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## Woodward-Clyde Consultants

ESTIMATES OF MAXIMUM PAST CONSOLIDATION PRESSURE  
OF COHESIVE FILL MATERIALS  
DIESEL GENERATOR BUILDING  
MIDLAND PLANT - UNITS 1 and 2  
MIDLAND, MICHIGAN

for

Consumers Power Company  
1945 West Parnall Road  
Jackson, Michigan

by

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and

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22 July 1981

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Consulting Engineers, Geologists  
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Offices in Other Principal Cities



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## 1. INTRODUCTION

This report presents estimates of the maximum past consolidation pressure of cohesive fill materials obtained at the Diesel Generator Building (DGB) at Consumers Power Company (CPCo) Midland Plant - Units 1 and 2.

Estimates of maximum past consolidation pressure ( $p'_c$ ) were determined from the results of laboratory tests performed on specimens of cohesive fill materials obtained using undisturbed sampling techniques. These specimens were tested in 1981 by Woodward-Clyde Consultants (WCC) and in 1978 by Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD). The samples tested by GZD were obtained prior to the surcharge program for the DGB, while those tested by WCC were obtained after the surcharge program had been completed.

Estimates of maximum past consolidation pressure was determined from one-dimensional consolidation test results by using the Casagrande (1936) graphical technique. The applicability of other techniques (Janbu, 1969; Schmertmann, 1955) was also investigated.

## 2. DATA SOURCES

Test results from 27 one-dimensional consolidation tests performed by WCC were obtained from Appendix E of a report (WCC, 1981) to CPCo concerning the test results of the Soil Boring and Testing Program for the DGB. These tests were performed on specimens of cohesive fill samples obtained above el. 600 from seven borings located outside of the DGB, but inside the crest of the surcharge fill, as shown on Fig. 1. At the time the borings were drilled, the ground surface was at approximate el. 634. Index properties of these WCC test specimens are presented in the order of decreasing elevation in Table 1.

Test results from 14 one-dimensional consolidation tests performed by GZD were obtained from a report to Bechtel prepared by GZD (1980). These tests were performed on specimens of cohesive fill samples obtained above el. 600 from nine

borings located inside and one boring (DG-7) located outside of the foundation area of the DGB, as shown on Fig. 2. As recorded on the boring logs (CPCo, 1980), the ground surface at the time the borings were drilled was at approximate el. 628 for the interior borings and approximate el. 631 for boring DG-7. Index properties of these GZD test specimens are presented in the order of decreasing elevation in Table 2.

### 3. DATA PREPARATION

The data used to estimate maximum past consolidation pressure were all presented as volumetric strain ( $\epsilon_v$ ) plotted vs the logarithm of applied pressure ( $\log p'$ ). The shape of the compression curve on a strain- $\log p'$  plot is the same as that on a plot of void ratio ( $e$ ) vs  $\log$  of pressure ( $e$ - $\log p'$ ) because the ordinates ( $\epsilon_v$  and  $e$ ) are proportional. The strain- $\log p'$  form of presentation, therefore, is equally applicable for determining various consolidation characteristics such as compression indices and maximum past consolidation pressure.

The WCC data were presented in the form of strain- $\log p'$  plots. Therefore, they were used directly for the determination of maximum past consolidation pressure. Copies of the WCC consolidation data are presented in boring/sample-number order in Appendix A.

The GZD data, however, were presented in the form of  $e$ - $\log p'$  plots. From these data, we estimated the value of the void ratio at each load by scaling directly from the plots. The initial void ratio ( $e_0$ ) and the scaled void ratio for each test load were used to calculate the volumetric strain by dividing the change in void ratio ( $e_0 - e$ ) by the quantity  $(1 + e_0)$ . The resulting values were then plotted on strain- $\log p'$  plots, as had been done for the WCC data. Copies of the transformed (strain- $\log p'$ ) and original ( $e$ - $\log p'$ ) GZD compression curves are presented in boring/sample-number order in Appendix B.



#### 4. ANALYTICAL PROCEDURE

##### 4.1 Casagrande Technique

Estimates of the maximum past consolidation pressure were made using the Casagrande graphical technique for each of the 27 WCC and 14 GZD consolidation test results. In an effort to assess the level of uncertainty inherent in performing this construction (resulting primarily from the selection of the point of maximum curvature of the compression curve), we have utilized the estimates made by three geotechnical engineers, each working independently of the others. Each engineer was instructed to review the Casagrande technique and to provide his/her best estimate of the maximum past consolidation pressure utilizing this technique and the consolidation test results provided (as in Appendices A and B).

For the WCC data, two estimates of maximum past consolidation pressure were made by each engineer. One estimate was made assuming that the maximum test load on the specimen was 16 tons per square foot (tsf), the same as had been used in the GZD testing; the engineers, therefore, disregarded the test data at pressures greater than 16 tsf. The other estimate, however, was made utilizing the entire compression curve to the maximum test load of 64 tsf.

##### 4.2 Other Techniques

Estimates of maximum past consolidation pressures were also made using other techniques. Using the WCC data only, six tests were evaluated using a technique described by Janbu (1969) and four tests were evaluated using a technique proposed by Schmertmann (1955). For the test results evaluated, these techniques were judged to be not applicable.

The test data evaluated did not exhibit the characteristic shape (form) described by Janbu. For the test data evaluated by the Schmertmann technique, the resulting curves of "void-ratio reduction" were all quite symmetrical and did not, therefore, provide a definitive estimate of the maximum past consolidation pressure. Evaluation of additional test data using these techniques, therefore, was discontinued.

## 5. DATA PRESENTATION

The estimates of the maximum past consolidation pressure are summarized for the WCC and GZD data in Tables 3 and 4, respectively, in the order of decreasing elevation of the specimens. For each test, the estimated value of the maximum past consolidation pressure by each engineer is tabulated, as is the average of these three estimates. For the WCC data, the three estimates and the average are presented in Table 3 for both conditions of maximum load of 16 tsf and of 64 tsf.

The estimates of the maximum past consolidation pressure from the WCC and GZD test results are presented graphically on Fig. 3 for the condition of maximum load of 16 tsf. For each test, the minimum, maximum, and average of the estimates are plotted at the elevation of the test specimen. Also shown for reference are in-situ effective overburden pressure distributions for the range of ground surface elevations that existed in 1978 and 1981 when the samples were obtained. A total unit weight of 132.4 pounds per cubic foot (pcf) and a submerged unit weight of 70 pcf were assumed to calculate the overburden pressures. The ground water level was assumed to be equal to that of the maximum cooling pond operating level, el. 627.

The estimates of maximum past consolidation pressure from the WCC test results for the condition of maximum load of 64 tsf (Table 3) are similarly plotted vs elevation on Fig. 4. The minimum, maximum, and average of the estimates are plotted. Also shown is the in-situ effective overburden pressure distribution that existed in 1981, calculated using the assumptions previously described.

## 6. CONCLUSIONS

This report presents estimates of the maximum past consolidation pressure of cohesive fill materials as determined by three geotechnical engineers using the Casagrande graphical technique. These estimates are based solely on the results of one-dimensional consolidation tests performed in the laboratory.

For samples at the same elevation, the estimated maximum past consolidation pressures of specimens tested by WCC in 1981 are, in all but three cases, larger than those for specimens tested by GZD in 1978 (Fig. 3).

In addition, the maximum past consolidation pressures estimated from the results of tests having maximum loads of only 16 tsf are smaller than are those estimated from the results of tests having maximum loads of 64 tsf. For the data in Table 3, the difference in the average estimates for the two maximum loading conditions ranges from 0 tsf to 3.07 tsf and averages about 1.0 tsf. Because of the better definition of the virgin portion of the compression curve, the estimated maximum past consolidation pressures determined from the results of tests having maximum loads of 64 tsf are considered better estimates of the maximum past consolidation pressure.

The Janbu technique for estimating maximum past consolidation pressure was judged to be not applicable because the data did not exhibit the characteristic form described by Janbu. Similarly, the Schmertmann technique was not appropriate for these test results because a definitive value of the maximum past consolidation pressure could not be determined.

## 7. REFERENCES

- Casagrande, A. (1936). The determination of the pre-consolidation load and its practical significance. In Proceedings, First International Conference on Soil Mechanics, Cambridge, MA, v 3, pp 60-64.
- Consumers Power Company (1980). Interim report - settlement of diesel generator foundations and building, Midland plant - units 1 and 2. In Response to 10 CFR 50.55(e) submitted to the Nuclear Regulatory Commission.
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- Janbu, N. (1969). The resistance concept applied to deformations of soils. In Seventh International Conference on Soil Mechanics and Foundation Engineering, Mexico City, Mexico, v 1, pp 191-196.
- Schmertmann, J.H. (1955). The undisturbed consolidation of clay. In Transactions, American Society of Civil Engineers, v 120, p 1201.
- Woodward-Clyde Consultants (1981). Test results, diesel generator building, soil boring and testing program, Midland plant - units 1 and 2, Midland, Michigan. Report prepared for Consumers Power Company, Jackson, MI, by Woodward-Clyde Consultants, Chicago, IL, 8 July 1981, 9 p, 8 appendices.

TABLE 1  
INDEX PROPERTIES OF CONSOLIDATION TEST SPECIMENS  
TESTED BY WCC IN 1981

<u>Boring Number</u>	<u>Sample and Section Number</u>	<u>Elev. (ft)</u>	<u>Initial Water Content (%)</u>	<u>Initial Total Density (pcf)</u>	<u>Liquid Limit (%)</u>	<u>Plastic Limit (%)</u>	<u>Specific Gravity</u>
COE-13B	S-1B	625.3	9.9	137.9	23	13	2.75
COE-9	S-3B	625.0	13.7	135.9	21	12	2.76
COE-12A	S-2D	623.8	11.2	139.2	21	13	2.76
COE-9	S-4A	623.0	12.3	137.9	20	12	2.74
COE-10A	S-1B	622.8	11.1	137.2	20	13	2.73
COE-12A	S-3C	621.5	11.9	138.8	21	13	2.74
COE-11A	S-2B	621.0	10.5	138.6	22	12	2.75
COE-10A	S-2C	620.2	12.3	133.0	21	13	2.74
COE-9	S-5B	620.0	11.0	139.3	21	13	2.73
COE-11A	S-4B	619.3	11.8	137.9	22	12	2.75
COE-13B	S-3D	619.1	9.6	142.2	19	13	2.74
COE-9	S-6B	617.8	12.1	136.6	22	14	2.75
COE-9	S-6C	617.5	11.7	139.2	20	12	2.74
COE-13A	S-3C	617.3	11.0	142.6	20	12	2.73
COE-11A	S-5B	616.7	12.1	135.1	21	12	2.71
COE-12A	S-5C	616.7	9.7	141.5	21	12	2.78
COE-13A	S-4B	615.4	12.1	136.5	21	12	2.75
COE-12A	S-6B	614.6	18.0	132.3	46	18	2.77
COE-9A	S-8B	614.1	13.8	137.5	26	14	2.75
COE-12A	S-7C	612.8	17.2	132.1	38	17	2.75
COE-13A	S-5C	612.5	10.0	145.4	24	13	2.74
COE-13A	S-6C	611.2	10.9	144.9	24	13	2.79
COE-12A	S-8B	610.6	14.6	135.9	23	14	2.74
COE-13A	S-8B	609.2	10.7	141.3	21	12	2.74
COE-12A	S-9B	608.0	14.5	135.0	28	15	2.78
COE-13A	S-9B	606.9	10.4	140.1	23	14	2.74
COE-12A	S-10B	605.6	18.8	131.1	34	15	2.73

TABLE 2  
INDEX PROPERTIES OF CONSOLIDATION TEST SPECIMENS  
TESTED BY GZD IN 1978

<u>Boring Number</u>	<u>Sample Number</u>	<u>Elev. (ft)</u>	<u>Initial Water Content (%)</u>	<u>Initial Total Density (pcf)</u>	<u>Liquid Limit (%)</u>	<u>Plastic Limit (%)</u>	<u>Specific Gravity</u>
DG-16	-	626.6	11.3	136.8	19	12	2.72
DG-9	S-1	625.6	13.3	135.9	20	13	2.71
DG-9	S-3	622.1	11.7	134.8	21	12	2.72
DG-9	S-4	620.1	13.4	133.3	23	12	2.72
DG-11	S-6	618.3	9.9	140.3	21	12	2.71
DG-10	S-4	618.1	13.9	133.1	21	11	2.72
DG-21	S-5	617.0	17.7	130.3	22	13	2.71
DG-23	S-7	616.6	13.3	133.0	19	11	2.72
DG-21	S-5	615.0	13.1	135.5	20	12	2.71
DG-10	S-5	614.9	14.9	137.4	32	13	2.69
DG-19	S-9	614.2	15.3	131.7	26	13	2.73
DG-7	S-4	613.8	11.8	140.3	20	12	2.72
DG-26	S-7	613.3	30.0	121.2	39	14	2.75
DG-17	S-3	610.0	12.2	140.6	23	13	2.72



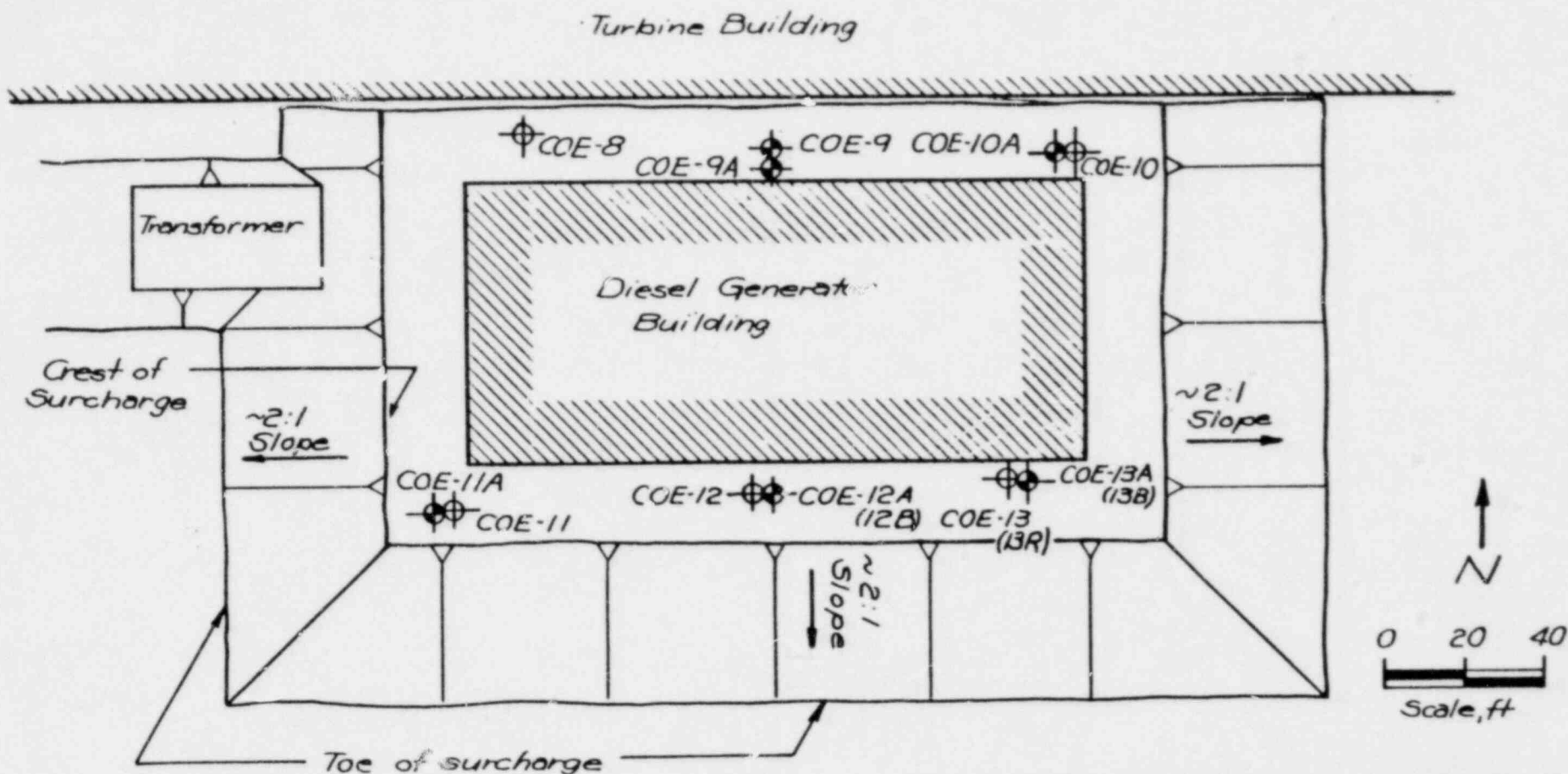
TABLE 3  
ESTIMATES OF MAXIMUM PAST CONSOLIDATION PRESSURE,  $p'_c$   
FROM CONSOLIDATION TESTS BY WCC IN 1981

Boring Number	Sample Number	Elev. (ft)	$p'_c$ , Max. Past Consolidation Pressure (tsf)							
			Max. Load = 16 tsf				Max. Load = 64 tsf			
			Determination				Determination			
			1	2	3	Avg.	1	2	3	Avg.
COE-13B	S-1B	625.3	1.4	1.3	1.1	1.27	1.6	1.6	1.25	1.48
COE-9	S-3B	625.0	1.05	1.05	0.80	0.97	1.5	1.8	1.5	1.60
COE-12A	S-2D	623.8	1.6	1.6	1.35	1.52	2.3	2.4	2.1	2.27
COE-9	S-4A	623.0	1.05	1.15	0.92	1.04	1.25	1.4	1.3	1.32
COE-10A	S-1B	622.8	1.6	1.1	0.95	1.22	1.8	1.2	1.05	1.35
COE-12A	S-3C	621.5	1.1	1.1	0.90	1.03	1.45	1.6	1.35	1.47
COE-11A	S-2B	621.0	2.1	2.1	2.1	2.10	3.25	3.4	3.3	3.32
COE-10A	S-2C	620.2	1.4	1.3	1.1	1.27	2.0	1.9	1.8	1.90
COE-9	S-5B	620.0	1.4	1.35	1.4	1.38	1.65	1.8	1.9	1.78
COE-11A	S-4B	619.3	1.65	0.9	0.94	1.16	1.65	0.9	1.0	1.18
COE-13B	S-3D	619.1	1.8	2.4	2.6	2.27	2.1	2.8	3.2	2.70
COE-9	S-6B	617.8	1.2	1.0	0.80	1.00	1.4	1.2	0.98	1.19
COE-9	S-6C	617.5	1.5	1.5	1.4	1.47	1.5	1.5	1.4	1.47
COE-13A	S-3C	617.2	1.6	2.0	2.4	2.00	2.7	3.8	4.6	3.70
COE-11A	S-5B	616.7	1.2	1.0	0.88	1.03	1.45	1.3	1.2	1.32
COE-12A	S-5C	616.7	1.65	2.15	1.9	1.90	2.4	2.65	2.6	2.55
COE-13A	S-4B	615.3	1.35	1.7	1.6	1.55	1.85	2.7	2.2	2.25
COE-12A	S-6B	614.6	3.5	3.9	3.4	3.60	4.5	5.6	5.4	5.17
COE-9A	S-8B	614.1	1.5	1.9	1.65	1.68	1.9	2.6	2.0	2.17
COE-12A	S-7C	612.8	4.4	4.1	4.1	4.20	7.5	7.1	7.1	7.23
COE-13A	S-5C	612.4	2.4	2.1	1.	2.13	5.9	5.1	4.6	5.20
COE-13A	S-6C	611.1	2.4	2.0	2.0	2.13	4.7	3.6	3.5	3.93
COE-12A	S-8B	610.6	3.0	2.6	1.8	2.47	5.4	5.0	3.4	4.60
COE-13A	S-8B	609.1	2.1	1.95	2.0	2.02	4.9	4.6	5.0	4.83
COE-12A	S-9B	608.0	1.65	2.0	1.9	1.85	3.3	3.8	3.8	3.63
COE-13A	S-9B	606.8	2.1	2.1	1.8	2.00	2.9	3.4	3.0	3.10
COE-12A	S-10B	605.6	1.7	2.0	2.2	1.97	2.35	2.9	2.8	2.68



TABLE 4  
ESTIMATES OF MAXIMUM PAST CONSOLIDATION PRESSURE,  $p'_c$   
FROM CONSOLIDATION TESTS BY GZD IN 1978\*

Boring Number	Sample Number	Elevation (ft)	$p'_c$ , Max. Past Consolidation Pressure (tsf)			
			Determination			Average
			1	2	3	
DG-16	-	626.6	1.1	0.88	0.70	0.89
DG-9	S-1	626.6	0.43	0.45	0.36	0.41
DG-9	S-3	622.1	0.83	0.62	0.60	0.68
DG-9	S-4	620.1	0.36	0.29	0.26	0.30
DG-11	S-6	618.3	1.37	1.50	1.25	1.37
DG-10	S-4	618.1	0.38	0.32	0.35	0.35
DG-21	S-5	617.0	1.50	1.45	1.20	1.38
DG-23	S-7	616.6	1.40	1.35	1.20	1.32
DG-21	S-5	615.0	0.42	0.32	0.34	0.36
DG-10	S-5	614.9	0.67	0.80	0.88	0.78
DG-19	S-9	614.2	0.55	0.73	0.75	0.68
DG-7	S-4	613.8	0.98	0.95	0.95	0.96
DG-26	S-7	613.3	1.10	1.35	1.3	1.25
DG-17	S-3	610.0	1.45	1.45	1.25	1.38

\*Maximum test loading on specimens was 16 tsf.



### LEGEND

- COE-8  Boring location and number
- COE-10  Boring from which consolidation test specimen was obtained
- ( ) Indicates first attempt to drill a boring

Source: Bechtel drawings C3 and C-1040Q

CONSUMERS POWER COMPANY  
Midland Plant-Units 1&2

Boring Location Plan (WCC)  
Borings Drilled in 1981

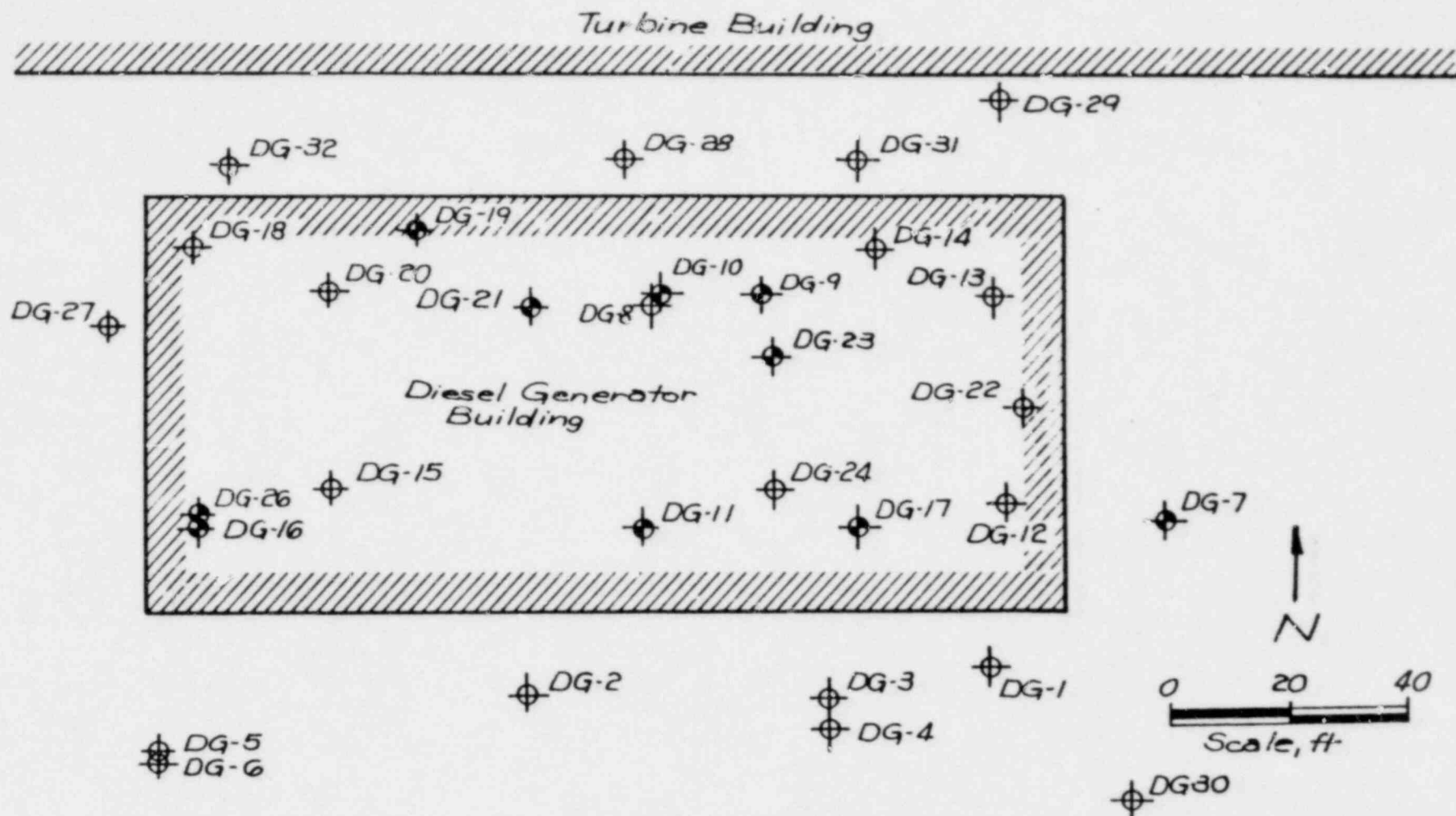
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Fig. 1

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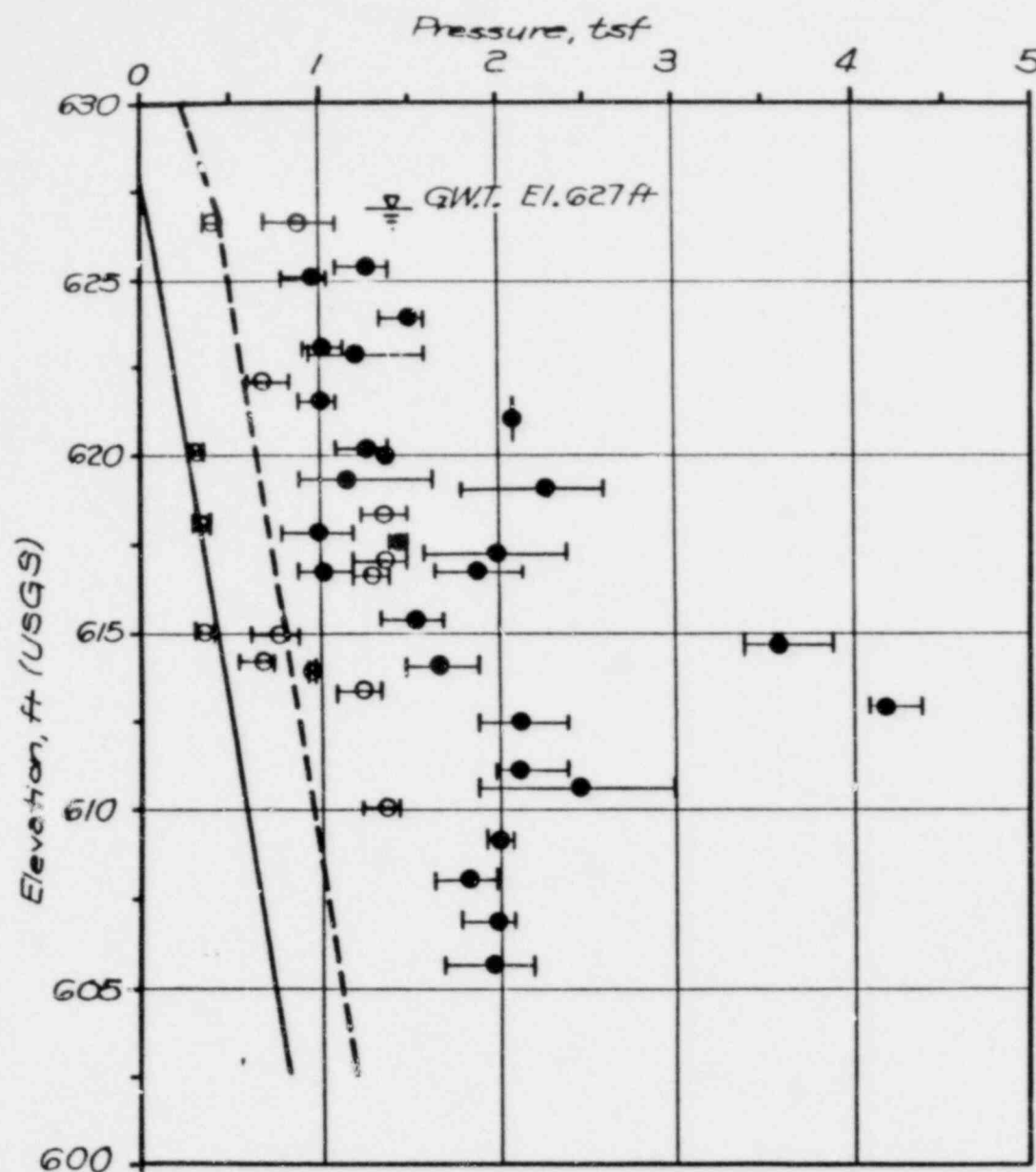


### LEGEND

- DG-32 Boring location and number
- Boring from which consolidation test specimen was obtained

Source: Fig. 67, Rev. GR (CPCo, 1980)

CONSUMERS POWER COMPANY Midland Plant-Units 1&2		
Boring Location Plan (GZD) Borings Drilled in 1978		
81C217-4	22 July 81	Fig. 2
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# LEGEND

Estimate of Maximum Past Consolidation Pressure ( $p_c'$ ):

○ Average of three determinations from GZD data (1978)

● Average of three determinations from WCC data (1981)

— Range of three determinations

Estimated In-situ Effective Overburden Pressure for Ground Surface at Indicated Elevation:

— El. 628 ft (1978)

- - - El. 634 ft (1981)

CONSUMERS POWER COMPANY  
Midland Plant-Units 1&2

Estimates of Maximum Past Consolidation Pressure  
From Tests by GZD and WCC  
(For Maximum Test Load of 16 tsf)

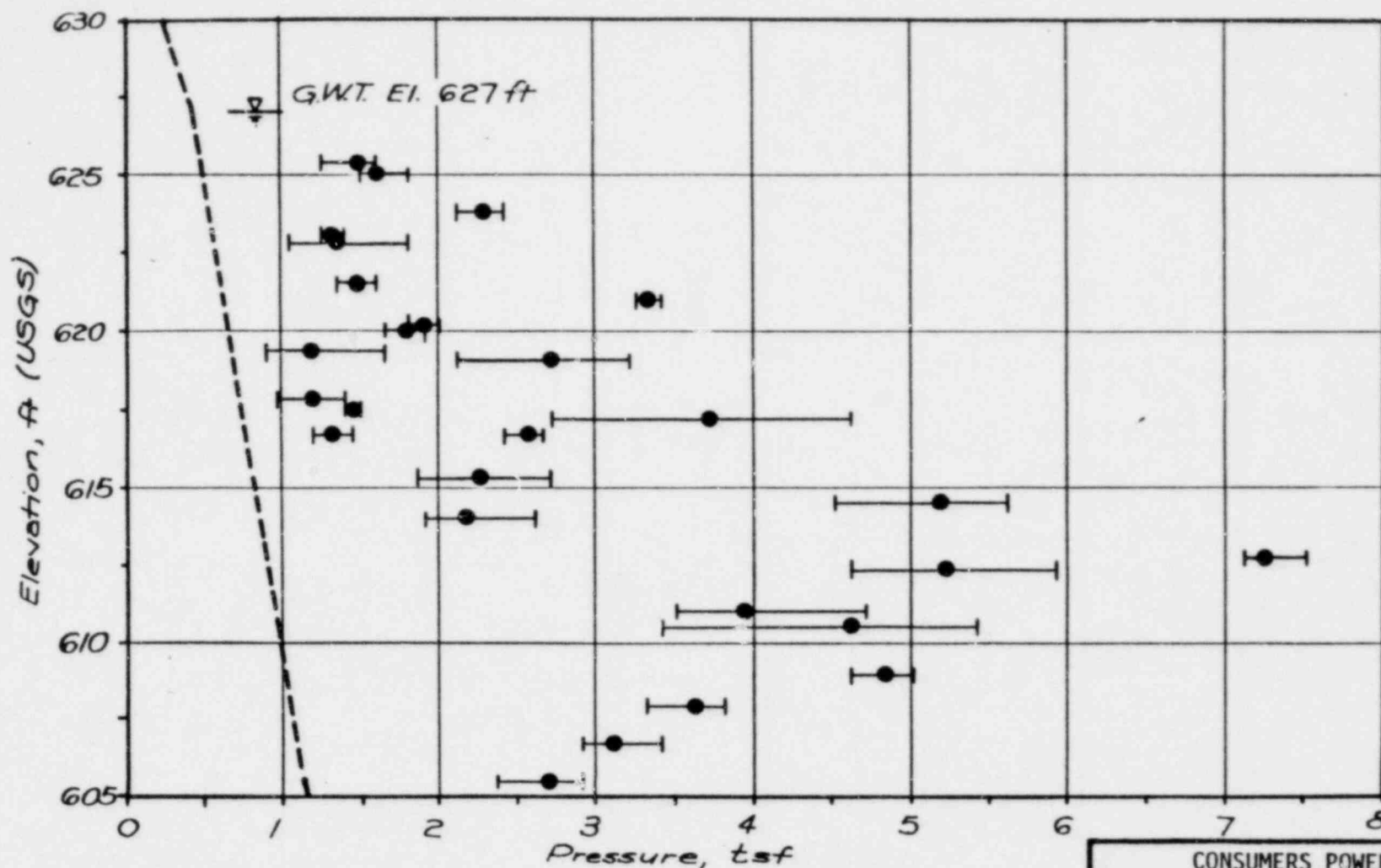
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Fig. 3

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### LEGEND

Estimate of Maximum Past Consolidation Pressure ( $p_c'$ ):

● Average of three determinations from WCC data (1981)

— Range of three determinations

Estimated In-situ Effective Overburden Pressure for Ground Surface at Indicated Elevation

----- El 634 ft (1981)

CONSUMERS POWER COMPANY  
Midland Plant-Units 1&2

Estimates of Maximum Past Consolidation Pressure  
From Tests by WCC  
(For Maximum Test Load of 64 tsf)

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Fig. 4

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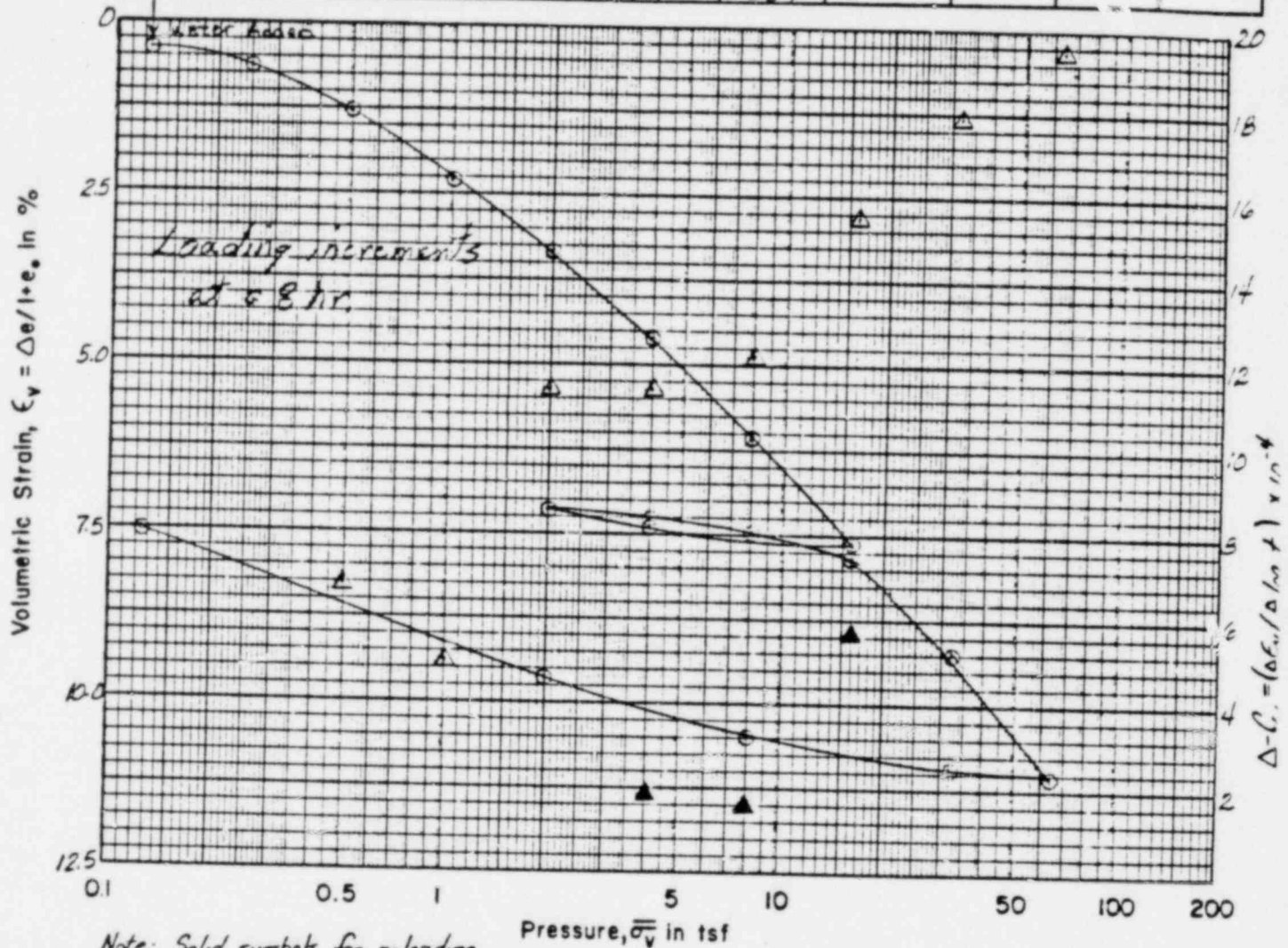


APPENDIX A

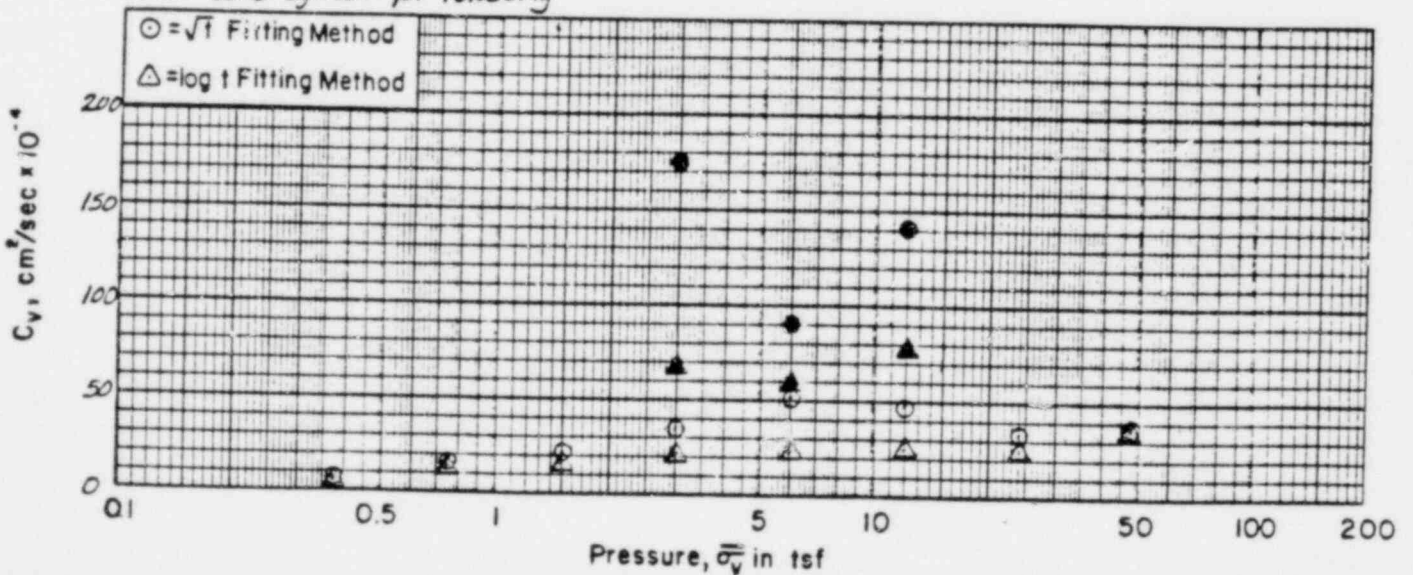
Consolidation Test Results, Tested by WCC in 1981

# CONSOLIDATION TEST

Boring No: COE-9		Sample No: S-3B				Depth, ft: 9.0			
Material: CL, br. m. to f. sandy s.p. silty CLAY, trace s. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.7	135.9	0.440	86.1	0.615	2.50	2.762	21	12
Final	13.0	142.1	0.369	97.7	0.584				

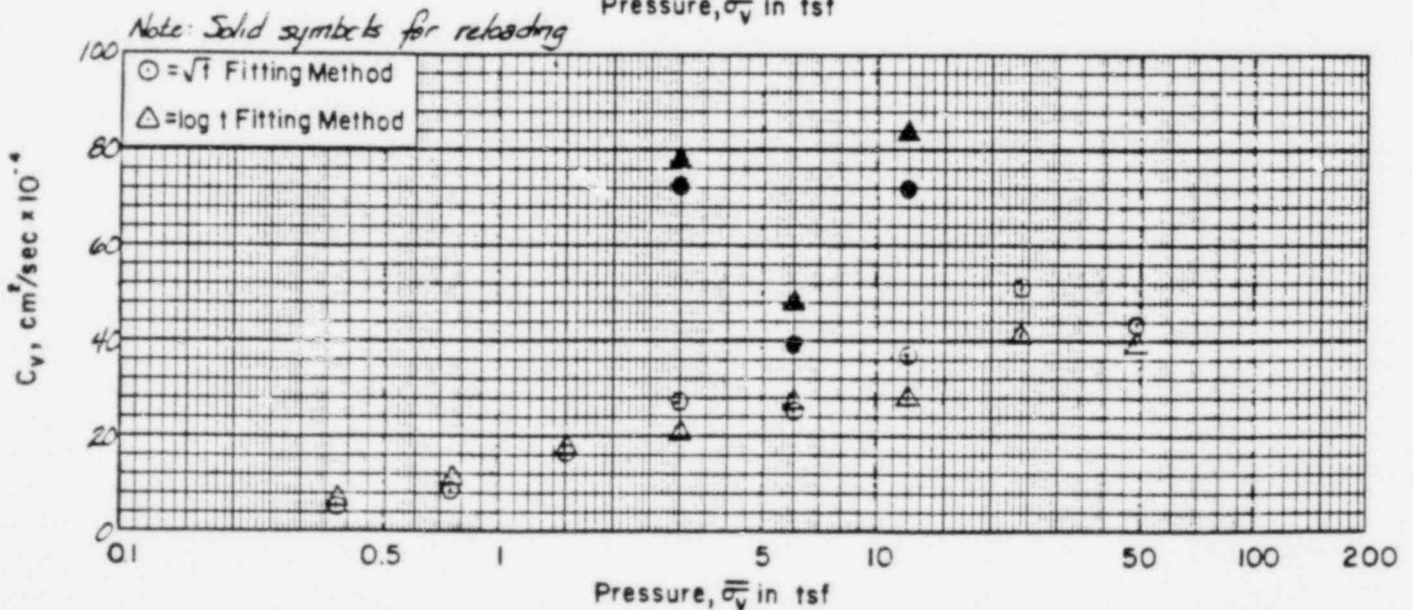
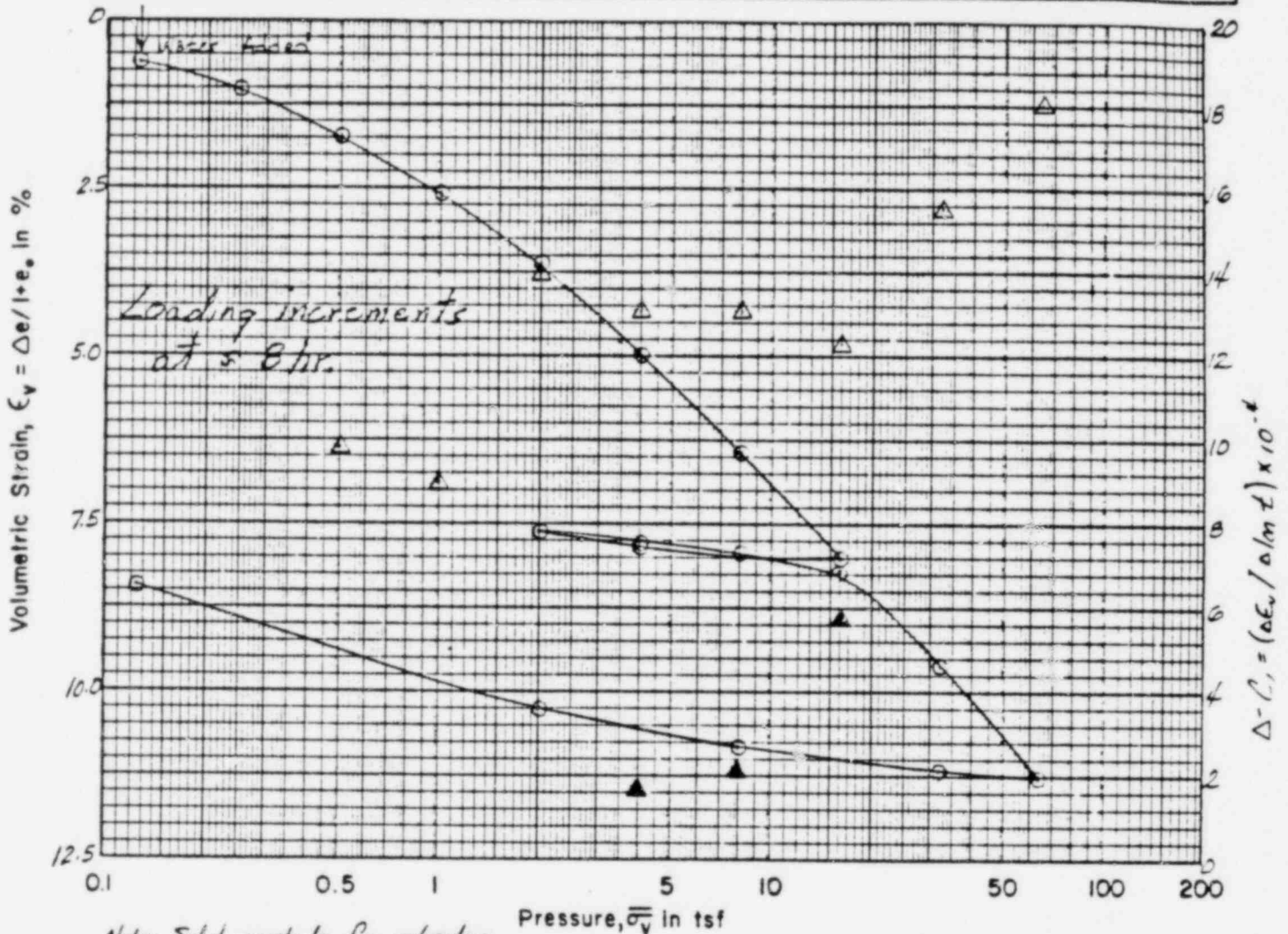


Note: Solid symbols for reloading



# CONSOLIDATION TEST

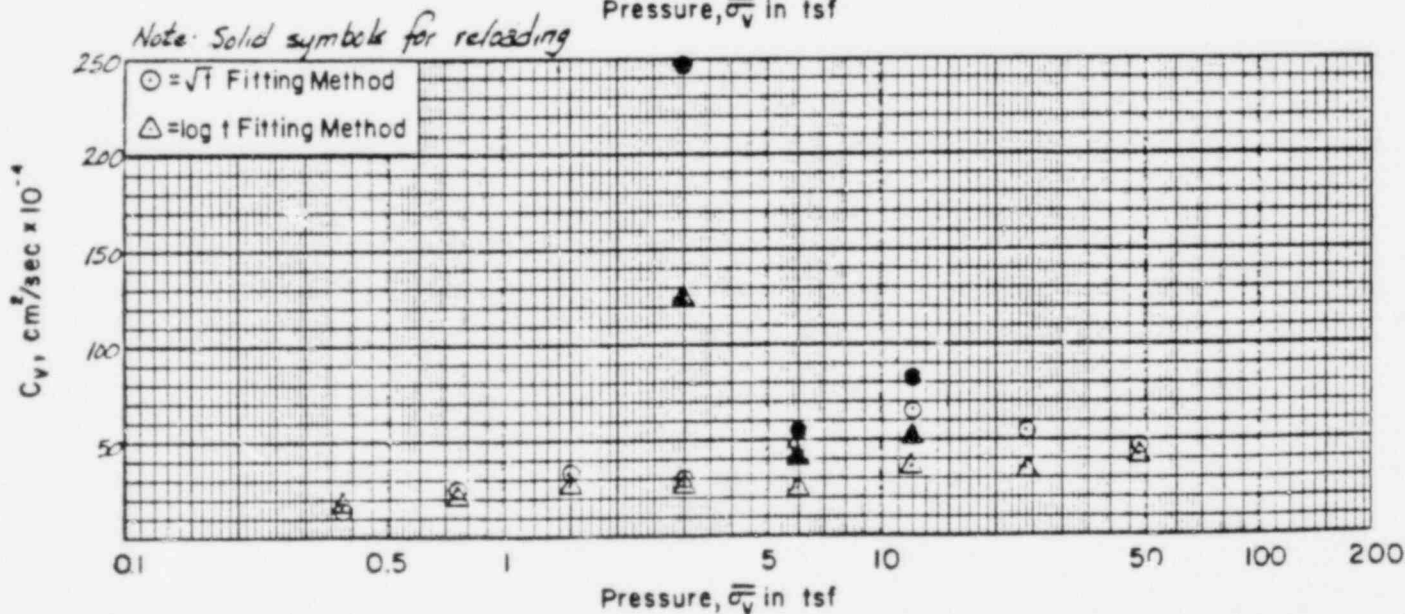
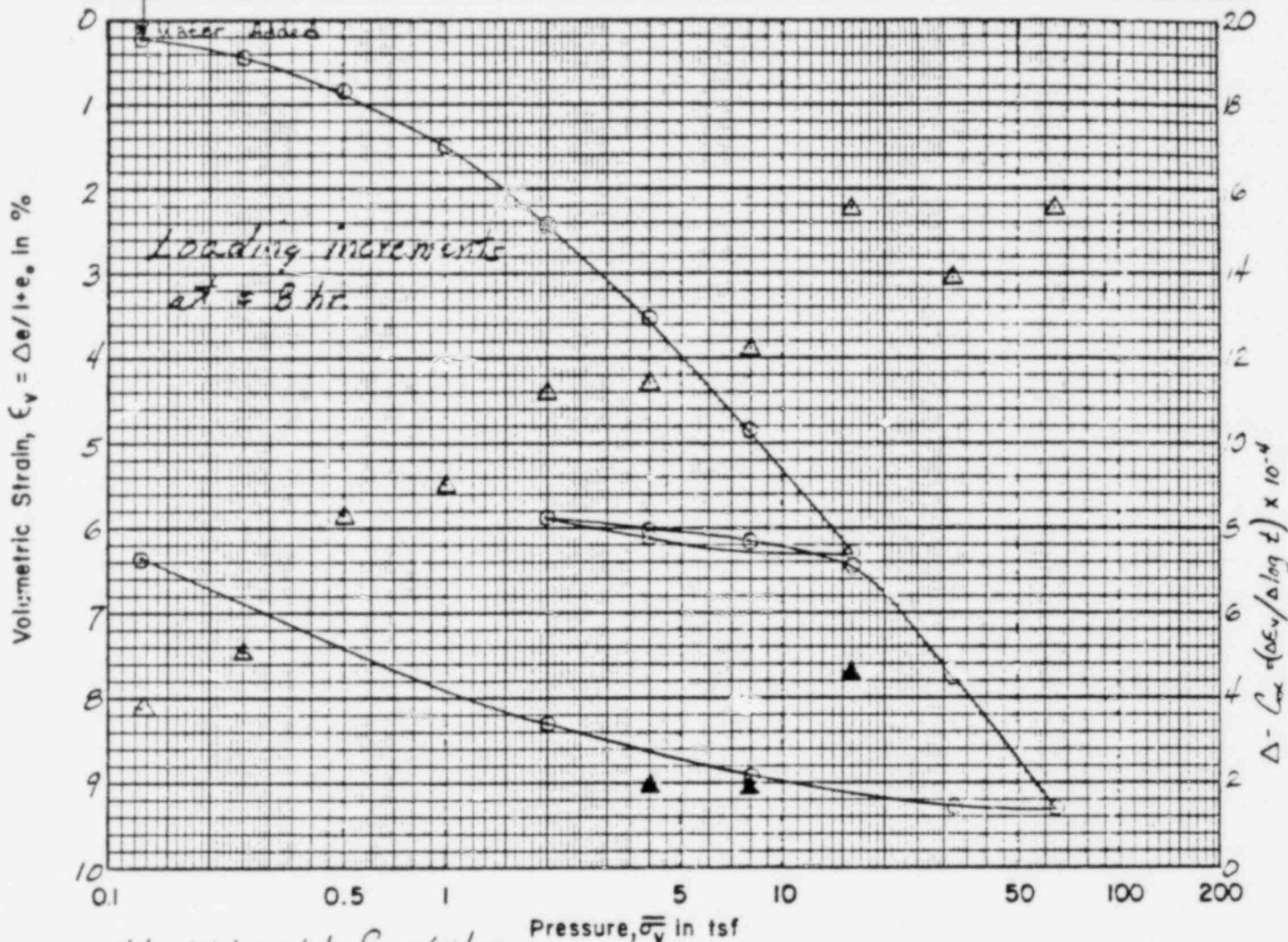
Boring No: COE-9		Sample No: S-4A				Depth, ft: 11.0			
Material: CL, br. m. to s. sandy s.p. silty CLAY, trace s. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.3	137.9	0.393	85.9	0.611	2.50	2.745	20	12
Final	10.5	145.3	0.301	95.8	0.571				





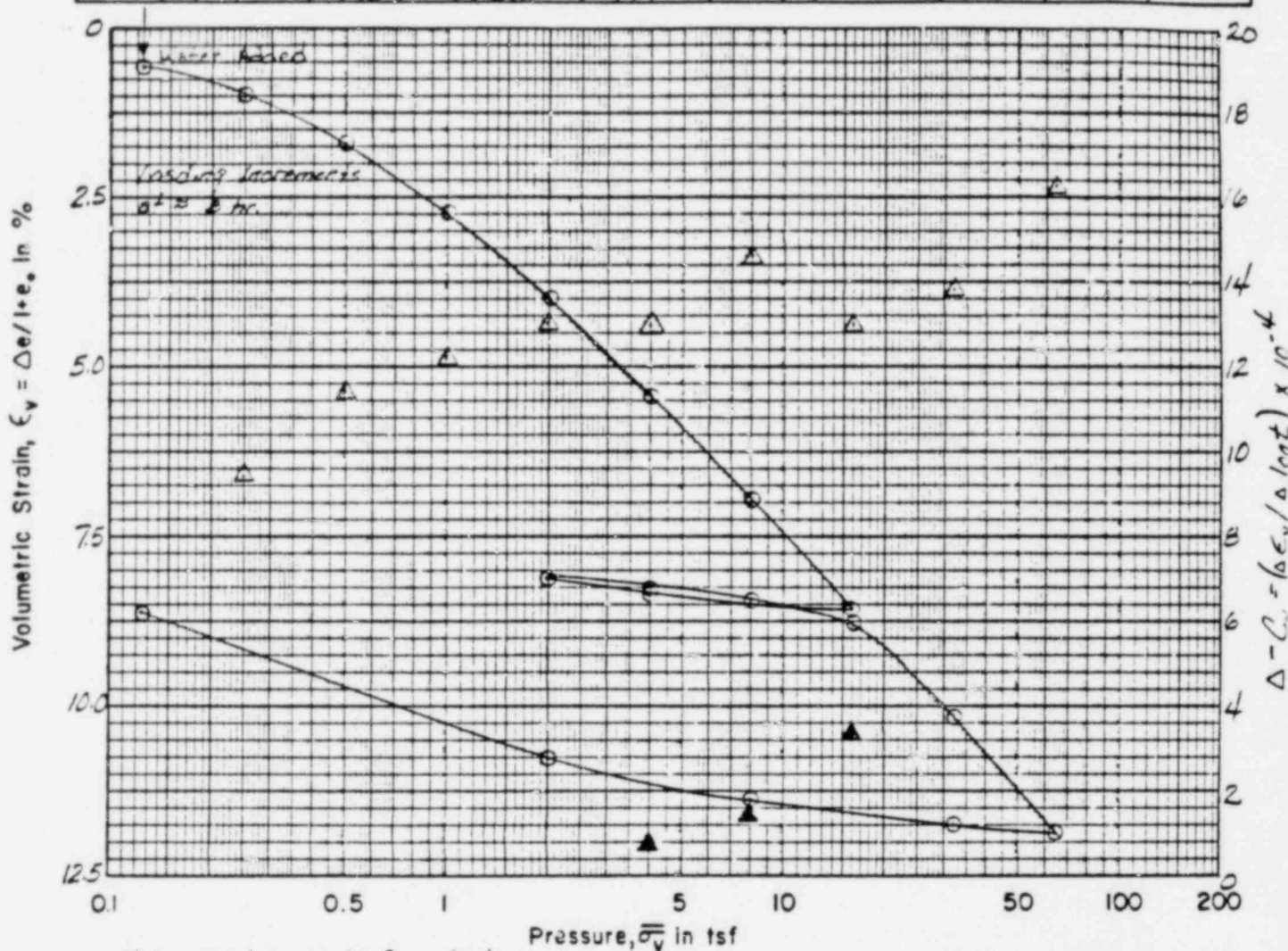
# CONSOLIDATION TEST

Boring No: <i>CDE-9</i>		Sample No: <i>S-5B</i>				Depth, ft: <i>14.0</i>			
Material: <i>CL, brown &amp; sandy s.p. silty CLAY, trace &amp; gravel to m. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>11.0</i>	<i>139.3</i>	<i>0.357</i>	<i>84.5</i>	<i>0.611</i>	<i>2.50</i>	<i>2.732</i>	<i>21</i>	<i>13</i>
Final	<i>10.3</i>	<i>147.0</i>	<i>0.277</i>	<i>101.6</i>	<i>0.575</i>				

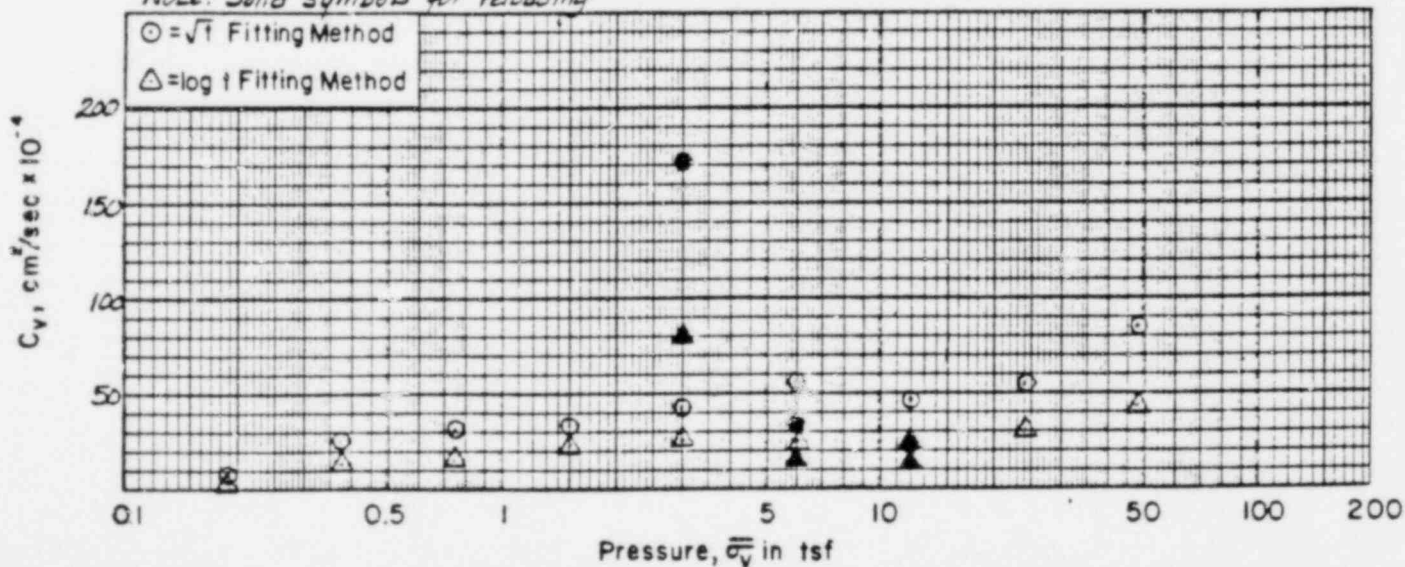


# CONSOLIDATION TEST

Boring No: COE-9		Sample No: 5-6B				Depth, ft: 16.2			
Material: CL, br. m to f sandy s.p. silty CLAY, trace s. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.1	136.6	0.428	81.9	0.615	2.50	2.751	22	14
Final	10.7	145.7	0.302	97.1	0.569				

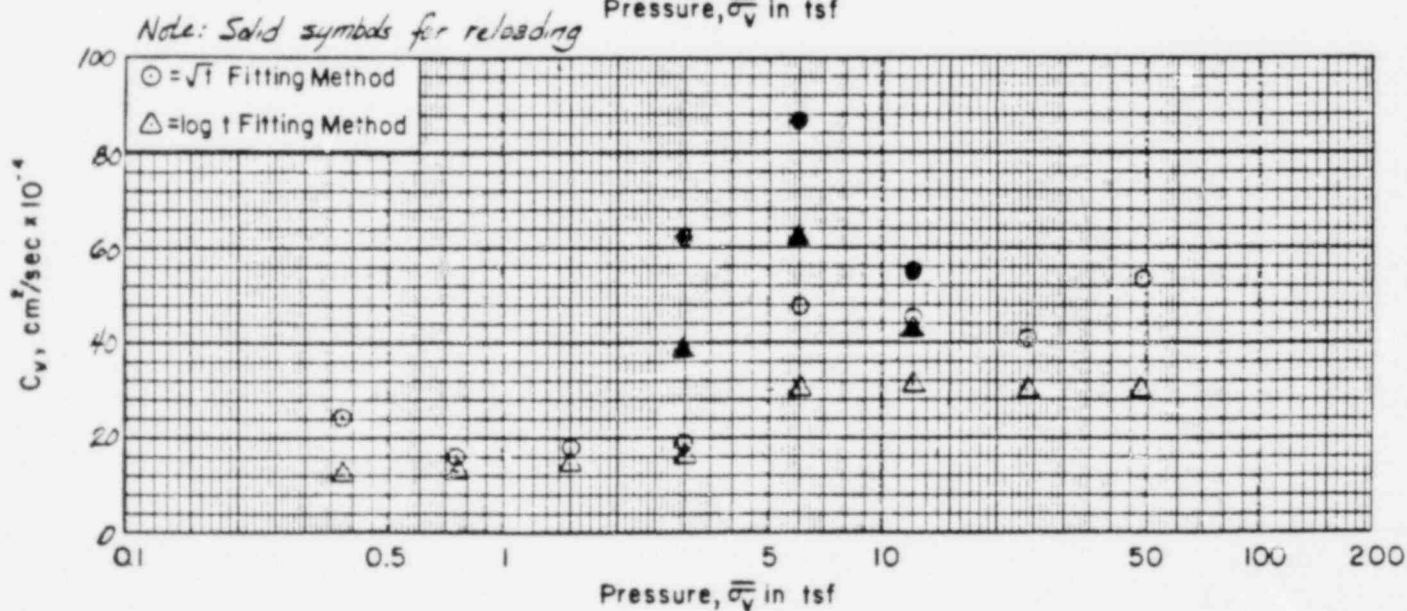
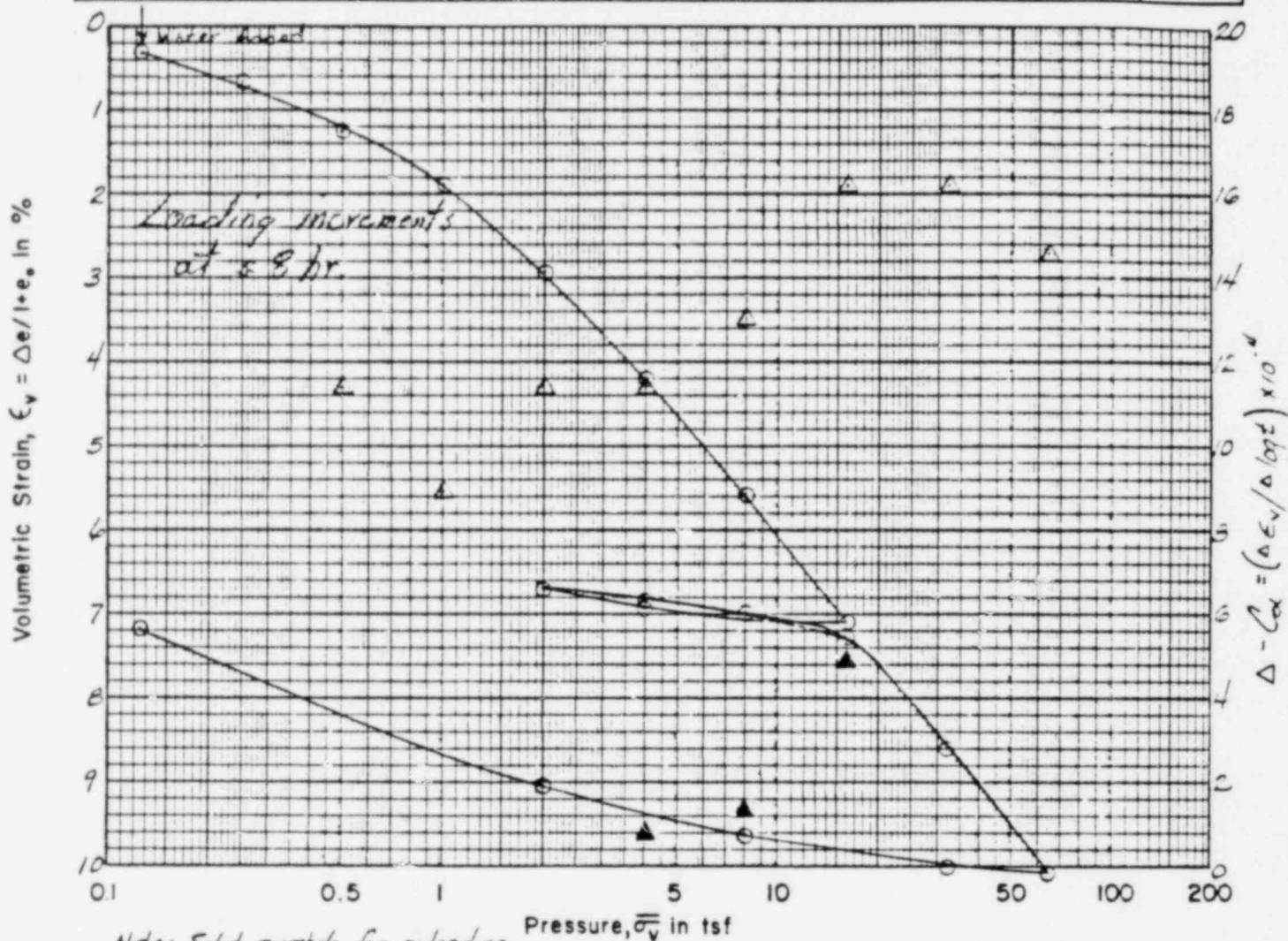


Note: Solid symbols for reloading



# CONSOLIDATION TEST

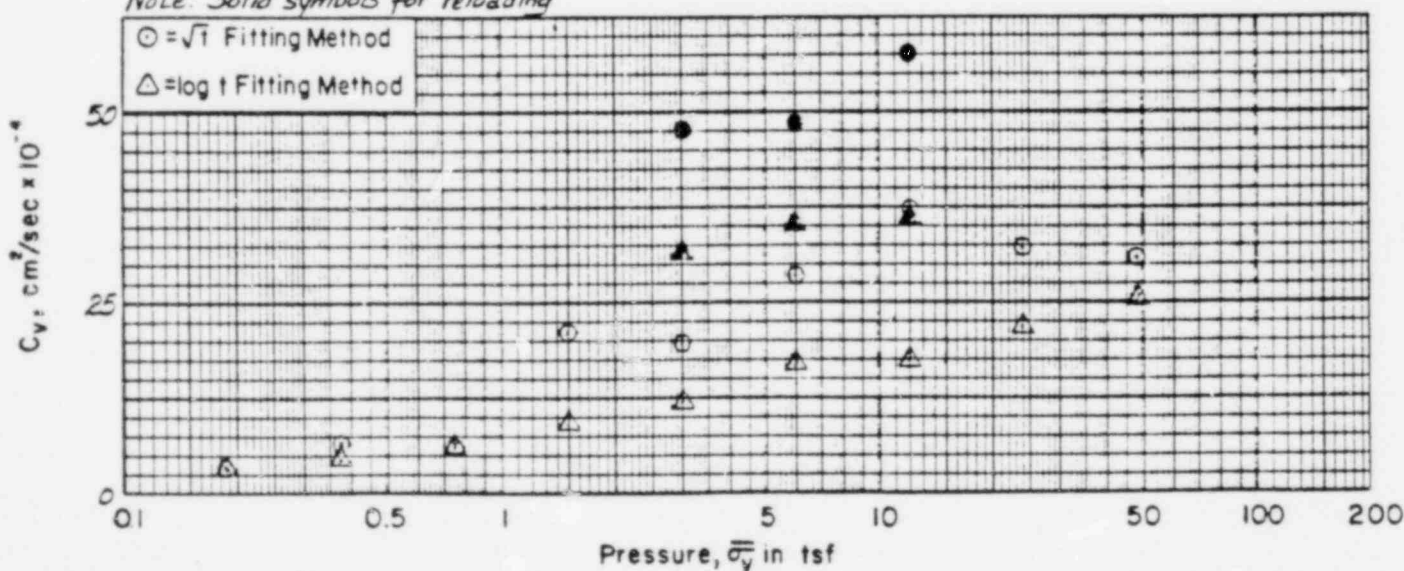
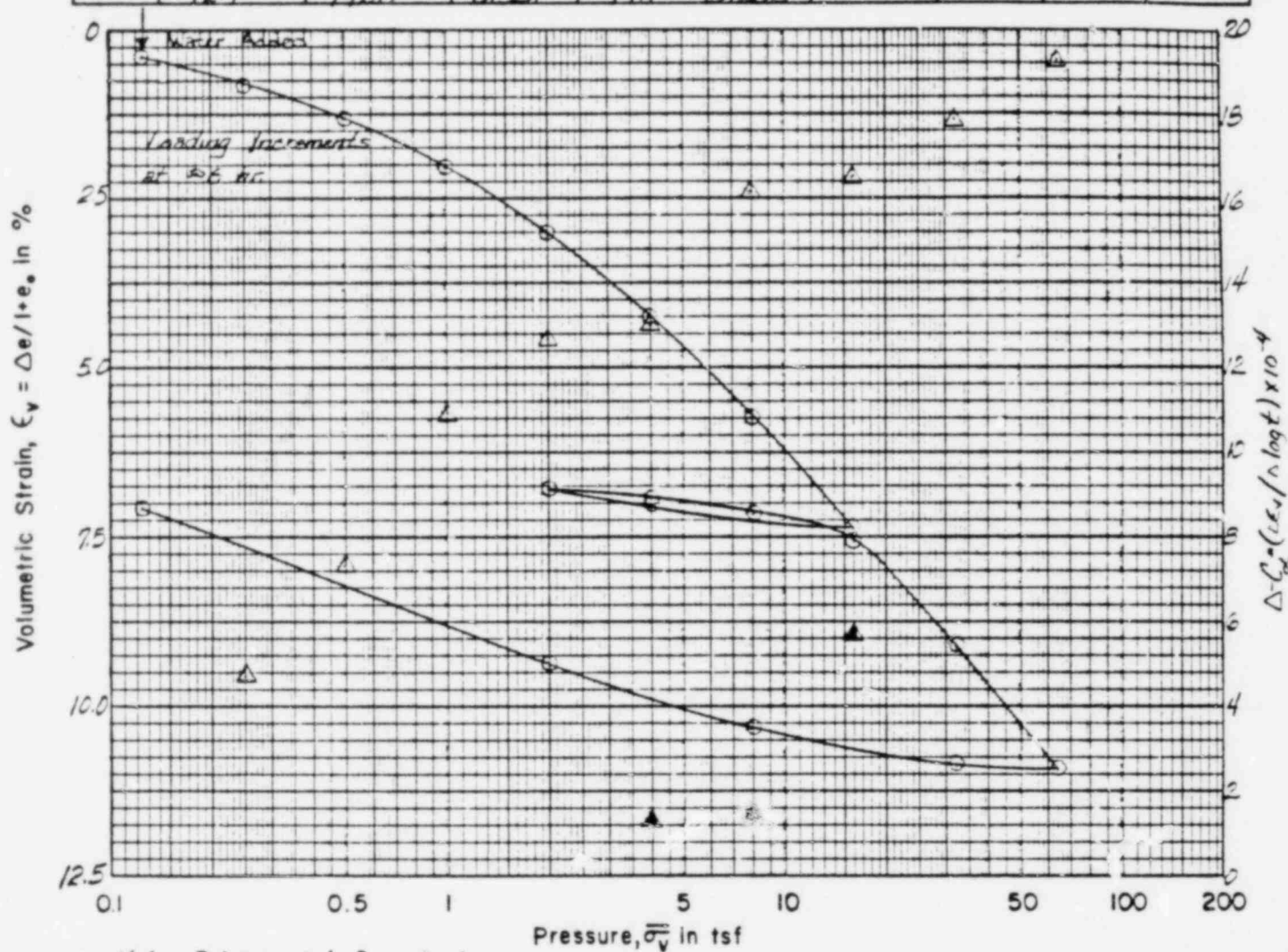
Boring No: COE-9		Sample No: S-6C				Depth, ft: 16.5			
Material: CL, brown & sandy s.p. silty CLAY, some f. gravel to m. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.7	139.2	0.374	86.3	0.616	2.50	2.745	20	12
Final	10.4	146.1	0.292	97.3	0.580				





# CONSOLIDATION TEST

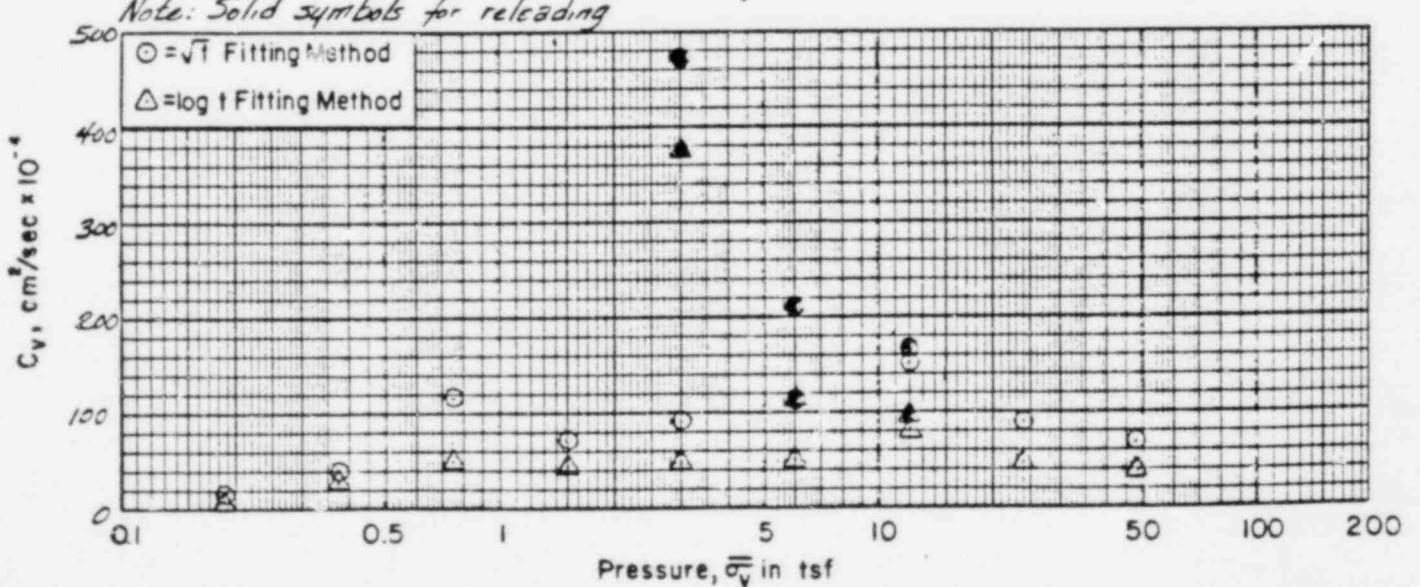
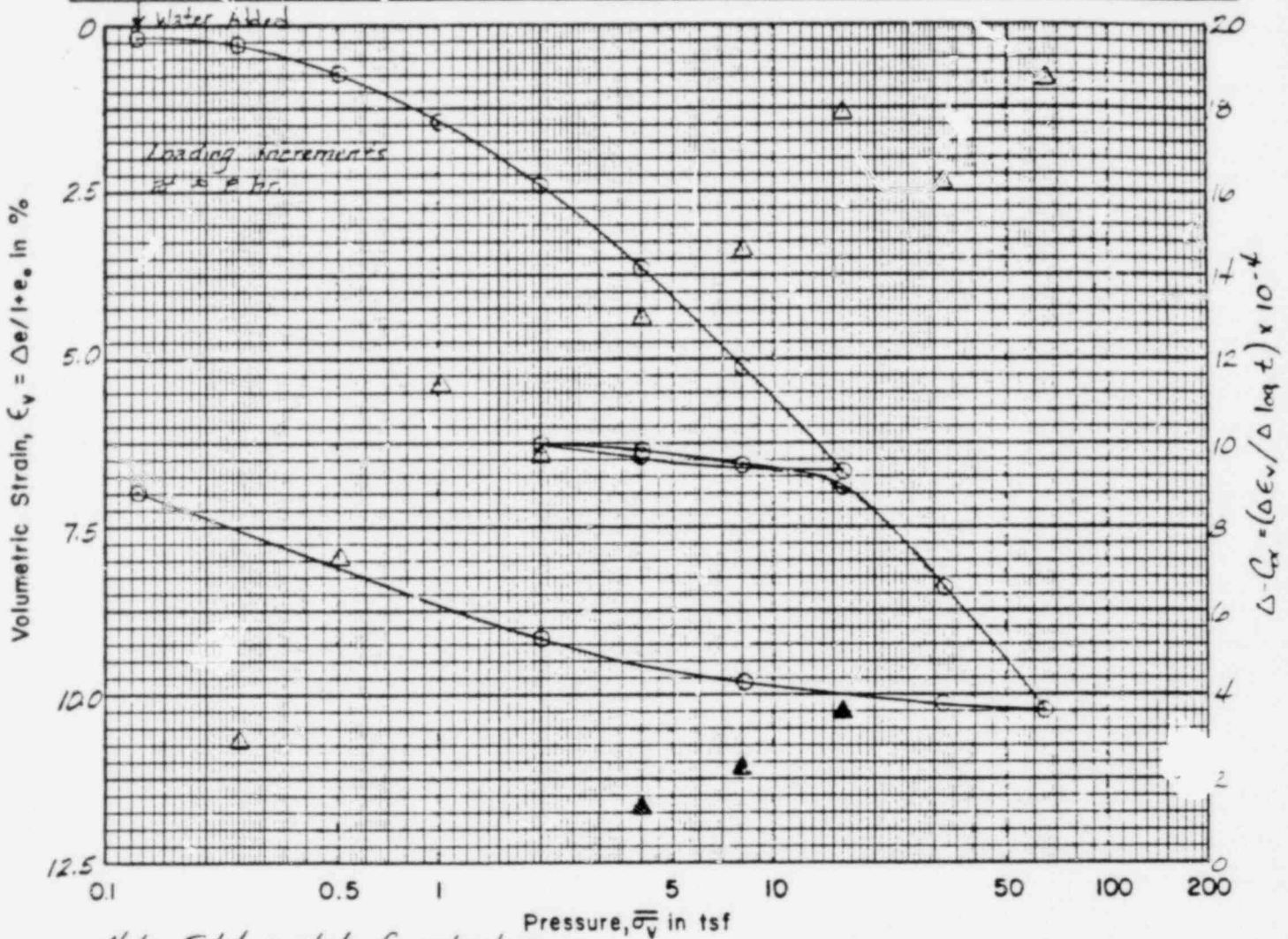
Boring No: CDE-9A		Sample No: S-8B				Depth, ft: 19.9			
Material: CL, br. & sandy m.p. s. H <sub>2</sub> CLAY, trace S. gravel to m. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.8	137.5	0.413	91.0	0.614	2.50	2.748	26	14
Final	12.7	142.9	0.351	99.9	0.585				





# CONSOLIDATION TEST

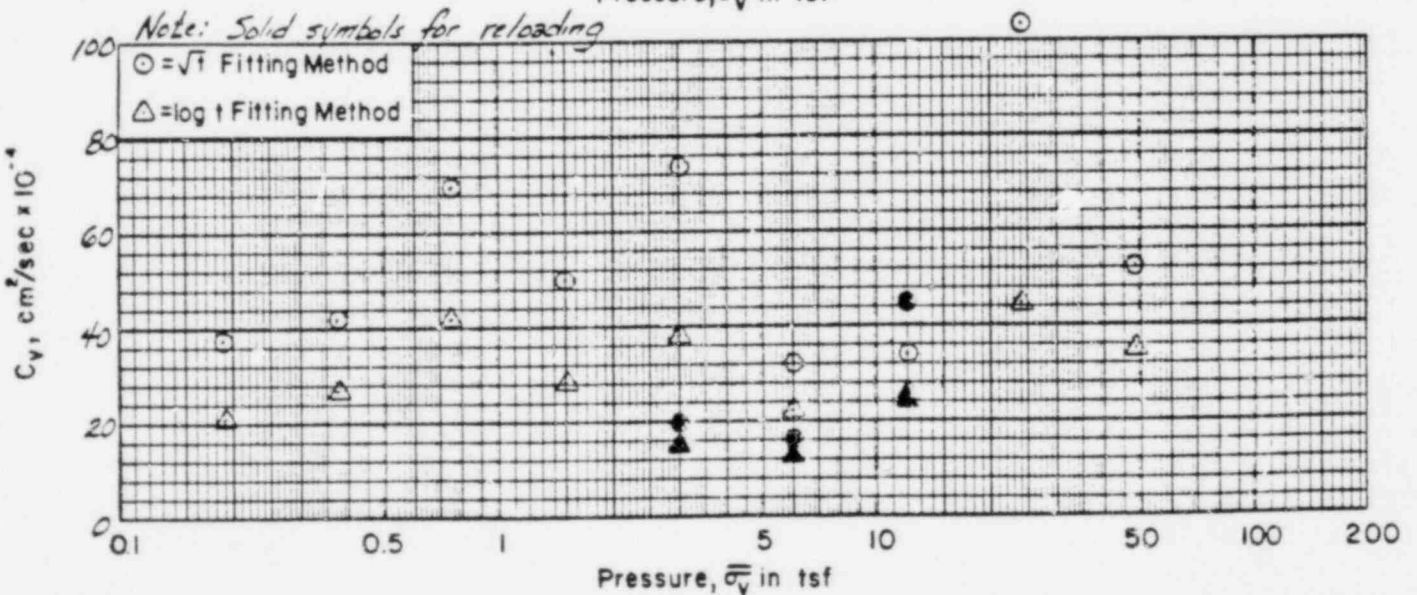
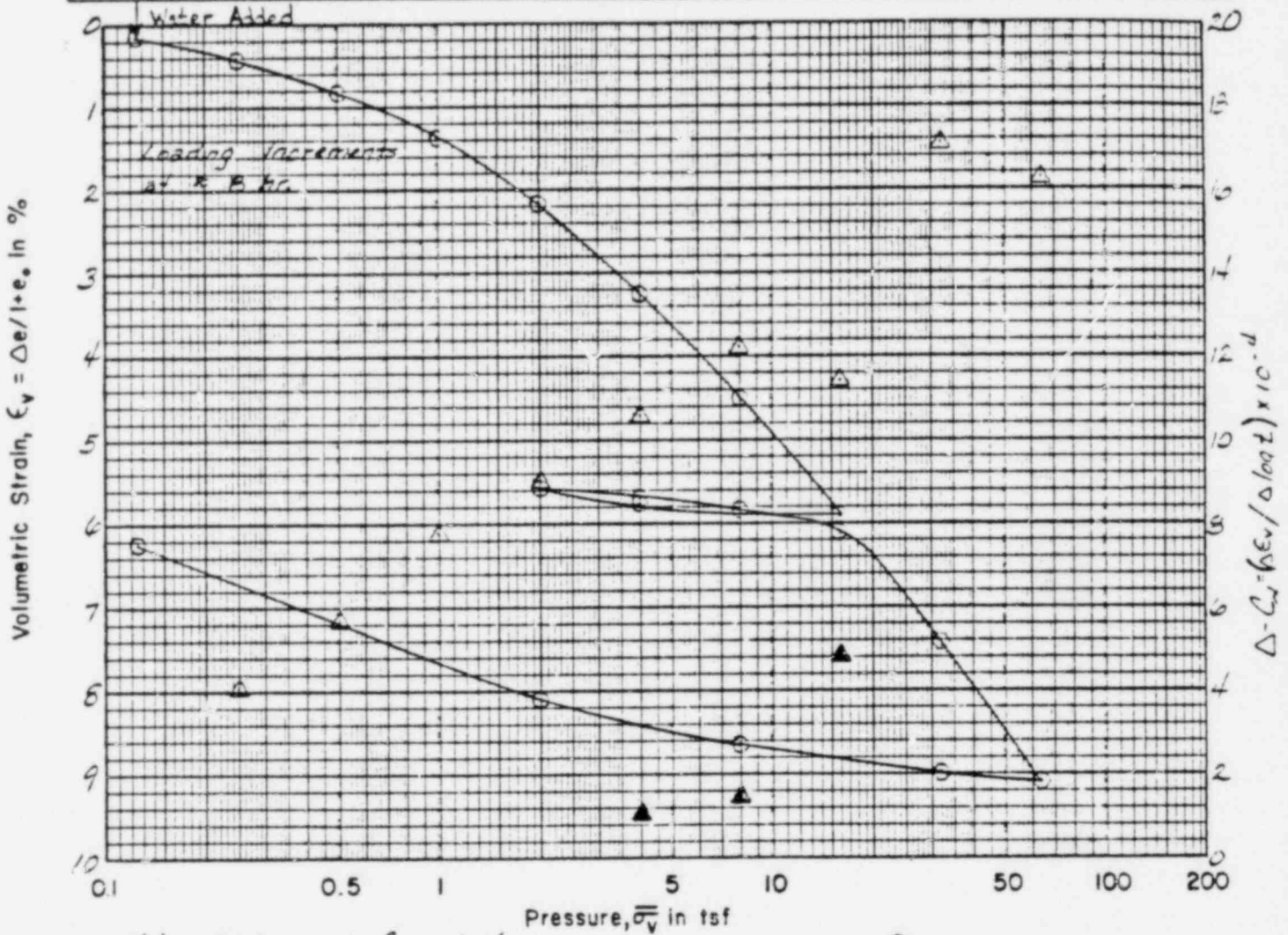
Boring No: COE-10A		Sample No: S-20				Depth, ft: 13.8			
Material: CL mottled br gr and orange-br. f. sandy s.p. silty CLAY fr. c-r. ss-s									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.3	133.0	0.443	76.4	0.616	2.50	2.741	21	13
Final	12.5	143.0	0.343	99.7	0.574				





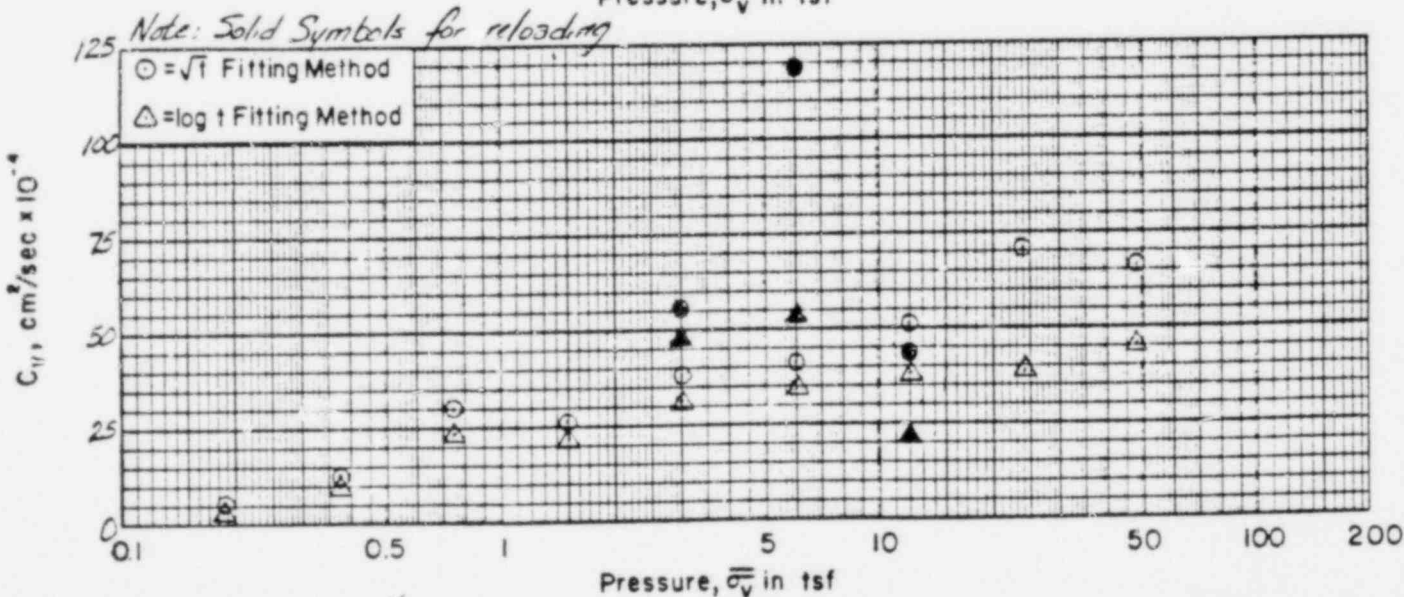
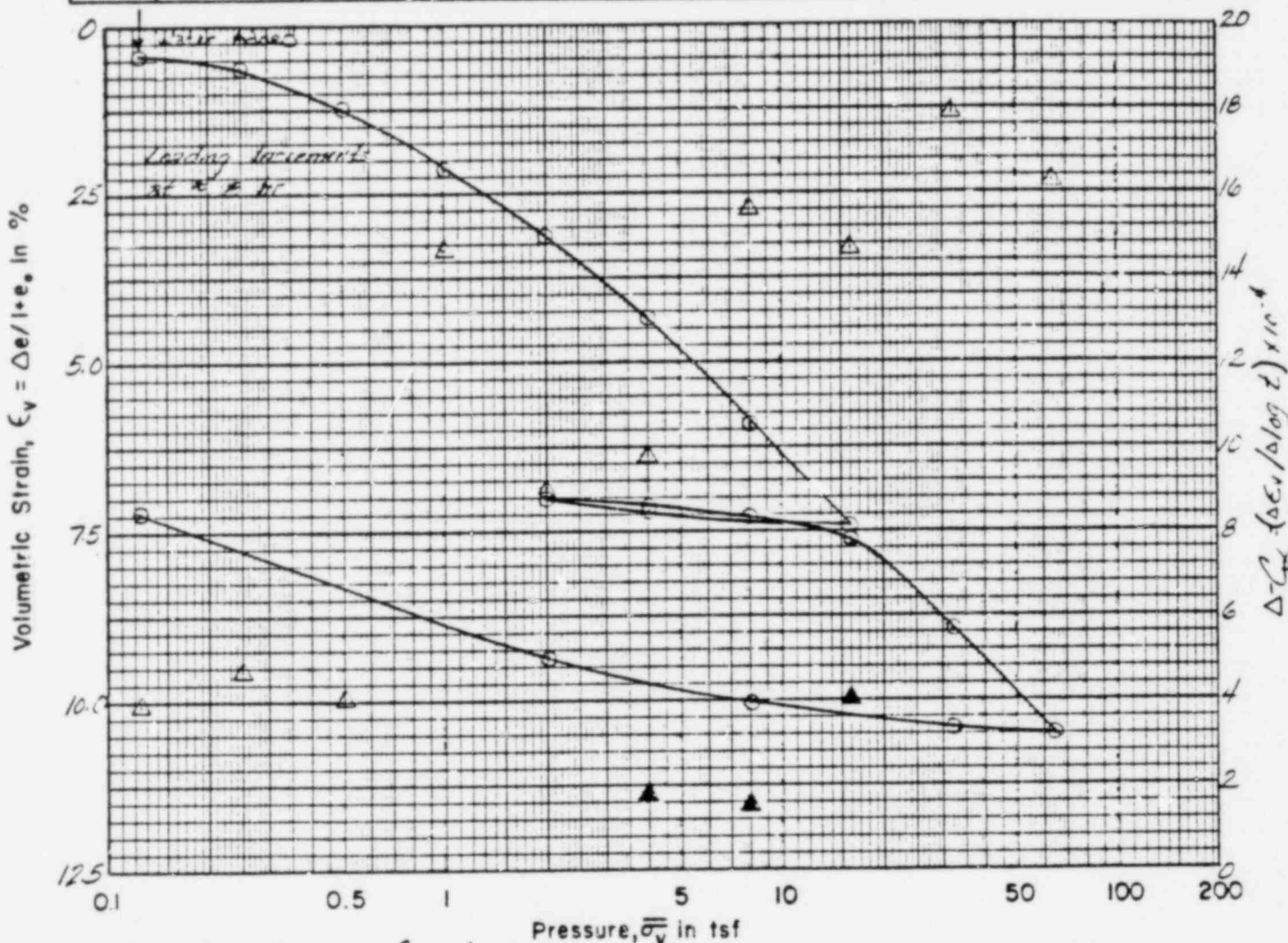
# CONSOLIDATION TEST

Boring No: <i>COE-11A</i>			Sample No: <i>S-2B</i>			Depth, ft: <i>12.4</i>			
Material: <i>CL, mottled gray &amp; brown m.to. S sandy spt to mp. silty CLAY, r. 5.9 gravel to 6.5 sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>10.5</i>	<i>138.6</i>	<i>0.366</i>	<i>79.0</i>	<i>0.614</i>	<i>2.50</i>	<i>2.748</i>	<i>22</i>	<i>12</i>
Final	<i>10.8</i>	<i>145.6</i>	<i>0.303</i>	<i>97.8</i>	<i>0.586</i>				



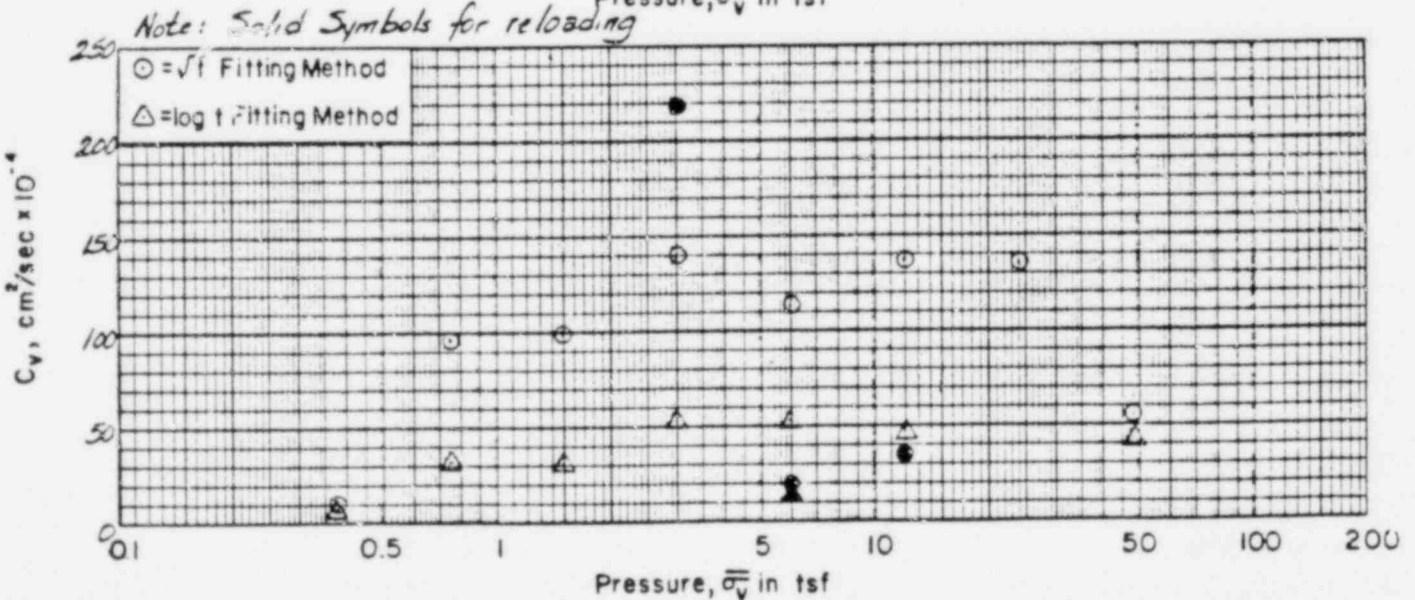
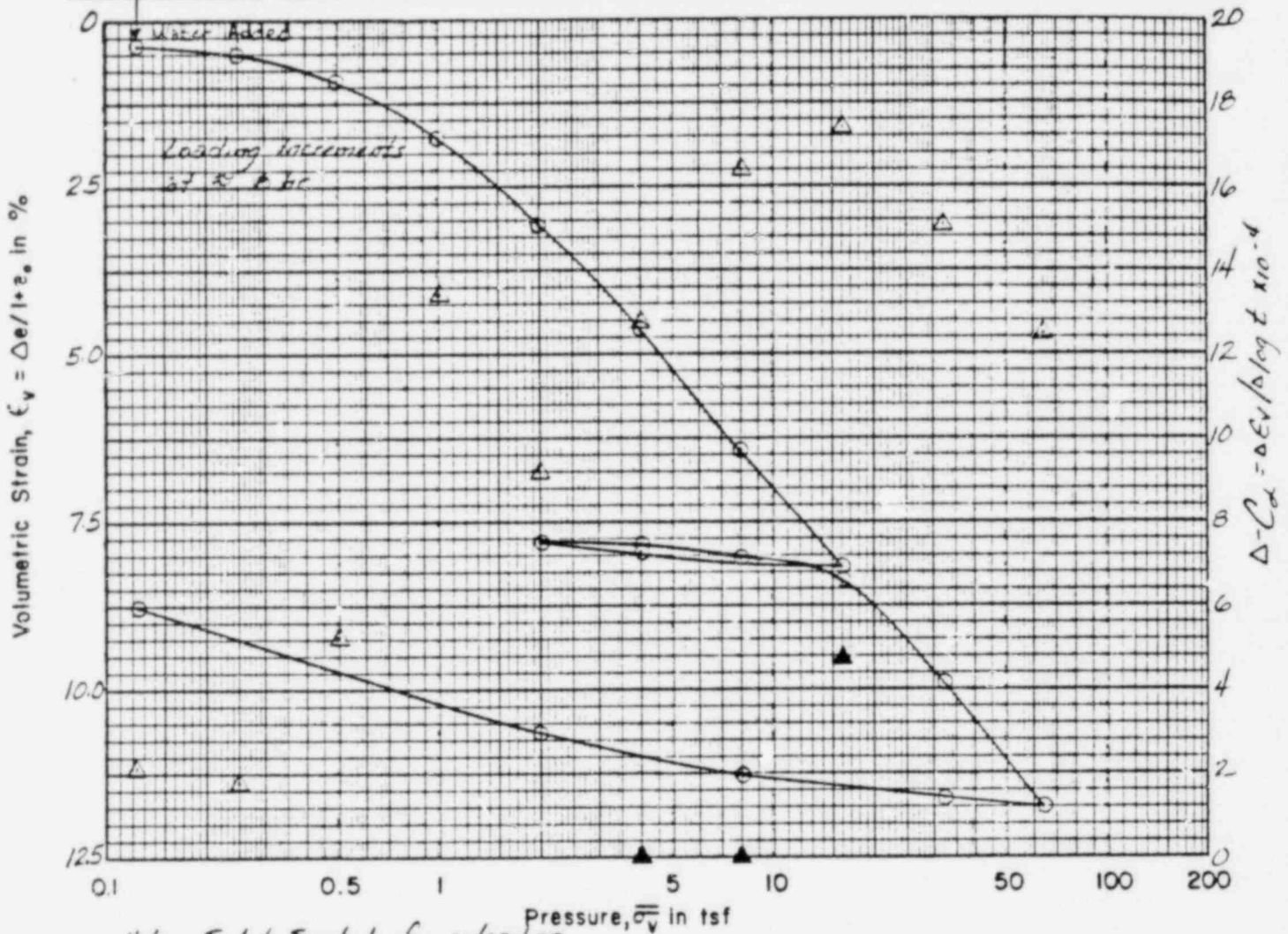
# CONSOLIDATION TEST

Boring No: <i>DE-11A</i>		Sample No: <i>S-4B</i>				Depth, ft: <i>14.1</i>			
Material: <i>CL, gr-br m to S sandy sp to mp silty CLAY, trace of gravel to c. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>11.8</i>	<i>137.9</i>	<i>0.389</i>	<i>83.3</i>	<i>0.614</i>	<i>2.50</i>	<i>2.747</i>	<i>22</i>	<i>12</i>
Final	<i>11.6</i>	<i>145.1</i>	<i>0.318</i>	<i>100.3</i>	<i>0.583</i>				



# CONSOLIDATION TEST

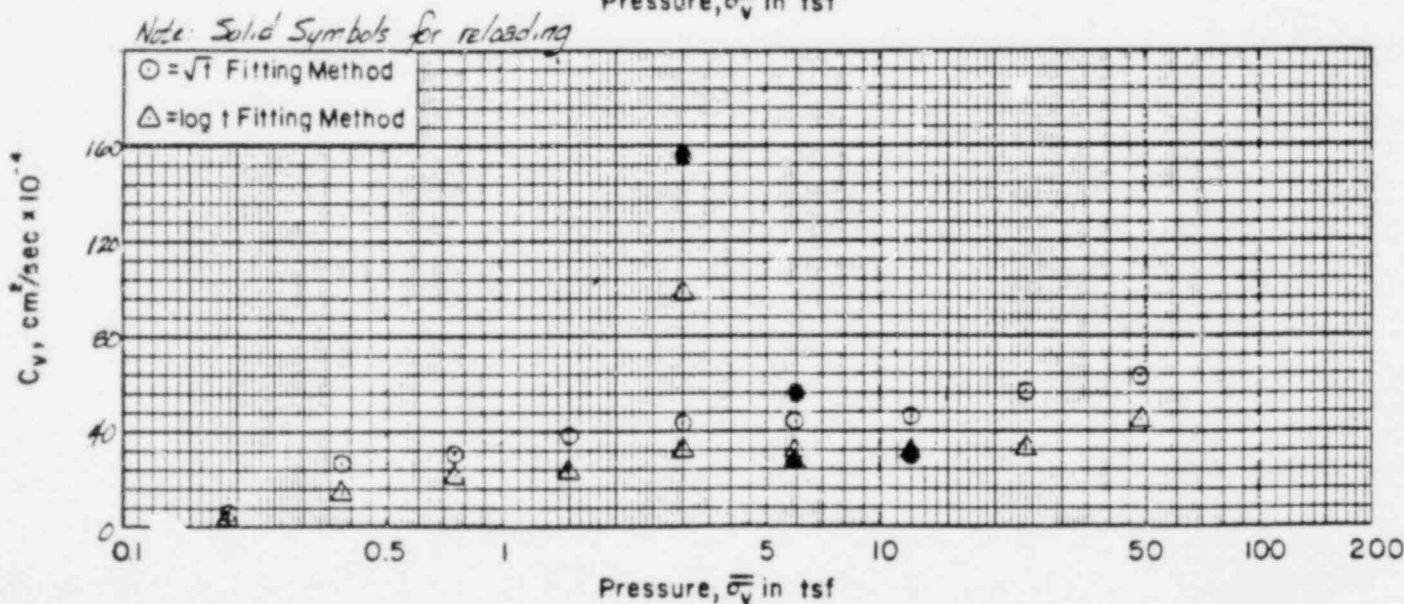
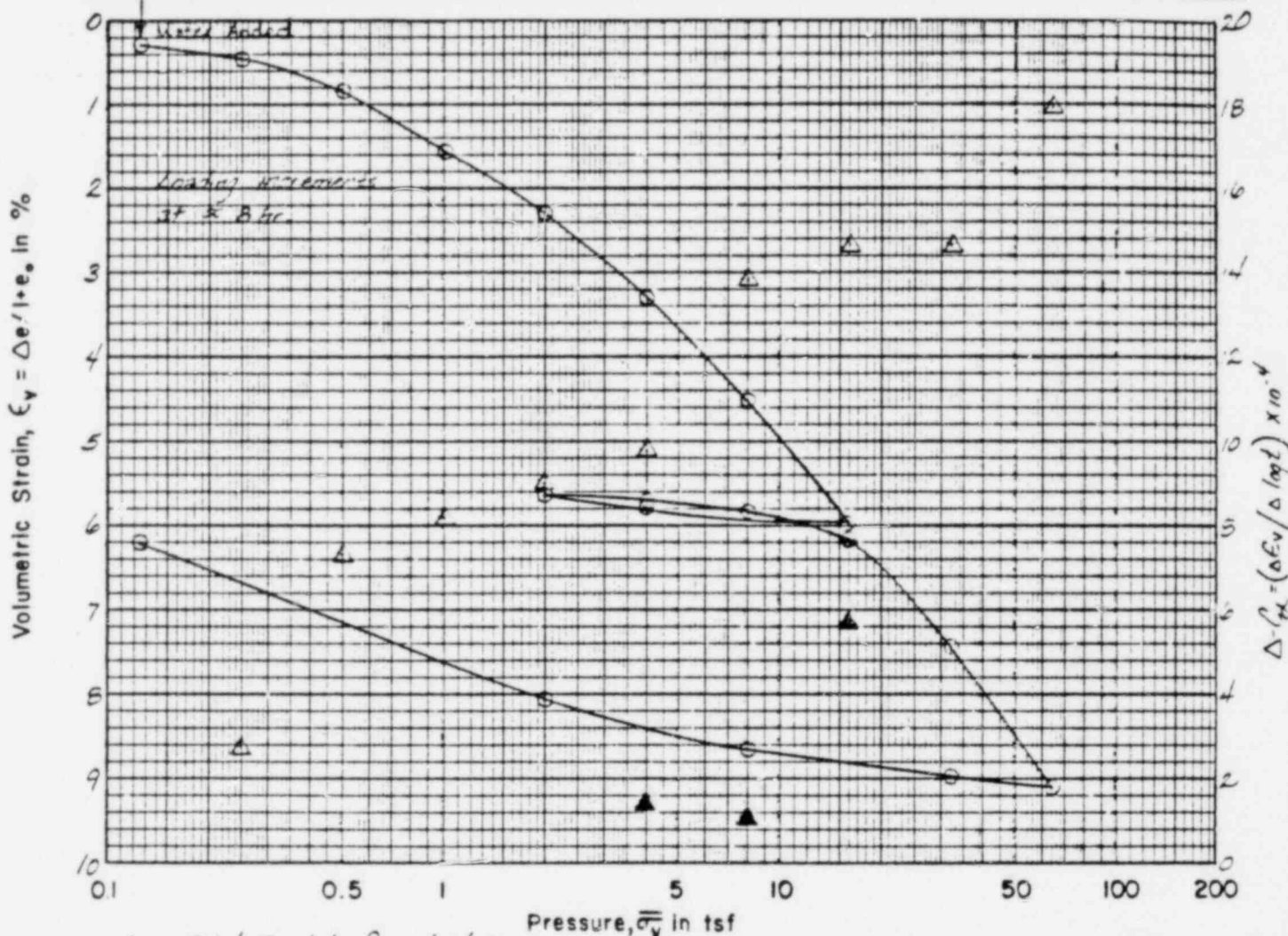
Boring No: COE-11A			Sample No: S-5B			Depth, ft: 16.7			
Material: CL, gr-br m to s. sandy sp s. H <sub>2</sub> CLAY, trace s. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.1	135.1	0.403	81.4	0.610	2.50	2.714	21	12
Final	11.0	144.7	0.297	100.4	0.564				





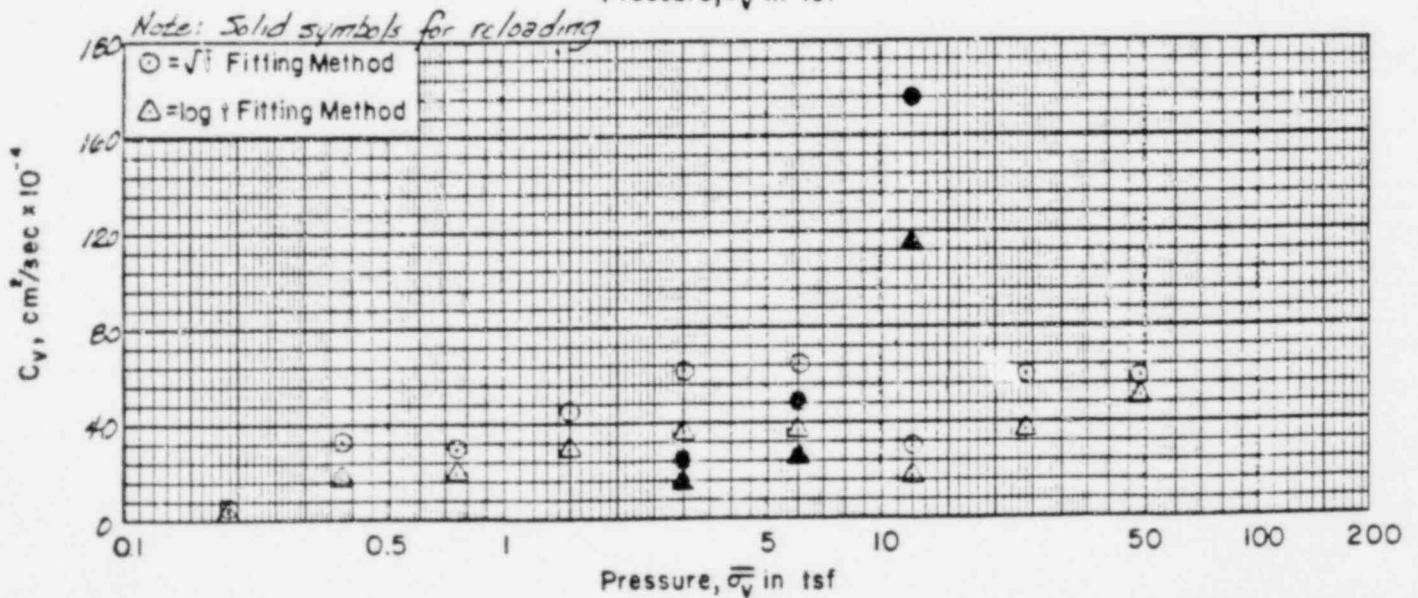
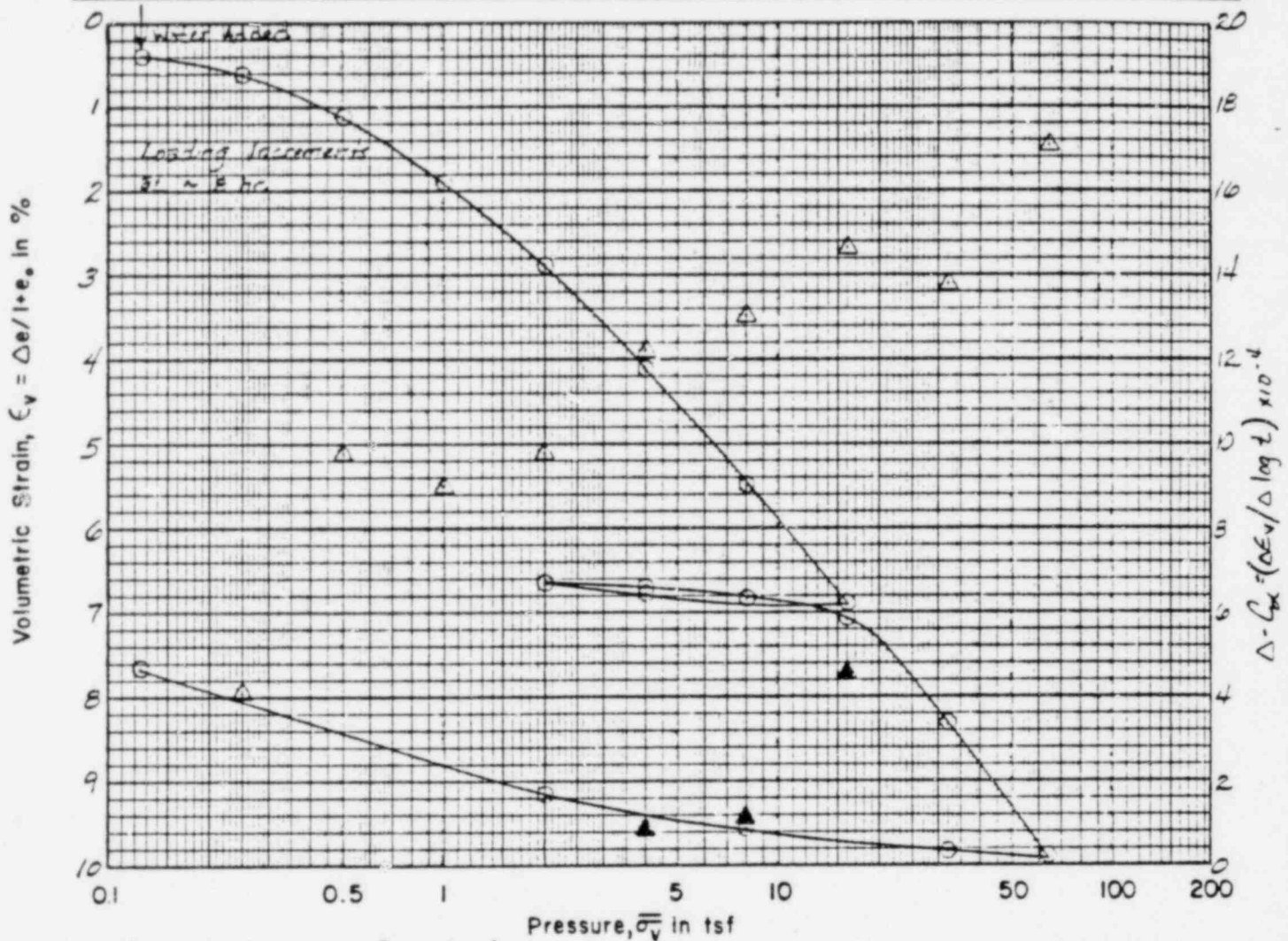
# CONSOLIDATION TEST

Boring No: COE-12A		Sample No: S 2-D				Depth, ft: 9.6			
Material: CL, br. m. s. sandy s. p. silty CLAY, trace s. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.2	129.2	0.376	82.4	0.614	2.50	2.764	21	13
Final	10.8	145.3	0.314	95.6	0.586				



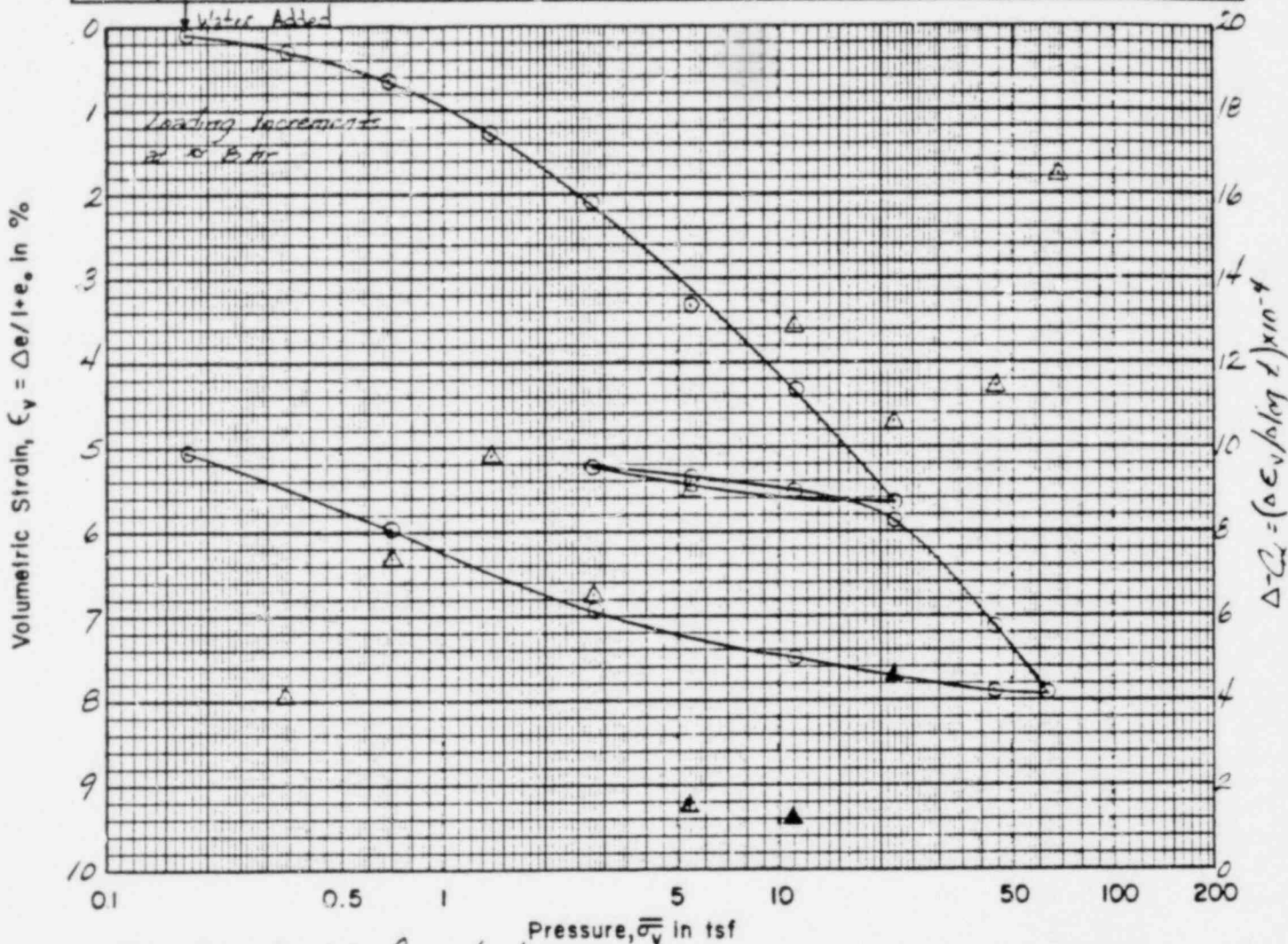
# CONSOLIDATION TEST

Boring No: COE-12A		Sample No: S-3C				Depth, ft: 12.1			
Material: CL, mottled gray & br. S. sandy s.p. silty CLAY, tr. S. grave to m. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.9	132.8	0.376	86.7	0.614	2.50	2.740	21	13
Final	10.5	147.1	0.283	102.0	0.573				

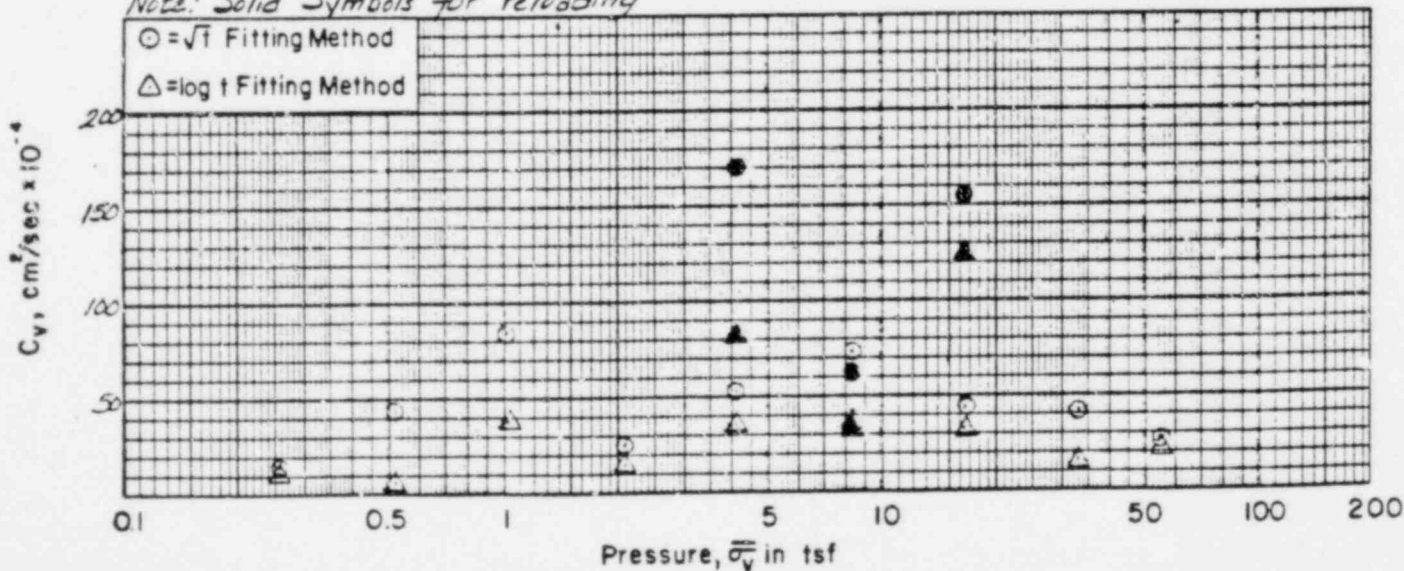


# CONSOLIDATION TEST

Boring No: <i>CDE-12A</i>			Sample No: <i>S-5C</i>			Depth, ft: <i>16.9</i>			
Material: <i>Cl, mottled br, grq lt. br. n to s. sandy sp silty CLAY, some s. gravel to c. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>9.7</i>	<i>141.5</i>	<i>0.345</i>	<i>78.4</i>	<i>0.611</i>	<i>250</i>	<i>2.783</i>	<i>21</i>	<i>12</i>
Final	<i>9.4</i>	<i>146.1</i>	<i>0.299</i>	<i>87.7</i>	<i>0.590</i>				



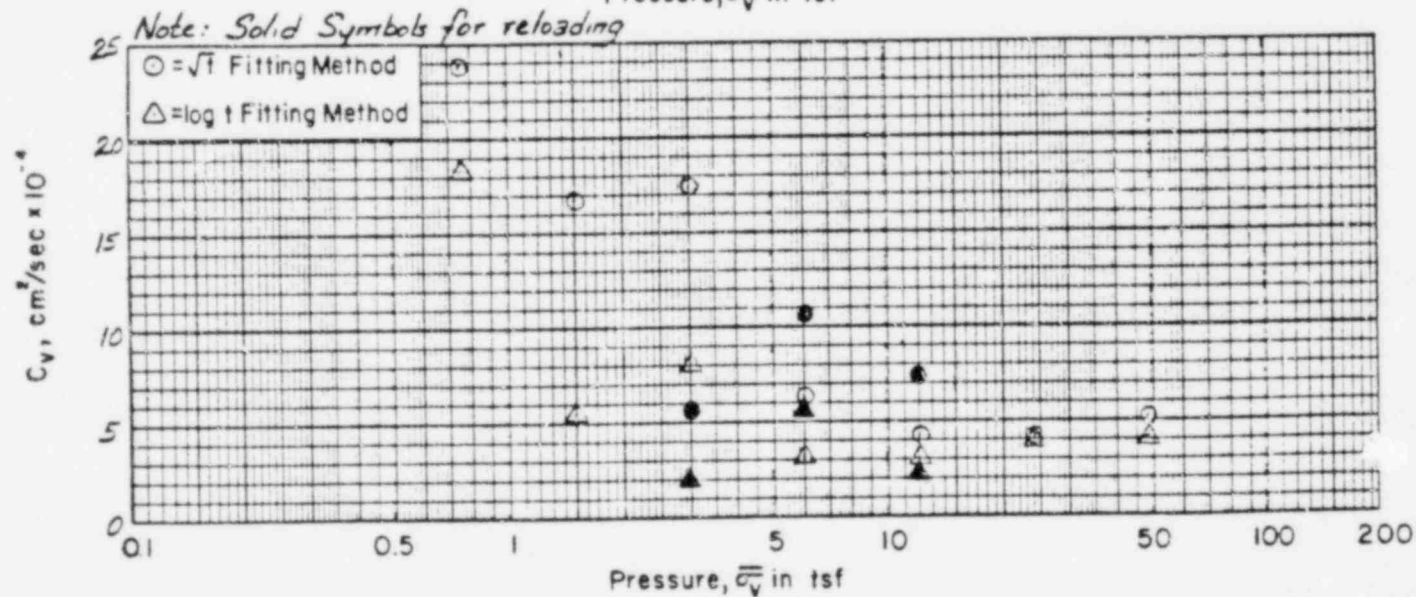
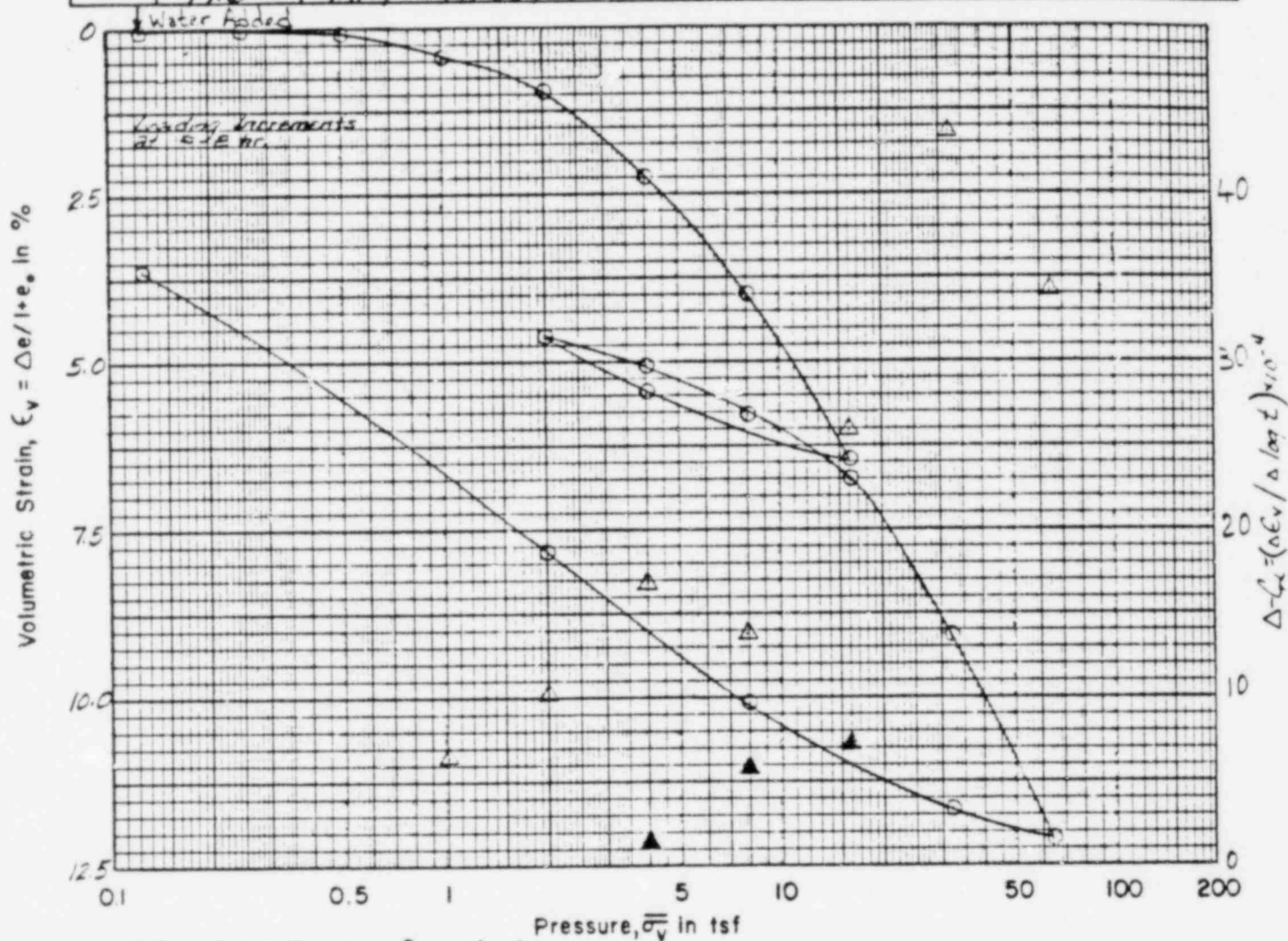
Note: Solid Symbols for reloading





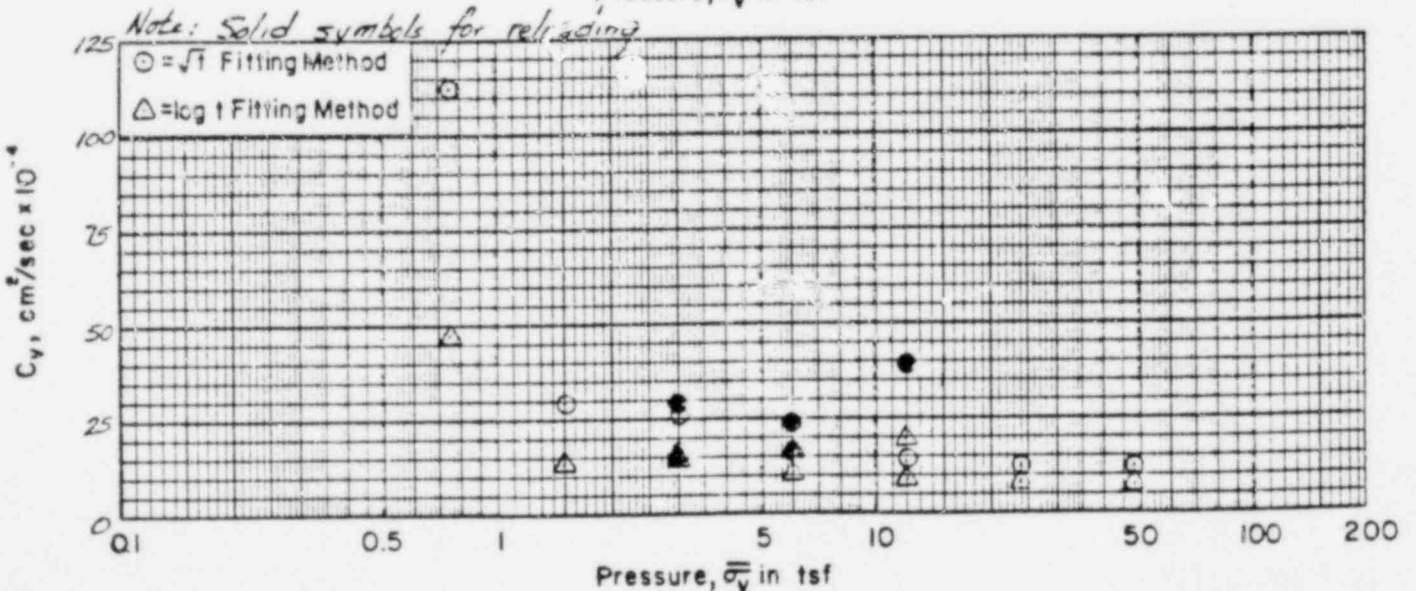
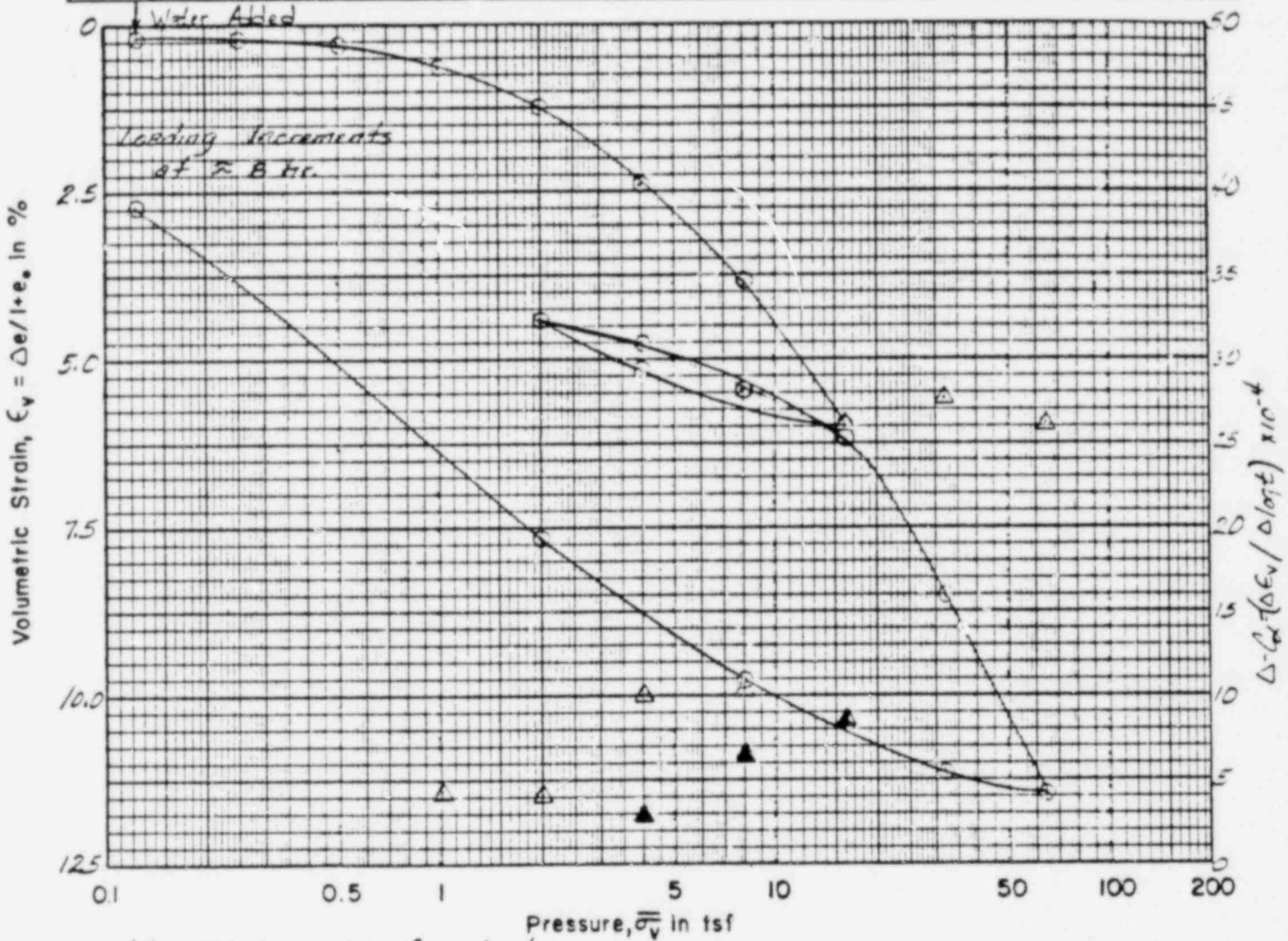
# CONSOLIDATION TEST

Boring No: COE-12A		Sample No: S-6B				Depth, ft: 19.0			
Material: CL, mottled br, gr and red-br plastic silty CLAY, some m.to s. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	18.0	132.3	0.542	92.3	0.617	2.50	2.774	46	18
Final	19.6	131.9	0.567	95.7	0.627				



# CONSOLIDATION TEST

Boring No: COE 12A			Sample No: S-7C			Depth, ft: 20.8			
Material: CL, mottled br gr. & orange-br plastic silty CLAY some m. to f. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	17.2	132.1	0.519	91.2	0.614	2.50	2.747	38	17
Final	19.7	131.6	0.557	97.0	0.630				



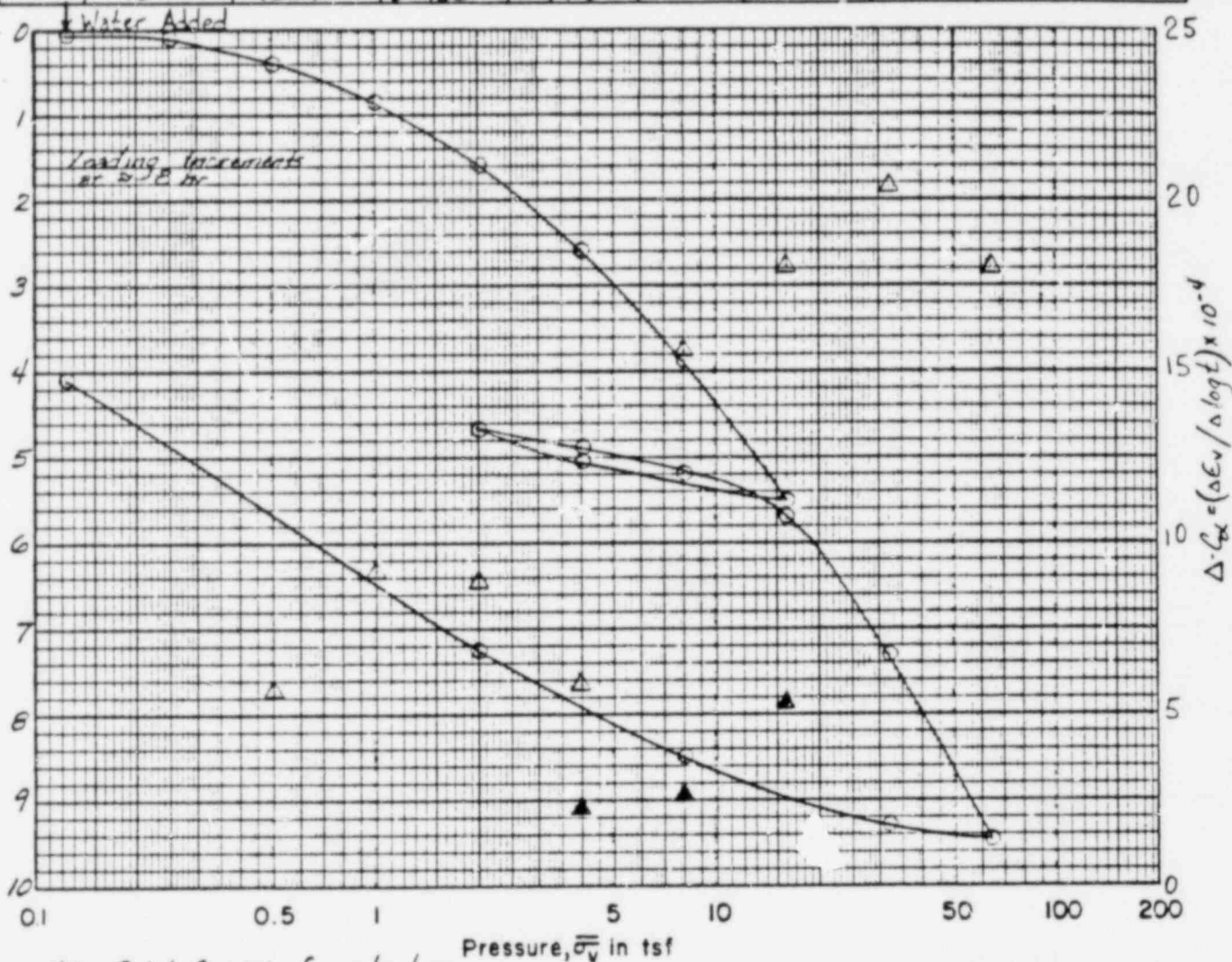


# CONSOLIDATION TEST

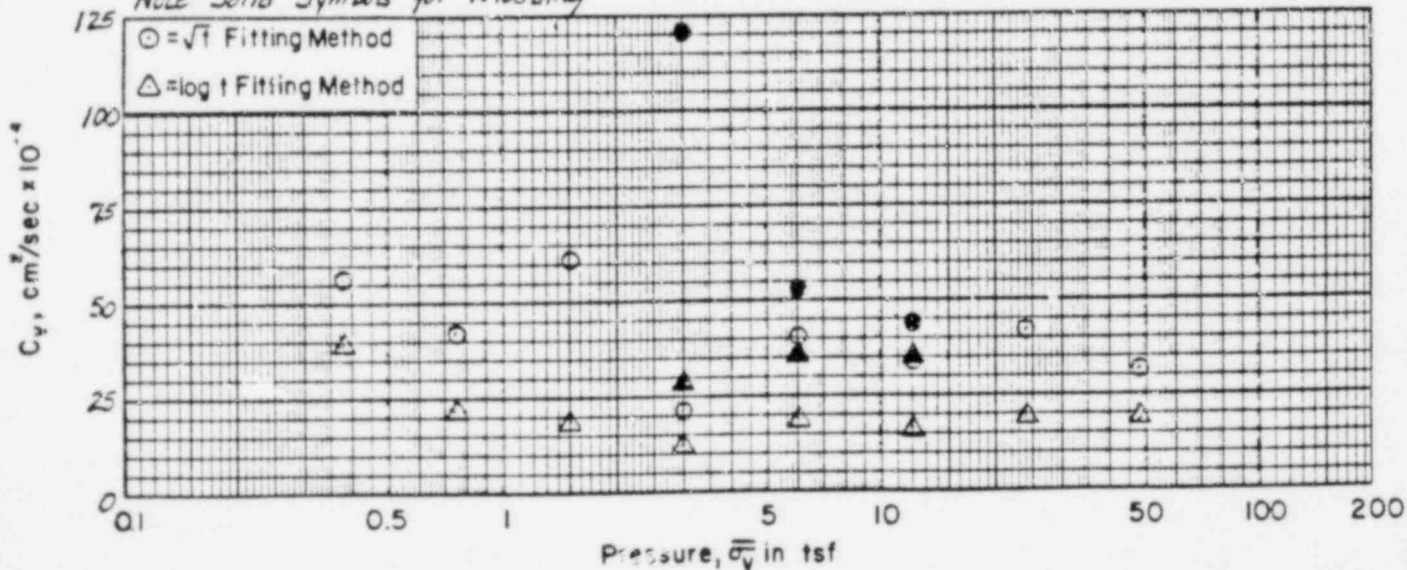
Boring No: <i>CDE-12A</i>			Sample No: <i>S-BB</i>			Depth, ft: <i>23.0</i>			
Material: <i>CL, mottled H br, brgy H gr sp. silty CLAY, some s. gravel to s. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>14.6</i>	<i>135.9</i>	<i>0.443</i>	<i>90.7</i>	<i>0.611</i>	<i>2.50</i>	<i>2.745</i>	<i>23</i>	<i>14</i>
Final	<i>15.7</i>	<i>138.2</i>	<i>0.433</i>	<i>99.8</i>	<i>0.606</i>				

06/29/81

Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$  in %

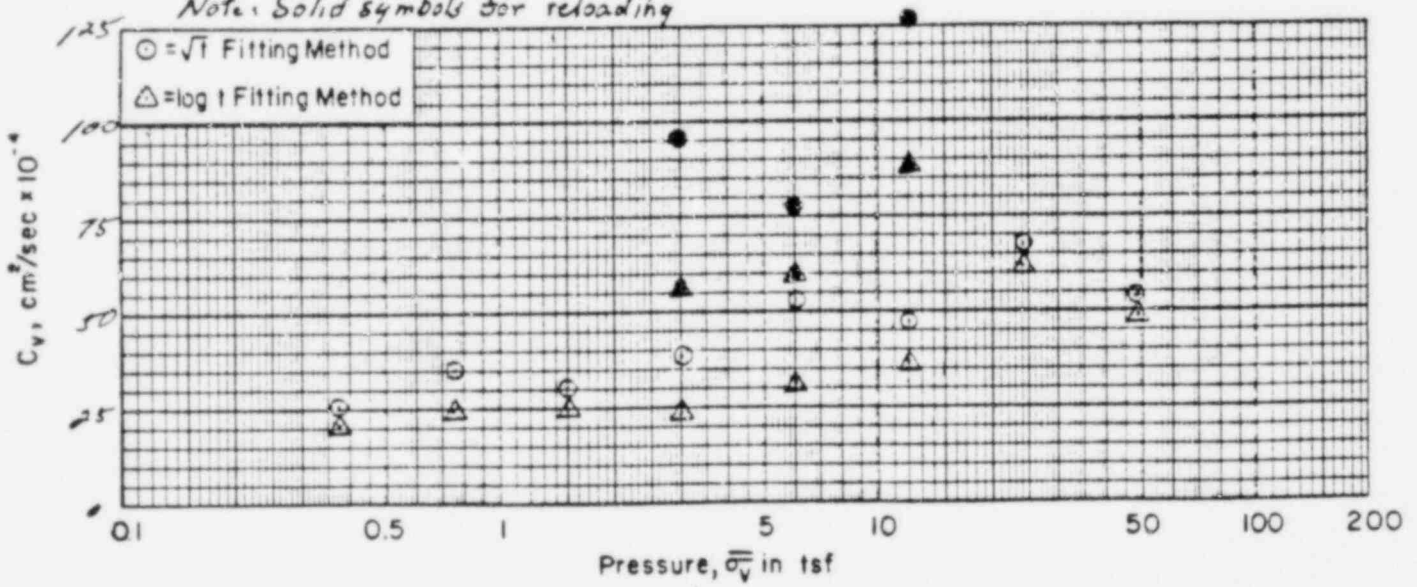
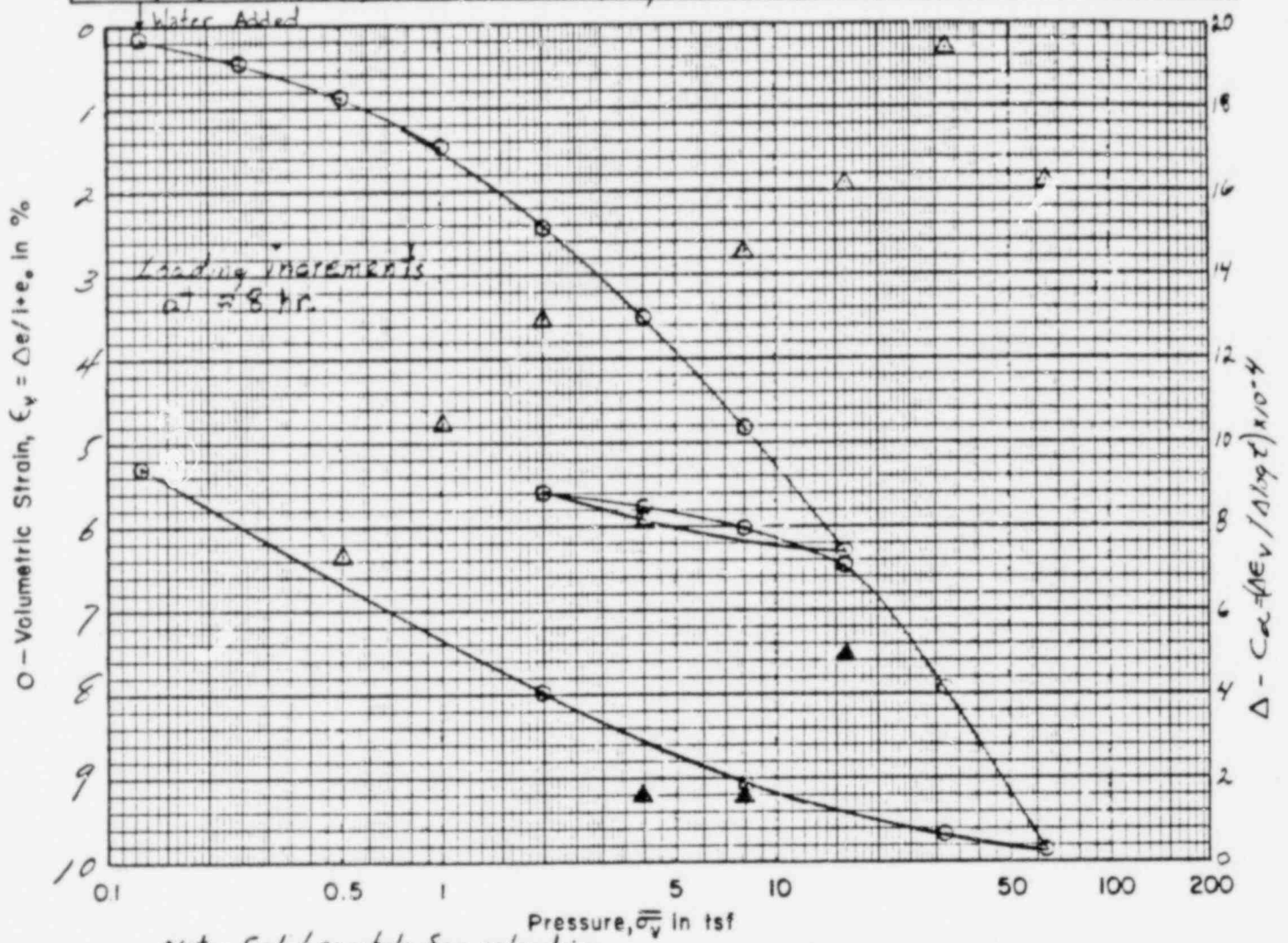


Note: Solid Symbols for reloading



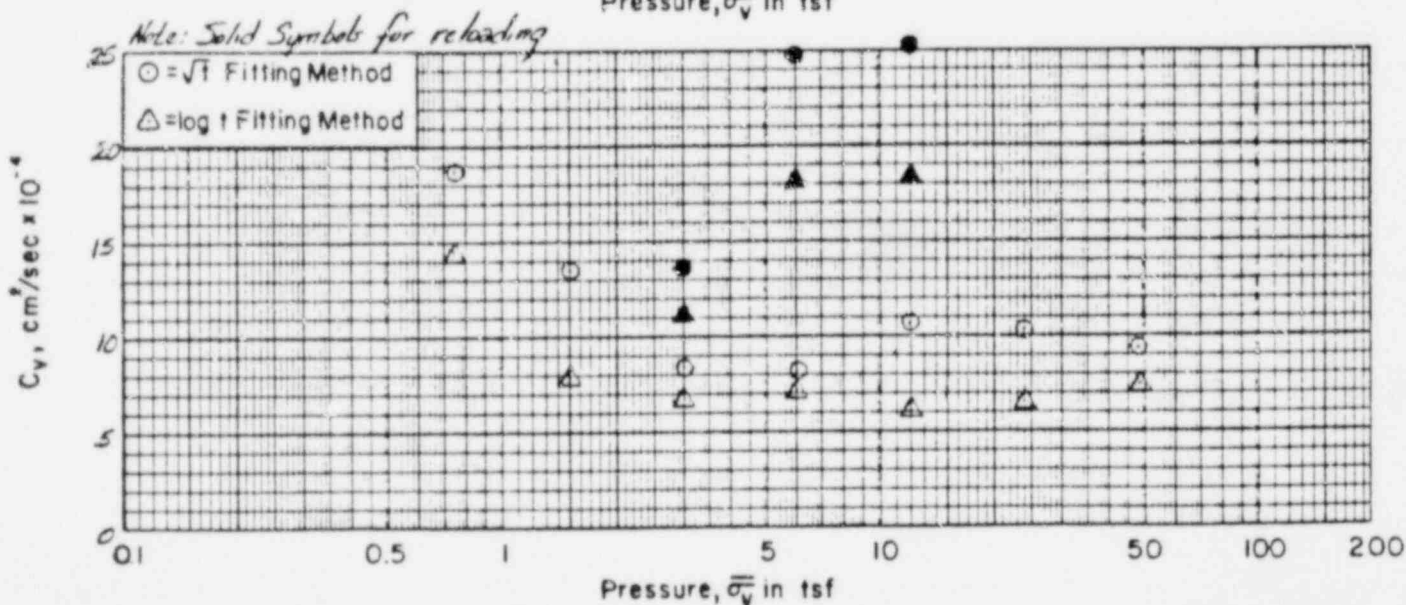
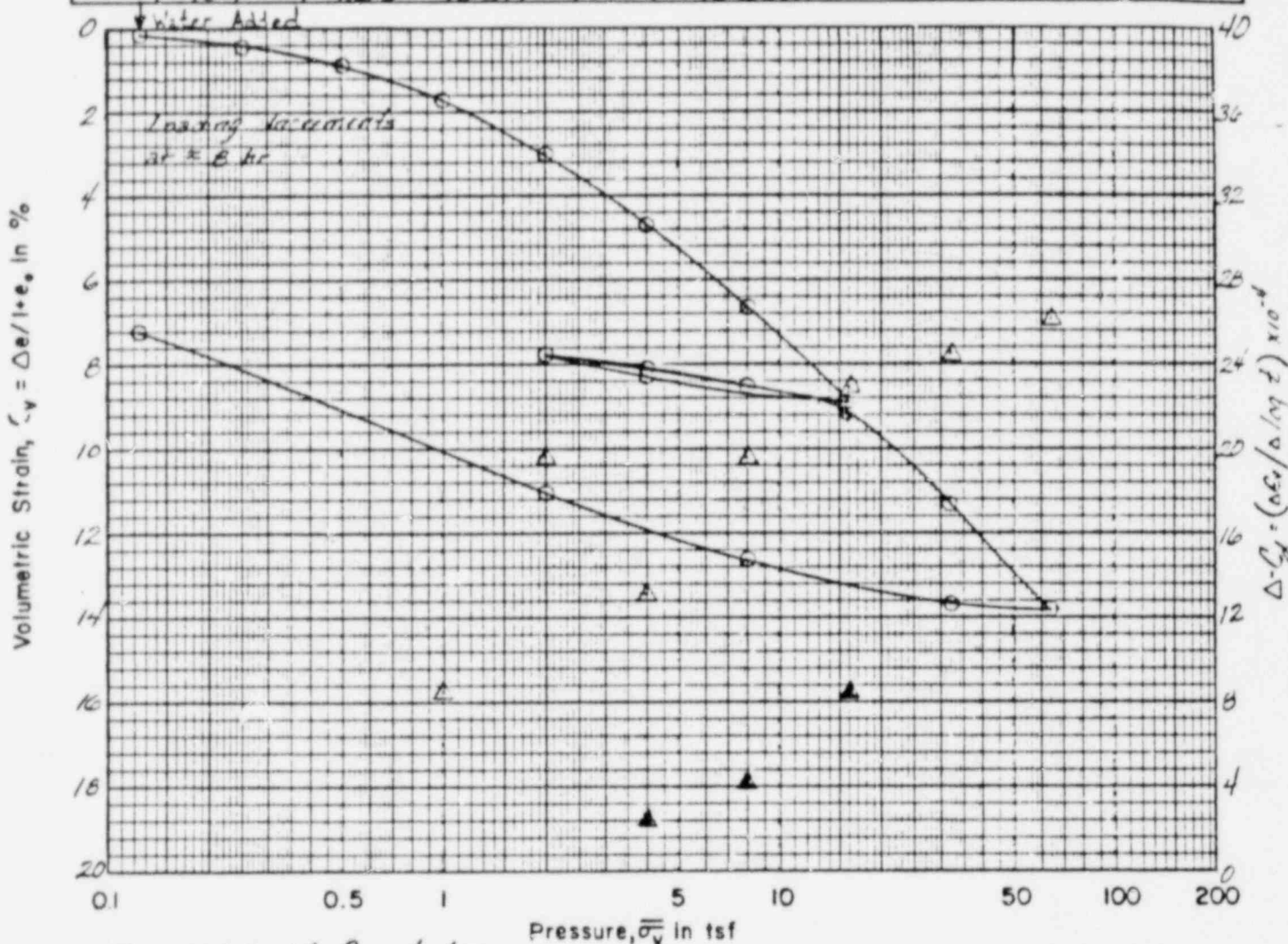
# CONSOLIDATION TEST

Boring No:		COE-12A		Sample No:		S-9B		Depth, ft:		25.1	
Material: CL, brown med plastic silty CLAY, some s & gravel to 8 sand											
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %		
Initial	14.5	135.0	0.470	85.7	0.618	2.50	2.783	28	13		
Final	14.8	139.2	0.431	95.7	.601						



# CONSOLIDATION TEST

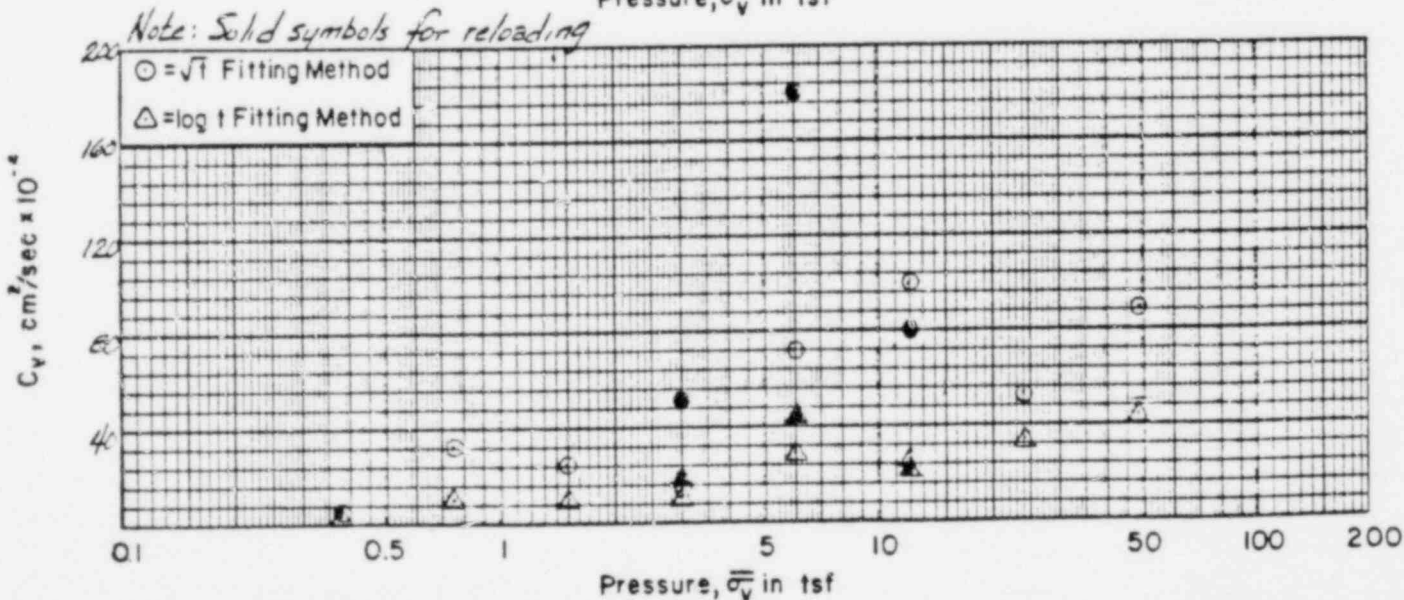
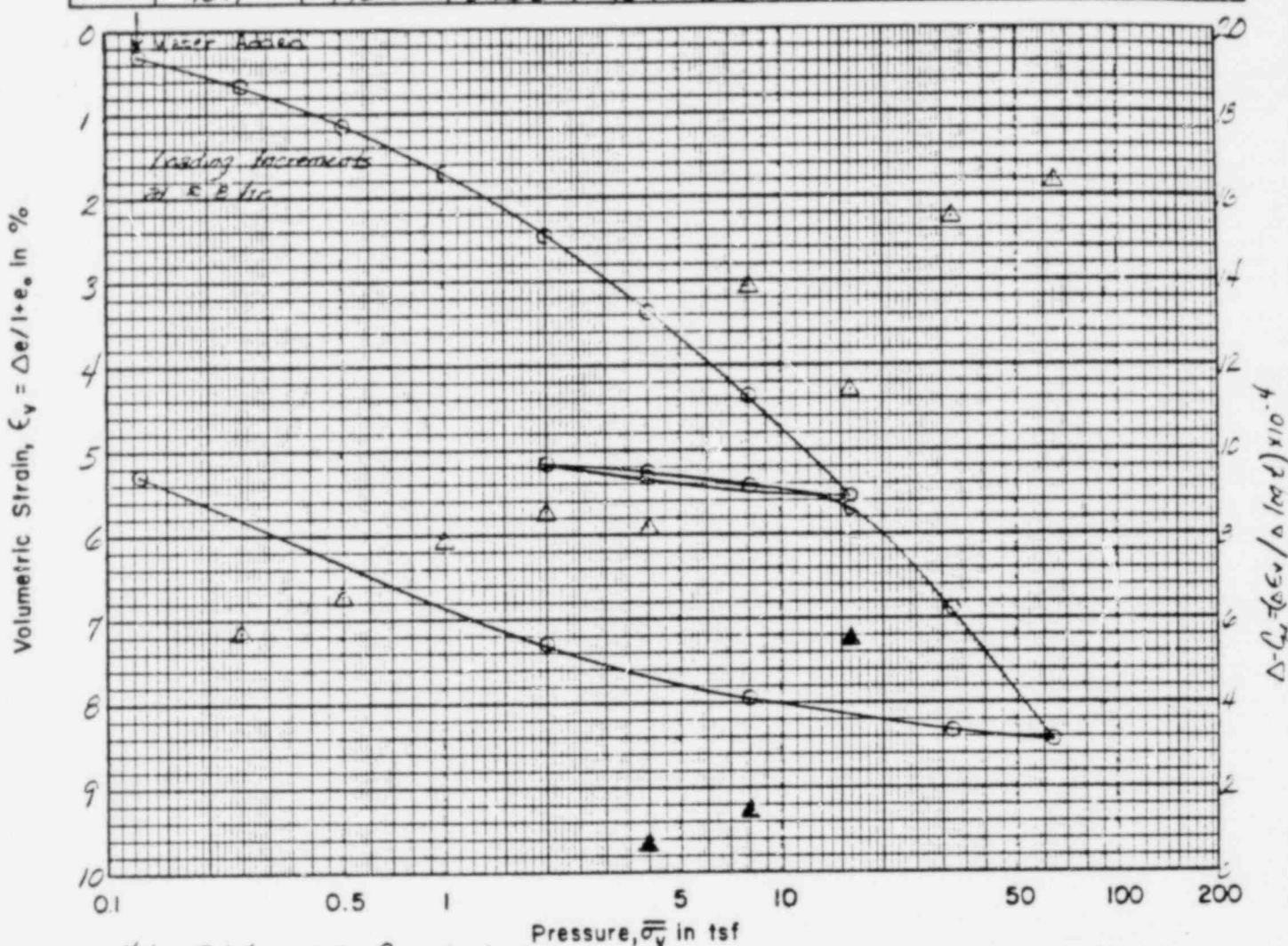
Boring No: COE-12A		Sample No: S-10B				Depth, ft: 28.0			
Material: CL, brown m.p. silty CLAY, some S. sand, trace c to m sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	18.8	121.1	0.542	94.6	0.612	2.50	2.732	34	15
Final	18.9	133.5	0.517	100.0	0.602				





# CONSOLIDATION TEST

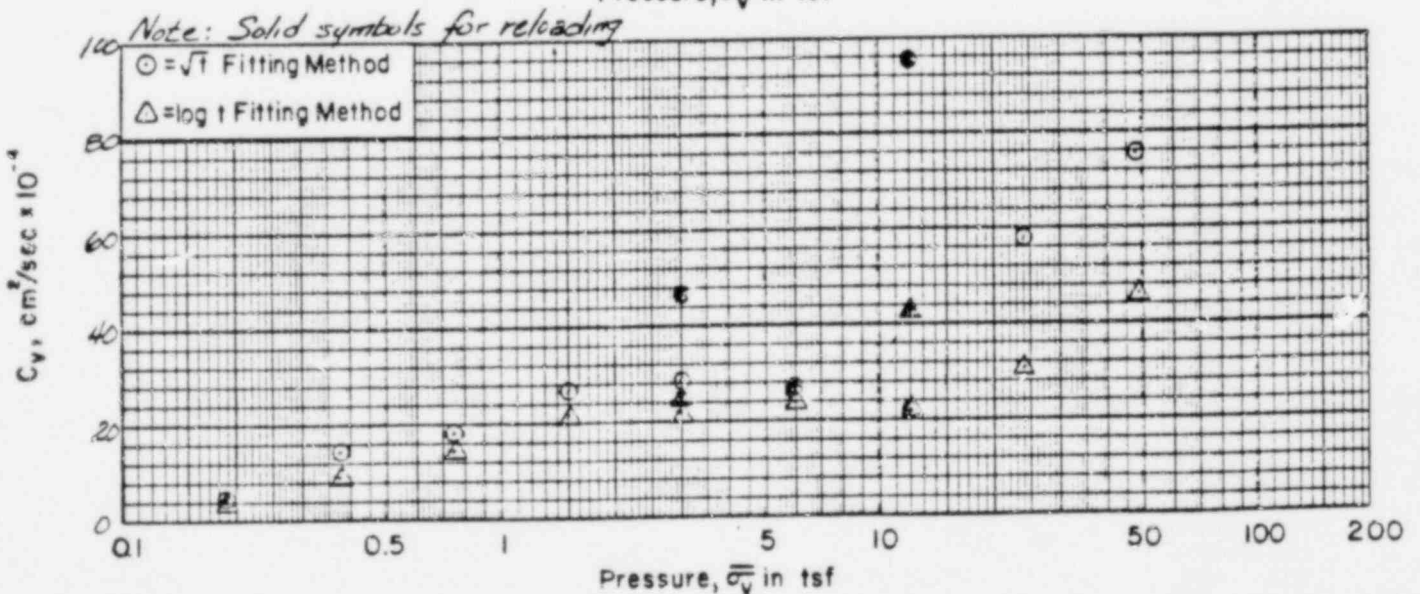
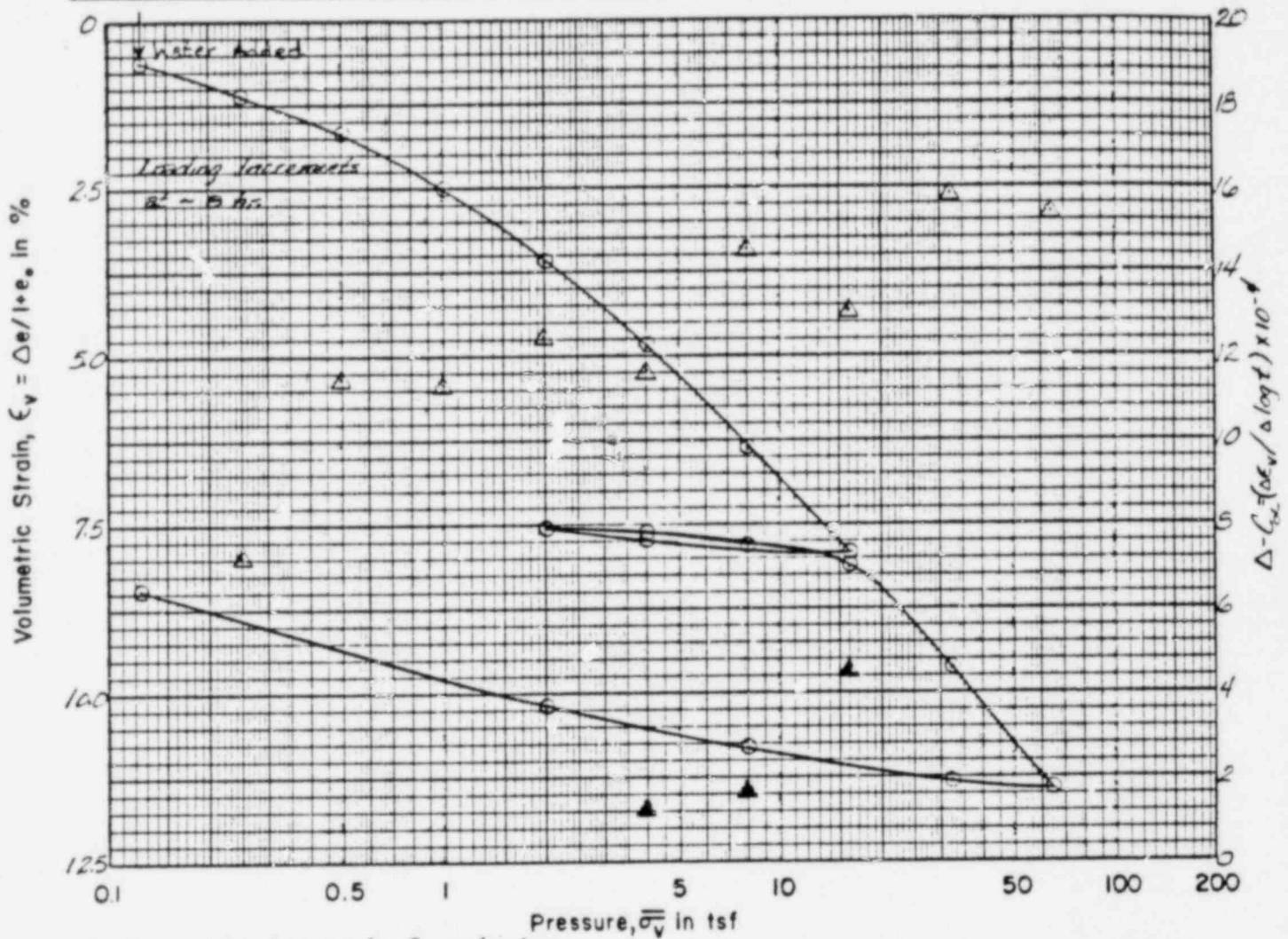
Boring No: <i>COE-13A</i>		Sample No: <i>S-30</i>				Depth, ft: <i>16.3</i>			
Material: <i>CL, gr. br &amp; sandy s.p. silty CLAY, some &amp; gravel to m. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>11.0</i>	<i>142.6</i>	<i>0.325</i>	<i>92.0</i>	<i>0.613</i>	<i>2.50</i>	<i>2.733</i>	<i>20</i>	<i>12</i>
Final	<i>10.1</i>	<i>145.7</i>	<i>0.286</i>	<i>96.1</i>	<i>0.595</i>				





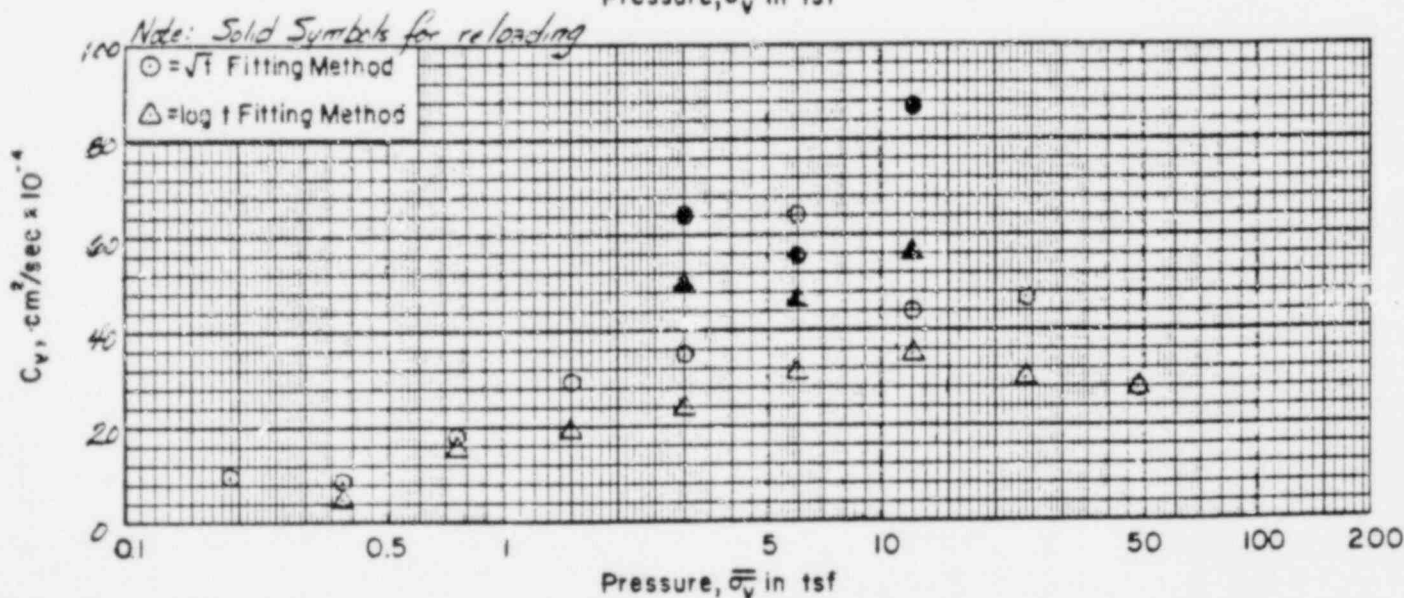
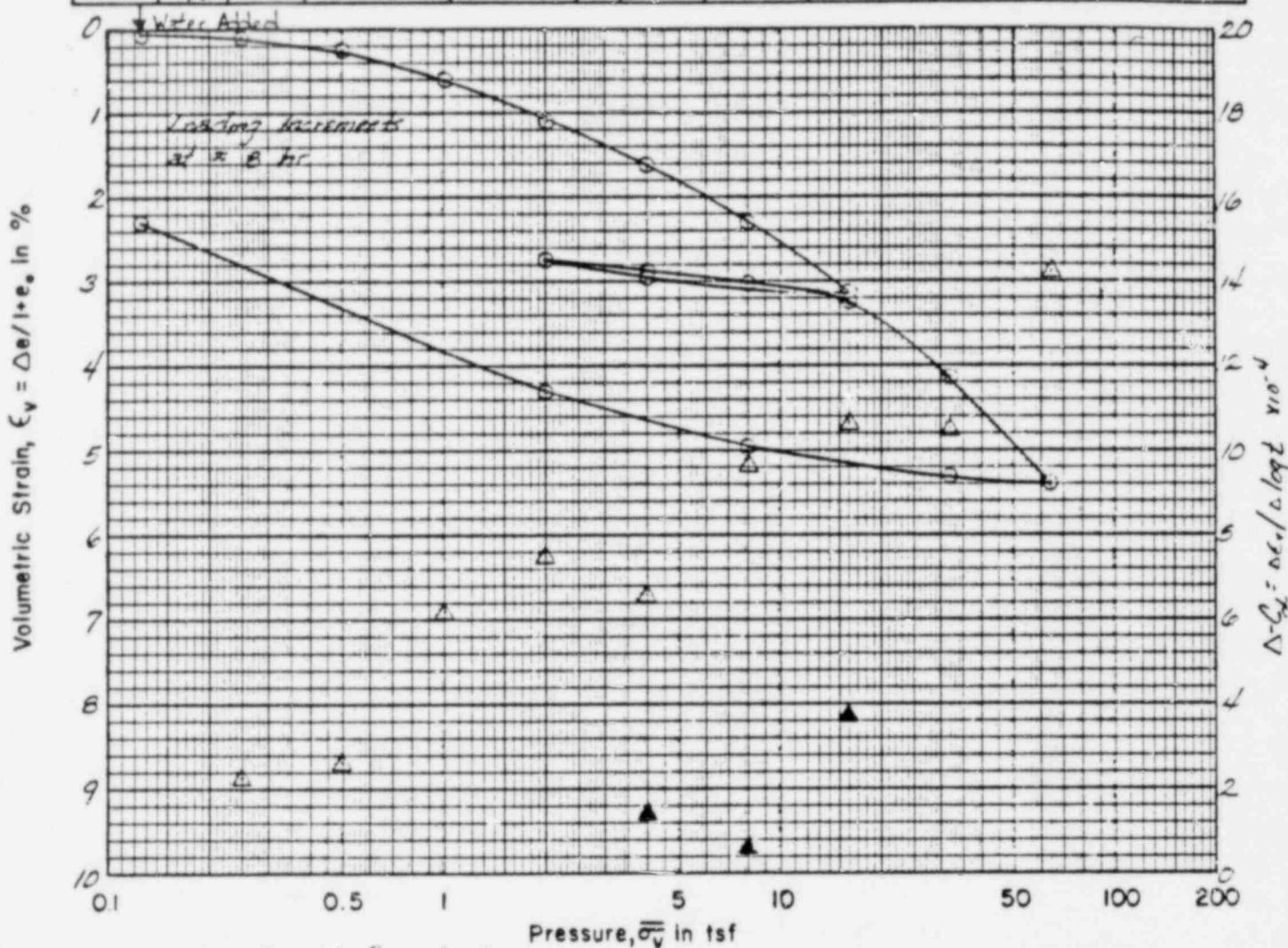
# CONSOLIDATION TEST

Boring No: COE-13A			Sample No: S-4B			Depth, ft: 18.2			
Material: CL, gr-br m. to f. sandy sp. silty CLAY, trace S gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.1	136.5	0.410	81.4	0.619	2.50	2.754	21	12
Final	10.6	146.6	0.294	99.3	0.568				



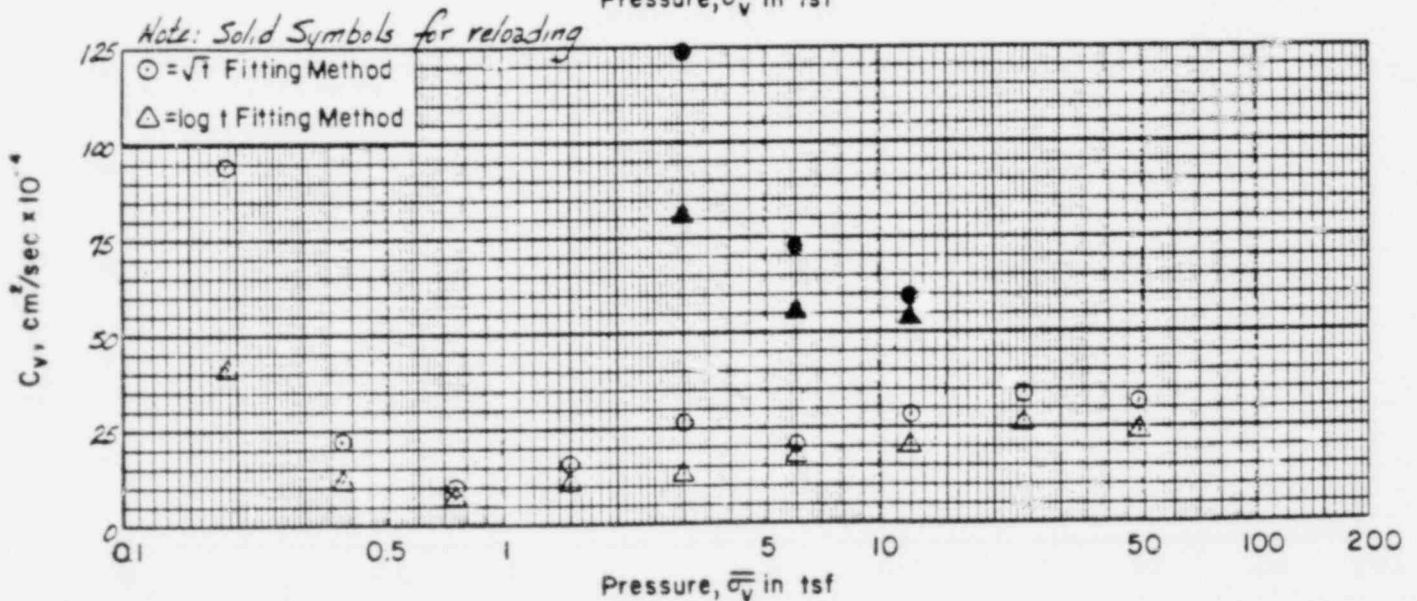
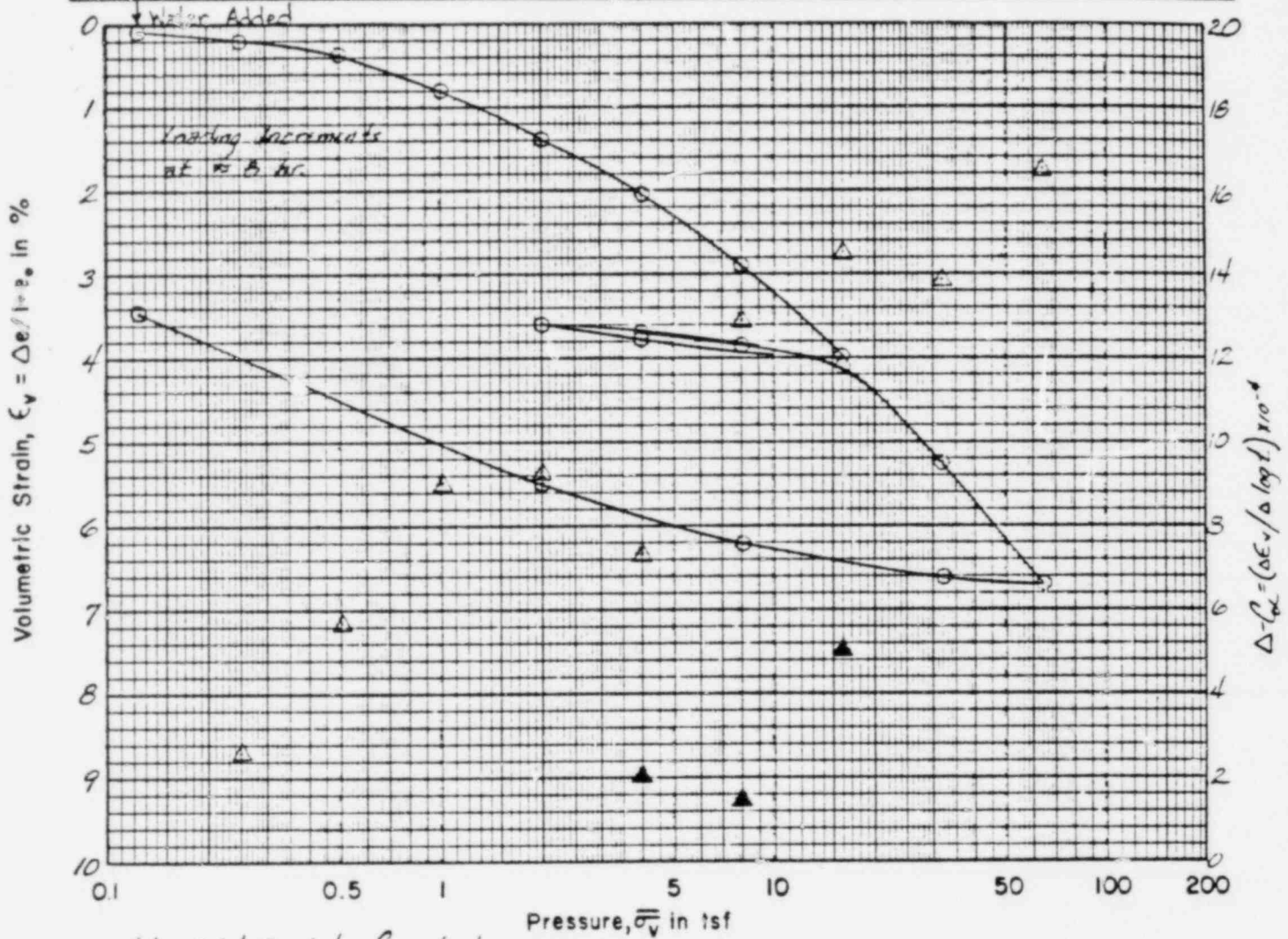
# CONSOLIDATION TEST

Boring No: COF-13A		Sample No: S-5C				Depth, ft: 21.1			
Material: CL, mottled br. & orange-br s. sandy m.p. silty CLAY, w. s. gravel to m. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	10.0	145.4	0.294	93.5	0.611	2.50	2.745	24	13
Final	10.1	145.9	0.292	95.5	0.610				



# CONSOLIDATION TEST

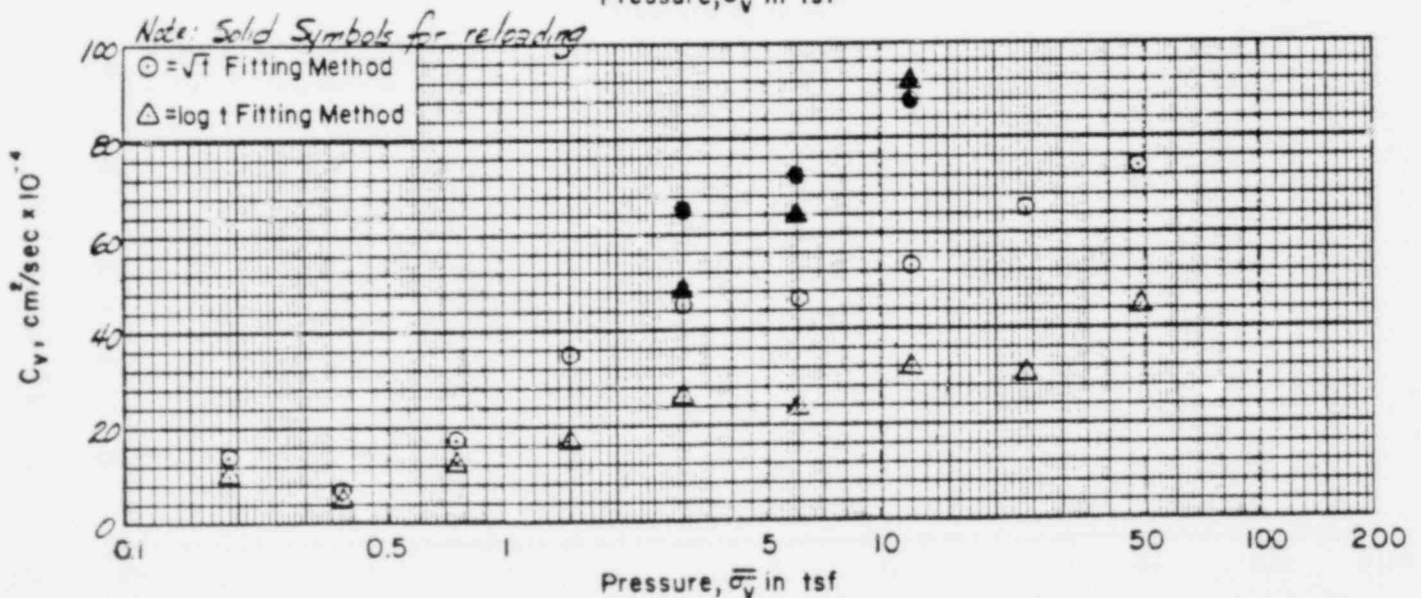
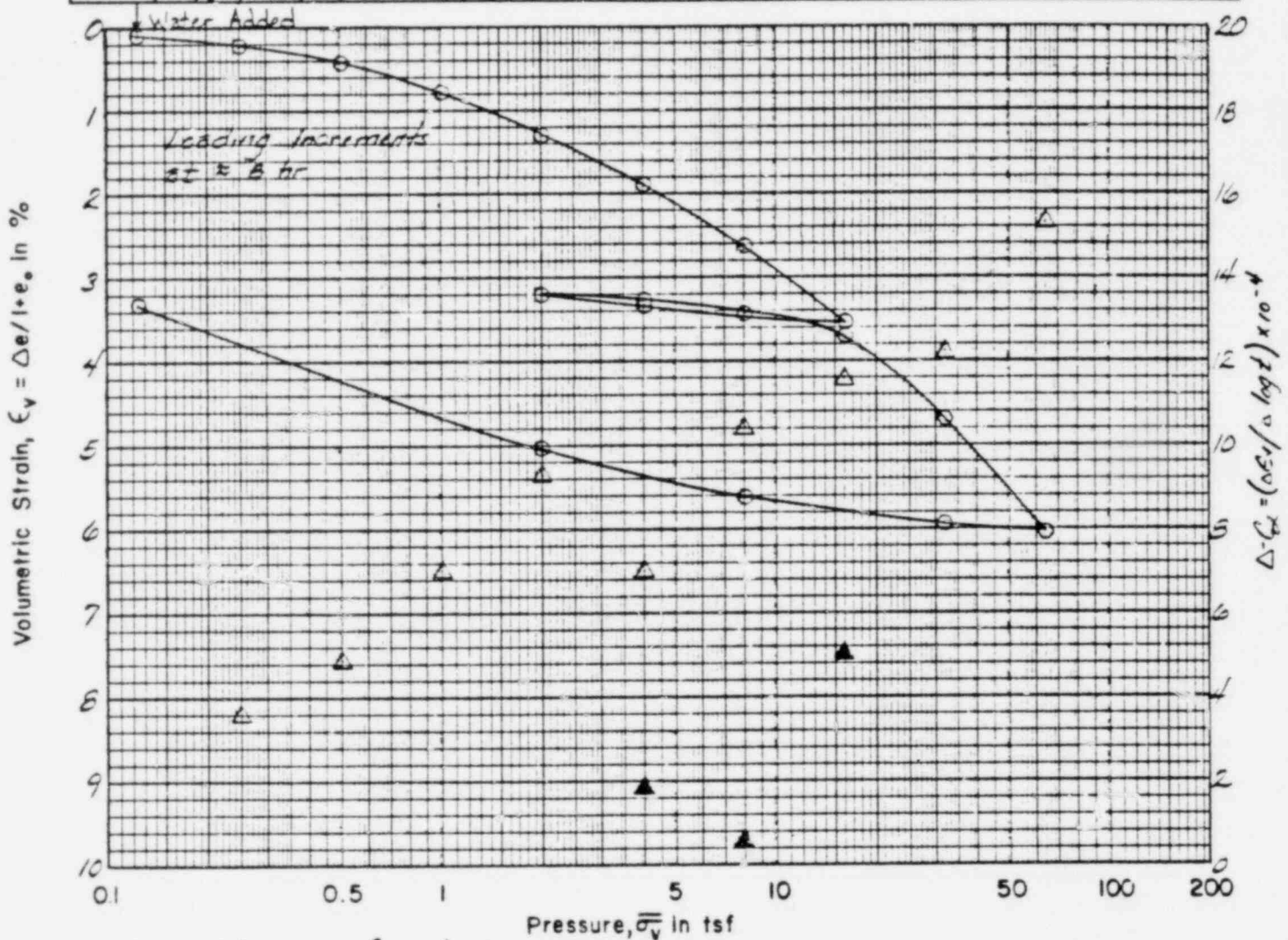
Boring No: COE-13A		Sample No: S-6C				Depth, ft: 22.4			
Material: CL, br. m to f. sandy mp silty CLAY, trace f. gravel to c. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	10.9	144.9	0.331	91.9	0.613	2.50	2.790	24	13
Final	10.6	146.5	0.314	94.7	0.605				





# CONSOLIDATION TEST

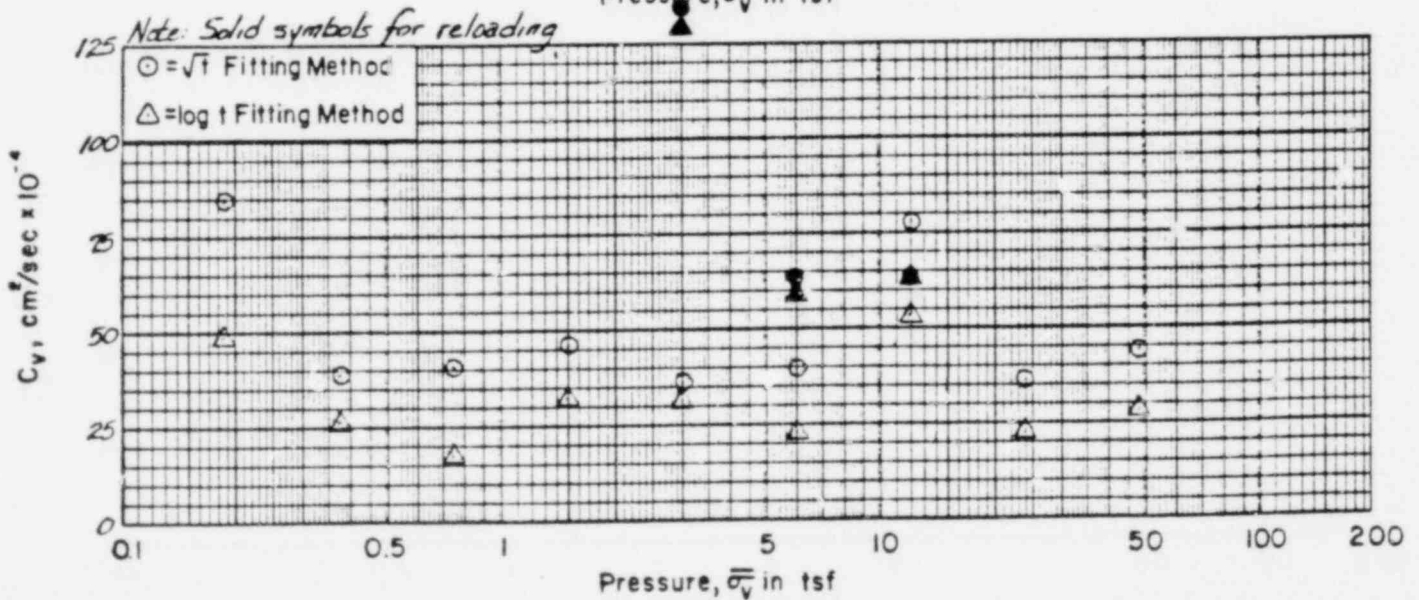
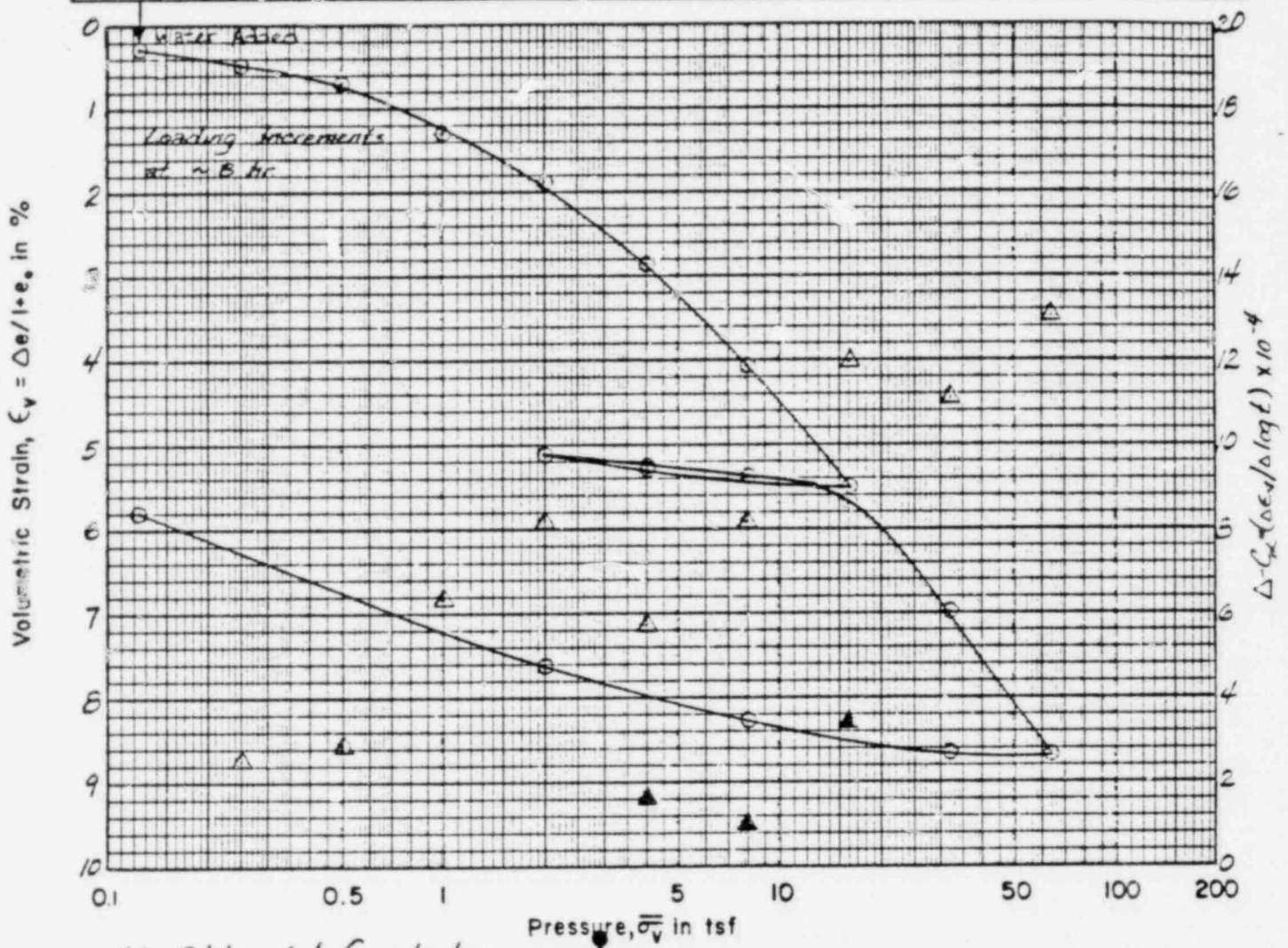
Boring No: <i>CDL-13A</i>		Sample No: <i>S-BB</i>				Depth, ft: <i>24.4</i>			
Material: <i>CL, mottled gr-br. &amp; br. m to s. sandy s.p. silty CLAY, tr. &amp; gravel to s. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>10.7</i>	<i>141.3</i>	<i>0.340</i>	<i>86.4</i>	<i>0.613</i>	<i>2.50</i>	<i>2.744</i>	<i>21</i>	<i>12</i>
Final	<i>10.4</i>	<i>144.7</i>	<i>0.304</i>	<i>93.7</i>	<i>0.597</i>				





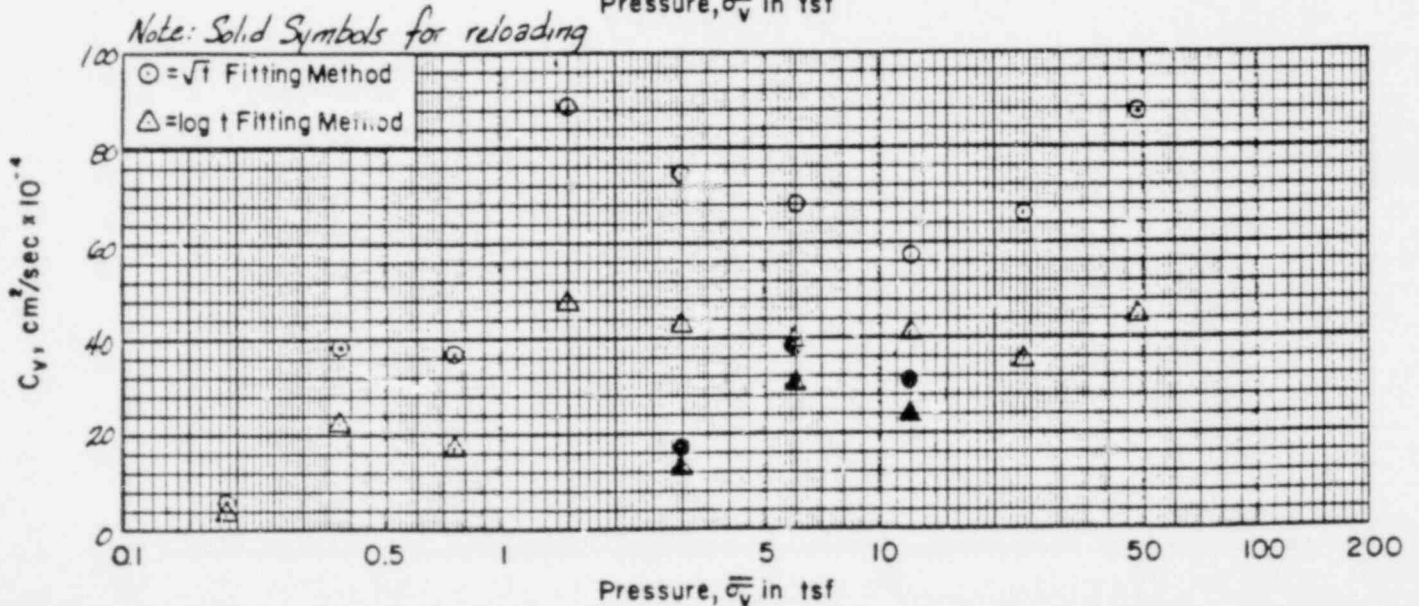
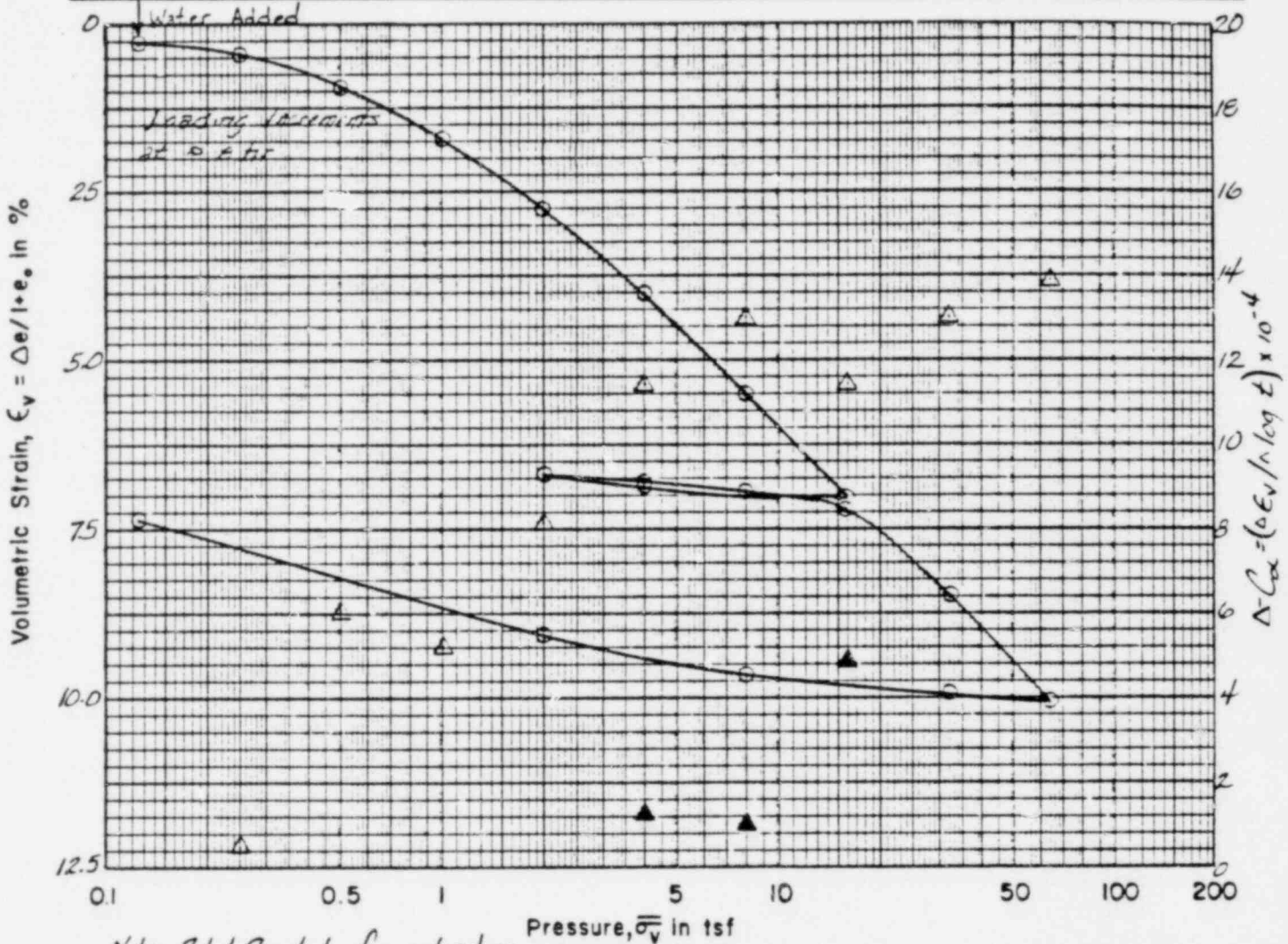
# CONSOLIDATION TEST

Boring No: <i>COE-13A</i>		Sample No: <i>S-9B</i>				Depth, ft: <i>26.7</i>			
Material: <i>CL, br. &amp; sandy s.p. silty CLAY, trace S. gravel to m. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>10.4</i>	<i>140.1</i>	<i>0.346</i>	<i>82.1</i>	<i>0.613</i>	<i>2.50</i>	<i>2.742</i>	<i>23</i>	<i>14</i>
Final	<i>10.6</i>	<i>145.4</i>	<i>0.300</i>	<i>97.1</i>	<i>0.592</i>				



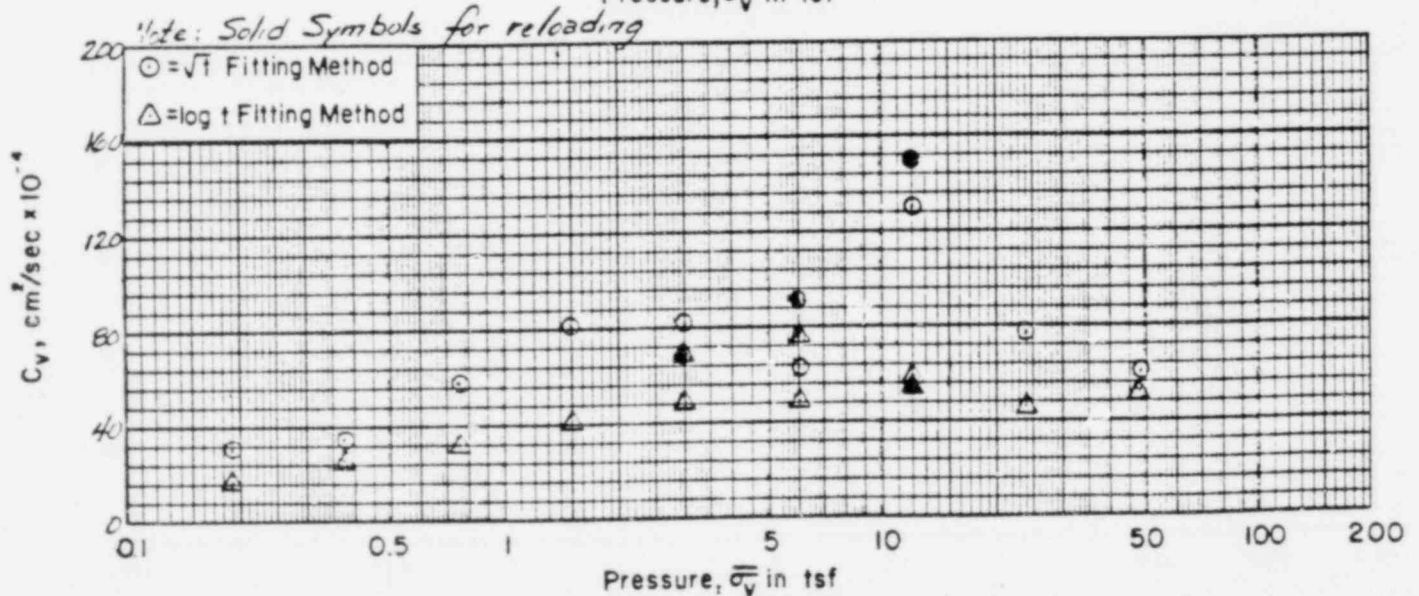
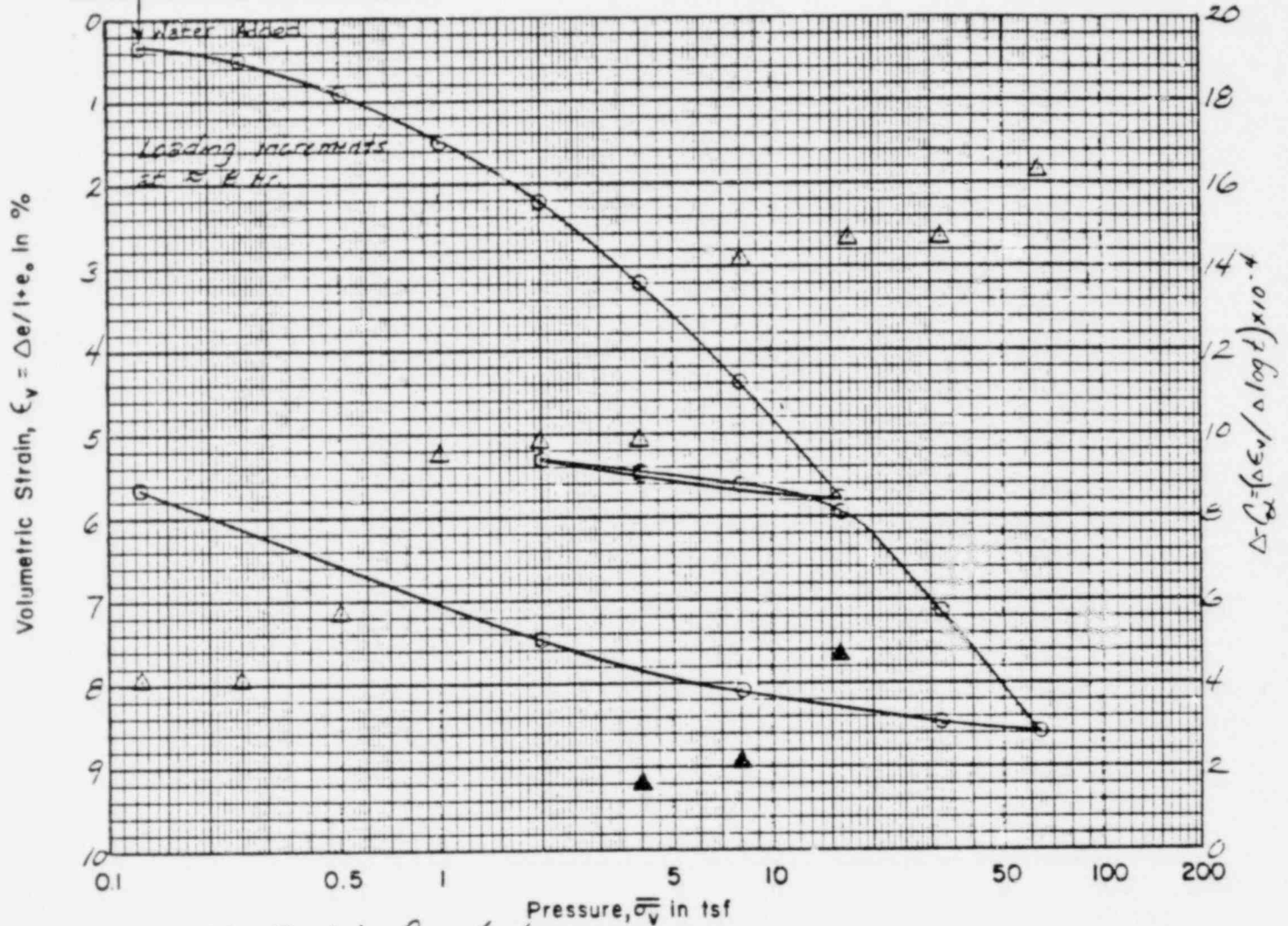
# CONSOLIDATION TEST

Boring No: <i>COE-13B</i>			Sample No: <i>S-1B</i>			Depth, ft: <i>8.2</i>			
Material: <i>CL, gr-br m to S, sandy spt to mp silty CLAY, trace S gravel to c. sand</i>									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	<i>9.9</i>	<i>137.9</i>	<i>0.365</i>	<i>74.4</i>	<i>0.613</i>	<i>2.50</i>	<i>2.748</i>	<i>23</i>	<i>13</i>
Final	<i>10.0</i>	<i>145.9</i>	<i>0.291</i>	<i>94.2</i>	<i>0.560</i>				



# CONSOLIDATION TEST

Boring No: COE-13B		Sample No: S-3D				Depth, ft: 14.4			
Material: CL-ML, br. S. sandy S.P. silty CLAY, trace c. to m. sand									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	9.6	142.2	0.315	83.1	0.612	2.50	2.740	19	13
Final	9.8	147.6	0.270	99.1	0.591				





APPENDIX B

Consolidation Test Results, Tested by GZD in 1978

- Strain-log p plots (by WCC from GZD data)
- Void ratio-log p plots (original GZD data)

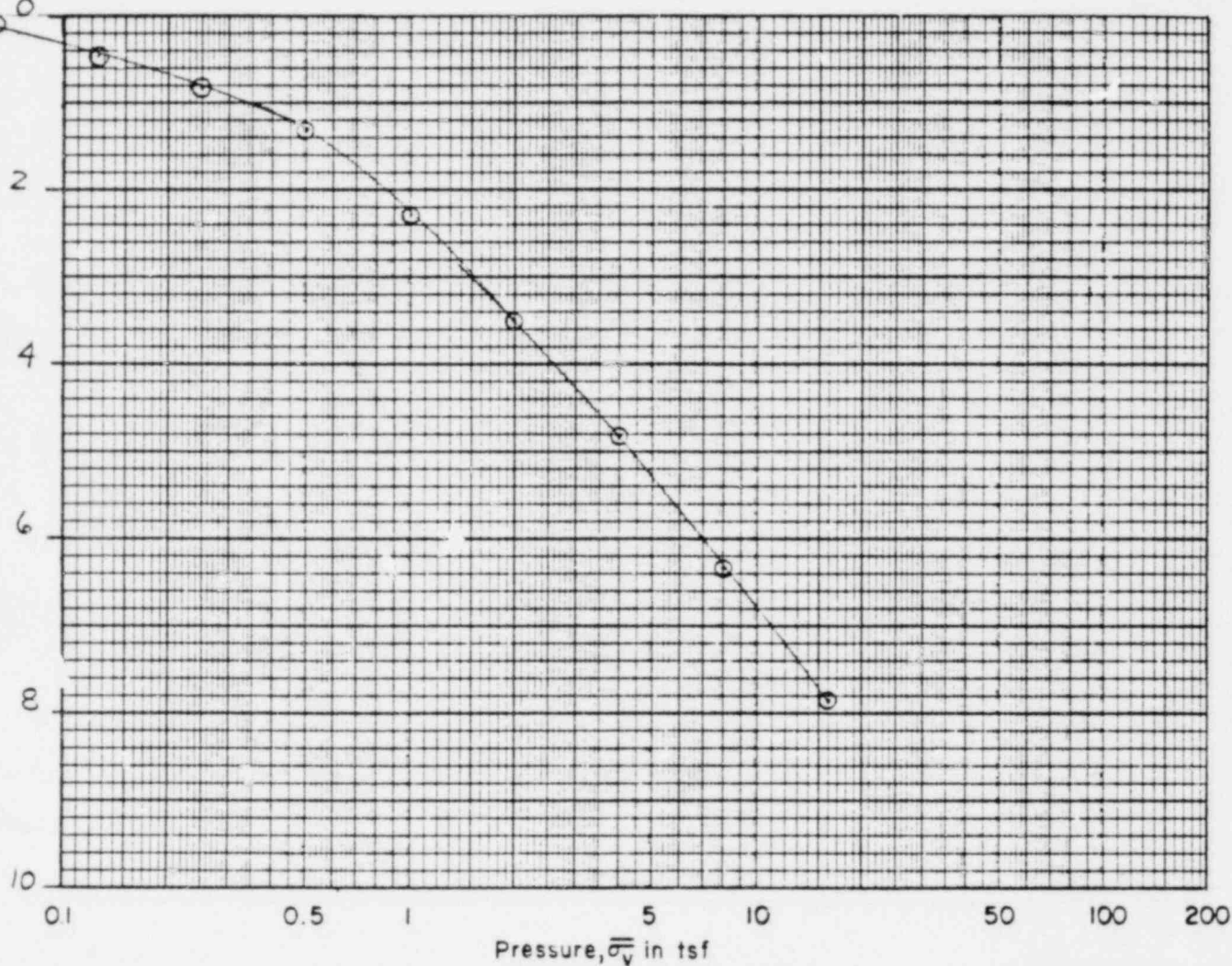


# CONSOLIDATION TEST

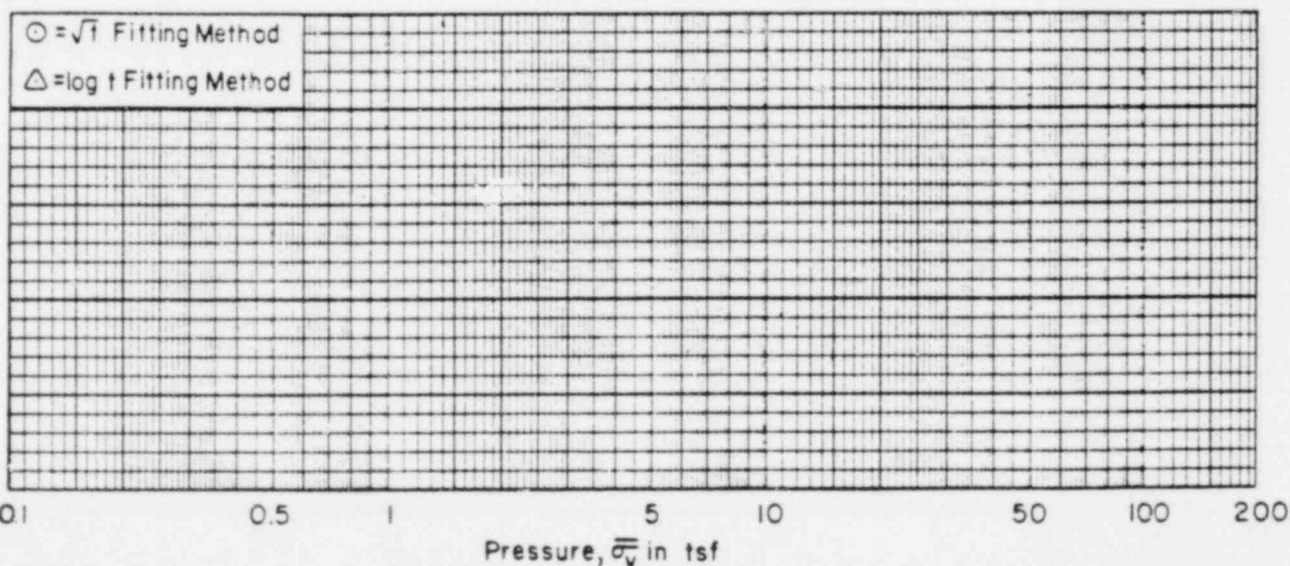
Data calculated from  
e vs  $\log \bar{\sigma}_v$  plotted data  
GZD+A (1978)

Boring No: DG-7			Sample No: 4			Depth, ft: 17.0-17.3			
Material: Brown Mottled Dark Grey Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.8	140.3	0.35	92	0.800	2.50"	2.72	20	12
Final	11.0	147.8	0.28	100+	0.754				

Plotted by JWS Checked by ~~SAH~~ 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$



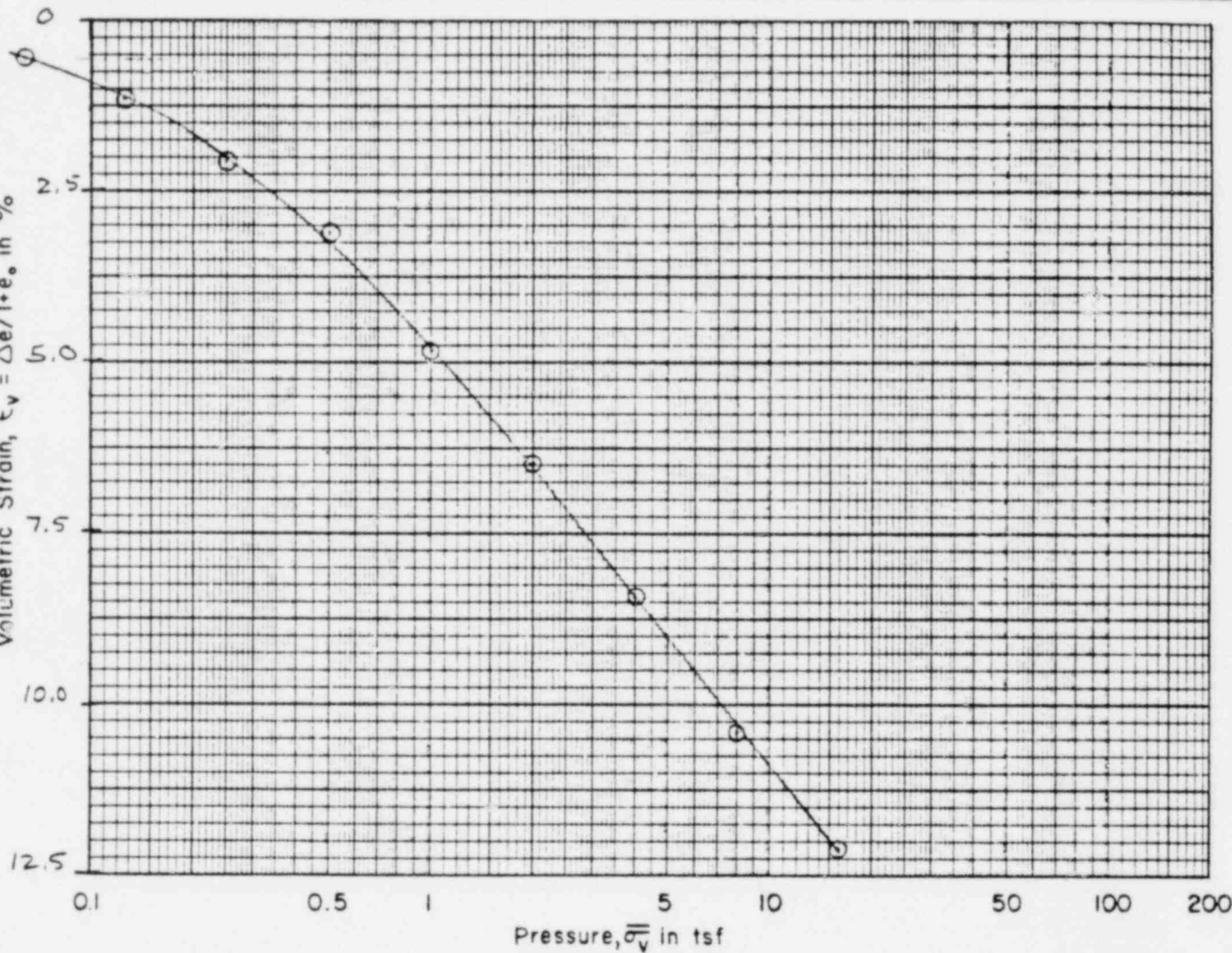
# CONSOLIDATION TEST

Data Calculated from  
e vs  $\log \bar{\sigma}_v$  plotted data  
GZ D & A (1978)

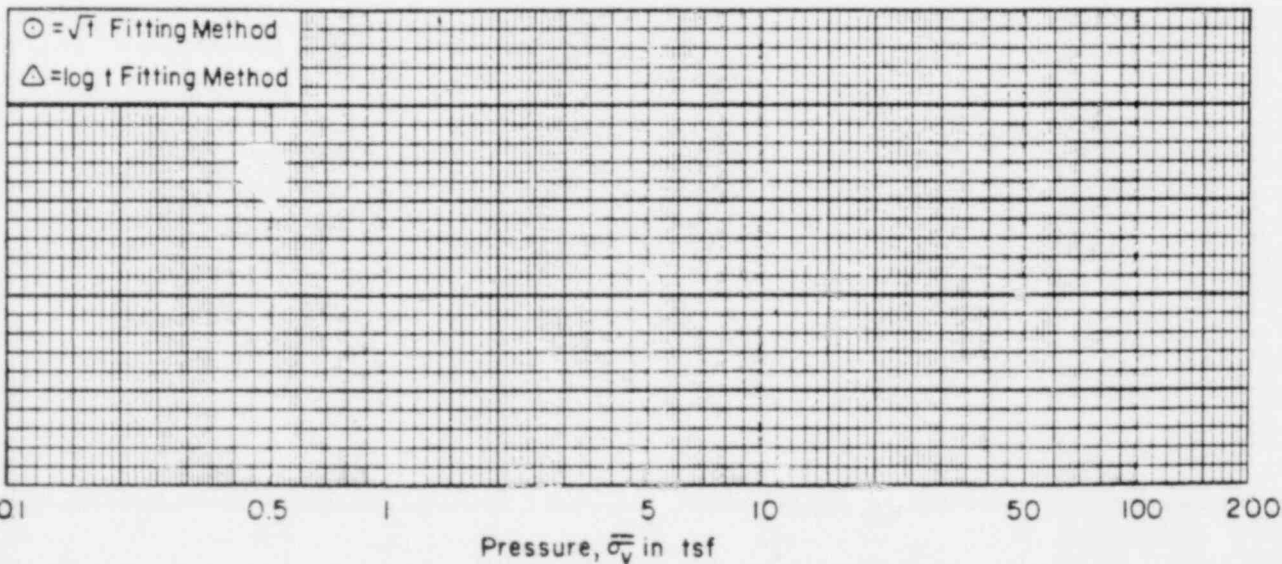
Boring No: DG-9			Sample No: 1			Depth, ft: 1.4 - 1.6			
Material: Grey Brown Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
initial	13.3	135.9	0.410	88%	0.800	2.50"	2.71	20	13
Final	9.8	147.8	0.26	100+	0.713				

Plotted by JWS Checked by STH 8 July 81

Volumetric Strain,  $\epsilon_v = \Delta e / 1 + e_0$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$

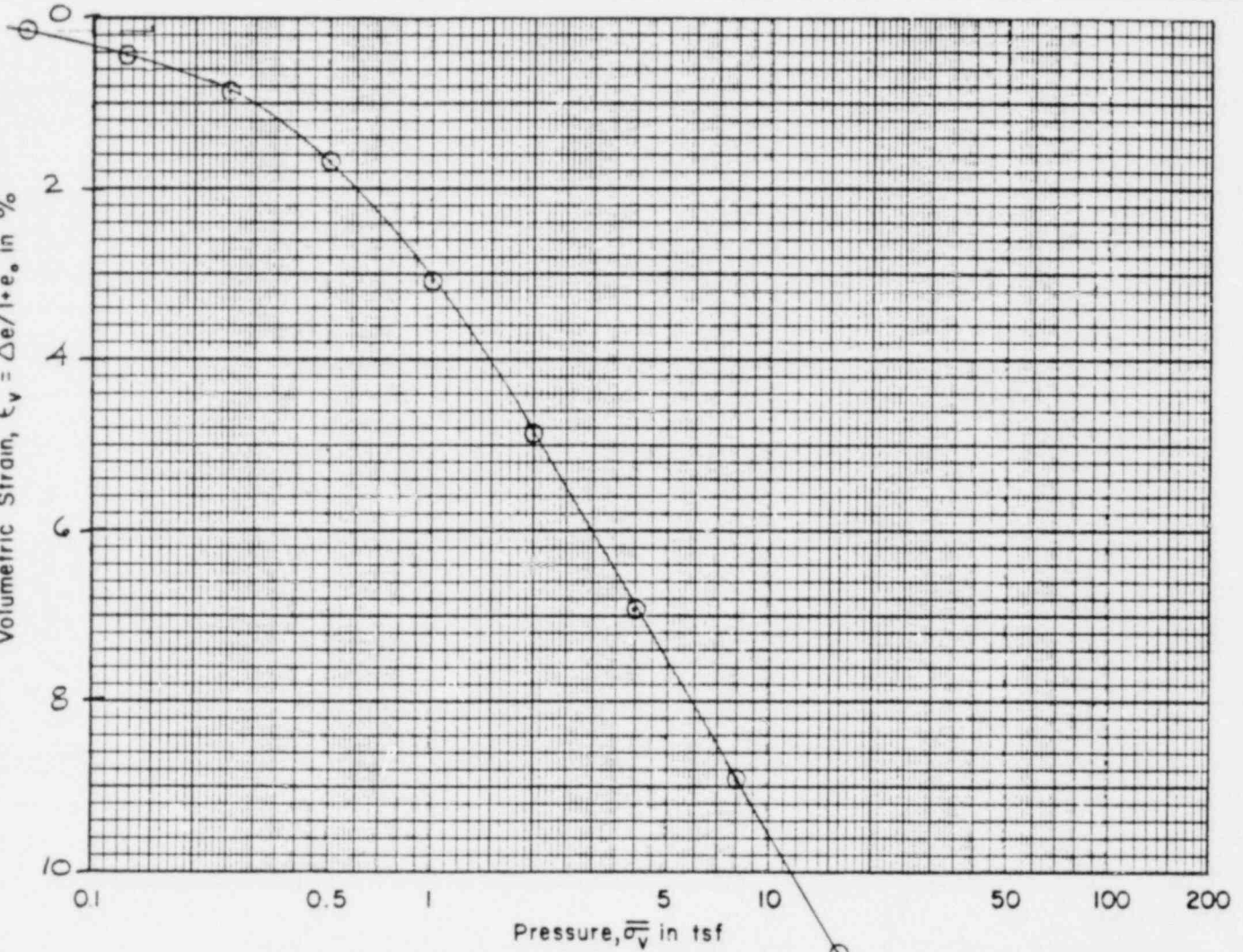


# CONSOLIDATION TEST

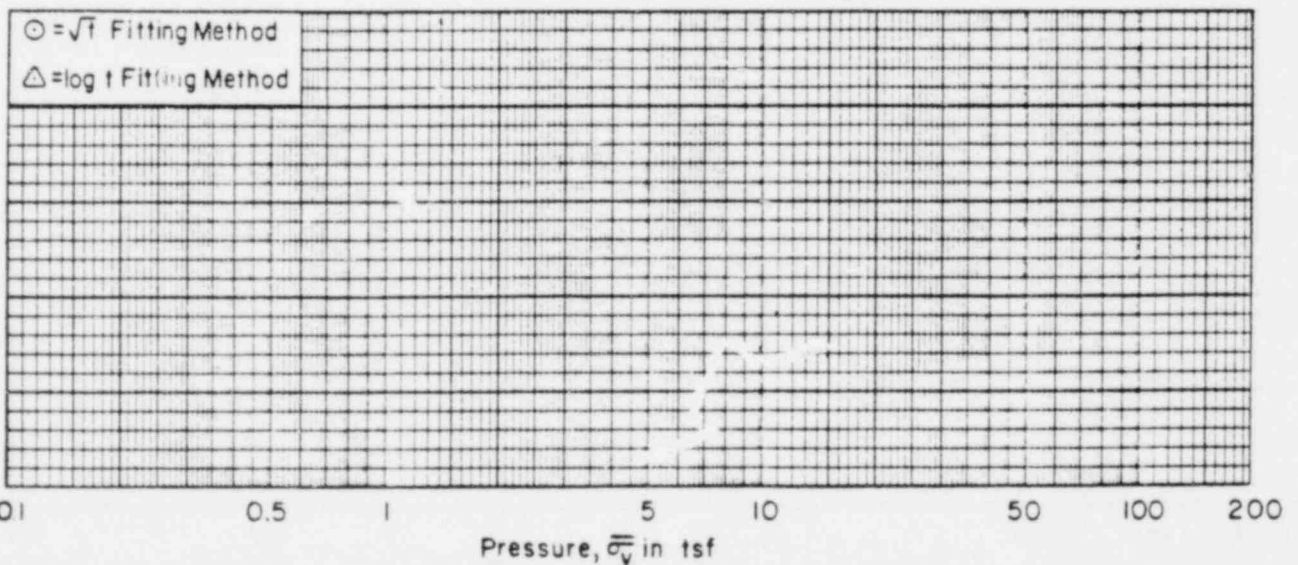
Data Calculated from  
e vs  $\log \bar{\sigma}_v$  plotted data  
GZD8A (1978)

Boring No: DG-9			Sample No: 3			Depth, ft: 5.7-6.0			
Material: Brown Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.7	134.8	0.41	78	0.800	2.50"	2.72	≥ 1	12
Final	9.9	147.5	0.27	100+	0.720				

Plotted by JWS checked by QJH 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / 1 + e_0$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$





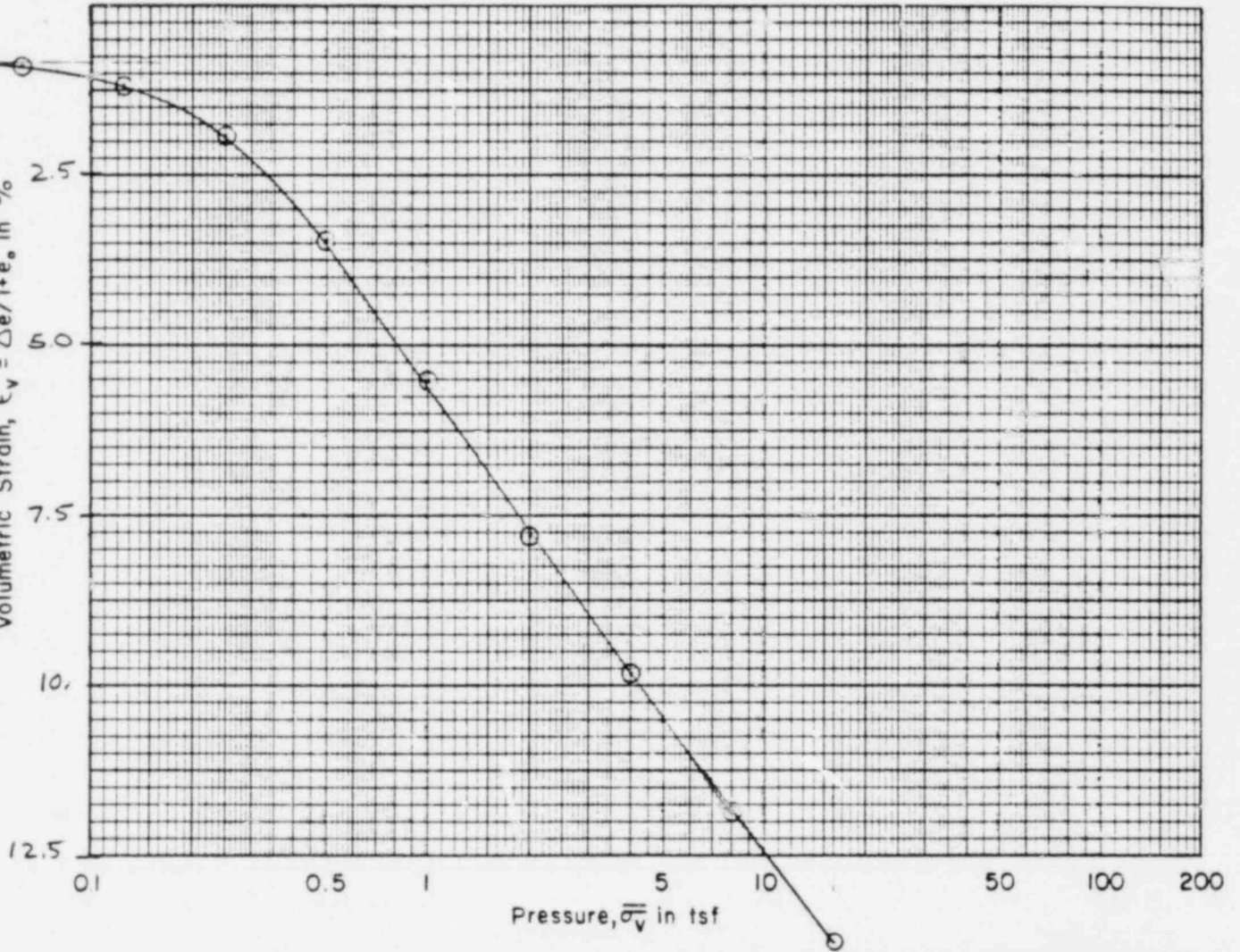
# CONSOLIDATION TEST

Data Calculated from  
e vs Log  $\bar{\sigma}_v$  plotted data  
GZD & A (1978)

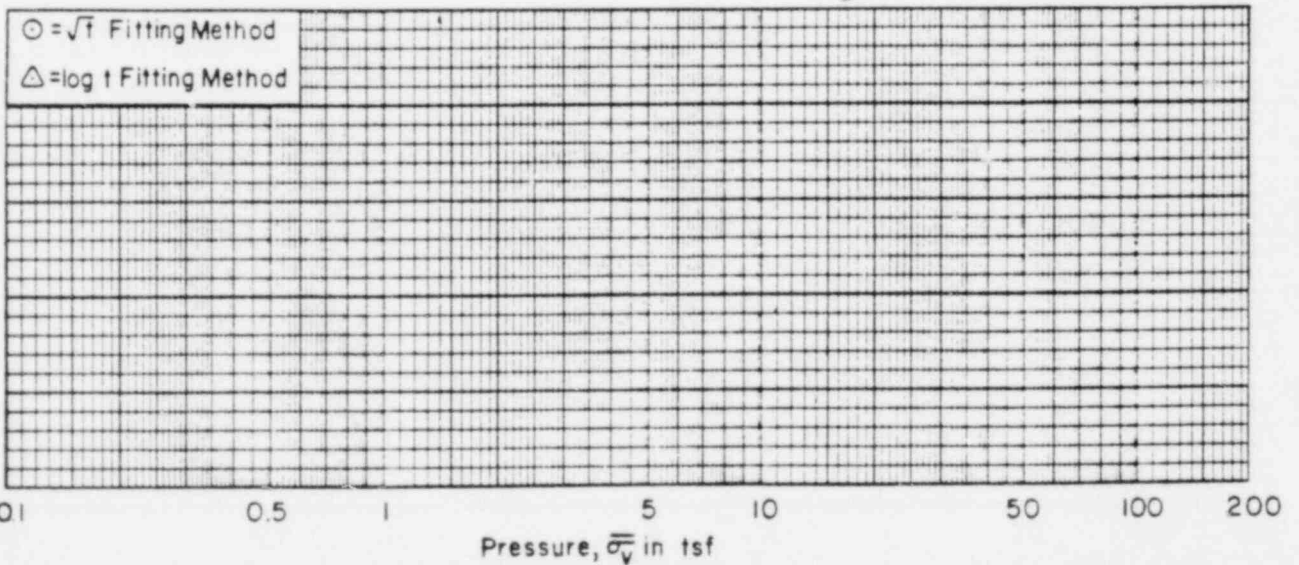
Boring No: DG-9			Sample No: 4			Depth, ft: 7.7 - 8.1			
Material: Brown Mottled Gray Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.4	133.3	0.444	81	0.800	2.50"	2.72	23	12
Final	10.7	145.5	0.29	100	0.716				

Plotted by JWS Checked by BJW 8 July 81

Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$



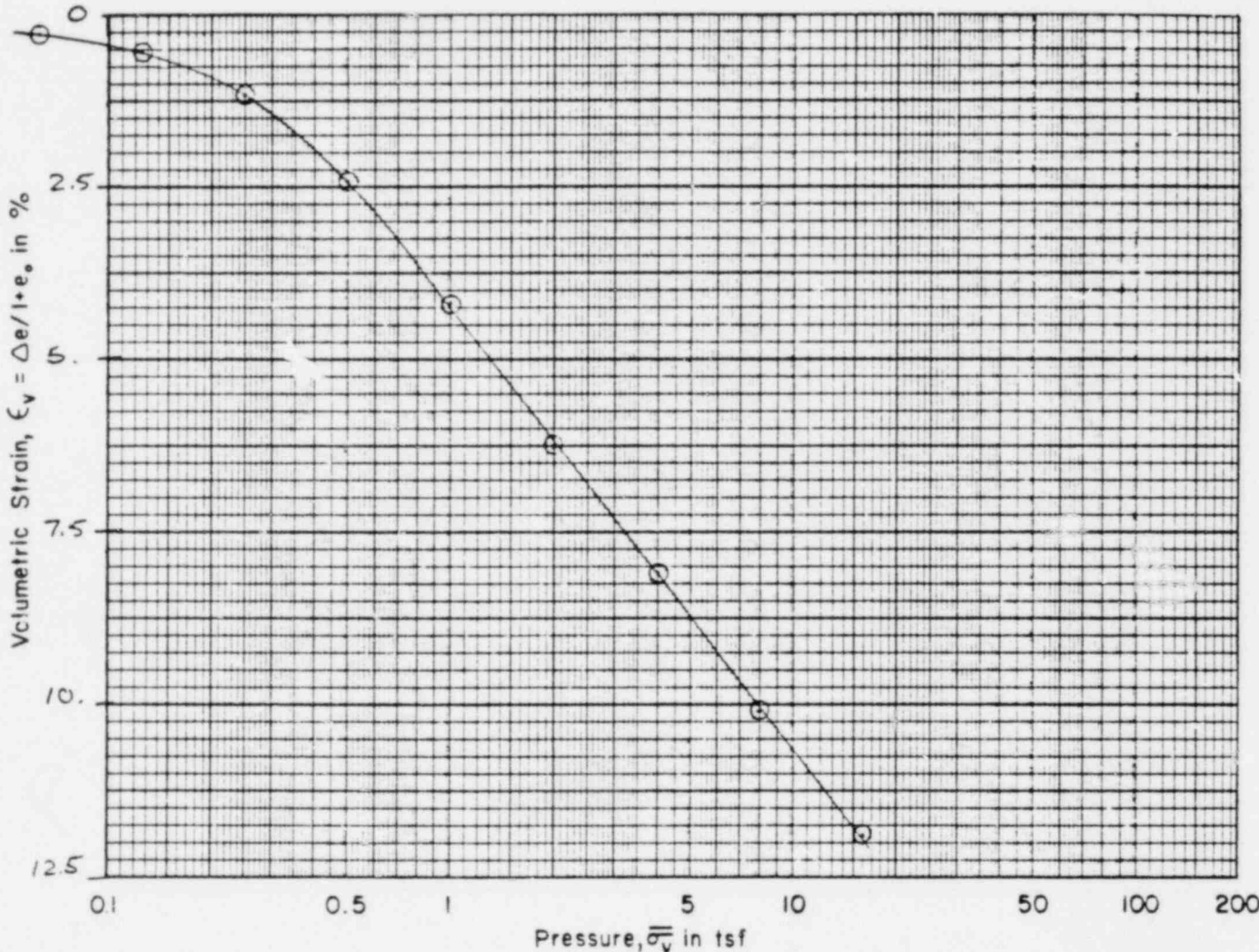


# CONSOLIDATION TEST

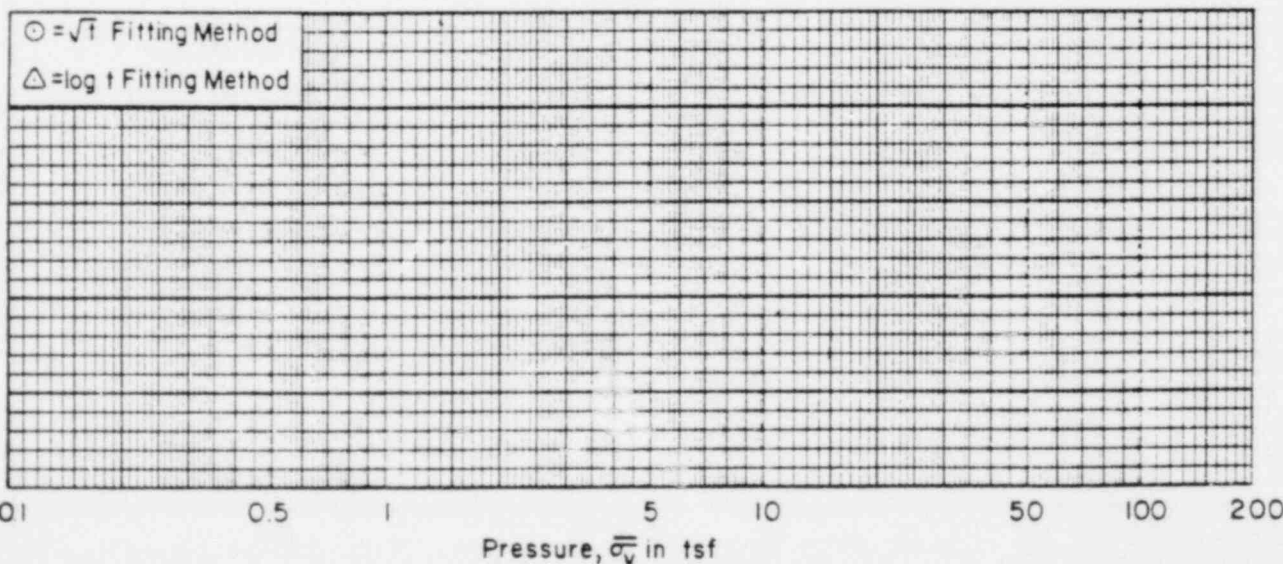
Data Calculated from  
e vs Log  $\bar{\sigma}_v$  plotted data  
GZ D & A (1978)

Boring No: DG-10			Sample No: 4			Depth, ft: 9.7 - 10.0			
Material: Dark Grey Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.9	133.1	0.45	83	0.800	2.50"	2.72	21	11
Final	11.5	144.2	0.31	100	0.722				

Plotted by JWS Checked by JWS E July 81



$C_v$ , cm<sup>2</sup>/sec x 10<sup>-4</sup>

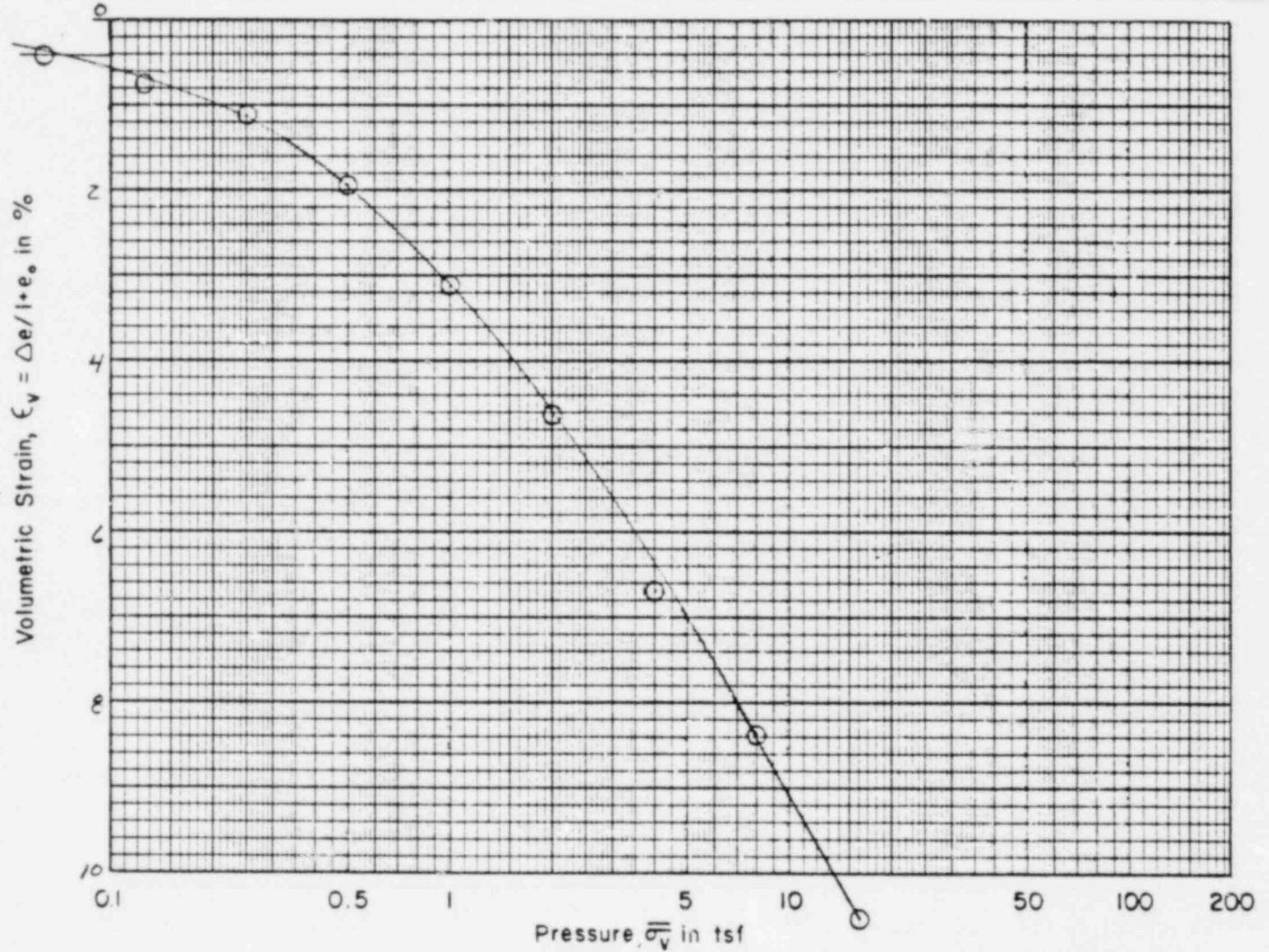


# CONSOLIDATION TEST

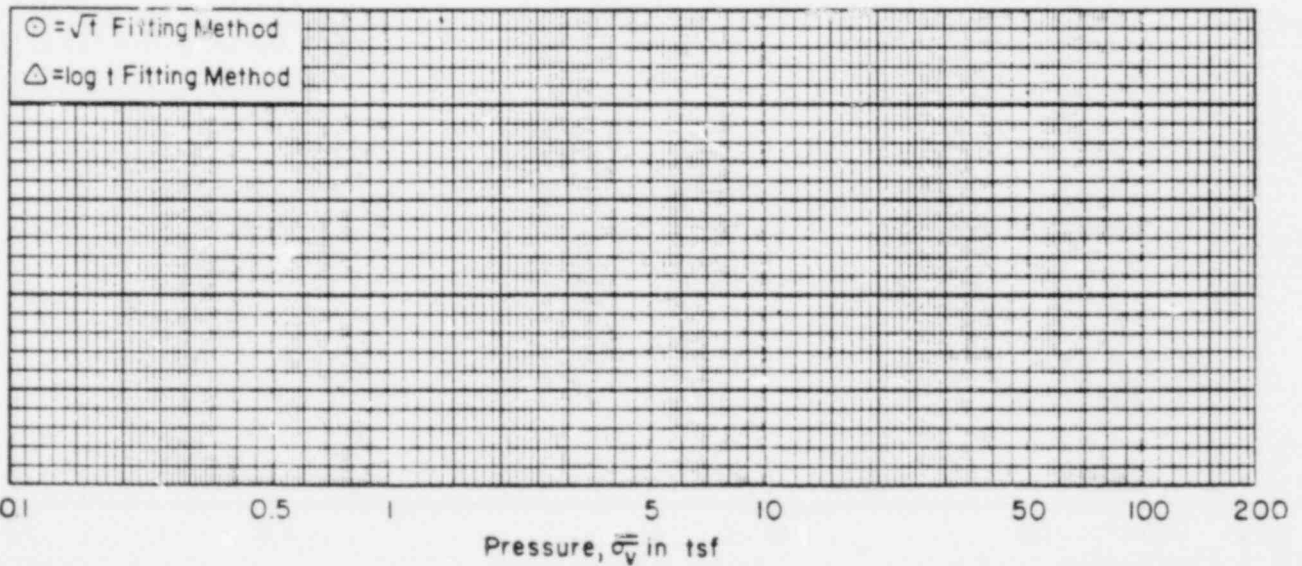
DATA CALCULATED FROM  $e$  VS  $\log \bar{\sigma}_v$  PLOTTED DATA GZD & A  
(1978)

Boring No: DG-10		Sample No: 5			Depth, ft: 13.0-13.2				
Material: GREY SANDY CLAY (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	14.9	137.4	0.40	99	0.800	2.50	2.69	32	13
Final	12.6	145.9	0.30	—	0.739				

Plotted by SAH Checked by JWS 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / 1 + e_0$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$

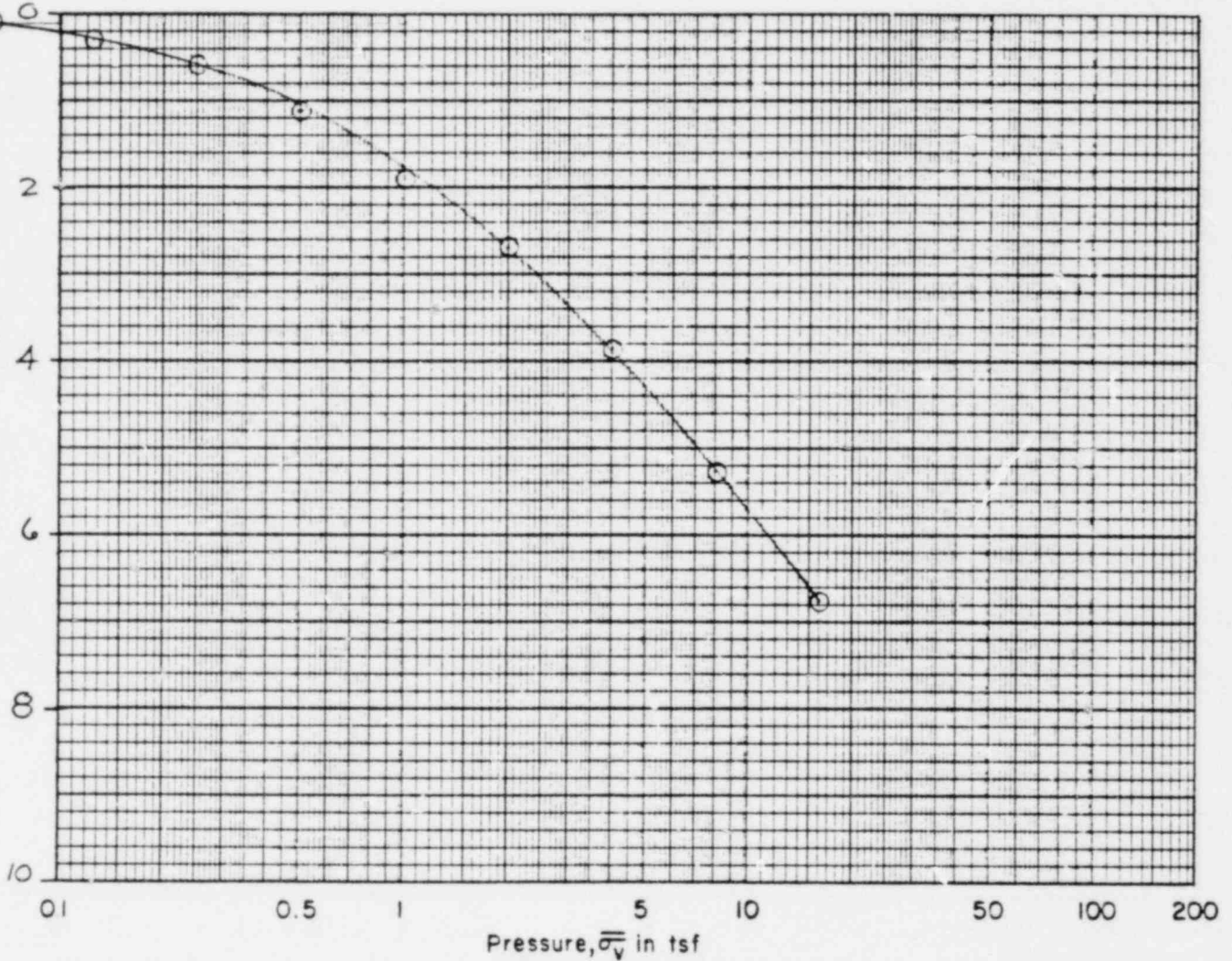


# CONSOLIDATION TEST

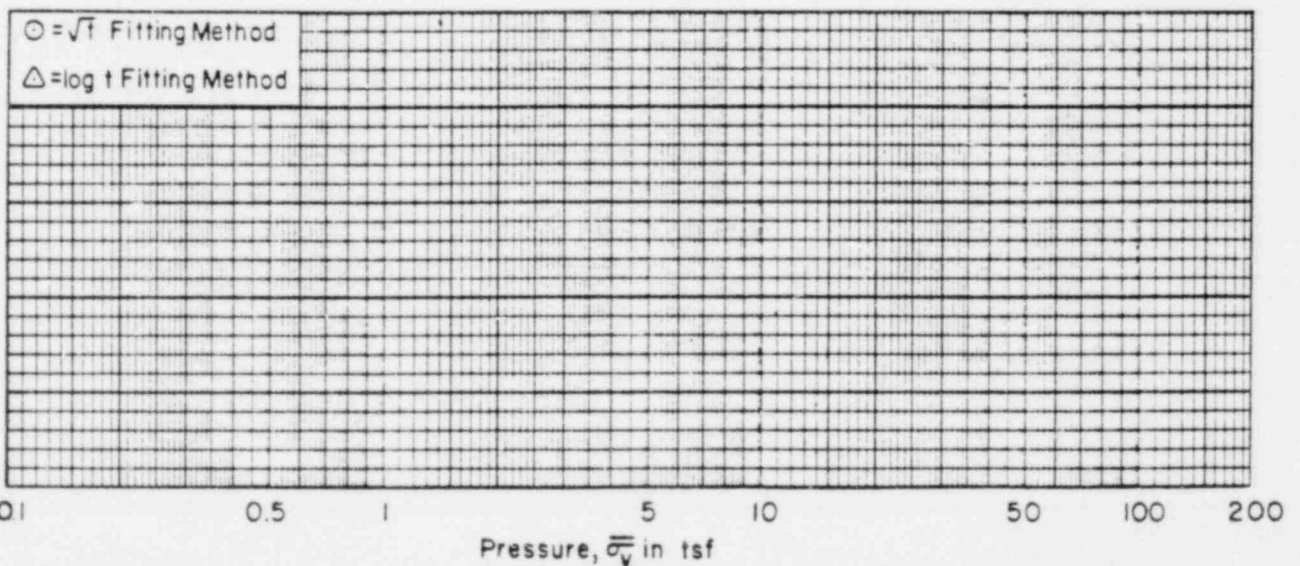
Data Calculated from  
e vs Log  $\bar{\sigma}_v$  plotted data  
G, Z, D & A (1978)

Boring No: DG - 11			Sample No: 6			Depth, ft: 9.6 - 9.8			
Material: Grey Brown Clayey Sand (SC)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	9.9	140.3	0.33	83	0.800	2.50"	2.71	21	12
Final	10.0	148.3	0.26	100 +	0.758				

Plotted by Jub Checked by OB 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$  in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$



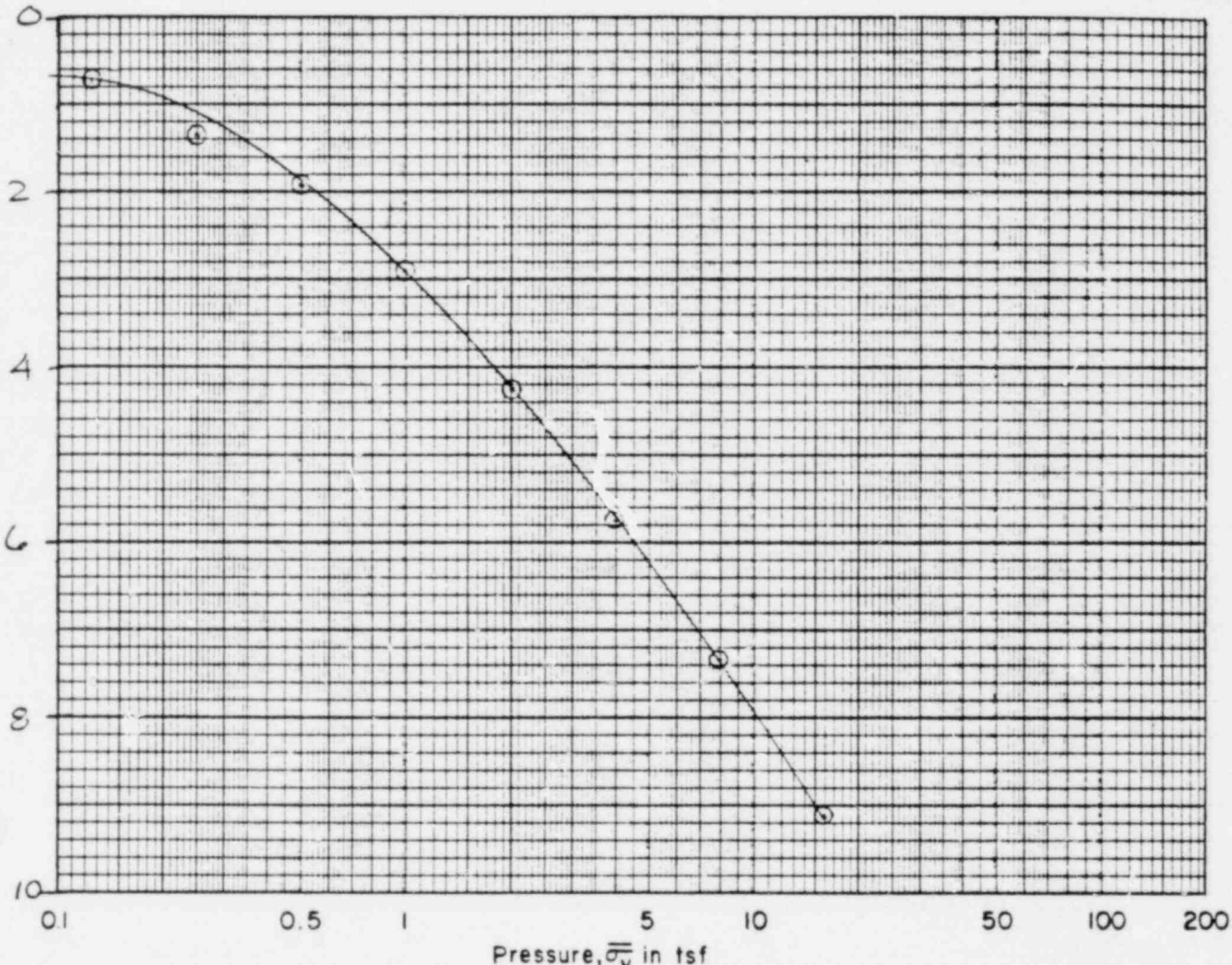


# CONSOLIDATION TEST

Data Calculated from  
e vs Log  $\bar{\sigma}_v$  plotted data  
G, Z, D + A (1978)

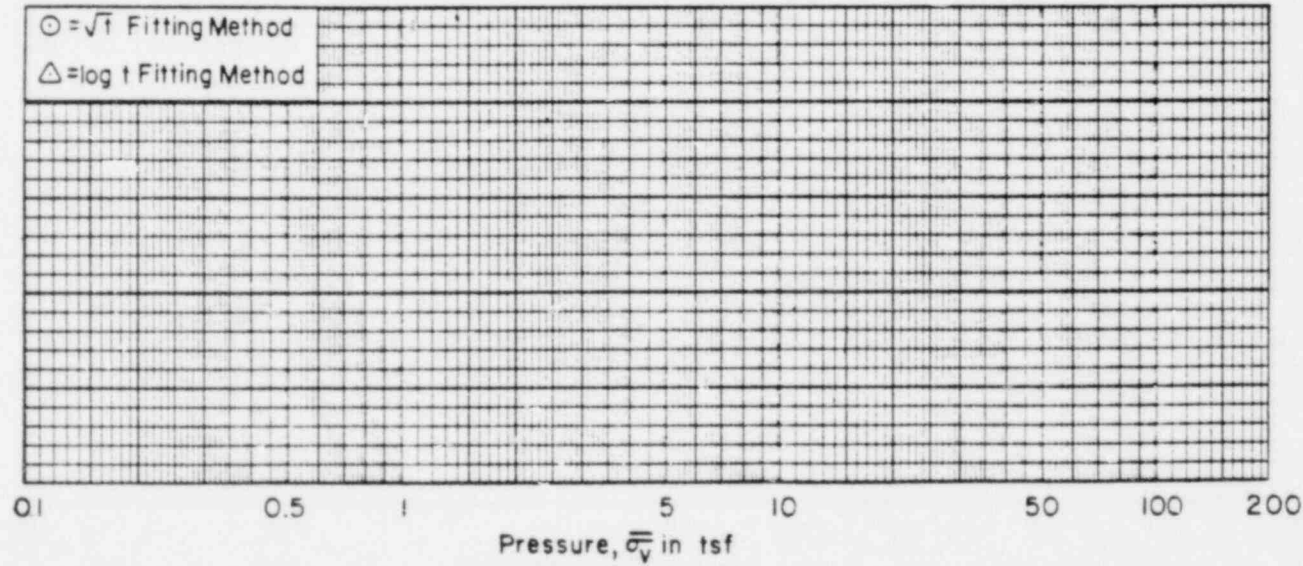
Boring No: DG-16			Sample No: —			Depth, ft: 1.2-1.7			
Material: Grey Sandy Clayey Silt (CL-ML)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	11.3	136.8	0.38	81	0.800	2.50"	2.72	19	12
Final	10.0	145.5	0.28	96	0.743				

Plotted by JWS checked by adw 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / 1 + e_0$ , in %



$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$

○ =  $\sqrt{t}$  Fitting Method  
△ = log t Fitting Method

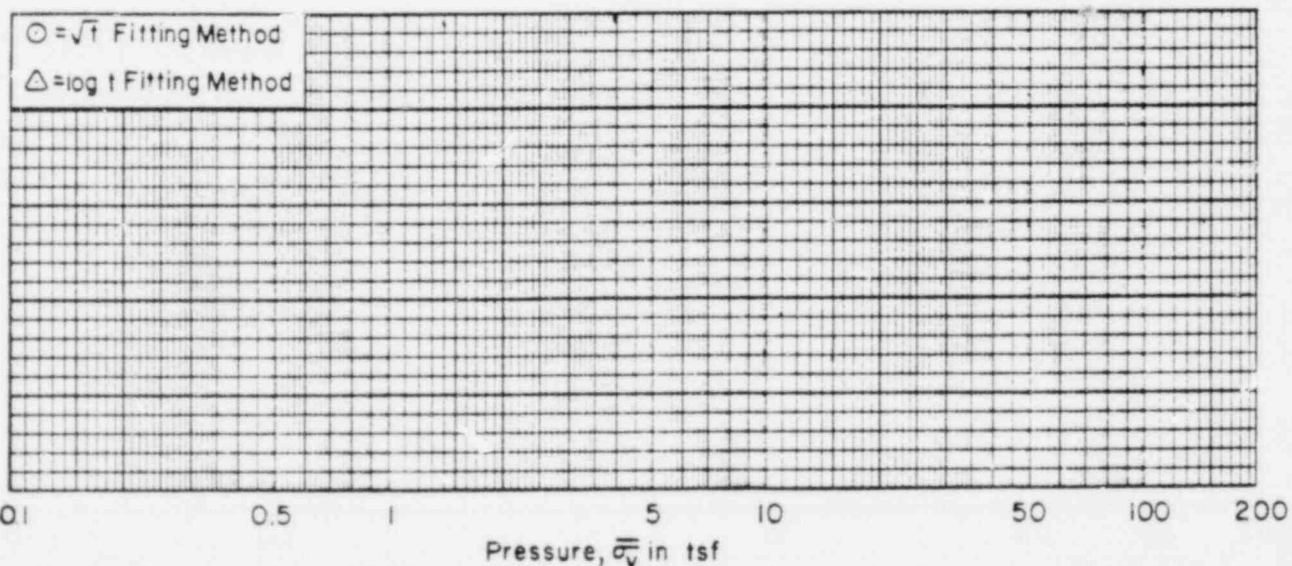
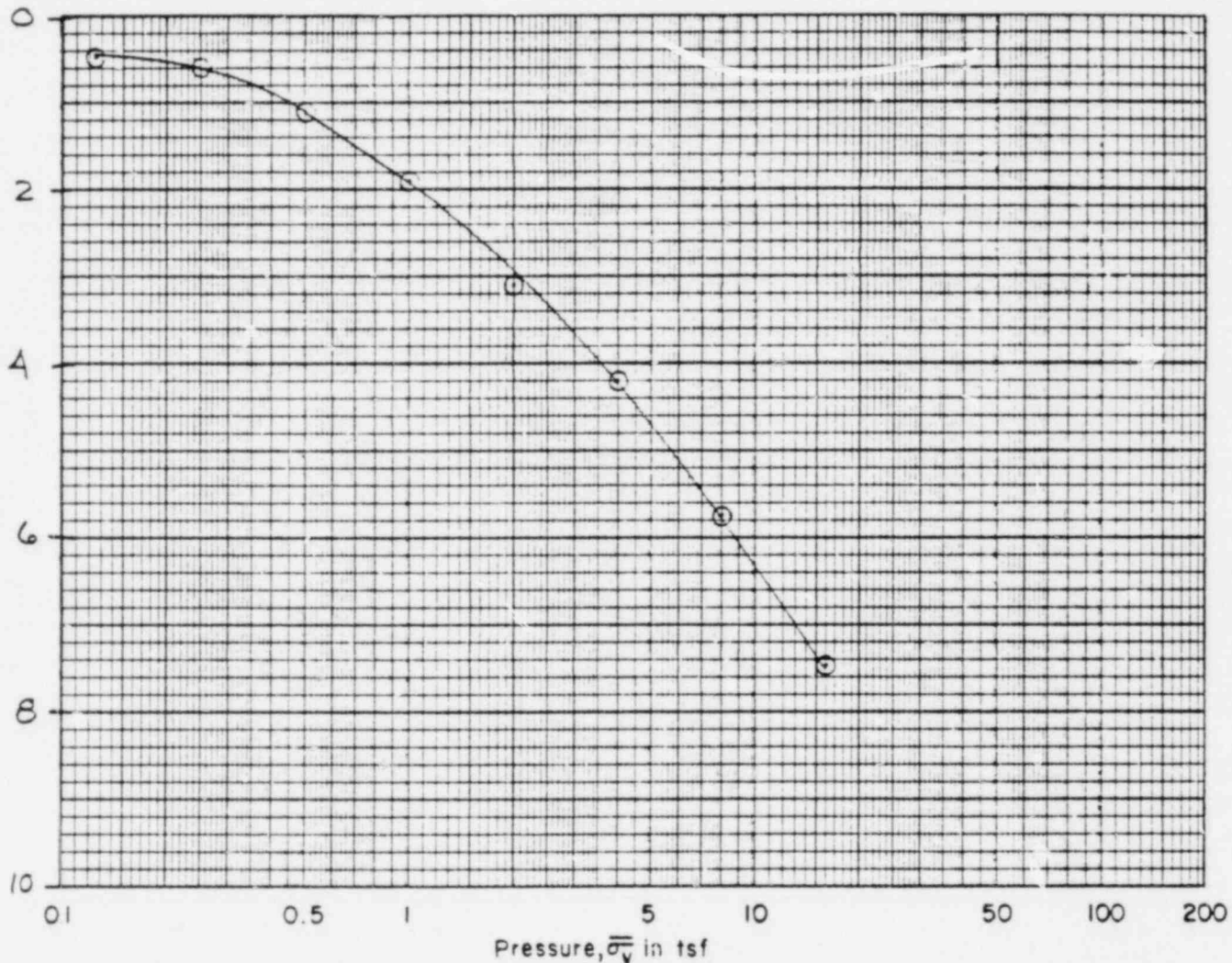




# CONSOLIDATION TEST

Data Calculated from  
e vs  $\log \bar{\sigma}_v$  plotted data  
G, Z, D & A (1978)

Soring No: DG-17			Sample No: 3			Depth, ft: 17.8-18.3			
Material: Brown Mottled Grey Silty, Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	12.2	140.6	0.36	93	0.800	2.50"	2.72	23	13
Final	10.9	146.9	0.28	100+	0.757				

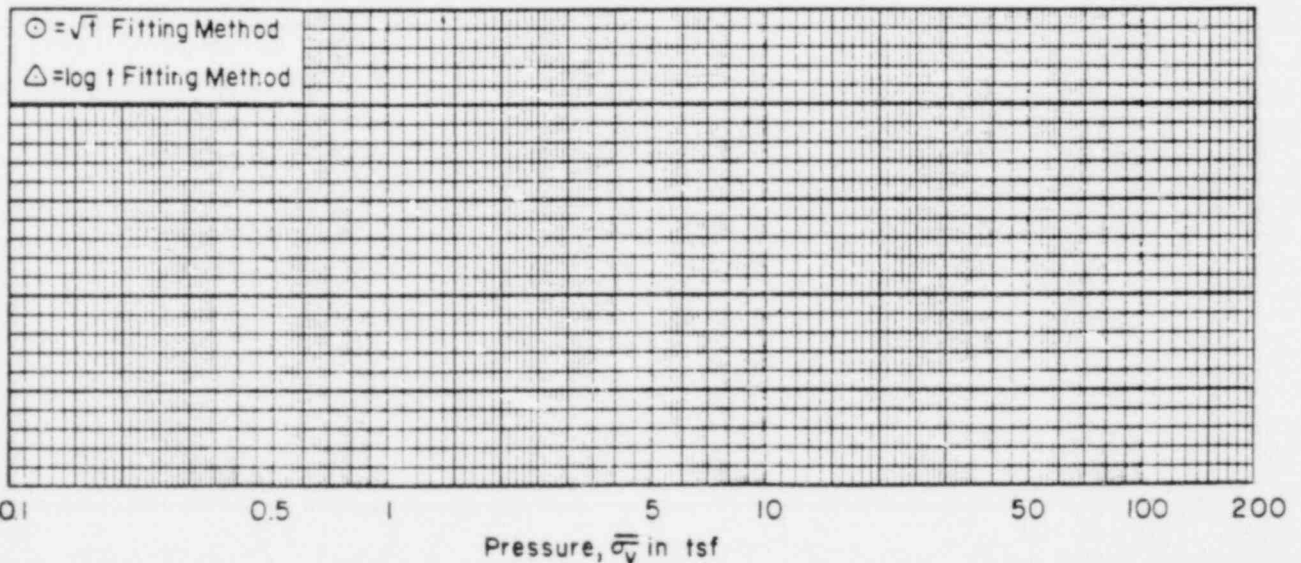
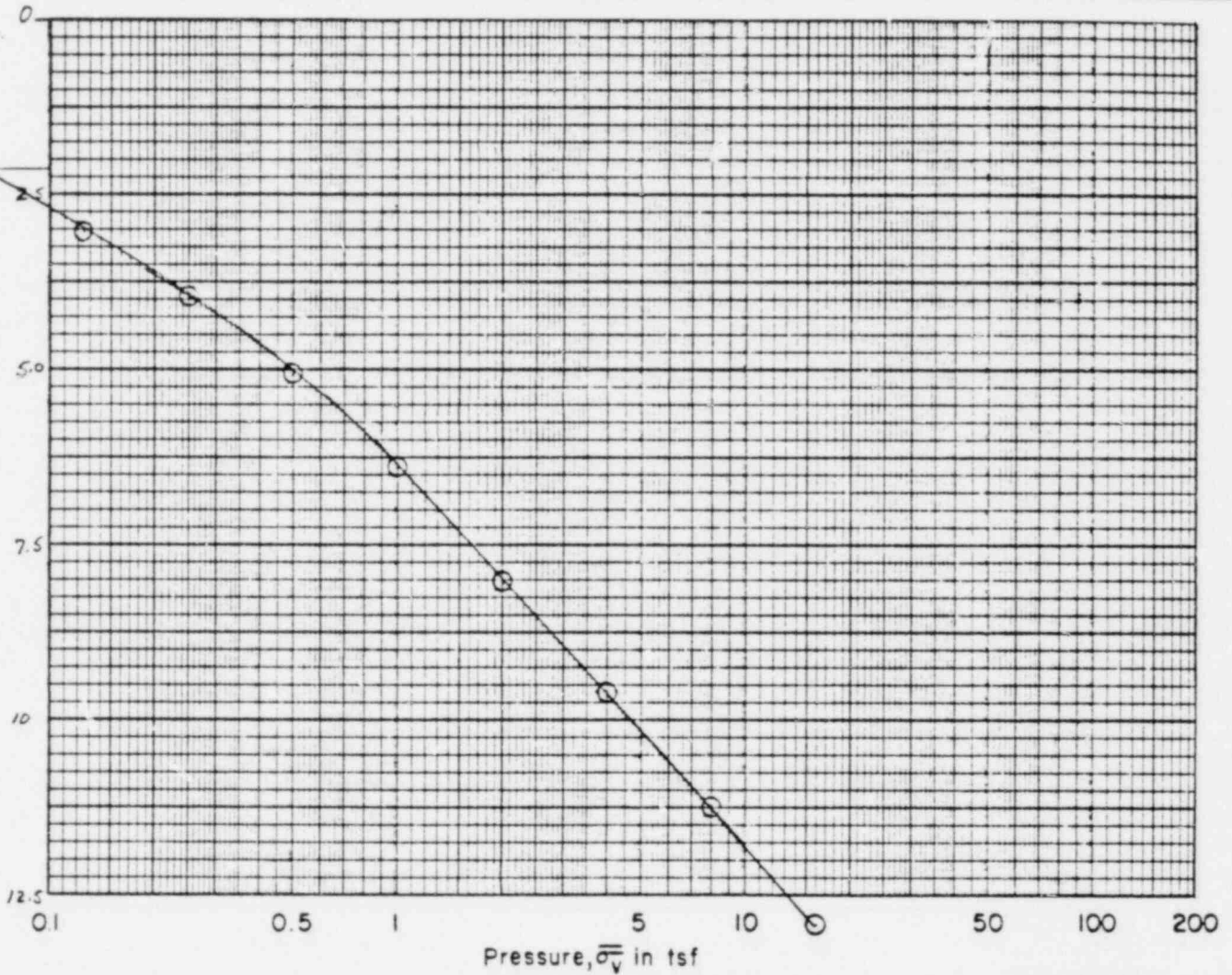


# CONSOLIDATION TEST

DATA CALCULATED FROM  
C VS LOG  $\bar{\sigma}_v$  PLOTTED  
DATA GZD&A (1978)

Boring No: DG-19			Sample No: 9			Depth, ft: 13.5-14.0			
Material: GREY BROWN SANDY CLAY (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	15.3	131.7	0.49	85	0.834	2.50	2.73	26	13
Final	12.0	143.7	0.33	100	0.742				

Plotted by AKH Checked by JWS 8 July 81  
Volumetric Strain,  $\epsilon_v = \Delta e / 1 + e_0$  in %  
  
 $C_v, \text{ cm}^2/\text{sec} \times 10^{-4}$



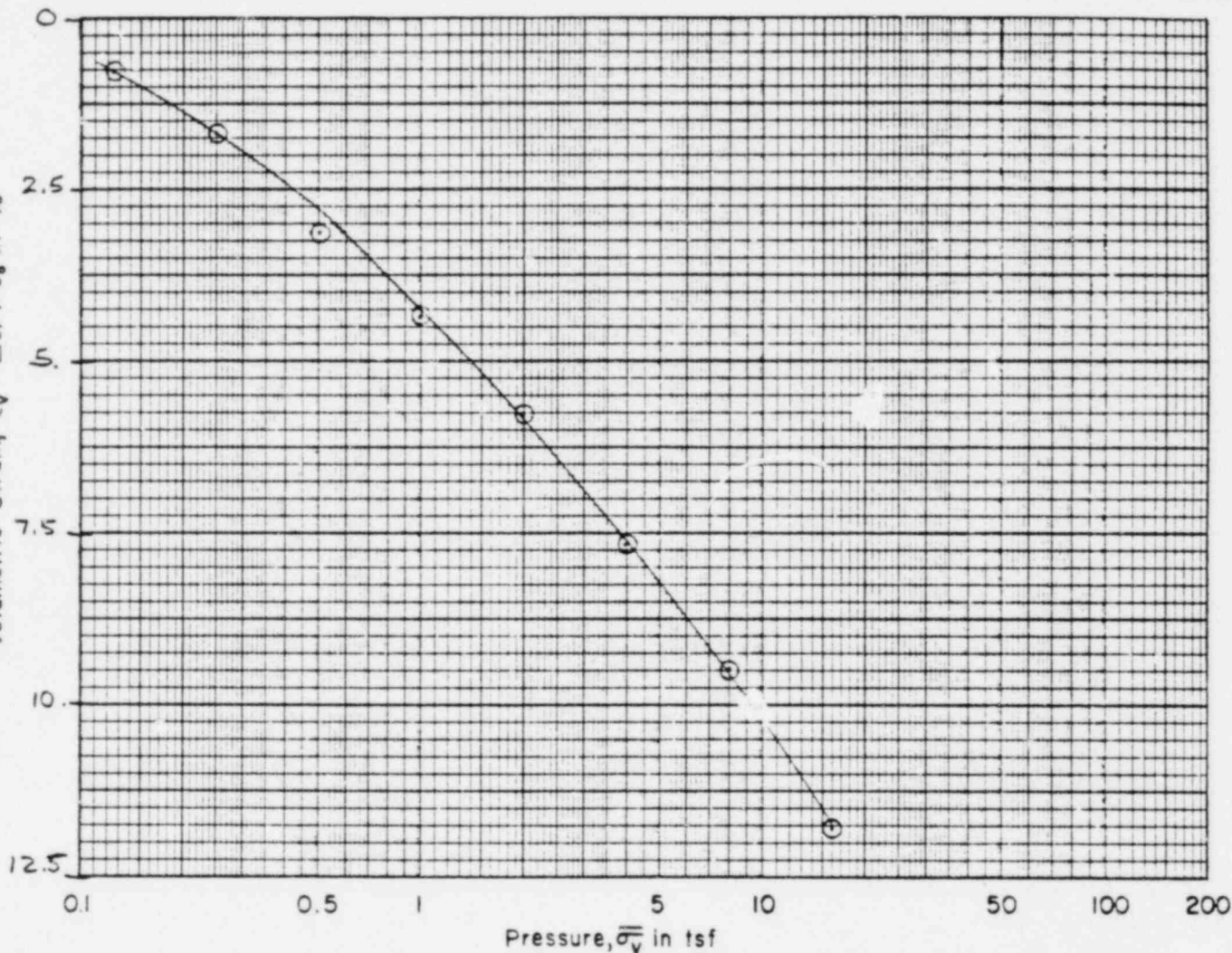
# CONSOLIDATION TEST

Data Calculated from  
e vs  $\log \bar{\sigma}_v$  plotted data  
G, Z, D & A (1978)

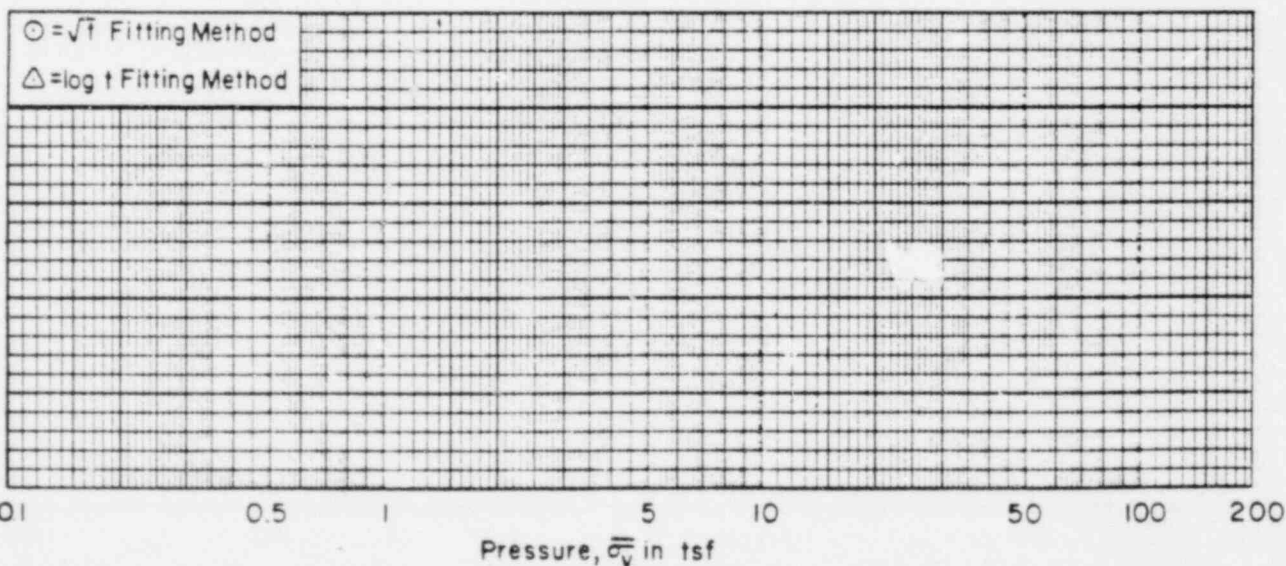
Boring No: DG-21			Sample No: 5			Depth, ft: 10.8 - 11.1			
Material: Brown Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	17.7	130.3	0.53	91	0.750	2.50"	2.71	22	13
Final	16.2	138.5	0.42	100	0.696				

Plotted by JWS Checked by WJS 8 July 81

Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$ , in %



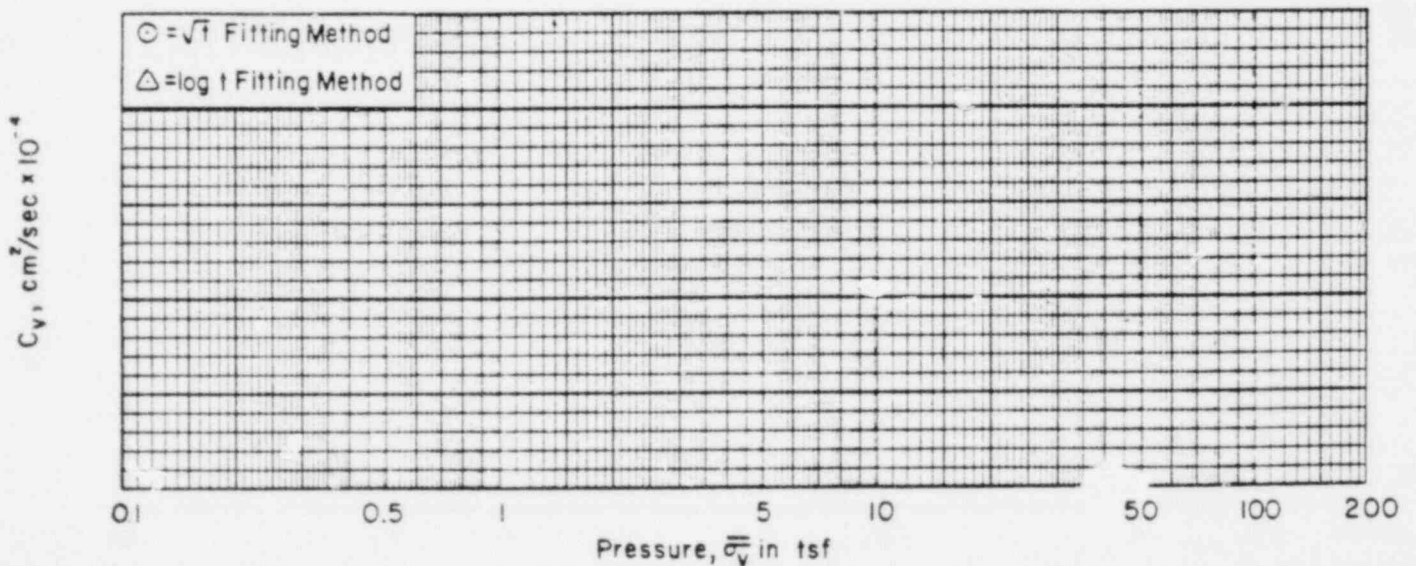
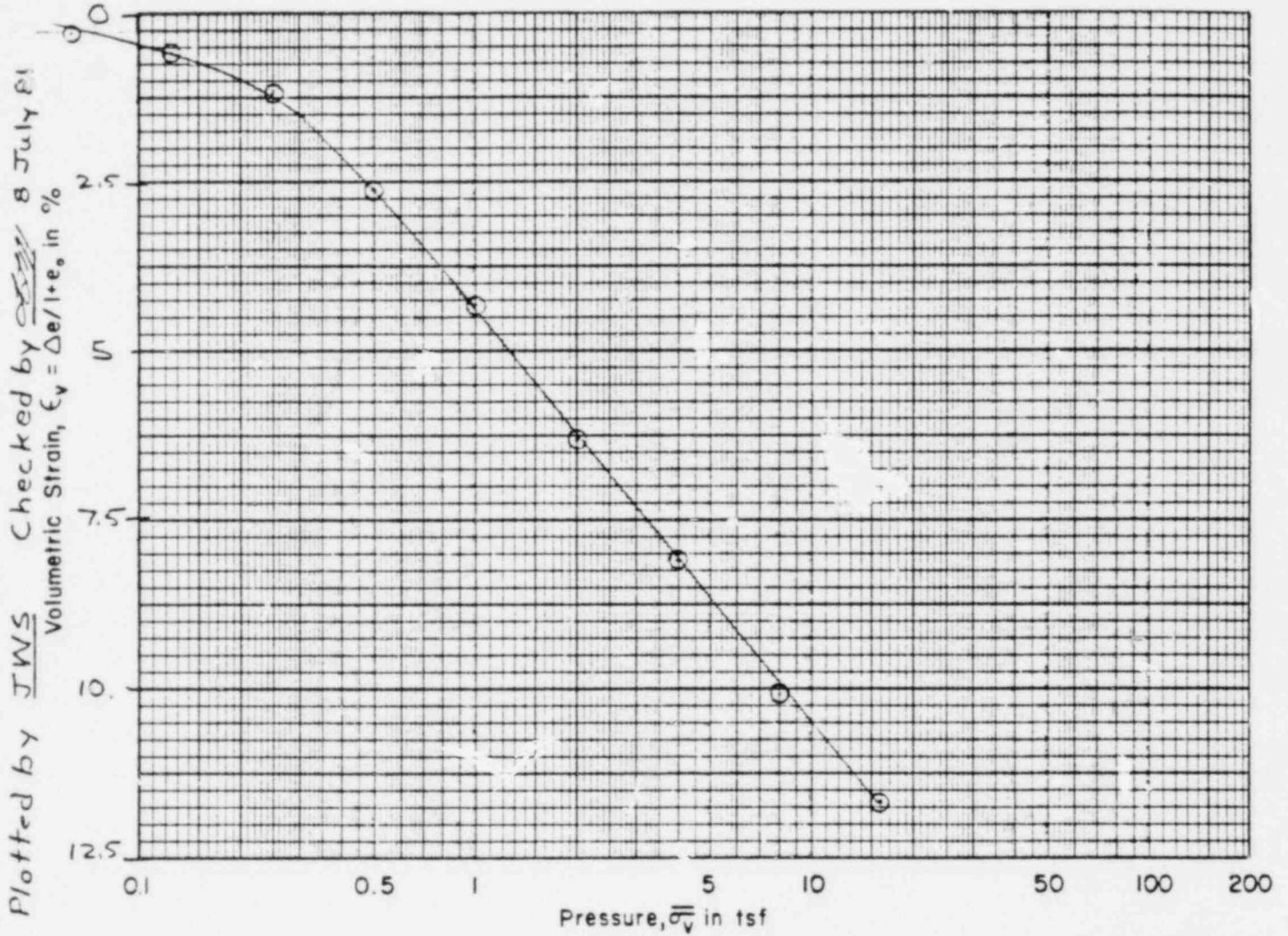
$C_v$ , cm<sup>2</sup>/sec  $\times 10^{-4}$





Data Calculated from  
CONSOLIDATION TEST  $e$  vs  $\log \bar{\sigma}_v$  plotted data  
G, Z, D & A (1978)

Boring No: DG-21			Sample No:			Depth, ft: 12.7 - 13.2			
Material: Brown Sandy Clay (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.1	135.5	0.41	86	0.800	2.50	2.71	20	12
Final	10.7	147.3	0.27	100	0.720				



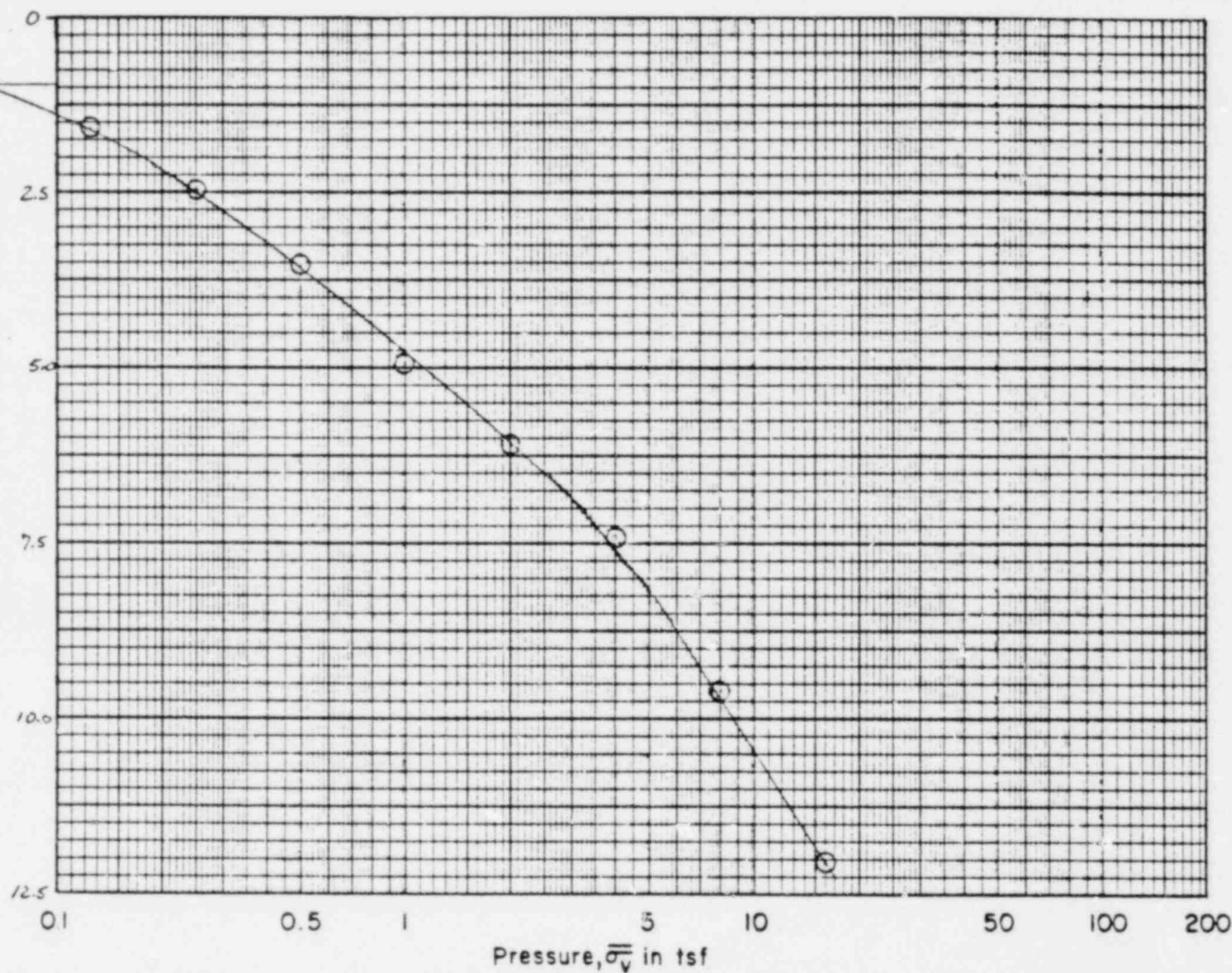


# CONSOLIDATION TEST

DATA CALCULATED FROM  
C VS LOG  $\bar{\sigma}_v$  PLOTTED DATA  
GZD & A (1978)

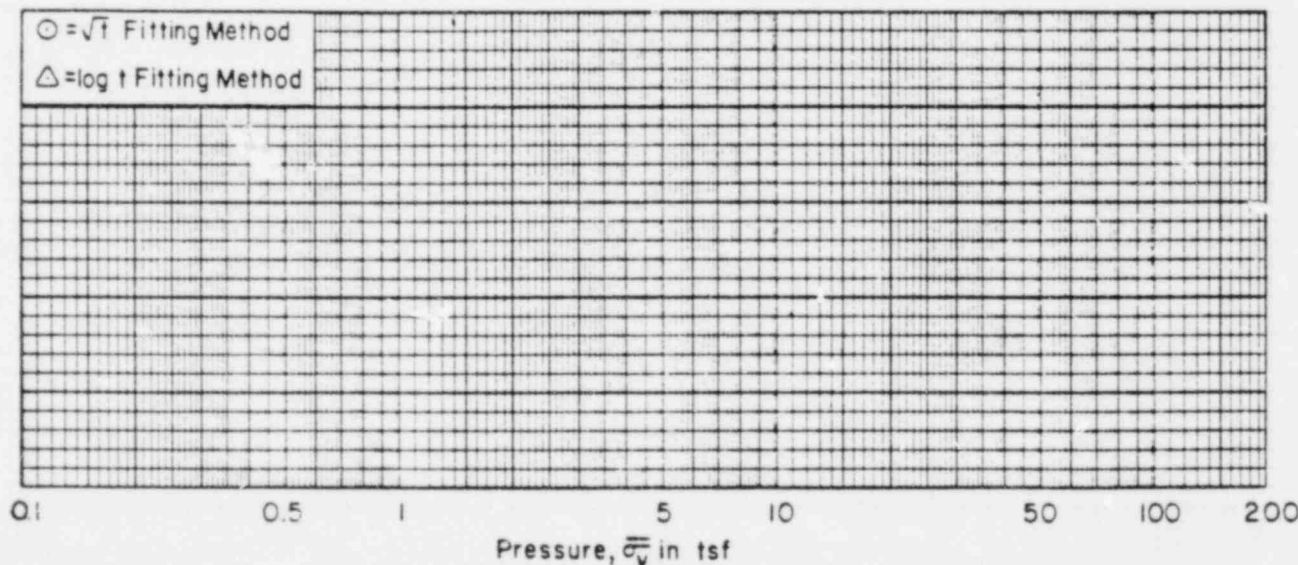
Boring No: DG-23		Sample No: 7		Depth, ft: 11.3 - 11.5					
Material: GREY SANDY CLAY (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	13.3	133.0	0.45	81	0.800	2.50	2.72	19	11
Final	10.7	145.6	0.29	100	0.714				

Plotted by ASH Checked by JWS 8 JUL 81  
Volumetric Strain,  $\epsilon_v = \Delta e / (1 + e_0)$  in %



$C_v, \text{cm}^2/\text{sec} \times 10^{-4}$

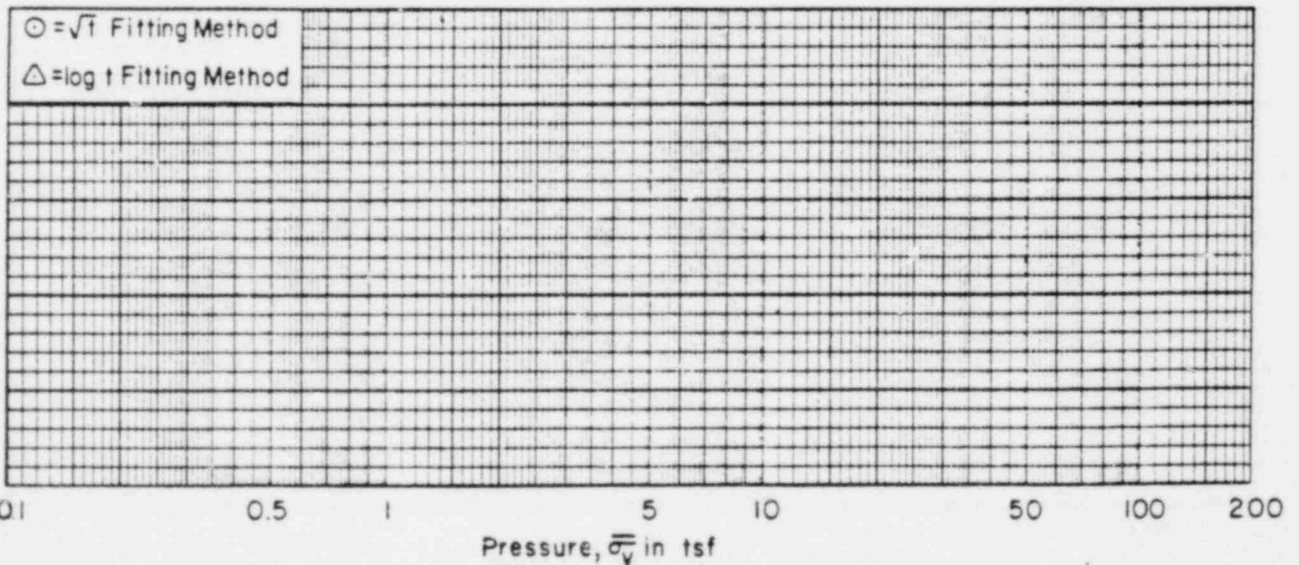
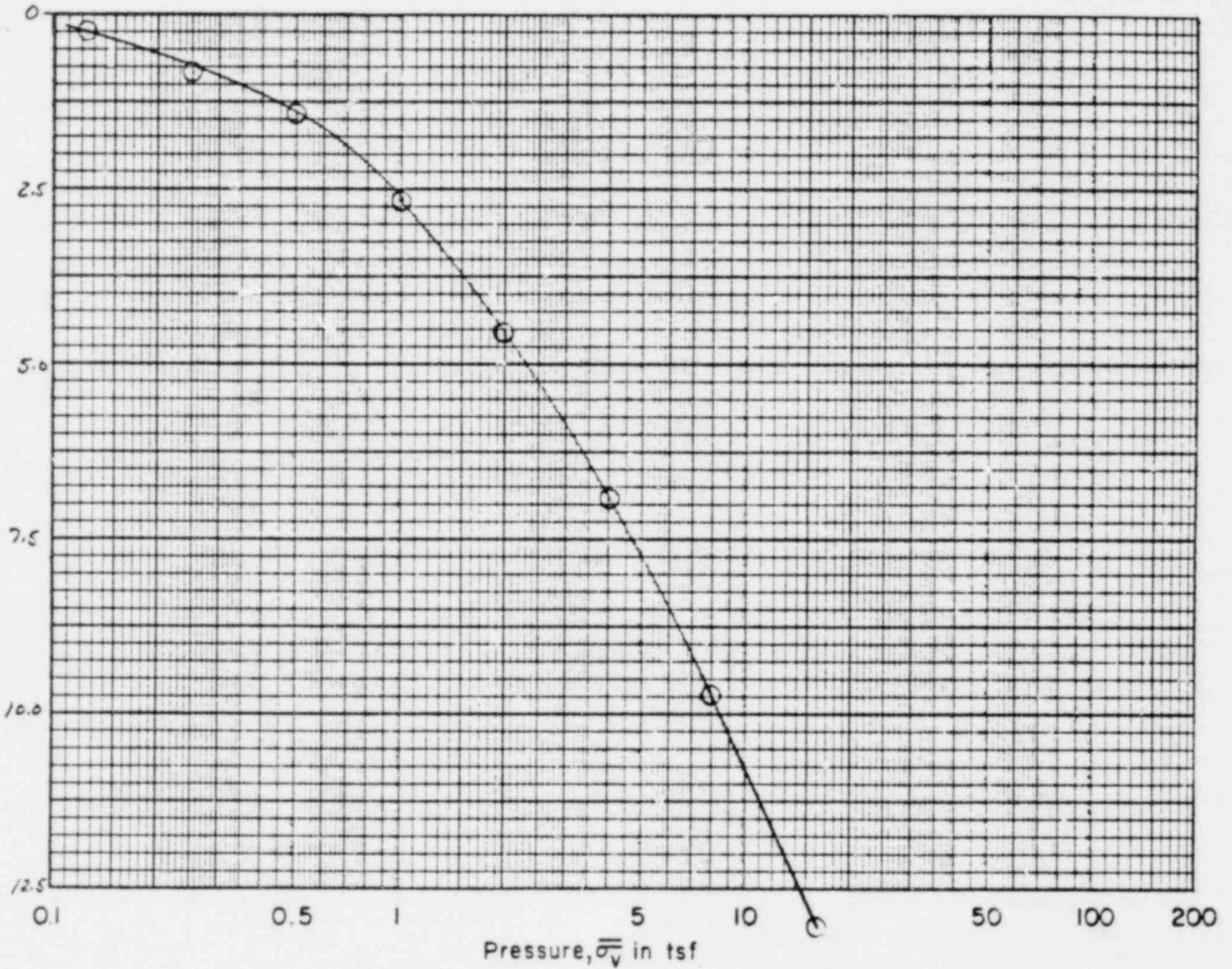
○ =  $\sqrt{t}$  Fitting Method  
△ = log t Fitting Method

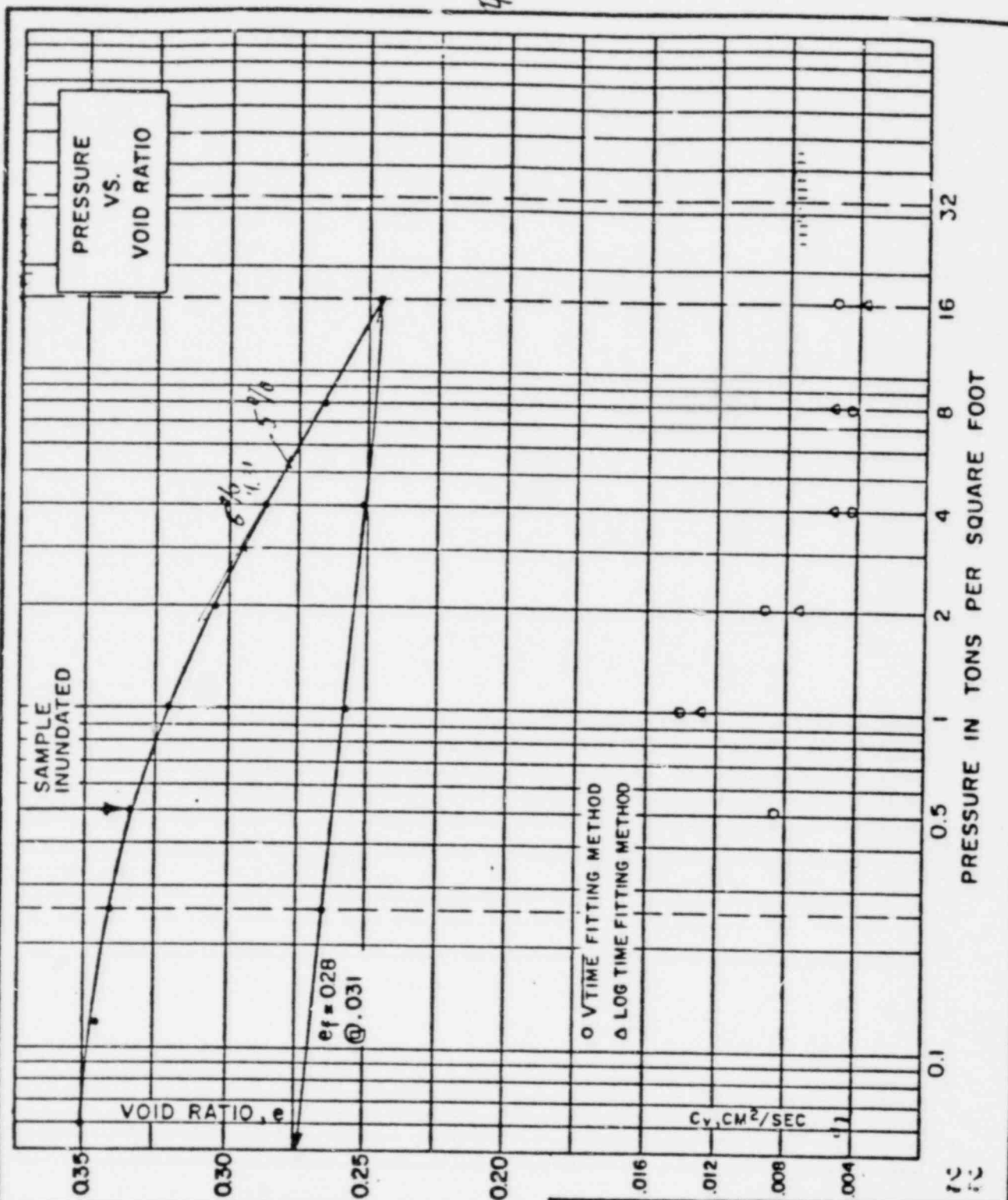


# CONSOLIDATION TEST

DATA CALCULATED FROM  
C vs LOG  $\bar{\sigma}_v$  PLOTTED DATA  
G Z D & A (1978)

Boring No: DG - 2 G		Sample No: 7		Depth, ft: 14.6 - 14.8					
Material: BROWN SILTY CLAY (CL)									
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation, %	Height, inches	Diameter, inches	Specific Gravity	Liquid Limit, %	Plastic Limit, %
Initial	30.0	121.2	0.84	98	0.750	2.50	2.75	39	14
Final	27.9	125.8	0.75	100	0.711				





SOIL DESCRIPTION: BROWN MOTTLED DARK GREY SANDY CLAY  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN LIMIT 20% LIMIT 12% GRAVITY 2.72

	WATER CONTENT, %	TOTAL UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	11.8	140.3	0.35	92	0.800
FINAL	11.0	147.8	0.28	100+	0.754

GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES, INC.  
 CONSULTANTS IN GEOTECHNICAL ENGINEERING

CONSUMERS POWER COMPANY  
 MIDLAND PLANT UNITS 1 & 2  
 MIDLAND, MICHIGAN

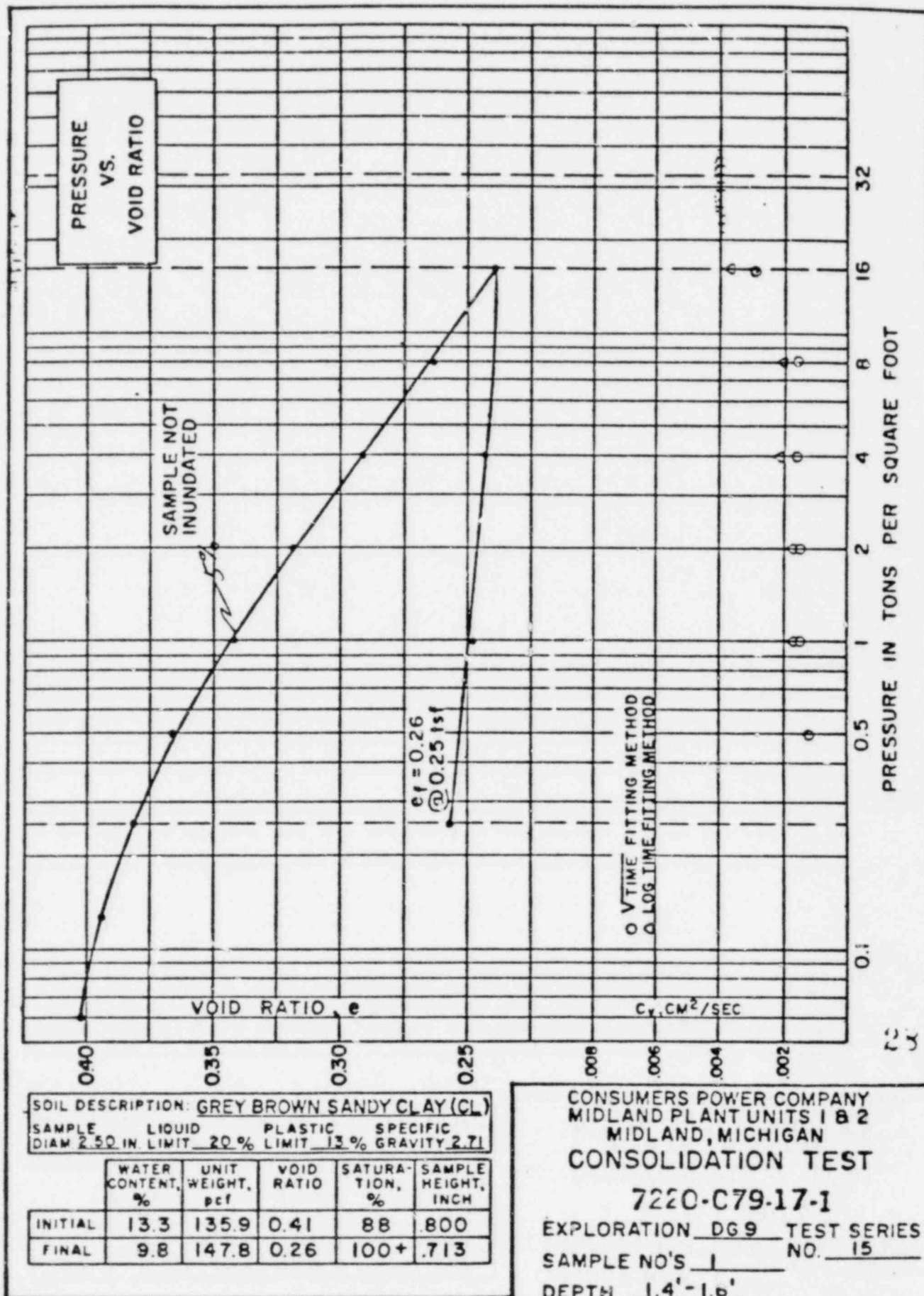
### CONSOLIDATION TEST

7220-C79-17-1

BORING NO DG 7 TEST SERIES  
 SAMPLE 4 NO. 11  
 DEPTH 17.0'-17.3' DATE OCT. 1978  
 TECH. *[Signature]*  
 REVIEWER *[Signature]* FILE 2190

FIGURE





GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES, INC.  
CONSULTANTS IN GEOTECHNICAL ENGINEERING

CONSUMERS POWER COMPANY  
MIDLAND PLANT UNITS 1 & 2  
MIDLAND, MICHIGAN  
**CONSOLIDATION TEST**

7220-C79-17-1

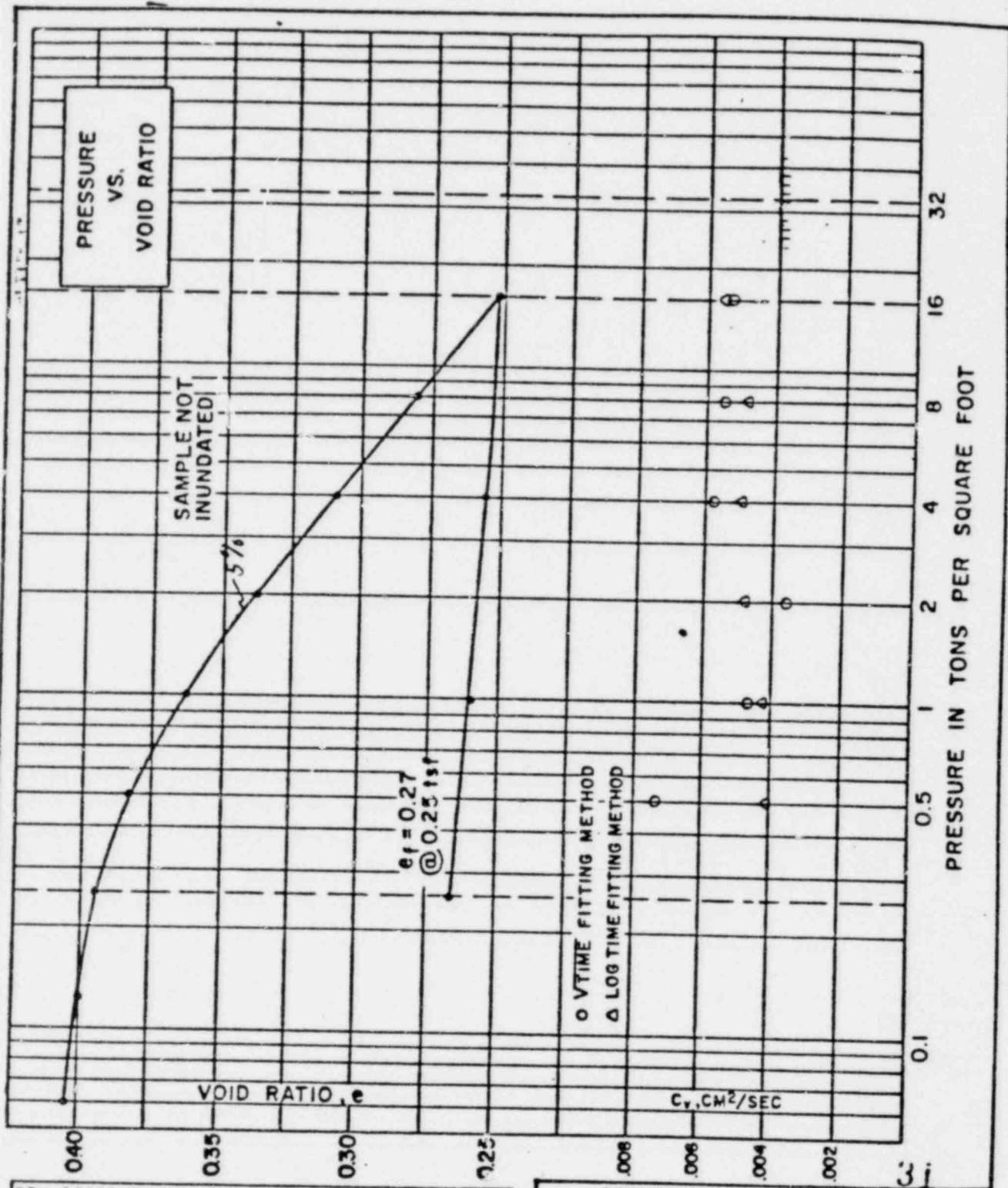
EXPLORATION DG9 TEST SERIES

SAMPLE NO'S 1 NO. 15

DEPTH 1.4'-1.6'

REVIEWER *J. J. J.* FILE 2190





SOIL DESCRIPTION: BROWN SANDY CLAY (CL)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN. LIMIT 21 % LIMIT 12 % GRAVITY 2.72

	WATER CONTENT, %	UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	11.7	134.8	0.41	78	0.800
FINAL	9.9	147.5	0.27	100+	0.720

GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES, INC.  
 CONSULTANTS IN GEOTECHNICAL ENGINEERING

CONSUMERS POWER COMPANY  
 MIDLAND PLANT UNITS 1 & 2  
 MIDLAND, MICHIGAN

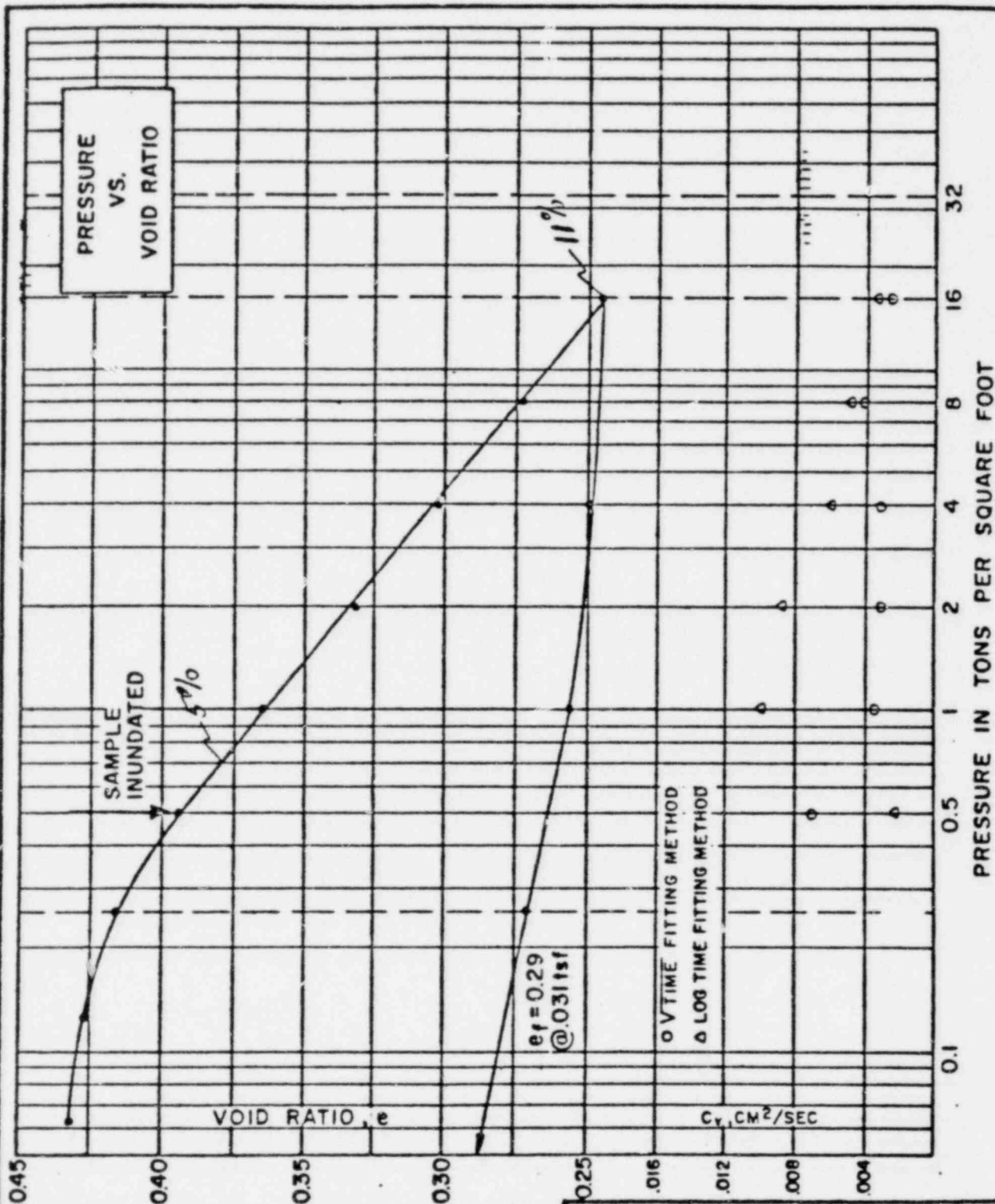
CONSOLIDATION TEST  
 7220-C79-17-1

EXPLORATION DG 9 TEST SERIES

SAMPLE NO'S 3 NO. 17

DEPTH 5.7'-6.0'

REVIEWER J. E. Lyons FILE 2190



SOIL DESCRIPTION: BROWN MOTTLED GREY SANDY CLAY (CL)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN LIMIT 23% LIMIT 12% GRAVITY 2.72

	WATER CONTENT, %	TOTAL UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	13.4	133.3	0.45	81	0.800
FINAL	10.7	145.3	0.29	100	0.716

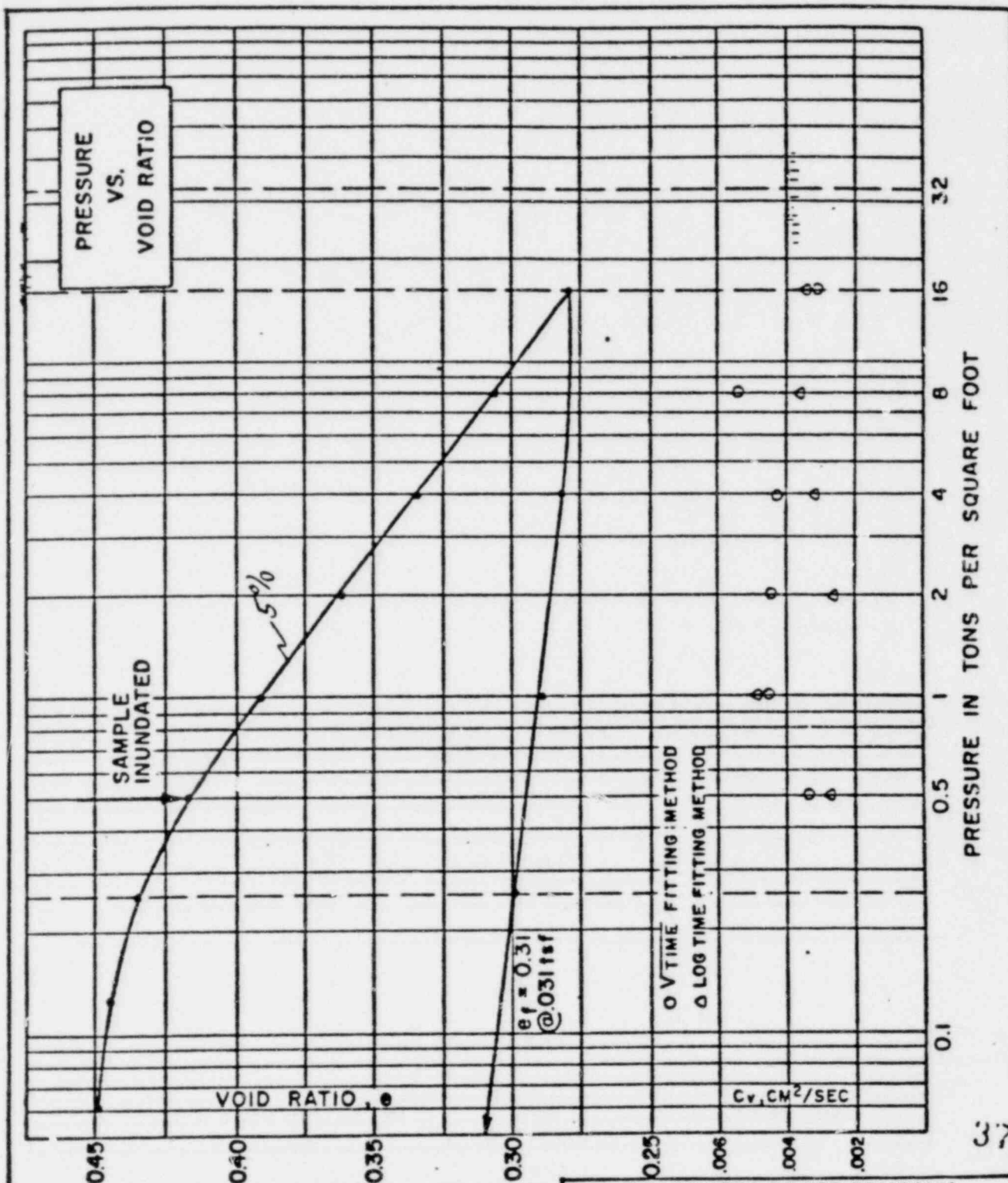
GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES, INC.  
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CONSUMERS POWER COMPANY  
 MIDLAND PLANT UNITS 1 & 2  
 MIDLAND, MICHIGAN

**CONSOLIDATION TEST**  
**7220-C79-17-1**

BORING NO. DG 9 TEST SERIES  
 SAMPLE 4 NO. 18  
 DEPTH 7.7' - 8.1' DATE OCT 1978  
 TECH. D. J. [Signature]  
 REVIEWER J. [Signature] FILE 2190

FIGURE



SOIL DESCRIPTION: DARK GREY SANDY CLAY (CL)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN. LIMIT 21 % LIMIT 11 % GRAVITY 2.72

	WATER CONTENT, %	UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	13.9	133.1	0.45	83	0.800
FINAL	11.5	144.2	0.31	100	0.722

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 MIDLAND, MICHIGAN  
**CONSOLIDATION TEST**

7220-C79-17-1

EXPLORATION DG 10 TEST SERIES  
 SAMPLE NO'S 4 NO. 25  
 DEPTH 9.7'-10.0'  
 REVIEWER J. Elyas FILE 2190



# PRESSURE VS. VOID RATIO

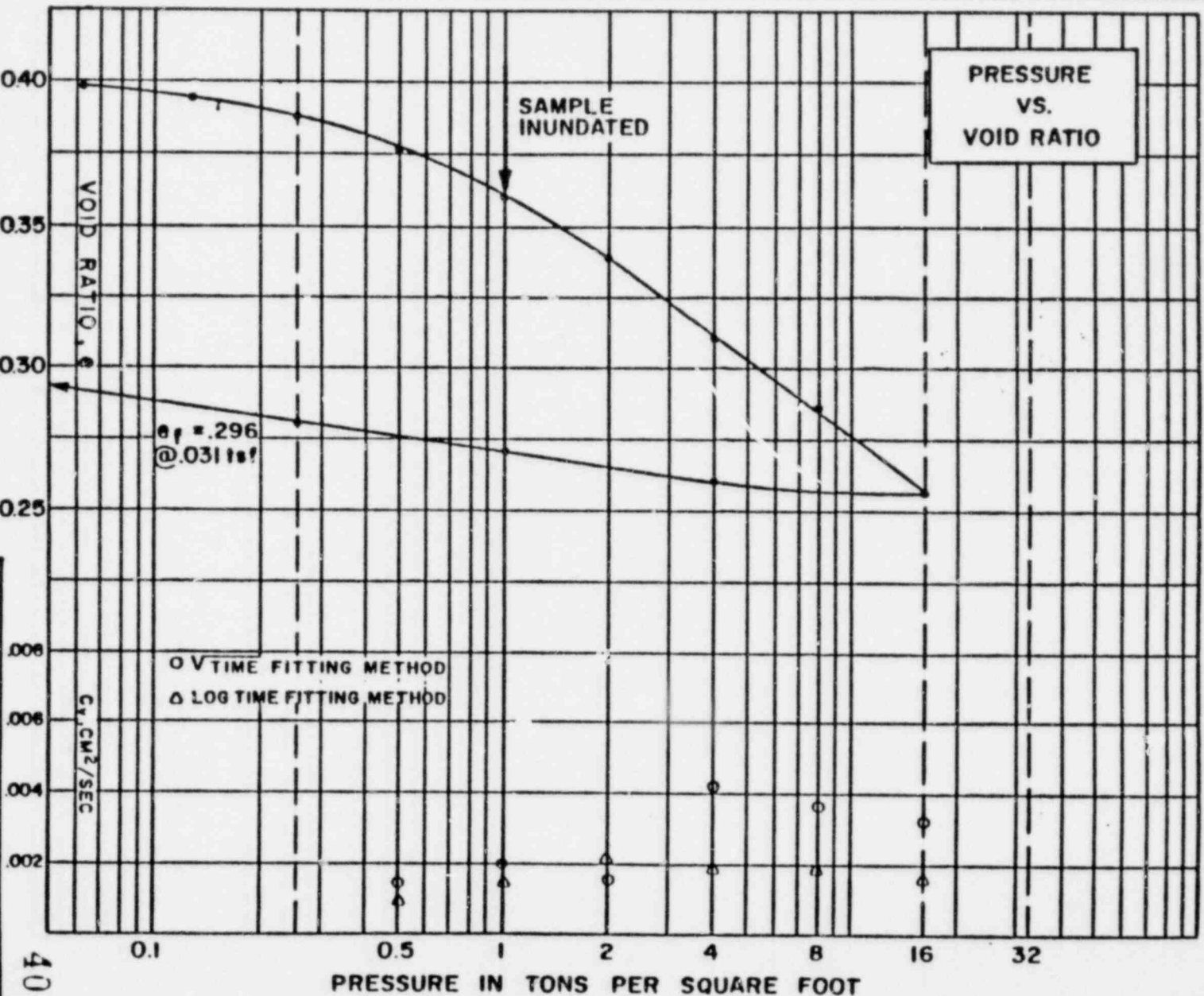
SAMPLE  
INUNDATED

$e_f = .296$   
@ .031 tsf

O VTIME FITTING METHOD  
Δ LOG TIME FITTING METHOD

$C_v$ , CM<sup>2</sup>/SEC

PRESSURE IN TONS PER SQUARE FOOT



SOIL DESCRIPTION: GREY SANDY CLAY (CL)

SAMPLE LIQUID PLASTIC SPECIFIC  
DIAM 2.50 IN. LIMIT 52% LIMIT 13% GRAVITY 2.69

	WATER CONTENT, %	UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	14.9	137.4	0.40	99	0.800
FINAL	12.6	145.9	0.30	-	0.739

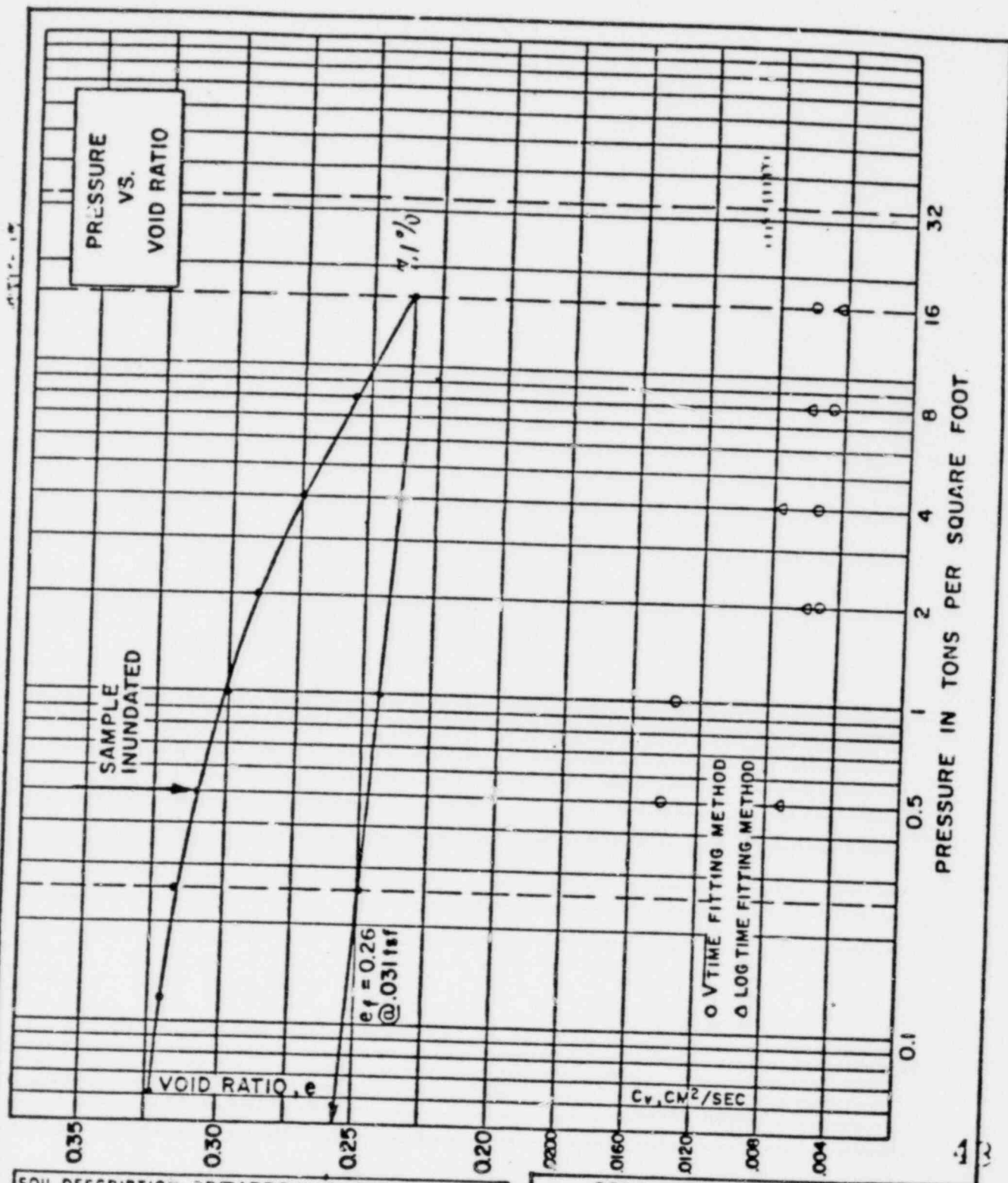
CONSUMERS POWER COMPANY  
MIDLAND PLANT UNITS 1 & 2  
MIDLAND, MICHIGAN  
CONSOLIDATION TEST

722C-C79-17-1

EXPLORATION DGD TEST SERIES  
SAMPLE NO'S 5  
NO. 25

DEPTH 13.0'-13.2'

REVIEWER *J. B. G. W.* FILE 2190



SOIL DESCRIPTION: GREY BROWN CLAYEY SAND (SC)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN. LIMIT 21.0% LIMIT 12% GRAVITY 2.71

	WATER CONTENT, %	UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	9.9	140.3	0.33	83	0.800
FINAL	10.0	148.3	0.26	100+	0.758

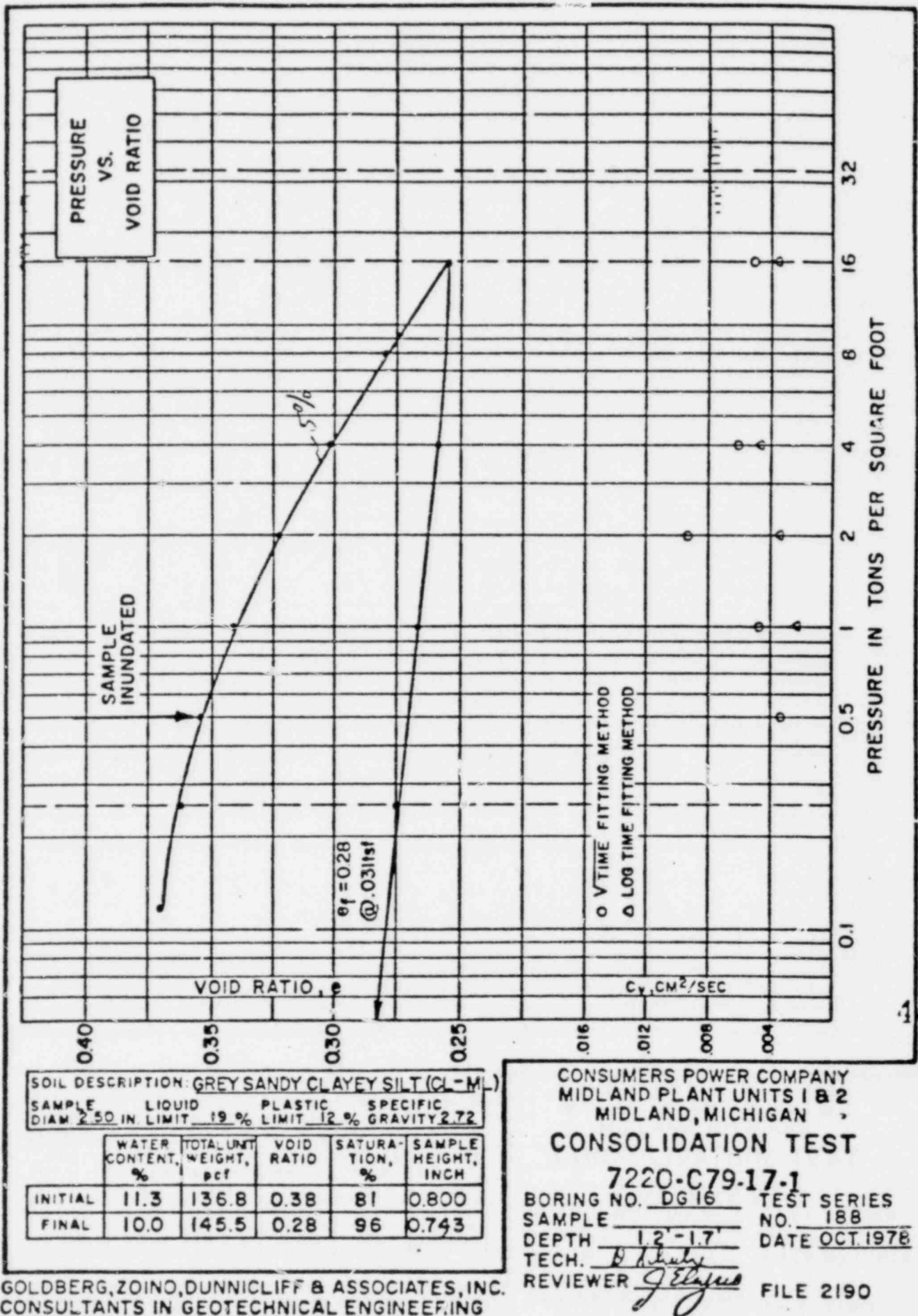
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 MIDLAND PLANT UNITS 1 & 2  
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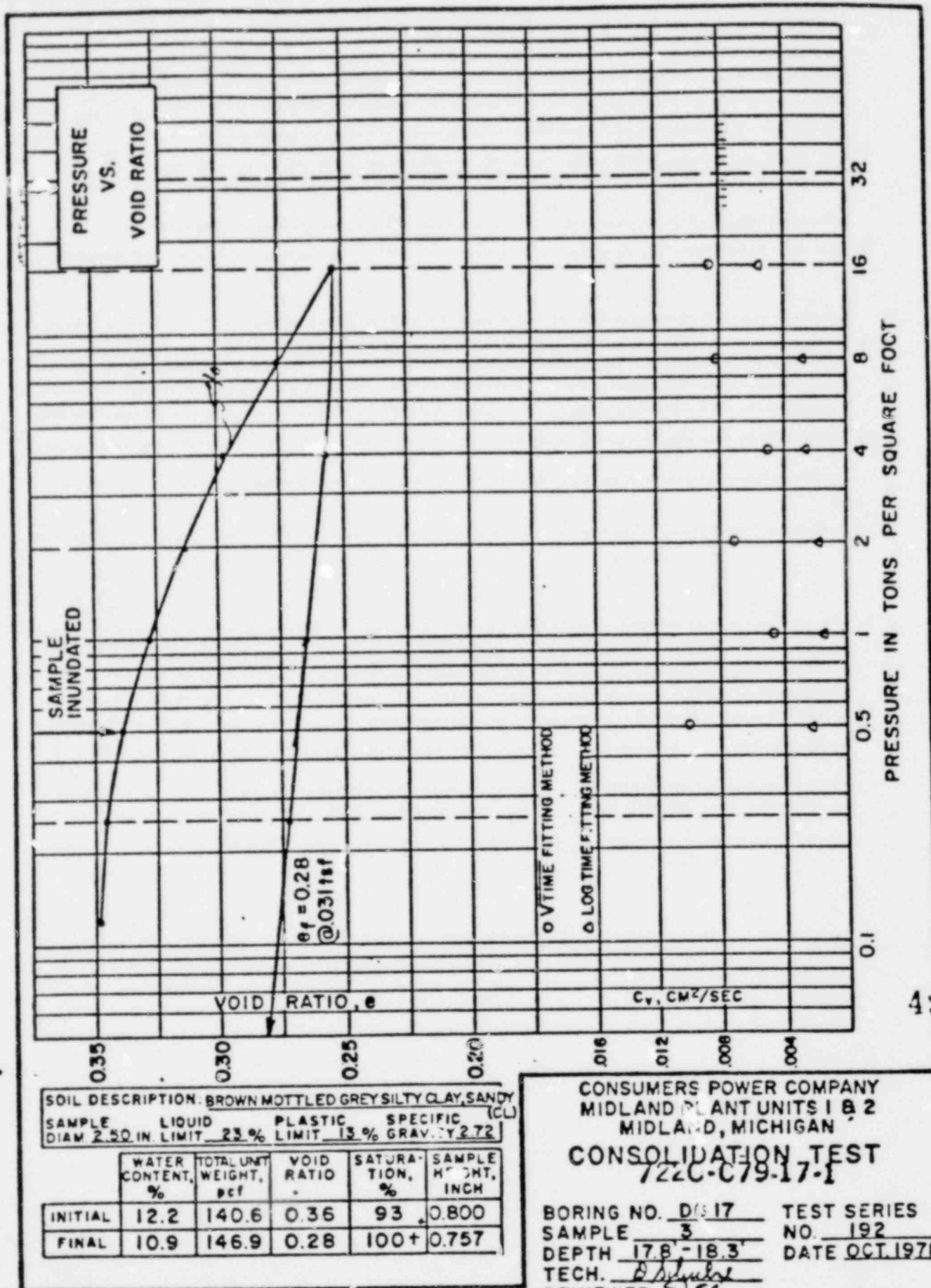
CONSOLIDATION TEST  
 7220-C79-17-1

EXPLORATION DG II TEST SERIES  
 SAMPLE NO'S 6 NO. 27  
 DEPTH 9.6'-9.8'

REVIEWER J. J. [Signature] FILE 2190

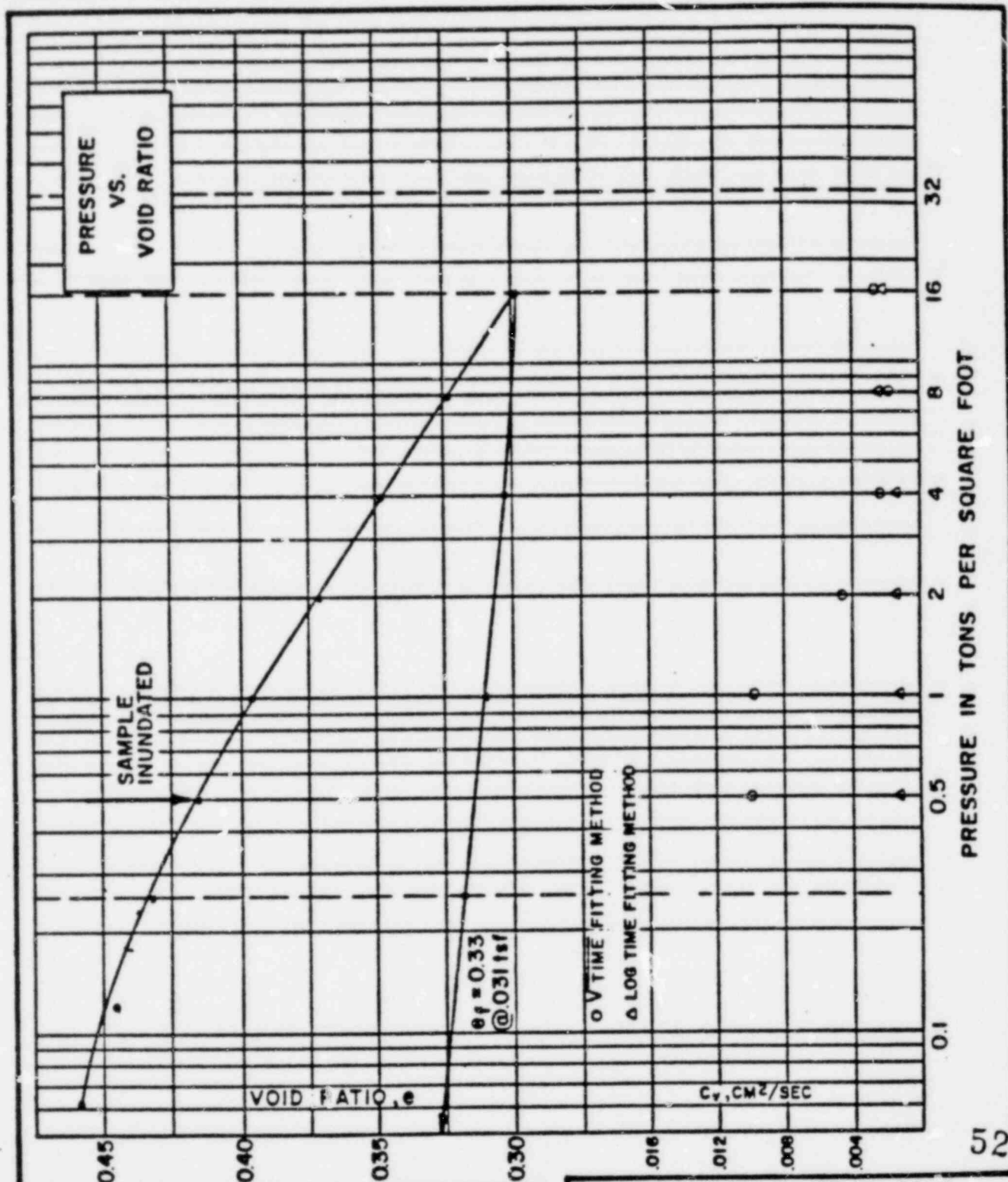






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FIGURE



SOIL DESCRIPTION: **GREY BROWN SANDY CLAY (CL)**  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN LIMIT 26 % LIMIT 13 % GRAVITY 2.73

	WATER CONTENT, %	TOTAL UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	15.3	131.7	0.49	85	0.834
FINAL	12.0	143.7	0.33	100	0.742

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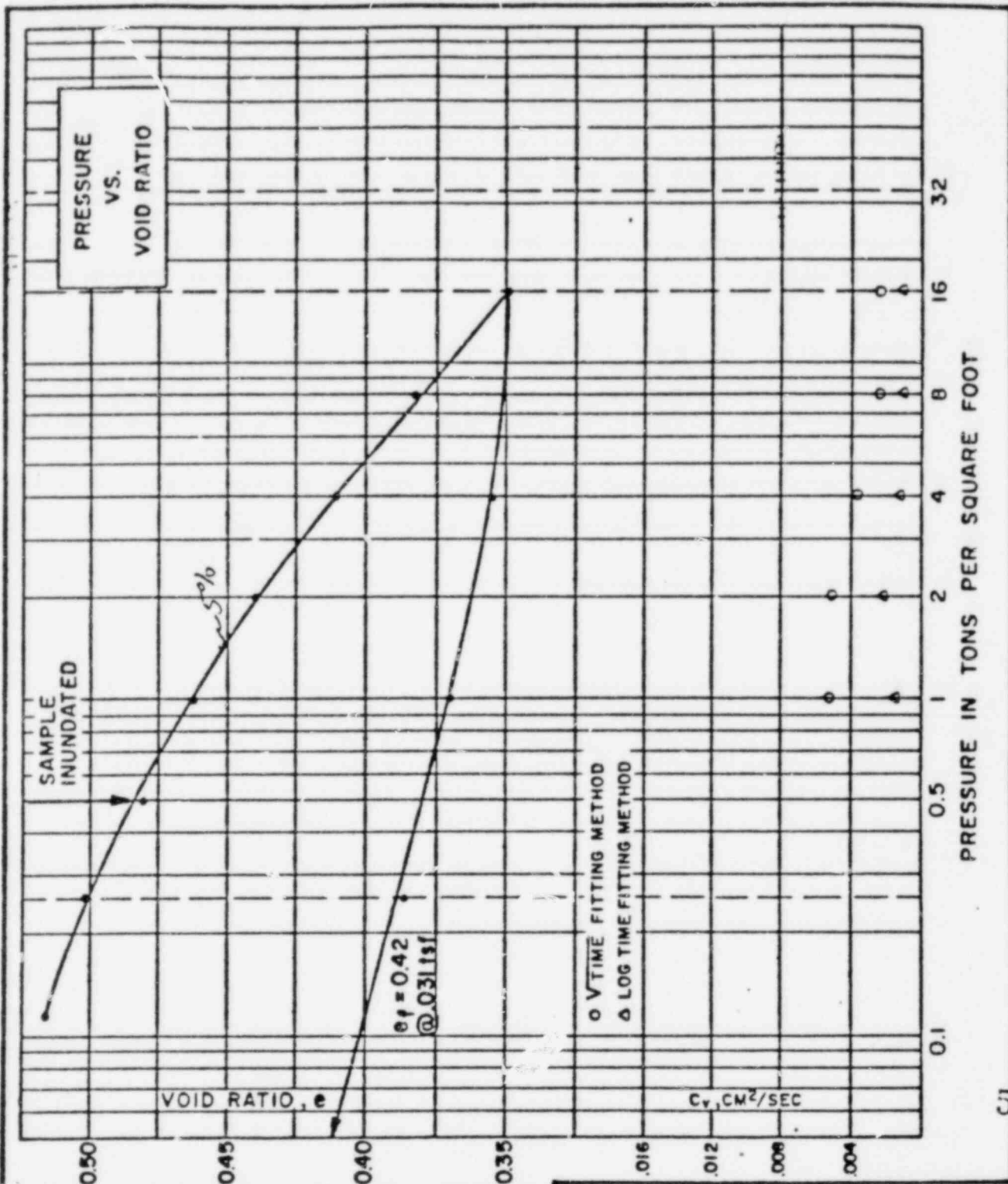
### CONSOLIDATION TEST

7220-C79.17-1

BORING NO. DG 19 TEST SERIES  
 SAMPLE 9 NO. 194  
 DEPTH 13.5'-14.0' DATE OCT. 1978  
 TECH. B. J. J. J.  
 REVIEWER J. J. J. FILE 2190

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FIGURE



SOIL DESCRIPTION: BROWN SANDY CLAY (CL)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN LIMIT 22% LIMIT 13% GRAVITY 2.71

	WATER CONTENT, %	TOTAL UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	17.7	130.3	0.53	91	0.750
FINAL	16.2	138.5	0.42	100+	0.696

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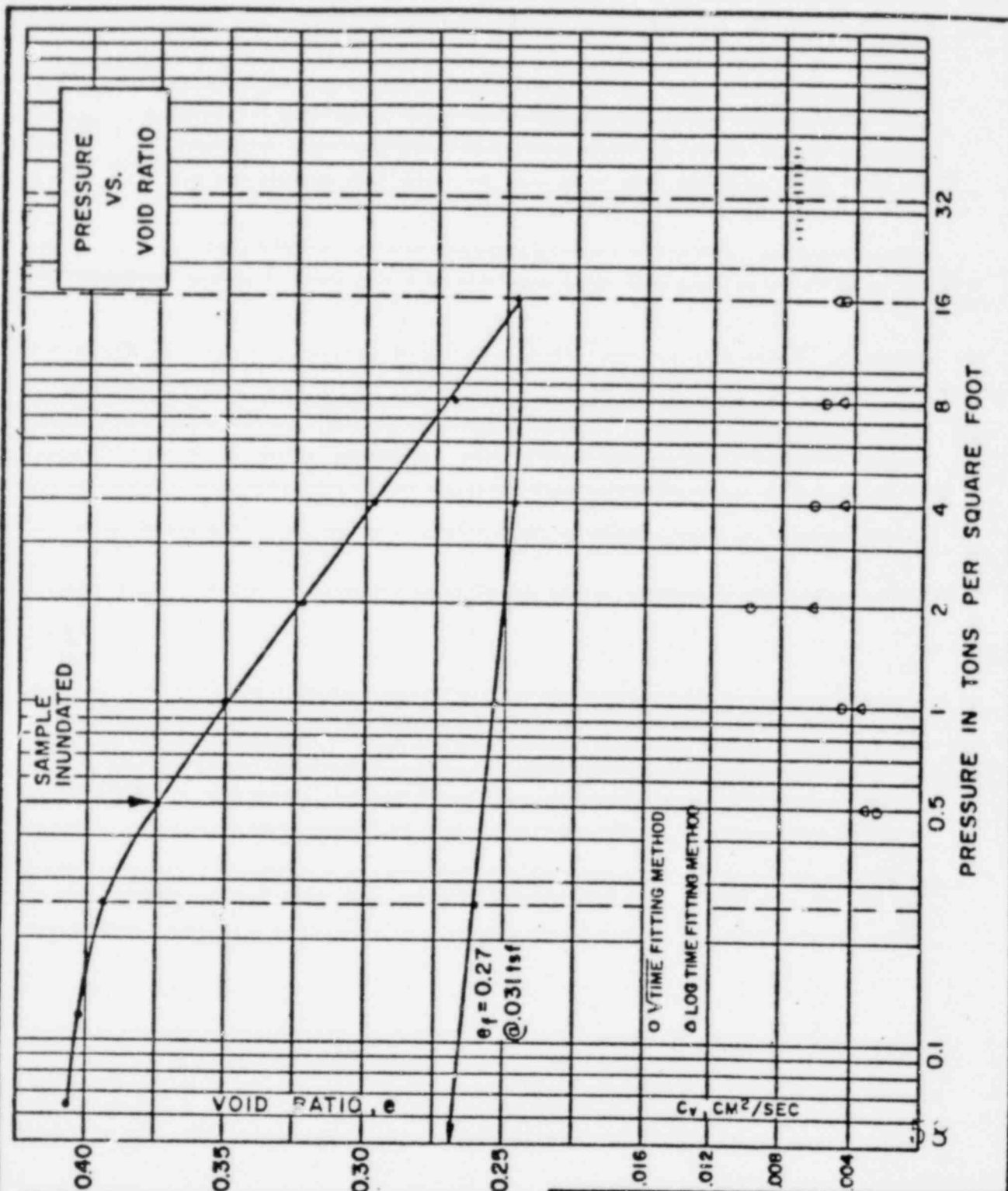
### CONSOLIDATION TEST

7220-C79-17.1

BORING NO. DG 21 TEST SERIES  
 SAMPLE 5 NO. 202  
 DEPTH 10.8' - 11.1' DATE OCT 1978  
 TECH. D. A. Smith  
 REVIEWER G. J. G. G. FILE 2190

FIGURE





SOIL DESCRIPTION: BROWN SANDY CLAY (CL)  
 SAMPLE LIQUID PLASTIC SPECIFIC  
 DIAM 2.50 IN LIMIT 20% LIMIT 12% GRAVITY 2.71

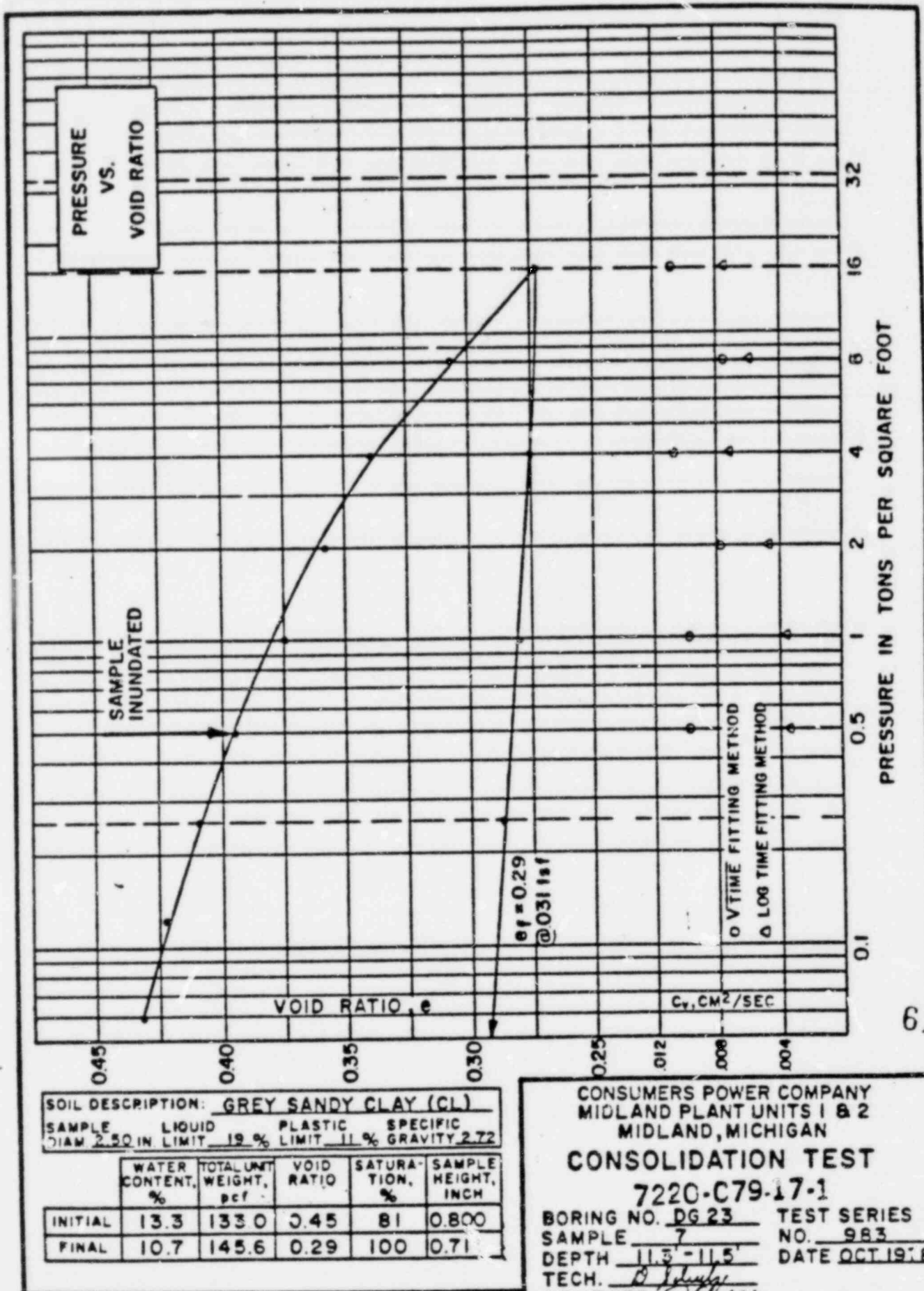
	WATER CONTENT, %	TOTAL UNIT WEIGHT, pcf	VOID RATIO	SATURA- TION, %	SAMPLE HEIGHT, INCH
INITIAL	13.1	135.5	0.41	86	0.800
FINAL	10.7	147.3	0.27	100+	0.720

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**CONSOLIDATION TEST**  
**7220-C79-17-1**

BORING NO. DG 21 TEST SERIES  
 SAMPLE 5 NO. 203  
 DEPTH 12.7-13.2' DATE OCT. 1978  
 TECH. W. J. Smith  
 REVIEWER J. J. Smith FILE 2190

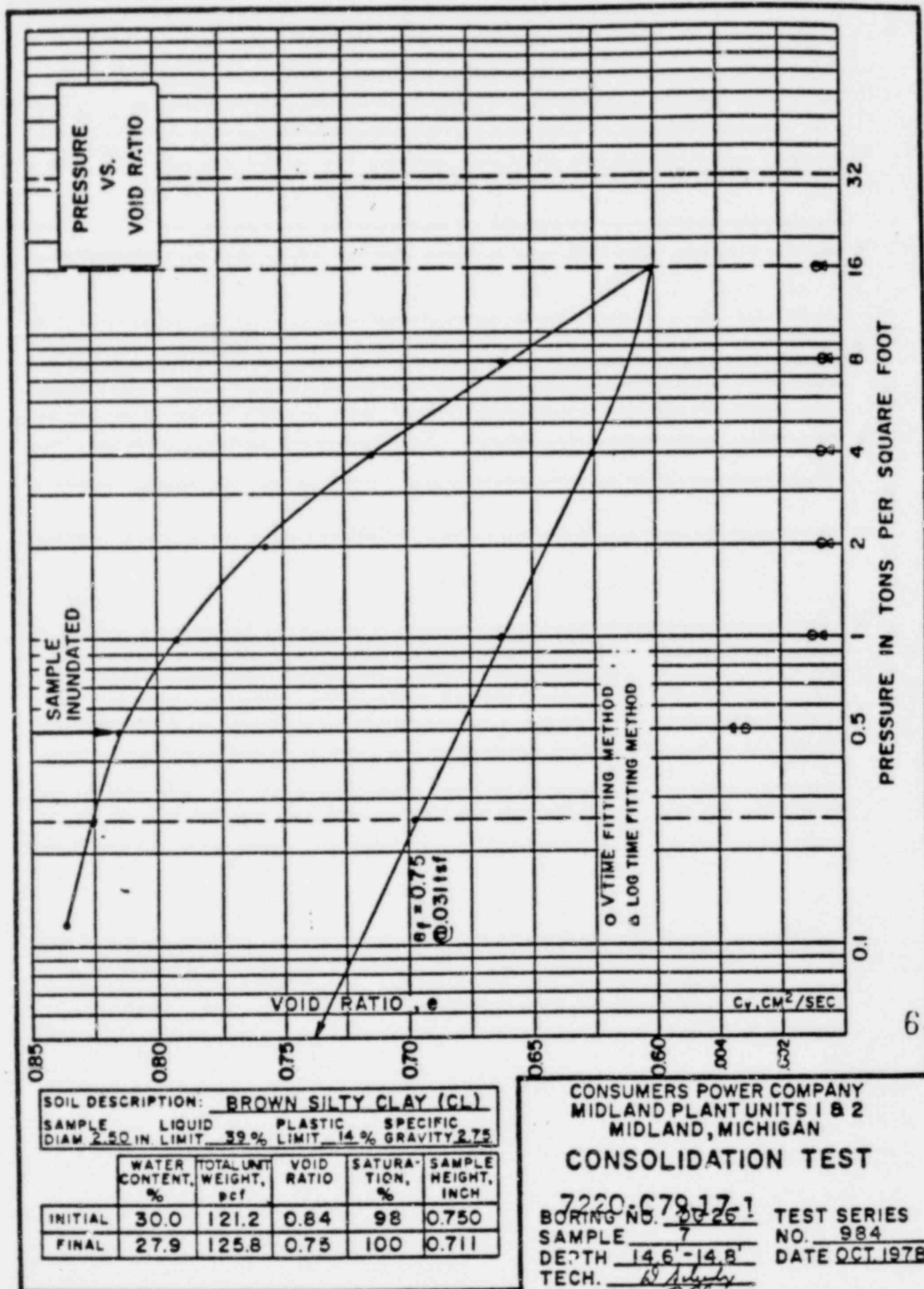
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FIGURE



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FIGURE



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FIGURE