

PRELIMINARY ENGINEERING REPORT

THE HILLSBORO IMPOUNDMENT PROJECT

SWC PROJECT #1476

PREPARED BY

NORTH DAKOTA STATE WATER COMMISSION

BISMARCK, NORTH DAKOTA

AUG. 24, 1972

PRELIMINARY ENGINEERING REPORT
THE HILLSBORO IMPOUNDMENT PROJECT
SWC Project #1476

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August 24, 1972

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I. Introduction

It is being proposed that an artificial reservoir be constructed in the Hillsboro area to provide a water supply for a 50,000 acre capacity sugar beet processing plant. The source of water is to be the Goose River and the quantity required annually for the processing plant would be 1,400 acre-feet. The storage facilities required are to supply the 1,400 acre-feet consumptive use and also such losses incurred through seepage and evaporation. The water supply is to be provided solely for purposes of the sugar beet refinery plant.

II. Facilities Proposed

Facilities proposed to provide the water supply consist of an artificial reservoir, a pumping station located on the Goose River, and a pipeline extending from the pumping station to the reservoir.

III. Location

The artificial reservoir as currently planned, is to be located within the S $\frac{1}{2}$ of Section 29, Township 146 North, Range 50 West in Traill County. The pumping station is to be located on the Goose River in the SE $\frac{1}{4}$ of Section 32, Township 146 North, Range 50 West which is approximately one-half mile upstream from a lowhead dam on the Goose River referred to as Foogman Dam. The pipeline would extend from the pumping station to the artificial reservoir. See Exhibit #1 for facilities location map.

IV. Existing Facilities

The land area on which the artificial reservoir is to be constructed is presently being utilized as cultivated land. The pipeline is to parallel an existing roadway. The pumping station is located within the reservoir area of Foogman Dam which will provide the pumping pool.

Foogman Dam is located in the N $\frac{1}{2}$ of Section 5, Township 145 North, Range 50 West. The drainage area above the dam is 1,203 square miles. The spillway crest elevation is 881.14 MSL and is 13 feet above the streambed. The length of the weir is 100 feet. The dam creates a reservoir with a surface area of 44.5 acres and storage capacity of 190 acre-feet.

The dam was originally constructed by the Works Projects Administration in 1938 and consists of a rubble masonry gravity type structure. The structure was renovated in 1963 by the State Water Commission through application of a 3 inch layer of reinforced pneumatically applied mortar. The structure is presently in good condition.

V. Water Supply

The water supply and availability was developed from records of the gaging station located on the Goose River at Hillsboro 600 feet upstream from Foogman Dam. The duration flow curve for the years 1941 through 1969 were developed to determine availability of water to supply the reservoir and pumping rates. A copy of the curve is attached and referred to as Exhibit #2. The average discharge for 38 years of record is 61.7 cubic feet per second or 44,700 acre-feet per year. The median of yearly mean discharges is 36 cubic feet per second or 26,100 acre-feet per year.

VI. Engineering Investigations

Engineering field investigations consisted of area windshield reconnaissance, developing topography on proposed location of the artificial reservoir at a scale of 1" = 100', sounding and developing topography of the Goose River pumping location area and cross sections and profiles in the area of the proposed pipeline location. In addition, a number of borings were taken in the artificial reservoir area and pumping intake structure area to determine various soil

properties required for design. A report covering all laboratory tests and design criteria on the soils is a part of this report listed as Exhibit #3.

VII. Design Data

1. Artificial Reservoir

The artificial reservoir will consist of a rolled earthfill dike following the perimeter of an area encompassing 180 acres. The earthfill dike has a top width of 15 feet with 3:1 outside slope and 4:1 inside slope. The inside slope is to have a four inch asphalt liner a distance of 53' 6" from the top of the dike extending downward toward the toe to provide for erosion control. The top of the dike is to be set at elevation 914.0 MSL. The water surface will be 911.0 MSL at maximum level. The bottom of the artificial reservoir will be 895.5 providing a maximum elevation differential of 15.5 feet. The artificial reservoir is being proposed to be constructed one year in advance of filling in order to allow for differential settlement and observation prior to filling. Construction of the dike will require placement of 564,000 cubic yards of earth and placement of 52,000 square yards of asphalt liner.

The water surface of the reservoir at elevation 911.0 provides an area of 160 acres and a capacity of 2,360 acre-feet. The reservoir area-capacity curve is attached as Exhibit #4.

2. Pumping Facilities

The intake structure is to consist of a structural steel sheet piling structure and the necessary structural members to support the pumps and motors. A metal type building will house the facilities. There will be two pumps installed each one capable of discharging 20 cubic feet per second for maximum capability of 40 cubic feet per second. This is more than adequate to provide the 1,850 acre-feet of water required annually for consumptive use and evaporation losses.

The pumping facilities are to be designed in a manner which will permit both pumps to operate at the same time, or a single pump to operate. Electric motors are to be used for power for the pumps.

The duration flow curve indicates sufficient flows in the Goose River to allow pumping at a rate of 40 cfs for a 56 day period which would yield a total of 4,480 acre-feet. Additional pumping could be conducted for a period of 19 days at the rate of 20 cfs which would yield another 760 acre-feet for a total of 5,240 acre-feet. It is our opinion that this is a more than adequate safety factor design to allow for low water years, to annually meet the requirement of 1,850 acre-feet.

The pipeline will consist of 42 inch inside diameter reinforced concrete pressure pipe which will be buried at least six feet below ground level to prevent heaving due to frost action.

The pipeline will be 42 inch reinforced concrete pipe ASTM designation 361. Flap gate is to be provided at the discharge end. The total length of pipe required is 3,826 lineal feet.

VIII. Physical Features and Engineering Data

A. Artificial Reservoir

1. Total Project Area	180 acres
2. Surface Water Area	160 acres
3. Pool Elevation	911 MSL
4. Bottom of Reservoir	895.5 MSL
5. Capacity at Elevation 911.0	2370 A.F.
6. Average Depth at Elevation 911.0	15.5 feet

- | | |
|-------------------------|---------------------|
| 7. Length of Embankment | 11,069 feet |
| 8. Top Width | 15 feet |
| 9. Inside Slope | 4:1 |
| 10. Outside Slope | 3:1 |
| 11. Top of Embankment | 914.0 MSL |
| 12. Embankment Yardage | 564,000 Cubic Yards |

B. Pumping Structure

1. Structural Steel Sheet Piling Structure

- | | |
|---------------------------|--------------|
| a. Top of Structure | 892 MSL |
| b. Controlled Water Level | 881.14 MSL |
| c. Bottom of Sump | 872.5 MSL |
| d. Depth of Sump | 8.64 feet |
| e. S.S.S.P. | MP110 U.S.S. |

2. Pumps

- | | |
|--|---------|
| a. 20 cfs Axial/Mixed Flow Pumps | 2 Units |
| b. 100 HP Electric Motor | 2 Units |
| 1. 1200 RPM | |
| 2. 460 Volts 3 Phase 60 Cycle | |
| 3. Power Panel, Motor Control and
Flow Controls | |

- | | |
|-----------------------------|---------|
| 3. Flanged End Check Valves | 2 Units |
| 4. Surge Tank and Equalizer | 2 Units |
| 5. Pump House | 1 Unit |

C. Pipeline

- | | |
|------------------------|-----------|
| 1. 42" R.C.P. ASTM 361 | 3826 feet |
| 2. Flap Gate | 1 Unit |
| 3. 2" Vent Pipe | |

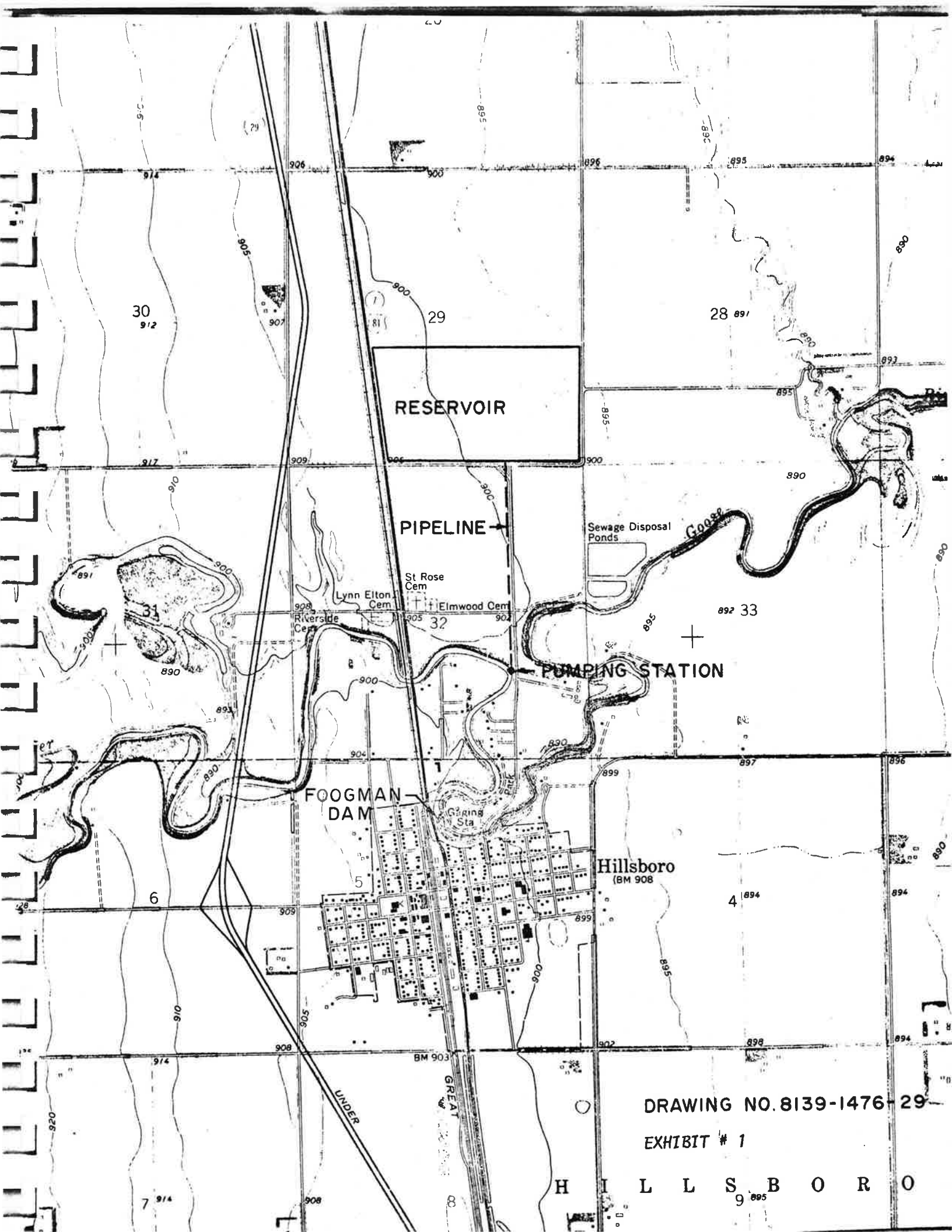
IX. Estimated Construction Costs

1. Earthfill Embankment - 564,000 Yd. ³ @ \$0.45	\$253,800.00
2. Reservoir Area Stripping, Placement and Seeding - 26,000 Yd. ³ @ \$0.60	15,600.00
3. Asphalt Liner 4" Thick - 52,000 Yd. ² @ \$2.22/Yd. ²	115,440.00
4. Pipe, 36" RCP - 4,000 L.F. @ \$22.00/L.F.	88,000.00
5. Pumps (two pumps)	25,000.00
6. Valves (two valves)	2,000.00
7. Pumping Structure	14,000.00
8. Pump House	6,000.00
9. Electrical	2,000.00
10. Rock Riprap - 500 tons @ \$10.00/Ton	<u>5,000.00</u>
Subtotal	\$525,040.00
Contingencies	52,060.00
Construction Inspection	51,900.00
Contract Administration	<u>50,000.00</u>
TOTAL COST	<u><u>\$679,000.00</u></u>

X. Water Permit

Application for a water permit is to be made by the Trail County Water Management District to the State Water Commission for the diversion of 2,670 acre-feet annually from the Goose River at a maximum pumping rate of 40 cubic feet per second. The application for the permit has been discussed informally with the State Water Commission and no objections or problems regarding granting the permit are anticipated.

* * * * *



RESERVOIR

PIPELINE

Sewage Disposal Ponds

PUMPING STATION

FOOGMAN DAM

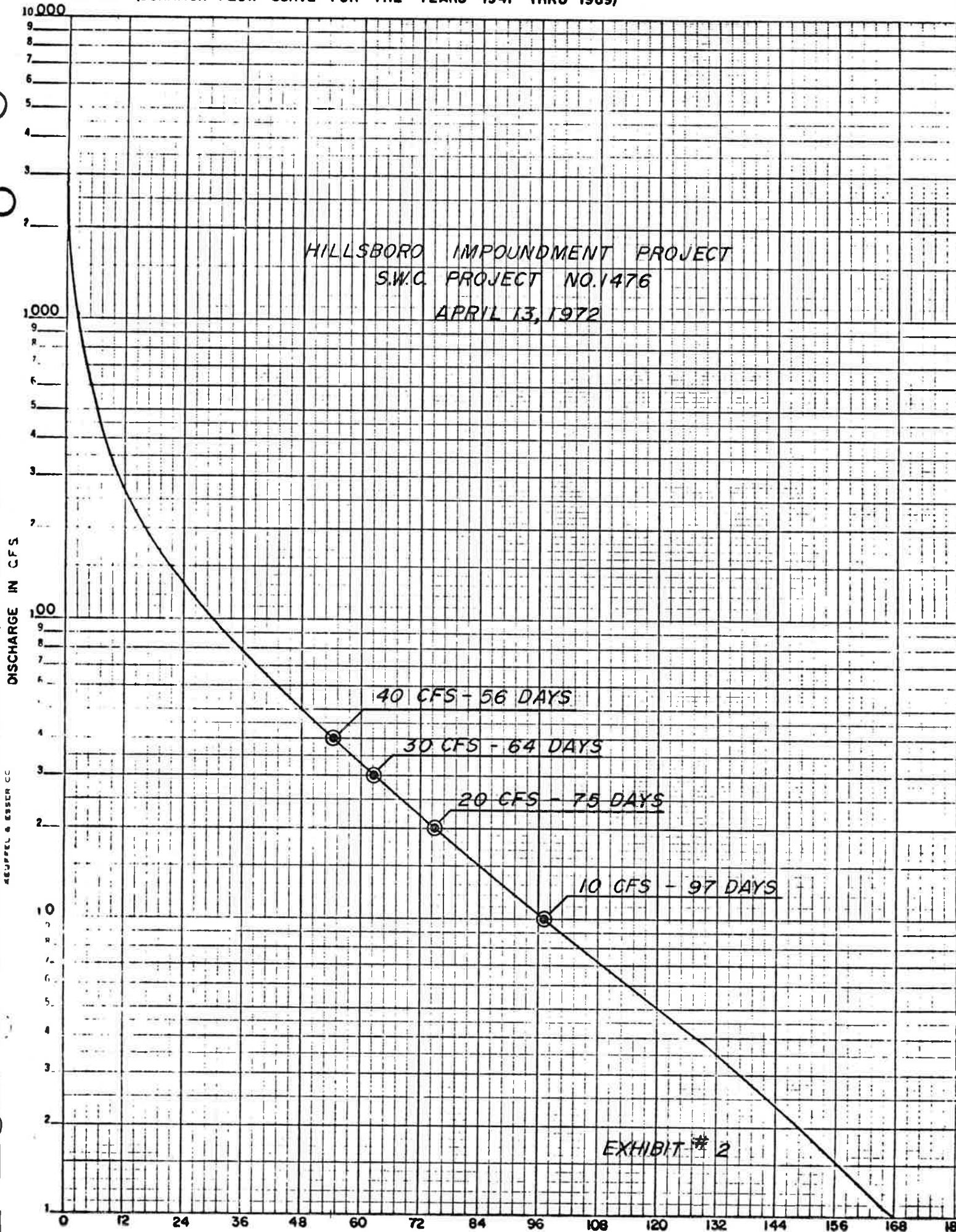
Hillsboro (BM 908)

DRAWING NO. 8139-1476-29

EXHIBIT # 1

H I L L S B O R O

MOOSE RIVER AT HILLSBORO, N. DAK.
YEARLY (DURATION FLOW CURVE FOR THE YEARS 1941 THRU 1969)



Engineering File

Soil Exploration Company

FORMERLY OPERATED AS A DEPARTMENT OF
TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.
662 CROMWELL AVENUE - ST. PAUL, MINN. 55114 - 645-6446

BRANCH OFFICES:
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BISMARCK, ND.
SIOUX FALLS, SD.
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JOHN F. GISLASON-Treasurer

June 28, 1972

COPY

North Dakota State Water Commission
State Office Building
900 Boulevard
Bismarck, North Dakota 58501

Attention: Mr. Arland Grunseth

Re: Laboratory Tests - Proposed Reser-
voir - Hillsboro, North Dakota -
N.D.S.W.C. Project Number 1476 -
#900-320

Gentlemen:

East Site - Section 29

This report includes the results of the laboratory tests requested by you on May 22 and June 6, 1972. We are transmitting five copies of our report.

As discussed with you, the C-U test requested on the sample from 24½'-26' at boring 5 is incomplete. Peak stress for the second and third stages were definitely less than normally expected on the first sample tested. Slight excess pore pressure build-up was suspected as the main cause for the erratic results. The second sample was then trimmed to a 2" diameter and allowed to consolidate for three days under each confinement. However, the results were still erratic and quite similar to those of the first sample tested. The samples do contain some seams of alkali and it appears that the initial onset of shear caused an actual breakage of alkali particles and a subsequent pronounced shear plane. We are reporting the peak deviator stress of the initial portion from both C-U (stage) tests.

You will note that some of the samples are described as being slightly slickensided. The description is based strictly on examination of tested samples and it is possible that most of the slickensided planes were caused by compression of the sample. Several samples were trimmed down from 2 13/16 inch to 2 inch diameters, as indicated on the attached data sheets. Many of the strength test results from the same thin wall tube do not compare well, because of sample variance.

EXHIBIT #3

Page 2 - Laboratory Tests - Proposed Reser-
voir - Hillsboro, North Dakota -
N.D.S.W.C. Project Number 1476 -
#900-320

All the samples will be held at this office for three months and will then be discarded, unless we are notified to do otherwise.

If you have any questions regarding the results of the tests, or if we can be of any further service to you, please contact us.

Very truly yours,

SOIL EXPLORATION COMPANY

Gordon R. Eischens

Wilfred A. Wahl, P. E.

GRE/WAW:kmj

Encs.

REPORT OF TESTS OF SOIL

PROJECT: RESERVOIR, HILLSBORO, NORTH DAKOTA - N.D.S.W.C. #1476

June 28, 1972

REPORTED TO: North Dakota State Water Commission

JOB NO.: 900-320

Boring No.	5	5	5	5	7	7	7	10
Depth (ft.)	13-14½	24½-26	24½-26	24½-26	30-31	50-51	50-51	4½-6
	Bottom	Top	Middle	Bottom	Bottom	Top	Bottom	Bottom
Soil Type (ASTM: D 2488)	CH Fat Clay, brown and gray mot- led, a few roots	CH Fat Clay, brown and gray mot- led, slightly slicken- sided, seams of alkali	CH Fat Clay, brown and gray mot- led, slightly slicken- sided, seams of alkali	CH Fat Clay, brown and gray mot- led, slightly slicken- sided, seams of alkali	CH Fat Clay, brownish gray	CH Fat Clay, gray, slightly slicken- sided, trace of gravel	CH Fat Clay, gray, slightly slicken- sided, trace of gravel	CH Fat Clay, brown mottled, blocky structure
Moisture Content (%)					51.0	47.7		41.2
Dry Density (pcf)					70.4	73.3		76.1
Unconfined Compressive Strength (psf)	1,900	1,500		3,300	4,100	3,100	2,300	1,500
Sample Diameter (inches)	2 13/16	2		2	1 15/16	1 15/16	1 15/16	1 15/16
Sample Height (inches)	5 5/8	4		4	3 7/8	3 7/8	3 7/8	3 7/8
C-U Triaxial Confining Pressure (psf)			1,500					
Deviator Stress (psf)			5,300					

Maximum (Soil Class)

REPORT OF TESTS OF SOIL

PROJECT: RESERVOIR, HILLSBORO, NORTH DAKOTA - N.D.S.W.C. #1476

June 28, 1972

REPORTED TO: North Dakota State Water Commission

JOB NO.: 900-320

Boring No.	10	11	11	11	11	11	11	11
Depth (ft.)	8-9½	14½-16	14½-16	19½-21	19½-21	19½-21	24½-26	24½-26
	Top	Middle	Bottom	Top	Middle	Bottom	Middle	Middle
Soil Type (ASTM: D 2488)	CH Fat Clay, brown and some gray mottled	CH Fat Clay, brown and some gray mottled	CH Fat Clay, brown mottled, a few lenses of silty clay	CH Fat Clay, brown mottled, seams of alkali	CH Fat Clay, brown mottled	CH Fat Clay, brown mottled, seams of alkali	CH Fat Clay brownish gray, slightly slicken- sided	CH Fat Clay, brownish gray, slightly slicken- sided
Moisture Content (%)	43.1							
Dry Density (pcf)	75.6							
Unconfined Compressive Strength (psf)	1,500	2,100		2,100			1,400	2,100
Sample Diameter (inches)	1 15/16	2 13/16		2 13/16			2 15/16	2
Sample Height (inches)	3 7/8	5 5/8		5			5 5/8	3
U-U Triaxial (See attached graph)			*				*	
C-U Triaxial Confining Pressure (psf)					1,500			
Deviator Stress (psf)					4,000			

REPORT OF TESTS OF SOIL

PROJECT: RESERVOIR, HILLSBORO, NORTH DAKOTA - N.D.S.W.C. #1476
 REPORTED TO: North Dakota State Water Commission

June 28, 1972
 JOB NO.: 900-320

Boring No.	11	11	11	11	11	13	13
Depth (ft.)	24½-26	44½-46	54½-56	64½-66	64½-66	4½-6	7-8½
	Bottom	Middle	Middle	Top	Bottom		Middle
Soil Type (ASTM: D 2488)	CH Fat Clay, brownish gray, slightly slicken- sided	CH Fat Clay, gray	CH Fat Clay, gray, slightly slicken- sided	ML-CL Clayey Silt, gray	CL-ML Clayey Silt, gray, lenses of silt	CH Fat Clay, brown mottled, slightly blocky and slicken- sided	CH Fat Clay brown mottled, slightly slicken- sided
Moisture Content (%)			45.9	29.7		37.2	42.3
Dry Density (pcf)			74.7	92.5		81.8	77.7
Unconfined Compressive Strength (psf)	3,900	2,700	1,600	1,100	3,200	2,400	2,700
Sample Diameter (inches)	2	2 13/16	1 15/16	1 15/16	1 15/16	1 15/16	1 15/16
Sample Height (inches)	4	5 5/8	3 7/8	3 7/8	3 7/8	3 7/8	3 1/2

SOIL EXPLORATION COMPANY
 TRIAXIAL TEST DATA

JOB NO. 900-320

PROJECT PROPOSED RESERVOIR, HILLSBORO, N.D.

BORING NO. 5 SAMPLE NO. _____ DEPTH 13' - 14 1/2' (Middle)

TYPE OF TEST Unconsolidated-Undrained (Staged)

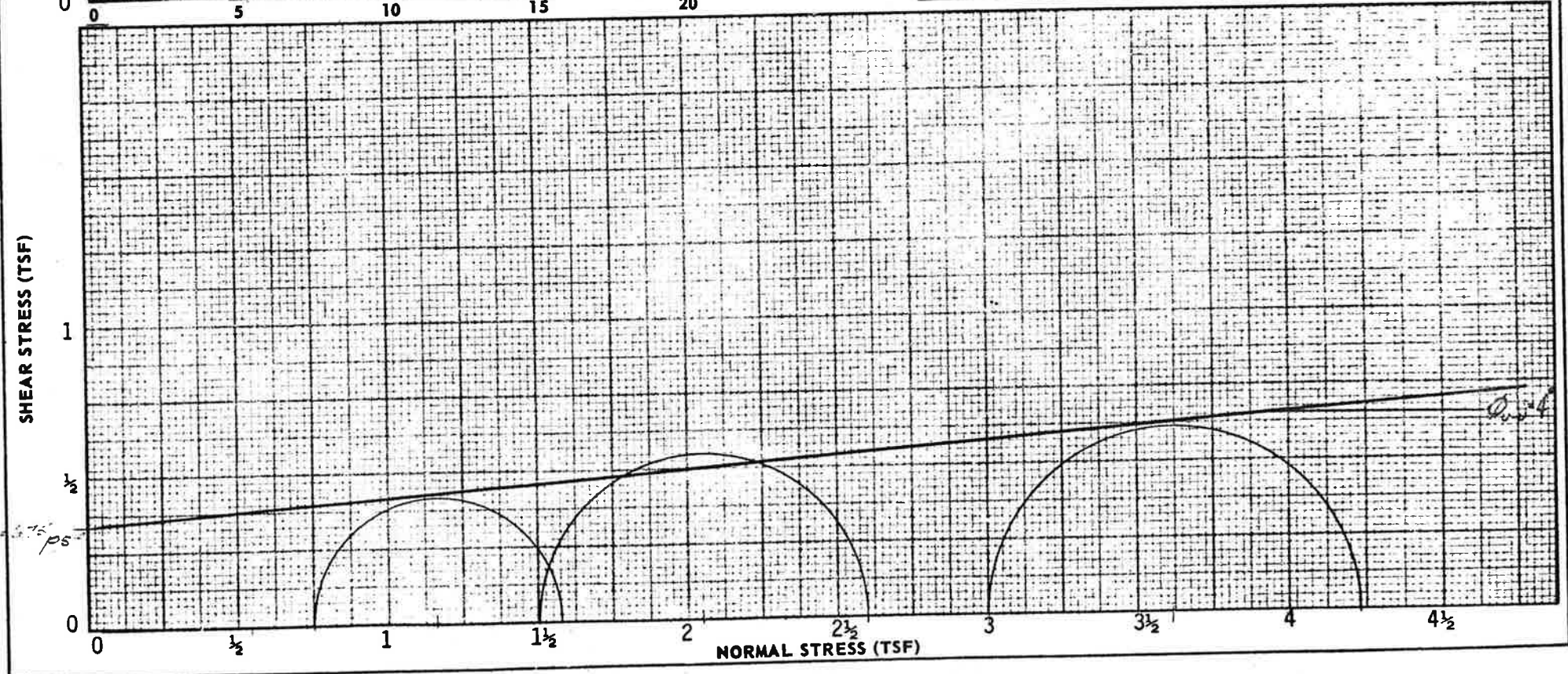
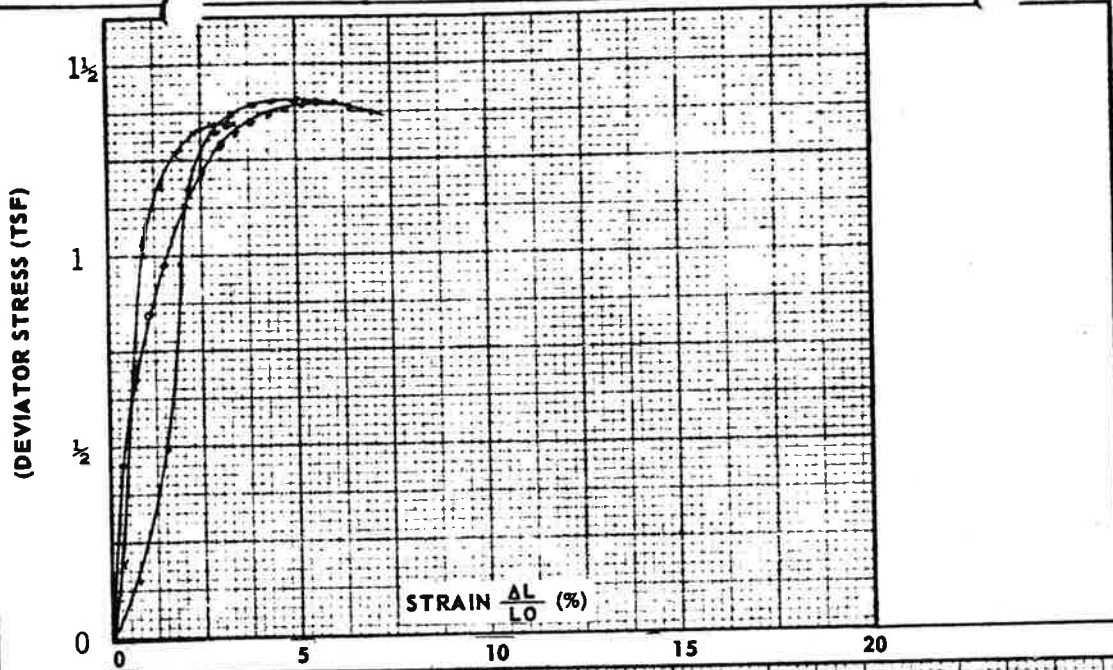
SAMPLE SIZE: 2 13/16 x 5 5/8

SOIL TYPE: (CH) Fat Clay

MOISTURE-DENSITY: _____ % - _____ PCF

ATTERBERG LIMITS: LL _____ PL _____

REMARKS Sample confined under initial pressure with both ends sealed off, stressed under constant strain of 0.10 inches/minute to peak strength, above steps repeated twice more.



SOIL EXPLORATION COMPANY
 TRIAXIAL TEST DATA

JOB NO. 900-320

PROJECT PROPOSED RESERVOIR, HILLSBORO, N.D.

BORING NO. 11 SAMPLE NO. _____ DEPTH 14'-16' (Bottom)

TYPE OF TEST Unconsolidated-Undrained (Staged)

SAMPLE SIZE: 2 13/16 x 5 5/8

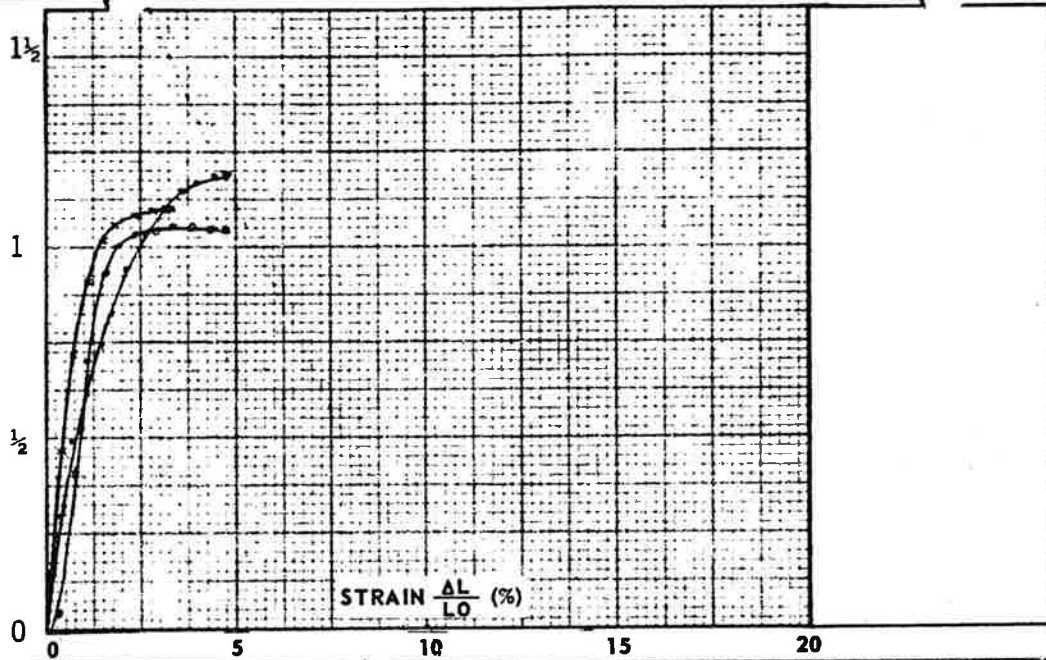
SOIL TYPE: (CH) Fat Clay

MOISTURE-DENSITY: _____ % - _____ PCF

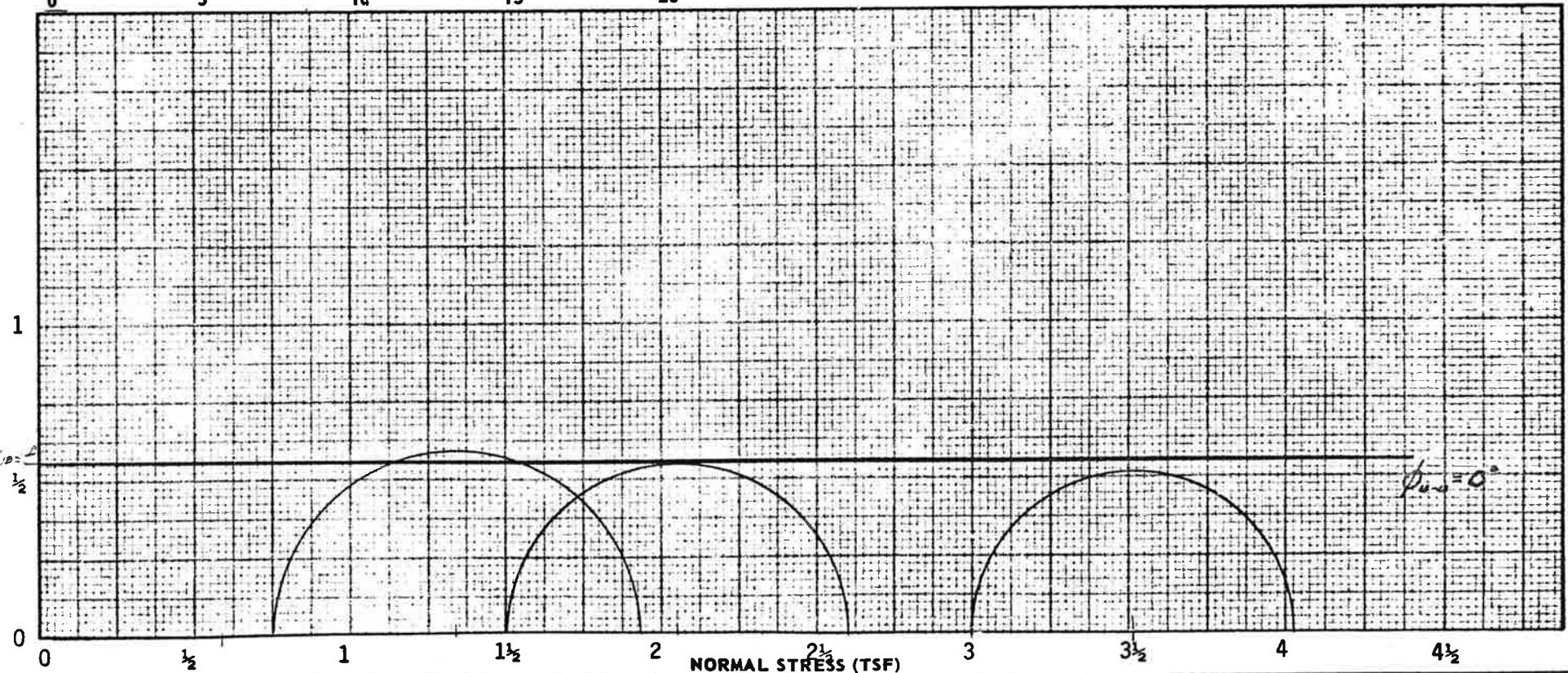
ATTERBERG LIMITS: LL _____ PL _____

REMARKS Sample confined under initial pressure
with both ends sealed off, stressed under constant
strain of 0.10 inches/minute to peak strength,
above steps repeated twice more.

(DEVIATOR STRESS (TSF))



(SHEAR STRESS (TSF))



SOIL EXPLORATION COMPANY
TRIAxIAL TEST DATA

JOB NO. 900-320

PROJECT PROPOSED RESERVOIR, HILLSBORO, N.D.

BORING NO. 11 SAMPLE NO. _____ DEPTH 19 1/2' - 21'
 (Bottom)

TYPE OF TEST Unconsolidated-Undrained (Staged)

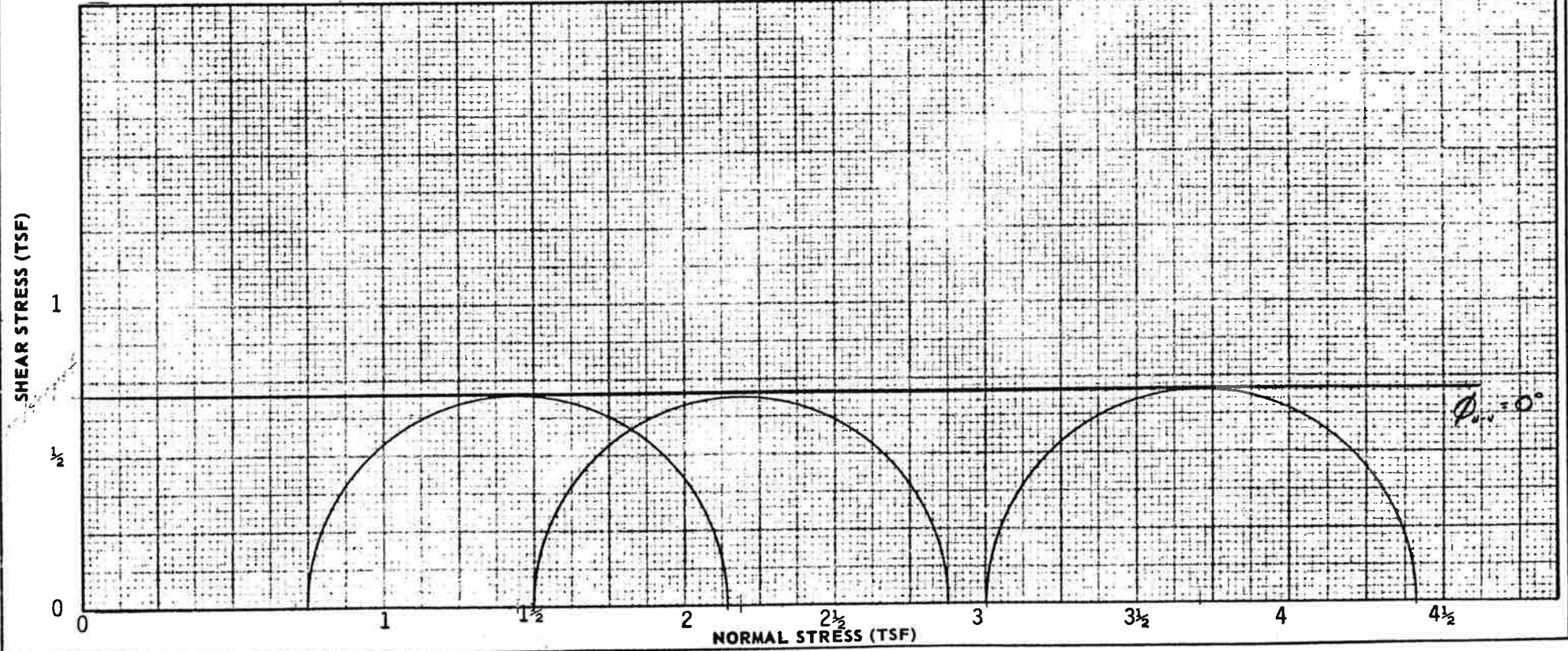
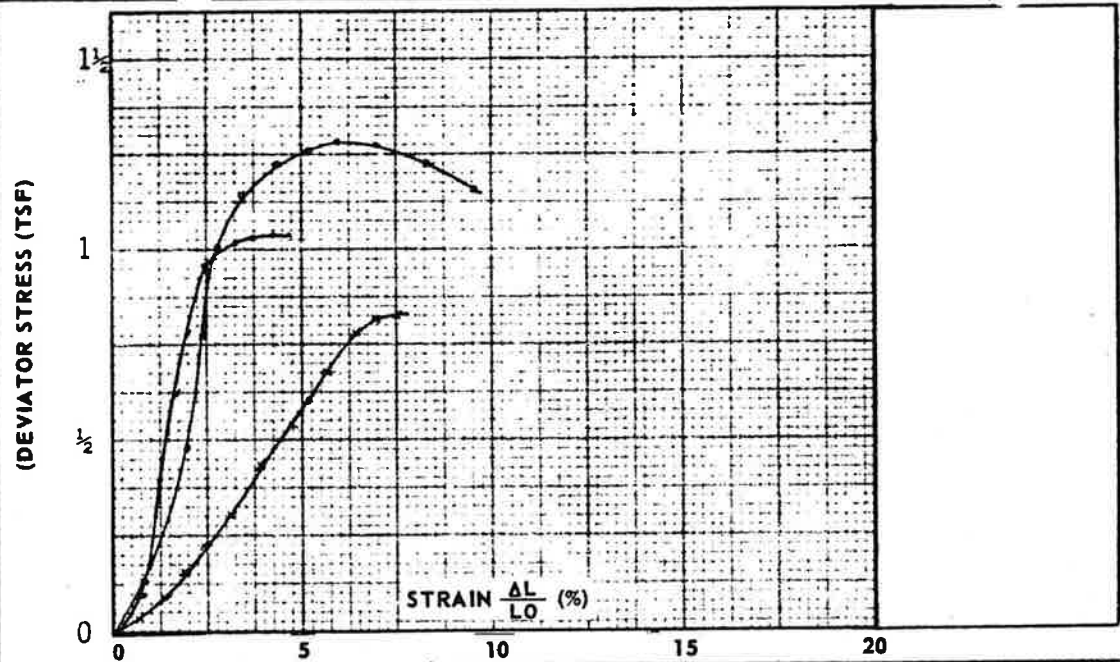
SAMPLE SIZE: 2 13/16 x 5 5/8

SOIL TYPE: (CH) Fat Clay

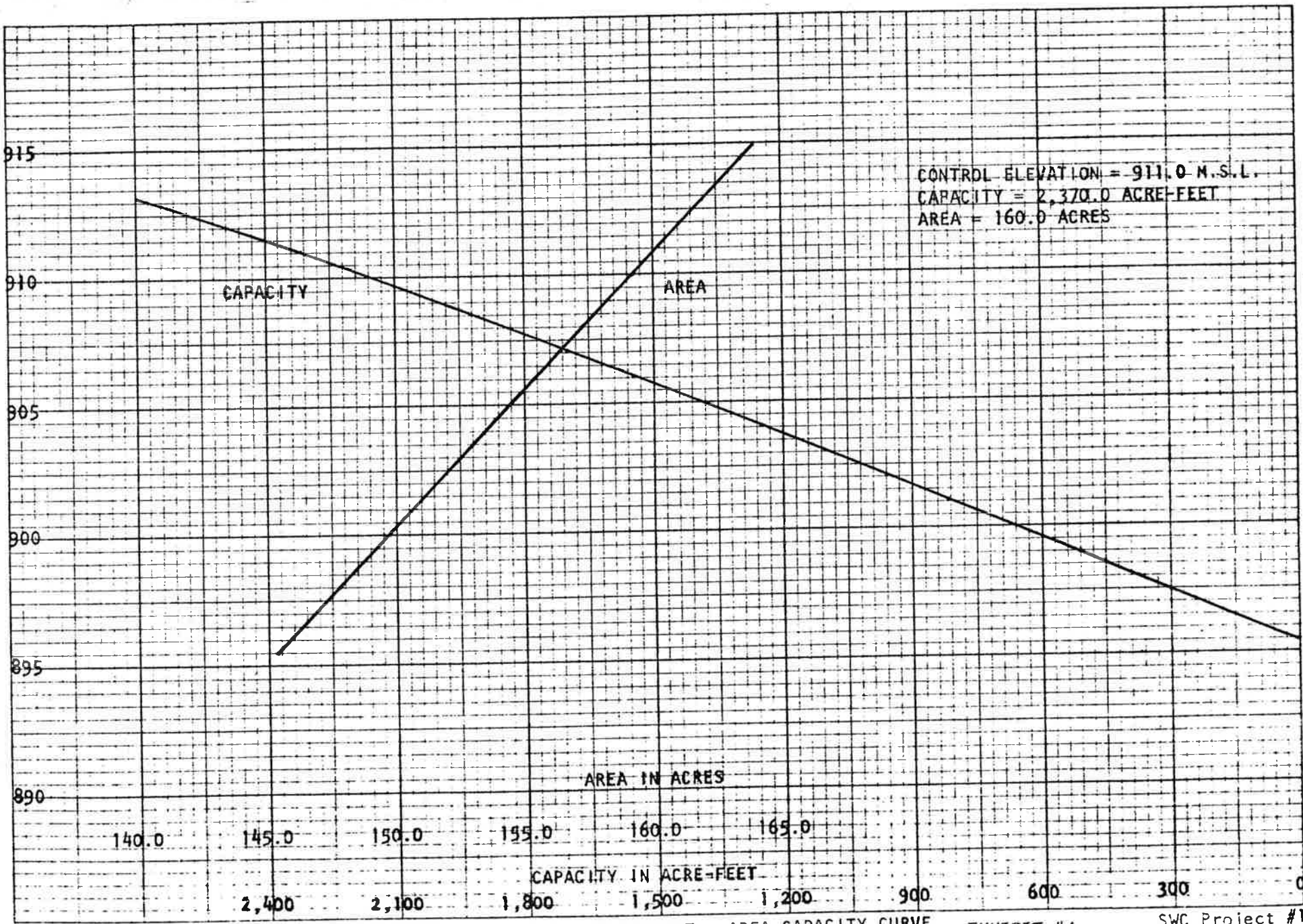
MOISTURE-DENSITY: _____ % - _____ PCF

ATTERBERG LIMITS: LL _____ PL _____

REMARKS Sample confined under initial pressure with both ends sealed off, stressed under constant strain of 0.10 in./min. to peak strength, above steps repeated twice more.



ELEVATION M. S. L.



NORTH DAKOTA STATE WATER COMMISSION
WORKSHEET
EARTHWORK QUANTITY
AND
AREA CAPACITY

PROJECT NAME HILLSBORO Res. NO. 1476 DATE 6-26-72

COUNTY TRAIL COMPUTED BY SMH CHECKED BY _____

FOR AREA CAPACITY

Cut or Fill	Elev. or Sta.	Dist. In Feet	End Area Ac.	Sum of Areas	Half Sum of Areas	Dist. X $\frac{1}{2}$ SA	Accumulated Q Capacity
	875.5		145.414				0
		2.5					
	898.0		147.834				366.598 H.F.
		2					
	900		149.747				664.180
		1					
	901		150.703				814.905
		1					
	902		151.659				965.587
		1					
	903		152.616				1,117.745
		1					
	904		153.572				1,270.819
		1					
	905		154.528				1,424.870
		1					
	906		155.485				1,579.877
		1					
	907		156.441				1,735.890
		1					
	908		157.397				1,892.760
		1					
	909		158.353				2,050.635
		1					
	910		159.310				2,209.468
		1					
	911		160.266				2,369.256