LIGO-C970547-A-D

FINAL REPORT

SUBSIDENCE STUDY FOR LIGO DIKES AT LIVINGSTON, LOUISIANA

Prepared for: California Institute of Technology, LIGO Project

April, 1997
WC File No. 94B 315

Woodward-Clyde

2822 O'Neal Lane
Baton rouge, Louisiana 70816
504-751-1873

Woodward-Clyde
Engineering & sciences applied to the earth & its environment

April 11, 1997

Mr. Fred Asiri
LIGO Project
California Institute of Technology
102-33 Bridge Laboratory
Pasadena, California 91125

Re: Geotechnical Investigation of Dikes
WCC File No. 94B315

Dear Mr. Asiri:

Attached please find Table IA which incorporates the information given to us during the teleconference on 04/03/'97 by the design engineers. At that meeting we were informed that the slab was designed as a "structural slab" and it is expected to distribute the loads uniformly at the rate of 400 p.s.f. instead of the 1,000 p.s.f. shown in our report dated April 1, 1997.

As you can see the attached Table IA shows that the total imposed load will be less than, or about equal to, the preconsolidation pressures of some of the specimens. At locations represented by those specimens settlements due to dead loads are estimated to be negligible. At two other locations expected settlements due to dead loads are estimated to be on the order of 0.7 to 0.8 inches.

If you have any questions concerning the above please call us.

Sincerely

Ara Arman, P.E.
Vice President

Attachment

94B315\GID.LTR LIGO

Woodward-Clyde Consultants — A Subsidiary of Woodward-Clyde Group, Inc.
2822 O'Neal Lane • Baton Rouge, Louisiana 70816
(504) 751-1873 • Fax (504) 753-3616

TABLE 1A

LIGO LIVINGSTON SITE
CONSOLIDATION STUDY

Station No.	Dike Load (lb/ft^2)	Slab Load (lb/ft^2)	Total Load (lb/ft^2)	% Strain (lb/ft^2)	Dike Subsidance (inches)	Preconsolidation Pressure (lb/ft^2)
S/E 8+00	576	400	976	N*	N*	1,300
S/E 33+00	504	400	904	N	N	1,300
S/E 58+00	696	400	1096	N	N	1,500
S/E 83+00	948	400	1348	N	N	1,400
S/E 108+00	1,140	400	1540	0.7	0.8	1,000
S/E 128+00	1,020	400	1420	0.7	0.7	700
S/W 33+00*	480**	400	880	N	N	1,200

NOTES:

* N= Negligible

** Assume column of soil at S/W Sta. 33+00 subjected to consolidation = 48 inches
Assume soil unit wet weight = 120 lb/ft^2

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April 4, 1997

Mr. Fred Asiri
LIGO Project
California Institute of Technology
102-33 Bridge Laboratory
Pasadena, California 91125

Re: Geotechnical Investigation of Dikes
WCC File No. 94B315

Dear Mr. Asiri:

We have completed the sampling and consolidation testing of dikes and corner station fill materials as directed by you. The scope of this activity was to perform undisturbed sampling at six predetermined locations on each dike of the LIGO facility at Livingston, Louisiana and perform tests to estimate the potential for consolidation of soils forming the dikes. Additionally we were requested to sample and perform consolidation tests for two predetermined locations at the corner station.

Please find below a brief description of the work completed and a discussion of the results.

Sampling and Sample Selection:

On March 24, 1997, we began the undisturbed sampling operations with a drill rig mounted on an all terrain vehicle (ATV). The site conditions and the weather prediction of an 80% rain (it did not materialize) for the evening of March 24 compelled us to use the ATV to meet the schedule for our deliverables.

As per our earlier discussions, to avoid areas disturbed by prior sampling operations, the boreholes were located near, but not exactly at, stations tested by Delta Testing Laboratories on March 10, 1997.

Continuous samples were obtained through the full depth of the dikes with some extension into the natural ground. Field observations indicated that soil types at a given location varied considerably with depth. In place materials were observed to be non-homogeneous. Visual identification of the samples in the laboratory verified the latter observation.

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Field moisture content and density of selected samples were determined in the laboratory prior to other testing. Specimens for consolidation testing were selected based on their visual soil classification (i.e., clay vs. silt), density (i.e., low vs. high density), field moisture (i.e., high vs. low) and depth (i.e., near surface samples were avoided).

Samples obtained from the South-East (S/E) dike appeared to have larger variations in density and soil types thus testing was concentrated mainly on specimens selected from samples taken from there. One sample obtained from below the subgrade of the S/W Station 33+00, where the dike is shallow, appeared to have high clay and moisture contents, it was also selected for testing.

Consolidation tests as per ASTM D 2435 were performed starting with a load increment of 1/2 ton/sq.ft. and continuing until primary and long-term consolidation under 4 tons/sq.ft. was completed.

The moisture content, density and percent saturation of each specimen were measured and computed both prior to and upon completion of consolidation tests.

Discussion of Test Results:

Visual observation of all samples showed that soil types and the associated moisture contents, within the profile of the dike at tested locations, varied considerably (see attached logs of borings).

The degree of saturation of undisturbed samples prior to testing varied from 92% to 98%. The moisture contents of specimens were 4% to 9% above the optimums and densities were 6% to, 12% below maximums as determined by Delta Testing Laboratories. Specimens upon submergence in the consolidometer, under initial load increments, appeared to be taking water. As specimens were subjected to additional load increments they approached 100% saturation as a result of consolidation. It should be noted here that to obtain the full spectrum of loading conditions each specimen was subjected to loads (4tons/sq.ft.) far exceeding the expected dead loads that the dikes will be expected to support.

For the purpose of estimating the consolidation of the dikes we assumed (exclusive of subgrade settlement) an average unit wet weight of 120 lb/cu.ft. for the compacted soils. A maximum total load of 1,000.00 lb/sq.ft. was assigned to the slab, tunnel, tunnel cover and associated hardware (Table 1).

Consolidation test results showed that five out of seven samples obtained from the dikes showed preconsolidation pressures averaging slightly above 1,300 lb/sq.ft. In other words five out of the seven locations had received the similar compactive effort resulting in relatively uniform preconsolidation. Two of the samples (S/E Sta. 128+00 and S/W Sta. 33+00) exhibited lower preconsolidation pressures. They might not have been subjected to the same compactive effort.

The preconsolidation pressures of six out of the seven specimens were computed to be equivalent to loads exceeding the estimated dead loads exerted by the dikes. The specimen from S/E Station 128+00 was underconsolidated and may under the load of the dike continue subsiding. However the amount of this consolidation is expected to be in the order of a fraction of an inch.

Estimated consolidation under expected dead loads for the tested locations vary from a maximum of 1.30 in. for S/E Station 128+00, to a negligible 0.1 in. (due to it's low height) for S/W Station 33+00. We should note that the specimen tested for the latter station was not part of the dike specimen it was from a sample obtained from 0.4 ft. to 1.4 ft. below the theoretical bottom of the dike. We tested this specimen because it appeared to be wet and relatively soft. For the purpose of determining settlement for this particular station we assumed a theoretical height of 4 ft. for the dike.

Test results also indicate that because of variations in soil types, moisture contents and apparent relative densities some subsidence due to periodic desiccation may take place. It is estimated that for dike sections having eight to ten feet height and an abundance of clayey soils (worst case) such incremental subsidence will not exceed 3/4 inch.

In summary the test results indicate that consolidation of the tested areas of the S/E dike due to estimated dead loads will not exceed 1.30 in. with an average of about 0.6 in. It is estimated that 90% of the consolidation due to the incremental loads will take place during the construction.

Soils within the dikes are not homogeneous, there are obvious variations in expected consolidation due to differing densities at different locations, varying heights of the dikes, and varying soil types. Thus differential settlements along the dikes should be expected. If the small number of samples tested are indicative of the general condition of the dikes, the maximum expected differential settlement due to dead loads should not exceed 1.3 inches. If subsidence

due to desiccation as estimated above also takes place total differential settlement may be as much as 2.0 inches (worst case scenario).

At the time of the preparation of this report we had not been advised of the type and weight of the paving train to be used by the contractor to lay the slabs over the dikes. It is imperative for the contractor to assure that the dike as is constructed can support the paving train with only negligible vertical displacement along each dike. Since there are differences in densities, soil types, etc. it will be advisable to proof roll the entire length of both dikes using a 50 ton rubber tire vehicle (i.e. roller) to identify softer spots and take corrective action prior to beginning of the paving operations. Only four of the wheels should be in contact with the ground and they should be capable of exerting a minimum of 150 psi (all tires) contact pressure. The proof rolling should be done under the supervision of a qualified engineer.

The above is a summary of our findings. If you have any questions please call us.

Sincerely,

Robert A. SeGall, P.E.

Ara Arman, P.E., P.L.S.

STATE OF LOUISIANA
ARA ARMAN
Reg. No. 5269
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

AA:wv

W:\LIGO\94B315-006\GID-315.LTR

TABLE 1

LIGO LIVINGSTON SITE
CONSOLIDATION STUDY

Station No.	Dike Load (lb/ft^2)	Slab Load (lb/ft^2)	Total Load (lb/ft^2)	% Strain (lb/ft^2)	Dike Subsidance (inches)	Preconsolidation Pressure (lb/ft^2)
S/E 8+00	576	1,000	1,576	0.6	0.35	1,300
S/E 33+00	504	1,000	1,504	0.5	0.25	1,300
S/E 58+00	696	1,000	1,696	0.4	0.28	1,500
S/E 83+00	948	1,000	1,948	0.3	0.28	1,400
S/E 108+00	1,140	1,000	2,140	1.0	1.14	1,000
S/E 128+00	1,020	1,000	2,020	1.3	1.33	700
S/W 33=00*	480*	1,000	1,480	0.25	0.12	1,200

NOTES:

* Assume column of soil at S/W Sta. 33+00 subjected to consolidation = 48 inches
Assume soil unit wet weight= 120 lb/ft^2

LOGS OF BORINGS

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-1 (SW 8+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.0		15	135			Very stiff, tan Sandy CLAY with silt or Clayey SAND with silt (CL)
5			3.5		16				Stiff, light gray Silty CLAY with sandy silt pockets (CL)
									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-2 (SW 33+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			3.5						Stiff, brown Sandy SILT with clay pockets (SC)
			1.0		18 24	128 126	77	56	
									Tan CLAY and Silty CLAY with sand (CH-CL)
			1.5		18	129			Tan Sandy SILT with clay (ML)
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-3 (SW 58+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.5+						Intermixed light gray and tan Sandy SILT and Silty CLAY (CL)
			2.25		24	126			
			1.5		19	130			Tan Sandy SILT with clay (ML-SC)
5					17	132			
									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-4 (SW 83+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			3.75						Hard, light gray and tan Silty CLAY with sand (CL)
			4.50		14	136			Very stiff, tan Clayey SAND (SC)
			3.75		14 15	133 129			---light gray and tan below 4'
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-5 (SW 108+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, tan Silty CLAY with ferrous streaks (CL)
			4.00+		19	133			---tan, light gray and yellow, with some fine sand to brownish gray with ferrous nodules at 2'
			3.50		19	127			---tan and light gray, with fine sand, becoming more clayey at 4'
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

APR 6 97 WCSGBR 4B315 B05

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-6 (SW 128+00)**
FILE: **94B315**
DATE: **3/24/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.50						Gray and tan Sandy SILT with clay pockets and streaks, roots (CL)
			4.00+		16	133			
			3.25		25	123			
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-12 (SE 8+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, light gray and tan Silty CLAY with ferrous streaks (CL)
			2.50		17	136			---light gray and gray, with clay and silt pockets at 2'
			2.00		16	130	30	17	---greenish gray, light gray and tan, with sandy silt pockets at 4'
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-11 (SE 33+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, light gray and tan Silty CLAY (CL)
			4.00+		13	133			---yellow, tan and light gray, with sand pockets at 2'
			4.00+		17	132	27	12	---with roots at 6'
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-10 (SE 58+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, tan, yellow and light gray Silty CLAY (CL)
			4.00+		14	134			
			4.25		14	131	34	20	
5									Bottom of boring at 6'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

APR 6 97 WCSGBR 4B315 B10

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-9 (SE 83+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+		15	136			Tan, yellow and light gray Silty CLAY with sand pockets (CL)
			4.00+		16	130	50	34	Gray, tan and brown CLAY with silt (CL-CH)
5			4.00+		16	131			Tan, yellow, brown and light gray Silty CLAY to CLAY (CH-CL)
			4.00+		14				---with gravel at 8'
									Bottom of boring at 8'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-8 (SE 108+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00						Very stiff, light gray and tan Silty CLAY with ferrous nodules and streaks (CL)
			3.25		15	128			---with silt pockets and voids at 2'
			4.00+		12	137			---with clayey silt pockets, 4'-8'
5			3.00		17 19	117 133	44	30	
			4.25		18	129			
10									Bottom of boring at 10'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-7 (SE 128+00)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, light gray and tan Silty CLAY with ferrous nodules (CL)
			2.50		13	138			---tan, with sand and roots at 2'
					12	137			---with clay pockets at 4'
5			3.75		14 18	134 132	34	18	---with sand pockets at 6'
									Bottom of boring at 8'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-13 (SE 1+50.92)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+		15	133			Greenish gray, tan and light gray Silty CLAY (CL) with sand pockets
			4.00+		17	133			---becoming more sandy at 2'
			4.00+		19	130	40	19	
5			3.50		25	127			---reddish brown, tan, yellow and light gray, with clay and sand pockets at 6'
									Bottom of boring at 8'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

Woodward-Clyde Consultants

LOG OF BORING

PROJECT: **LIGO**
LOCATION: **Livingston, Louisiana**
CLIENT: **California Institute of Technology**

BORING: **B-14 (SW 1+50.92)**
FILE: **94B315**
DATE: **3/25/97**
TECHNICIAN: **M. Savoy**
APPROVED:
PAGE: **1 of 1**

Dry Augered: **Full Depth**

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.	Compress. Stress (tsf)	Moist. Content (%)	Wet Unit Weight (pcf)	L.L. (%)	P.I. (%)	Description of Stratum
0			4.00+						Hard, light gray and tan Silty CLAY with ferrous nodules (CL)
			1.50		15	133			---tan, yellow and light gray, with sand at 2'
			4.00+		16	132			---with wood fragments at 4'
5			3.25		23	124	45	24	---greenish gray, tan and yellow, with sand at 6'
									Bottom of boring at 8'. Borehole grouted full depth.

Unified Soil Classifications based on limited laboratory test data and visual observations.

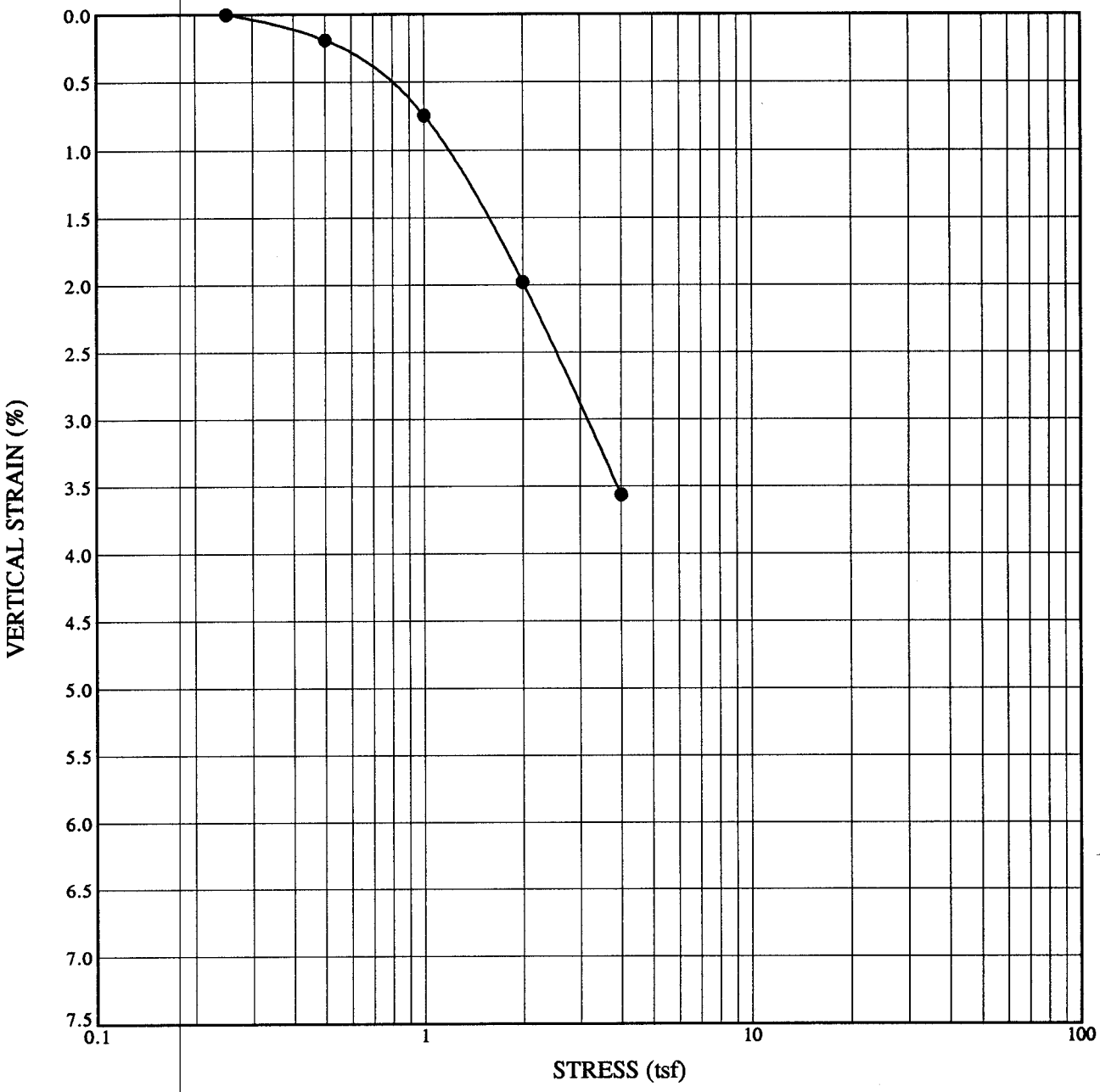
STRESS-STRAIN CURVES

FROM

CONSOLIDATION TESTS

FOR THE

SOUTH EAST DIKE



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-12 (SE 8+00)**
DEPTH: **4' - 6'**
DESCRIPTION: **(CL) Silty Clay with sandy silt pockets**
SPECIFIC GRAVITY: **2.66 (assumed)**

INITIAL MOISTURE CONTENT (%):	**16.2**	FINAL MOISTURE CONTENT (%):	**15.5**
INITIAL DRY UNIT WEIGHT (pcf):	**113**	FINAL DRY UNIT WEIGHT (pcf):	**117**
INITIAL % SATURATION:	**92.3**	FINAL % SATURATION:	**99.1**

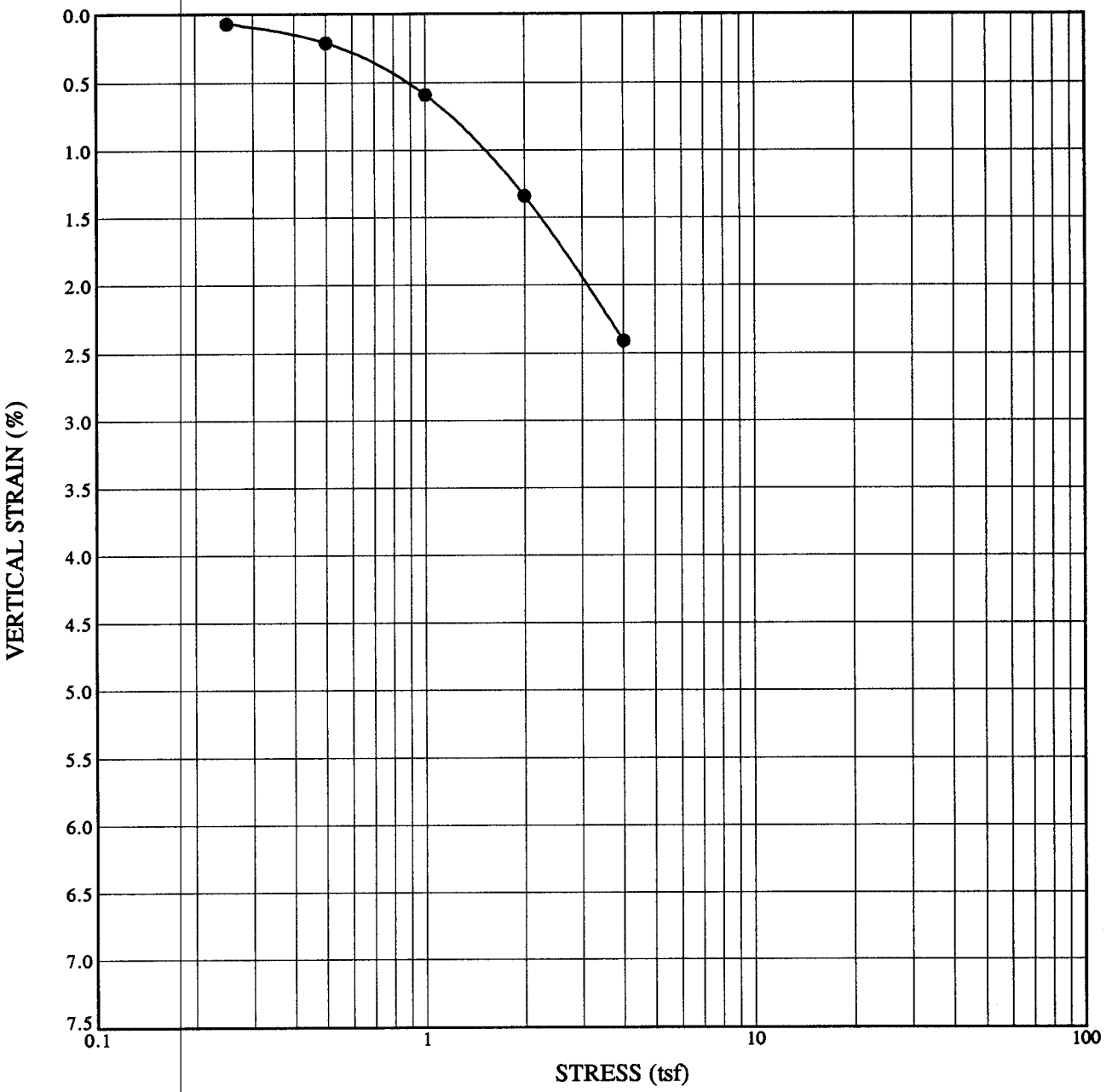
LL = **30** PL = **13** PI = **17**
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE:	94B315		
BORING:	B-11 (SE 33+00)		
DEPTH:	4' - 6'		
DESCRIPTION:	(CL) Silty Clay with sand pockets and roots		
SPECIFIC GRAVITY:	2.65 (assumed)		
INITIAL MOISTURE CONTENT (%):	16.1	FINAL MOISTURE CONTENT (%):	16.2
INITIAL DRY UNIT WEIGHT (pcf):	113	FINAL DRY UNIT WEIGHT (pcf):	115
INITIAL % SATURATION:	92.6	FINAL % SATURATION:	97.9

LL = 27 PL = 15 PI = 12

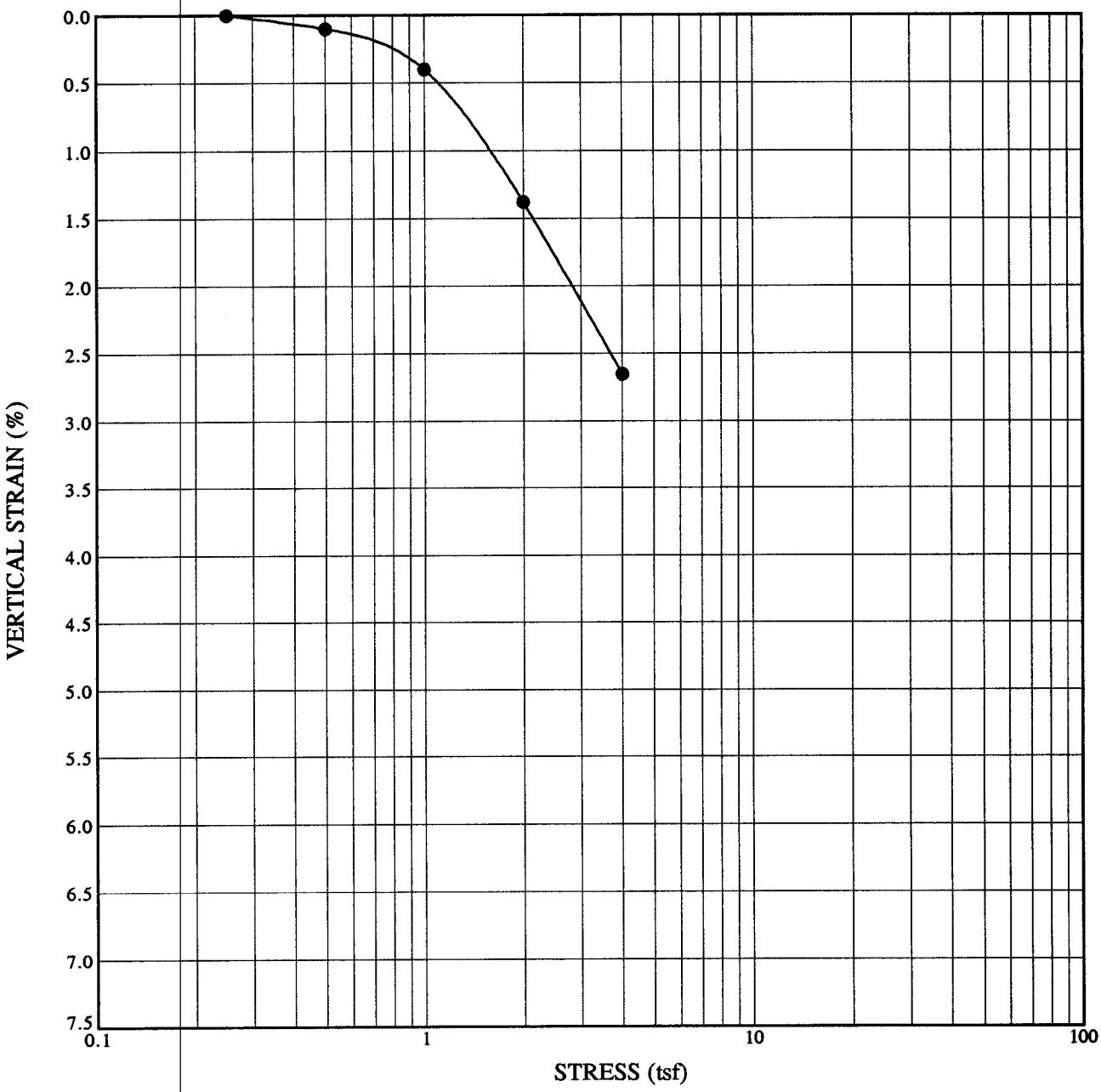
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE:	**94B315**
BORING:	**B-10 (SE 58+00)**
DEPTH:	**4' - 6'**
DESCRIPTION:	**(CL) Silty Clay**
SPECIFIC GRAVITY:	**2.68 (assumed)**
INITIAL MOISTURE CONTENT (%):	**14.3**
INITIAL DRY UNIT WEIGHT (pcf):	**119**
INITIAL % SATURATION:	**93.5**
LL = **34** PL = **14** PI = **20**	
INUNDATION AT START	

FINAL MOISTURE CONTENT (%):	**14.6**
FINAL DRY UNIT WEIGHT (pcf):	**120**
FINAL % SATURATION:	**100.1**

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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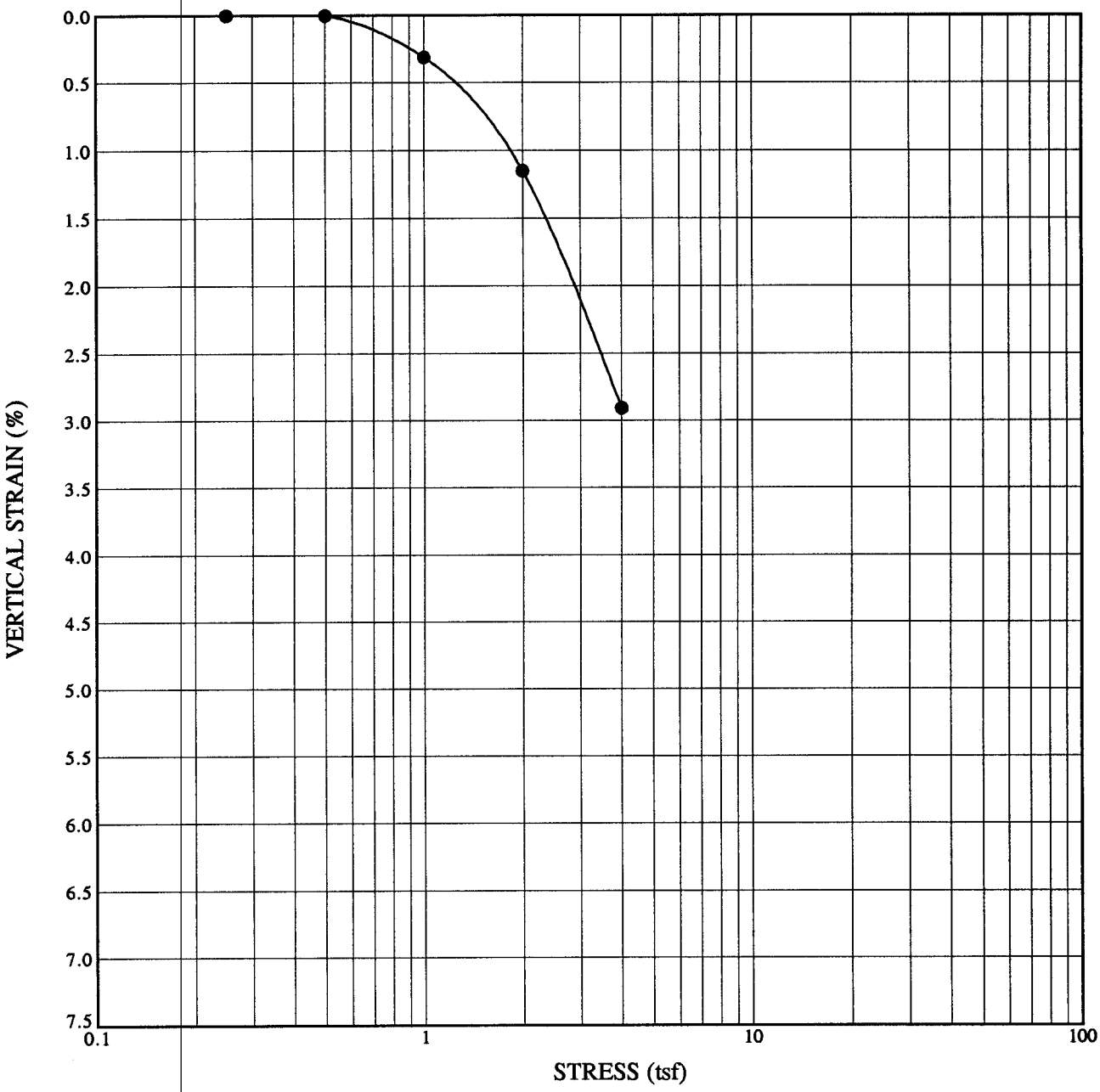
APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE:	**94B315**
BORING:	**B-9 (SE 83+00)**
DEPTH:	**2' - 4'**
DESCRIPTION:	**(CL-CH) Clay with silt**
SPECIFIC GRAVITY:	**2.73 (assumed)**
INITIAL MOISTURE CONTENT (%):	**19.8**
INITIAL DRY UNIT WEIGHT (pcf):	**108**
INITIAL % SATURATION:	**92.7**
FINAL MOISTURE CONTENT (%):	**20.0**
FINAL DRY UNIT WEIGHT (pcf):	**110**
FINAL % SATURATION:	**99.6**

LL = **50** PL = **16** PI = **34**

INUNDATION AT START

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CONSOLIDATION TEST
ASTM D 2435-80

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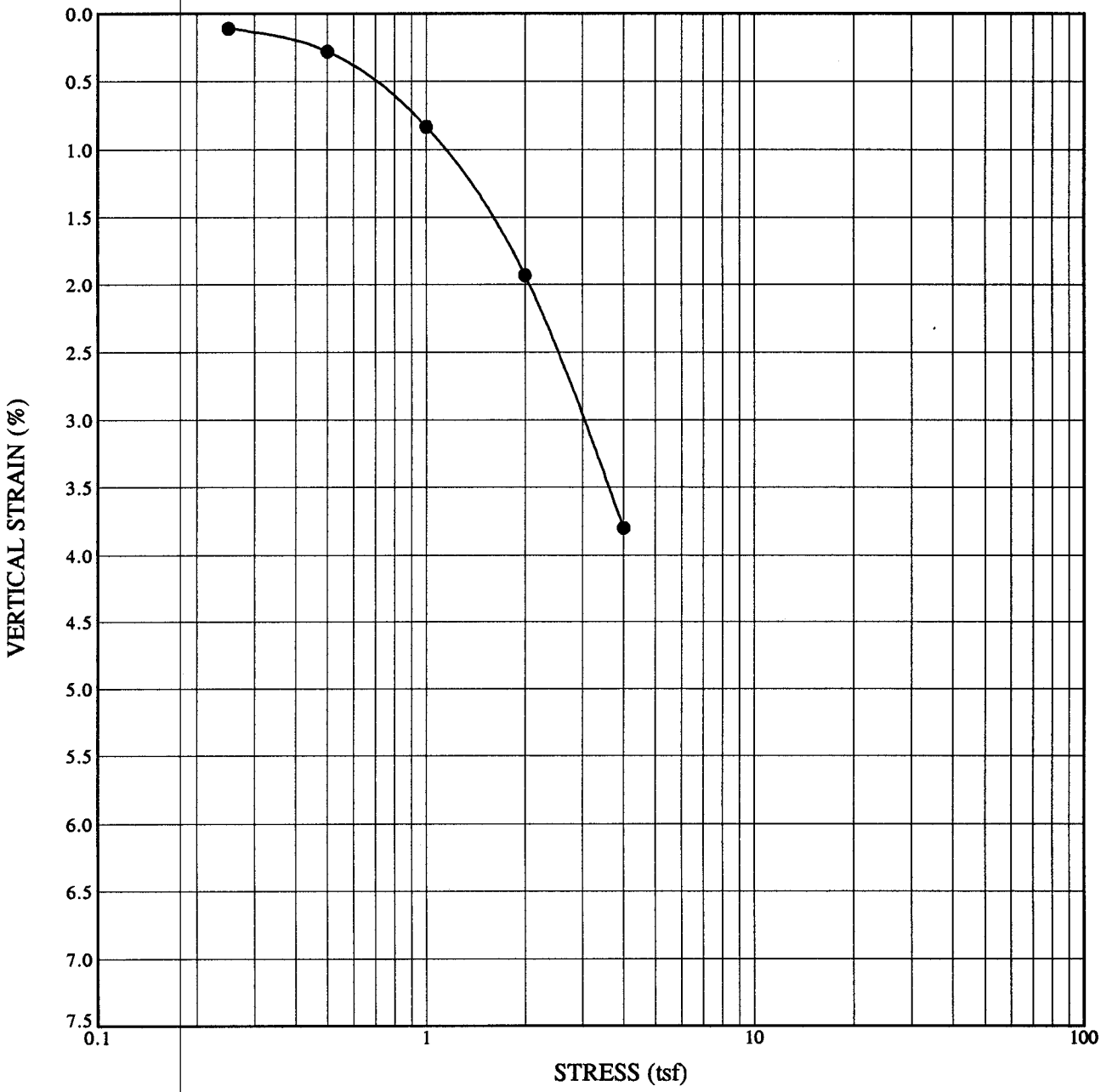
APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE:	**94B315**		
BORING:	**B-8 (SE 108+00)**		
DEPTH:	**6' - 8'**		
DESCRIPTION:	**(CL) Silty Clay with clayey silt pockets**		
SPECIFIC GRAVITY:	**2.73 (assumed)**		
INITIAL MOISTURE CONTENT (%):	**20.0**	FINAL MOISTURE CONTENT (%):	**18.2**
INITIAL DRY UNIT WEIGHT (pcf):	**108**	FINAL DRY UNIT WEIGHT (pcf):	**112**
INITIAL % SATURATION:	**94.7**	FINAL % SATURATION:	**96.8**

LL = **44** PL = **14** PI = **30**

INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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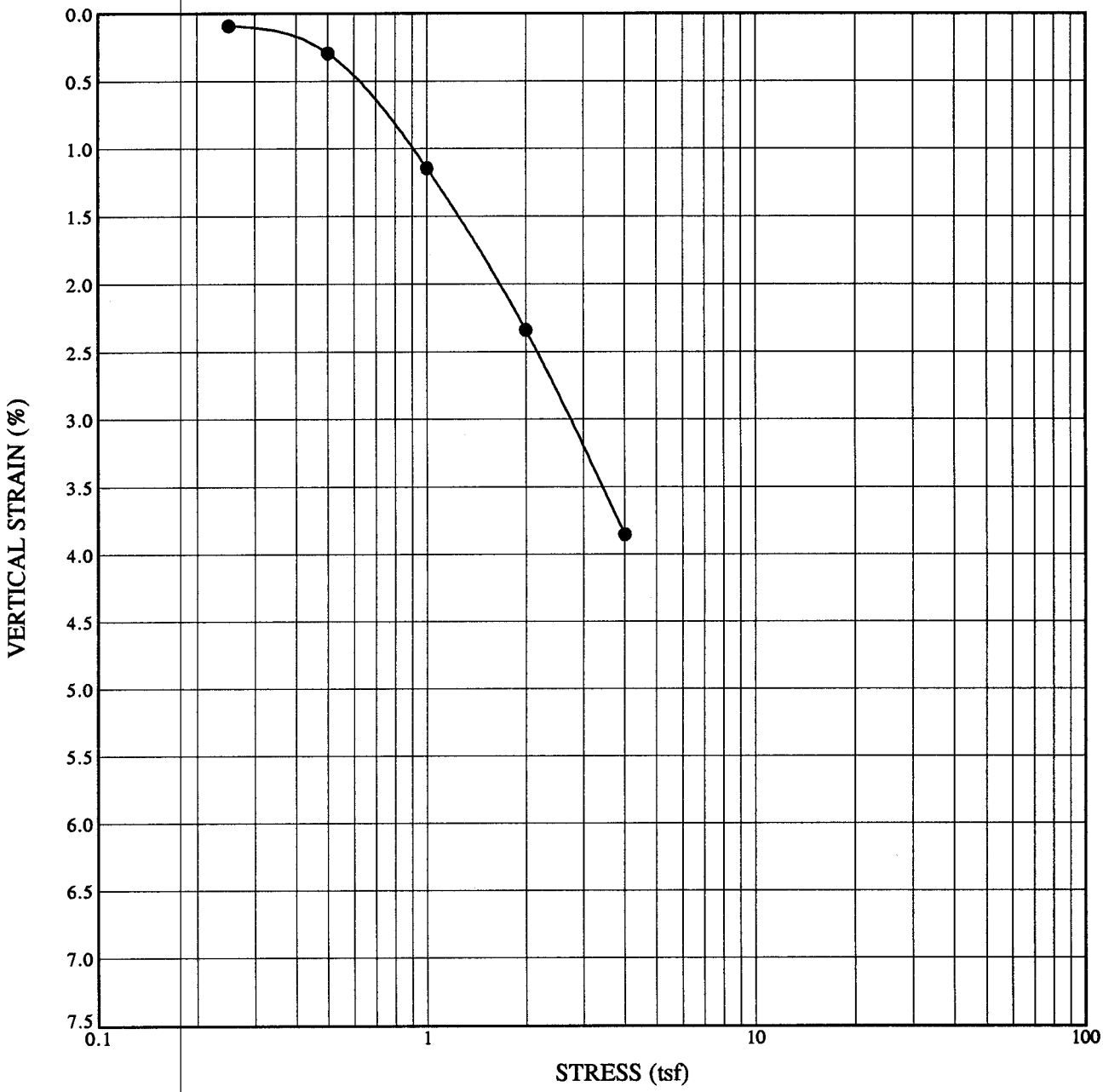
APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-7 (SE 128+00)**
DEPTH: **6' - 8'**
DESCRIPTION: **(CL) Silty Clay with sand pockets**
SPECIFIC GRAVITY: **2.68 (assumed)**

INITIAL MOISTURE CONTENT (%):	**16.3**	FINAL MOISTURE CONTENT (%):	**15.6**
INITIAL DRY UNIT WEIGHT (pcf):	**114**	FINAL DRY UNIT WEIGHT (pcf):	**118**
INITIAL % SATURATION:	**94.6**	FINAL % SATURATION:	**101.4**

LL = **34** PL = **16** PI = **18**
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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APR 1 97 CONSLD1 4B315

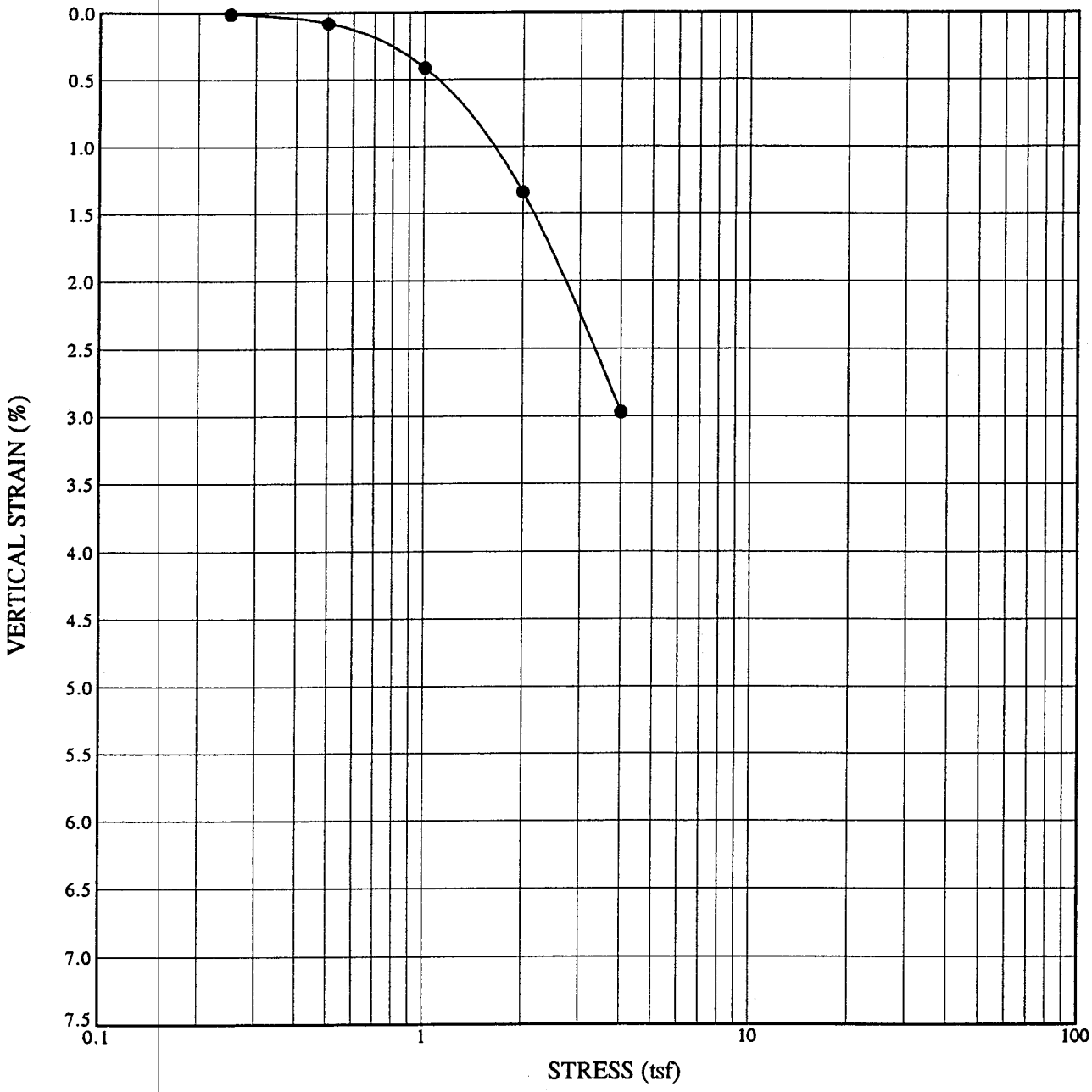
STRESS-STRAIN CURVE

FROM

CONSOLIDATION TEST

FOR THE

SOUTH WEST DIKE



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-2 (SW 33+00)**
DEPTH: **2' - 4'**
DESCRIPTION: **(CH) Clay with silt streaks and pockets, trace of fine sand**
SPECIFIC GRAVITY: **2.78 (assumed)**

INITIAL MOISTURE CONTENT (%):	**28.3**	FINAL MOISTURE CONTENT (%):	**26.3**
INITIAL DRY UNIT WEIGHT (pcf):	**96**	FINAL DRY UNIT WEIGHT (pcf):	**99**
INITIAL % SATURATION:	**97.98**	FINAL % SATURATION:	**97.8**

LL = PL = PI =
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 2 97 CONSLD1 4B315

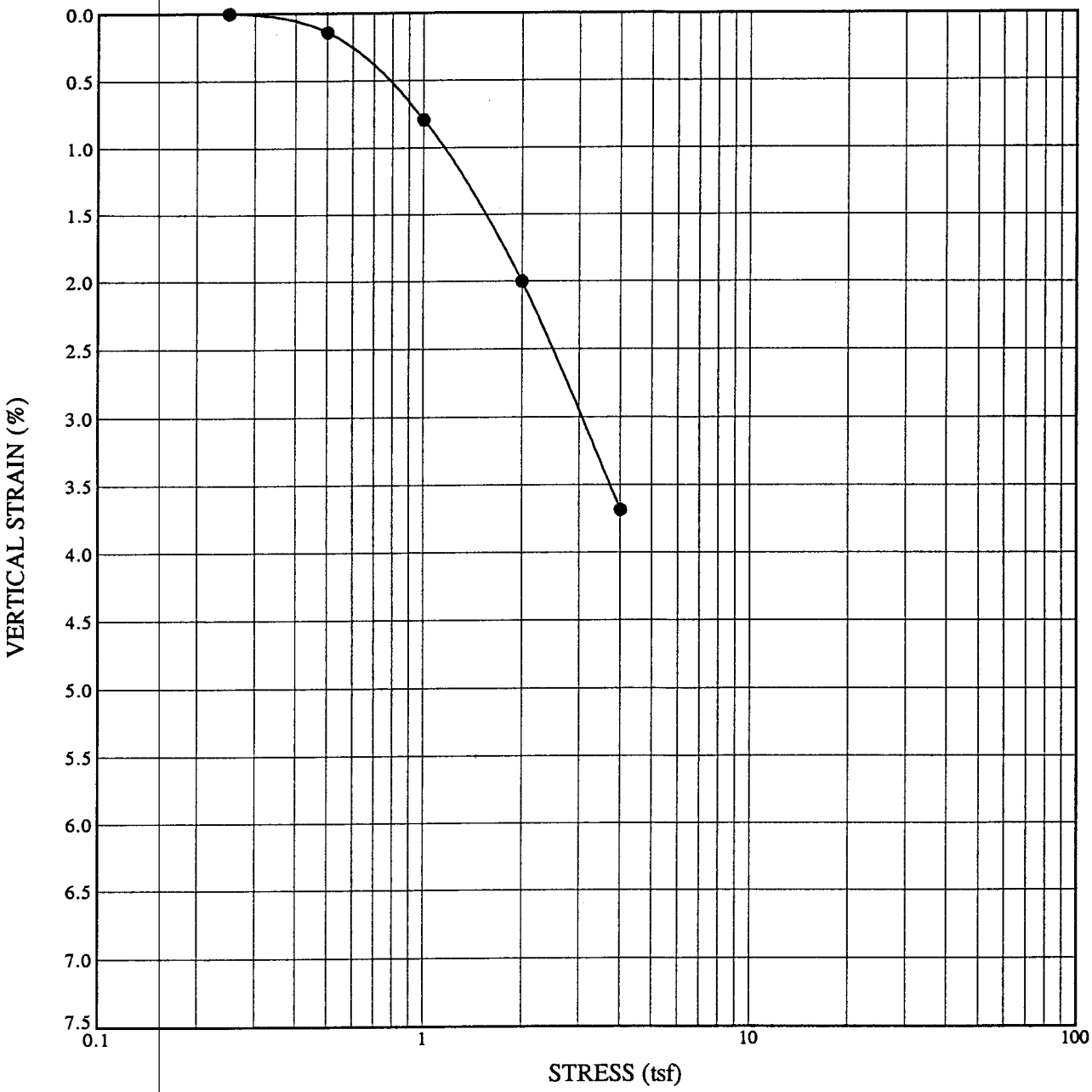
STRESS-STRAIN CURVES

FROM

CONSOLIDATION TESTS

FOR THE

CORNER STATION



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-14 (SW 1+50.92)**
DEPTH: **6' - 8'**
DESCRIPTION: **(CL) Silty Clay with sand**
SPECIFIC GRAVITY: **2.72 (assumed)**
INITIAL MOISTURE CONTENT (%): **22.0**
INITIAL DRY UNIT WEIGHT (pcf): **102**
INITIAL % SATURATION: **91.0**
LL = **45** PL = **21** PI = **24**
INUNDATION AT START

FINAL MOISTURE CONTENT (%): **22.4**
FINAL DRY UNIT WEIGHT (pcf): **105**
FINAL % SATURATION: **98.6**

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CONSOLIDATION TEST
ASTM D 2435-80

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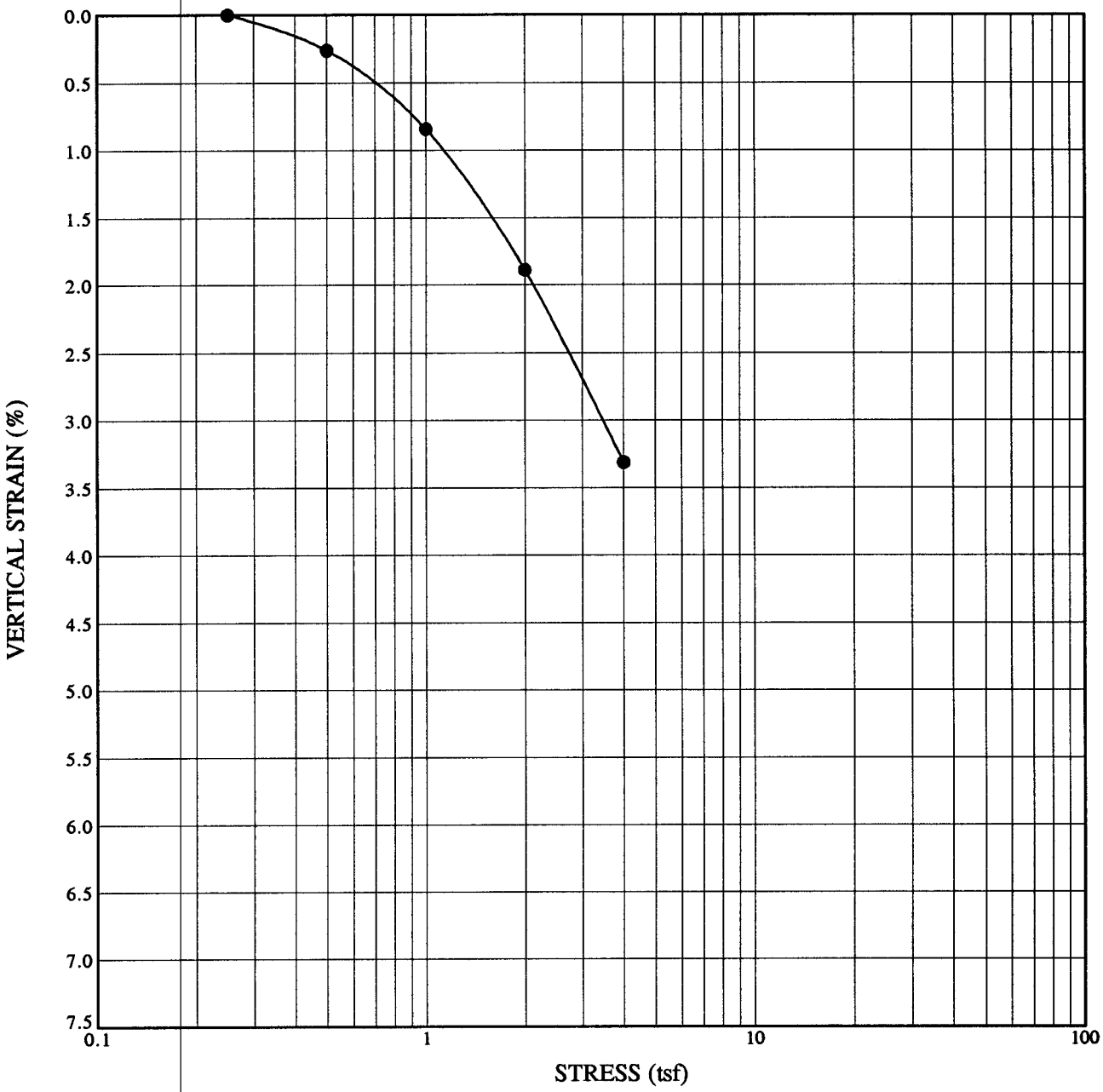
APR 1 97 CONSLD1 4B315



● STRAIN READINGS

Sample Data:

FILE:	**94B315**		
BORING:	**B-13 (SE 1+50.92)**		
DEPTH:	**4' - 6'**		
DESCRIPTION:	**(CL) Silty Clay with sand pockets to more sandy**		
SPECIFIC GRAVITY:	**2.73 (assumed)**		
INITIAL MOISTURE CONTENT (%):	**21.3**	FINAL MOISTURE CONTENT (%):	**21.2**
INITIAL DRY UNIT WEIGHT (pcf):	**104**	FINAL DRY UNIT WEIGHT (pcf):	**107**
INITIAL % SATURATION:	**90.7**	FINAL % SATURATION:	**98.3**

LL = **40** PL = **21** PI = **19**

INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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APR 1 97 CONSLD1 4B315

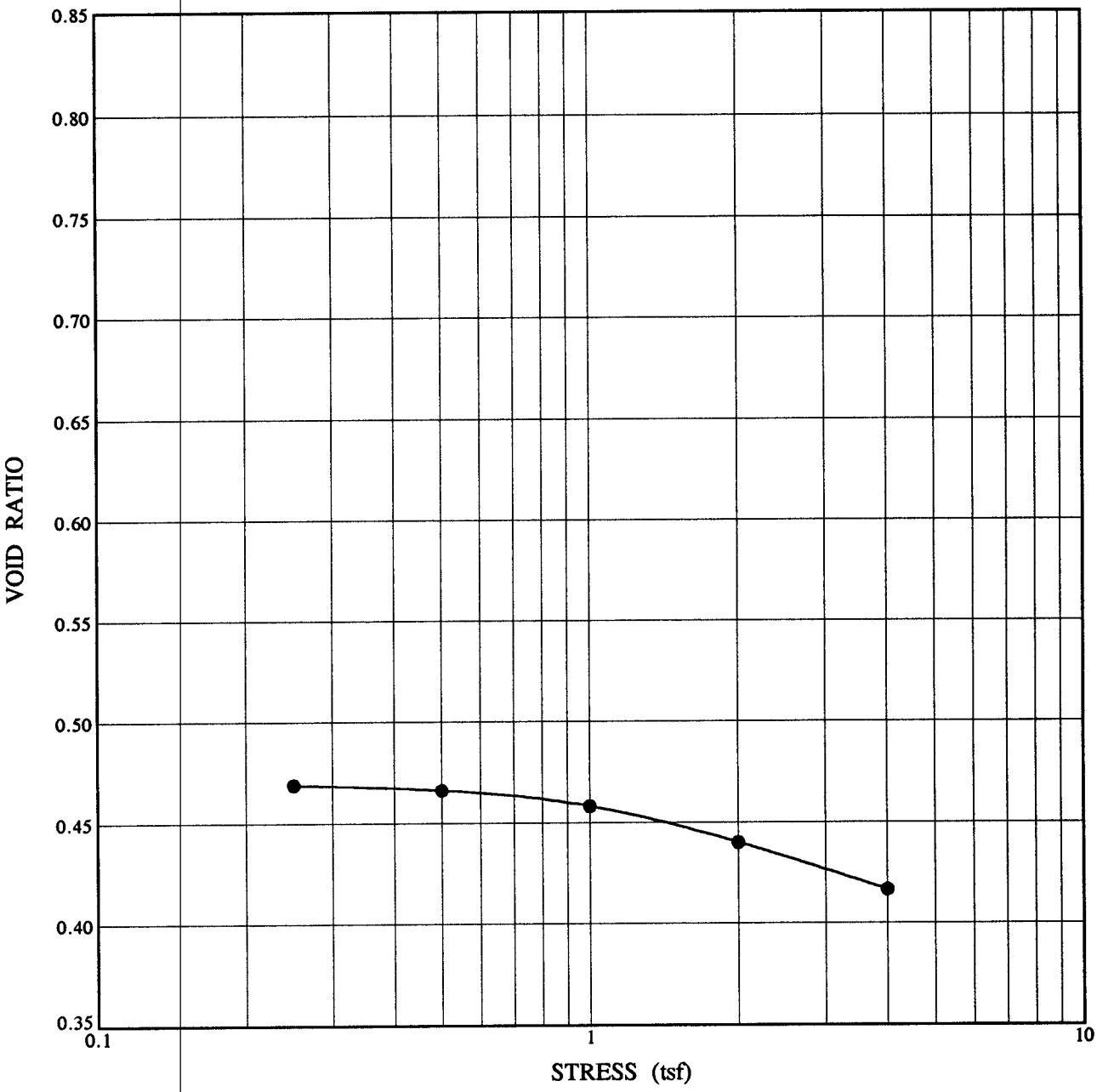
VOID RATIO-STRESS CURVES

FROM

CONSOLIDATION TESTS

FOR THE

SOUTH EAST DIKE



● STRAIN READINGS

Sample Data:

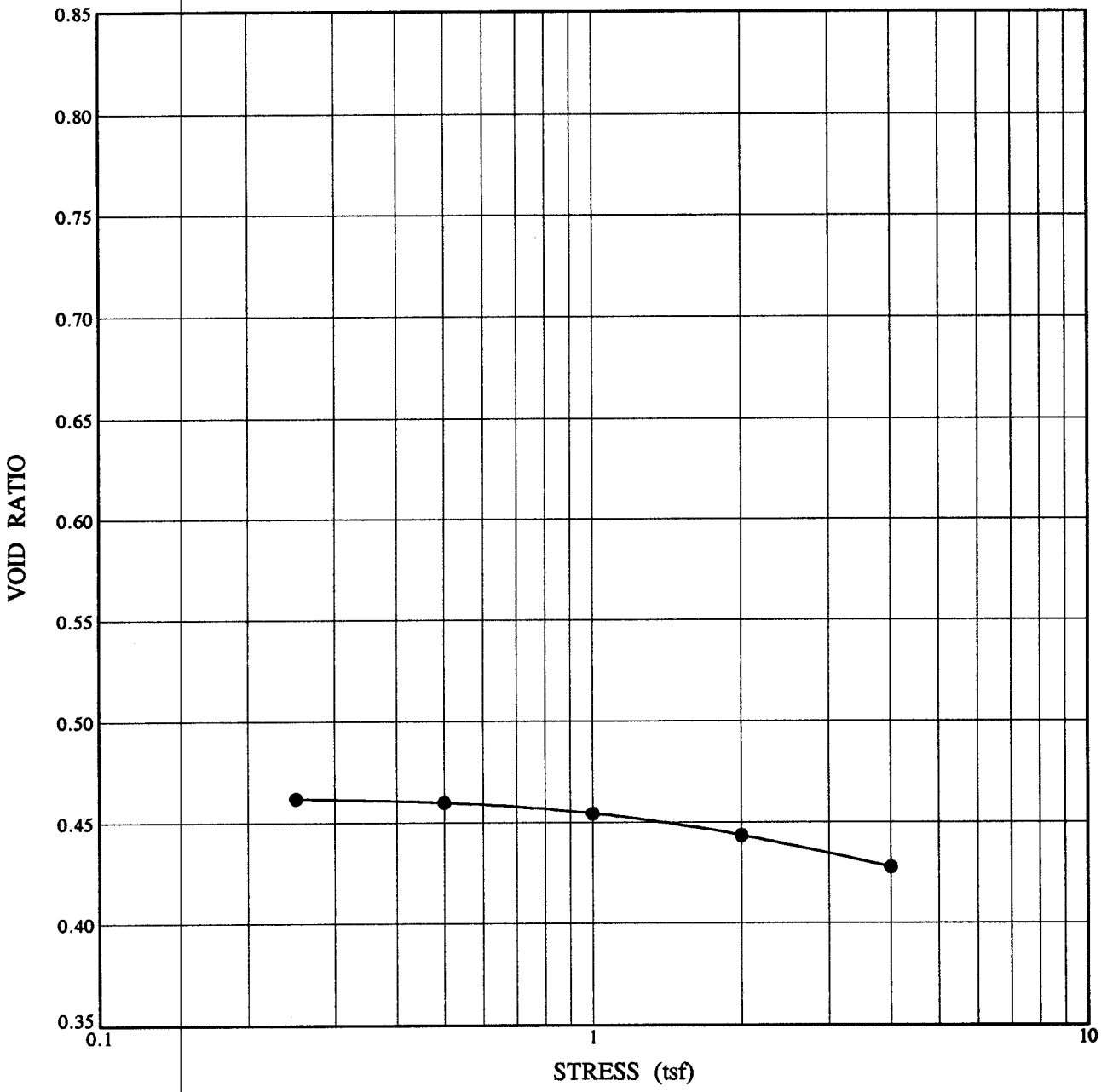
FILE: **94B315**
BORING: **B-12 (SE 8+00)**
DEPTH: **4' - 6'**
DESCRIPTION: **Silty Clay with sandy silt pockets**
SPECIFIC GRAVITY: **2.66**
INITIAL MOISTURE CONTENT (%): **16**
INITIAL DRY UNIT WEIGHT (pcf): **113**
FINAL MOISTURE CONTENT (%): **16**
FINAL DRY UNIT WEIGHT (pcf): **117**
LL = **30** PL = **13** PI = **17**
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 2 97 CONSLV1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-11 (SE 33+00)**
DEPTH: **4' - 6'**
DESCRIPTION: **Silty Clay with sand pockets and roots**
SPECIFIC GRAVITY: **2.65**
INITIAL MOISTURE CONTENT (%): **16**
INITIAL DRY UNIT WEIGHT (pcf): **113**
FINAL MOISTURE CONTENT (%): **16**
FINAL DRY UNIT WEIGHT (pcf): **115**
LL = **27** PL = **15** PI = **12**
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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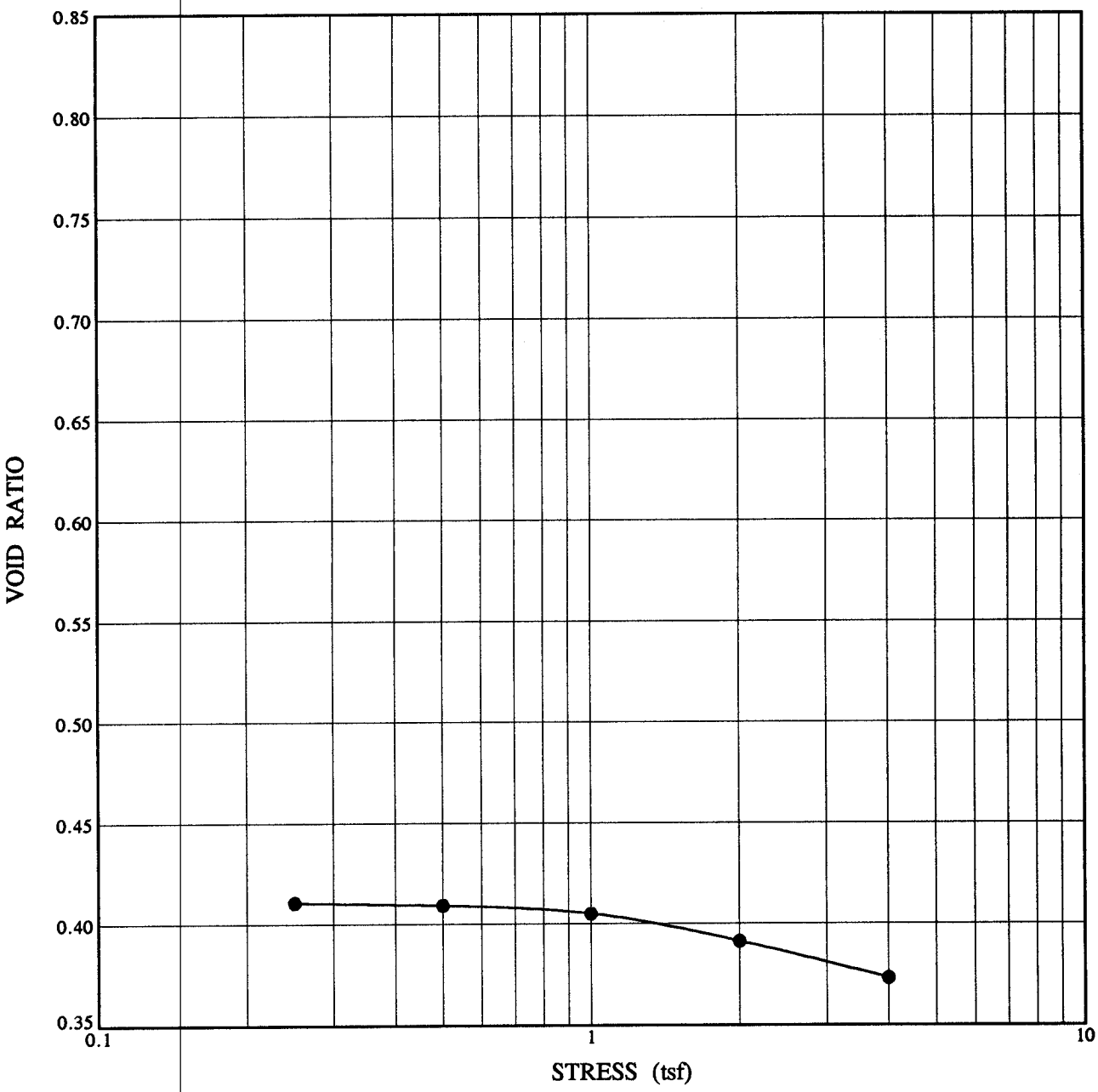
APR 2 97 CONSLV1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-10 (SE 58+00)**
DEPTH: **4' - 6'**
DESCRIPTION: **Silty Clay**
SPECIFIC GRAVITY: **2.68**
INITIAL MOISTURE CONTENT (%): **14**
INITIAL DRY UNIT WEIGHT (pcf): **119**
LL = **34** PL = **14** PI = **20**
INUNDATION AT START

FINAL MOISTURE CONTENT (%): **15**
FINAL DRY UNIT WEIGHT (pcf): **120**

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CONSOLIDATION TEST
ASTM D 2435-80

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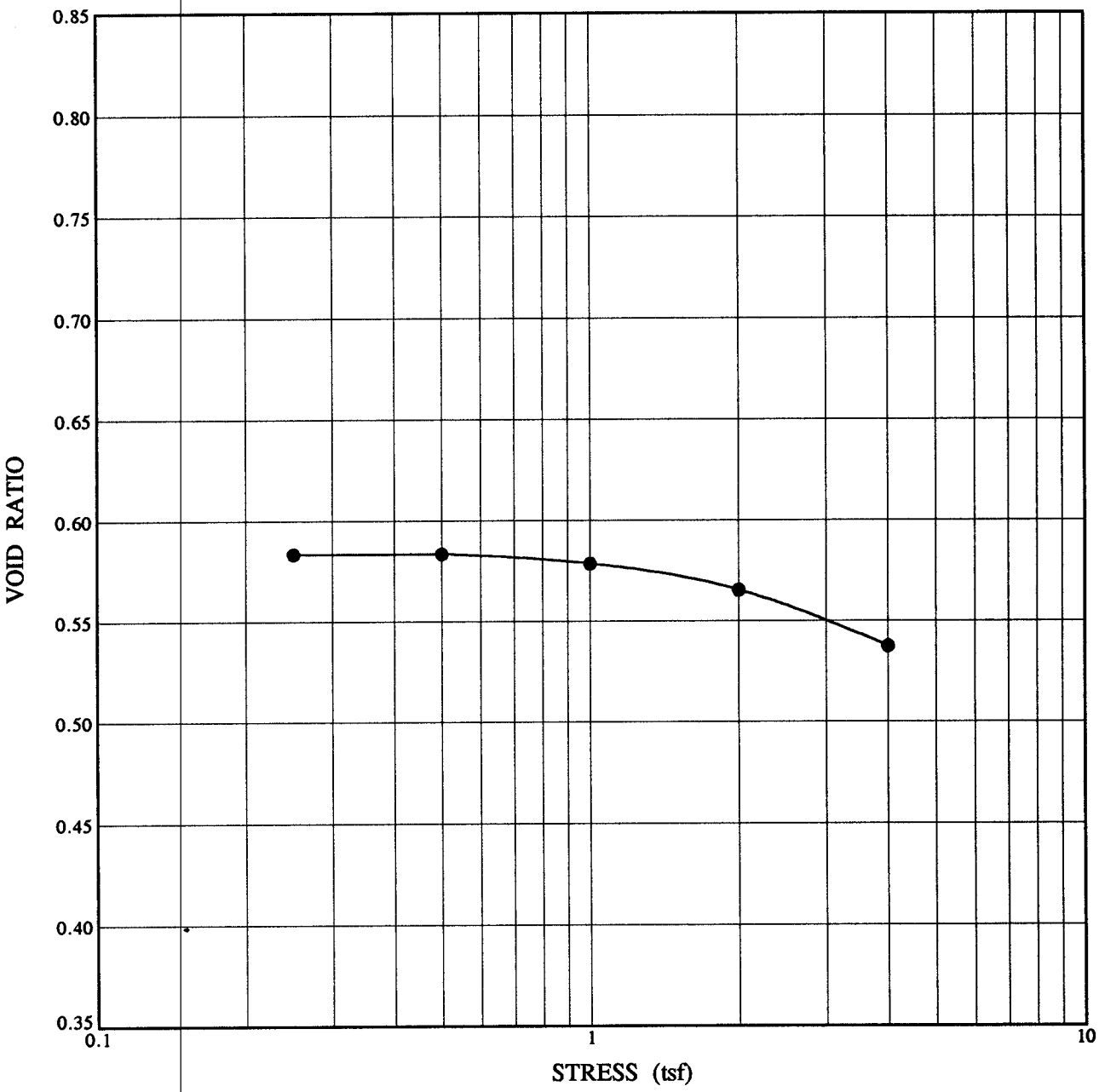
APR 2 97 CONSLV1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-9 (SE 83+00)**
DEPTH: **2' - 4'**
DESCRIPTION: **Clay with silt**
SPECIFIC GRAVITY: **2.73**
INITIAL MOISTURE CONTENT (%): **20**
INITIAL DRY UNIT WEIGHT (pcf): **108**
LL = **50** PL = **16** PI = **34**
INUNDATION AT START

FINAL MOISTURE CONTENT (%): **20**
FINAL DRY UNIT WEIGHT (pcf): **110**

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CONSOLIDATION TEST
ASTM D 2435-80

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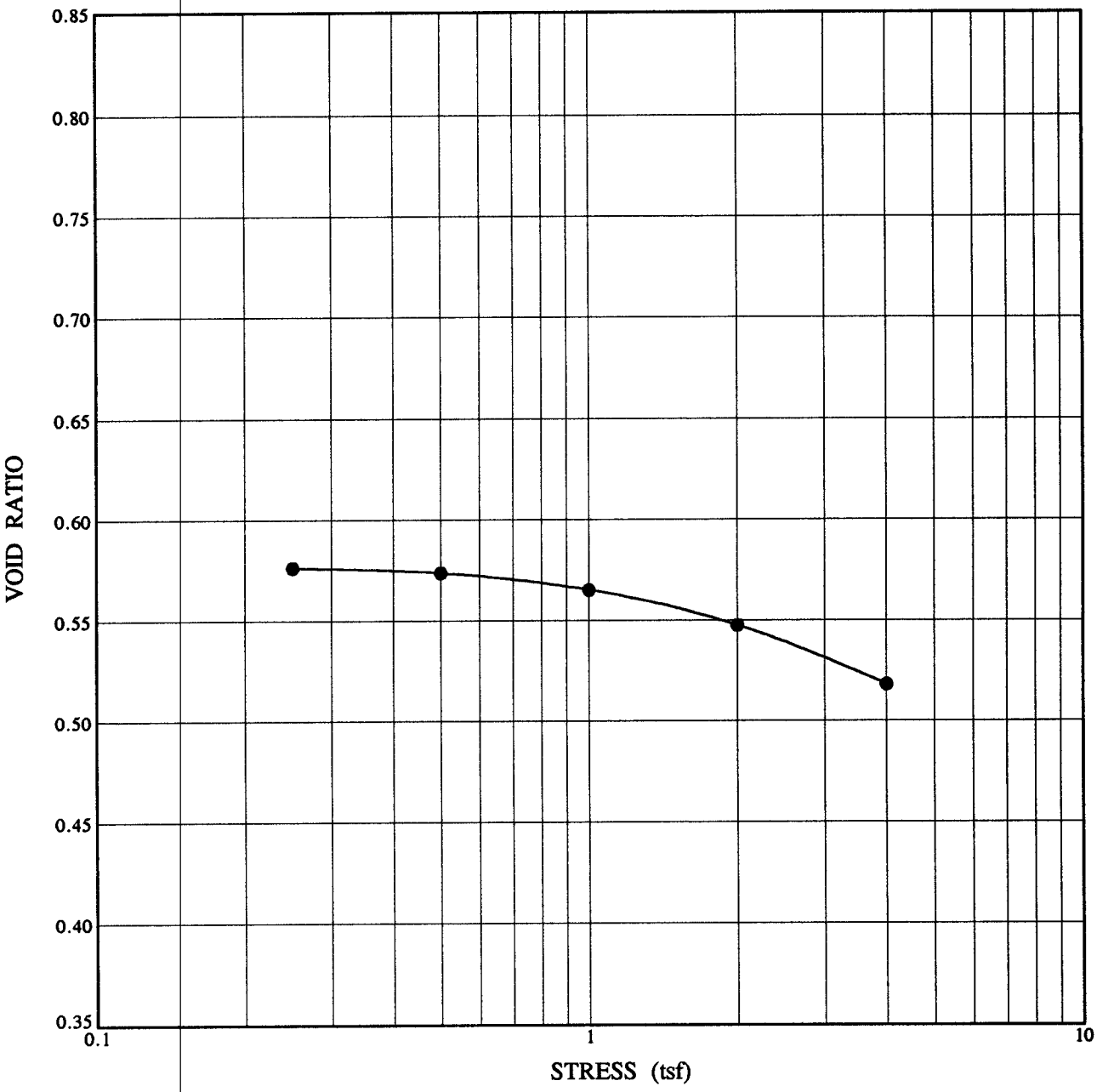
APR 2 97 CONSLV1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-8 (SE 108+00)**
DEPTH: **6' - 8'**
DESCRIPTION: **Silty Clay with clayey silt pockets**
SPECIFIC GRAVITY: **2.73**
INITIAL MOISTURE CONTENT (%): **20**
INITIAL DRY UNIT WEIGHT (pcf): **108**
FINAL MOISTURE CONTENT (%): **18**
FINAL DRY UNIT WEIGHT (pcf): **112**
LL = **44** PL = **14** PI = **30**
INUNDATION AT START

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CONSOLIDATION TEST
ASTM D 2435-80

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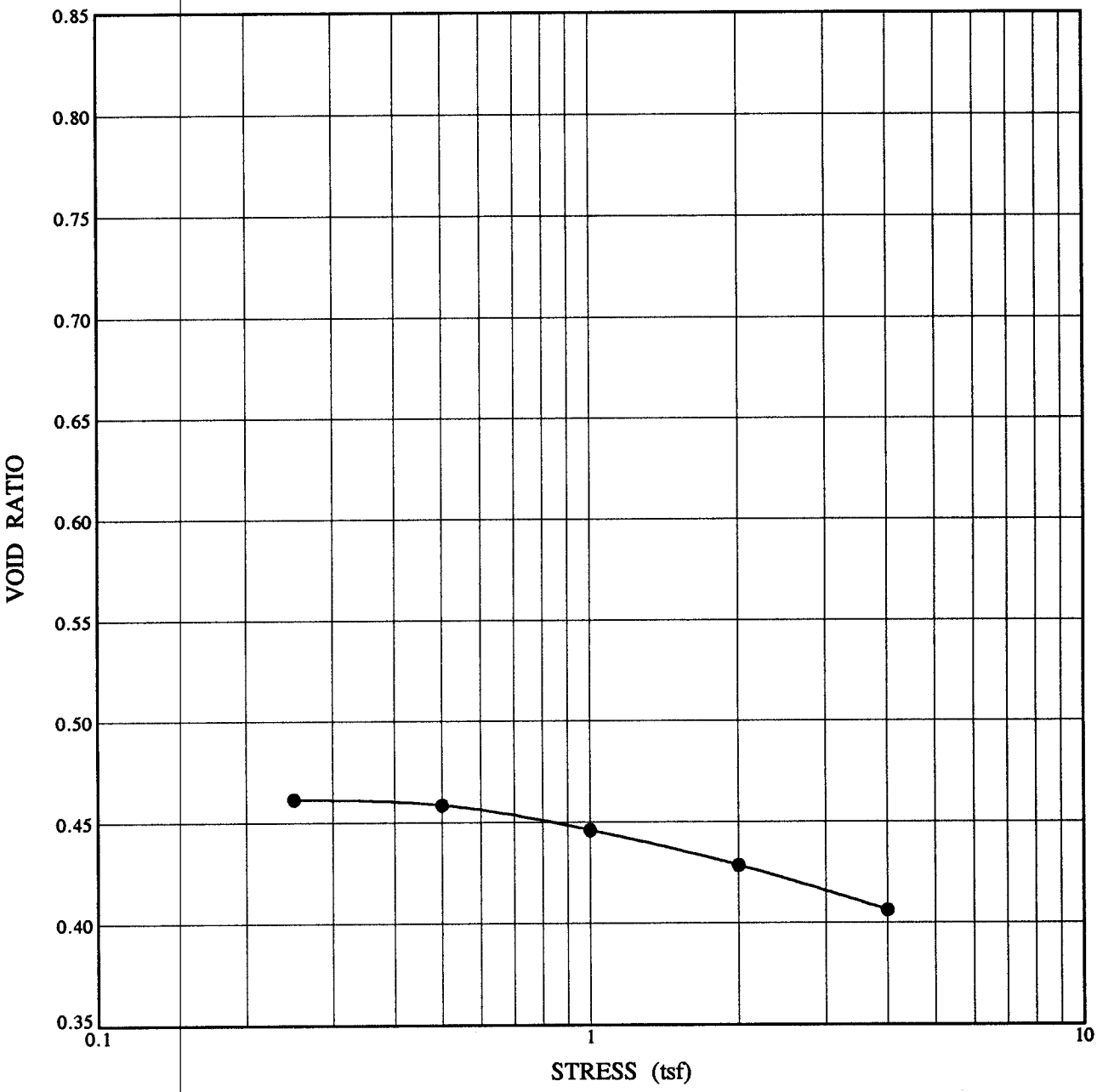
APR 2 97 CONSLV1 4B315



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-7 (SE 128+00)**
DEPTH: **6' - 8'**
DESCRIPTION: **Silty Clay with sand pockets**
SPECIFIC GRAVITY: **2.68**
INITIAL MOISTURE CONTENT (%): **16**
INITIAL DRY UNIT WEIGHT (pcf): **114**
LL = **34** PL = **16** PI = **18**
INUNDATION AT START

FINAL MOISTURE CONTENT (%): **16**
FINAL DRY UNIT WEIGHT (pcf): **118**

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 2 97 CONSLV1 4B315

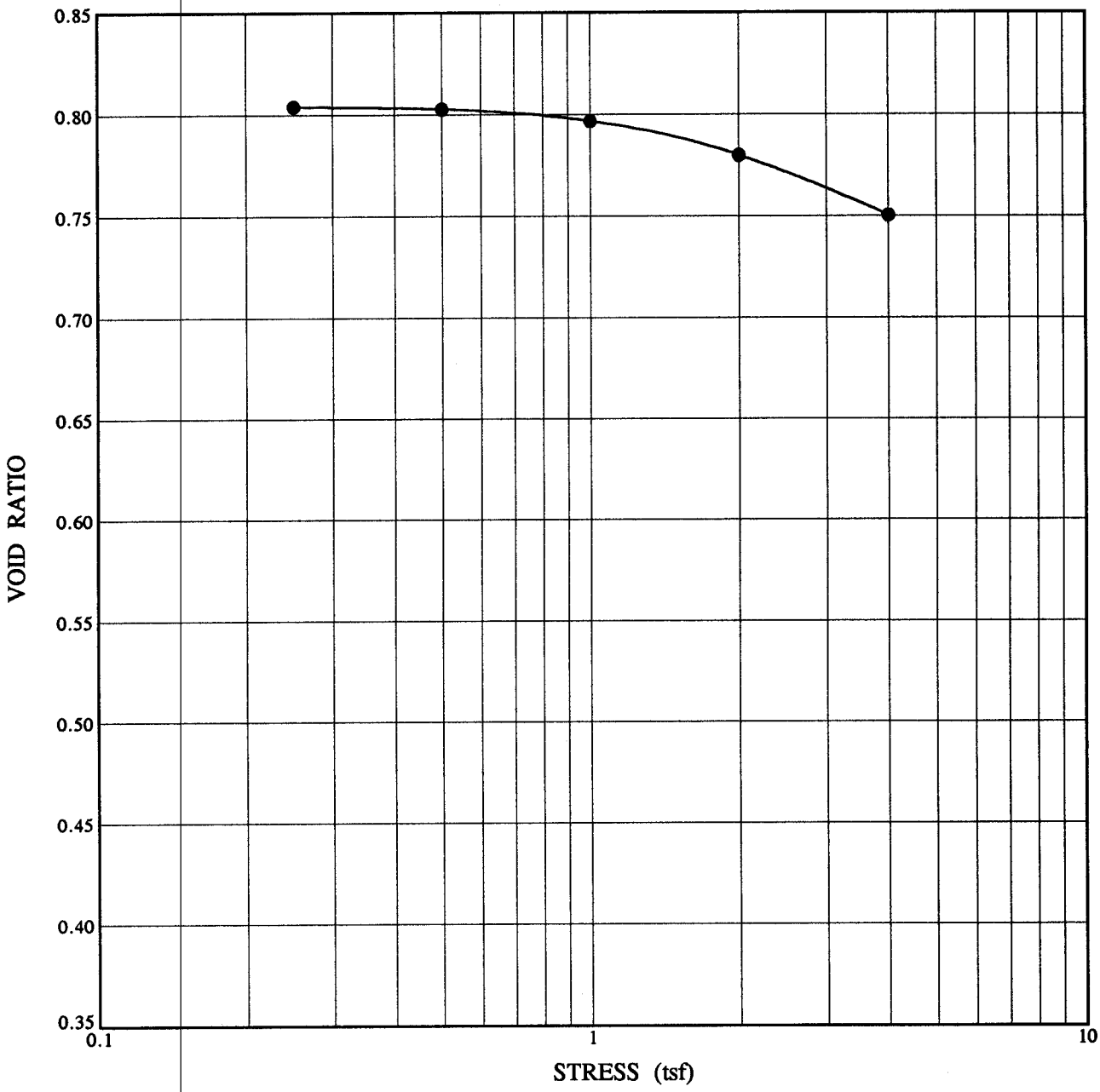
VOID RATIO-STRESS CURVE

FROM

CONSOLIDATION TEST

FOR THE

SOUTH WEST DIKE



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-2 (SW 33+00)**
DEPTH: **2' - 4'**
DESCRIPTION: **Clay with silt streaks and pockets, trace of fine sand**
SPECIFIC GRAVITY: **2.78**
INITIAL MOISTURE CONTENT (%): **28** FINAL MOISTURE CONTENT (%): **26**
INITIAL DRY UNIT WEIGHT (pcf): **96** FINAL DRY UNIT WEIGHT (pcf): **99**
LL = PL = PI =
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

Woodward-Clyde Consultants

APR 2 97 CONSLV1 4B315

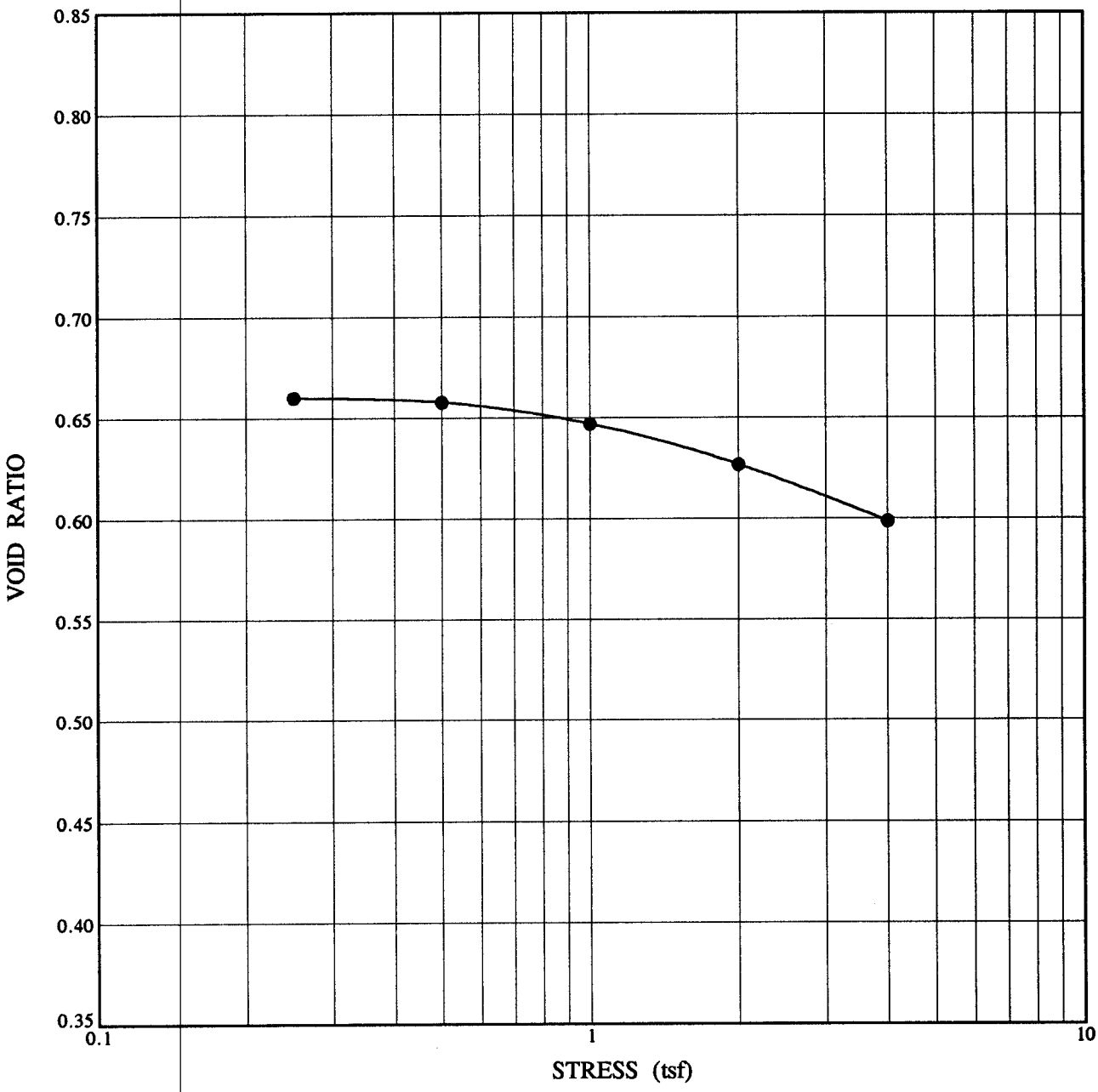
VOID RATIO-STRESS CURVES

FROM

CONSOLIDATION TESTS

FOR THE

CORNER STATION



● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-14 (SW 1+50.92)**
DEPTH: **6' - 8'**
DESCRIPTION: **Silty Clay with sand**
SPECIFIC GRAVITY: **2.72**
INITIAL MOISTURE CONTENT (%): **22**
INITIAL DRY UNIT WEIGHT (pcf): **102**
LL = **45** PL = **21** PI = **24**
INUNDATION AT START

FINAL MOISTURE CONTENT (%): **22**
FINAL DRY UNIT WEIGHT (pcf): **105**

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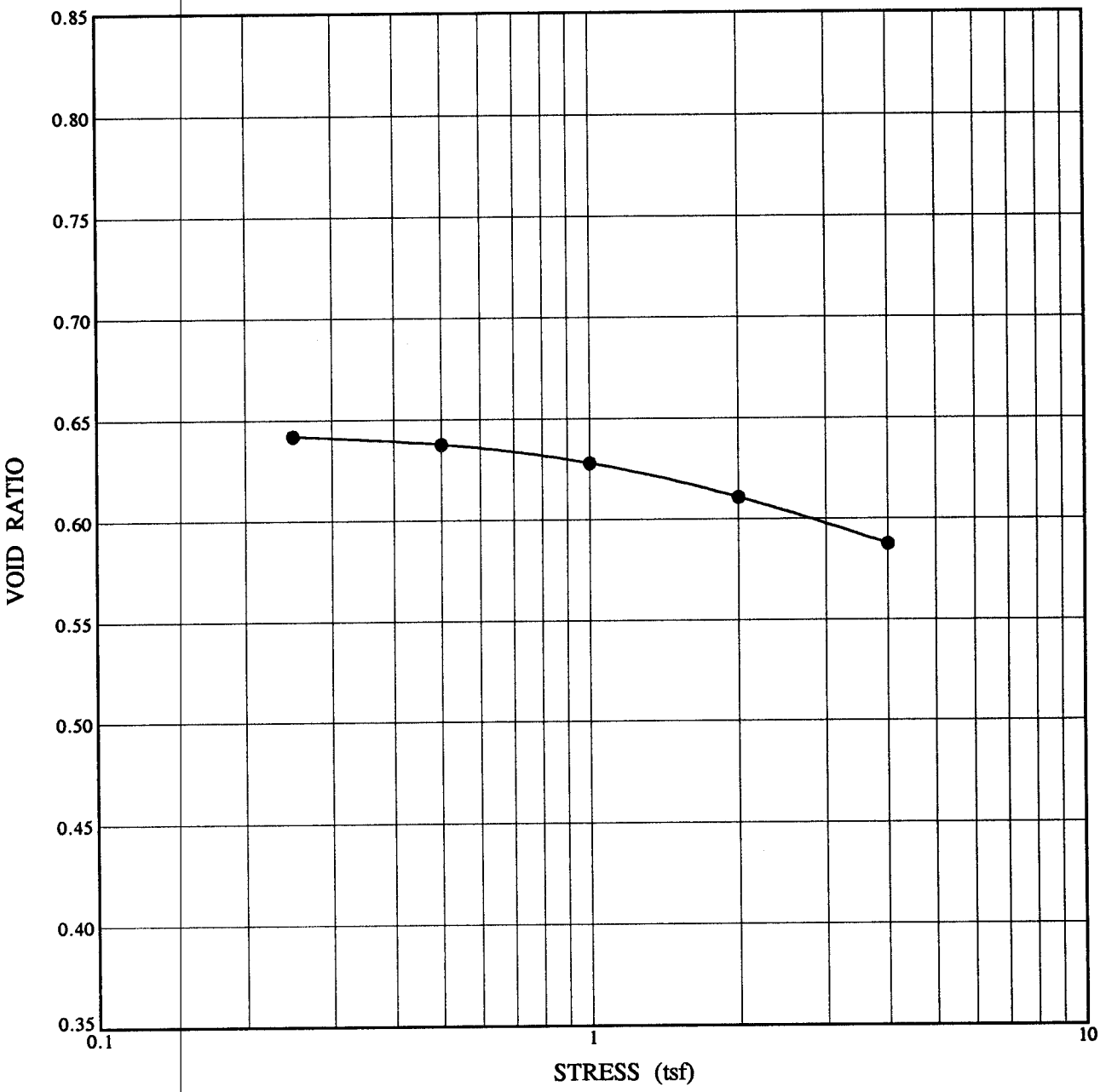

● STRAIN READINGS

Sample Data:

FILE: **94B315**
BORING: **B-13 (SE 1+50.92)**
DEPTH: **4' - 6'**
DESCRIPTION: **Silty Clay with sand pockets to more sandy**
SPECIFIC GRAVITY: **2.73**
INITIAL MOISTURE CONTENT (%): **21** FINAL MOISTURE CONTENT (%): **21**
INITIAL DRY UNIT WEIGHT (pcf): **104** FINAL DRY UNIT WEIGHT (pcf): **107**
LL = **40** PL = **21** PI = **19**
INUNDATION AT START

LIGO

CONSOLIDATION TEST
ASTM D 2435-80

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APR 2 97 CONSLV1 4B315