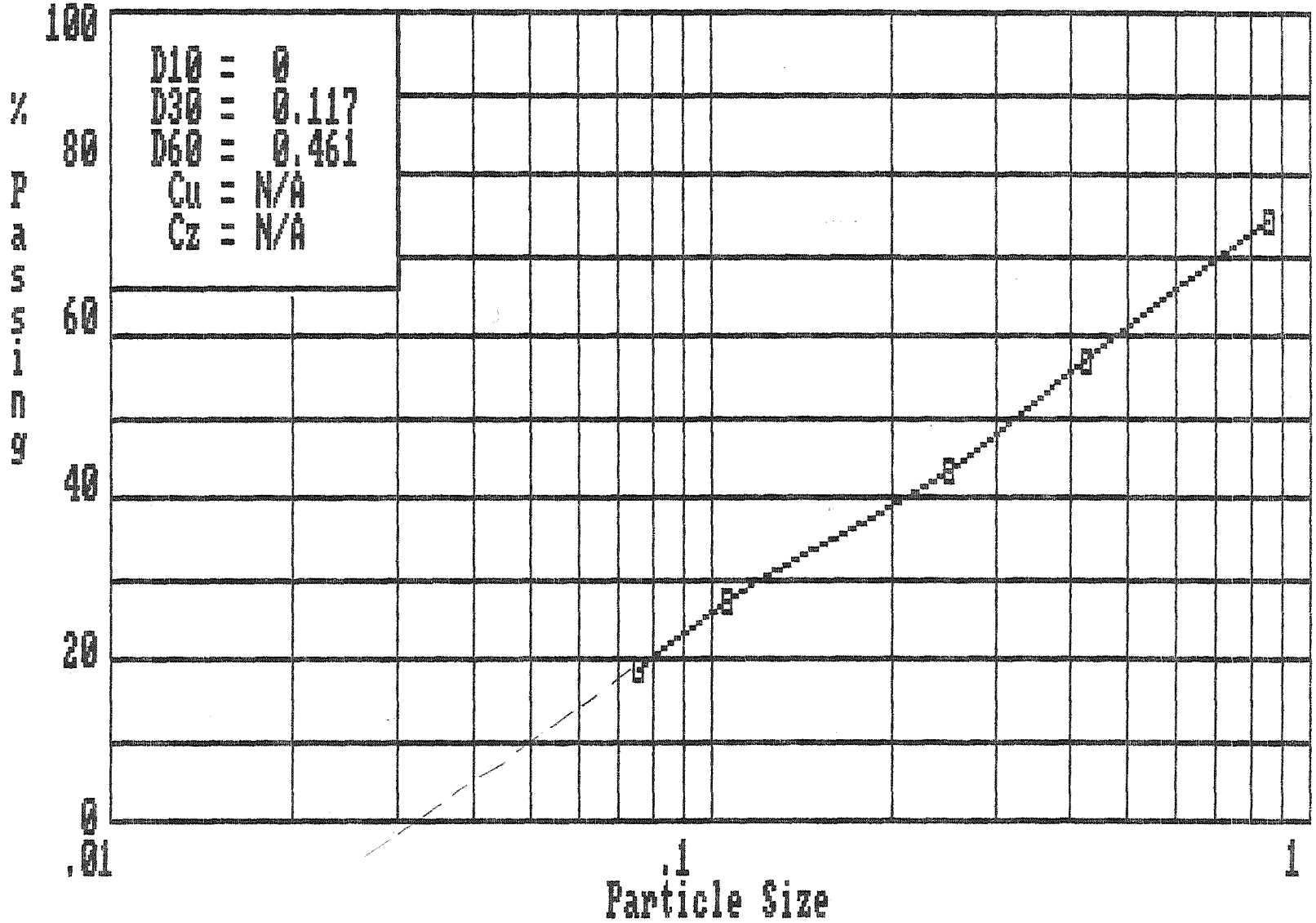
10 = 0
30 = 0.128
60 = 0.477
Cu = N/A
Cz = N/A



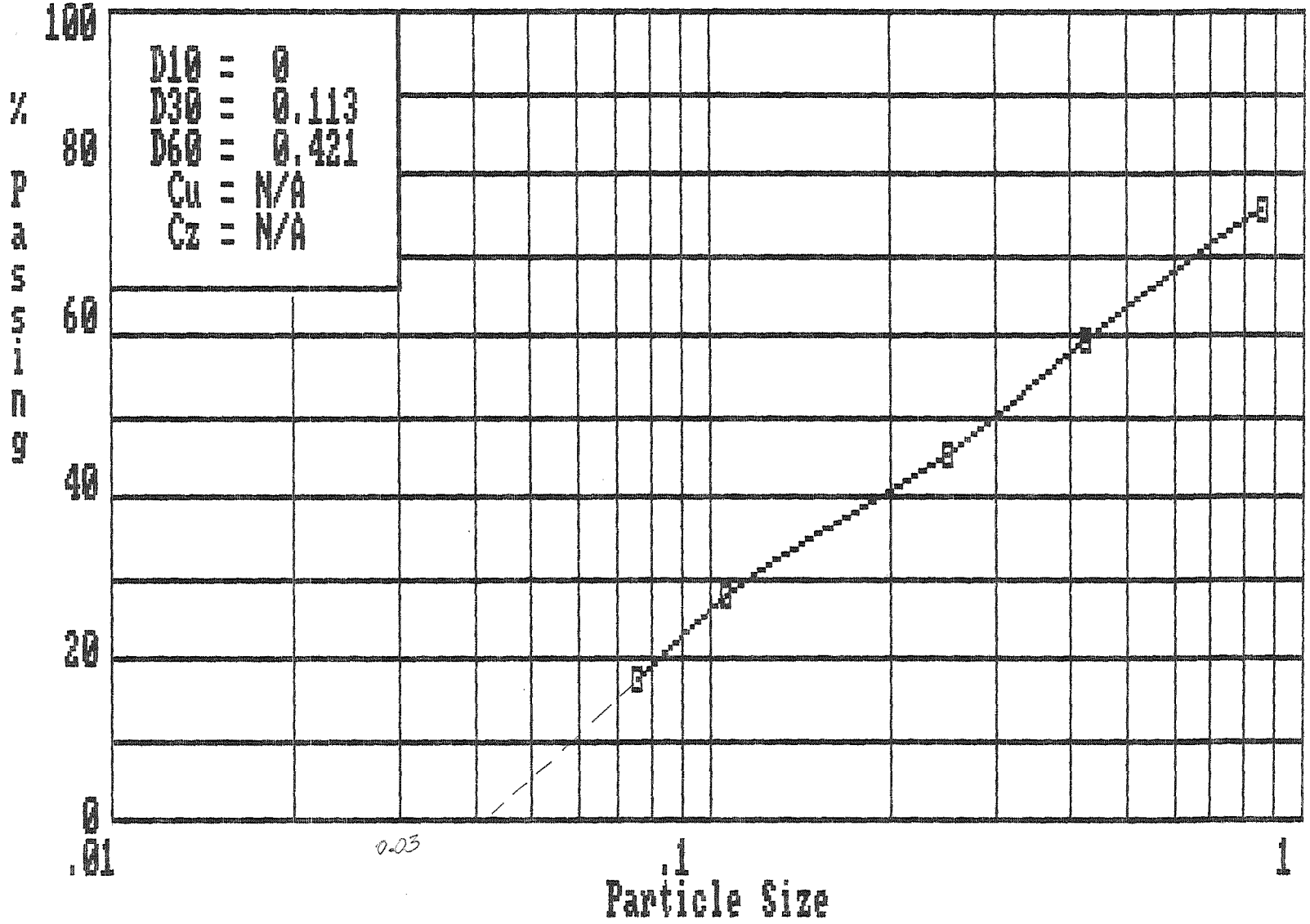
ring No. = MR-2	Depth = 65-70'	Number = 7



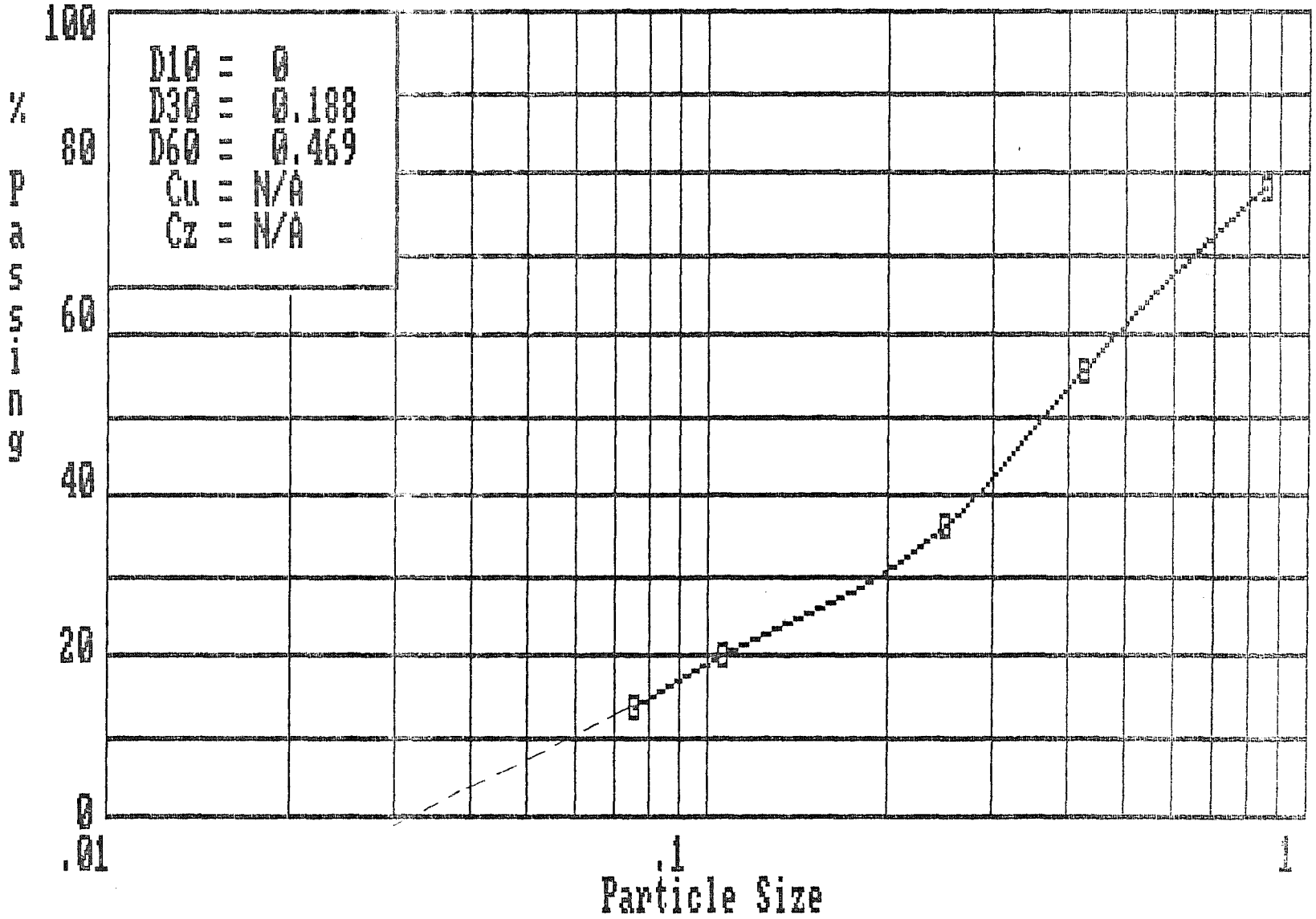
Boring No. = MR-2	Depth = 55-60'	Number = 6



Boring No. = MR-2	Depth = 45-50'	Number = 5



Boring No. = MR-2	Depth = 75-80'	Number = 8



ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. SSC

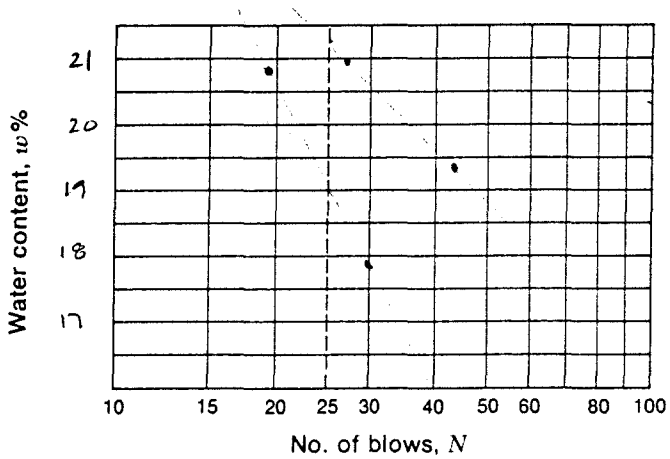
Location of Project _____ Boring No. MA-10 Sample No. 36"–5'

Description of Soil _____

Depth of Sample _____ Tested By CLM Date _____

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	59.0	54.9	58.9	67.2		
Wt. of dry soil + can	56.1	52.6	55.5	62.9		
Wt. of can	39.9	41.6	38.6	40.7		
Wt. of dry soil	16.2	11.0	16.4	22.2		
Wt. of moisture	2.90	2.30	3.40	4.30		
Water content, w%	17.90	20.91	20.73	19.37		
No. of blows, N	30	27	19	43		



Flow index F_i = ?

Liquid limit = 20

Plastic limit = 20

Plasticity index I_P = ?

NP

21
19
20

Plastic Limit Determination

Can no.	5			
Wt. of wet soil + can	55.1			
Wt. of dry soil + can	52.4			
Wt. of can	39.1			
Wt. of dry soil	13.3			
Wt. of moisture	2.70			
Water content, $w\% = w_P$	20%			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project SSC Job No. _____

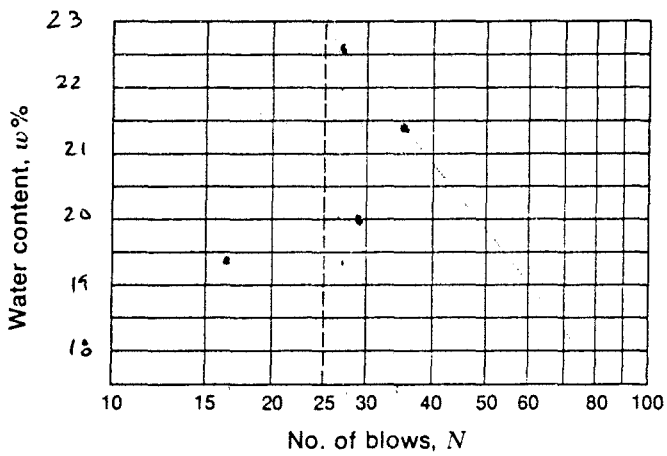
Location of Project _____ Boring No. MA-10 Sample No. 30'-30' 6"

Description of Soil _____

Depth of Sample _____ Tested By _____ Date _____

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	54.9	57.6	50.7	54.5		
Wt. of dry soil + can	52.3	54.5	48.8	51.7		
Wt. of can	39.4	40.0	39.0	39.3		
Wt. of dry soil	12.9	14.5	9.80	12.4		
Wt. of moisture	2.60	3.10	1.90	2.80		
Water content, w%	20.16	21.38	19.39	22.58		
No. of blows, N	29	35	17	27		



Flow index F_i = _____

Liquid limit = 23

Plastic limit = 19.19

Plasticity index I_P = 4

Plastic Limit Determination

Can no.	5			
Wt. of wet soil + can	50.9			
Wt. of dry soil + can	49.0			
Wt. of can	39.1			
Wt. of dry soil	9.9			
Wt. of moisture	1.90			
Water content, $w\% = w_P$	19.19			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project SSC Job No. MA-11 30' to 31'6"

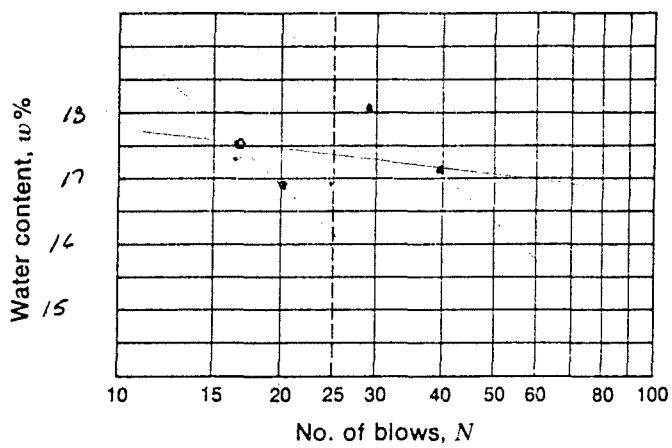
Location of Project _____ Boring No. MA-11 Sample No. _____

Description of Soil _____

Depth of Sample 30'–30'6" Tested By GM Date 2/25/89

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	61.3	55.1	63.2	63.7		
Wt. of dry soil + can	58.4	52.7	59.7	60.4		
Wt. of can	41.4	39.4	39.0	41.6		
Wt. of dry soil	17.00	13.30	20.70	18.80		
Wt. of moisture	2.90	2.40	3.50	3.30		
Water content, w%	17.06	18.05	16.91	17.55		
No. of blows, N	39	28	20	17		



Flow index F_i = _____

Liquid limit = 2

Plastic limit = 17.8%

Plasticity index I_P = _____

Plastic Limit Determination

Can no.	5			
Wt. of wet soil + can	54.2			
Wt. of dry soil + can	52.1			
Wt. of can	40.3			
Wt. of dry soil	11.8			
Wt. of moisture	2.10			
Water content, $w\% = w_P$	17.8			

ATTERBERG LIMITS DETERMINATION

Data Sheet 3

Project SSC Job No.

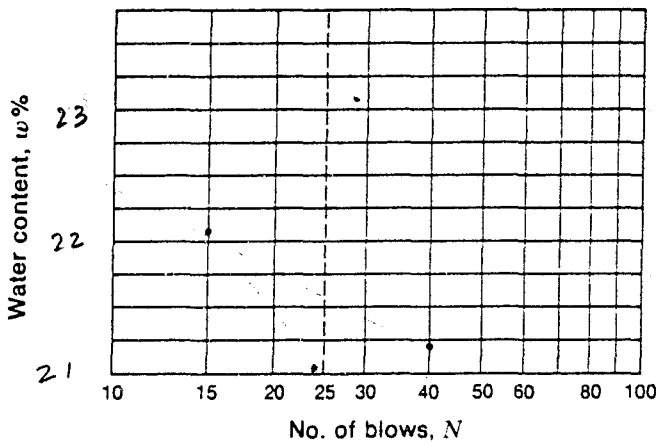
Location of Project Boring No. MA-12 Sample No. 6"-2'

Description of Soil

Depth of Sample 6"-2' Tested By GM Date 2/25/98

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	61.1	56.4	59.1	60.4		
Wt. of dry soil + can	57.3	53.2	53.2	57.2		
Wt. of can	39.4	39.3	41.3	42.7		
Wt. of dry soil	17.9	13.9	14.7	14.5		
Wt. of moisture	3.8	3.2	3.1	3.2		
Water content, w%	21.23	23.02	21.09	22.07		
No. of blows, N	40	27	24	15		



Flow index F_i = ?

Liquid limit = ?

Plastic limit = 9.23 ?

Plasticity index I_p = ?

21
21.5
22
22.7
10

Plastic Limit Determination

Can no.	5			
Wt. of wet soil + can	45.7			
Wt. of dry soil + can	45.1			
Wt. of can	38.6			
Wt. of dry soil	6.5			
Wt. of moisture	0.6			
Water content, $w\% = w_P$	9.23			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project SSC Job No. _____

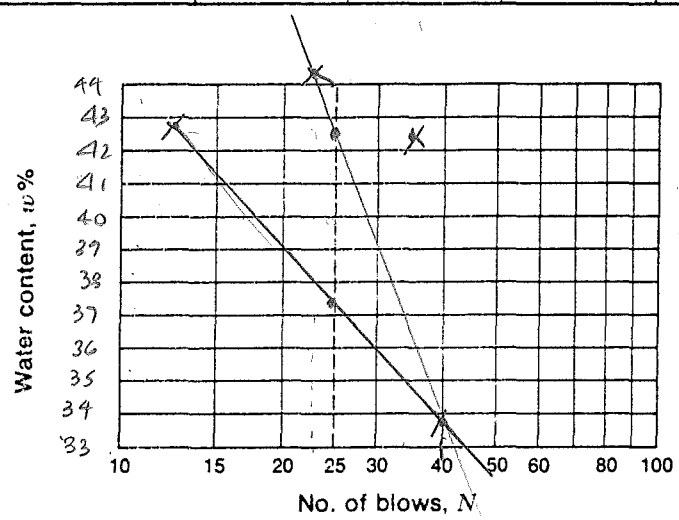
Location of Project Maricopa Boring No. MA-12 Sample No. _____

Description of Soil _____

Depth of Sample 30'3" - 32'9" Tested By GM Date 3/4/88

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	63.8	64.5	69.9	68.2		
Wt. of dry soil + can	57.7	57.1	53.5	59.9		
Wt. of can	39.6	39.7	39.1	40.5		
Wt. of dry soil	18.1	17.4	14.4	19.4		
Wt. of moisture	6.10	7.40	6.40	8.30		
Water content, w%	33.7	42.5	44.4	42.7		
No. of blows, N	40	35	22	13		



Flow index F_i = _____

Liquid limit = _____

Plastic limit = _____

Plasticity index I_P = _____

LL_{min} = 37.5 %

LL_{max} = 42.5 %

Plastic Limit Determination

Can no.				
Wt. of wet soil + can				
Wt. of dry soil + can				
Wt. of can				
Wt. of dry soil				
Wt. of moisture				
Water content, $w\% = w_P$				

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project SSC Job No. _____

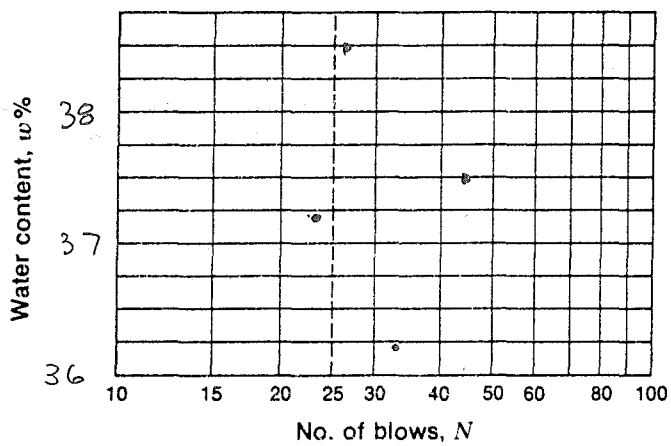
Location of Project Maricopa Boring No. MK-12 Sample No. _____

Description of Soil _____

Depth of Sample 61-63.5 Tested By GM Date 3/4/93

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	58.5	59.1	57.6	61.9		
Wt. of dry soil + can	53.4	53.7	52.5	55.7		
Wt. of can	39.7	39.3	38.5	39.6		
Wt. of dry soil	13.7	14.4	14.0	16.1		
Wt. of moisture	5.10	5.40	5.10	6.20		
Water content, w%	37.2	37.5	36.4	38.5		
No. of blows, N	23	45	32	26		



Flow index F_i = _____

Liquid limit = _____

Plastic limit = _____

Plasticity index I_p = _____

LL > 36.2%

Plastic Limit Determination

Can no.				
Wt. of wet soil + can				
Wt. of dry soil + can				
Wt. of can				
Wt. of dry soil				
Wt. of moisture				
Water content, $w\% = w_P$				

3=41
26=3n
01=2n
37=00

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. MR-1 5-10'

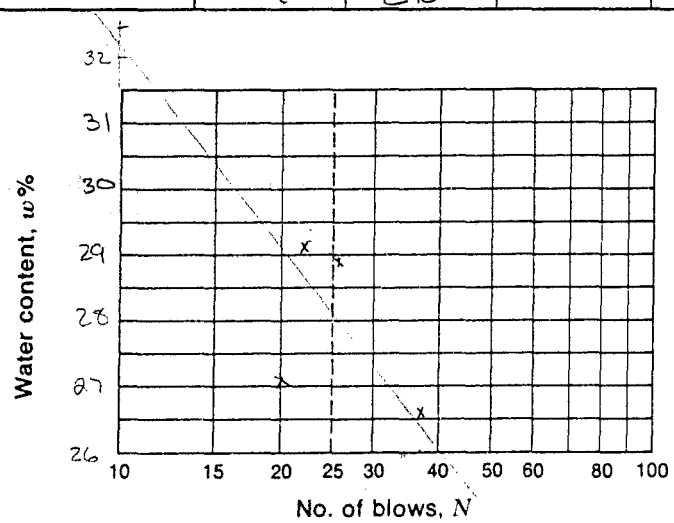
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample _____ Tested By _____ Date _____

Liquid Limit Determination

Can no.	37	26	23	20		
Wt. of wet soil + can	42.0	47.2	43.8	42.3		
Wt. of dry soil + can	39.0	43.2	40.4	39.4		
Wt. of can	27.7	29.0	28.5	28.7		
Wt. of dry soil	11.3	14.2	11.6	10.7		
Wt. of moisture	3	4	3.4	2.9		
Water content, w%	26.6	28.2	29.3	27.1		
No. of blows, N	37	26	23	20		



Flow index F_i = -24.48

Liquid limit = 28.2%

Plastic limit = _____

Plasticity index I_P = _____

$F_i \frac{41-26}{\log 41/10} = 24.48$

Plastic Limit Determination

Can no.	00	02		
Wt. of wet soil + can	41.2	42.0		
Wt. of dry soil + can	39.3	39.9		
Wt. of can	29.0	28.7		
Wt. of dry soil	10.3	11.2		
Wt. of moisture	1.9	2.1		
Water content, $w\% = w_P$	18.4	18.8		

Av wp = 18.6%

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. MR-1 15-2C

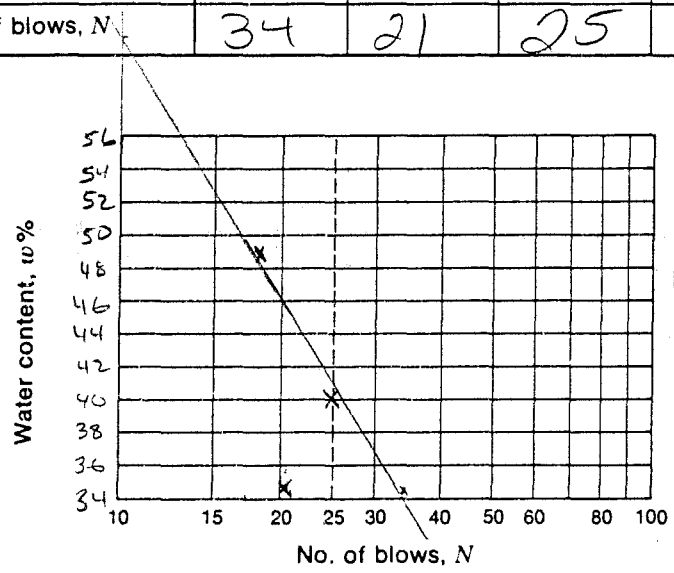
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample _____ Tested By JM Date _____

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	39.0	41.0	39.0	43.4		
Wt. of dry soil + can	36.3	37.8	35.8	38.7		
Wt. of can	28.5	28.6	27.8	29.1		
Wt. of dry soil	7.8	9.2	8.0	9.6		
Wt. of moisture	2.7	3.2	3.2	4.7		
Water content, w%	34.6	34.7	40.0	49.0		
No. of blows, N	34	21	25	17		



Flow index F_i = 52.9

Liquid limit = 41

Plastic limit = 21.9

Plasticity index I_P = 19.1

$$F_i = \frac{62.1 - 34}{\log \frac{34}{10}} = 52.9$$

Plastic Limit Determination

Can no.	5	6		
Wt. of wet soil + can	36.5			
Wt. of dry soil + can	35.1			
Wt. of can	28.7	29.2		
Wt. of dry soil	6.4			
Wt. of moisture	1.4			
Water content, $w\% = w_P$	21.9			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project MR-1 Job No. _____

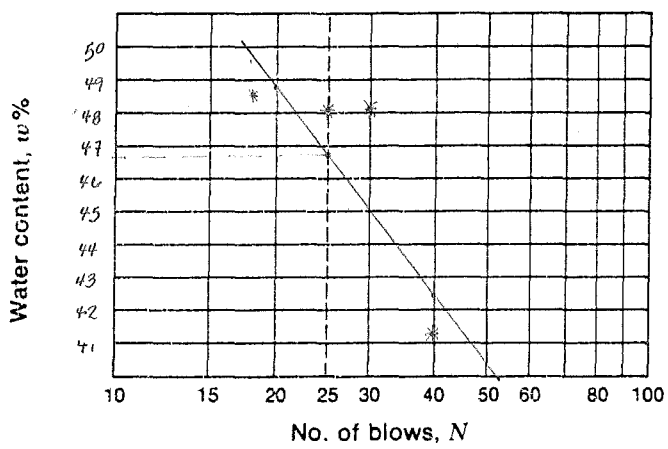
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample 15-20 Tested By _____ Date 2/26/88

Liquid Limit Determination

Can no.	4	2	3	1		
Wt. of wet soil + can	39.8	35.5	36.1	37.8		
Wt. of dry soil + can	36.5	33.0	33.6	34.4		
Wt. of can	28.5	27.8	28.4	27.4		
Wt. of dry soil	8.0	5.2	5.2	7.0		
Wt. of moisture	3.3	2.5	2.5	3.4		
Water content, w%	41.25	48.1	48.1	48.6		
No. of blows, N	40	30	25	18		



Flow index F_i = -9.23

Liquid limit = 46.8 %

Plastic limit = 21.45 %

Plasticity index I_P = 25.35 %

$$F_i = \frac{41.4 - 48.8}{\log 40/20} = -9.23$$

Plastic Limit Determination

Can no.	5	6		
Wt. of wet soil + can	29.6	11.5		
Wt. of dry soil + can	29.5	11.3		
Wt. of can	28.8	10.6		
Wt. of dry soil	0.7	0.7		
Wt. of moisture	0.1	0.2		
Water content, $w\% = w_P$	14.3	28.6		

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project MR-1 Job No. _____

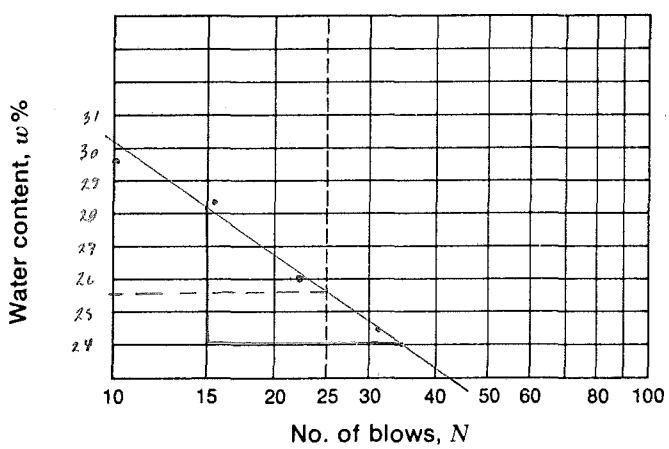
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample 25-30 Tested By _____ Date 2/25/88

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	38.1	36.4	37.7	43.3		
Wt. of dry soil + can	36.0	34.6	35.6	39.9		
Wt. of can	27.4	27.7	28.2	28.4		
Wt. of dry soil	8.6	6.9	7.4	11.5		
Wt. of moisture	2.1	1.8	2.1	3.4		
Water content, w%	24.42	26.09	28.38	29.6		
No. of blows, N	32	23	16	10		



Flow index F_i = −4.96

Liquid limit = 25.6 %

Plastic limit = 21.88 %

Plasticity index I_P = 3.72 %

$$F_i = \frac{24 - 28.2}{\log 35/15} = -4.96$$

Plastic Limit Determination

Can no.	5	6		
Wt. of wet soil + can	32.7			
Wt. of dry soil + can	32.0			
Wt. of can	28.8	10.6		
Wt. of dry soil	3.2			
Wt. of moisture	0.7			
Water content, $w\% = w_P$	21.88			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project MR-1 Job No. _____

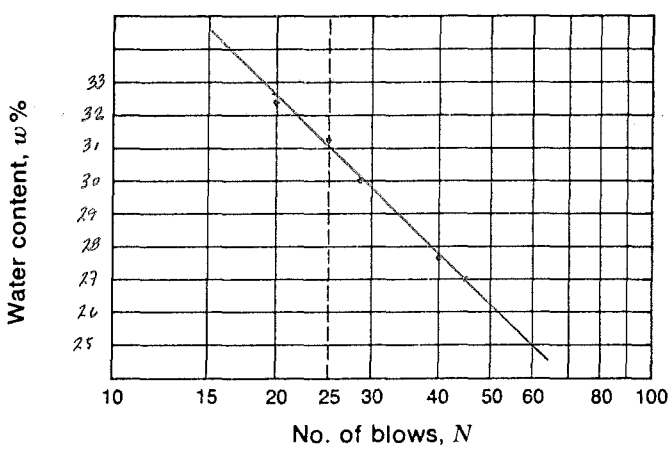
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample 35-40 Tested By _____ Date 2/25/88

Liquid Limit Determination

Can no.	2	1	3	4		
Wt. of wet soil + can	42.7	42.8	46.5	41.3		
Wt. of dry soil + can	39.7	39.5	42.7	38.2		
Wt. of can	28.9	28.5	30.50	28.6		
Wt. of dry soil	10.8	11.0	12.2	9.6		
Wt. of moisture	3.0	3.3	3.8	3.1		
Water content, w%	27.78	30.0	31.15	32.3		
No. of blows, N	40	28	25	19		



Flow index F_i = -6.91

Liquid limit = 31.00 %

Plastic limit = 17.15 %

Plasticity index I_P = 13.85 %

$$F_i = \frac{27 - 32.6}{\log 45/20} = -6.91$$

Plastic Limit Determination

Can no.	5	4		
Wt. of wet soil + can	28.6	10.9		
Wt. of dry soil + can	28.5	10.8		
Wt. of can	28.0	10.1		
Wt. of dry soil	0.5	0.7		
Wt. of moisture	0.1	0.1		
Water content, $w\% = w_P$	20	14.3		

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project MR-2 Job No. _____

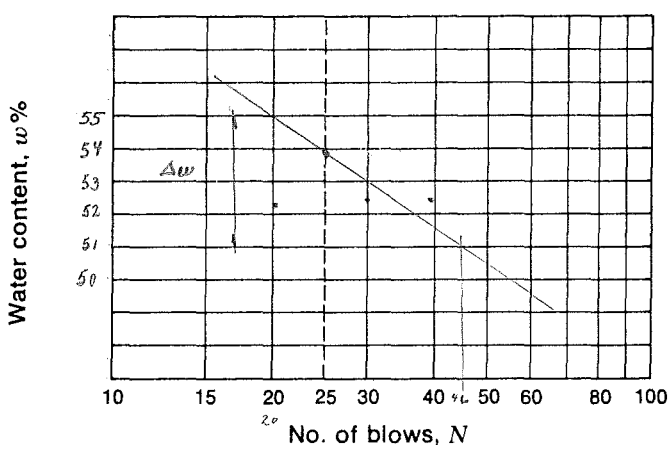
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample 5-10 Tested By _____ Date 2/24/88

Liquid Limit Determination

Can no.	1	2	3	5		
Wt. of wet soil + can	39.8	40.0	40.0	42.2		
Wt. of dry soil + can	35.5	35.9	35.9	37.5		
Wt. of can	27.3	27.7	28.3	28.5		
Wt. of dry soil	8.2	8.2	7.6	9.0		
Wt. of moisture	4.3	4.3	4.1	4.7		
Water content, w%	52.44	52.44	53.95	52.22		
No. of blows, N	39	30	25	20		



Flow index F_i = -4.74

Liquid limit = 54%

Plastic limit = 50%

Plasticity index I_p = 4%

$$F_i = \frac{\Delta w}{\log N_2/N_1} = \frac{51 - 54.95}{\log 46/20} = -4.74$$

Plastic Limit Determination

Can no.	4			
Wt. of wet soil + can	29.7			
Wt. of dry soil + can	29.4			
Wt. of can	28.8			
Wt. of dry soil	0.6			
Wt. of moisture	0.3			
Water content, $w\% = w_p$	50			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. MR-2 15-20'

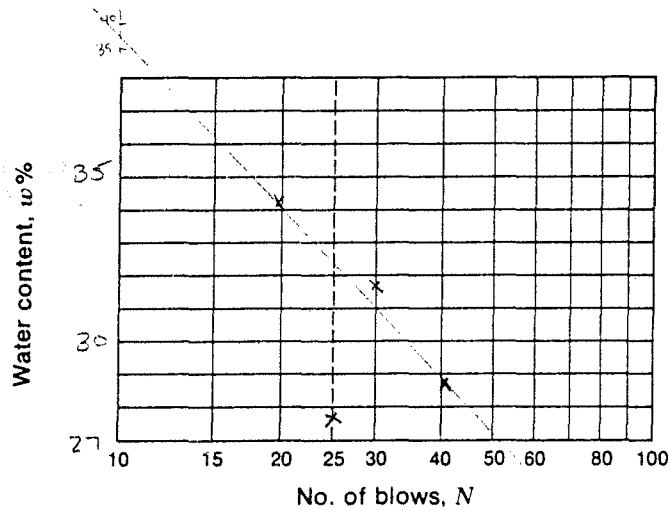
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample _____ Tested By _____ Date _____

Liquid Limit Determination

Can no.	41	30	25	19		
Wt. of wet soil + can	42.4	42.7	51.8	51.4		
Wt. of dry soil + can	39.3	39.4	46.6	45.6		
Wt. of can	28.5	29.0	29.3	28.7		
Wt. of dry soil	10.8	10.4	17.3	16.9		
Wt. of moisture	3.1	3.3	4.8	5.8		
Water content, w%	28.7	31.7	27.7	34.3		
No. of blows, N	41	30	25	19		



Flow index F_i = 17.5

Liquid limit = 32.4

Plastic limit = _____

Plasticity index I_P = _____

Plastic Limit Determination

Can no.	00	01		
Wt. of wet soil + can	41.0	43.6		
Wt. of dry soil + can	38.7	40.8		
Wt. of can	27.7	28.7		
Wt. of dry soil	11.0	12.1		
Wt. of moisture	2.3	2.8		
Water content, $w\% = w_P$	20.9	23.1		

Av w_P = 22.0%

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. MR-2 25-30

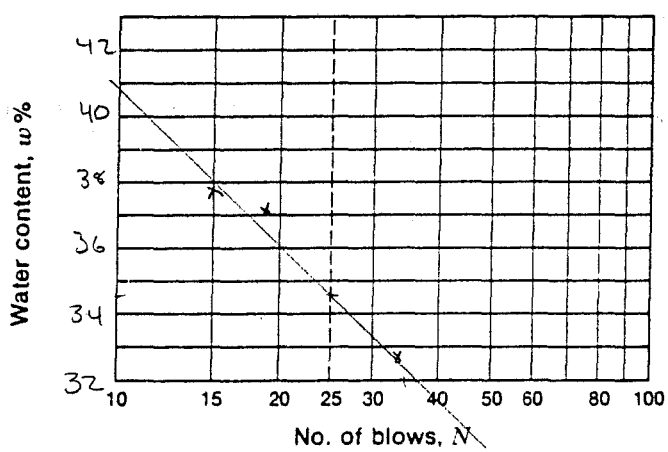
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample _____ Tested By JM Date _____

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	45.0	48.6	46.7	44.3		
Wt. of dry soil + can	41.3	43.5	41.8	40.6		
Wt. of can	30.0	28.9	28.6	30.8		
Wt. of dry soil	11.3	14.6	13.2	9.8		
Wt. of moisture	3.7	5.1	4.9	3.7		
Water content, w%	32.7	14.4	37.1	37.8		
No. of blows, N	34	28	18	15		



Flow index F_i = 15.5

Liquid limit = 34.6

Plastic limit = 27.0

Plasticity index I_P = 7.6

$$F_i = \frac{40.8 - 32}{\log(37/10)} =$$

Plastic Limit Determination

Can no.	6			
Wt. of wet soil + can	38.6			
Wt. of dry soil + can	36.6			
Wt. of can	29.2			
Wt. of dry soil	7.4			
Wt. of moisture	2.0			
Water content, $w\% = w_P$	27.0			

ATTERBERG LIMITS DETERMINATION Data Sheet 3

Project _____ Job No. MR-2 35-40

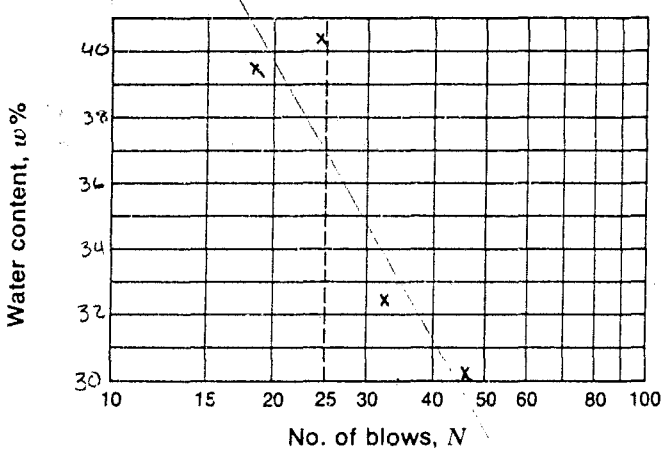
Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____

Depth of Sample _____ Tested By JM Date _____

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	42.1	45.0	41.7	45.8		
Wt. of dry soil + can	38.9	41.2	37.8	40.9		
Wt. of can	28.3	29.5	28.2	28.5		
Wt. of dry soil	10.6	11.7	9.6	12.4		
Wt. of moisture	3.2	3.8	3.9	4.9		
Water content, w%	30.2	32.5	40.6	39.5		
No. of blows, N	47	33	24	17		



Flow index F_i = 28.

Liquid limit = 37.0

Plastic limit = 20.1

Plasticity index I_P = 16.9

$F_i \quad \frac{48.3 - 30}{\log 45/10} = 28$

Plastic Limit Determination

Can no.	5	6		
Wt. of wet soil + can	40.9	35.4		
Wt. of dry soil + can	39.3	34.1		
Wt. of can	30.6	28.1		
Wt. of dry soil	8.7	6.0		
Wt. of moisture	1.6	1.3		
Water content, $w\% = w_P$	18.4	21.7		

w_p ave. 20.1

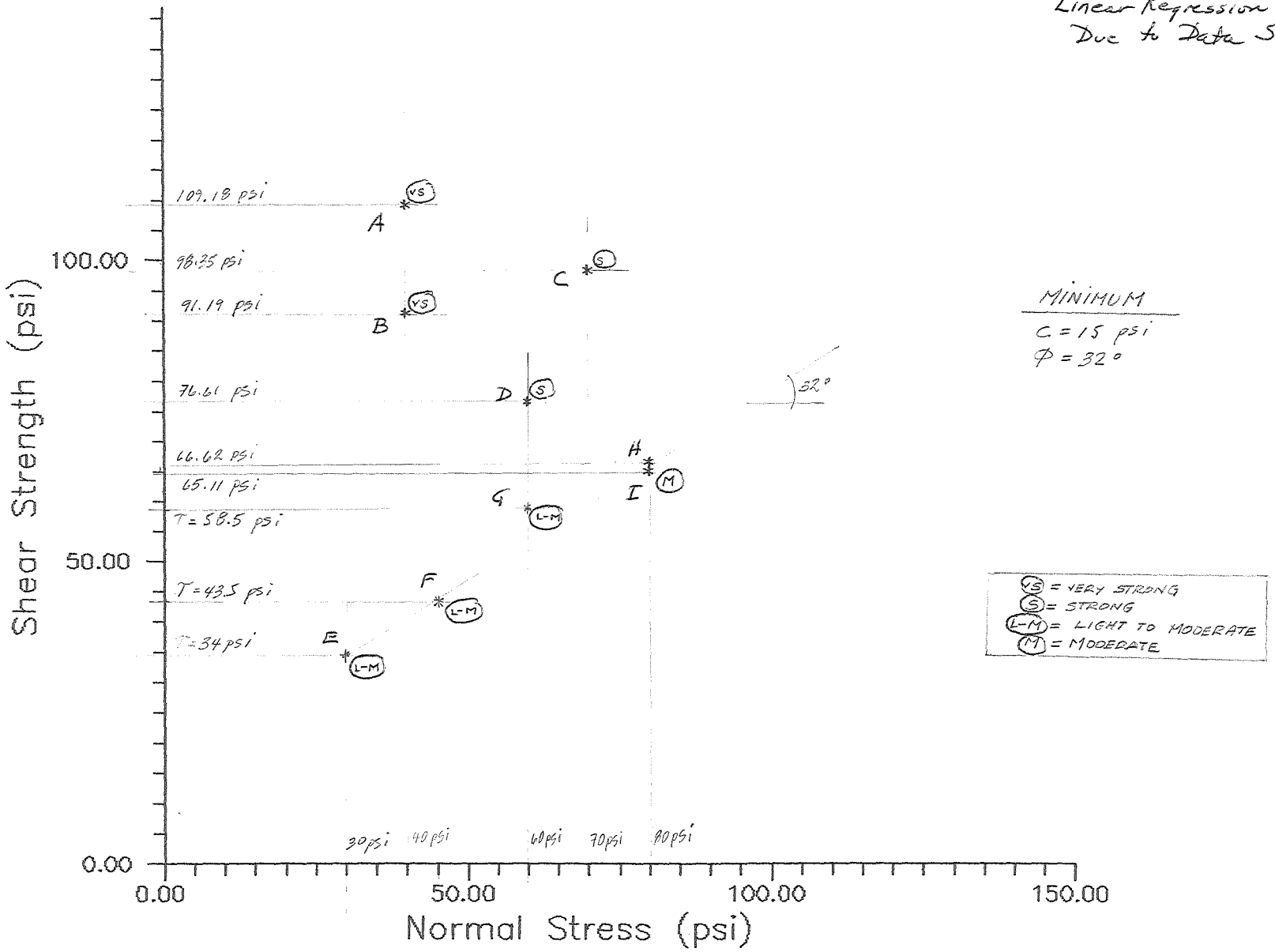
C.2 -- Direct Shear Test Data

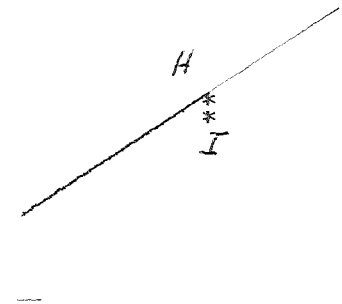
MA-12

CURVE	DEPTH	NORMAL STRESS (PSI)	SHEAR STRESS (PSI)
A	61' - 63'5"	40	109.18
B	61' - 63'5"	40	91.19
C	61' - 63'5"	70	98.35
D	61' - 63'5"	60	76.61
E	30'2" - 32" 9'	30	34.00
F	30'2" - 32" 9'	45	43.50
G	30'2" - 32" 9'	60	58.50
H	61' - 63'5"	80	66.62
I	61' - 63'5"	80	65.11

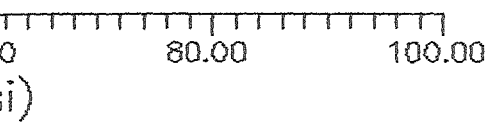
MA-12

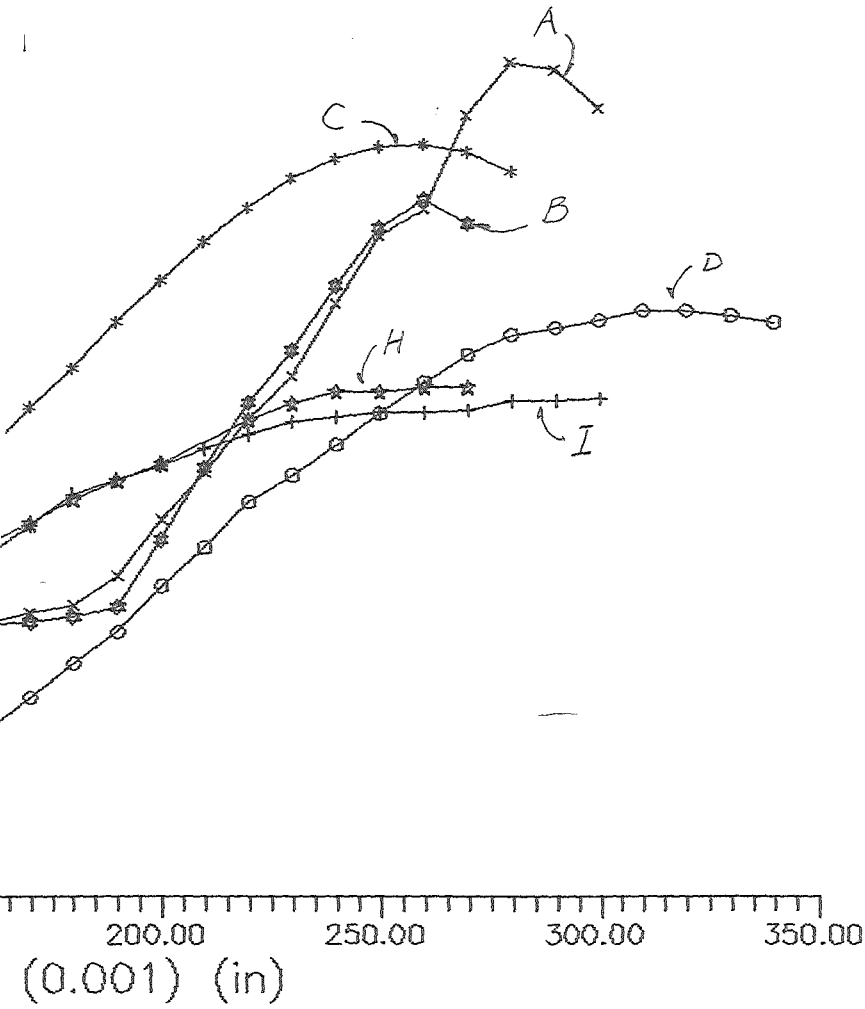
Direct Shear Test Results
Considering All Points.
Linear Regression Not Applied
Due to Data Scatter.

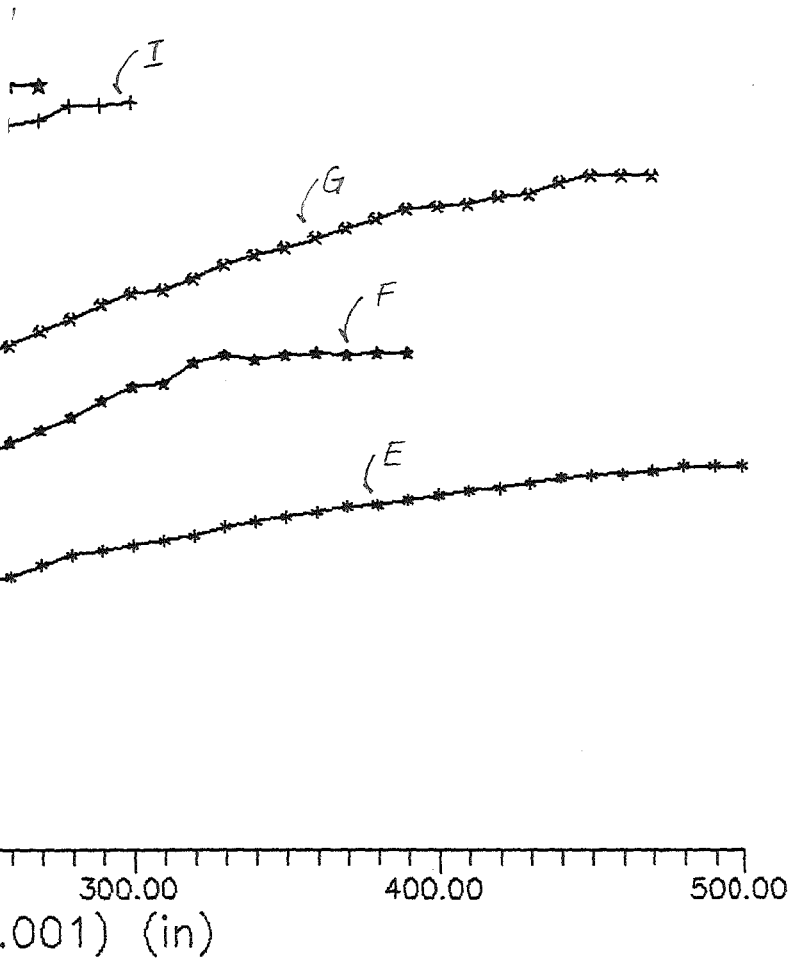


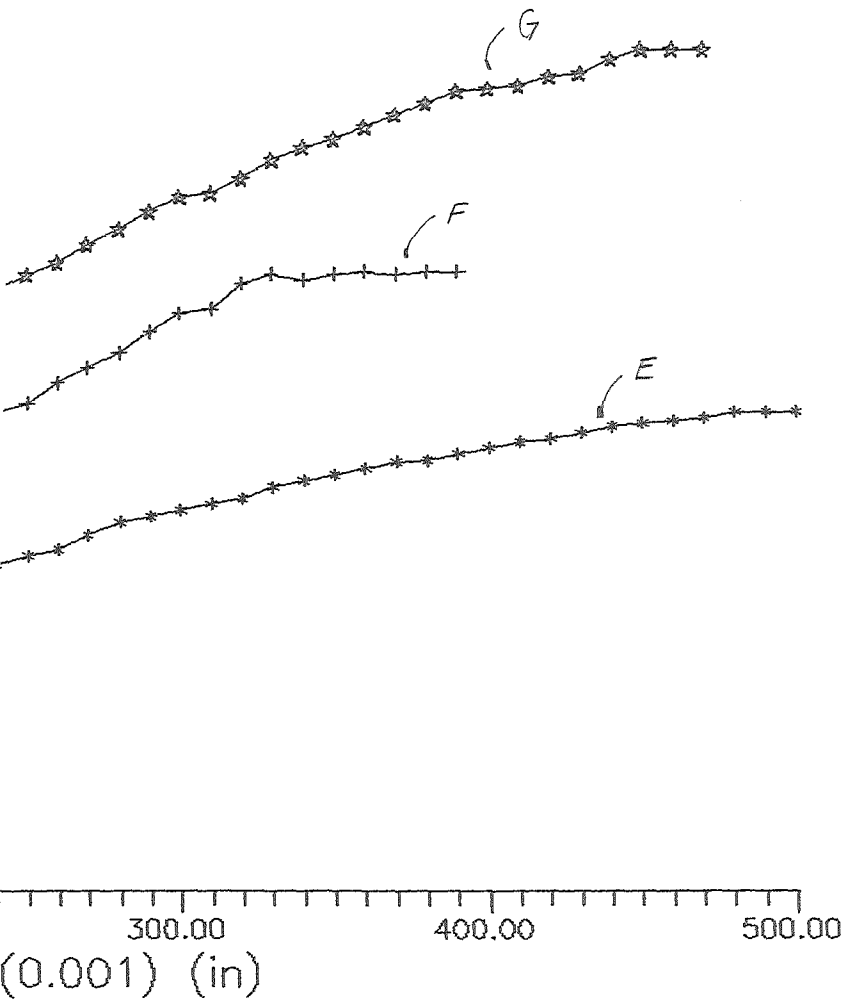


$\phi = 32°$
$c = 15.5$ psi




A
C
B
D
H
I
200.00
250.00
300.00
350.00
(0.001) (in)

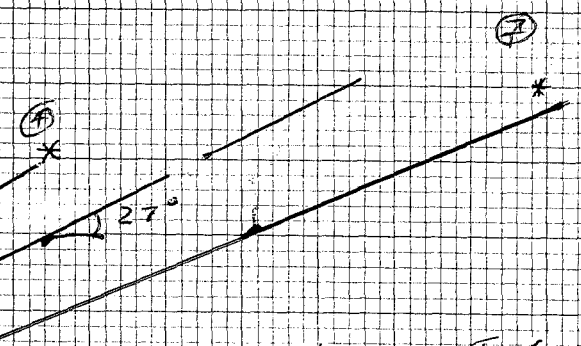

I
G
F
E
300.00
400.00
500.00
.001) (in)


G
F
E
300.00
400.00
500.00
(0.001) (in)

MD-12

CURVE	DEPTH	NORMAL STRESS (PSI)	SHEAR STRESS (PSI)
A	37'7" - 38'	3.31	83.91
B	37'7" - 38'	15.00	92.76
C	54'5" - 55'1"	30.00	76.30
D	51'9" - 52'5"	50.00	79.00
E	40'6" - 40'11"	70.00	105.25
F	42'11" - 43'4"	134.60	140.90
G	44'10" - 45'4"	199.00	149.30

E. Muller 2/16/88

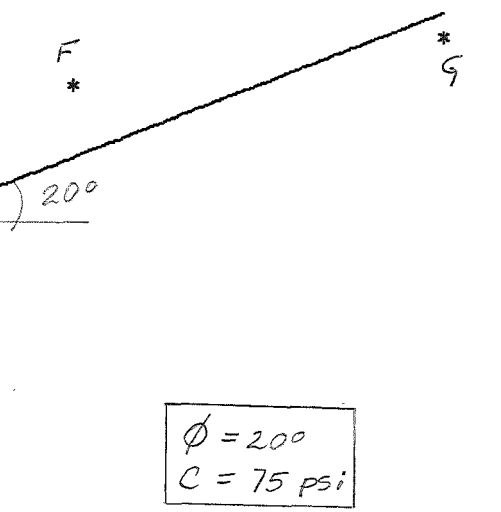


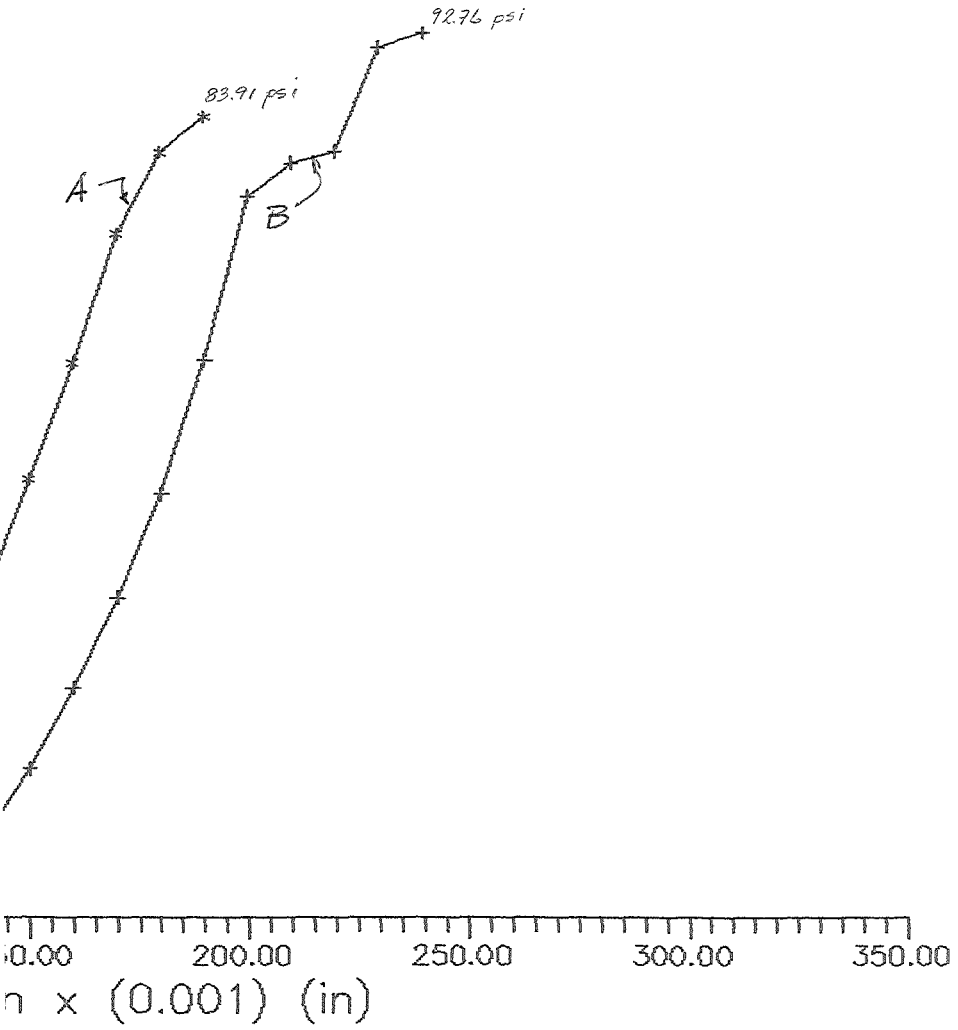
Interval	σ_n (psi)	τ_f (psi)	
37'7" to 38'	3.31	83.8	1
37'7" to 38'	15.0	92.7	2
40'6" to 40'11"	70.1	105.3	3
42'11" to 43'4"	134.7	140.9	4
54'5" to 55'1"	30	76.3	5
51'9" to 52'5"	50	79.0	6
44'10" to 45'4"	200	149.3	7

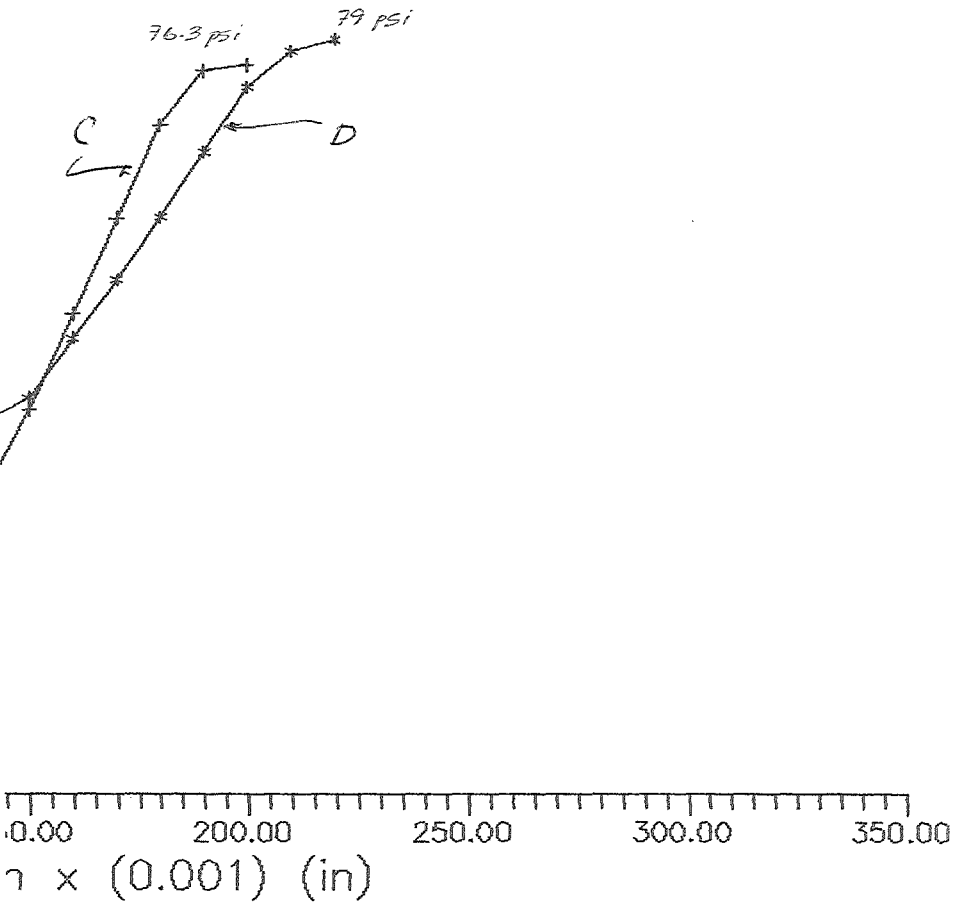
$\times 27^0$

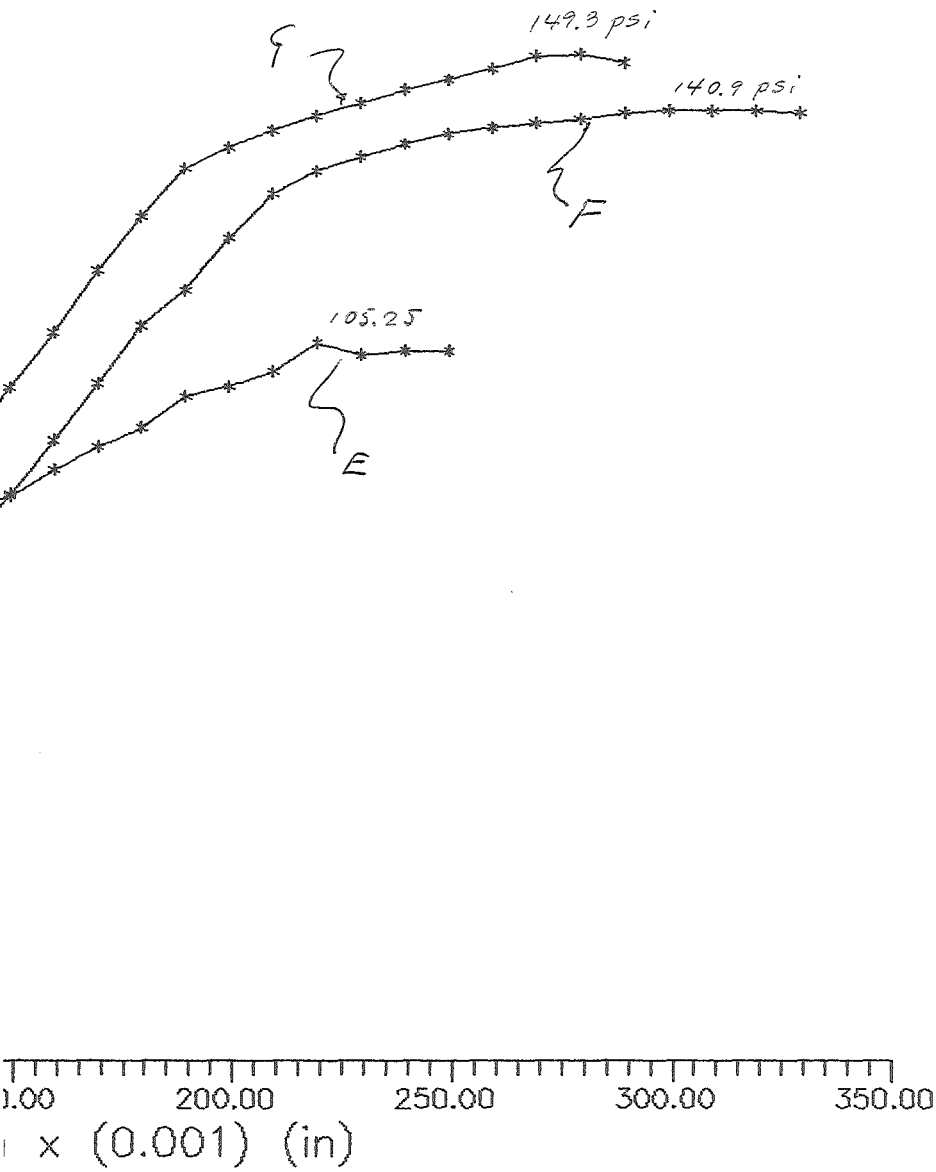
30 140 150 160 170 180 190 200

Direct Shear Test Results
Considering All Points.
Curve by Linear Regression




92.76 psi
83.91 psi
A
B
0.00
200.00
250.00
300.00
350.00
n x (0.001) (in)


76.3 psi
79 psi
C
D
0.00
200.00
250.00
300.00
350.00
n x (0.001) (in)


149.3 psi
140.9 psi
105.25
G
F
E
200.00
250.00
300.00
350.00
x (0.001) (in)

Direct Shear Test Results
Considering Selected Points
Curve by Linear Regression

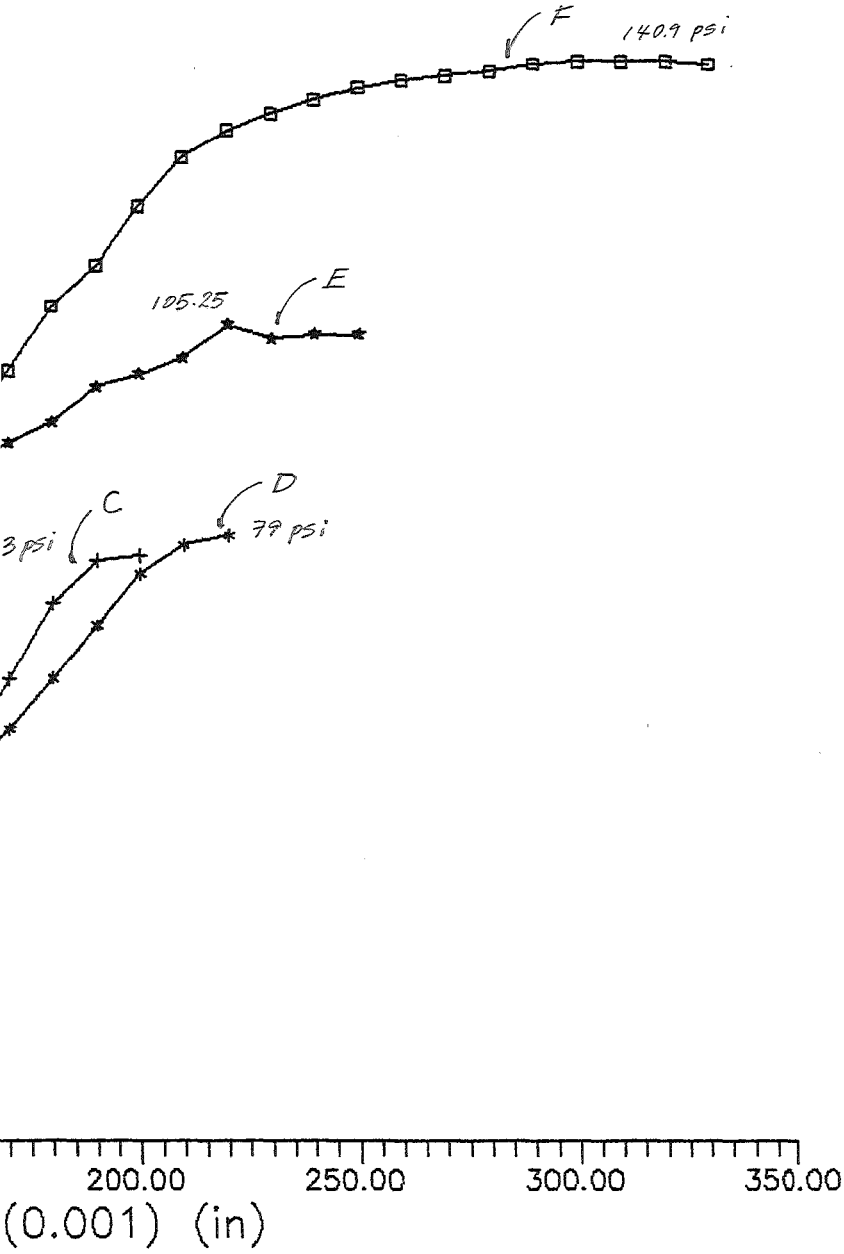
-12

F

$\phi = 32°$
$C = 54$ psi

150.00 200.00

)


F
140.9 psi
E
105.25
D
C
3 psi
79 psi
200.00
250.00
300.00
350.00
(0.001) (in)

le MA-12

(in)	w %	γ_t (pcf)	γ_d (pcf)	E	S %
.00	3.45	106.9	103.2	0.60	15.2
.014	4.44	109.3	104.6	0.58	20.3
7	7.48	105.9	98.6	0.65	29.2
.06	7.10	106.1	99.1	0.67	29.2
.12	17.37	109.8	93.5	0.77	59.9
3	12.7	102.9	91.3	0.91	41.0
3	12.0	104.3	93.2	0.77	41.0
3	12.7	100.7	89.2	0.88	40.1

Samples Hole # MD-12

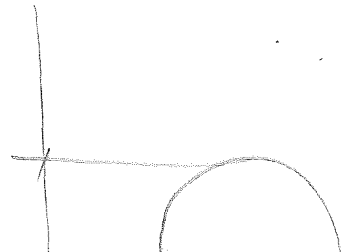
Moisture content (%)	γ_t (pcf)	γ_d (pcf)	S (%)	E
8.07	128.1	118.5	54.2	0.40
12.72	129.5	114.9	76.7	0.44
12.77	130.0	115.2	77.8	0.43
11.46	130.7	117.3	74.1	0.41
11.62	126.4	113.3	66.9	0.46
28.38	130.81	101.9	120.8*	0.62
7.20	140.0	130.5	71.6	0.27
9.17	136.2	124.7	74.6	0.33
12.46	125.1	111.2	67.9	0.49
12.54	131.2	116.6	79.4	0.42
8.90	117.6	108.0	44.4	0.53
7.87	129.4	120.0	55.1	0.38
10.38	132.8	120.3	73.4	0.37

* part of sample lost during testing

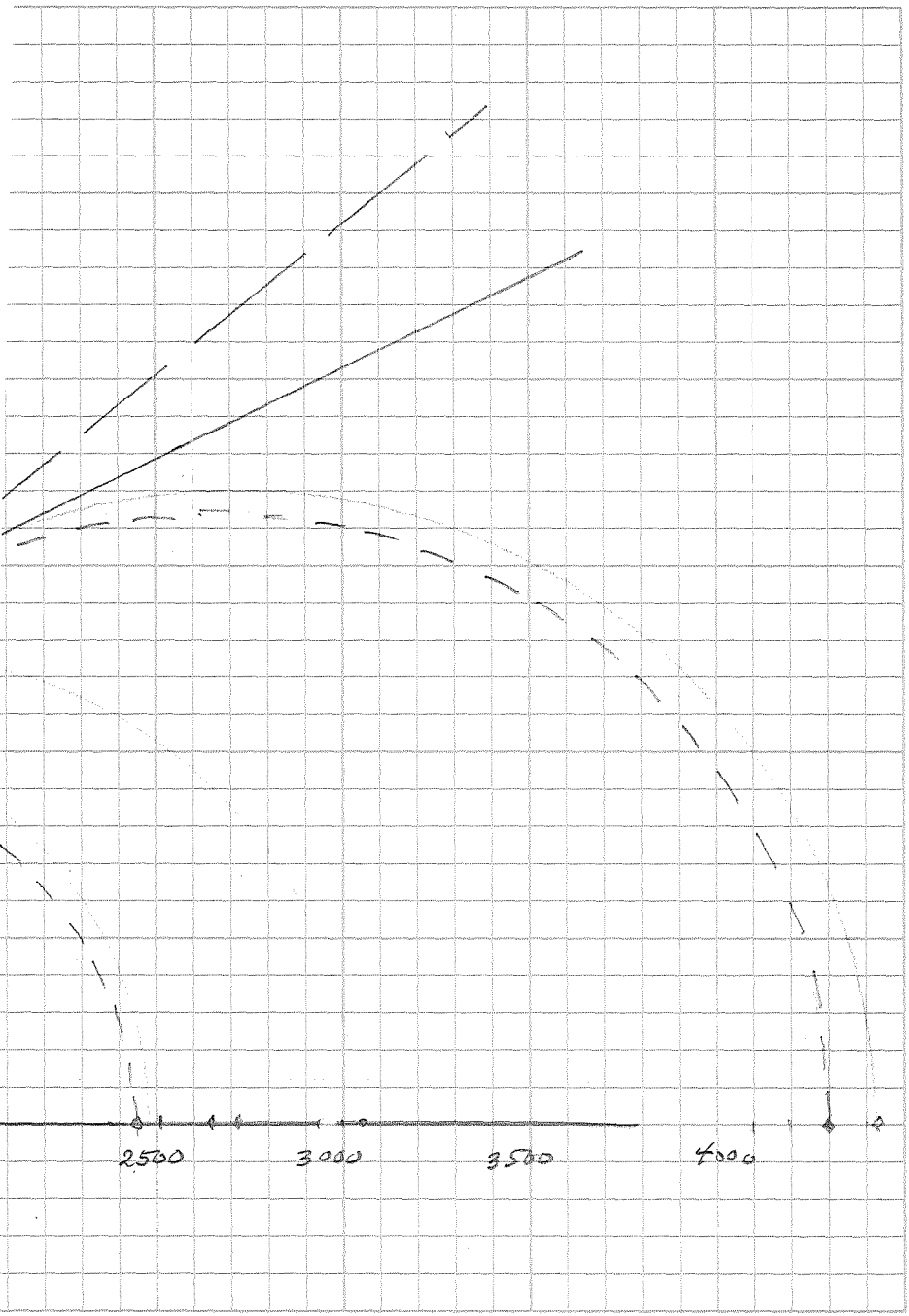
C.3 -- Triaxial Test Data

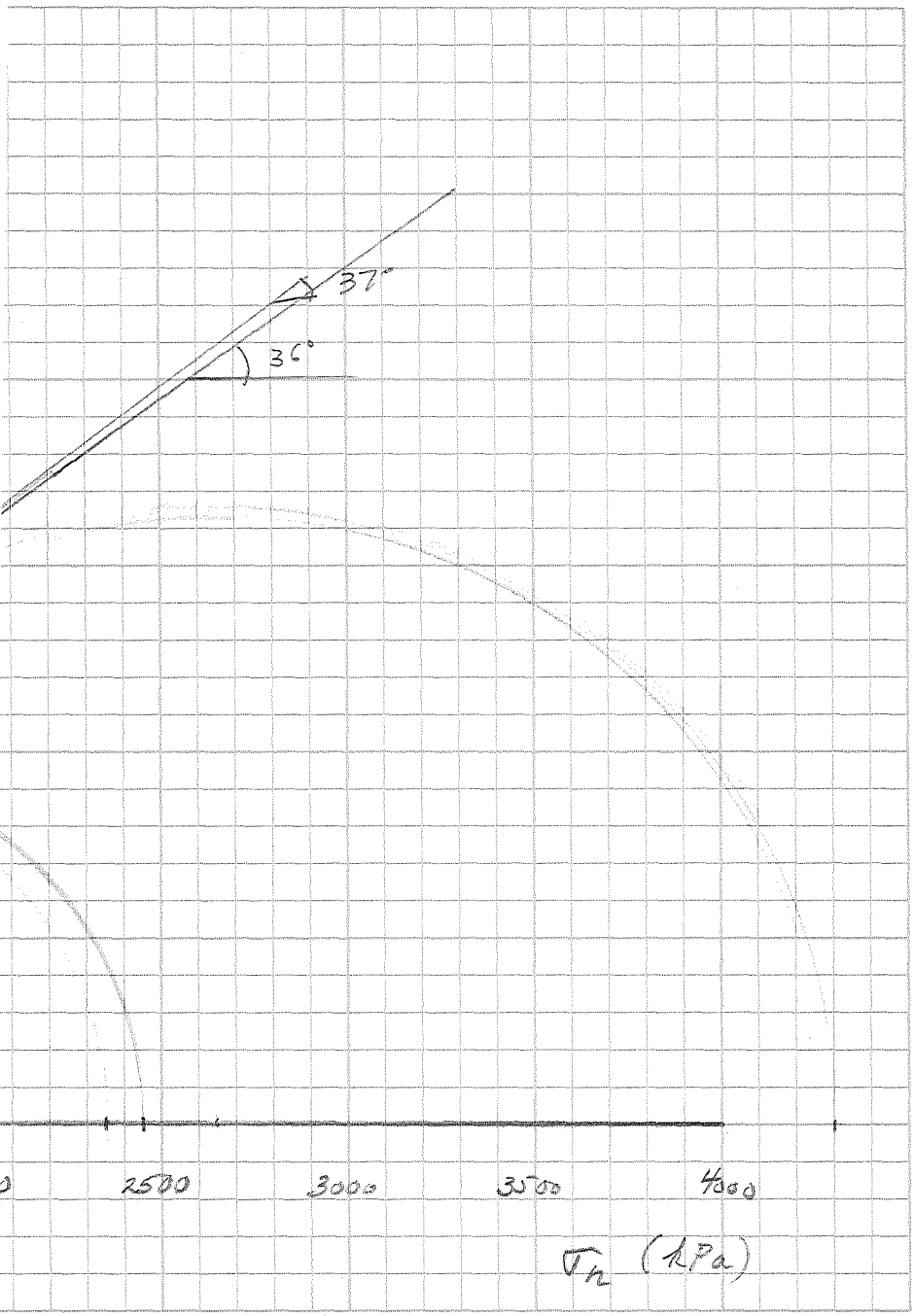
	Sample #	σ_v'	σ_3 (kPa)	σ_{1p}	"Δu_p" (kPa)	$\sigma_{1(5\%)}$	"$\Delta u_{5\%}$"
Trial	44	5580 psf / 279 kPa	274	2504	1115	1300	513
	47	5921 psf / 296 kPa	500	3053	1277	2450	975
	54 *	6780 psf / 339 kPa	1000	4422	1711	4300	1650
	51 *	6448 psf / 322 kPa	308	2929	1311	1700	696
	59 * (1)	7378 psf / 369 kPa	356	2213	929	1800	722
	62 *	7750 psf / 388 kPa	370	3228	1429	2350	990

* Capped

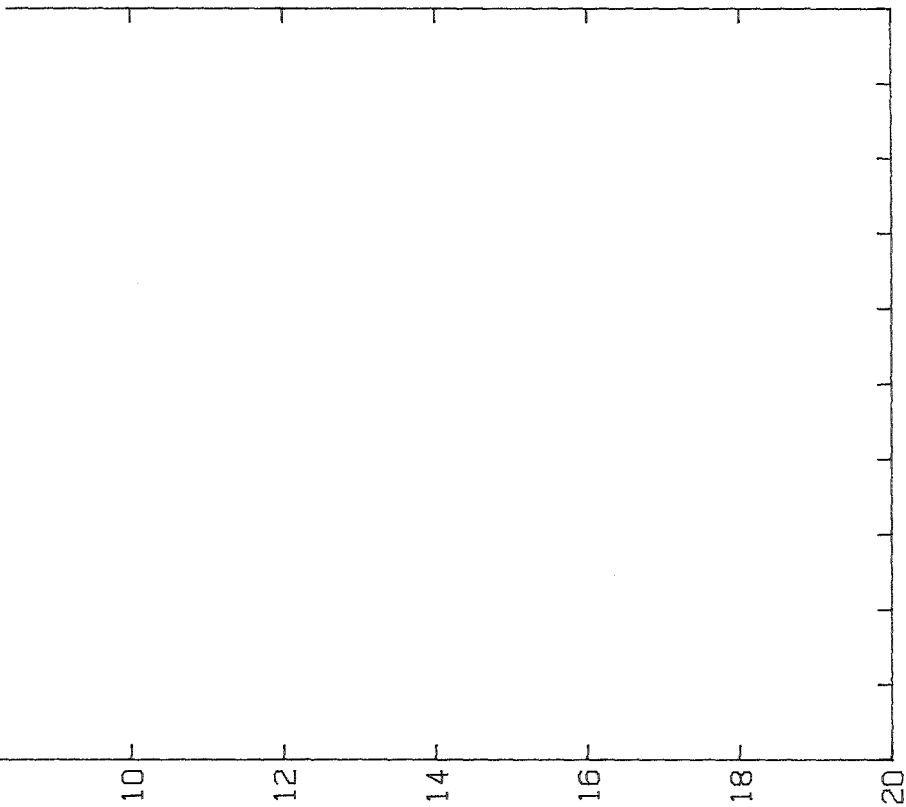


NATIONAL 42-381 50 SHEETS 5 SQUARE 42-382 100 SHEETS 5 SQUARE 42-389 200 SHEETS 5 SQUARE Made in U.S.A.

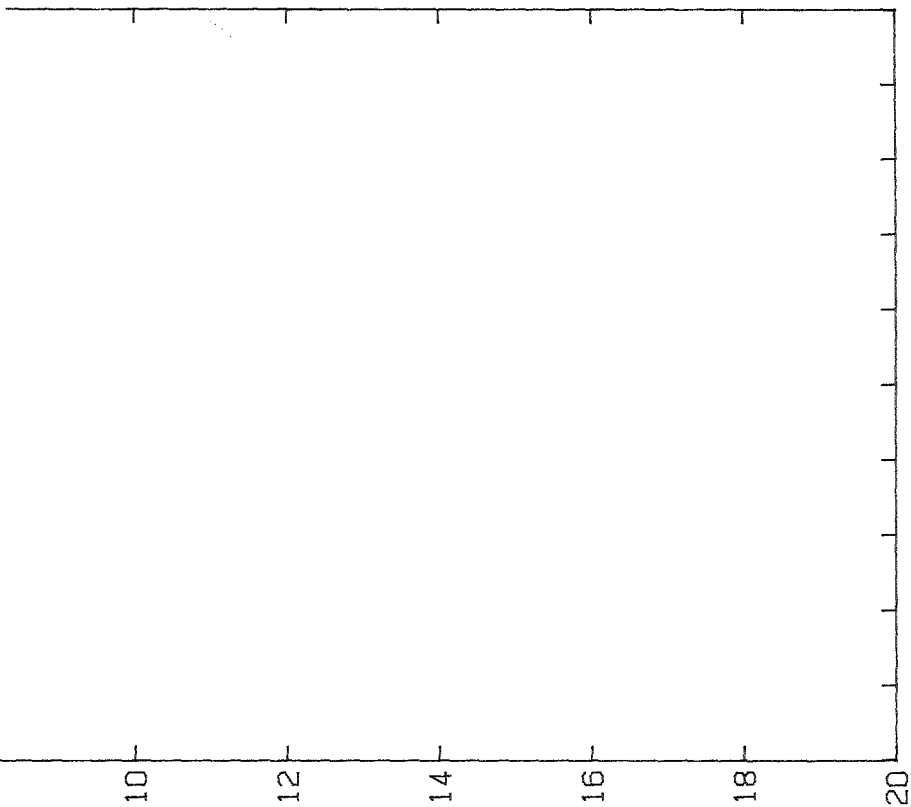

2500
3000
3500
4000


37°
36°
2500
3000
3500
4000
σ_n (kPa)

A (MARA44)
S v. % AXIAL STRAIN

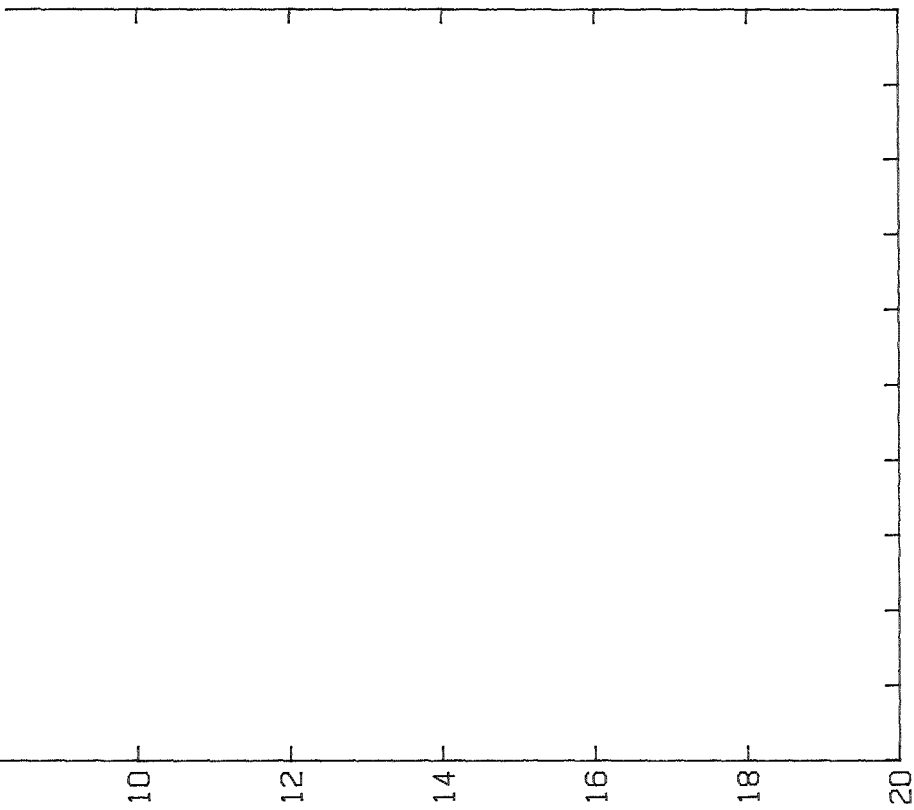


IARA47)
SS v. % AXIAL STRAIN



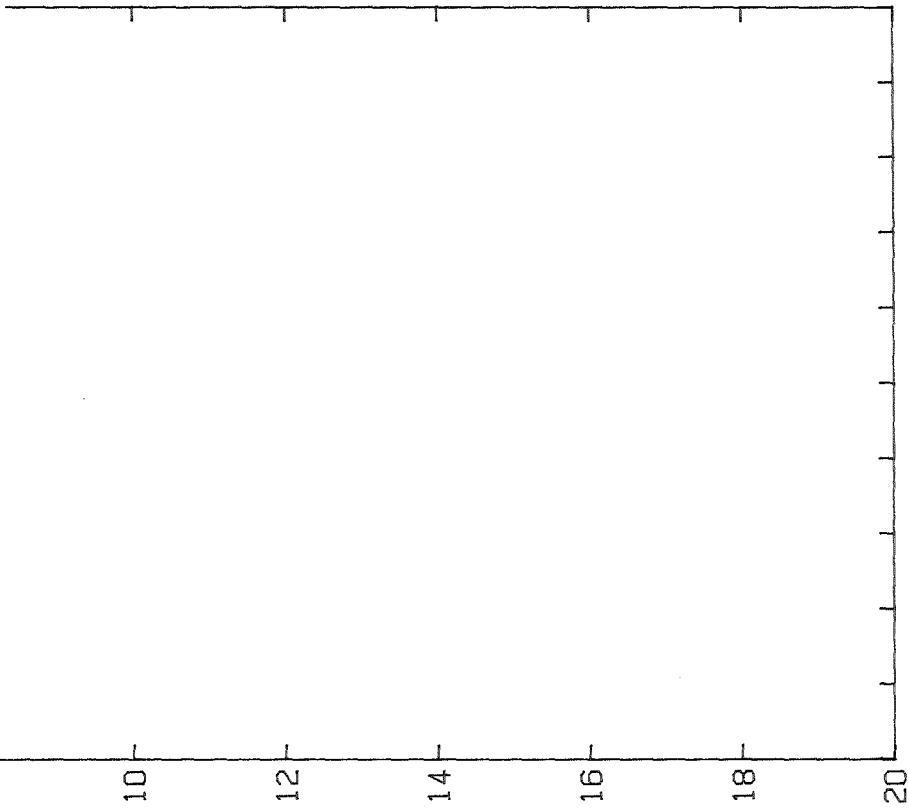
Capped

PA (MARA54)
SS v. % AXIAL STRAIN



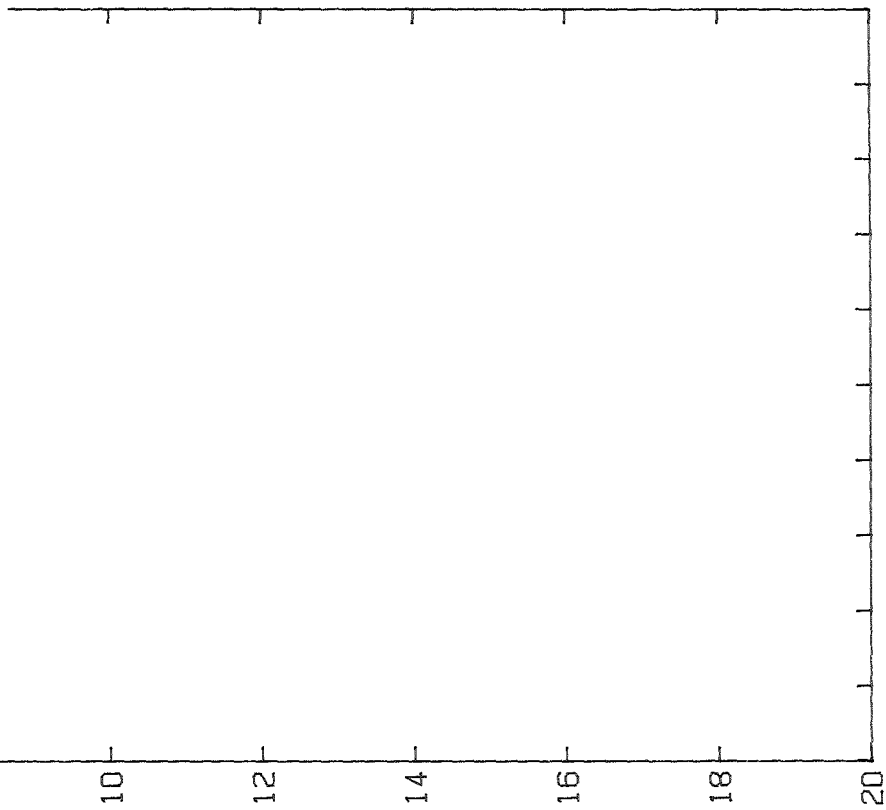
Capped

(MARA51)
SS v. % AXIAL STRAIN



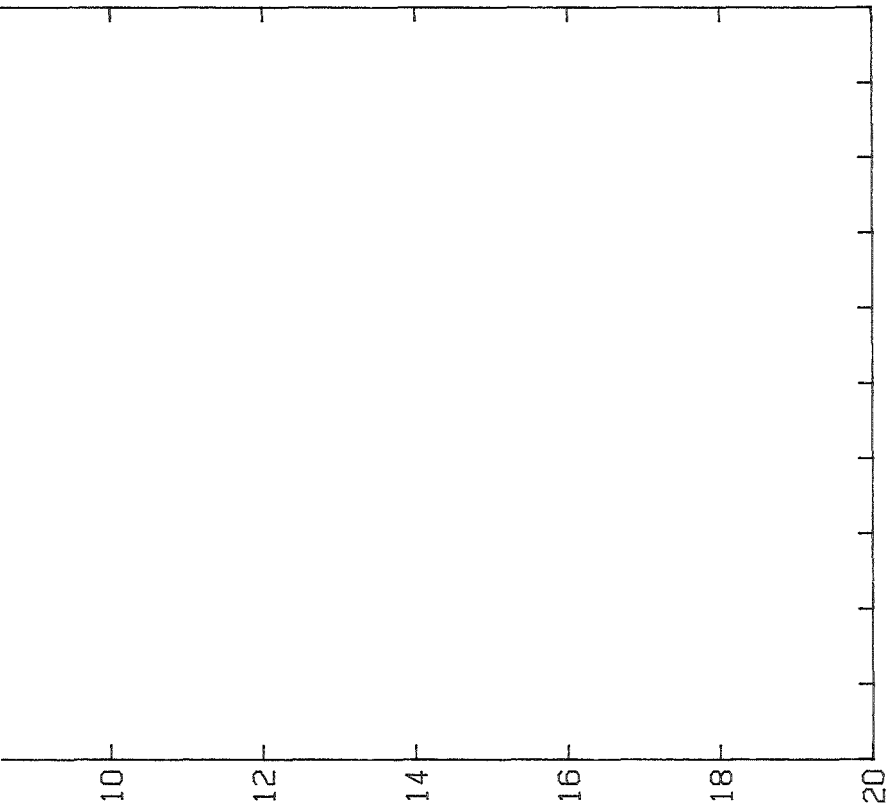
Capped

(MARA59)
v. % AXIAL STRAIN



capped

(MARA62)
S v. % AXIAL STRAIN



LOG OF TEST BORING No. : MA-1

No.	DEPTH (ft.)	BLOWS (Na)	BLOWS PER FOOT (N)	E (tsf)
1	2.0	7 / 12.0	7	125
2	6.0	23 / 12.0	23	359
3	11.0	74 / 12.0	74	1014
4	15.0	23 - 50 / 5.0	83	1123
5	21.0	88 / 12.0	88	1183
6	26.0	78 / 12.0	78	1063
7	30.0	43 - 50 / 4.0	118	1535
8	35.0	50 / 6.0	100	1325
9	40.0	45 - 50 / 4.0	120	1558
10	45.0	50 / 4.0	150	1900
11	50.0	37 - 50 / 2.0	187	2311
12	55.0	50 / 2.5	240	2884
13	60.0	50 / 5.0	120	1558
14	65.0	50 / 3.0	200	2453
15	70.0	50 / 3.0	200	2453
16	75.0	50 / 3.0	200	2453

LOG OF TEST BORING No. : MA-3

No.	DEPTH	BLOWS	BLOWS PER FOOT	E

LOG OF TEST BORING No. : MA-4

No.	DEPTH (ft.)	BLOWS (Na)	BLOWS PER FOOT (N)	E (tsf)
1	2.0	6 / 12.0	6	109
2	6.0	11 / 12.0	11	187
3	11.0	27 - 50 / 5.0	87	1171
4	15.0	50 / 5.0	120	1558
5	20.0	42 - 50 / 5.0	102	1349
6	25.0	50 / 5.0	120	1558
7	30.0	50 / 5.0	120	1558
8	35.0	50 / 4.0	150	1900
9	40.0	31 - 50 / 4.0	106	1396
10	45.0	33 - 50 / 4.0	108	1419
11	50.0	50 / 4.0	150	1900
12	56.0	62 / 12.0	62	867
13	61.0	28 - 50 / 5.0	88	1183
14	66.0	26 - 50 / 5.0	86	1159
15	70.0	25 - 50 / 4.0	100	1325
16	75.0	24 - 50 / 5.5	79	1070
17	80.0	50 / 5.5	109	1432
18	85.0	50 / 5.0	120	1558
19	90.0	35 - 50 / 5.0	95	1266
20	95.0	50 / 5.0	120	1558
21	100.0	50 / 6.0	100	1325

LOG OF TEST BORING No. : MA-10

No.	DEPTH (ft.)	BLOWS (Na)	BLOWS PER FOOT (N)	E (tsf)
1	2.0	11 / 12.0	11	187
2	5.0	25 / 12.0	25	387
3	9.0	50 / 5.5	109	1432
4	14.0	50 / 5.0	120	1558
5	31.0	92 / 12.0	92	1231
6	35.0	50 / 3.0	200	2453
7	41.0	50 / 3.5	171	2139
8	55.0	50 / 3.5	171	2139
9	60.0	50 / 4.5	133	1711
10	65.0	50 / 5.0	120	1558
11	69.0	100 / 2.5	480	5337
12	80.0	50 / 2.0	300	3516
13	85.0	50 / 4.5	133	1711
14	90.0	50 / 4.5	133	1711
15	95.0	50 / 2.0	300	3516
16	100.0	50 / 2.0	300	3516
17	105.0	50 / 1.5	400	4539
18	110.0	50 / 3.0	200	2453
19	115.0	50 / 4.0	150	1900
20	120.0	50 / 2.5	240	2884
21	125.0	50 / 2.0	300	3516
22	130.0	50 / 2.5	240	2884
23	135.0	50 / 2.0	300	3516
24	140.0	50 / 3.5	171	2139
25	145.0	50 / 3.5	171	2139
26	150.0	50 / 2.0	300	3516

LOG OF TEST BORING No. : MA-12

No.	DEPTH (ft.)	BLOWS (Na)	BLOWS PER FOOT (N)	E (tsf)
1	2.0	9 / 12.0	9	156
2	6.0	26 / 12.0	26	401
3	10.0	48 - 50 / 3.0	148	1877
4	15.5	41 - 50 / 2.5	161	2023
5	20.5	34 - 50 / 2.5	154	1945
6	25.5	43 - 50 / 3.0	143	1821
7	30.0	100 / 9.0	133	1711
8	34.0	46 - 50 / 5.0	106	1396
9	39.0	28 - 50 / 5.0	88	1183
10	44.0	50 / 4.5	133	1711
11	49.0	50 / 5.0	120	1558
12	54.0	41 - 50 / 3.0	141	1798
13	59.0	100 / 10.0	120	1558
14	64.0	45 - 50 / 2.0	195	2398
15	69.0	49 - 50 / 1.5	249	2980
16	74.0	50 / 5.5	109	1432

LOG OF TEST BORING No. : MA-13

Triaxial Test Results - Boring No. MD-12

No.	DEPTH (ft.)	Ei (tsf)	Ep (tsf)	E (5%) (tsf)
1	44.83	1543	1250	260
2	47.50	1250	1177	490
3	51.75	1496	1261	340
4	54.75	1700	1233	860
5	59.83	982	786	360
6	62.25	1313	1133	470

Ei = initial tangent modulus
Ep = chord modulus at peak
E(5%) = chord modulus at 5% strain

LOG OF TEST BORING No. : MA-1

No.	DEPTH (ft.)	Cp (ft/sec)	E (ksi)	E (tsf)
1	0.0 - 56.7	2085	79	5694

LOG OF TEST BORING No. : MA-3

No.	DEPTH (ft.)	Cp (ft/sec)	E (ksi)	E (tsf)
1	0.0 - 5.6	800	11	838
2	5.6 - 300.0	3958	284	20522

LOG OF TEST BORING No. : MA-10

No.	DEPTH (ft.)	Cp (ft/sec)	E (ksi)	E (tsf)
1	0.0 - 43.8	2124	82	5909
2	43.8 - 106.3	3536	227	16379
3	106.3 - 318.8	6550	780	56202

LOG OF TEST BORING No. : MA-11

No.	DEPTH (ft.)	Cp (ft/sec)	E (ksi)	E (tsf)
1	0.0 - 8.3	444	3	258
2	8.3 - 29.2	2388	103	7470
3	29.2 - 220.8	3361	205	14798

LOG OF TEST BORING No. : MD-12

No.	DEPTH (ft.)	Cp (ft/sec)	E (ksi)	E (tsf)
1	0.0 - 7.9	550	5	396
2	7.9 - 31.6	5557	561	40453
3	31.6 - 147.4	8128	1201	86544

C.4 -- Consolidation Test Data

Consolidation Test #2

Seating Load = 200 psf $L = 1''$

$\Delta L = 0.0017''$ $L = 2.2 - .0017 = 2.1983''$

Apply 1200 psf

After 21 hrs gage = 14102 = 0.0302"

$$\epsilon = \frac{.0302 - .0017}{2.1983} \times 100 = 1.2965\ \%$$

Wet Sample

gage = 7+07 = 0.1407"

$$\epsilon = \frac{0.1407 - .0017}{2.1983} \times 100 = 6.32\ \%$$

Consolidation Test #3

Apply 200 psf seating load $\Delta L = 0+97$

$L = 2.2 - 0.0097 = 2.1903''$

Apply 2400 psf

$\Delta L = 3+195 = 0.0795''$

$$\epsilon = \frac{0.0795' - 0.0097}{2.1903} \times 100' = 3.19\%$$

Wet Sample

$\Delta L = 8+45 = 0.1645''$

$$\epsilon = \frac{0.1645 - 0.0097}{2.1903} \times 100 = 7.07\%$$

For $L = 1''$

2/24/88 GM

Consolidation Test #5

$L = 2.2''$

apply 200# seating load $\Delta L = 0.0020''$ $L' = 2.1980''$

apply 1200 psf

$\Delta L = 1+42 = 0.0242''$

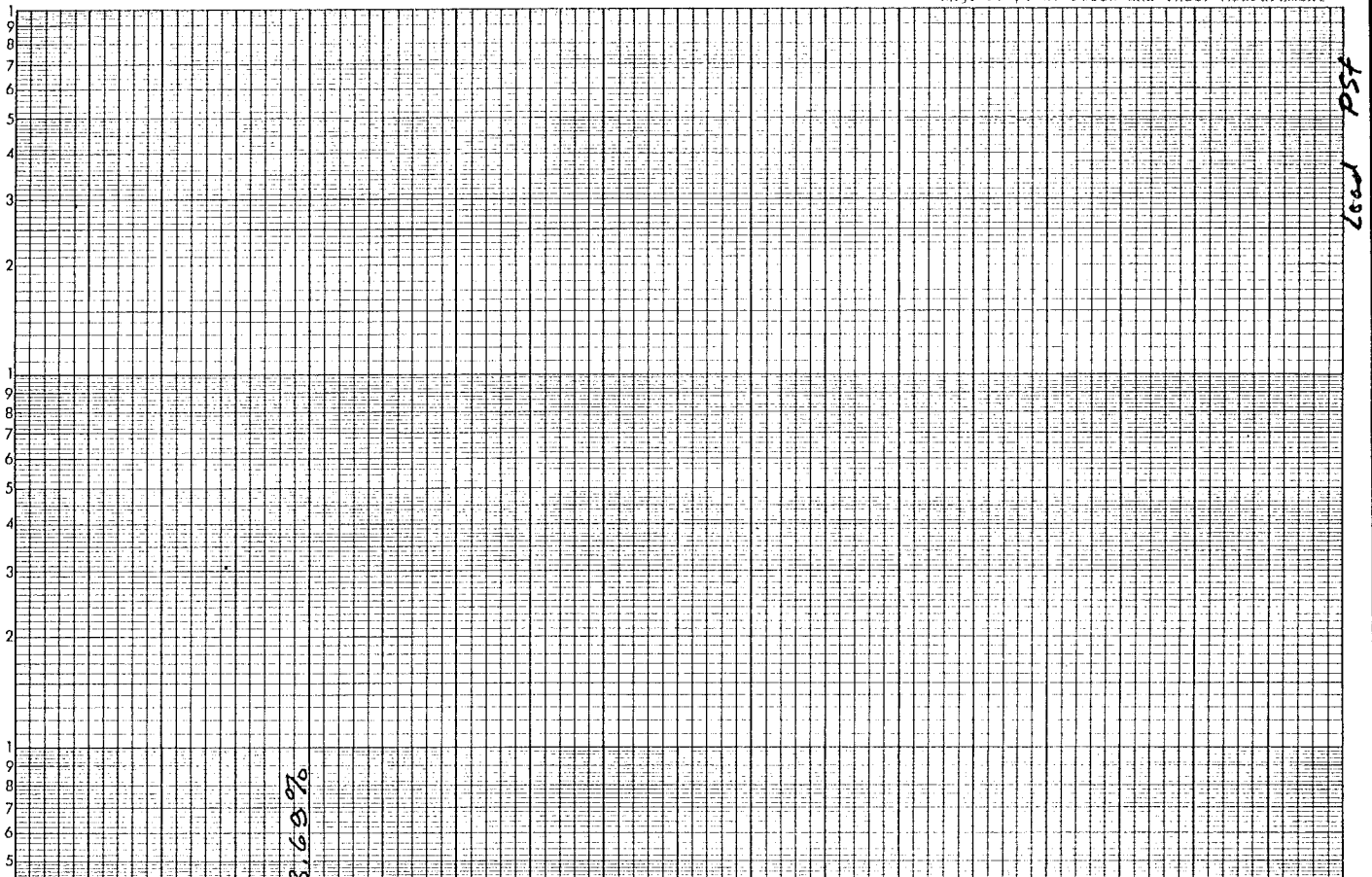
$$\epsilon = \frac{.0242 - .0020}{2.1980} \times 100 = 1.01\%$$

apply 2400 psf $\Delta L = 0.0544''$

$$\epsilon = \frac{.0544 - .0020}{2.1980} \times 100 = 2.56\%$$

Wet sample $\Delta L = 6+191 = .1391''$

McGraw-Hill Book Co. 5 Cycles x 2 mm
Eng. Prop. of Soils and Their Measurement



GM

2/29/08

Consolidation Test # 4

200 psf seating load $\Delta L = .0017$

$L = 2.2 - .0017 = 2.1983''$

Apply 1200 psf $\Delta L = 1+31 = 0.0231''$

$$\epsilon = \frac{.0231 - .0017}{2.1983} \times 100 = 0.97\%$$

Apply 2400 psf $\Delta L = 0.0542$

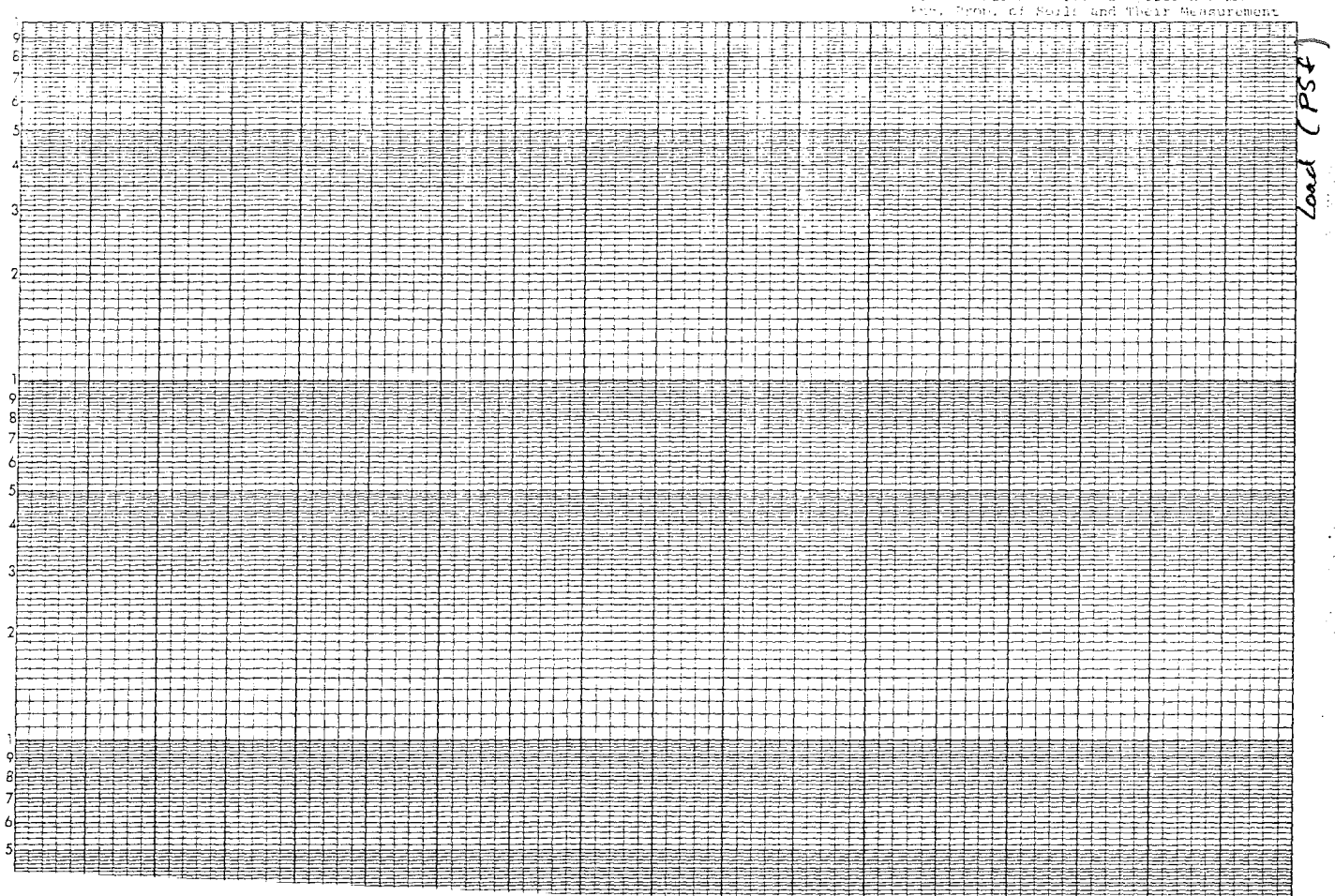
$$\epsilon = \frac{0.0542 - .0017}{2.1983} \times 100 = 2.39\%$$

Apply 4800 psf $\Delta L = 4+99 = 0.0899''$

$$\epsilon = \frac{0.0899 - 0.0017}{\quad} = 4.01\%$$

EM 2/24/97

Consolidation Test #9



1st

1

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project _____ Job No. _____

Location of Project _____ Boring No. MA-12 Sample No. 1C

Description of Soil _____ Depth of Sample 61–63.5'

Tested By _____ Date of Testing _____

Disturbed sample
Packed back to orig density

Loading Test Data

Load 1/4 TSF ~~kPa~~ Load 1/2 TSF kPa

Date applied 2/19 Date applied 2/19

Applied by JM GM Applied by JM GM

Clock time and date	Elapsed time, min	*Dial readings × _____ Original	Adjusted
10:30	0	11+93	.2250
	0.1 6	11+95	.2295
	0.25 15	11+95	11

Clock time and date	Elapsed time, min	Dial readings × _____ 11+96 Original	Adjusted
10:41	0	11+96	.2296
	0.1	11.156	.2356
	0.25	11+156	.2356

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project SSC Job No.

Location of Project Boring No. MA-12 Sample No. 1C

Description of Soil Depth of Sample 61 – 63.5

Tested By EM JM Date of Testing

Disturbed, repacked

Loading Test Data Gage = 1.15

Load 1 TSF kPa

Date applied 2/20/87

Applied by EM

Clock time and date	Elapsed time, min	*Dial readings × ____ Original	Adjusted
9:46	0	11+191	0.2391
	0.1	12+75	0.2475
	0.25	[illegible]	[illegible]

Load 2 TSF kPa 2.35 gage

Date applied 2/20

Applied by Em

Clock time and date	Elapsed time, min	Dial readings × ____ Original	Adjusted
1:30	0	12+113	0.2513
	0.1	12+182	0.2582
	0.25	[illegible]	[illegible]

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project SSC Job No.

Location of Project Boring No. MA12 Sample No. 1C

Description of Soil Depth of Sample 61 – 63.5'

Tested By EM JM Date of Testing

Loading Test Data

Load 4TSF kPa Grage = 4.8 Load 8 TSF kPa

Date applied 2/20 Date applied

Applied by EM Applied by

Clock time and date	Elapsed time, min	*Dial readings × ____ Original	Adjusted
1:45	0	12+199	.2599
	0.1	13+115	.2715
	0.25		

Clock time and date	Elapsed time, min	Dial readings × ____ Original	Adjusted
2:45	0	13+137	.2737
	0.1	14+65	.2865
	0.25		

4

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project SSC Job No. _____

Location of Project Maricopa Boring No. MA-12 Sample No. 1C

Description of Soil _____ Depth of Sample 61 – 63.5'

Tested By _____ Date of Testing _____

Loading Test Data

Load 16 TSF kPa

Date applied 2/22/98

Applied by GM

Clock time and date	Elapsed time, min	*Dial readings × _____ Original	Adjusted
12:20	0	14+138	0.2930
	0.1	15+61	0.3061
	0.25	15+65	0.3065

Load 8 TSF kPa unload

Date applied 2/22/98

Applied by GM

Clock time and date	Elapsed time, min	Dial readings × _____ Original	Adjusted
1p:30	0	15+44	0.3094
	0.1	15+82	0.3082
	0.25	15+82	0.3082

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project _____ Job No. _____

Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____ Depth of Sample _____

Tested By _____ Date of Testing _____

Loading Test Data

UN Load 4 TSF kPa

Date applied 2/22/07

Applied by GM

Clock time and date	Elapsed time, min	*Dial readings × _____	
		Original	Adjusted
2:25	0	15+81	0.3081
	0.1	15+53	0.3053
	0.25		

UN Load 2 TSF kPa

Date applied 2/22/07

Applied by GM

Clock time and date	Elapsed time, min	Dial readings × _____	
		Original	Adjusted
2:25	0	15+51	0.3051
	0.1	15+22	0.3022
	0.25		

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project _____ Job No. _____

Location of Project _____ Boring No. _____ Sample No. _____

Description of Soil _____ Depth of Sample _____

Tested By _____ Date of Testing _____

Loading Test Data

Re Load 4TSF kPa

Date applied _____

Applied by _____

Clock time and date	Elapsed time, min	*Dial readings × _____	
		Original	Adjusted
402	0	15+19	0.3019
	0.1	15+40	0.3040
	0.25		

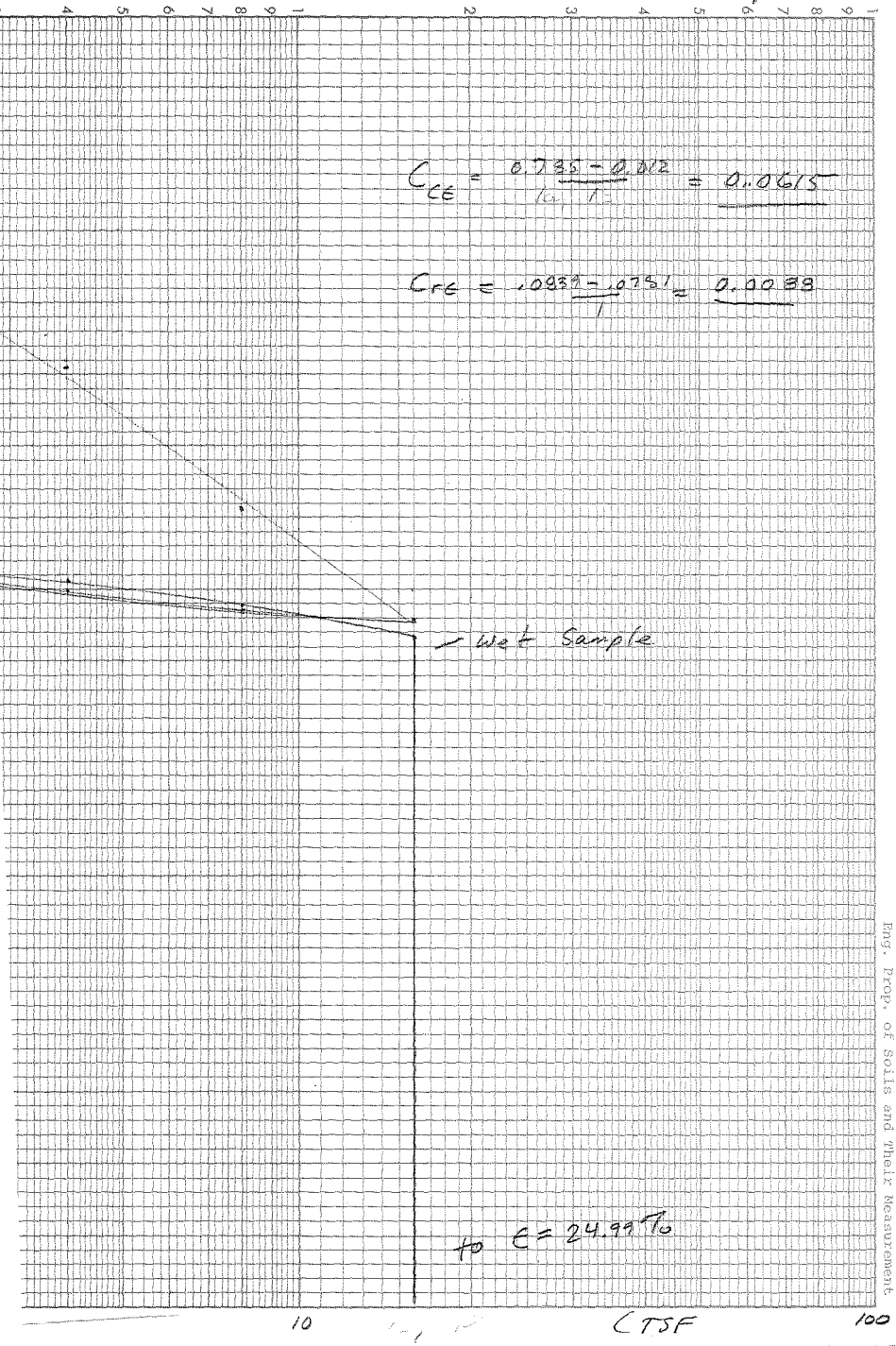
Re Load 8 TSF kPa

Date applied _____

Applied by _____

Clock time and date	Elapsed time, min	Dial readings × _____	
		Original	Adjusted
455	0	15+44	0.3044
	0.1	15+69	0.3069
	0.25		

Disturbed Sample Pack to Original Density



McGraw-Hill Book Co. 3 cycles x 2 mm
Eng. Prop. of Soils and Their Measurement

CONSOLIDATION TEST (Time–compression data) Data Sheet 15

Project _____ Job No. _____

Location of Project SSC Boring No. MA-12 Sample No. 1C

Description of Soil _____ Depth of Sample 61-63.5'

Tested By _____ Date of Testing _____

Loading Test Data

Load 16 TSF kPa

Date applied 2/22/95

Applied by GM

Clock time and date	Elapsed time, min	*Dial readings × ____ Original	Adjusted
5:30	0	15+73	0.3073
	0.1	15+97	0.3097

Load 16 TSF kPa Submerge

Date applied _____

Applied by _____

Clock time and date	Elapsed time, min	Dial readings × ____ Original	Adjusted
6:01	~~0~~	20+82	0.4082
603	0.1	20+113	0.4113 next page