WehranEnviroTech

REMEDIAL INVESTIGATION

REPORT FOR THE MAHOPAC BUSINESS DISTRICT SITE

MAHOPAC, PUTNAM COUNTY, NEW YORK

VOLUME II - APPENDICES A - F

Prepared For

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Albany, New York

February 1990

Wehran-New York, Inc.
Middletown, New York

Environmental Engineers • Scientists • Constructors

APPENDIX A
BORING LOGS

MAHOPAC BUSINESS DISTRICT RI/FS

KEY TO SOILS IDENTIFICATION

GRANULAR SOILS – PARTICLE SIZE CLASSIFICATION

	Material	Fractions	Passing	Retained On
BOULDERS	Material retained on the 9-inch sieve			9 inch
COBBLES	Material passing the 9-inch sieve and retained on the 3-inch sieve		9 inch	3 inch
GRAVEL	Material passing the 3-inch sieve and retained on the No. 10 sieve	coarse (c) medium (m) fine (f)	3 inch 1 inch 3/8 inch	1 inch 3/8 inch No. 10
SAND	Material passing the No. 10 sieve and retained on the No. 200 sieve	coarse (c) medium (m) fine (f)	No. 10 No. 30 No. 60	No. 30 No. 60 No. 200
SILT	Material passing the No. 200 sieve that is non-plastic in character and exhibits little or no strength when air-dried		No. 200	

CLAY SOILS – PLASTICITY CLASSIFICATION

Material*	Degree of Overall Plasticity	Overall Plasticity Index Sand-Silt-Clay Components
Clayey SILT	Slight	1 to 5
SILT & CLAY	Low	5 to 10
CLAY & SILT	Medium	10 to 20
Silty CLAY	High	20 to 40
CLAY	Very High	40 and greater

*Soils passing the No. 200 sieve that can be made to exhibit plasticity and clay qualities within a certain range of moisture content, and that exhibit considerable strength when air-dried.

PENETRATION RESISTANCE AND SOIL PROPERTIES ON BASIS OF THE STANDARD PENETRATION TEST (AFTER PECK, HANSON, AND THORNBURG, 1974)

Sands (Fairly Reliable)		Clays (Rather Unreliable)	
Number of blows per foot, N	Relative Density	Number of blows per foot, N	Consistency
		Below 2	Very Soft
0 – 4	Very Loose	2 – 4	Soft
4 – 10	Loose	4 – 8	Medium
10 – 30	Medium	8 – 15	Stiff
30 – 50	Dense	15 – 30	Very Stiff
Over 50	Very Dense	Over 30	Hard

TERMS IDENTIFYING COMPOSITION OF SOIL

Written*	Defining Range of Percentage by Weight
and	35 to 50
some	20 to 35
little	10 to 20
trace	0 to 10

*Plus (+) or minus sign (–) used after identifying term denotes extremes of range; e.g., "some (–) Gravel" indicates 20 to 24% Gravel; "some (+) Gravel" indicates 31 to 35% Gravel.

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-1S

SHEET NO. 1 **OF** 1

PROJECT: MAHOPAC RI/FS

CLIENT: NYSDEC

BORING CONTRACTOR: MINNESOTA WELL DRILLERS

JOB NO. 07509

ELEVATION 677.97

DATE STARTED 4-14-88

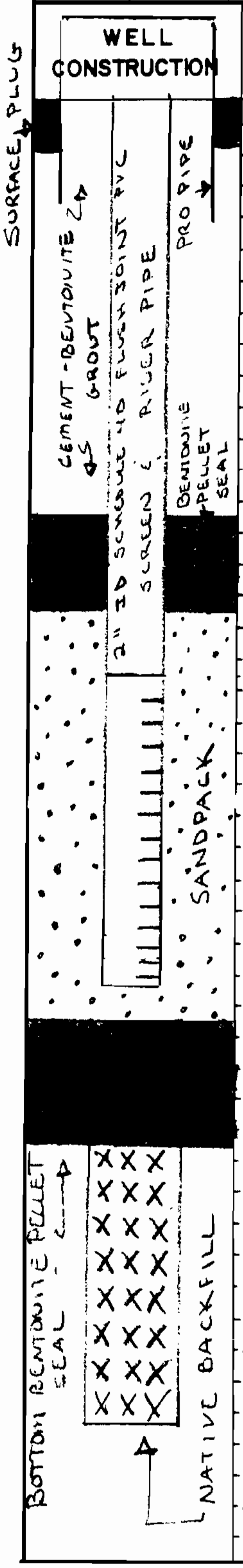
DATE FINISHED 4-25-88

DRILLER T. ERVIN

INSPECTOR LFC

GROUND WATER			
DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	AUGER	SS	NX	
DIA.	6 1/4"	2"	3"	
WT.				
FALL				



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	S1	SS	8-7, 9-15	**FILL / REWORKED SOIL**	6 1/4" ID HOLLOW STEM AUGERS ADVANCED TO 31', AIR HAMMER TO 32.3', NX CORE W/AIR TO 42.3'.
	S2	SS	18-13, 15-14	Yellow Brown f-mc SAND, some (-) Silt, little f-mc Gravel, tr. Clay, Dry 1.5'	
5	S3	SS	14-14, 10-8	Dk. Gray c SAND with CINDERS (ARBED) 2.5'	
	S4	SS	9-11, 31-28	Light Brown fine SAND, little silt, tr f-m Gravel, Damp 7.0'	W.T.
	S5	SS	6-7, 7-11	Light Brown c SAND, and f-m Gravel, tr. Silt, SATURATED 8.0'	@8' Pockets of c SAND and f-m Gravel
10	S6	SS	4-3, 6-4		
	S7	SS	WR-3, 2-4	Brown fine SAND, and to some clayey Silt, little (-) f-m Gravel, Sat. 12.0'	
15	S8	SS	WR-3, 2-4		
	S9	SS	10-19, 13-15	**GLACIAL OUTWASH**	
	S10	SS	16-16, 25-25	Yellow Brown c-m-f sand, some Silt, some m-f Gravel, Loose to medium Dense, SAT.	
20	S11	SS	71-17, 15-12	Grades to Yel. Br. c-m-f SAND, and (-) Silt, little (+) m-f Gravel 23.5'	
	S12	SS	7, 8-7		
25	S13	SS	3-9		
	S14	SS	9-15, 27-31	Greenish Gray Brown c-m-f sand, some to and clayey silt, some m-f Gravel	
	S15	SS	15-24, 17-31		
30	S16	SS	9-10, 50/1"	Grades to Gray Brown Cl. SILT, and f Sand, little f-mc Gravel, med. Dense. 31.0'	Partings of mc SAND, some f-m Gravel
35	RUN 1	NX CORE	32.3' TO 42.3'	**BEDROCK**	RUN 1 32.3' to 42.3'
40				GRANITIC GNEISS, MOSTLY DK+LT. GRAY W/ GREEN AND WHITE MINERALS. SPECKLED AND BANDED FELDSPATHIC & MAFIC MINERALS. VERY HARD. MINOR HOR. FRACTURES. 42.3'	RECOVERY = 100% RQD = 0.98 NX CORE
45					

E.O.B @ 42.3' BGS

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-1I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 1 OF 3
CLIENT: NYSDEC	JOB NO. 07509.03
BORING CONTRACTOR: MINNESOTA WELL DRILLING (SUB TO ANDERSON DRILLING)	ELEVATION 677.74
GROUND WATER	DATE STARTED 3-26-88
	DATE FINISHED 3-28-88
	DRILLER NORMAN ANDERSON
	INSPECTOR LFC

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	CORED	CHIPS		
DIA.	6"	OR		
WT.		CUTTINGS		
FALL				

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
6" STEEL WORKING CASING; CEMENT - BENTONITE GROUT MIX; 2" ID FLUSH JOINT SCHEDULE 40 PVC RISER PIPE	0				REFER TO MW-1S TEST BORING LOG FOR DETAILED SOIL DESCRIPTIONS FROM 0 TO 31.0' B.G.S.	8" BOREHOLE ADVANCED TO 41.0' BGS VIA MUD ROTARY DRILLING. 6" ID STEEL CASING INSTALLED TO 41.0' BGS. 6" OPEN ROCK BOREHOLE ADVANCED TO 131.8' BGS VIA PNEUMATIC AIR HAMMER DRILLING.
	5					
	10					
	15				W.L = 14.0 BGS	
	20					
	25					
	30				31.0'	
	35				BEDROCK (MAHOPAC GNEISS)	
	40					
	45					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-1I

PROJECT : MAHOPAC BUSINESS DISTRICT RI/FS
SHEET NO. 2 **OF** 3
CLIENT : NYSDEC
JOB NO. 07509.03

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	45			S-1 41' to 60'	BEDROCK (MAHOPAC GNEISS) Gray + PINK WASH COLOR MOSTLY BLACK + WHITE, PINK ROCK CHIPS, OCCASIONAL PINK BAND.	BANDED
	50					
	55					
	60			S-2 60' to 80'	Gray wash w/ zones of PINK + WHITE.	
	65					
	70					
	75					
	80			S-3 80' to 100'	Gray Green to Black wash. DK. Gray, Green + Black Rock chips	5-8 gpm.
	85					
	90					90' Fracturing (minor)
	95					

CEMENT/BENTONITE GROUT MIXTURE

2" ID FLUSH JOINT SCHEDULE 40 PVC RISER PIPE

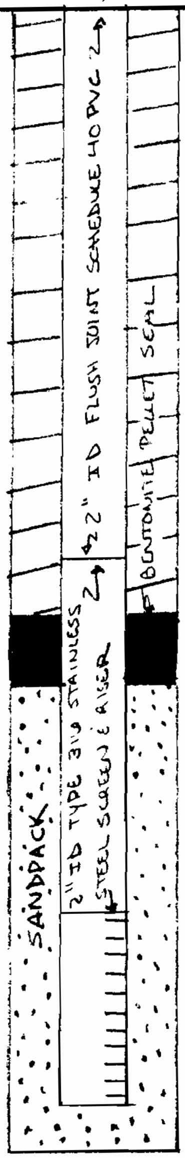
WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-1I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
SHEET NO. 3 **OF** 3
CLIENT: NYSDEC
JOB NO. 07509.03

WELL CONSTRUCTION



DEPTH IN FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
95				BEDROCK (MAHOPAC GNEISS)	Fracture @ 98' (major)
105			S-4 100 to 120'	Gray + milky Gray wash Gray, Black + white Rock chips.	
125			S-5 120' to 131'	Gray (Dark) wash Banded Black + White Rock chips.	YIELD ≡ 8 GPM VIA DRILL STEM TESTING.
				END OF BORING @ 131.8'	NOTE: 2" ID MONITORING WELL INSTALLED BY KENDRICK DRILLING START: 7/5/88 FINISH: 7/6/88

Depth scale: 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

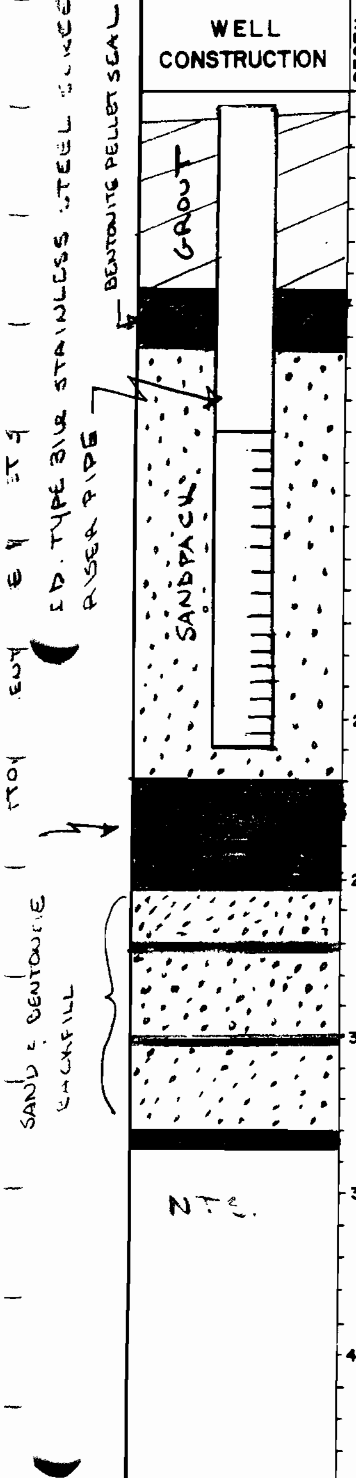
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	BORING NO. MW-2S
CLIENT: NYSDEC	SHEET NO. 1 OF 1
BORING CONTRACTOR: MINNESOTA WELL DRILLERS	JOB NO. 07509-03
	ELEVATION 666.00
	DATE STARTED 4-26-88
	DATE FINISHED 4-28-88
	DRILLER T. ERVIN
	INSPECTOR LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	AUGER	SS	NX	
DIA.	6 1/4"	2"	3"	
WT.		140 #		
FALL		30"		

WELL CONSTRUCTION



SAMPLE

NO.	TYPE	BLOWS PER 6 INCHES
S1	SS	7-16 / 16-25
S2	SS	16-16 / 20-15
S3	SS	10-17 / 12-9
S4	SS	9-10 / 13-18
S5	SS	6-8 / 14-20
S6	SS	20-25 / 31-53
S7	SS	20-33 / 34-19
S8	SS	2-6 / 12-21
S9	SS	7-16 / 24-43
S10	SS	11-23 / 26-24
S11	SS	55-66 / 76-75/3"
S12	SS	50/3"
RUN 1	NX CORE	27.21' TO 33.21'

CLASSIFICATION

BLACKTOP, GRAVEL & STONE 0.5'

FILL/REWORKED SOIL

Pale to Dk. Orange Brown fmc SAND, tr to little Silt, tr(s) fmc Gravel, Damp, mottled ~4.0'

GLACIAL OUTWASH

Dk. orange Brown fmc SAND, little(s) Silt, tr(s) fmc Gravel, moist to wet, med. Dense

@7' Grades to: Brown cmf SAND, tr Gravel, tr. Silt Alternating w/ Gray Brown f Sand, Some Silt, little Gravel

@11' Grades to: Yellow Brown cmf Sand, and(s) Cl. Silt, some mf Gravel

@15' Grades to: Yellow Brown cmf SAND, tr. to little Silt, occ. Silt parting

@18.5' Grades to: Yellow Brown SILT, and(s) cmf Sand, tr. f Gravel

@20' Gray Br. f SAND, some Silt, laminated, pockets of Brown cmf SAND and f Gravel 22.0'

DECOMPOSED BEDROCK

HIGHLY WEATHERED GRANITIC GNEISS, INCOMPETENT, FRACTURED 24.6'

BEDROCK

COMPETENT GRANITIC GNEISS GRAY, WHITE + GREEN MINERALS VERY HARD. HORIZONTAL FRACTURES. BANDED. 33.21'

E.O.B. @ 33.21' BGS

REMARKS

ADVANCED 6 1/4" ID HOLLOW STEM AUGERS TO 23.1' BGS. AIR HAMMER TO 27.21', NX CORE TO 33.21'

W.T (~7.5 BGS)

occ. cobble

occ. SILT PARTING

SOFT TO ~25' WEATHERED + FRACTURED

NX CORE RUN 1 27.21' to 33.21' RECOVERY = 89% RQD = 0.29

FRACTURE @ 33' CAUSES END OF CORE.

WEHRAN ENGINEERING
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TEST BORING LOG

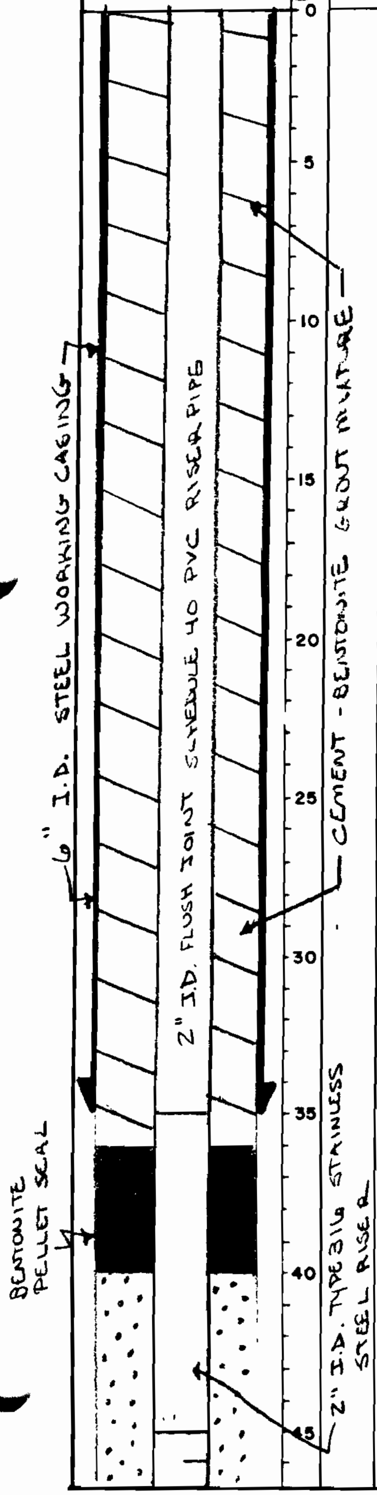
BORING NO. MW-2I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
BORING CONTRACTOR: KENDRICK DRILLING INC.

GROUND WATER					CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE		NONE		
				DIA.				
				WT.				
				FALL				

SHEET NO. 1 OF 3
JOB NO. 07509
ELEVATION 666.20
DATE STARTED 4-29-88
DATE FINISHED 8-18-88
DRILLER W. ERVIN / T. KENDRICK
INSPECTOR LFC

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS



CLASSIFICATION

REFER TO MW-2S TEST BORING LOG FOR DETAILED SOIL DESCRIPTIONS FROM 0 TO 22.0' BGS.

W.L. = 9.5' BGS

22.0'

BEDROCK

DECOMPOSED GRANITIC GNEISS INCOMPETENT, HIGHLY FRACTURED & WEATHERED

25.25'

(MAHOPAC GNEISS)

REMARKS

8" I.D. BOREHOLE ADVANCED TO 35' BGS., VIA MUD ROTARY DRILLING

6" ID STEEL CASING INSTALLED TO 35' BGS.

6" OPEN BEDROCK WELL ADVANCED TO 101' BGS VIA AIR HAMMER DRILLING.

WEATHERED BEDROCK FROM 22.0' TO 25.25'

36' Fracture (major)

WEHRAN ENGINEERING
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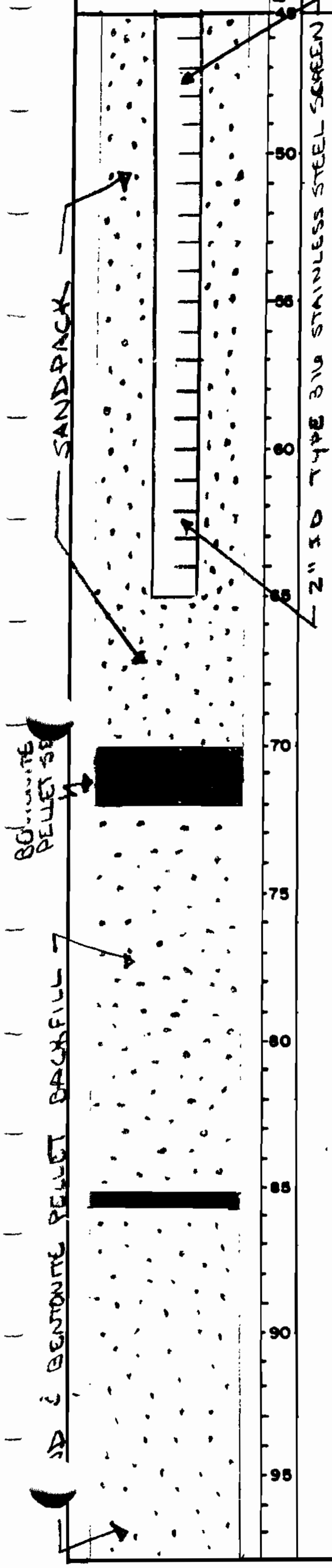
TEST BORING LOG

BORING NO. MW-2I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	**SHEET NO.** 2 **OF** 3
CLIENT: NYSDEC	**JOB NO.** 07509



WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	48				BEDROCK	48' Fracture (major)
					(MAHOPAC GNEISS)	49' Fracture (major)
						54', Fracture (major)
						55' Fracture (minor)
						60' Fracture ?
						65' Fracture ?
						80' Fracture (major?)

WEHRAN ENGINEERING
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TEST BORING LOG
BORING NO. MW-2I

PROJECT : MAHOPAC BUSINESS DISTRICT RI/FS
SHEET NO. 3 OF 3
CLIENT : NYSDEC
JOB NO. 07509

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	95				BEDROCK (MAHOPAC GNEISS)	YIELD = 10-15 gpm
	100				101.0'	NOTE: 2" I.D. MONITORING WELL INSTALLED BY KENDRICK DRILLING INC.
BOTTOM BENTONITE PELLET SEAL					END OF BOREHOLE	START: 9/23/88
	105					FINISH: 10/5/88
	110					
	115					
	120					
	125					
	130					
	135					
	140					
	145					

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TEST BORING LOG

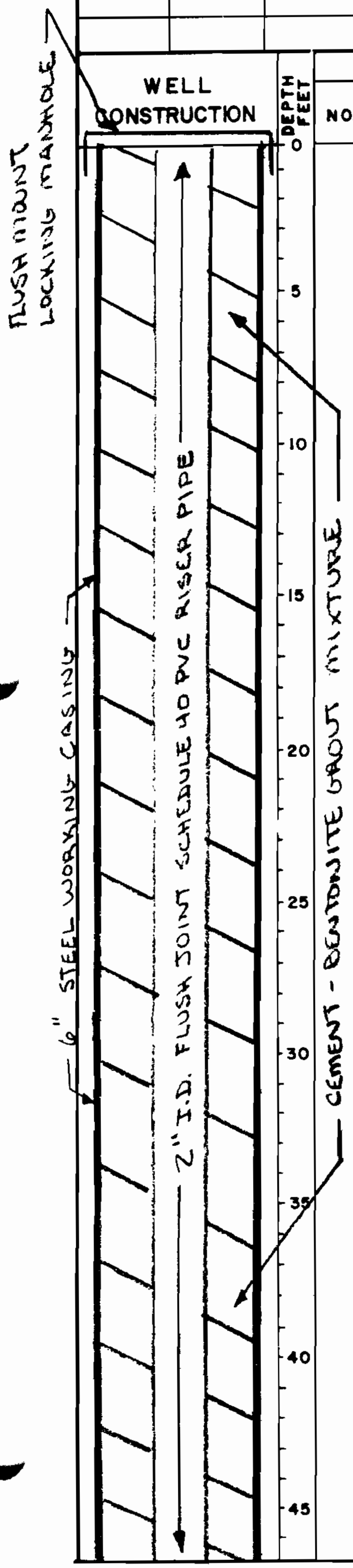
BORING NO. MW-2D

PROJECT: MAHOPAC BUSINESS DISTRICT RI / FS	SHEET NO. 1 OF 9
CLIENT: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERV.	JOB NO. 07509
BORING CONTRACTOR: MINNESOTA WELL DRILLERS	ELEVATION 666.10
	DATE STARTED 3-19-88
	DATE FINISHED 3-28-88
	DRILLER ANDERSON / LAVIN
	INSPECTOR LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		CHIPS		
DIA.	6"	OR		
WT.		CUTTINGS		
FALL				

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0–45				SEE MW-2S TEST BORING LOG FOR DETAILED SOIL DESCRIPTIONS FROM 0 TO 22 FEET BELOW GROUND SURFACE.	8" BOREHOLE ADVANCED VIA MUD ROTARY DRILLING TO 49.5' B.G.S. 6" STEEL CASING INSTALLED TO 49.5' B.G.S. OPEN 6" BOREHOLE ADVANCED TO 400.5' BGS. VIA PNEUMATIC AIR HAMMER DRILLING.
					GLACIAL DEPOSITS	
	22.0'				BEDROCK	WEATHERED BEDROCK FROM 22.0' to 25.25'
					DECOMPOSED GRANITIC GNEISS INCOMPETENT, HIGHLY FRACTURED	
	25.25				(MAHOPAC GNEISS)	
					Granitic Gneiss Black & white Banded Very Hard, competent Fractures occur at discrete intervals. Foliated, medium grained.	MINERALOGY INCLUDES: BIOTITE, HORNBLENDE, QTZ, FELDSPAR, PLAGIOCLASE, PYROXENE, MAGNETITE, SPHENE, Microcline etc

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-2D

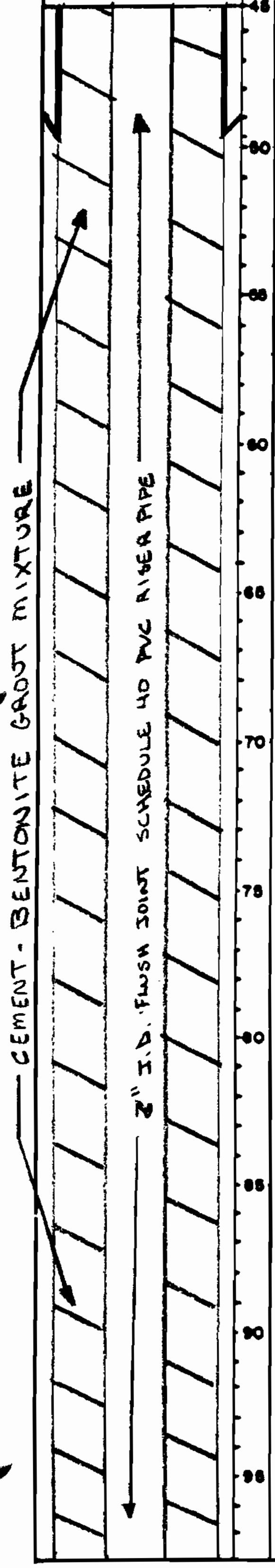
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS

SHEET NO. 2 OF 9

CLIENT: NYSDEC

JOB NO. 07509

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
45				BEDROCK	
				(MAHOPAC GNEISS)	
50					GROUNDWATER ENCOUNTERED @ 51 OR 51.5'
			S-1		5 to 8 GPM
55			50' to 60'	Gray wash Color Very Hard Black + white rock chips	52-53' } MAJOR 54-55' } FRACTURES 56' Fracture (major) 57' Fracture (major)
60					61-62' Fracture (minor)
65					66' } 67' } 68' } MAJOR FRACTURES 69' }
			S-2		
70			60' to 80'	Gray to Dk Gray wash Black + white rock chips.	Very hard ~15 to 20 gpm.
75					
80					79-80' MAJOR FRACTURE
85					
			S-3		
90			80' to 100'	Light Gray wash Black, Gray, white rock chips.	
95					@ 96' SOFT DRILLING

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TEST BORING LOG
BORING NO. MW-2D
SHEET NO. 3 **OF** 9
JOB NO. 07509

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC

WELL CONSTRUCTION: CEMENT - BENTONITE GROUT MIXTURE; 2" I.D. FLUSH JOINT SCHEDULE 40 PVC RISER PIPE

DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
95				BEDROCK (MAHOPAC GNEISS)	
100			S-4 100' to 109'	Gray water Dk & Lt Gray and Black, white rock chips.	
105					
110					
115					114' Fracture (minor)
120					
125					
130			S-5 120' to 140'	Milky gray color water Dk Gray + Black, white rock chips	25 GPM (+)
135					
140					
145					

WEHRAN ENGINEERING
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TEST BORING LOG

BORING NO. MW-2D
SHEET NO. 4 OF 9
JOB NO. 07509

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
CEMENT-BENTONITE GROUT MIXTURE; 2" I.D. FLUSH JOINT SCHED. 40 PVC RISER PIPE	145				BEDROCK	
				S-6	(MAHOPAC GNEISS)	
	150			140' to 160'	Greenish Gray wash Green, DK gray to Black, and white rock chips	~30 gpm(±) Extremely Hard.
	155					
	160					159' Fracture (minor)
						163' Fracture (minor)
	165					
				S-7		
	170			160' to 180'	Green Gray wash DK Gray, Green, Black + white chips.	~40 gpm(±)
	175					@170 to 175' Pink + white Vein of Qtz - Feldspar.
	180					180' Fracture (minor)
						183' Fracture (minor)
	185					
				S-8		
	190			180' to 200'	Green Gray wash DK Gray, Green, Black & white rock chips.	
	195					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-2D

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 5 OF 9
CLIENT: NYSDEC	JOB NO. 07509

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
CEMENT - BENTONITE GROUT MIXTURE; 2" I.D. FLUSH JOINT SCHEDULE 40 PVC RISER PIPE	195				BEDROCK (MAHOPAC GNEISS)	
	200					
	205					205' Fracture (minor)
				S-9 200' to 220'	Gray Green Wash; DK. Gray, Black, Green, and white rock chips.	
	210					211' Fracture (filled?)
	215					217' Fracture (minor) (filled)
	220					220' Fracture (minor)
	225					
				S-10 220' to 240'	Green Gray Wash; Green, Gray rock chips (less Black + white)	
	230					40 to 50 gpm.
	235					
	240					241' Fracture (minor)
	245					

WEHRAN ENGINEERING CONSULTING ENGINEERS	**TEST BORING LOG**
	BORING NO. MW-2D
PROJECT : MAHOPAC BUSINESS DISTRICT RI/FS	**SHEET NO.** 6 **OF** 9
CLIENT : NYSDEC	**JOB NO.** 07509

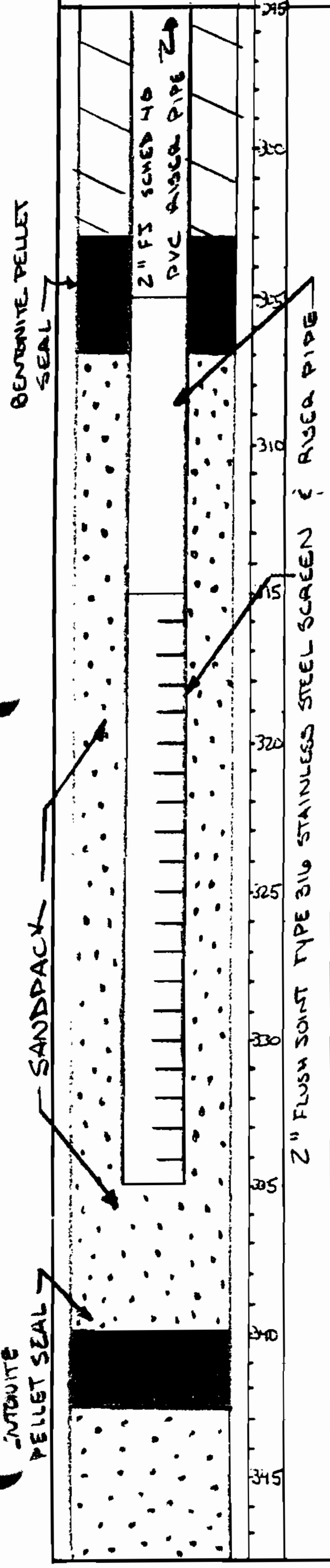
WELL CONSTRUCTION: CEMENT - BENTONITE GROUT MIXTURE; 2" FLUSH JOINT SCHEDULE 40 PVC RISER PIPE

DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
245				BEDROCK (MAHOPAC GNEISS)	
250			S-12 240' to 260'	Light Gray to Pink to Gray wash. Gray, Black, White and Pink rock chips.	252' Fracture (minor) 253' " " 257' Fracture (minor)
255					
260					261' Fracture (major) 262' Fracture (minor)
265					
270			S-13 260' to 280'	"	270' Fracture (minor)
275					
280					
285					
290			S-14 280' to 300'	Black to Dk Gray wash w/zones of milky gray + pink wash	292' Fracture (minor)
295					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-2D
SHEET NO. 7 **OF** 9
JOB NO. 07509

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC



Depth (feet)	Sample No.	Type	Blows per 6 inches	Classification	Remarks
295				BEDROCK (MAHOPAC GNEISS)	
300					
305					
	S-15		300' to 320'	Green Gray to Milky Gray wash	309' Fracture (minor)
310				Mostly Gray, Black + white, and Green chips.	315' Fracture (filled)
315					317' Fracture (filled)
320					319' to 320' major Fractures
					322' Fracture (minor)
325					
	S-16		320' to 340'	Green Gray to Dk Gray w/ white Banding.	329' 330 minor Fractures
330					
335					334 - 335 fractures (minor)
340					341' Fracture (minor)
					343' Fracture (minor)
345					345' Fracture (minor)
					347' Fracture (minor)

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG	
BORING NO.	MW-2D
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	**SHEET NO.** 8 **OF** 9
CLIENT: NYSDEC	**JOB NO.** 07504

WELL CONSTRUCTION: INTERLAYERED SAND & BENTONITE PELLET BACKFILL

DEPTH IN FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
345				BEDROCK	345 Fracture (minor)
					347 Fracture (minor)
			S-17	(MAHOPAC GNEISS)	348-350' minor Fractures
350			340' to 360'	Rose to Reddish Brown wash color	
355				Gray, white, Brown, Pink/rose rock chips.	355' Fracture (minor)
360					359' Fracture (minor)
					361' Fracture (minor)
365					
			S-18		
370			360' to 380'	PINK WASH	
				WHITE + PINK QTZ-FELDSPAR ROCK CHIPS.	
375					
380					379' Fracture (minor)
					380' " "
					381' " "
385					
			S-19	GRAY + PINK WASH	
390			380' to 400.5'	GRAY, WHITE, BLACK + PINK ROCK CHIPS.	393' Fracture (filled)
					395' " "
395					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-2D

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
SHEET NO. 9 OF 9
JOB NO. 07509

WELL CONSTRUCTION	DEPTH IN FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	396				BEDROCK (MAHOPAC GNEISS)	~ 50 gpm.
BOTTOM BENTONITE PELLET SEAL	400				400.5'	DEVELOP OPEN BEDROCK WELL FOR 4 HR VIA DRILL STEM DEVELOPMENT.
					END OF BOREHOLE	
	405					
						NOTE: 2" ID MONITORING WELL INSTALLED BY: KENDRICK DRILLING INC. START: 10/4/88 FINISH: 10/10/88

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-3S

PROJECT:	MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT:	NYSDEC
BORING CONTRACTOR:	KENDRICK DRILLING INC.
SHEET NO.	1 OF 2
JOB NO.	07509.03
ELEVATION	660.90
DATE STARTED	6-22-88
DATE FINISHED	6-26-88
DRILLER	JOHN STEVENSON
INSPECTOR	LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FJ	SS	NX	
DIA.	4"	2"	3"	
WT.	300#	140#		
FALL	30"	30"		

WELL CONSTRUCTION: CEMENT - BENTONITE GROUT

DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES
0	S1	SS	17-40 / 30-4
	S2	SS	11-11 / 9-5
5	S3	SS	10-12 / 5-3
	S4	SS	3-2 / 3-2
	S5	SS	1-2 / 1-2
10	S6	SS	1-0 / 1-2
	S7	SS	1-2 / 3-3
15	S8	SS	1-2 / 3-3
	S9	SS	1-2 / 2-3
	S10	SS	2-2 / 2-2
20	S11	SS	WOR-WOR / 2-6
	S12	SS	2-3 / 3-6
25	S13	SS	WOR-3 / 3-3
	S14	SS	8-10 / 15-21
	S15	SS	12-17 / 26-17
30	S16	SS	12-10 / 9-13
	S17	SS	21-12 / 11-9
35	S18	SS	12-9 / 12-19
	S19	SS	25-49 / 43-32
	S20	SS	30-71 / 100/2"
40	S21	SS	110-100*
	S22	SS	31*-69* / 68*-96*
45	S23	SS	45*-55* / 68*-86*

CLASSIFICATION

Stratum	Description	Bottom
FILL / REWORKED SOIL	Brown mottled Cl. SILT, and fmc Sand, tr. Gravel to Gray cr. fmc SAND, little Cl. Silt, little fm Gravel, med. Dense sat tr. PEAT DEPOSITS	~5.0'
RECENT ALLUVIAL SAND	Gray Brown fm SAND, little to some Cl. Silt, sat, Loose	8.6'
RECENT PEAT	Dk. Red Brown Decomposed VEGETATION, tr. Cl. Silt, tr. fm Sand, SAT, Loose plant material structure	17.5'
GLACIOLACUSTRINE	Gray CLAY & SILT, tr.(+) f Sand; to SILT & CLAY, little(-) f Sand; to Gray Silt some to and cmf Sand, laminated, Soft, sat	26.0'
GLACIAL OUTWASH	Gray cmf SAND, tr(+) Silt, tr(-) f Gravel @30' Grades to: Gray cmf SAND, some(-) Cl. Silt, little(-) mf Gravel @34' Gray cmf Sand, some cmf Gravel, some Cl. Silt	38.0'
GLACIAL TILL	Green Gray cmf Sand, and(+) Clayey Silt, little(-) mf Gravel, very Dense, Unsorted, Structure	

REMARKS

- ADVANCED 6 1/4" ID HOLLOW STEM AUGERS TO 28' BGS. DROVE 4" ID CASING TO 40' BGS. ADVANCED OPEN HOLE VIA MUD ROTARY TO 77' BGS.
- W.T. = ~1.5-2.0' BGS.
- Frequent interlayered lenses of f SAND and Silt (<1").
- occ Silt parting or f Sand parting
- occ. cobble
- Frequent Cobbles
- occ. Boulder

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-3S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS

SHEET NO. 2 OF 2

CLIENT: NYSDEC

JOB NO. 07509.03

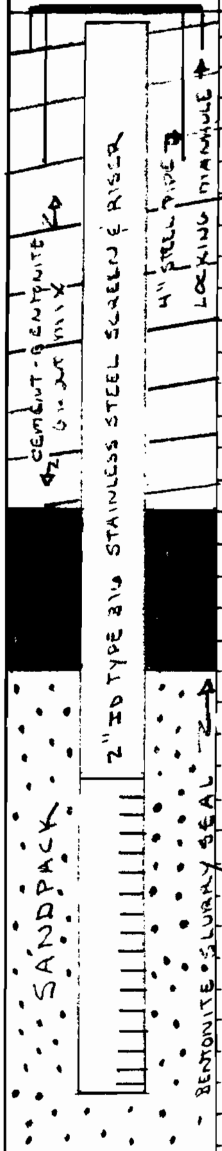
WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
CEMENT + BENTONITE GROUT MIX	45				GLACIAL TILL	
		S24	SS	24*-47* / 65*-55*	Green Gray cmf SAND,	Freq. Cobbles
		S25	SS	90*-104* / 81*	some cl. Silt, little fmc	Occ. Boulder
	50	S26	SS	14*-12* / 25*-102*	Gravel, V. Dense, unsorted	
						Grades to a more "SANDY TILL".
	55	S27	SS	58*-54* / 82*-55/3	Gray olive Brown fmc SAND, little cl. silt, trace fmc Gravel, v. Dense	occ. lense of gray cl. silt and f sand.
					60.5'	
	60				DECOMPOSED BEDROCK	
		S28	SS	112*/3"	WEATHERED GRANITIC GNEISS FRACTURED, INCOMPETENT	Rollerbit Hard + Soft from 60.5 to 65'.
					65.5'	
	65	S29	SS	75*-62/0*	BEDROCK	NX CORE
					GRAY GRANITIC GNEISS HIGHLY FRACTURED, WEATHERING DEPOSITS IN HORIZONTAL FRACTURE ZONES. HOR TO SUBVERTICAL FRACTURES. BANDED LIGHT FELDSPATHIC & ~~DARK~~ MAFIC MINERALS	RUN 1 67.0'-77.0'
	70	RUN 1	NX CORE	67.0' to 77.0'		RECOVERY = 88%
						RQD = 0.304
	75				77.0'	
N.T.S.					E.O.B. @ 77.0' BGS	
	80					
	85					
	90					
	95					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-3S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 1 OF 1
CLIENT: NYSDEC	JOB NO. 07509
BORING CONTRACTOR: KENDRICK DRILLING INC.	ELEVATION 660.90
	DATE STARTED 6-27-88
	DATE FINISHED 6-28-88
	DRILLER JOHN STEVENSON
	INSPECTOR LFC

GROUND WATER					CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE	FJ			
				DIA.	4"			
				WT.	300 #			
				FALL	30"			

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0, 5, 10, 15, 20, 25, 30, 35, 40, 45				PLEASE SEE TEST BORING LOG MW-3S FOR LITHOLOGY DESCRIPTION.	BOREHOLE FOR INITIAL TEST BORING GROUTED TO SURFACE. MW-3S MONITORING WELL INSTALLED ADJACENT TO THIS TEST BORING IN NEW BOREHOLE.

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-3I

SHEET NO. 1 OF 3

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS

CLIENT: NYSDEC

BORING CONTRACTOR: KENDRICK DRILLING INC.

JOB NO. 07509

ELEVATION 663.90

DATE STARTED 8-22-88

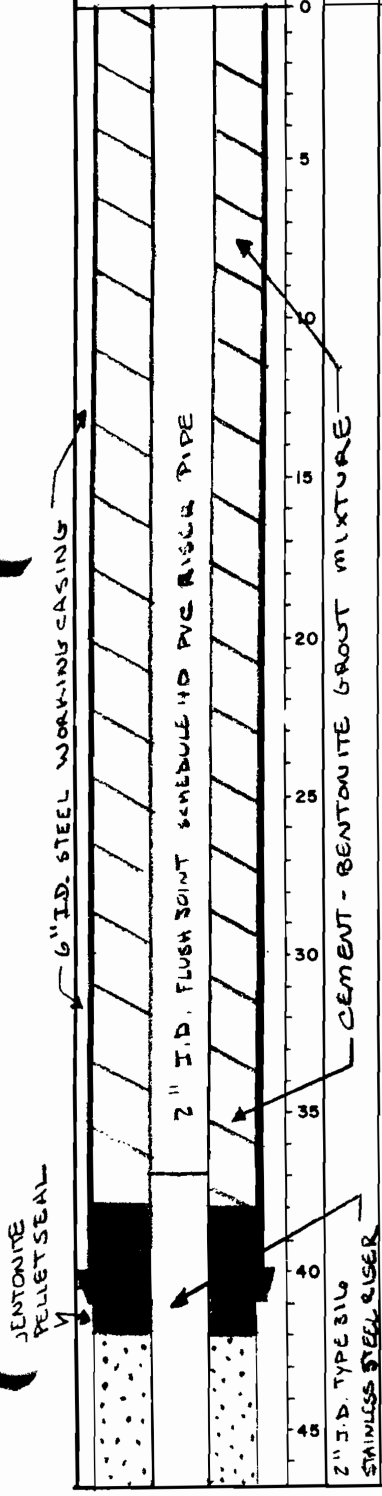
DATE FINISHED 8-23-88

DRILLER TERRY KENDRICK

INSPECTOR LFC

GROUND WATER			
DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		CHIPS		
DIA.		OR		
WT.		CUTTINGS		
FALL				

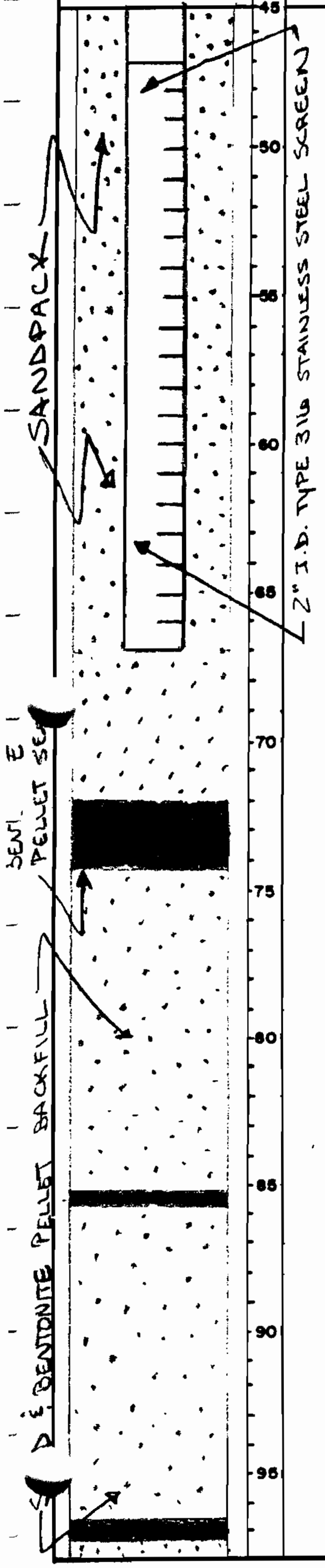
WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0				BLACKTOP, & GRAVEL	8" I.D. BOREHOLE ADVANCED TO 41.0' BELOW GROUND SURFACE VIA MUD ROTARY DRILLING.
					FILL / REWORKED SOIL	
	5				RECENT PEAT (?)	6" I.D. STEEL CASING INSTALLED TO 41.0' B.G.S.
	10				W.L. = 10.5' BGS	6" OPEN BEDROCK WELL ADVANCED TO 41.0' B.G.S. VIA pneumatic down-hole air HAMMER DRILLING.
	15					
	20				GLACIAL OUTWASH	NOTE: OVERBURDEN UNITS NOT SAMPLED AT THIS LOCATION. CONTACTS DETERMINED
	25				GLACIAL TILL	BASED ON DRILLING RATES, DRILL ACTION, AND WASH CONSTITUENTS.
	30				BEDROCK	THESE CONTACT DEPTHS SHOULD BE CONSIDERED ESTIMATES AT BEST.
	35				(MAHOPAC GNEISS)	
	40					41-44' Fractures (minor)
	45					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-3I
SHEET NO. 2 **OF** 3
JOB NO. 07509

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
45				BEDROCK	
			S-1	(MAHOPAC GNEISS)	
50			40' to 60'		50' Fracture (minor)
55				Brown to Orange wash color Orange Brown to pink rock chips, and Dk + Lt Brown chips; Soft Rock, lg chips (Pegmatite)	54' Fracture (minor)
					55' - 56' 57' Major Fracture
60					59' Fracture (minor)
					60' 61' MAJOR FRACTURE
65					
			S-2	SOFT + HARD TO ...	68' Fracture (MAJOR)
70			60' to 80'	Dk Gray to light brown Gray wash color	70' Fracture (filled)
				Gray, Black and white chips, Speckled and banded.	72' " "
75					
80					81' Fracture (major)
					82' Fracture (minor)
85					
			S-3	Mostly Green Gray wash w/ zones of Brown/orange + Gray Brown wash	
90			80' to 100'		93' Fracture (major)
95				Dk Gray, Black + white chips w/ Brown + Orange Bands in Fractures.	95' Fracture (minor)

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-3I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS

SHEET NO. 3 **OF** 3

CLIENT: NYSDEC

JOB NO. 07509

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	95				BEDROCK	
					(MAHOPAC GNEISS)	98' Fracture (minor filled?)
SAND & BENTONITE PELLET BACKFILL	100					
	105					106' Fracture (minor)
				S-4	Green Gray wash	
	110			100' to 120'	Gray, Green, Black + white chips.	
	115					
	120					
	125					
				S-5	Green Gray wash	
	130			120' to 141'	Gray, Green, Black + white rock chips.	
	135					YIELD = 50 gpm VIA DRILL STEM TEST NO.
	140				141.0'	
BOTTOM BENTONITE PELLET SEAL					END OF BOREHOLE	NOTE: 2" I.D MONITORING WELL INSTALLED BY KENDRICK DRILLING INC. START: 9-23-88 FINISH: 10-5-88
	145					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

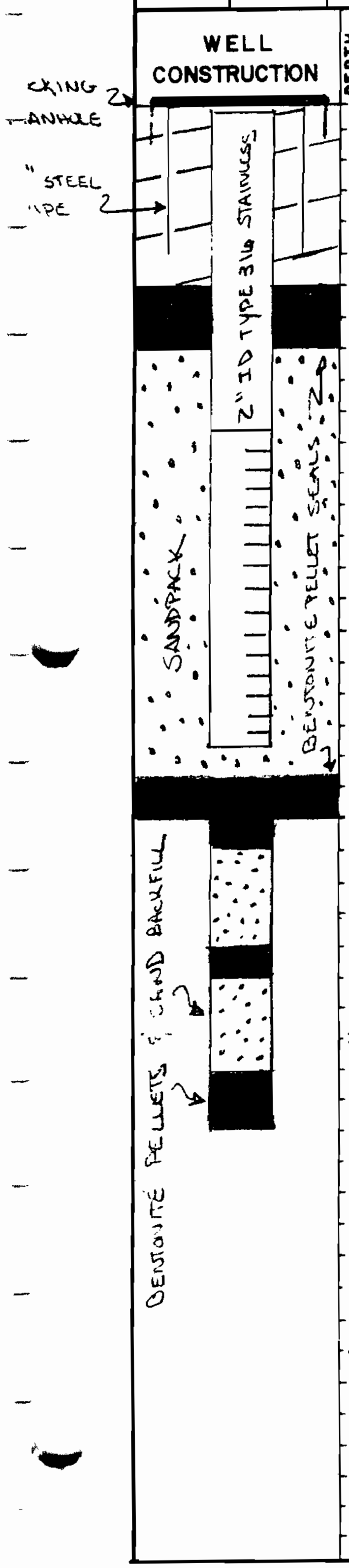
BORING NO. MW-4S
SHEET NO. 1 OF 1
JOB NO. 07509.03
ELEVATION 673.60
DATE STARTED 6-30-88
DATE FINISHED 7-1-88
DRILLER JOHN STEVENSON
INSPECTOR LFC

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
BORING CONTRACTOR: KENDRICK DRILLING INC.

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FJ	SS	NX	
DIA.	4"	2"	3"	
WT.	300#	140#		
FALL	30"	30"		



DEPTH FEET	NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	S1	SS	4-12 / 8-7	WEATHERED TILL	DROVE 4" CASING TO 23' BGS.
	S2	SS	7-13 / 21-28	Yellow Brown cmf Sand, and Silt, little(-) mf Gravel, occ. cobble	
5	S3	SS	28-35 / 48-56		
	S4	SS	26*-21* / 12*-18*		
	S5	SS	18*-19* / 16*-25*	10'	
10	S6	SS	24*-21* / 18*-19*	DECOMPOSED BEDROCK	
	S7	SS	23*-22* / 26*-26*	Highly weathered Rock, Residual Granitic Gneiss	W.T. (~13.5')
15	S8	SS	17*-23* / 17*-9*	"Yellow Brown cmf Sand, Some(-) Silt, trace Gravel"	
	S9	SS	9*-10* / 23*-11*		NOTE: ABLE TO "SPOON" DECOMPOSED ROCK
	S10	SS	3*-6* / 11*-11*	INCOMPETENT, FRACTURED,	
20	S11	SS	17*-30* / 50*-100/4	DENSE TO V. DENSE	
	S12	SS	100*/6"	BEDROCK	NX CORE RUN 1 23.0' to 33.0'
25	RUN 1	NX CORE	23.0' to 33.0'	GRANITIC GNEISS, WHITE, TO LT GRAY & PINK. SOFT BUT MORE COMPETENT SPECKLED APPEARANCE. HORIZONTAL FRACTURES.	RECOVERY = 80% RQD = 0.40
30				33.0'	
35				E.O.B. @ 33' BGS.	
40					
45					

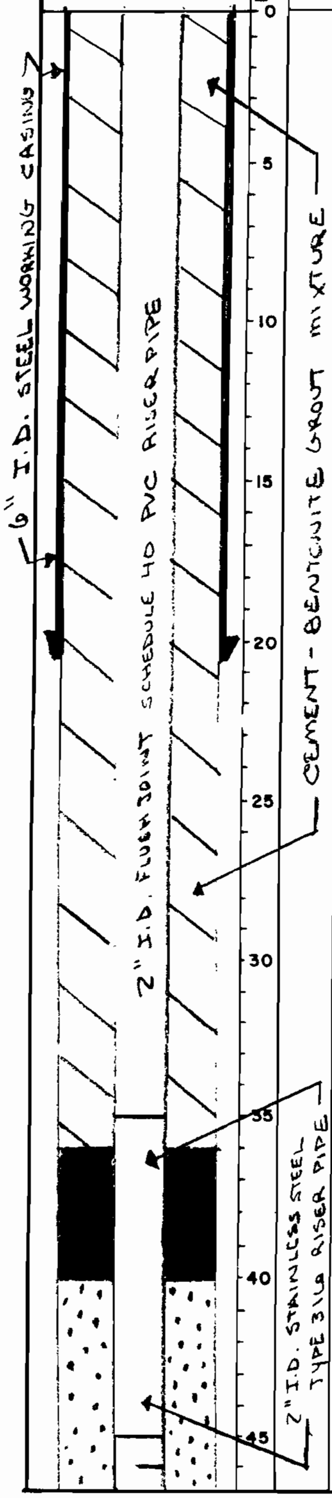
WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

PROJECT : MAHOPAC BUSINESS DISTRICT RI/FS	BORING NO. MW-5I
CLIENT : NYSDEC	SHEET NO. 1 OF 3
	JOB NO. 07509
BORING CONTRACTOR : KENDRICK DRILLING INC.	ELEVATION 663.50

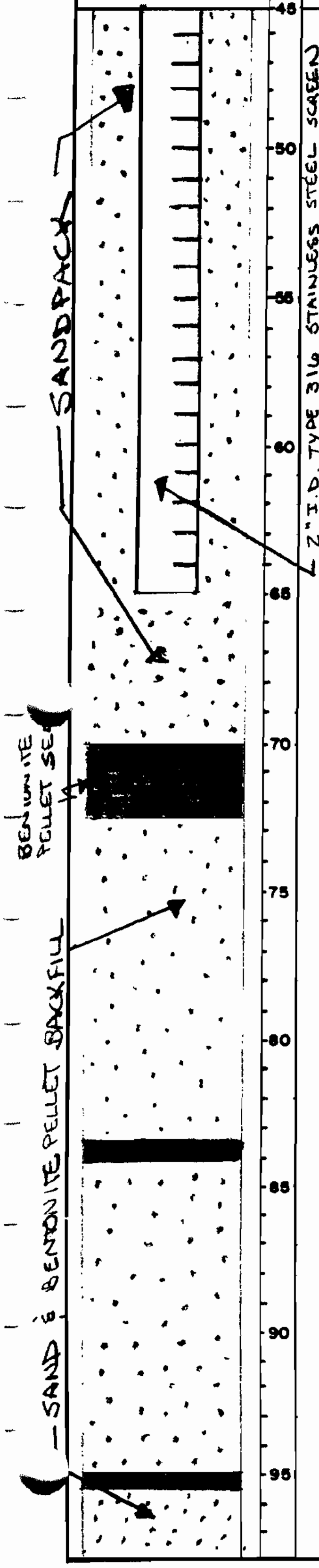
GROUND WATER					CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE		CHIPS		
				DIA.		OR		
				WT.		CUTTINGS		
				FALL				

DATE STARTED 8-11-88
DATE FINISHED 8-12-88
DRILLER TERRY KENDRICK
INSPECTOR LFZ



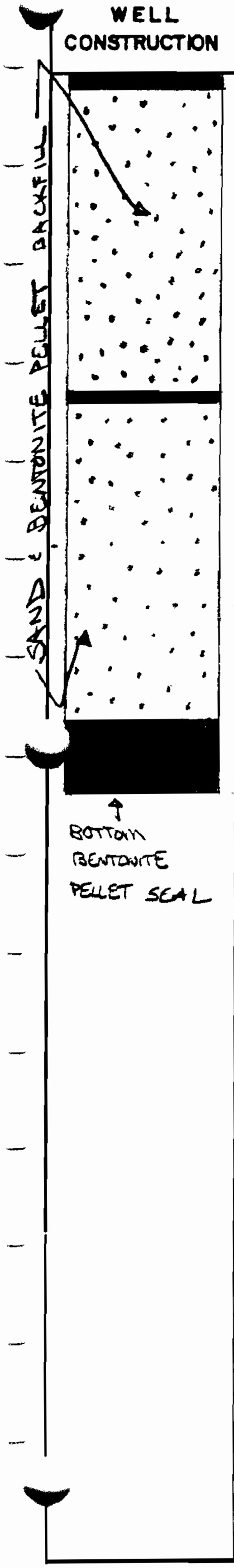
DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0–9.5				GLACIAL OUTWASH ∇ W.L. = 5.5' BGS ~9.5'	8" BOREHOLE ADVANCED TO 20.5 FEET BELOW GROUND SURFACE VIA AIR ROTARY DRILLING. 6" I.D. STEEL CASING INSTALLED TO 20.5 FT BGS.
9.5–	S-1		0' to 20'	BEDROCK (MAHOPAC GNEISS)	6" OPEN BEDROCK WELL ADVANCED TO 120.5' BGS. VIA DOWN-HOLE PNEUMATIC AIR HAMMER DRILLING.
20					20-21' Fracture (major)
30	S-2		20' to 40'	Gray to Green Gray water Predominantly Black + Gray. Gray Black + White chips (some Green)	~2 GPM
36					36' Fracture (minor)
41					41' Fracture (minor)
42					42' Fracture (major)
46					46' Fracture (major)

WEHRAN ENGINEERING CONSULTING ENGINEERS	TEST BORING LOG
	BORING NO. MW-5I
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 2 OF 3
CLIENT: NYSDEC	JOB NO. 07509



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
45				BEDROCK	46' Fracture (major)
				(MAHOPAC GNEISS)	
			S-3		48' Fracture (minor)
					49' Fracture (MAJOR)
50			40' to 60'		50' Fracture (major)
				Gray to [illegible] to gray wash. Gray, Black white, green and tan minerals.	53' Fracture (minor)
55					55' Fracture (minor)
				~5 GPM	58' Fracture (minor)
60					59' Fracture (major)
					62' Fracture (filled)
65					65' Fracture (minor)
					66' Fracture (major)
			S-4		68' Fracture (minor)
70			60' to 80'	Gray green [illegible] wash color. Gray green, Black, white. Speckled + Banding evident.	
					73' Fracture (minor)
75					~5 GPM
80					
85					
			S-5		
90			80' to 100'	Gray to lt green gray wash. Gray, green, white and Black, chips.	
95					

WEHRAN ENGINEERING CONSULTING ENGINEERS	TEST BORING LOG
	BORING NO. MW-5I
PROJECT : MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 3 OF 3
CLIENT : NYSDEC	JOB NO. 07509



WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	95				BEDROCK (MAHOPAC GNEISS)	
	100					
	105					
				S-6		
	110			100' to 120.5'	Gray Green wash color	(111-112') Fracture (minor)
					Black, Gray, White and green rock chips	
	115					
						YIELD = 16 GPM
	120				120.5'	Via [illegible] stem test [illegible].
					END OF BOREHOLE	
	125					NOTE: 2" I.D. MONITORING WELL INSTALLED BY KENDRICK DRILLING INC.
						START: 9/23/88
	130					FINISH: 10/6/88
	135					
	140					
	145					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

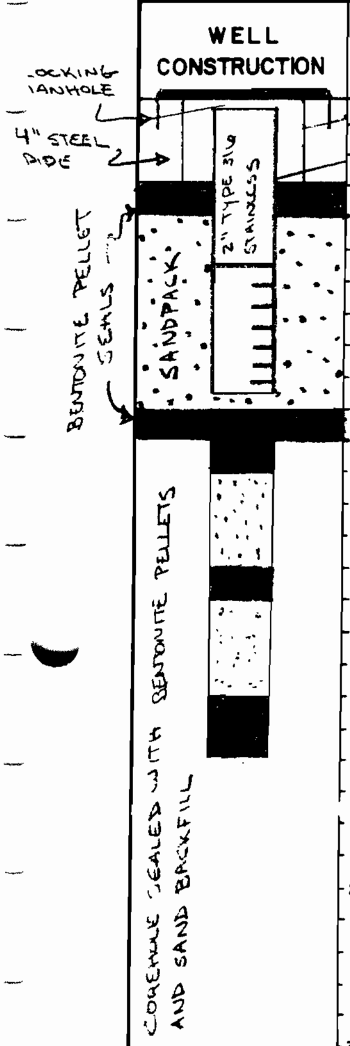
BORING NO. MW-6S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 1 OF 1
CLIENT: NYSDEC	JOB NO. 07509.03
BORING CONTRACTOR: KENDRICK DRILLING INC.	ELEVATION 666.43
	DATE STARTED 6-28-88
	DATE FINISHED 6-29-88
	DRILLER JOHN STEVENSON
	INSPECTOR LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FJ	SS	NX	
DIA.	4"	2"	3"	
WT.	300#	140#		
FALL	30"	30"		



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	S1	SS	4 / 2-3	BLACKTOP & C STONE, GRAVEL ½'	Drove 4" ID CASING TO 10' BGS.
	S2	SS	3-7 / 13-16	FILL / REWORKED SOIL Orange and Brown cmf SAND, some to little fm Gravel, tr to little cl. Silt, Damp, loose (mat)	
5	S3	SS	25-37 / 29-27		MULTICOLORED FILL MOTTLED IN PLACES.
	S4	SS	26-50 / 19-16	Yellow Brown cmf Sand, some Silt, and cs mf Gravel, sat Dense to V. Dense	▽ W.T.
10	S5	SS	12-7 / 8-65/3"	9.5'	
15	RUN 1	NX CORE	11.0' to 21.0'	BEDROCK GRAY GRANITIC GNEISS BANDED and SPECKLED, LT + DK GRAY, BLACK, GREEN, and WHITE MINERALS. MOSTLY HORIZONTAL FRACTURES 21.0'	NX CORE RUN 1 11.0' to 21.0' RECOVERY = 95% RQD = 0.70
20					
25				E.O.B. @ 21' BGS.	
30					
35					
40					
45					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-6I

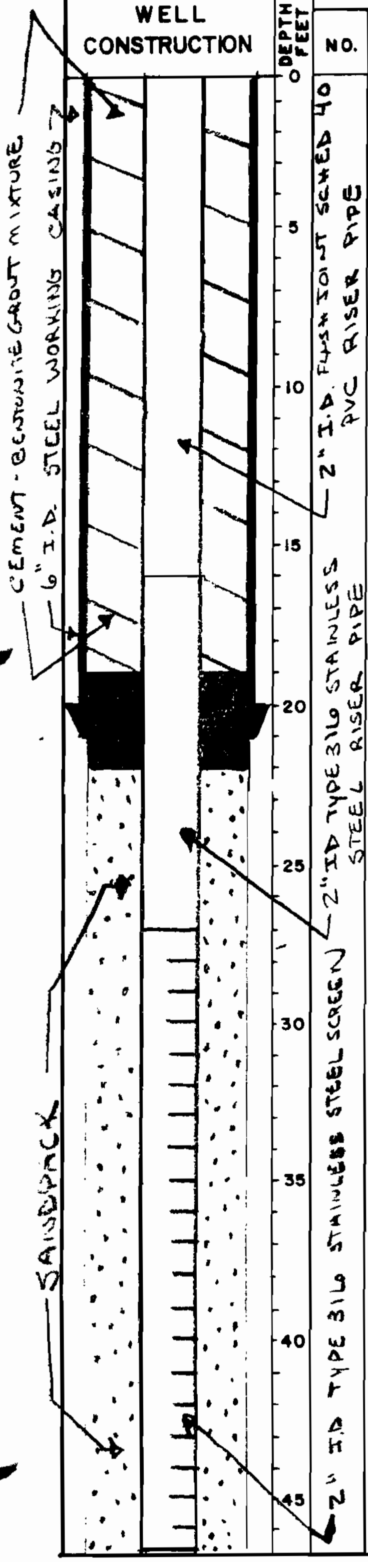
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 1 OF 3
CLIENT: NYSDEC	JOB NO. 07509
BORING CONTRACTOR: KENDRICK DRILLING INC.	ELEVATION 666.50
	DATE STARTED 8-15-88
	DATE FINISHED 8-16-88
	DRILLER TERRY KENDRICK
	INSPECTOR LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		CHIPS		
DIA.		OR		
WT.		CUTTINGS		
FALL				

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0				FILL/REWORKED SOIL	8" BOREHOLE ADVANCED TO 21.0' BELOW GROUND SURFACE VIA AIR ROTARY DRILLING
	5				REFER TO MW-6S TEST BORING LOG FOR SOIL DESCRIPTIONS	6" I.D. STEEL CASING INSTALLED TO 21.0' B.G.S.
				WL: 7.0' BGS		6" OPEN BEDROCK WELL DRILLED TO 121.0' BGS VIA DOWN-HOLE PNEUMATIC AIR HAMMER.
	10				BEDROCK	
					(MAHOPAC GNEISS)	
	15					
	20					
						23-24' Fractures (MAJOR)
	25					
						27' Fracture (minor)
						28' Fracture (MAJOR)
	30	S-1			Green gray & gray Brown wash.	30' Fracture (MAJOR)
		20' to 40'				31' " "
					White and Black Speckled Rock chips w/ green minerals & co.	34' Fracture (minor)
	35					
	40					41' Fracture (minor)
	45					



WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

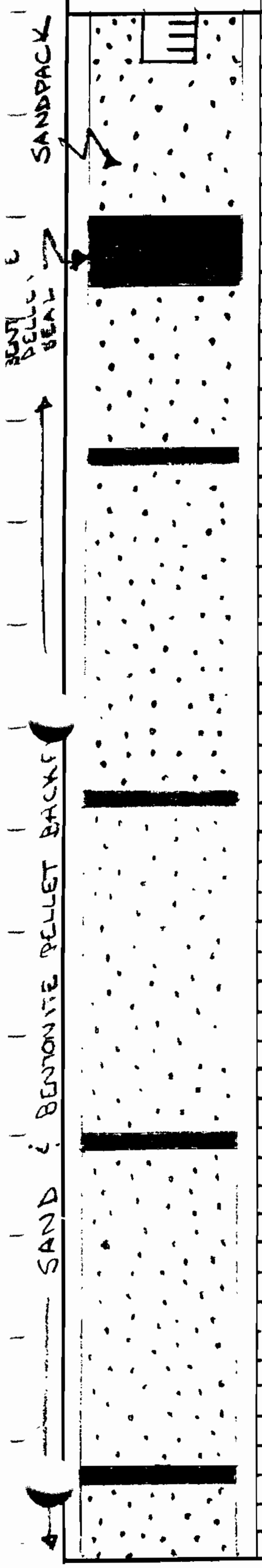
BORING NO. MW-6I

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS

SHEET NO. 2 **OF** 3

CLIENT: NYSDEC

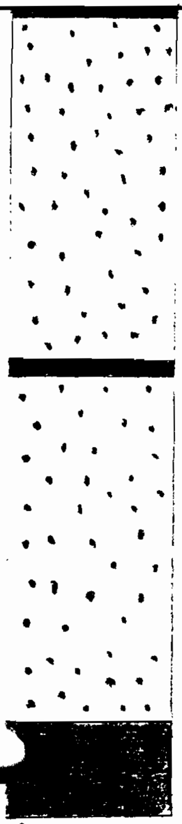
JOB NO. 07509

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	45				BEDROCK	46-47' Fractures (filled?) (minor)
				S-2	(MAHOPAC GNEISS)	
	50			40' to 60'	Green Gray wash color Green, Tan, Gray, White and Black minerals.	48' Fracture (minor)
	55					
	60					
	65					65' Fracture (MAJOR)
				S-3		68' Fracture (minor)
	70			60' to 80'	Green Gray to Pinky Gray wash color. White, Black, some tan and gray rock chips.	
	75					
	80					
	85					
				S-4		
	90			80' to 100'	Grayish Green wash color Bands of pinky white [illegible] Pink, Gray, white, Black, Green minerals.	
	95					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG	
BORING NO. MW-6 I	
PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	**SHEET NO.** 3 **OF** 3
CLIENT: NYSDEC	**JOB NO.** 07509

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	95				BEDROCK (MAHOPAC GNEISS)	
	100					
	105					
				S-5		
	110			100' to 120'	Green Gray wash color. Dk. Gray, Green, Black, and little white Rock chips.	(Amphibolite?)
	115					
	120				121.0'	YIELD ≑ 10GPM VIA DRILL STEM TEST.
BOTTOM BENTONITE PELLET SEAL					END OF BOREHOLE	NOTE: 2" I.D. MONITORING WELL INSTALLED BY KENDRICK DRILLING, INC. START: 9/23/88 FINISH: 10/6/88
	125					
	130					
	135					
	140					
	145					



WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-8S

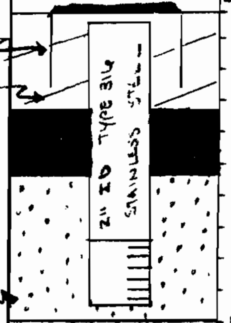
PROJECT:	MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT:	NYS DEC
BORING CONTRACTOR:	KENDRICK DRILLING INC.
SHEET NO.	1 OF 1
JOB NO.	07509.03
ELEVATION	664.70
DATE STARTED	7-13-88
DATE FINISHED	7-13-88
DRILLER	JOHN STEVENSON
INSPECTOR	LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FS			
DIA.	4"			
WT.	300 #			
FALL	30"			

BLUE COVER BOX
GROUT
BENTONITE PELLET SEAL
SANDPACK



WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0				BLACKTOP, & GRAVEL 1.0'	DROVE 4" ID CASING TO 10' BGS.
					FILL / REWORKED SOIL	
					DK. Brown Gray CLAYEY SILT, little-s f Sand, trace fine Gravel, freq. wood, root fragments	W.T. (24.5')
	5					
	10				10.0'	
					E.O.B. @ 10' BGS.	
	15					
	20					
	25					
	30					
	35					
	40					
	45					

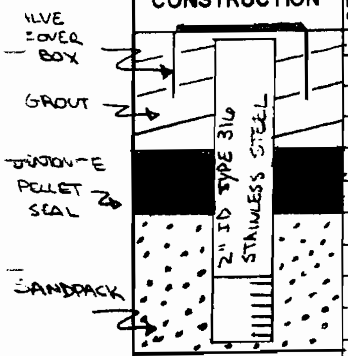
WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG
BORING NO. MW-9S

PROJECT: Mahopac Business District RI/FS	SHEET NO. 1 OF 1
CLIENT: NYSDEC	JOB NO. 07509.03
BORING CONTRACTOR: Kendrick Drilling Inc.	ELEVATION 667.60
	DATE STARTED 7-13-88
	DATE FINISHED 7-13-88
	DRILLER John Stevenson
	INSPECTOR LFC

GROUND WATER			
DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FS			
DIA.	4"			
WT.	300 #			
FALL	30"			

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	0–10				BLACKTOP, c GRAVEL, STONES FILL/REWORKED SOIL yellow Brown cmf Sand, and(-) mf Gravel, some Silt, occ. cobble 10.25'	DROVE 4" ID CASING 10.25' B.G.S. W.T (24.10')
					E.O.B. @ 10.25'	

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-10S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS	SHEET NO. 1 OF 1
CLIENT: NYSDEC	JOB NO. 07509.03
BORING CONTRACTOR: KENDRICK DRILLING INC.	ELEVATION 665.30
	DATE STARTED 7-8-88
	DATE FINISHED 7-8-88
	DRILLER JOHN STEVENSON
	INSPECTOR LFC

GROUND WATER					CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE	FJ			
				DIA.	4"			
				WT.	200 #			
				FALL	30"			

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
CURB BOX; GROUT; BENTONITE PELLET SEAL; 2" TYPE 316 STAINLESS; SANDPACK	0				BLACKTOP, C GRAVELS, COBBLES 1.0'	DRIVE 4" ID CASING TO 7.0' BGS
					FILL / REWORKED SOIL	
	5				Yellow Brown cmf Sand, and(+) mf Gravel, some Silt, occ. cobble	W.T. (5.87')
		S1	SS	10/1" Boulder	wood fragment @ 7.0'	
EOB @ 7.0' N.T.S.					7.0'	Probably shoring (wood) @ 7.0'
	10				E.O.B. @ 7.0' B.G.S.	
	15					
	20					
	25					
	30					
	35					
	40					
	45					

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING NO. MW-11S

PROJECT:	MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT:	NYSDEC
BORING CONTRACTOR:	KENDRICK DRILLING INC.

SHEET NO.	1 OF 1
JOB NO.	07509.03
ELEVATION	661.80
DATE STARTED	7-11-88
DATE FINISHED	7-11-88
DRILLER	JOHN STEVENSON
INSPECTOR	LFC

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	FJ	SS		
DIA.	4"	2"		
WT.	300#	140#		
FALL	30"	30"		

DEPTH FEET	WELL CONSTRUCTION	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	PROTECTIVE COVER BOX				BLACKTOP, C GRAVEL, COBBLES ±1.0'	DROVE 4" ID CASING TO 10' BGS.
	BENTONITE PELLET SEAL; 2" ID TYPE 316 STAINLESS STEEL				FILL / REWORKED SOIL	W.T. (23.0')
5	SANDPACK				DK. Brown Gray Clayey SILT, little f Sand, trace fn Gravel, frequent root and wood fragments, Peat in areas, loose	
		S1	SS	1-1, 1-1		
10	NATIVE BACKFILL					
		S2	SS	1-0, 1-0	12.0'	
	EOB @ 12.0' N.T.S.				E.O.B. @ 12.0' BGS.	
15						
20						
25						
30						
35						
40						
45						

MAHOPAC BUSINESS DISTRICT RI/FS

SUMMARY OF SHALLOW BEDROCK CORING PROGRAM

Boring No.	Ground Surface Elevation (MSL)	Bedrock Surface		NX Rock Core			Bedrock Description
		Depth (ft BGS)	Elevation (MSL)	Core Interval (ft BGS)	Recovery %	RQD	
MW-1S	677.92	31.0	646.92	32.3 – 42.3	100	0.98	Granitic Geniss
MW-2S	666.00	22.0	644.00	27.21 – 33.21	89	0.29	Granitic Gneiss
MW-3S	660.90	60.5	600.40	67.0 – 77.0	88	0.30	Granitic Gneiss
MW-4S	673.60	10.0	663.60	23.0 – 33.0	80	0.40	Decomposed Granitic Gneiss
MW-6S	666.43	9.5	656.93	11.0 – 21.0	95	0.70	Granitic Gneiss

By LFC Date 6-28-89 **WehranEnviroTech** Job No. 07509
Chkd. by ______ Date ______ Sheet No. 1 of 1
Subject HNU READINGS - MAHOPAC BUSINESS DISTRICT RI/FS

MAHOPAC BUSINESS DISTRICT RI/FS

W.E. JOB NO. 07509

HNU READINGS SUMMARY

MW-1S

SAMPLE NO.	DEPTH INTERVAL (FT. BGS)	HNU (ppm) SPOON	HNU (ppm) HEADSPACE	DATE
S-1	0-2'	0	0	4-14-88
S-2	2-4'	0	0	4-14-88
S-3	4-6'	0	0	4-14-88
S-4	6-8'	0	0	4-14-88
S-5	8-10'	0	0	4-14-88
S-6	10-12'	0	0	4-14-88
S-7	12-14'	0	0	4-14-88
S-8	14-16'	0	0	4-14-88
S-9	16-18'	0	0	4-14-88
S-10	18-20'	0	0	4-14-88
S-11	20-22'	0	0	4-16-88
S-12	22-24'	0	0	4-16-88
S-13	25-26'	0	0	4-16-88
S-14	26-28'	0	0	4-16-88
S-15	28-30'	0	0	4-16-88
S-16	30-32'	0	0	4-16-88

By LFC Date 6-28-89 **WehranEnviroTech** Job No. 07509
Chkd. by ______ Date ______ Sheet No. 1 of 1
Subject HNU READINGS - MAHOPAC BUSINESS DISTRICT RI/FS

MAHOPAC BUSINESS DISTRICT RI/FS
W.E. JOB NO 07509

HNU READINGS SUMMARY

MW-2S

SAMPLE NO.	DEPTH INTERVAL (FT. BGS)	HNU (ppm) SPOON	HNU (ppm) HD. SPACE	DATE
S-1	1-3'	0	0	4-26-88
S-2	3-5'	0	0	4-26-88
S-3	5-7'	0	0	4-26-88
S-4	7-9'	0	0	4-26-88
S-5	9-11'	0	0	4-26-88
S-6	11-13'	0	0	4-26-88
S-7	13-15'	0	0	4-26-88
S-8	15-17'	0	0	4-26-88
S-9	17-19'	0	0	4-26-88
S-10	19-21'	0	0	4-26-88
S-11	21-23'	0	0	4-26-88
S-12	23-23.5'	0	0	4-26-88

By LFC Date 6-28-89 WehranEnviroTech Job No. 07509
Chkd. by ______ Date ______ Sheet No. 1 of 2
Subject HNU READINGS - MAHOPAC BUSINESS DISTRICT RI/FS

MAHOPAC BUSINESS DISTRICT RI/FS

WE JOB NO 07509

HNU READINGS SUMMARY

MW-3S

SAMPLE NO.	DEPTH INTERVAL (FT. BGS)	HNU (ppm) SPOON	HNU (ppm) HEAD SPACE	DATE
S-1	0-2'	0	0	6-22-88
S-2	2-4'	0	0	6-22-88
S-3	4-6'	0	0	6-22-88
S-4	6-8'	0	0	6-22-88
S-5	8-10'	0	0	6-22-88
S-6	10-12'	0	0	6-22-88
S-7	12-14'	0	0	6-22-88
S-8	14-16'	0	0	6-22-88
S-9	16-18'	0	0	6-22-88
S-10	18-20'	0	0	6-22-88
S-11	20-22'	0	0	6-22-88
S-12	22-24'	0	0	6-22-88
S-13	24-26'	0	0	6-22-88
S-14	26-28'	0	0	6-22-88
S-15	28-30'	0	0	6-22-88
S-16	30-32'	0	0	6-22-88
S-17	32-34'	0	0	6-22-88

By LFC Date 6-28-89 **WehranEnviroTech** Job No. 02509
Chkd. by ______ Date ______ Sheet No. 2 of 2
Subject HNU READINGS CONT'D - MBD RI/FS

HNU READINGS SUMMARY (CONT'D)

MW-3S

SAMPLE NO.	DEPTH INTERVAL (FT. BGS)	HNU (ppm) SPOON	HNU (ppm) HEAD SPACE	DATE
S-18	34-36'	0	0	6-23-88
S-19	36-38'	0	0	6-23-88
S-20	38-40'	0	0	6-23-88
S-21	40-42'	0	0	6-23-88
S-22	42-44'	0	0	6-23-88
S-23	44-46'	0	0	6-23-88
S-24	46-48'	0	0	6-23-88
S-25	48-50'	0	0	6-23-88
S-26	50-52'	0	0	6-24-88
S-27	55-57'	0	0	6-24-88
S-28	60-62'	0	0	6-24-88
S-29	65-67'	0	0	6-24-88

MAHOPAC BUSINESS DISTRICT RI/FS

WE. JOB NO. 07509

HNU READINGS SUMMARY

MW-4S

SAMPLE NO.	DEPTH INTERVAL (FT. BGS)	HNU (ppm) SPOON	HNU (ppm) HEAD SPACE	DATE
S-1	0-2'	3.0	140.0	6-30-88
S-2	2-4'	0	1.2	6-30-88
S-3	4-6'	0	0	6-30-88
S-4	6-8'	0	0.8	6-30-88
S-5	8-10'	0	0	6-30-88
S-6	10-12'	0	0	6-30-88
S-7	12-14'	0	0	6-30-88
S-8	14-16'	0	0	6-30-88
S-9	16-18'	0	0	6-30-88
S-10	18-20'	0	0	6-30-88
S-11	20-22'	0	0	6-30-88
S-12	22-24'	0	0	6-30-88

By LFC Date 6-28-89 **WehranEnviroTech** Job No. 07509
Chkd. by ______ Date ______ Sheet No. 1 of 1
Subject HNU READINGS - MAHOPAC BUSINESS DISTRICT RI/FS

MAHOPAC BUSINESS DISTRICT RI/FS

W.E. JOB NO 07509

HNU READINGS SUMMARY

MW-6S

SAMPLE NO.	DEPTH INTERVAL (Ft. BGS)	HNU (ppm) SPOON	HNU (ppm) HEAD SPACE	DATE
S-1	0.5-2'	3.5	5.0	6-28-88
S-2	2-4'	0.2	0.8	6-28-88
S-3	4-6'	1.0	0	6-28-88
S-4	6-8'	0	4.0	6-29-88
S-5	8-10'	1.0	1.4	6-29-88

By LFC Date 6-28-89 WehranEnviroTech Job No. 07509.03
Chkd. by ______ Date ______ Sheet No. 1 of 1
Subject MANHOLE INVERT ELEVATIONS - MAHOPAC RI/FS

MAHOPAC BUSINESS DISTRICT RI/FS

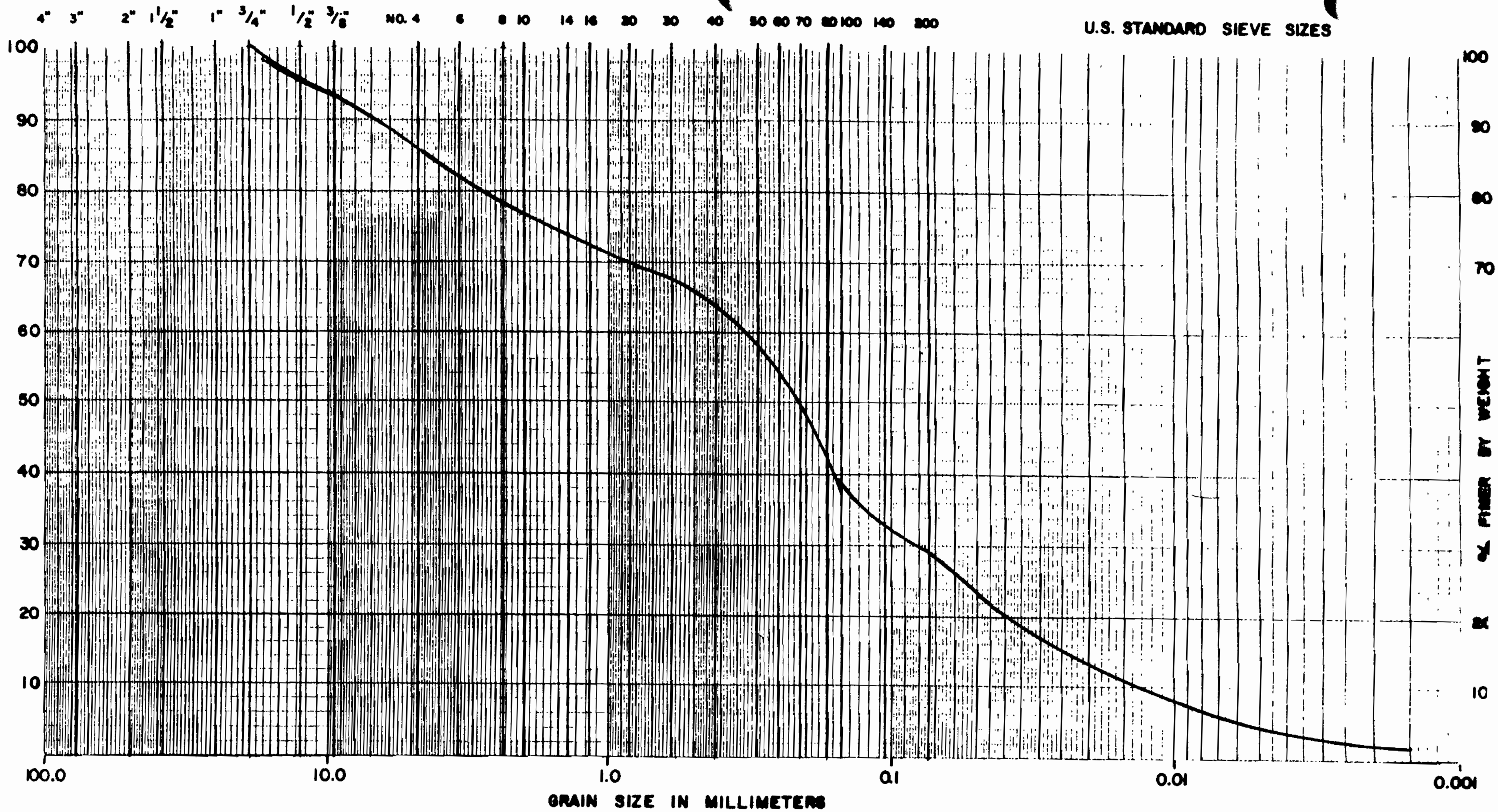
WE JOB NO. 07509

SUMMARY OF MANHOLE INVERT ELEVATIONS

MANHOLE AT WELL NO.	GROUND SURFACE ELEVATION (MSL)	DEPTH TO INVERT	INVERT ELEVATION (MSL)
MW-8S	664.70	3.0	661.70
MW-9S	667.60	9.0	658.60
MW-10S	665.30	7.0	658.30
MW-11S	661.80	7.0	654.80

APPENDIX B

LABORATORY SOIL TESTING RESULTS



3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW1S	14-16		Yellowbrown c-f Sand,	11.1			
S-8			some silt, some m-f Gravel				

MECHANICAL ANALYSIS

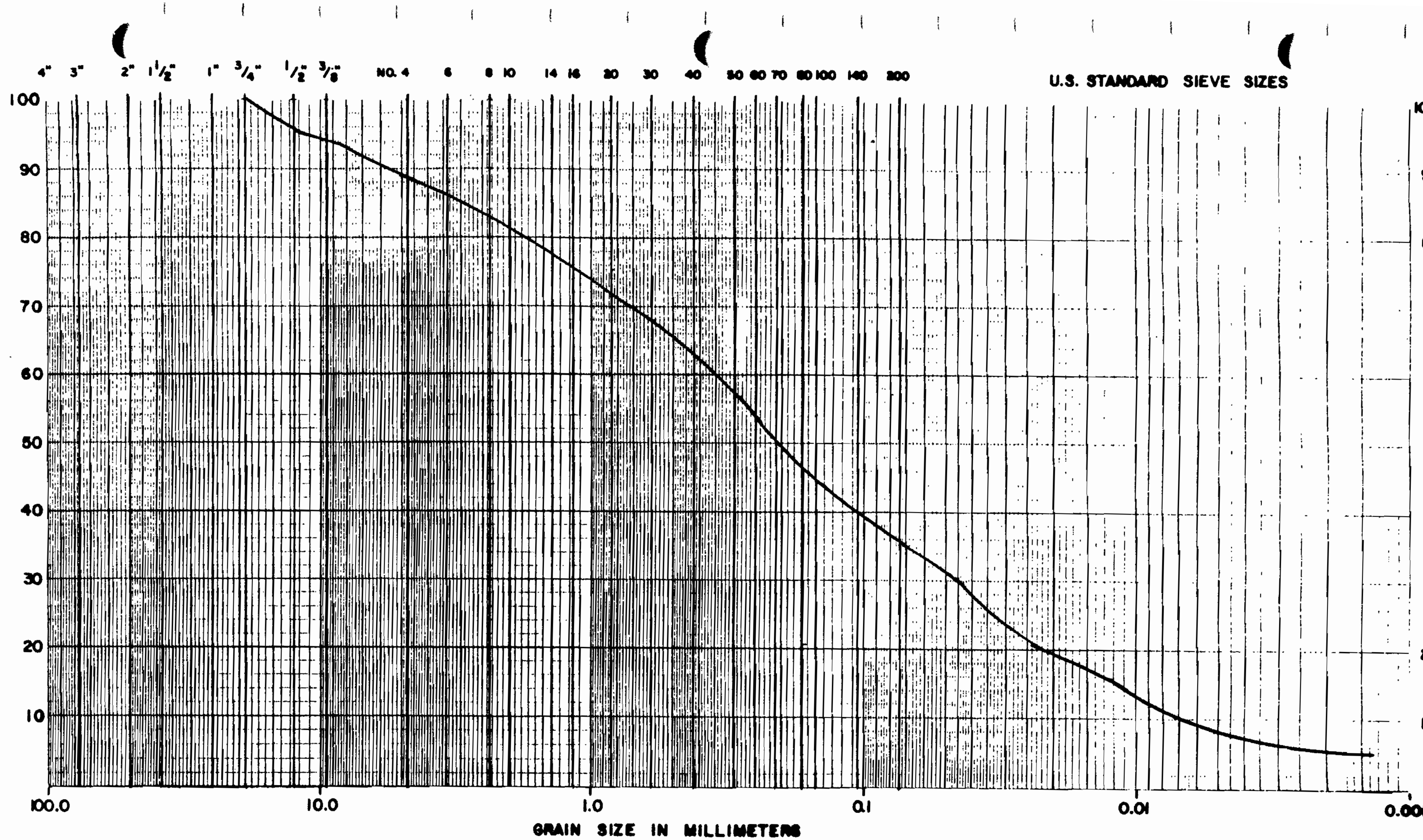
Client: NYSDEC

Project: MAHOPAC

Project Number: 07509

Date: 10-4-88 Figure No.:

WE WEHRAN ENGINEERING
CONSULTING ENGINEERS



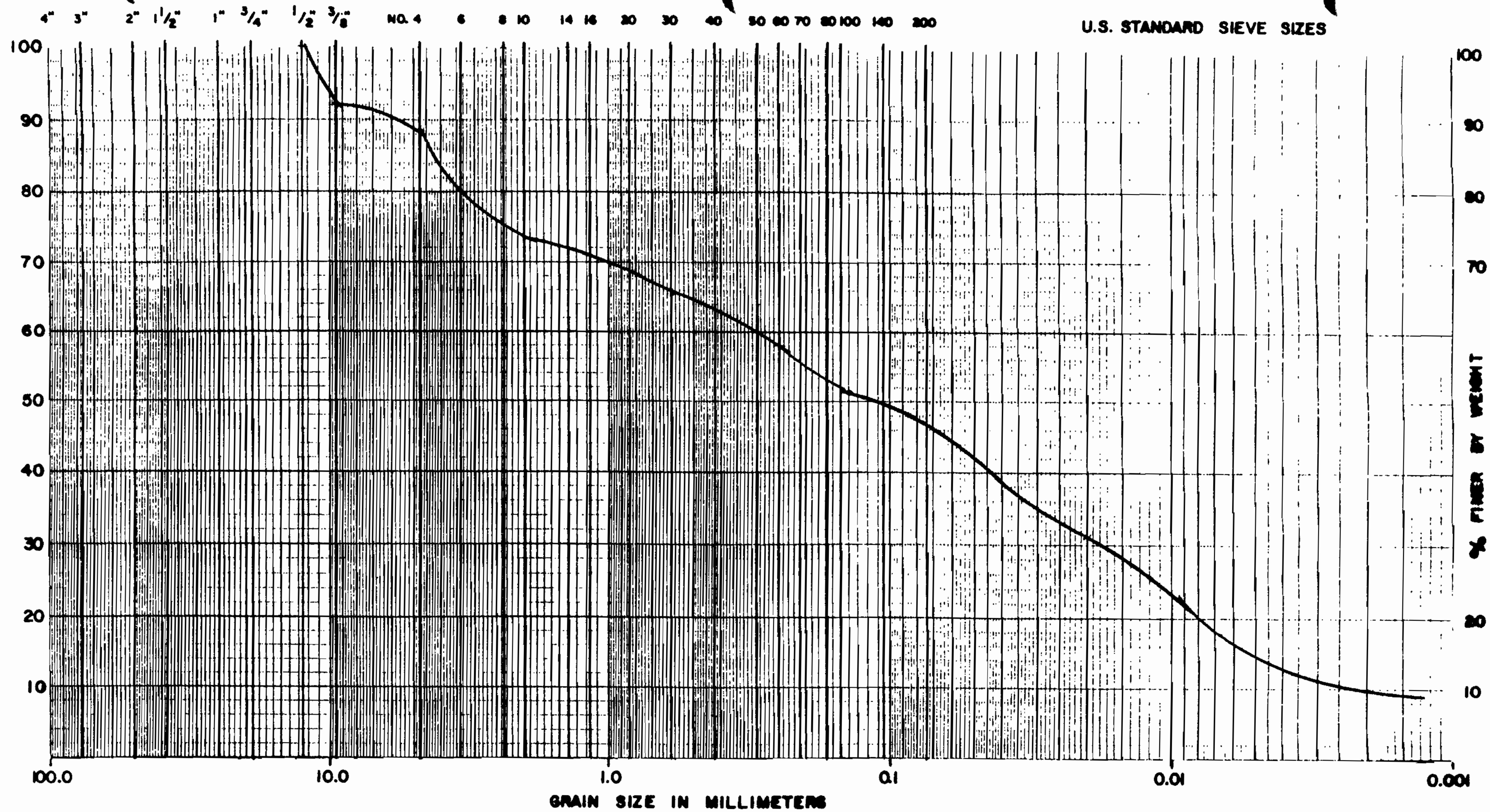
3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW15 S-10	18-20		Yellow brown a mf Sand, and(-) Silt, little(+) mf Gravel	13.8			

MECHANICAL ANALYSIS

Client: NYS DEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WE WEHRAN ENGINEERING
CONSULTING ENGINEERS



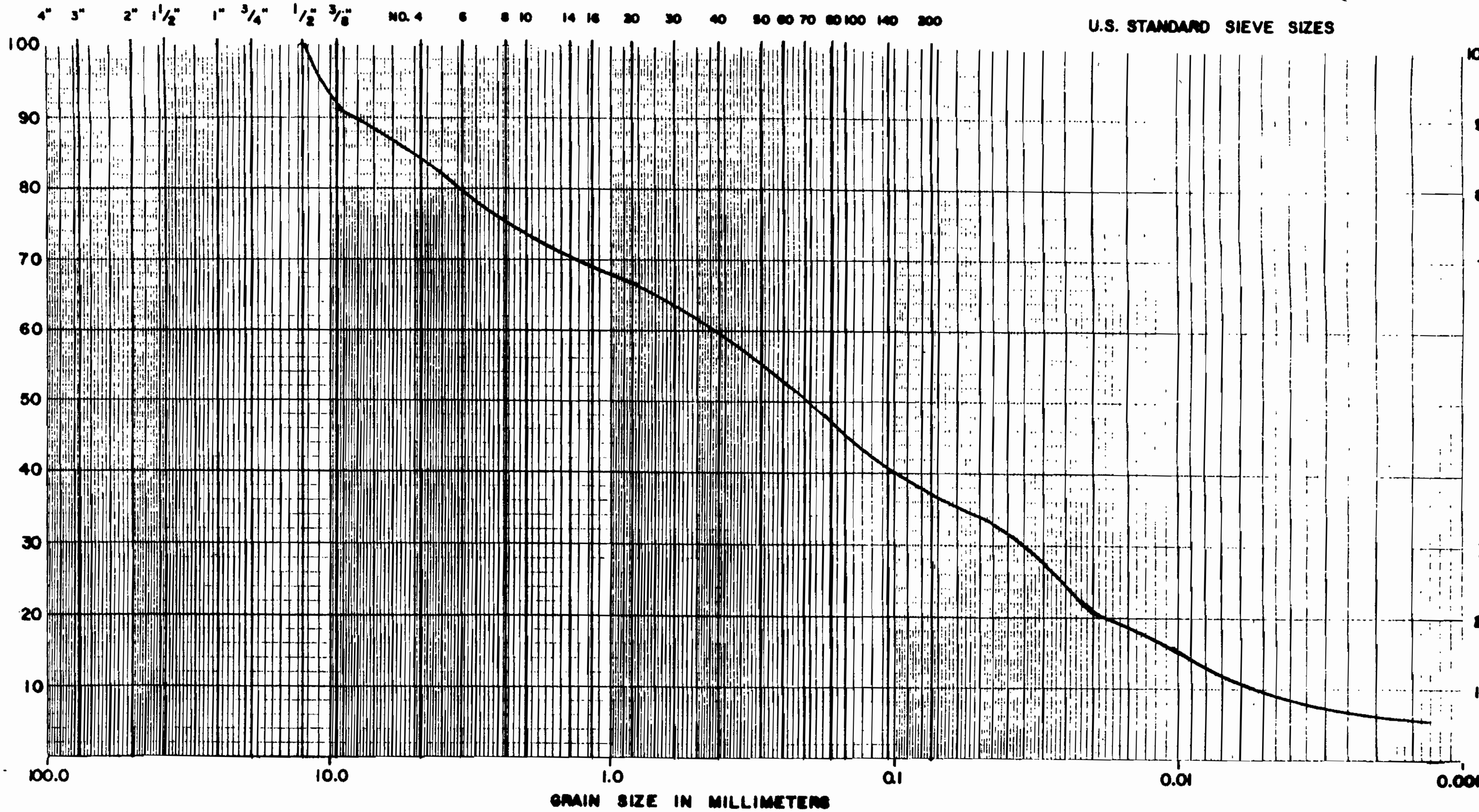
3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.005	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW15 S-14	26-28		Greenish brown cmf Sand and, clayey SILT, some mf gravel	10.6			

MECHANICAL ANALYSIS

Client: NYS DEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WE WEHRAN ENGINEERING
CONSULTING ENGINEERS



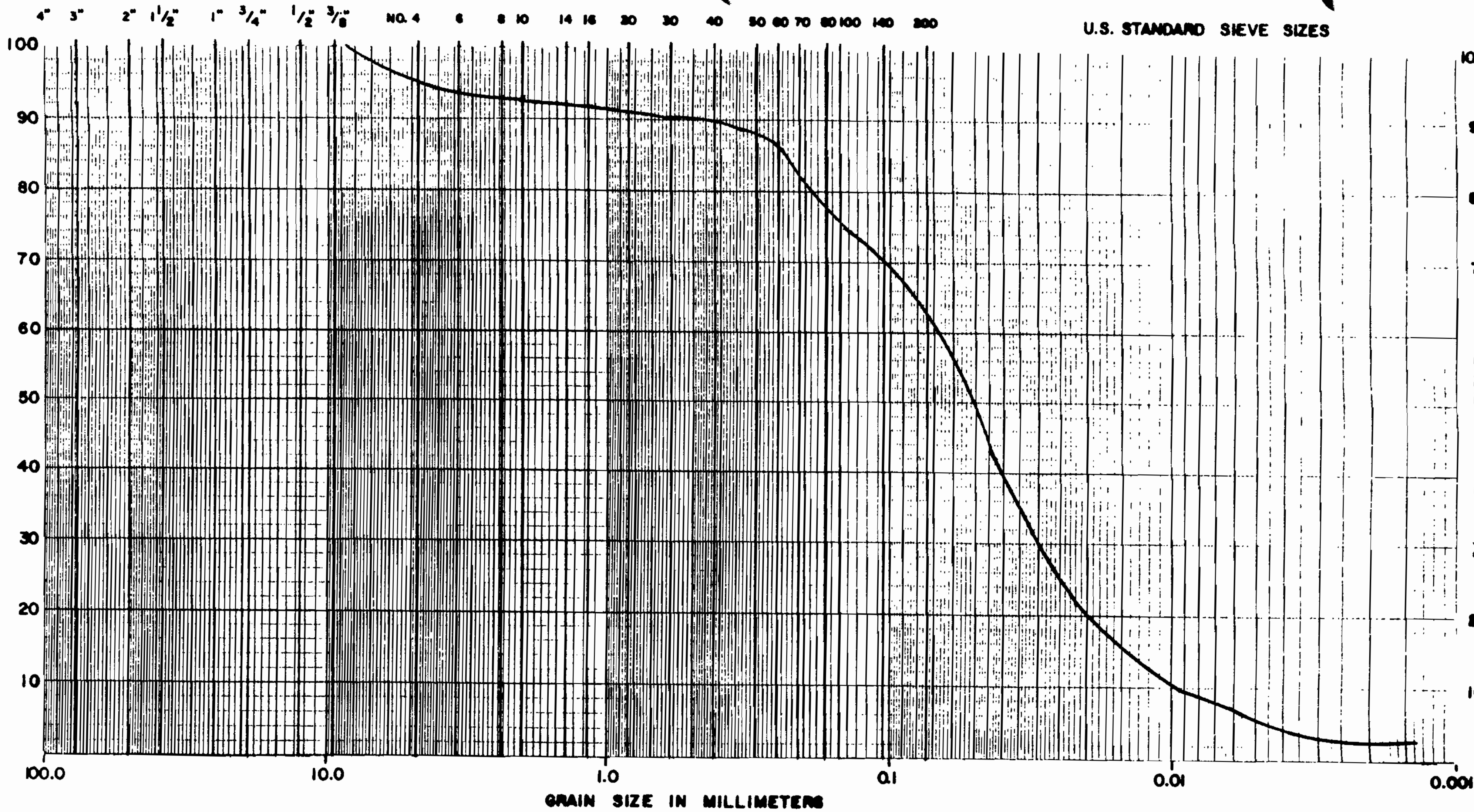
3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.005	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW 2S S-6	11-13		Yellowbrown cmf Sand, and(-) Clayey Silt, Some mf Gravel	9.4			

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WEHRAN ENGINEERING
CONSULTING ENGINEERS



3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006

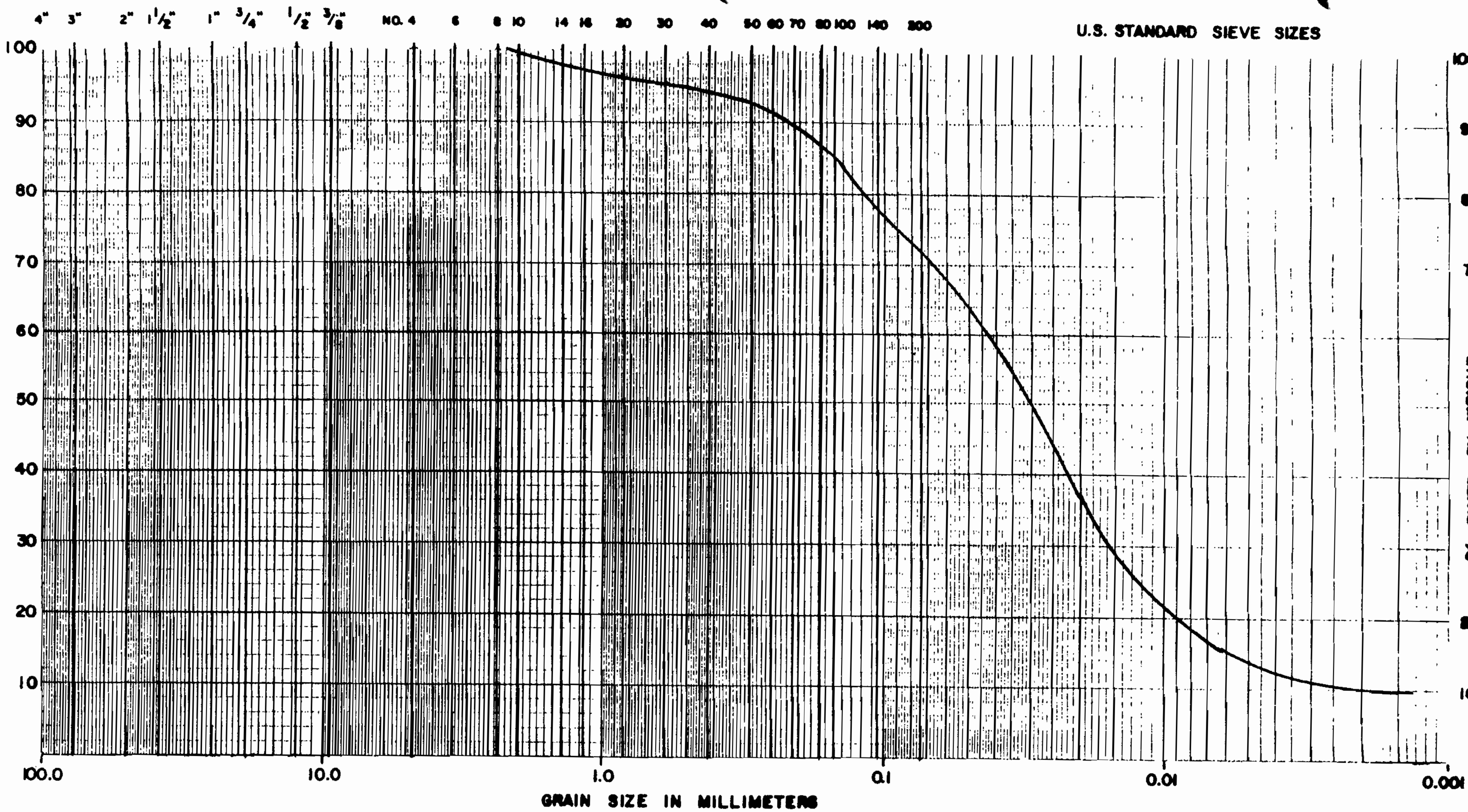
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW2S S-9	17-19		Yellowbrown SILT and(-), cmf Sand, trace f Gravel	17.3			

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WEHRAN ENGINEERING
CONSULTING ENGINEERS



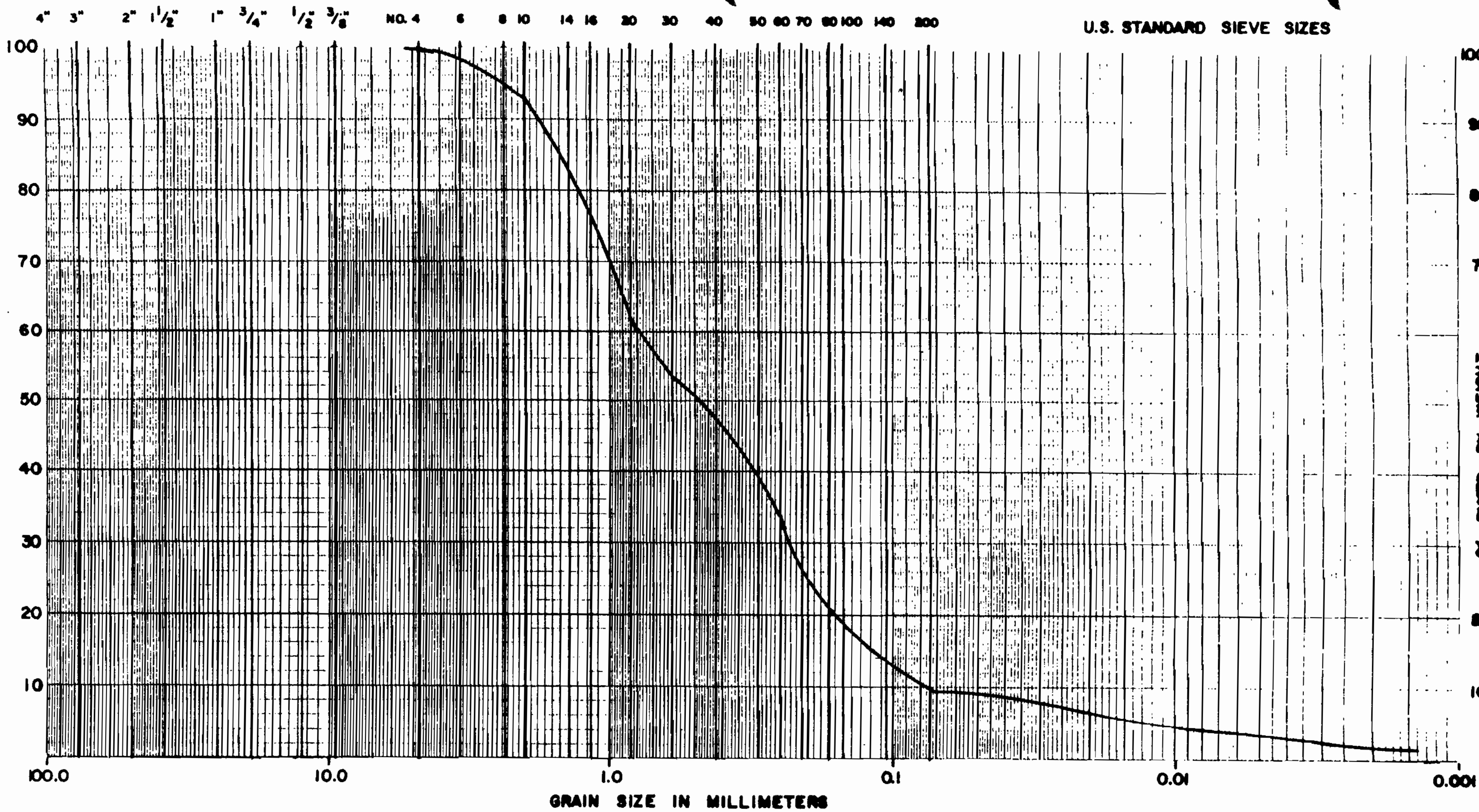
	3"		1"		3/8"		2.0mm		0.60		0.25		0.74		0.006	
COBBLES	COARSE		MEDIUM		FINE		COARSE		MEDIUM		FINE		SILT		CLAY	
	GRAVEL						SAND									

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW3S	22-24		Greenish gray SILT,	27.6			
S-12			Some cmf Sand				

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WEHRAN ENGINEERING
CONSULTING ENGINEERS



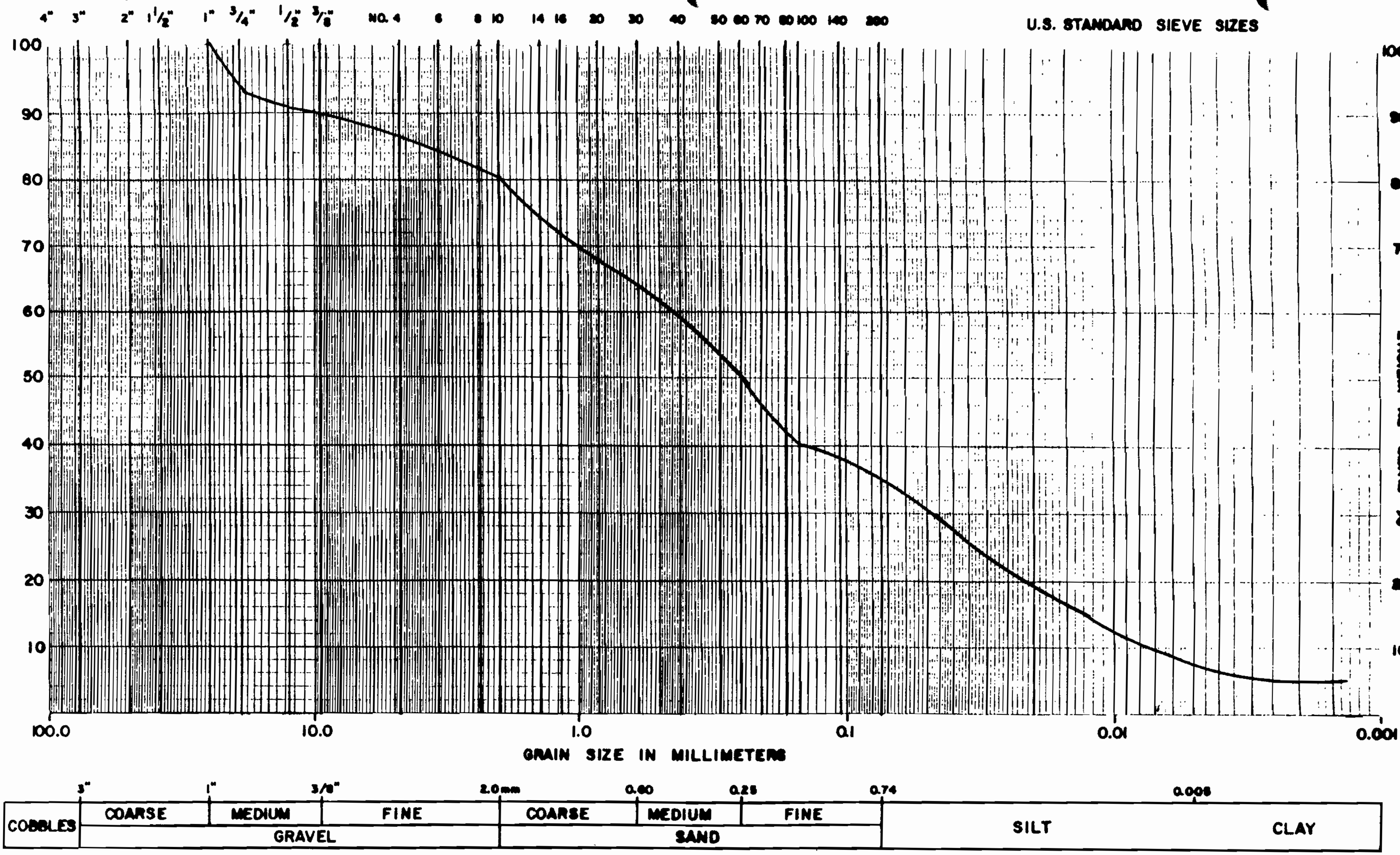
	3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT		CLAY
	GRAVEL			SAND					

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT. %	L.L. %	P. L.%	P. I.
MW 3S	26 28		Gray cmf SAND,	20.6			
S-14			trace silt, trace f Gravel				

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.: ______

WE WEHRAN ENGINEERING
CONSULTING ENGINEERS

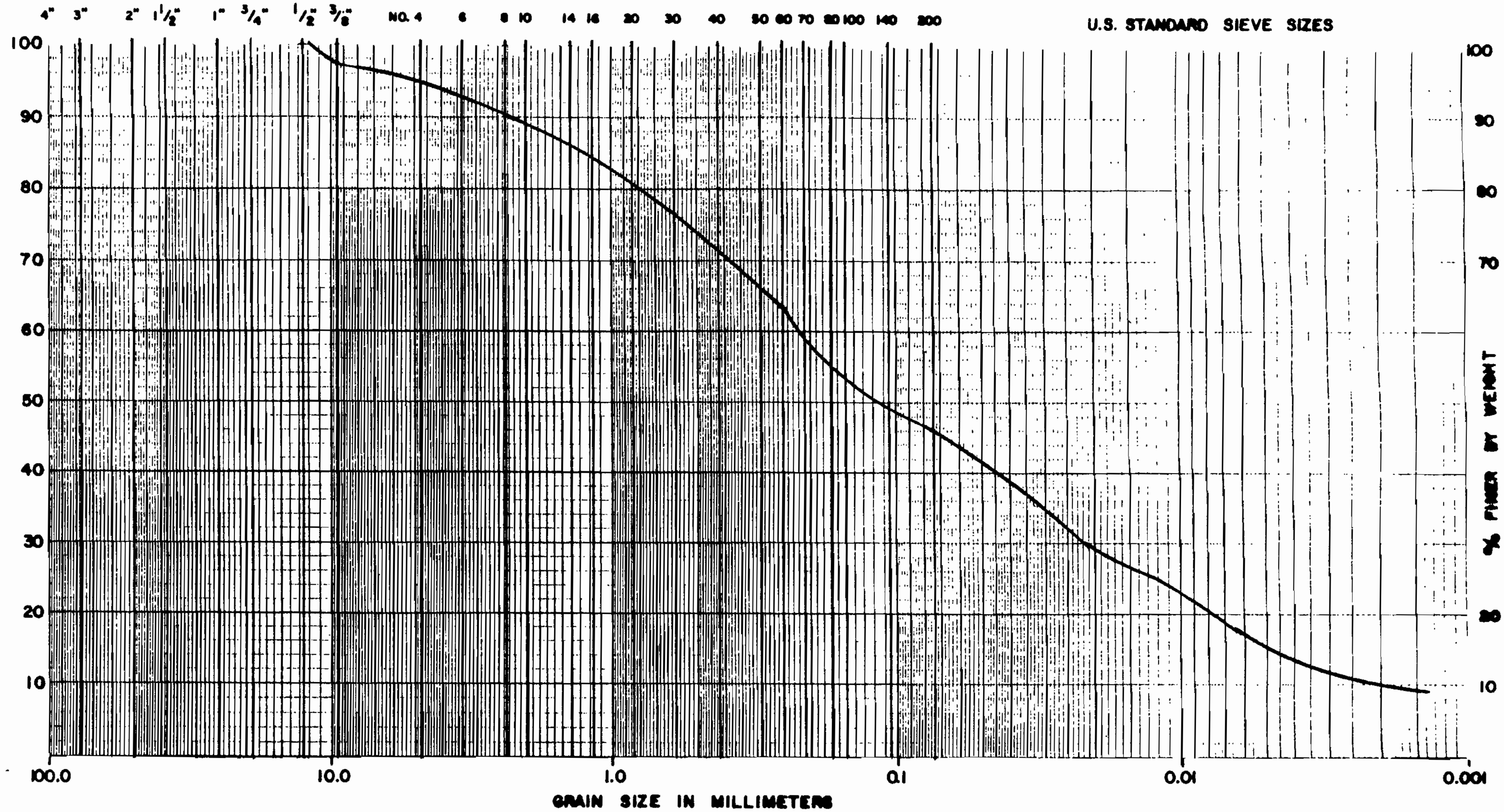


BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW35 S-17	32-34		Green gray cmf Sand, some(+) clayey SILT, little(+) mf Gravel	9.9			

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.: ____

WEHRAN ENGINEERING
CONSULTING ENGINEERS



3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006

COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW35 S-20	38-40		Green gray cmf Sand, and(+) Clayey SILT, little(-) mf Gravel	11.2	20	18	2

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.: ____

WEHRAN ENGINEERING
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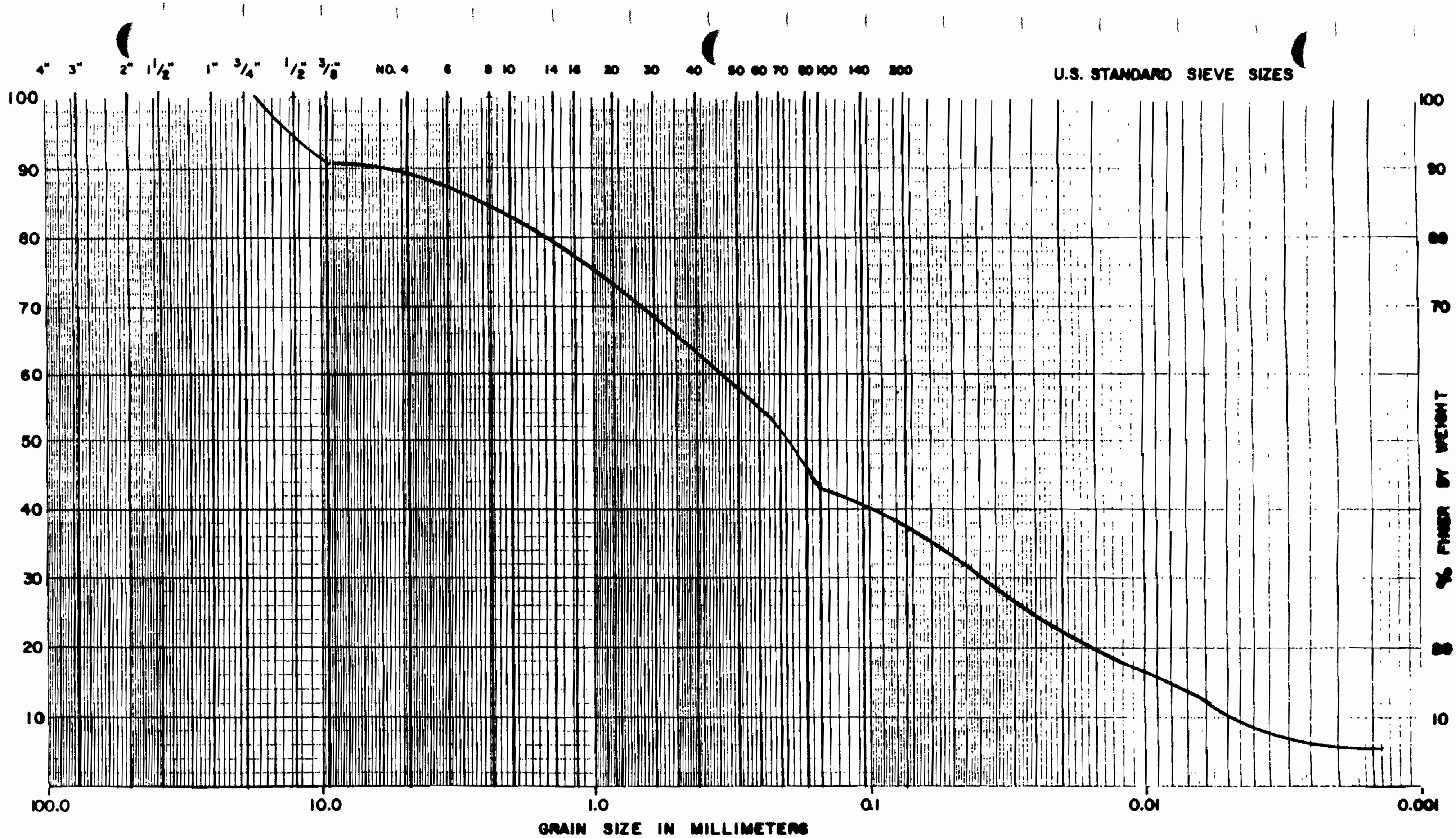


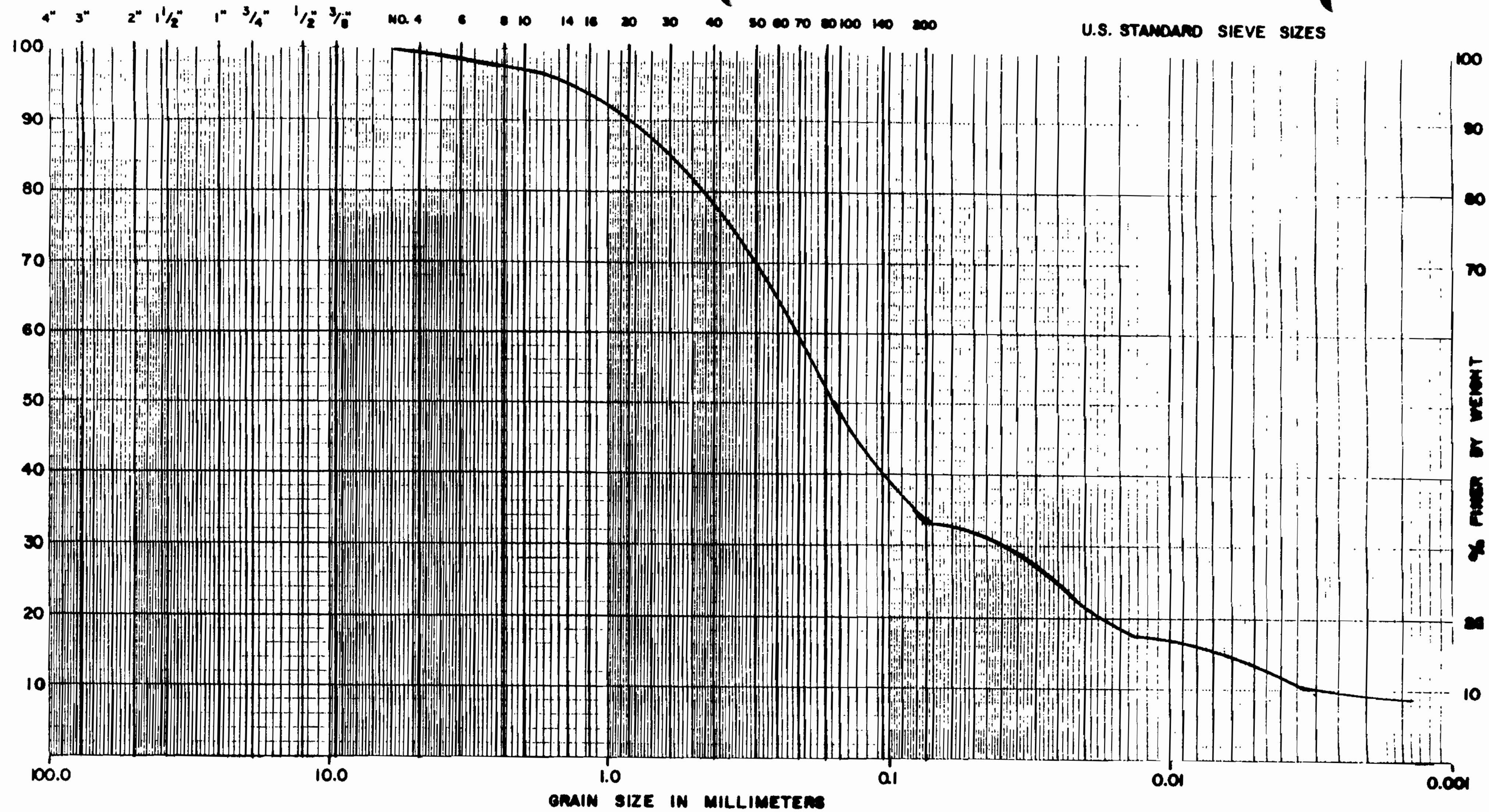
3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.005	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW 4S	8-10		Yellowbrown cmf Sand,	8.6			
S-5			and Silt, little(+) m-f Gravel				

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 02509
Date: 10-4-88 Figure No.: ____

WEHRAN ENGINEERING
CONSULTING ENGINEERS



3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.006	
COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW4S S-8	14-16		Yellow brown cmf SAND, some(+) silt, trace f gravel	13.1			

MECHANICAL ANALYSIS

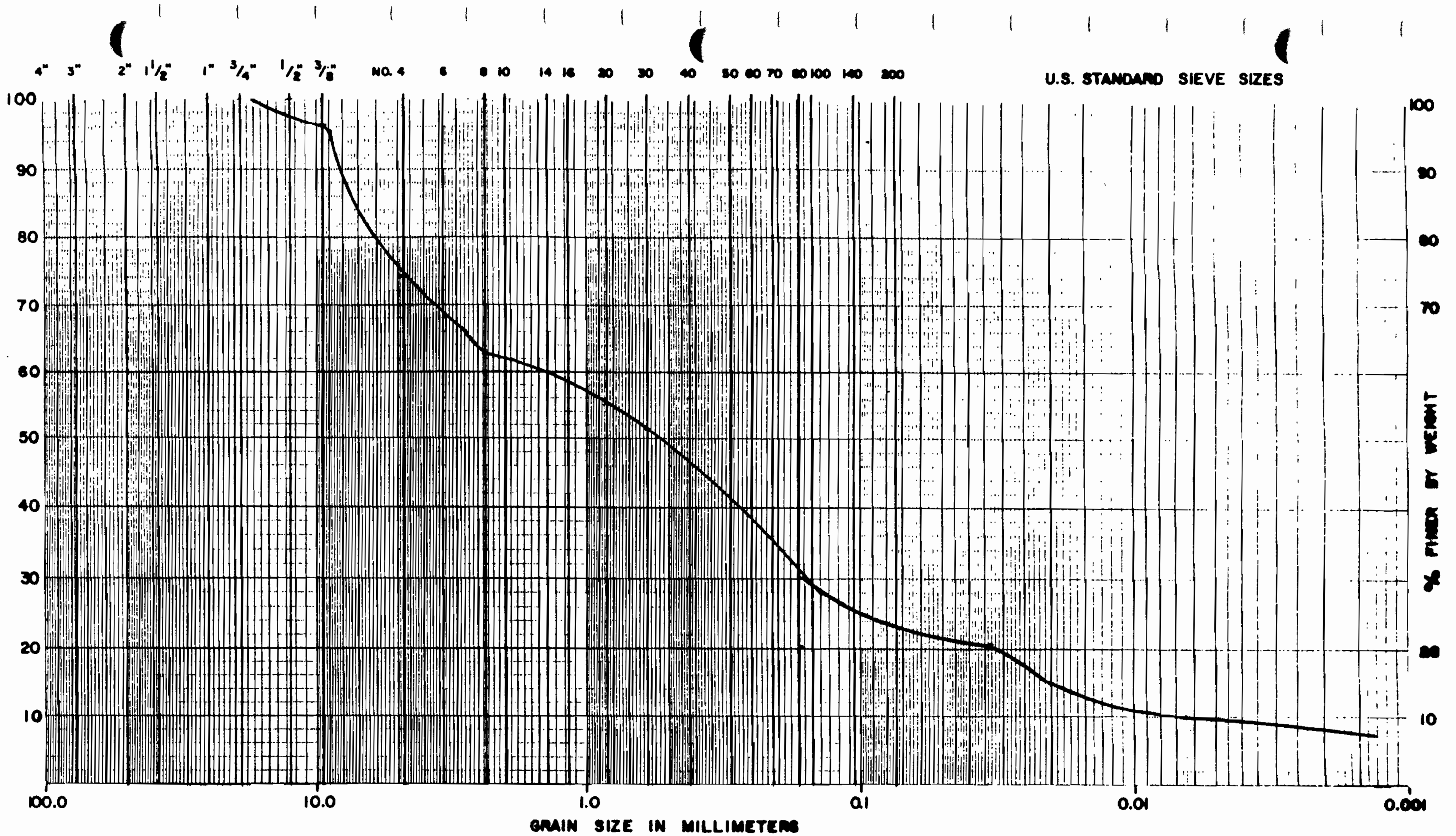
Client: NYSDEC

Project: MAHOPAC

Project Number: 07509

Date: 10-4-88 Figure No.:

WE WEHRAN ENGINEERING
CONSULTING ENGINEERS



3"	1"	3/8"	2.0mm	0.60	0.25	0.74	0.005

COBBLES	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL			SAND				

BORING NO. SAMPLE NO.	DEPTH	ELEV.	IDENTIFICATION	MOIST. CONT.%	L.L.%	P.L.%	P.I.
MW6S S-4	6-8		yellow brown cmf Sand, some Silt, and(-) mf Gravel	8.3			

MECHANICAL ANALYSIS

Client: NYSDEC
Project: MAHOPAC
Project Number: 07509
Date: 10-4-88 Figure No.:

WEHRAN ENGINEERING
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APPENDIX C

PERMEABILITY TESTING RESULTS

MAHOPAC BUSINESS DISTRICT RI/FS
SUMMARY OF IN SITU PERMEABILITY TEST RESULTS

Well No.	Test – Internal Depth Below Ground Surface (ft.)	Geologic Unit	Test Type	Permeability	
				(cm/sec)	(gpd/ft^2)
MW-1S	16.5 – 29.5	Stratified Drift	Recovery	8.08×10^{-5}	1.71×10^{0}
MW-2S	8.5 – 22.0	Stratified Drift	Recovery	7.44×10^{-5}	1.58×10^{0}
MW-3S	21.0 – 36.25	Stratified Drift	Recovery	3.44×10^{-5}	7.29×10^{-1}
MW-4S	8.0 – 21.5	Stratified Drift and Decomposed Bedrock	Recovery	2.24×10^{-4}	4.75×10^{0}
MW-6S	4.0 – 10.0	Stratified Drift	Recovery	1.38×10^{-3}	2.92×10^{1}
MW-1I	117.0 – 131.8	Granitic Gneiss	Slug	7.87×10^{-5}	1.67×10^{0}
MW-2I	40.0 – 70.0	Granitic Gneiss	Slug	4.16×10^{-3}	8.82×10^{1}
MW-3I	42.0 – 72.0	Granitic Gneiss	Slug	1.09×10^{-3}	2.31×10^{1}
MW-5I	40.0 – 70.0	Granitic Gneiss	Slug	8.32×10^{-4}	1.76×10^{1}
MW-6I	22.0 – 52.0	Granitic Gneiss	Slug	8.05×10^{-4}	1.71×10^{1}
MW-2D	307.0-340.0	Granitic Gneiss	Slug	1.25×10^{-4}	2.65×10^{0}

WEHRAN ENGINEERING
CONSULTING ENGINEERS

VARIABLE HEAD
PERMEABILITY TEST
PIEZOMETER No. MW-1S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
JOB NO: 07509
DATE OF TEST: AUGUST 9, 1988
SCREENED INTERVAL:

STAINLESS STEEL SCREEN: 18.5' to 28.5' BGS
SANDPACK: 16.5' to 29.5' BGS

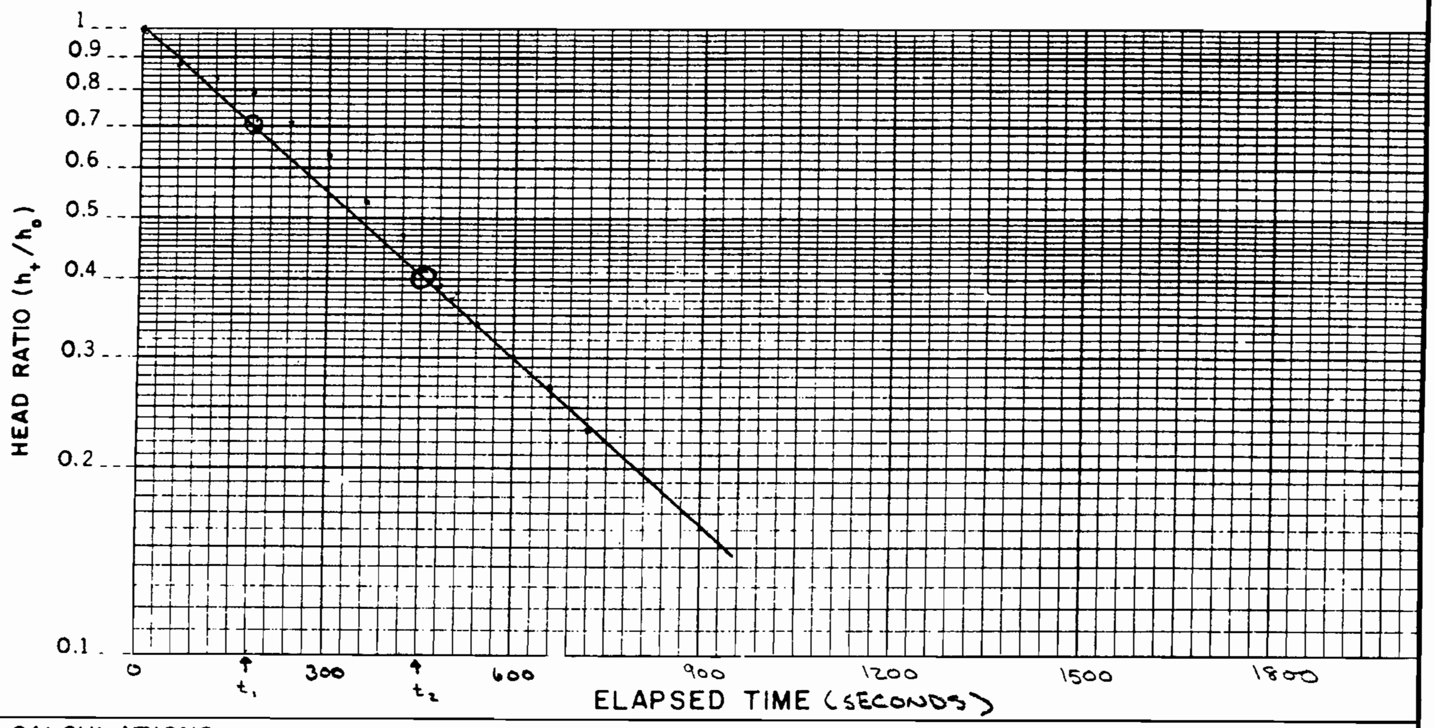
METHOD:
Hvorslev (1951)

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2-t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

FIELD DATA POINTS USED IN CALCULATIONS.

TEST DATA

ELAPSED TIME (SECONDS)	HEAD RATIO (h_t / h_o)
0	1.0
60	0.88
120	0.84
180	0.79
240	0.71
300	0.63
360	0.53
420	0.47
480	0.39
540	0.34
600	0.30
660	0.27
720	0.23



CALCULATIONS:

r = 1.188 inch = 3.018 cm
R = 5.25 inch = 13.335 cm
L = 13.0 feet = 396.24 cm
t_1 = 180 sec.
t_2 = 450 sec.
h_1 = 0.70
h_2 = 0.40

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2-t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

$$K = \frac{(3.018\text{ cm})^2 \ln(.70/.40)}{2(396.24\text{ cm})(450\text{ sec} - 180\text{ sec})} \cdot \ln\left(\frac{396.24\text{ cm}}{13.335\text{ cm}}\right)$$

$$K = 8.08 \times 10^{-5}\text{ cm/sec}$$

WEHRAN ENGINEERING
CONSULTING ENGINEERS

VARIABLE HEAD
PERMEABILITY TEST
PIEZOMETER No. MW-2S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
JOB NO: 07509
DATE OF TEST: AUGUST 9, 1998

SCREENED INTERVAL:

STAINLESS STEEL SCREEN: 11.0' to 21.0' BGS
SANDPACK INTERVAL: 8.5' to 22.0' BGS

METHOD:

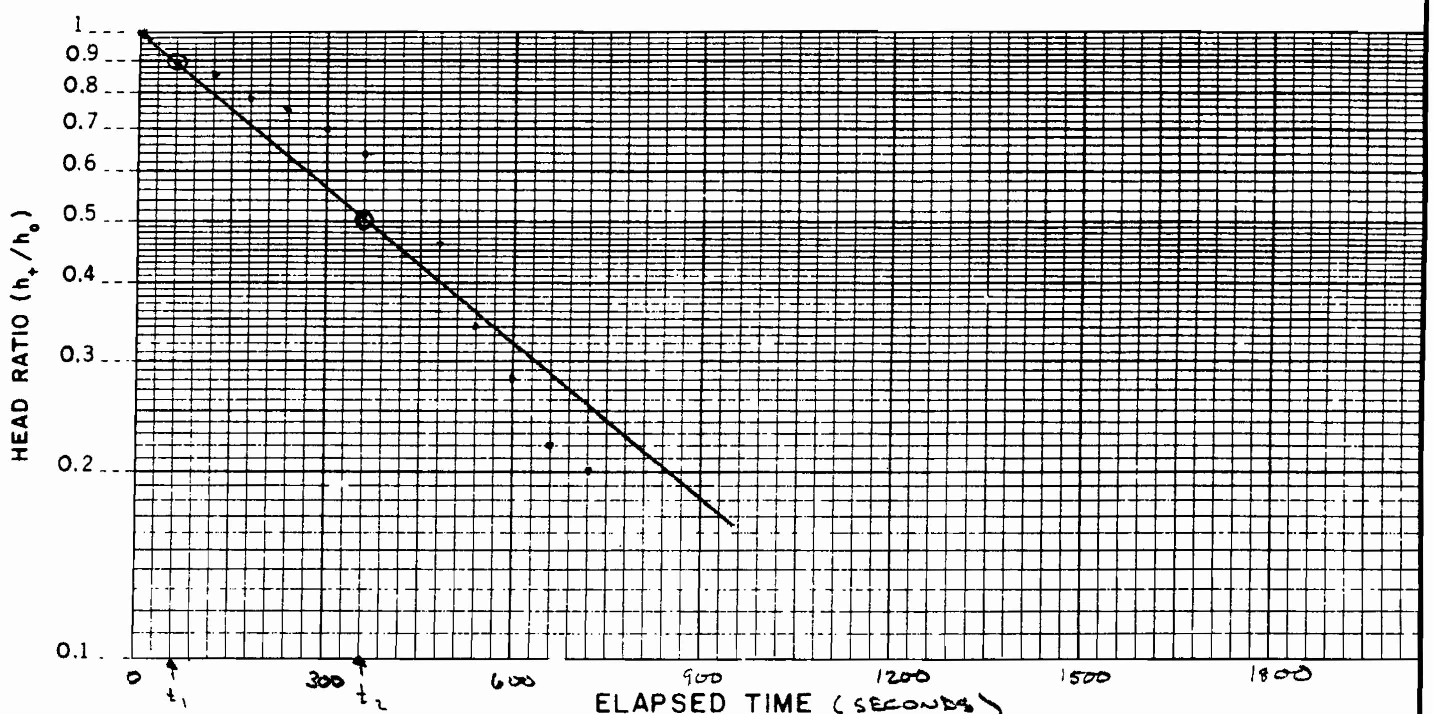
Hvorslev (1951)

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2 - t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

FIELD DATA POINTS USED IN CALCULATIONS.

TEST DATA

ELAPSED TIME (SECONDS)	HEAD RATIO (h_t / h_o)
0	1.0
60	0.89
120	0.85
180	0.78
240	0.75
300	0.70
360	0.64
480	0.46
540	0.34
600	0.28
660	0.22
720	0.20



CALCULATIONS:

r = 1.188 INCH = 3.018 cm
R = 5.25 INCH = 13.335 cm
L = 13.5 FEET = 411.48 cm
t_1 = 60 seconds
t_2 = 360 seconds
h_1 = .90
h_2 = .50

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2 - t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

$$K = \frac{(3.018\,cm)^2 \ln(.90/.50)}{2\,(411.48\,cm)(360\,sec - 60\,sec)} \cdot \ln\left(\frac{411.48\,cm}{13.335\,cm}\right)$$

$$K = 7.44 \times 10^{-5}\ cm/sec$$

WEHRAN ENGINEERING
CONSULTING ENGINEERS

VARIABLE HEAD PERMEABILITY TEST
PIEZOMETER No. MW-3S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
JOB NO: 07509
DATE OF TEST: AUGUST 9, 1988
SCREENED INTERVAL:
STAINLESS STEEL SCREEN: 24.25' to 34.25' BGS
SANDPACK INTERVAL: 21.0' to 36.25' BGS

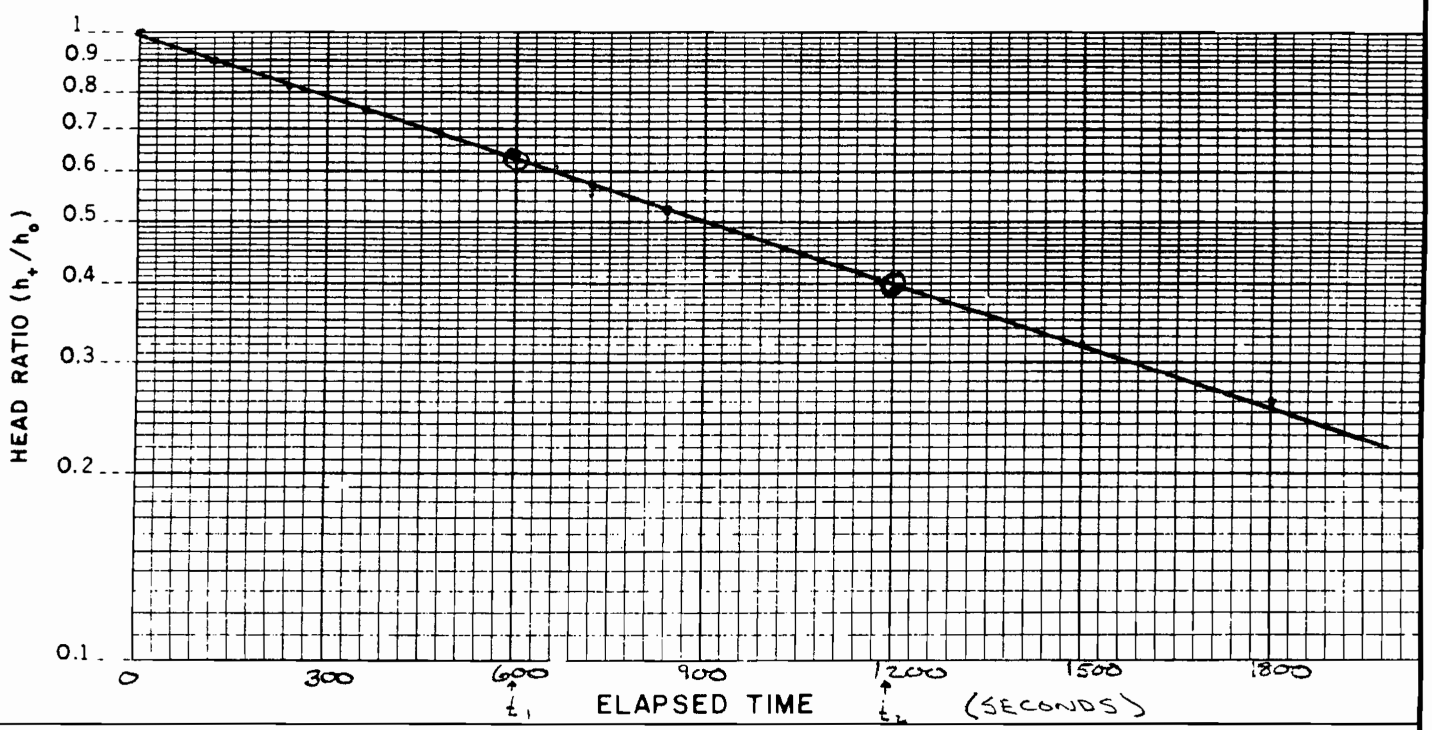
METHOD:
Hvorslev (1951)

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2-t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

FIELD DATA POINTS USED IN CALCULATIONS.

TEST DATA

ELAPSED TIME (SECONDS)	HEAD RATIO (h_t / h_o)
0	1.0
120	0.90
240	0.82
360	0.75
480	0.69
600	0.63
720	0.57
840	0.52
1200	0.39
1500	0.32
1800	0.26



CALCULATIONS:

r = 1.188 INCH = 3.018 cm
R = 2.25 INCH = 5.715 cm
L = 15.25 FEET = 464.82 cm
t_1 = 600 sec
t_2 = 1200 sec
h_1 = 0.63
h_2 = 0.39

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2 \cdot t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

$$K = \frac{(3.018\text{ cm})^2 \ln(.63/.39)}{2(464.82\text{ cm})(600\text{ sec})} \cdot \ln\left(\frac{464.82\text{ cm}}{5.715\text{ cm}}\right)$$

$$K = 3.44 \times 10^{-5}\text{ cm/sec}$$

WEHRAN ENGINEERING
CONSULTING ENGINEERS

VARIABLE HEAD PERMEABILITY TEST
PIEZOMETER No. MW-4S

PROJECT: MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT: NYSDEC
JOB NO: 07509
DATE OF TEST: AUGUST 9, 1988
SCREENED INTERVAL:

STAINLESS STEEL SCREEN: 10.5' to 20.5' BGS
SANDPACK INTERVAL: 8.0' to 21.5' BGS

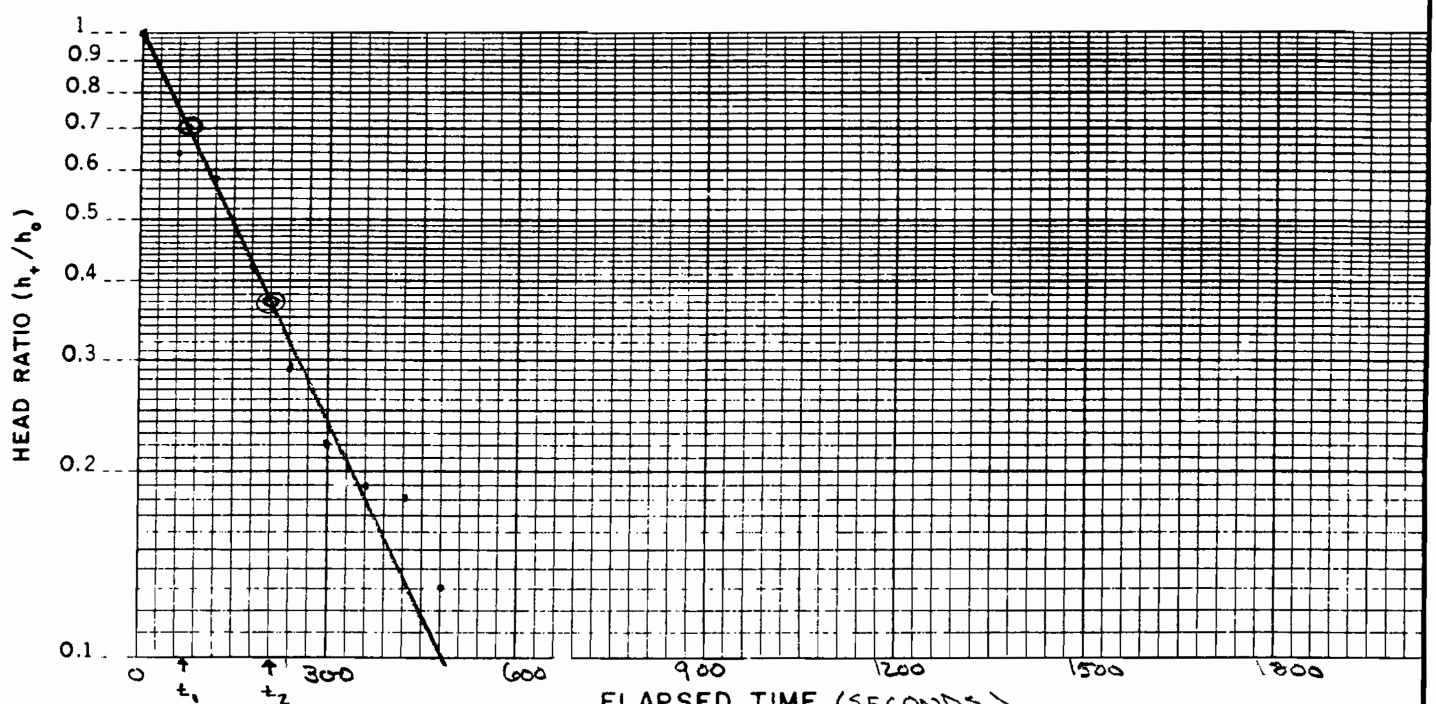
METHOD:
Hvorslev (1951)

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2-t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

FIELD DATA POINTS USED IN CALCULATIONS.

TEST DATA

ELAPSED TIME (SECONDS)	HEAD RATIO (h_t / h_0)
0	1.0
60	0.64
120	0.48
180	0.42
240	0.29
300	0.22
360	0.19
420	0.18
480	0.13
600	0.12
1200	0 02



CALCULATIONS:

r = 1.188 INCH = 3.018 cm
R = 2.25 INCH = 5.715 cm
L = 13.5 FEET = 411.48 cm
t_1 = 75 seconds
t_2 = 210 seconds
h_1 = 0.70
h_2 = 0.37

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2-t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

$$K = \frac{(3.018\text{ cm})^2 \ln(.70-.37)}{2(411.48\text{ cm})(135\text{ sec})} \cdot \ln \frac{(411.48\text{ cm})}{(5.715\text{ cm})}$$

$$K = 2.235 \times 10^{-4} \text{ cm/sec}$$

WEHRAN ENGINEERING
CONSULTING ENGINEERS

VARIABLE HEAD PERMEABILITY TEST
PIEZOMETER No. MW-6S

PROJECT:	MAHOPAC BUSINESS DISTRICT RI/FS
CLIENT:	NYSDEC
JOB NO:	07509
DATE OF TEST:	AUGUST 9, 1988

SCREENED INTERVAL:

STAINLESS STEEL SCREEN: 5.5' to 9.5' BGS
SANDPACK INTERVAL: 4.0' to 10.0' BGS

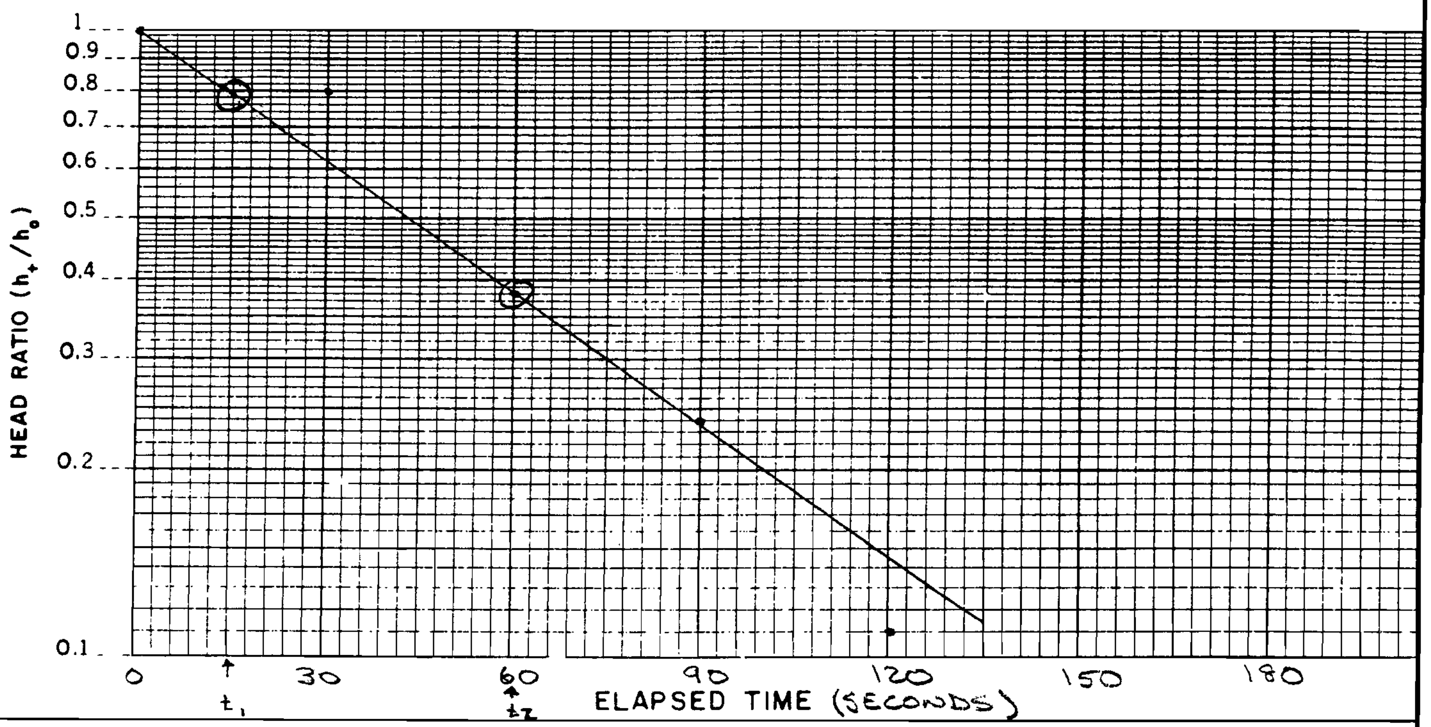
METHOD:

Hvorslev (1951)

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2 - t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

TEST DATA

ELAPSED TIME (SECONDS)	HEAD RATIO (h_t / h_o)
0	1.0
30	0.80
60	0.38
90	0.24
120	0.11
150	0.05
180	0.03
210	0.02
240	0.02



CALCULATIONS:

r = 1.188 INCH = 3.018 cm

R = 2.25 INCH = 5.715 cm

L = 6 FEET = 182.88 cm

t_1 = 15 seconds

t_2 = 60 seconds

h_1 = .78

h_2 = .38

$$K = \frac{r^2 \ln(h_1/h_2)}{2L(t_2 - t_1)} \cdot \ln\left(\frac{L}{R}\right)$$

$$K = \frac{(3.018\,cm)^2 \ln(.78/.38)}{2L(60\,sec - 15\,sec)} \cdot \ln\left(\frac{182.88\,cm}{5.715\,cm}\right)$$

$$K = 1.379 \times 10^{-3}\ cm/sec$$

MAHOPAC BUSINESS DISTRICT RI/FS

WE JOB NO. 02509

BEDROCK MONITORING WELL SLUG TEST DATA

CALCULATIONS BASED ON TRANSMISSIVITY VALUES FROM TYPE CURVE MATCHING ON DATA PLOTS AND FORMULA:

$$K = T/b$$

where: K = hydraulic conductivity (permeability) in Ft/min.

T = transmissivity in Ft^2/min.

b = saturated thickness (length of sandpack) in Ft.

NOTE: Curve matching using Theis Analysis performed using Graphical Well Analysis Program (GWAP) Software.

MAHOPAC BUSINESS DISTRICT RI/FS

WE = 07509

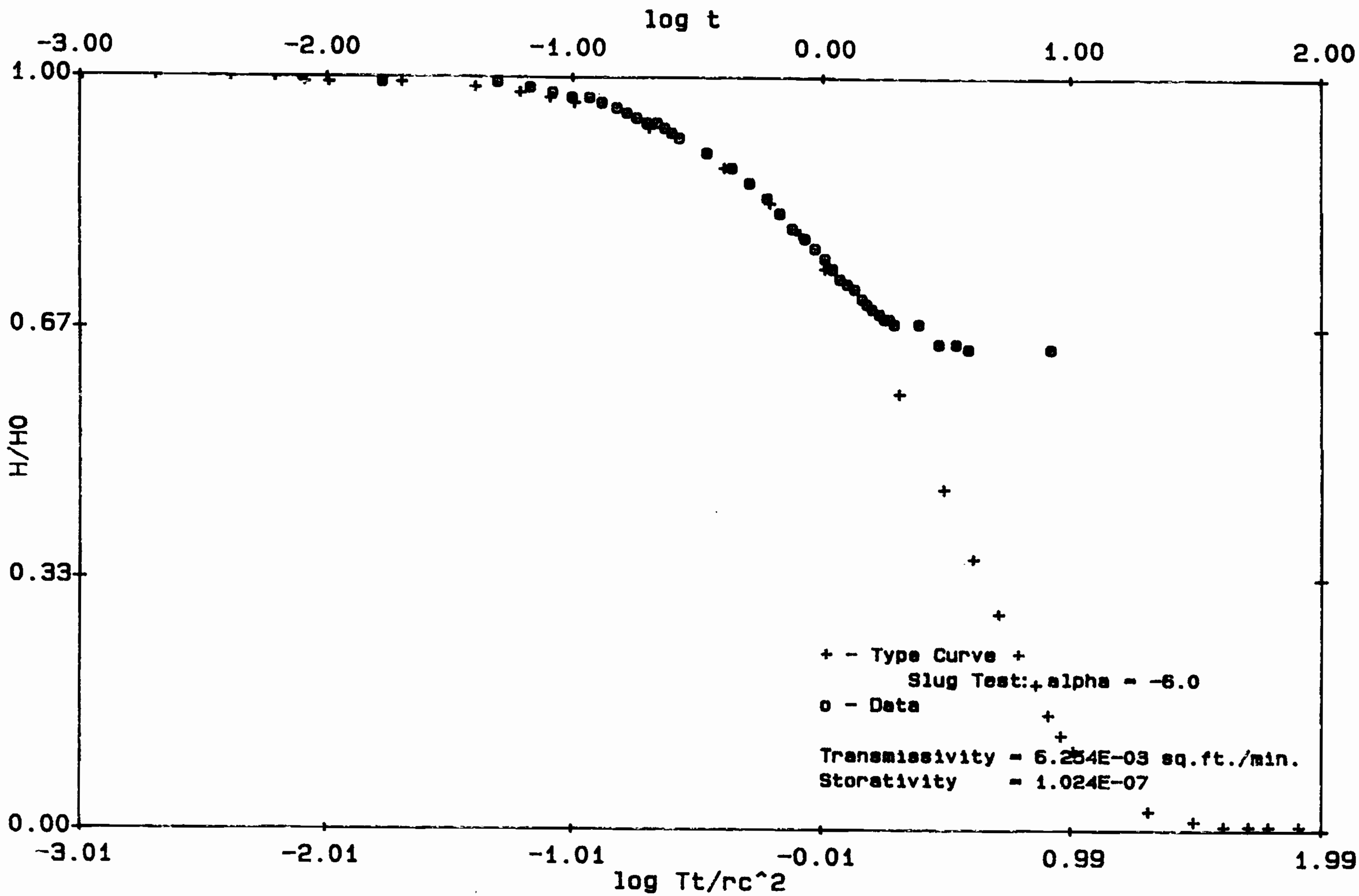
BEDROCK MONITORING WELL SLUG TEST DATA

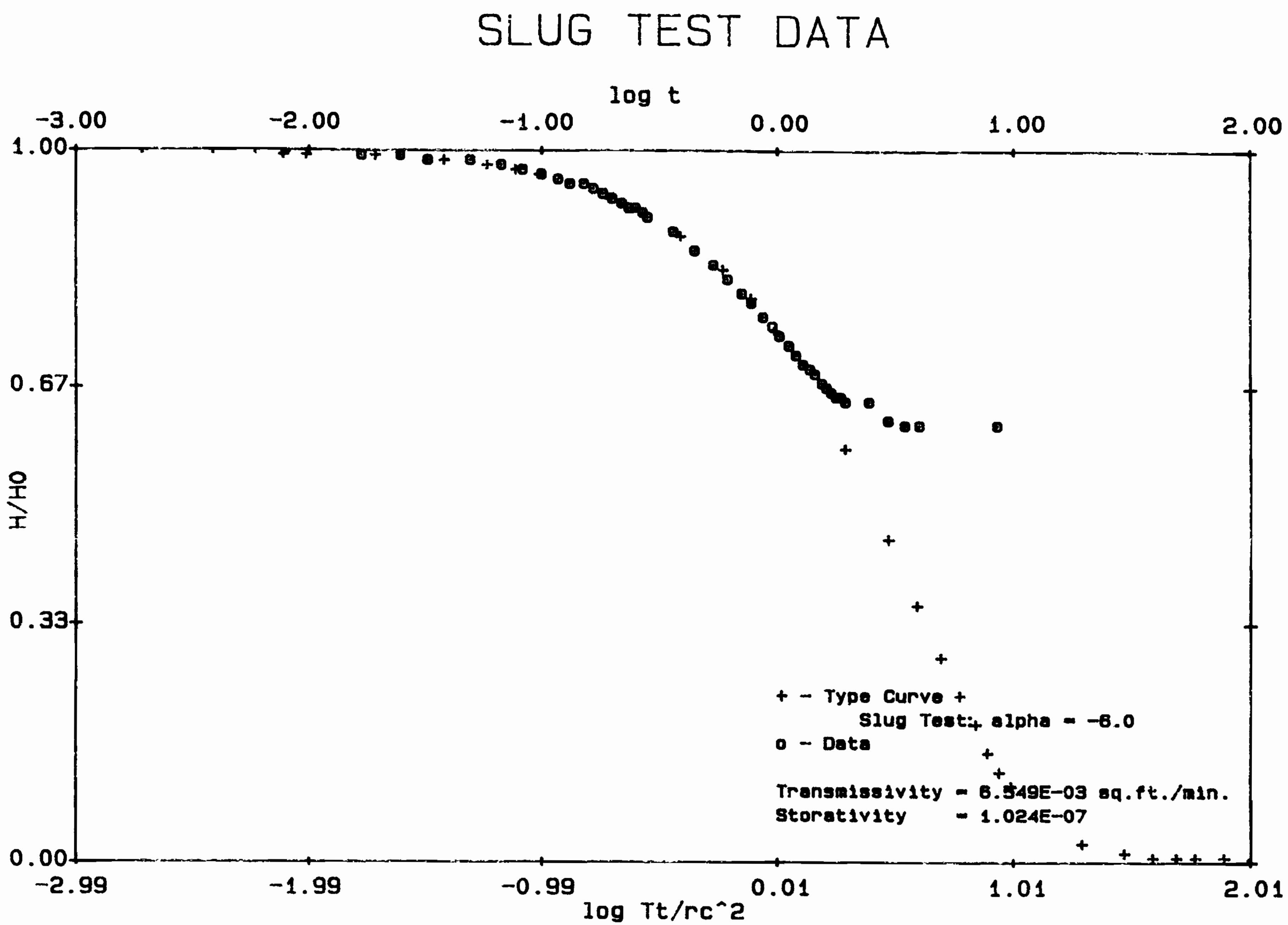
WELL NO.	TEST #	TRANSMISSIVITY (FT^2/MIN)	SANDPACK LENGTH (FT)	PERMEABILITY FT/MIN	PERMEABILITY cm/sec
1I	1	2.324×10^{-3}	15	1.549×10^{-4}	7.871×10^{-5}
2I	1	3.856×10^{-1}	30	1.285×10^{-2}	6.530×10^{-3}
	2	1.062×10^{-1}	30	3.540×10^{-3}	1.798×10^{-3}
2D	1a	9.912×10^{-3}	33	3.004×10^{-4}	1.523×10^{-4}
	1b	6.254×10^{-3}	33	1.895×10^{-4}	9.627×10^{-5}
	2a	6.549×10^{-3}	33	1.985×10^{-4}	1.008×10^{-4}
	2b	9.687×10^{-3}	33	2.936×10^{-4}	1.491×10^{-4}
3I	1	9.251×10^{-2}	30	3.084×10^{-3}	1.567×10^{-3}
	2	3.683×10^{-2}	30	1.210×10^{-3}	6.147×10^{-4}
5I	1	4.744×10^{-2}	30	1.581×10^{-3}	8.033×10^{-4}
	2	5.084×10^{-2}	30	1.695×10^{-3}	8.609×10^{-4}
6I	1a	4.428×10^{-2}	30	1.476×10^{-3}	7.498×10^{-4}
	1b	4.980×10^{-2}	30	1.660×10^{-3}	8.433×10^{-4}
	2a	4.531×10^{-2}	30	1.510×10^{-3}	7.673×10^{-4}
	2b	5.084×10^{-2}	30	1.695×10^{-3}	8.609×10^{-4}

AVERAGE K

MW-1I	7.87×10^{-5} cm/s
MW-2I	4.16×10^{-3} cm/s
MW-3I	1.09×10^{-3} cm/s
MW-5I	8.32×10^{-4} cm/s
MW-6I	8.05×10^{-4} cm/s
MW-2D	1.25×10^{-4} cm/s

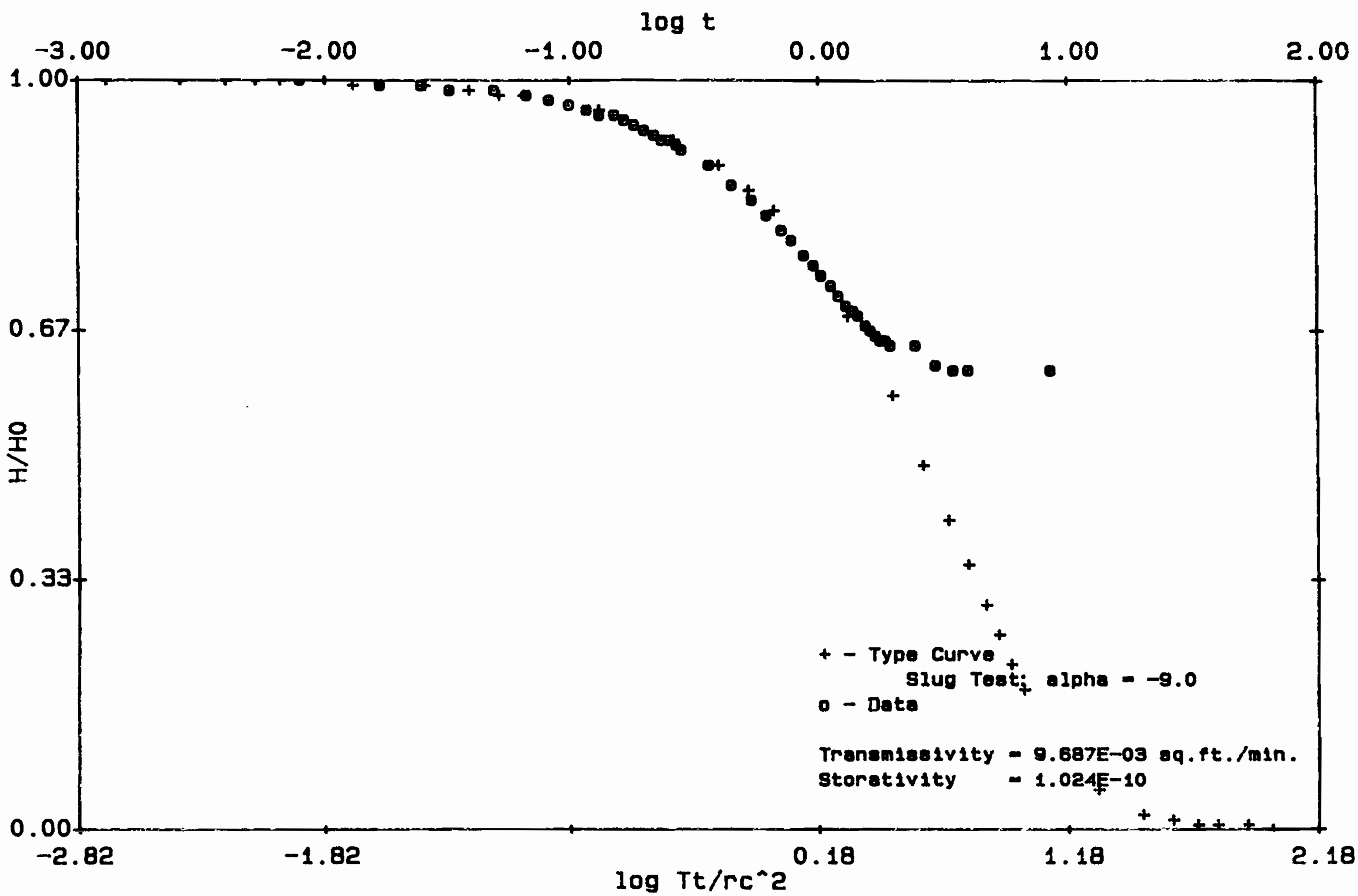
SLUG TEST DATA




SLUG TEST DATA
log t
-3.00
-2.00
-1.00
0.00
1.00
2.00
1.00
0.67
0.33
0.00
H/HO
-2.99
-1.99
-0.99
0.01
1.01
2.01
log Tt/rc^2
+ - Type Curve +
Slug Test: alpha = -8.0
o - Data
Transmissivity = 6.549E-03 sq.ft./min.
Storativity = 1.024E-07

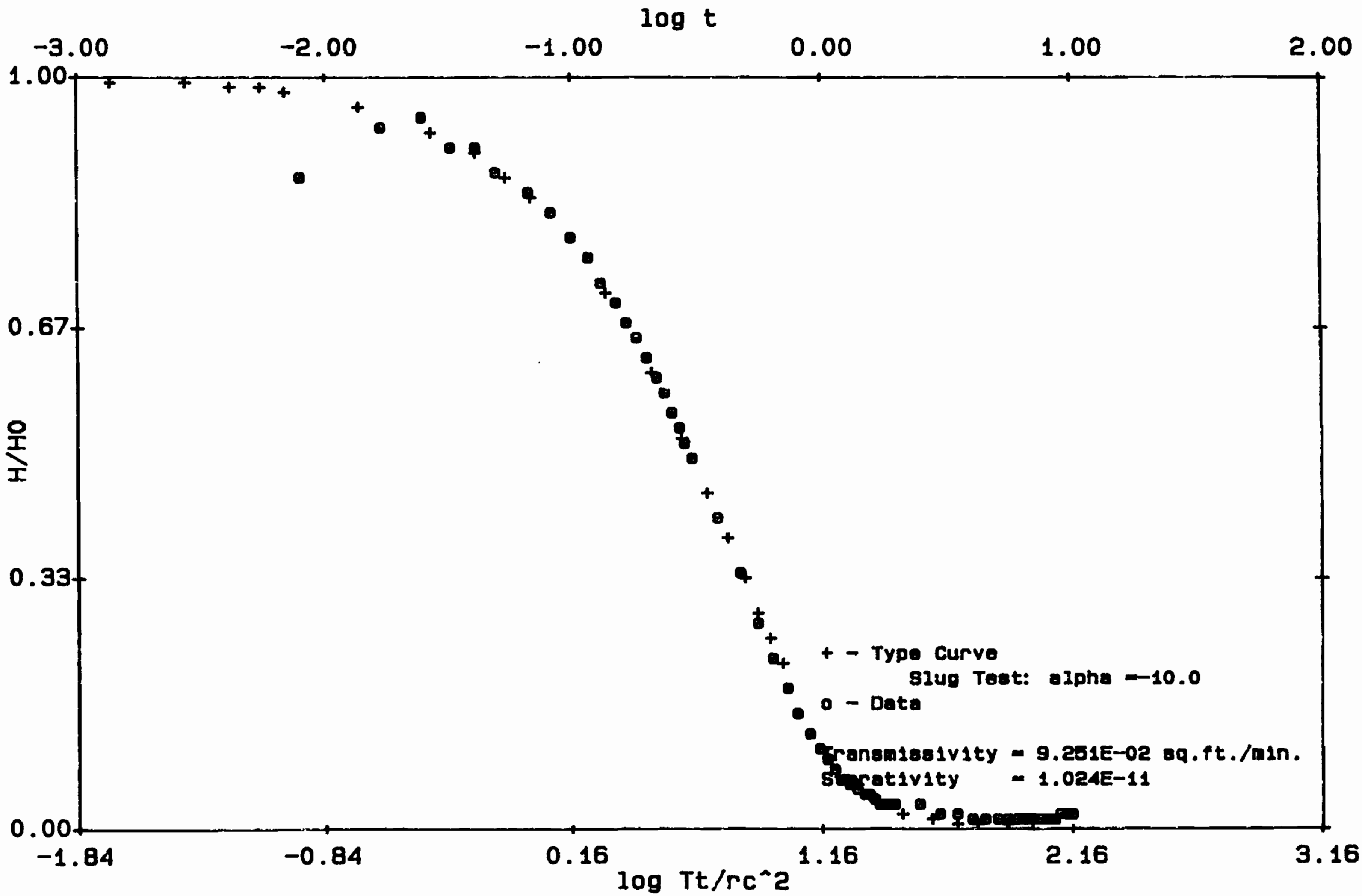
MW-2D B

SLUG TEST DATA

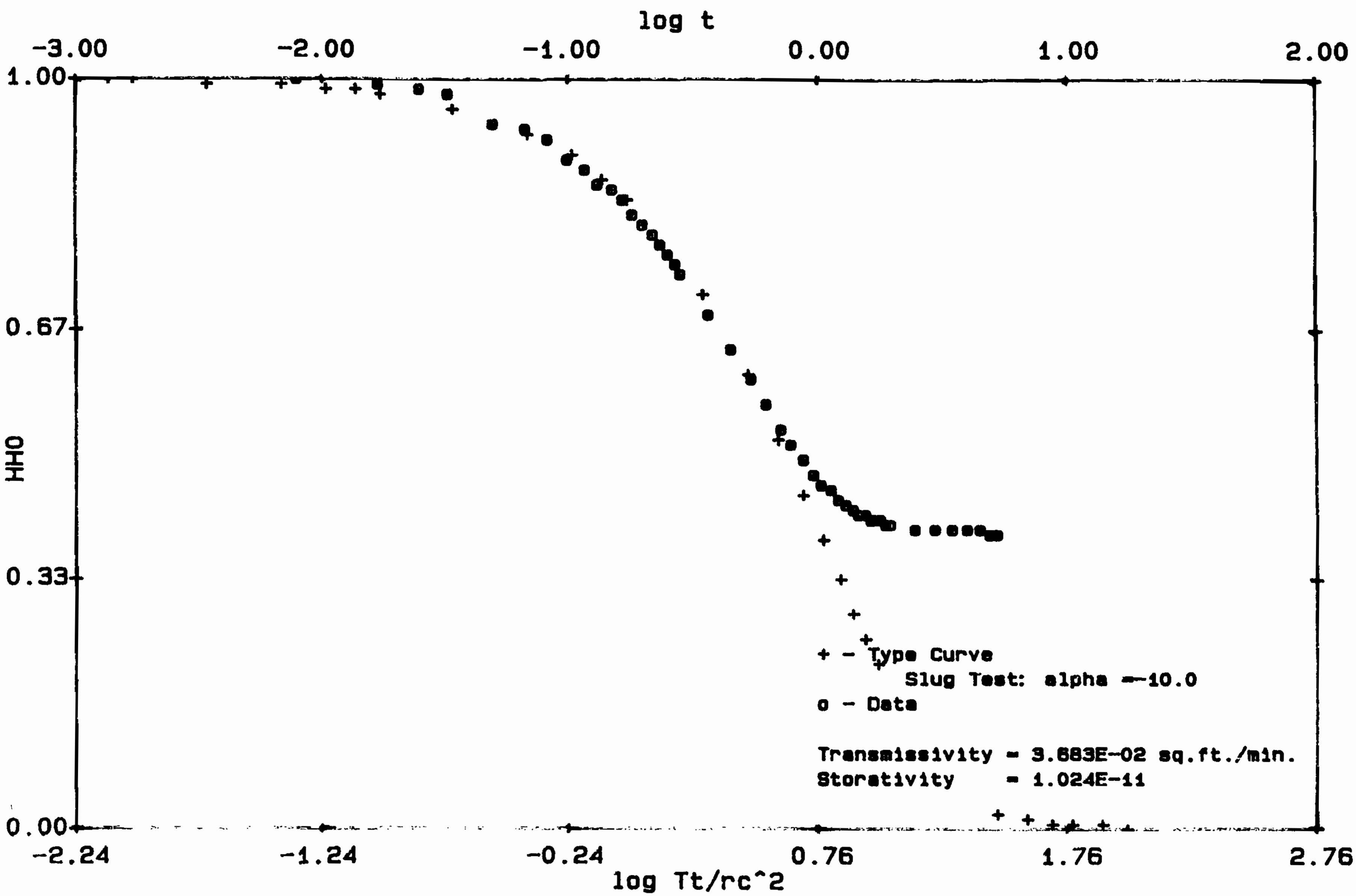


MW-7DB

SLUG TEST DATA

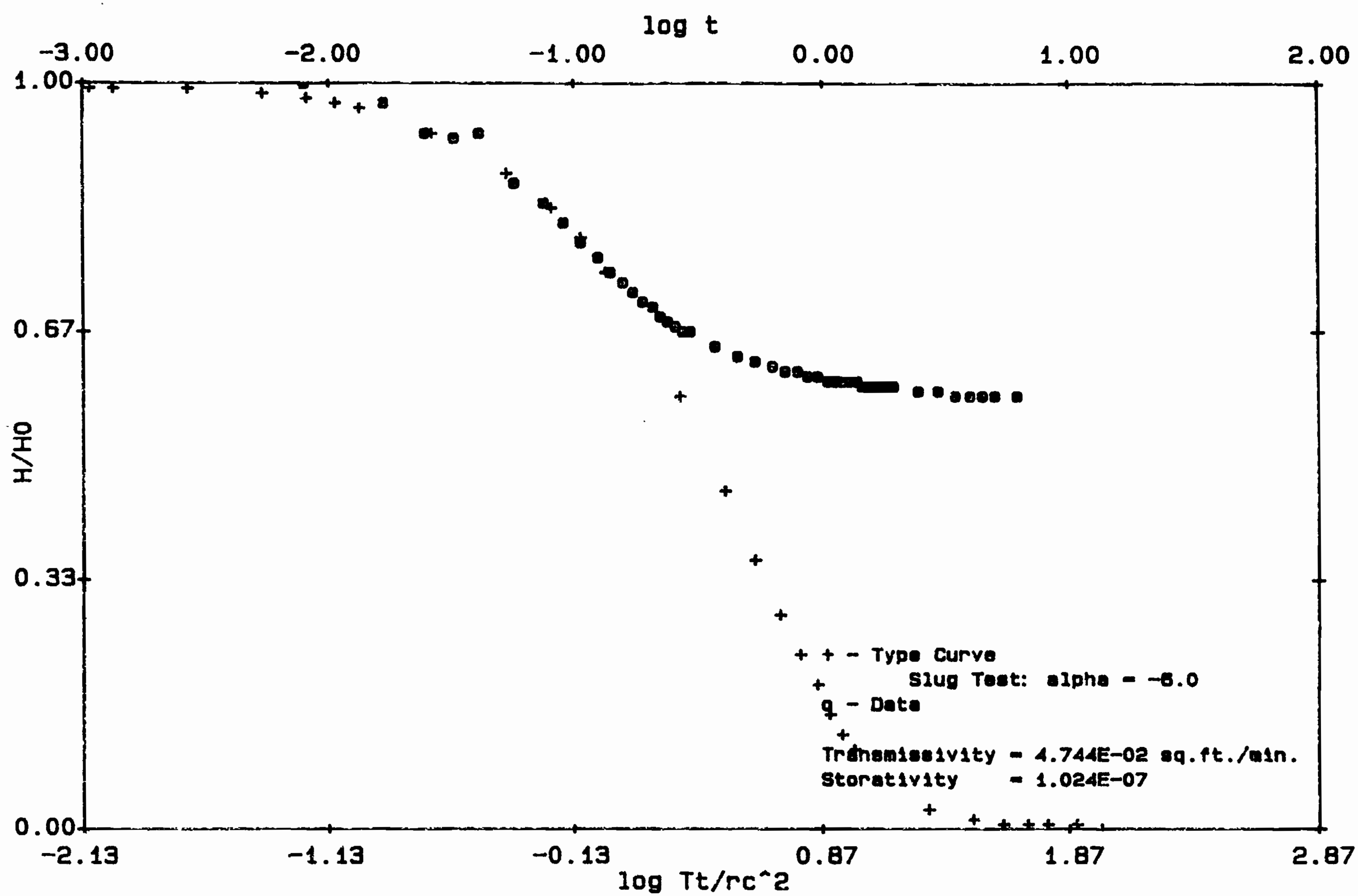


SLUG TEST DATA

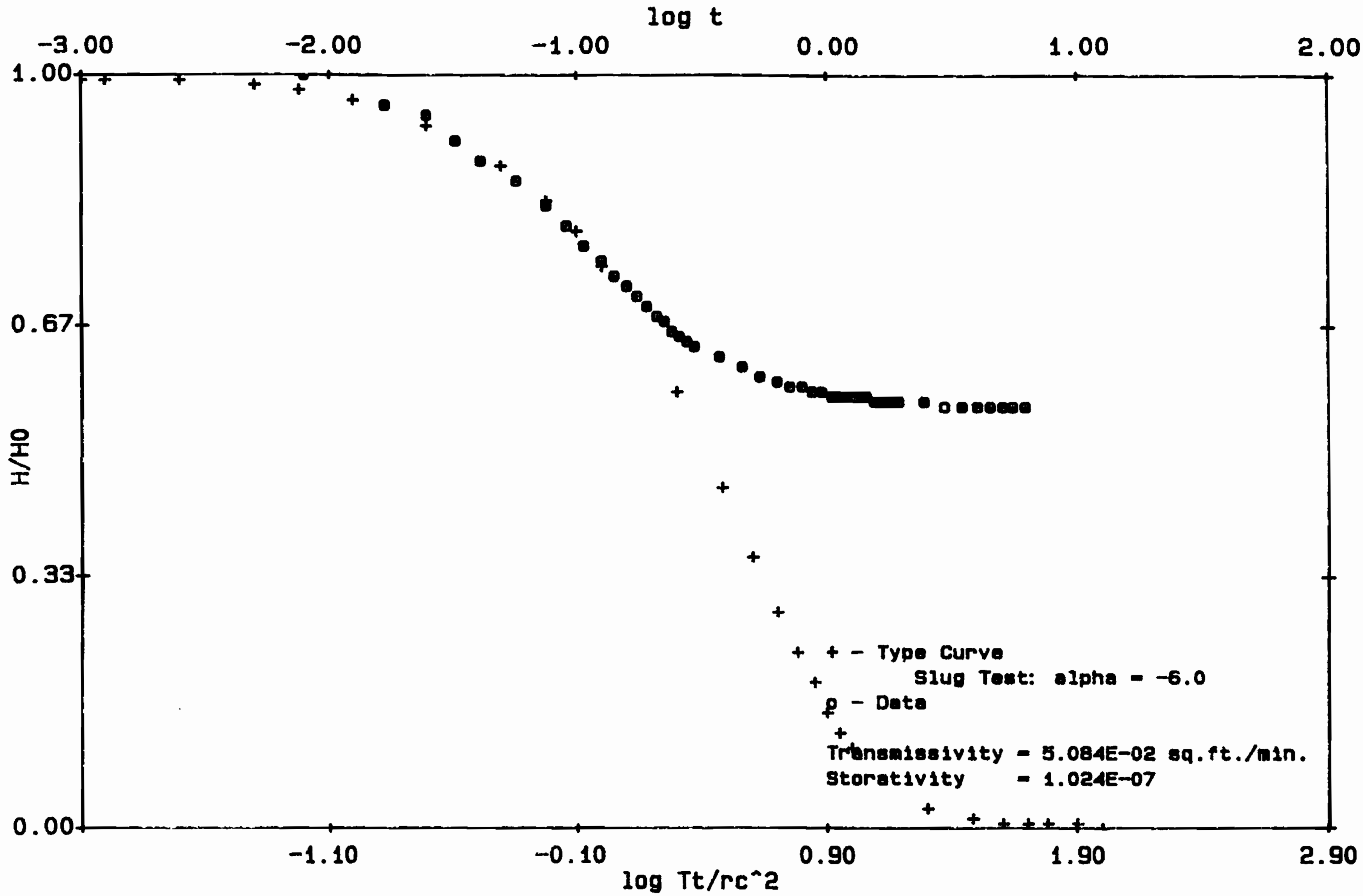


MW-3I B

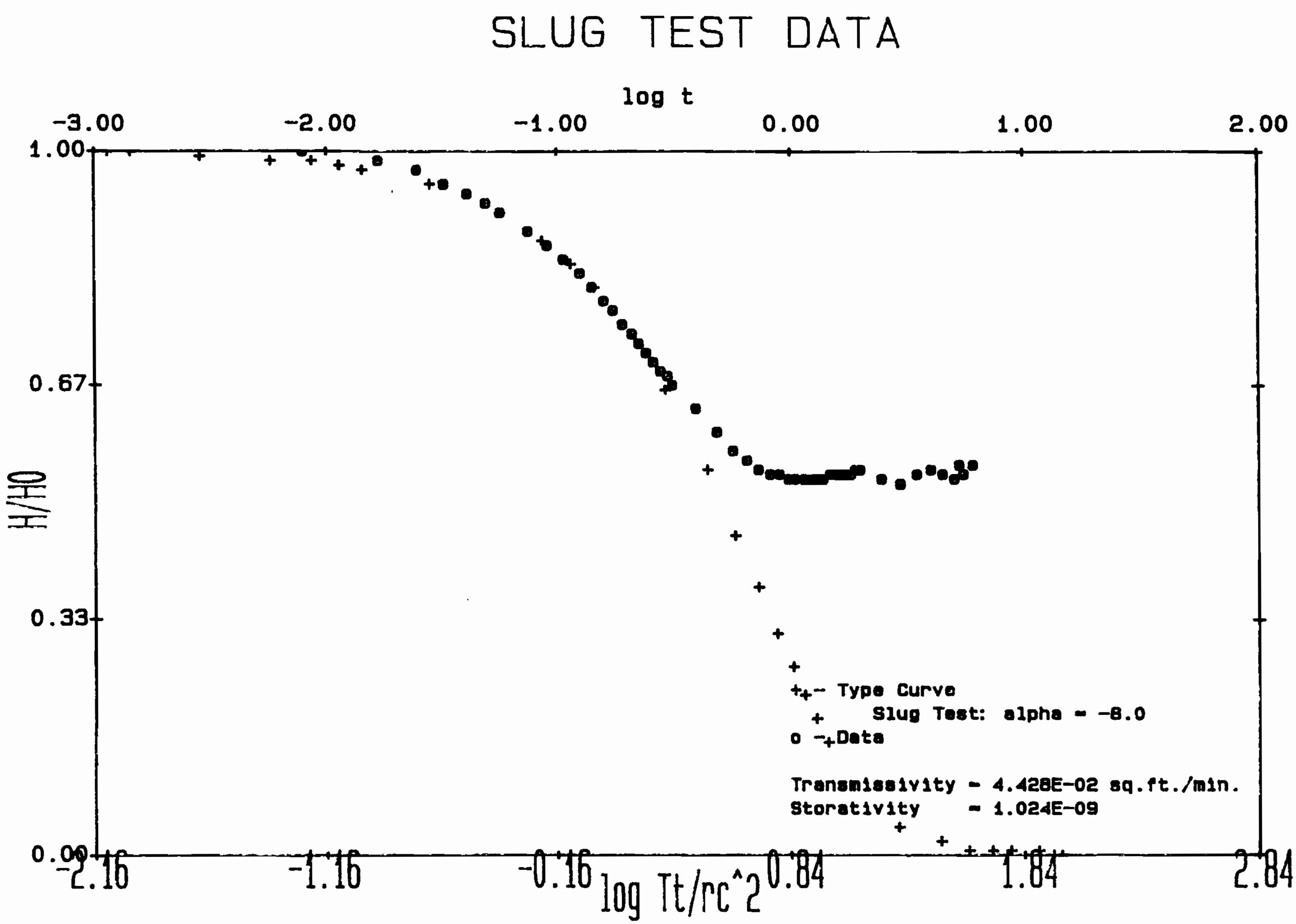
SLUG TEST DATA



SLUG TEST DATA

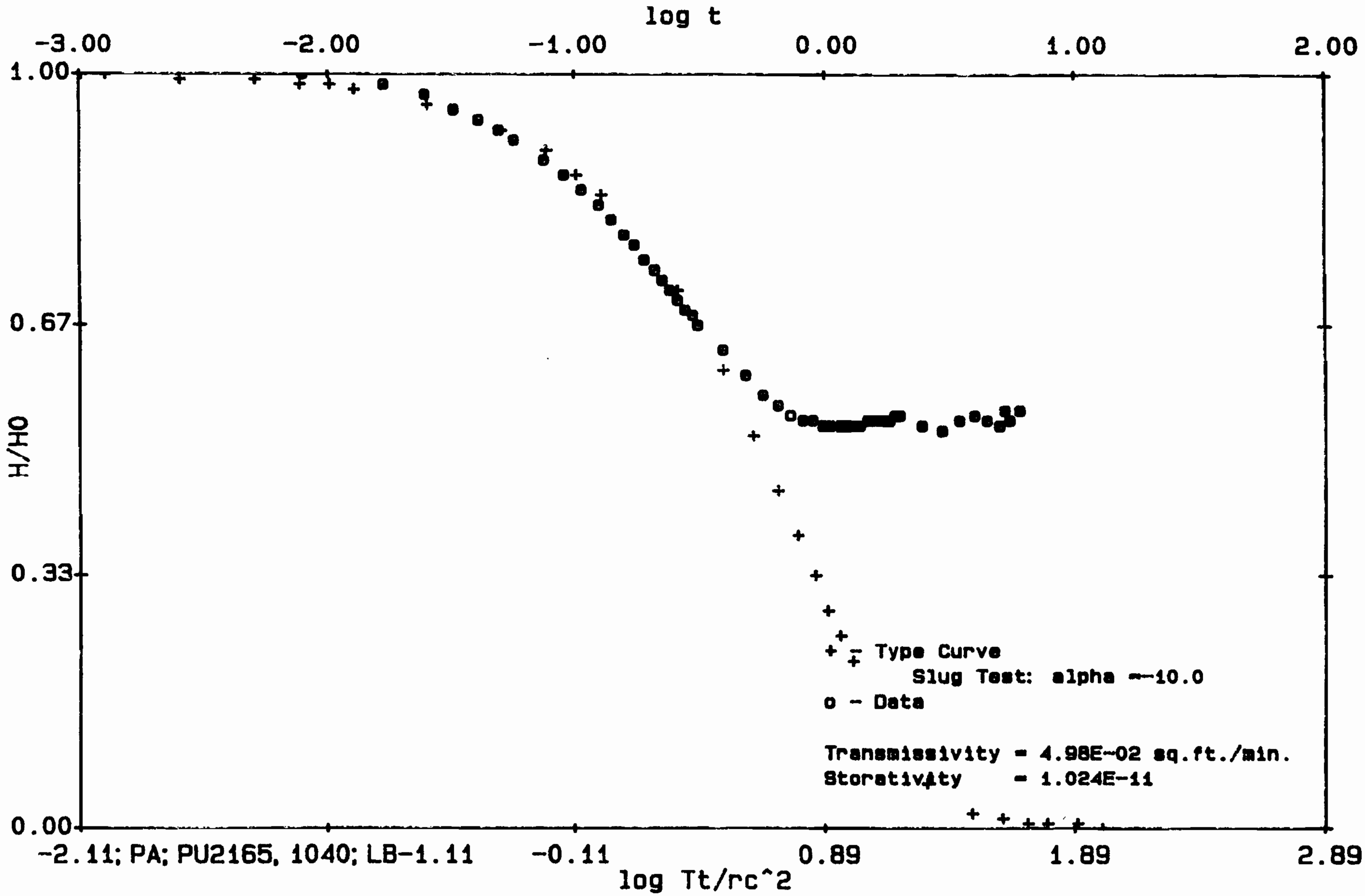


MW-5I B


SLUG TEST DATA
log t
-3.00
-2.00
-1.00
0.00
1.00
2.00
1.00
0.67
0.33
0.00
H/HO
-2.16
-1.16
-0.16
0.84
1.84
2.84
log Tt/rc^2
+ -- Type Curve
Slug Test: alpha = -8.0
o - Data
Transmissivity = 4.428E-02 sq.ft./min.
Storativity = 1.024E-09

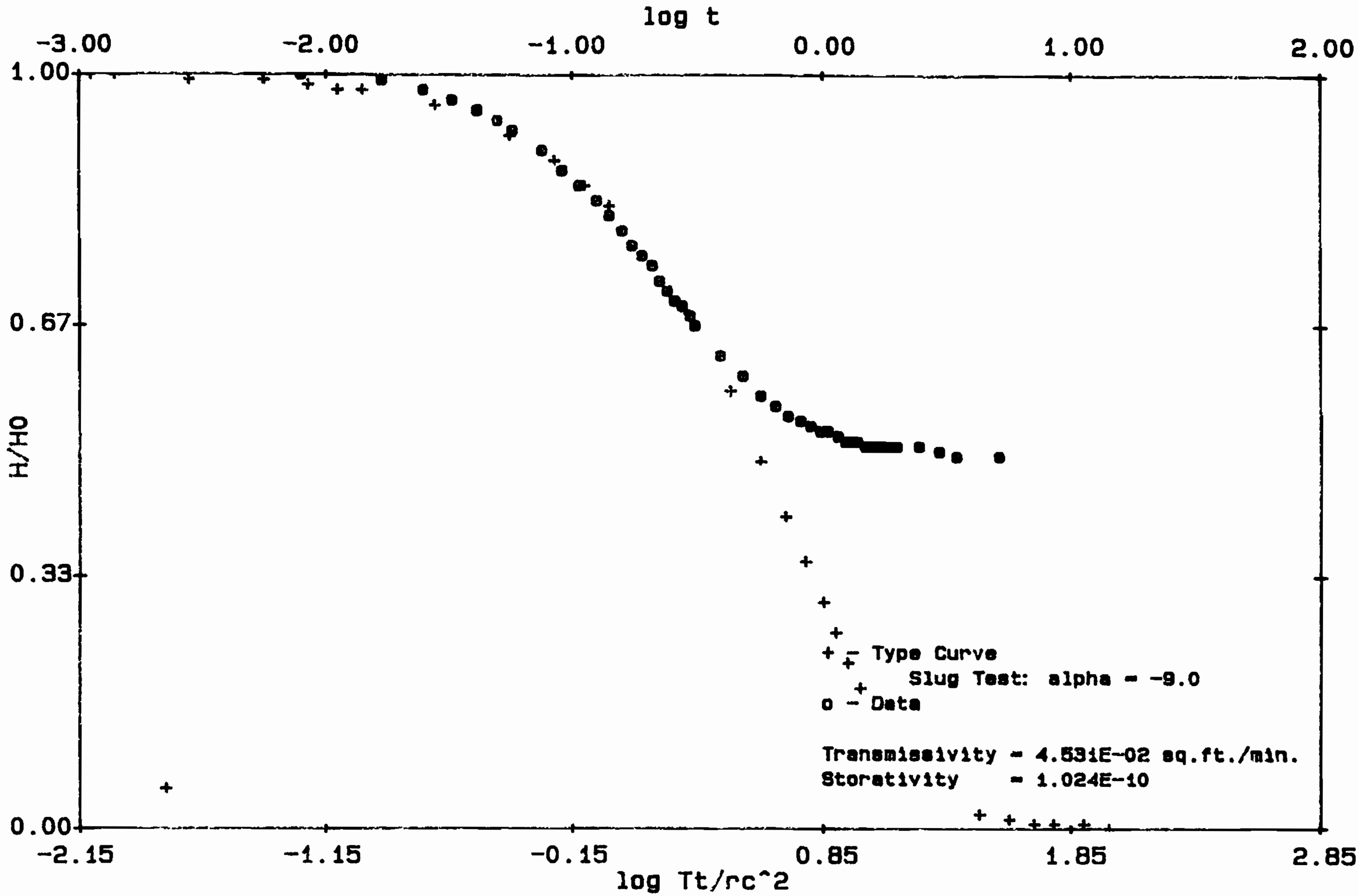
MW-6I A

SLUG TEST DATA



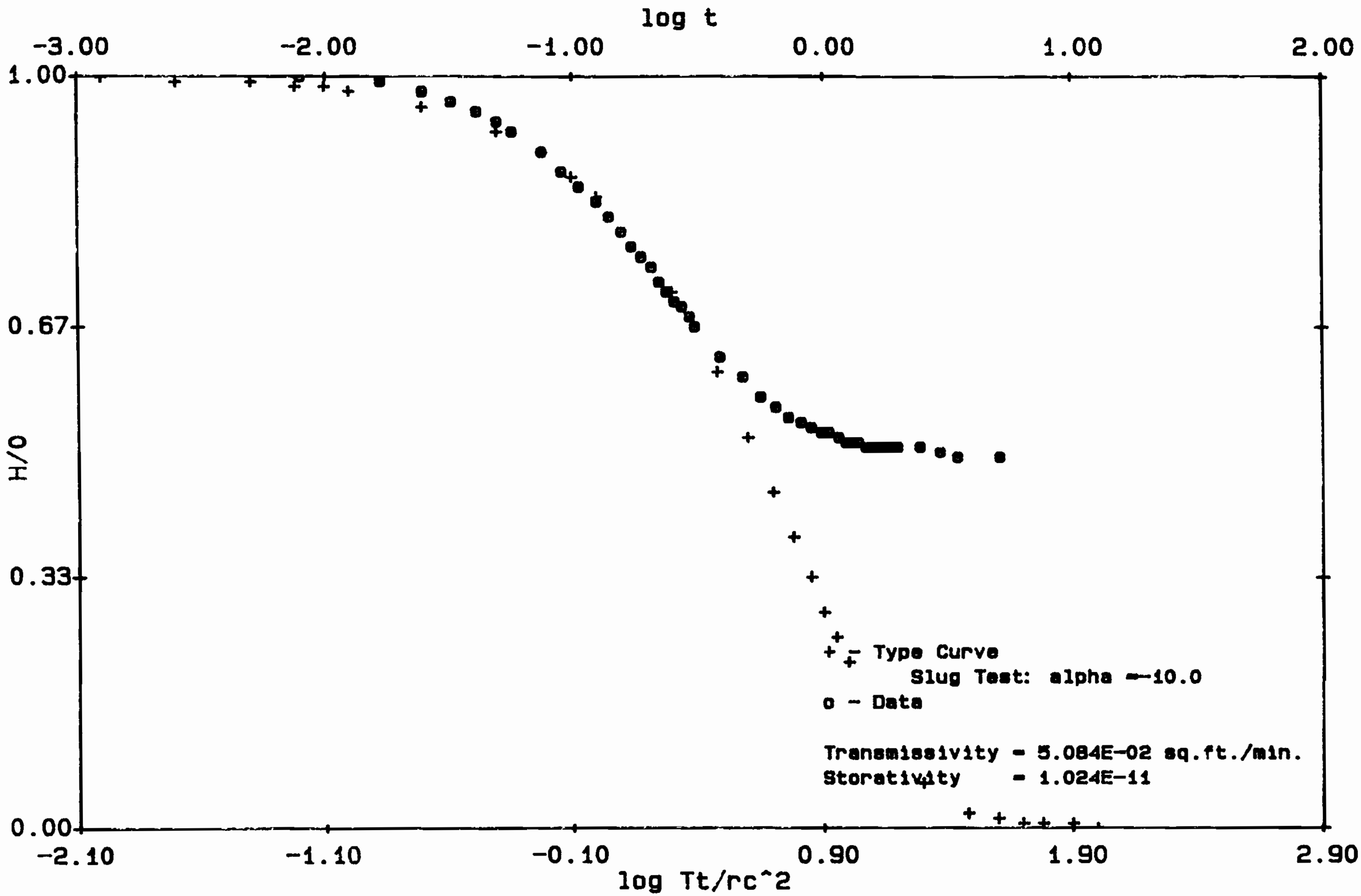
MW-6I A

SLUG TEST DATA



MW-6II B

SLUG TEST DATA



APPENDIX D
GEOPHYSICAL TESTING RESULTS

MAHOPAC BUSINESS DISTRICT
GEOPHYSICAL WATER SAMPLE RATIONALE

Sample Identification No.	Depth (ft)	Rationale
388-098-01	60	Collected below first major fracture zone. No purging of the well occurred for the purpose of trying to obtain existing conditions based on the pumping created by the Business District.
388-098-02	85	Collected below second fracture zone. No purging occurred for the same reason as above.
388-098-03	60	Collected below first fracture zone. A pump was placed at this point to obtain fresh formational water from the fracture zone. Sample was collected from the discharge hose.
388-098-04	80	Collected below second fracture zone with the same rationale and procedure as above.
388-098-04		Field Blank
388-098-06	88	Sample was collected below the first two major fracture zones while continuously pumping the zone to try to induce a vertically upward gradient within the bore hole.
388-098-07	107	Sample was collected below the first three fracture zones under the same rationale and procedures as above.
388-098-08		Field Blank
388-097-01	55	Sample collected within the first major fracture zone.
388-097-02	80	Sample collected within the second fracture zone.
388-097-03	57	Sample collected just below first major fracture zone.
388-097-04	82	Sample collected just below second major fracture zone.
388-97-05	140	Sample collected below major fracture zone.
388-97-06	180	Sample collected below a fracture zone.
388-97-07	230	Sample collected below a fracture zone.
388-97-08	340	Sample collected below a fracture zone.
388-97-09	380	Sample collected below a fracture zone.
388-97-10		Field Blank
388-97-13		Field Blank

MAHOPAC BUSINESS DISTRICT RI/FS

MW-2D AND MW-1I BOREHOLE DISCRETE POINT SAMPLING RESULTS

Sample ID	Well No.	Depth ft. BGS	Vinyl Chloride	1,1,1, Tri-Chloroethane	Trans-1,2,-Dichloroethene	Trichloroethene	Tetrachloroethene
388-097-01	MW-2D	55	ND	ND	ND	ND	16.0 ppb
388-097-02	MW-2D	80	ND	ND	ND	ND	18.6 ppb
388-097-03	MW-2D	57	ND	1.6 ppb	ND	1.9 ppb	16.9 ppb
388-097-04	MW-2D	82	ND	3.6 ppb	ND	3.7 ppb	24.5 ppb
388-097-05	MW-2D	140	ND	4.5 ppb	3.6 ppb	6.3 ppb	32.9 ppb
388-097-06	MW-2D	180	ND	6.4 ppb	ND	5.2 ppb	24.2 ppb
388-097-07	MW-2D	230	ND	ND	ND	2.5 ppb	25.6 ppb
388-097-08	MW-2D	340	ND	2.7	ND	ND	23.7 ppb
388-097-09	MW-2D	380	ND	ND	ND	ND	25.6 ppb
388-097-10	FB	FB	ND	ND	ND	ND	ND
388-098-01	MW-2D	60	ND	ND	ND	ND	25.3 ppb
388-098-02	MW-2D	85	ND	ND	ND	ND	26.1 ppb
388-098-03	MW-2D	60 (pump)	ND	ND	ND	ND	20.5 ppb
388-098-04	MW-2D	85 (pump)	ND	ND	ND	ND	16.8 ppb
388-098-05	FB	FB	ND	ND	ND	ND	ND
388-098-06	MW-1I	88	ND	ND	ND	ND	ND
388-098-07	MW-1I	106	ND	ND	ND	ND	ND
388-098-08	FB	FB	ND	1.7 ppb	ND	ND	ND

Notes: FB Field Blank
ND Not Detected
ppb Parts Per Billion

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

April 25, 1988

RECEIVED
MAY 02 1988
Middletown, N.Y. 10940

Mr. Ray Kapp
Wehran Engineering
666 E. Main Street
P. O. Box 2006
Middletown, NY 10940

Dear Mr. Kapp:

Re: Mahopac Business District Site
I.D. #340013

Enclosed is sampling data from the USGS point sampling conducted on April 5 and 6, 1988. Please ensure this data is used to help design final construction details for monitoring well MW-02D and MW-01I.

If there are any questions, please call me at (518) 457-1708.

Sincerely,

Scott Rodabaugh

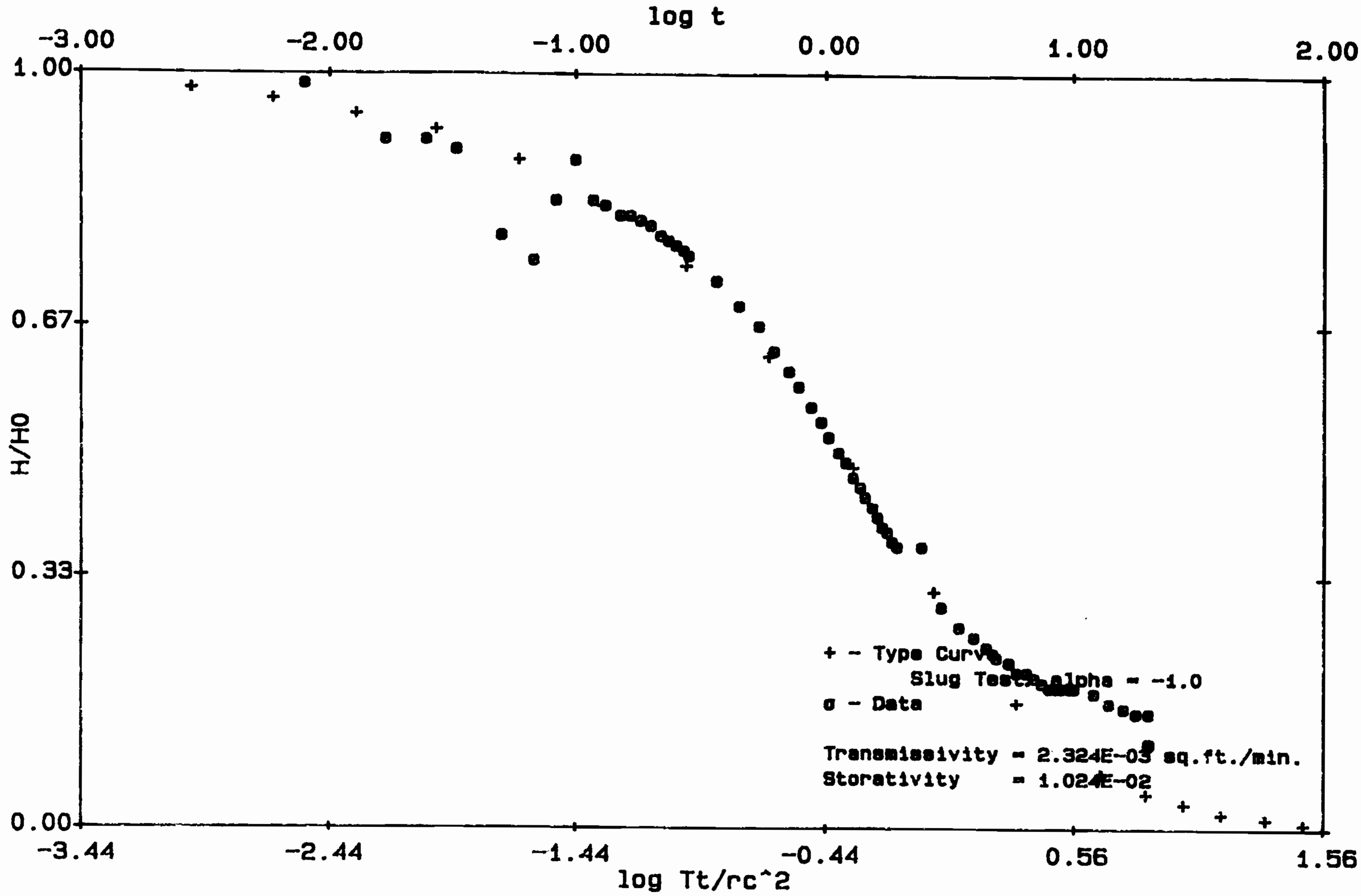
Scott Rodabaugh
Project Engineer
Division of Hazardous Waste
Remediation

Enclosure

cc: w/o enc. - T. Haelen, Wehran Engineering

Sample Number	Vinyl chloride	1,1,1-Trichloro ethane	Trans-1,2-Dichloroethene	Trichloroethene	Tetrachloro-ethene	
388-098-01	ND	ND	ND	ND	25.3 ppb	60'
388-098-02	ND	ND	ND	ND	26.1 ppb	85'
388-098-03	ND	ND	ND	ND	20.5 ppb	60 / PUMP DISCHARGE
388-098-04	ND	ND	ND	ND	16.8 ppb	85' PUMP DISCHARGE
388-098-05	ND	ND	ND	ND	ND	FIELD BLANK
388-098-06	ND	ND	ND	ND	ND ID	88' (FRACTURES)
388-098-07	ND	ND ?	ND	ND	ND ID	106' (FRACTURES)
388-098-08	ND	1.7 ppb	ND	ND	ND	FIELD BLANK
388-097-01	ND	ND	ND	ND	16.0 ppb	55'
388-097-02	ND	ND	ND	ND	18.6 ppb	80'
388-097-03	ND	1.6 ppb	ND	1.9 ppb	16.9 ppb	57'
388-097-04	ND	3.6 ppb	ND	3.7 ppb	24.5 ppb	82'
388-097-05	ND	4.5 ppb	3.6 ppb	6.3 ppb	32.9 ppb	140'
388-097-06	ND	6.4 ppb	ND	5.2 ppb	24.2 ppb	180'
388-097-07	ND	ND	ND	2.5 ppb	25.6 ppb	230'
388-097-08	ND	2.7 ppb	ND	ND	23.7 ppb	340'
388-097-09	ND	ND	ND	ND	25.6 ppb	380'
388-097-10	ND	ND	ND	ND	ND	FIELD BLANK

SLUG TEST DATA



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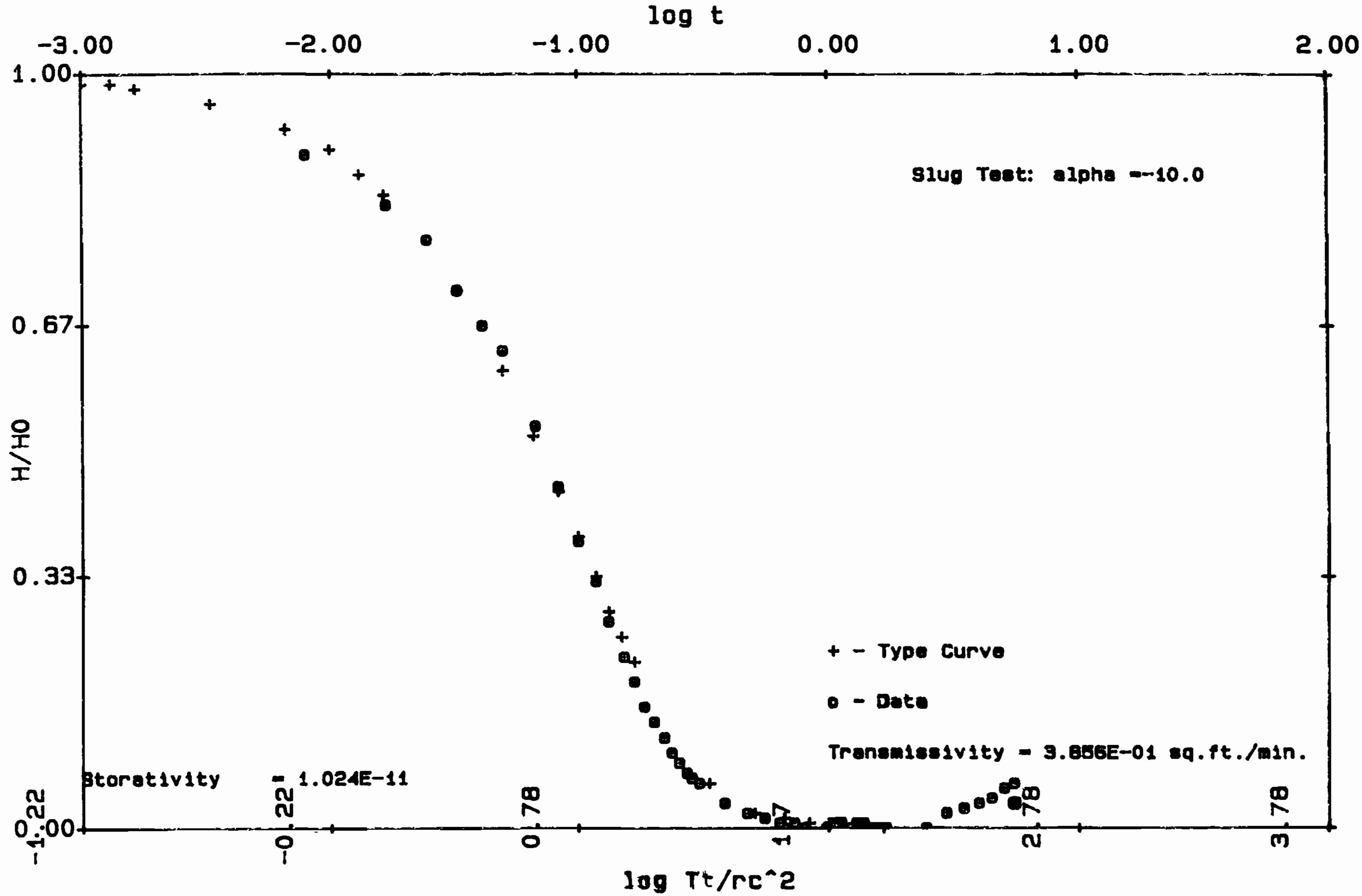
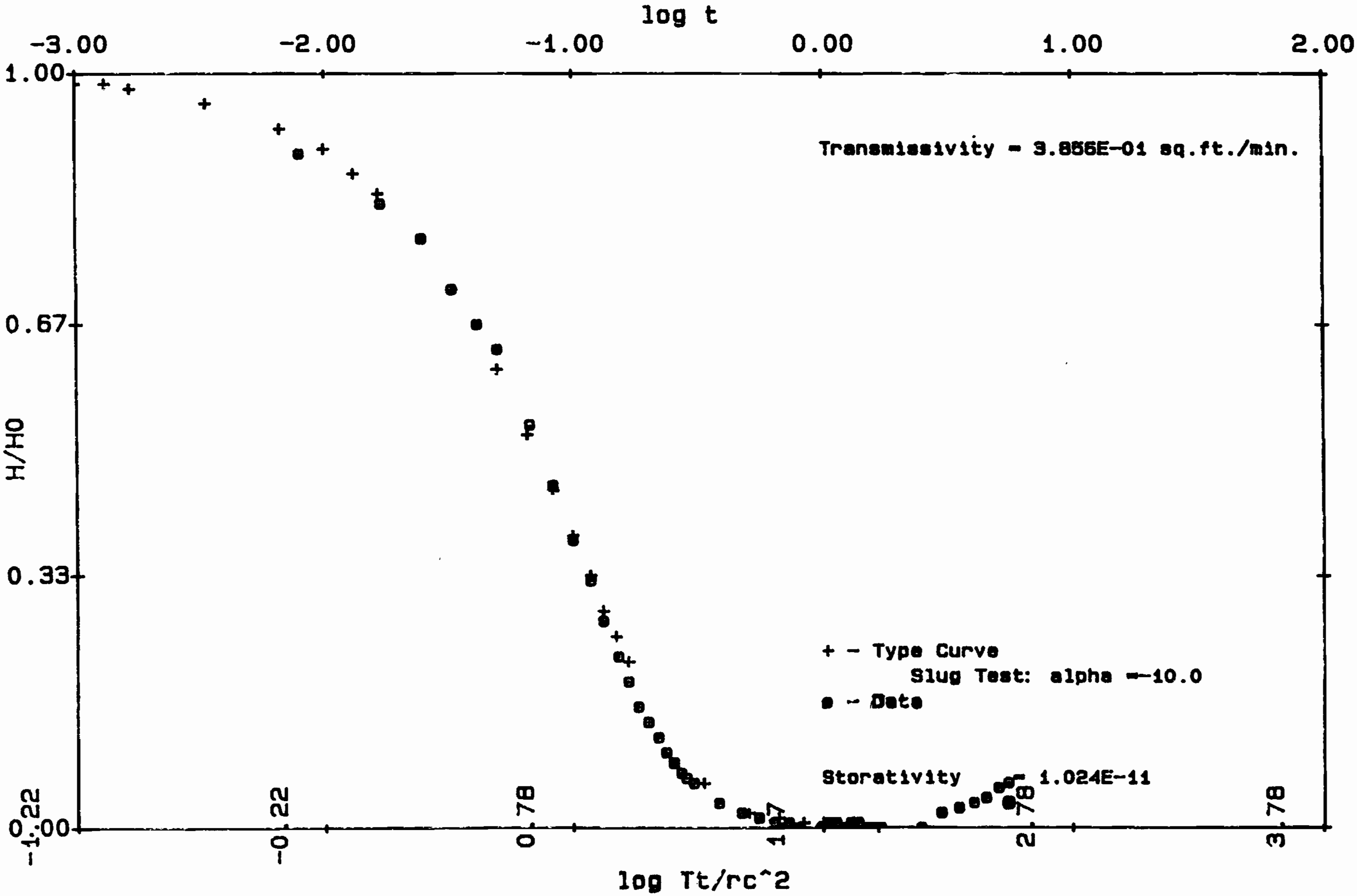


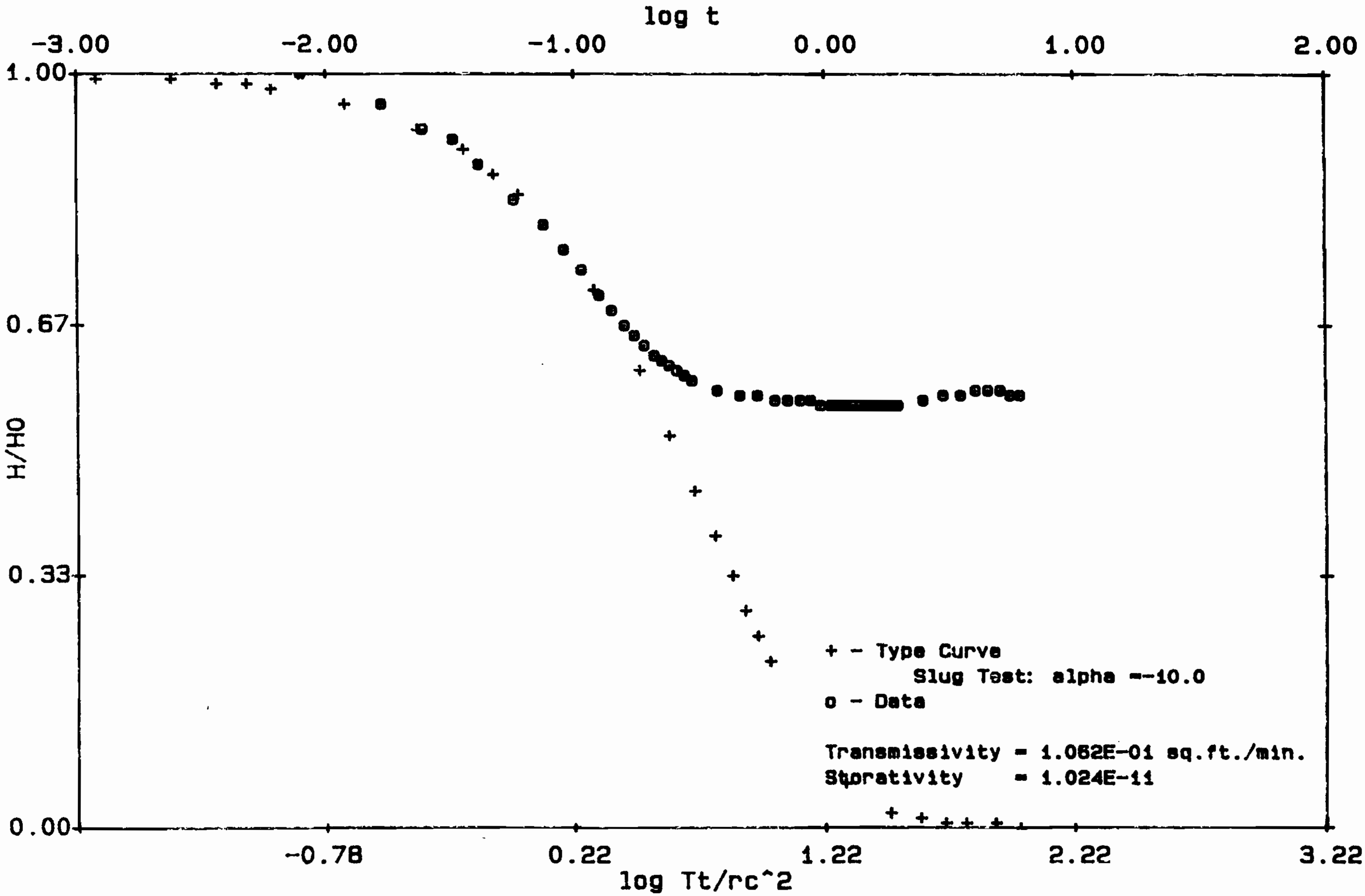
MW-ZI A

SLUG TEST DATA



MW-2I A

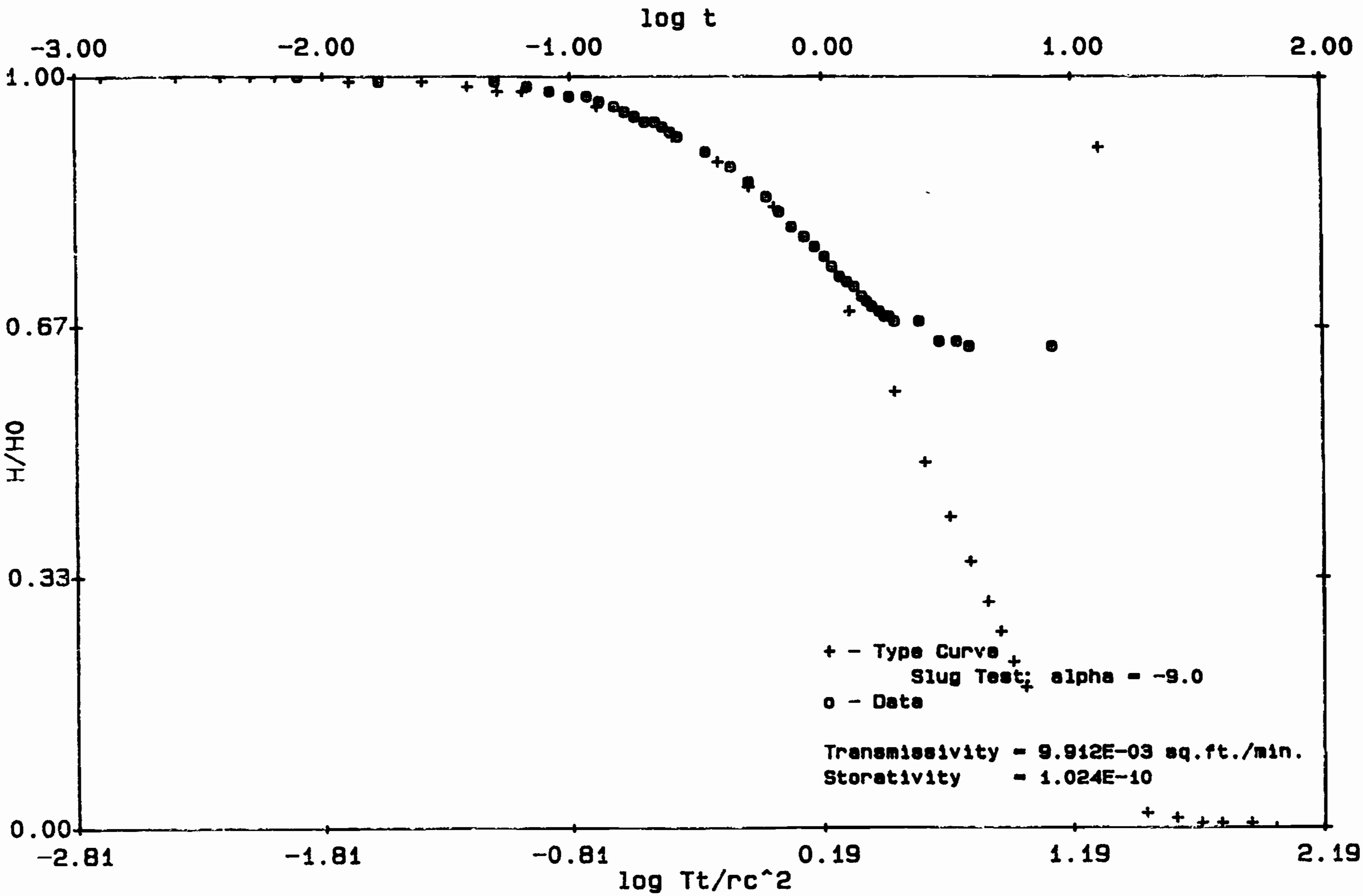
SLUG TEST DATA



-1.78

MW-7I R

SLUG TEST DATA



MW-2D A

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SOLID AND HAZARDOUS WASTE

Sample Chain of Custody Form*

Sample Descriptions:

Sample ID	Matrix	Sampling Point	Analysis Required
388-097-01	GW	55' (prior to pumping)	Parameters listed on back p.w.
-02	GW	80' (prior to pumping)	
-03	GW	57' (after transducer)	
-04	GW	82' "	
-05	GW	140' "	
-06	GW	180'	
-07	GW	230'	
-08	GW	340'	
-09	GW	382	
-10	GW	[illegible]	
-13	GW	Field Blank	

	Name	Date	Affiliation
Collected by:	John Williams	4/6/88	USGS
Relinquished by:	"	"	"
Received by:	Scott Rohrbaugh	4/6/88	NYSDEC
Relinquished by:	"	"	
Received by:	Maureen [illegible]	4/7/88	
Relinquished by:	"		
Received by:	[illegible]	[illegible]	
Relinquished by:	"	"	
Accessioned by:	" [illegible]	"	
Analyzed by:			
Reported by:			

* This form will be returned when the data is reported.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SOLID AND HAZARDOUS WASTE

Sample Chain of Custody Form

Sample Descriptions*

Sample ID	Matrix	Sampling Point	Analysis Requested
388-097-01	GW	55' (prior to pumping)	Parameters listed on back p.w.
-02	GW	80' (prior to pumping)	
-03	GW	57' (after [illegible])	
-04	GW	82' "	
-05	GW	140' "	
-06	GW	180'	
-07	GW	230'	
-08	GW	[illegible]	
-09	[illegible]	[illegible]	
-10	[illegible]	[illegible]	
-13	GW	Field Blank	

	Name	Date	Affiliation
Collected by:	John Williams	[illegible]/88	USGS
Relinquished by:	"	"	"
Received by:	Scott Rohrbaugh	[illegible]/6/88	[illegible]
Relinquished by:	"	"	
Received by:	Maureen [illegible]	[illegible]/7/88	
Relinquished by:	"		
Received by:	[illegible]	[illegible]	
Relinquished by:	"	"	
Accessioned by:	" [illegible]	"	
Analyzed by:			
Reported by:			

* This form will be returned when the data is reported.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

April 25, 1988

Mr. Ray Kapp
Wehran Engineering
666 E. Main Street
P. O. Box 2006
Middletown, NY 10940

Dear Mr. Kapp:

Re: Mahopac Business District Site
I.D. #340013

Enclosed is sampling data from the USGS point sampling conducted on April 5 and 6, 1988. Please ensure this data is used to help design final construction details for monitoring well MW-02D and MW-01I.

If there are any questions, please call me at (518) 457-1708.

Sincerely,

Scott Rodabaugh

Scott Rodabaugh
Project Engineer
Division of Hazardous Waste
Remediation

Enclosure

cc: w/o enc. - T. Haelen, Wehran Engineering

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SOLID AND HAZARDOUS WASTE

Sample Chain of Custody Form*

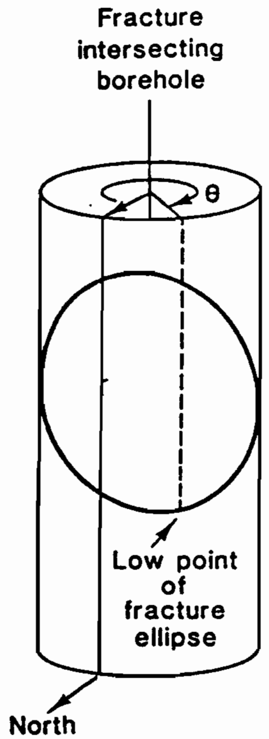
Sample Descriptions:

Sample ID	Matrix	Sampling Point	Analytical Requirements
383-028-01		MW-2D 60'	
383-028-02		MW-2D 85'	
383-028-03		PUMP DISCHARGE MW-2D	
383-028-04		PUMP DISCHARGE MW-2D	
383-028-05		FIELD BLANK	
[illegible]-028-06		MW-1D 60'	
[illegible]-028-07		MW-1D 131'	
[illegible]-08		FIELD BLANK	

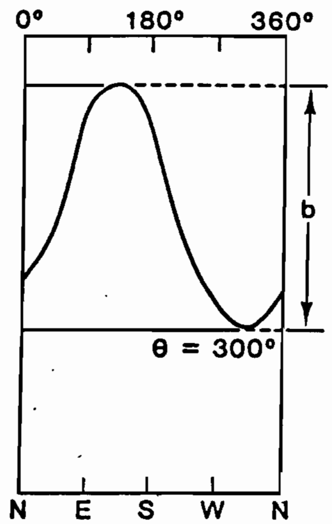
	Name	Date	Affiliation
Collected by:	RANDY LONGCIL	4-7-88	USGS
Relinquished by:	"	"	"
Received by:	LAWRENCE C. [illegible]	"	[illegible]
Relinquished by:	"	"	"
Received by:	JOHN WILLIAMS	"	USGS
Relinquished by:	"	"	USGS
Received by:	SCOTT RODABAUGH	"	NYS DEC
Relinquished by:	"		"
Accessioned by:	[illegible]	4-8-88	
Analyzed by:			
Reported by:			

* This form will be returned when the data is reported.

ACOUSTIC TELEVIEWER



Televiewer log

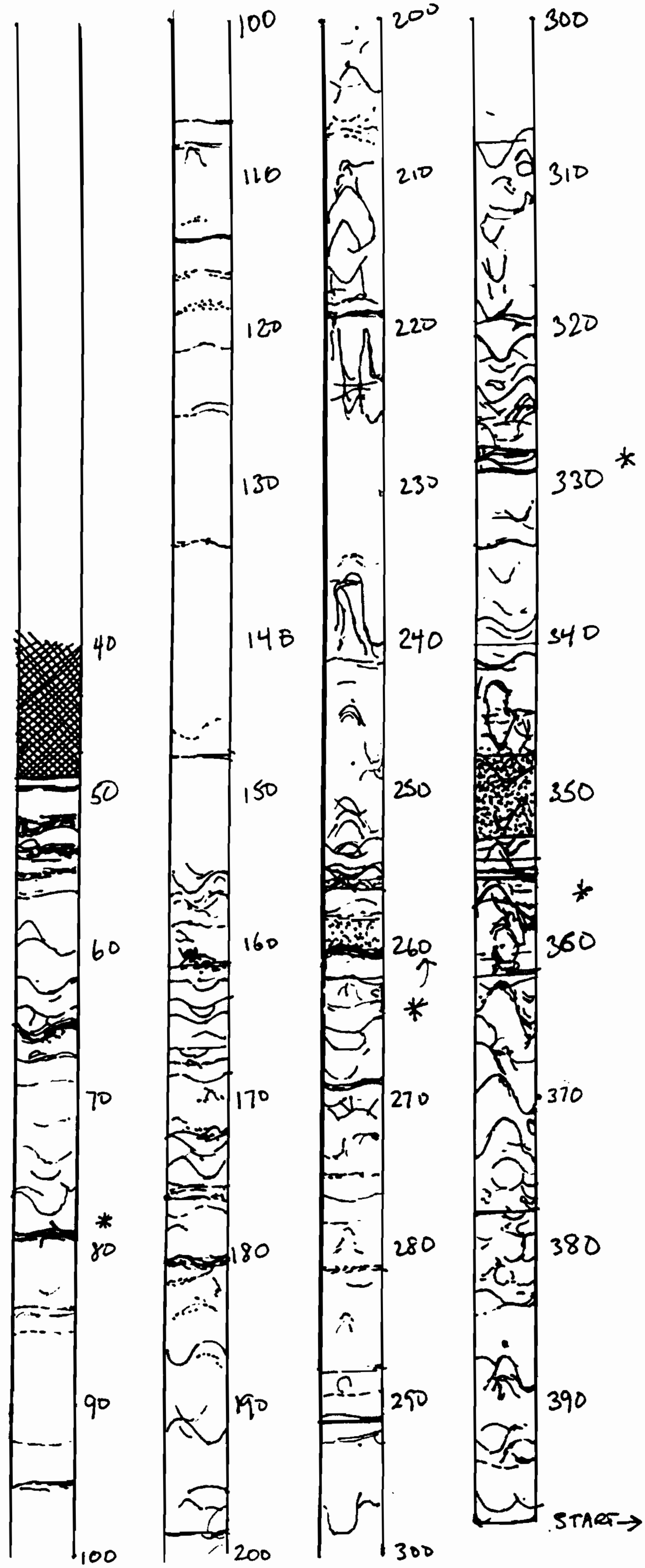


$$\text{Dip} = \tan^{-1} \frac{b}{\text{diameter}}$$

$$\text{Strike} = \theta \pm 90°$$

MAHOPAC N.Y.
MW 2D
9-15-88
TELEVIEWER LOG DATA

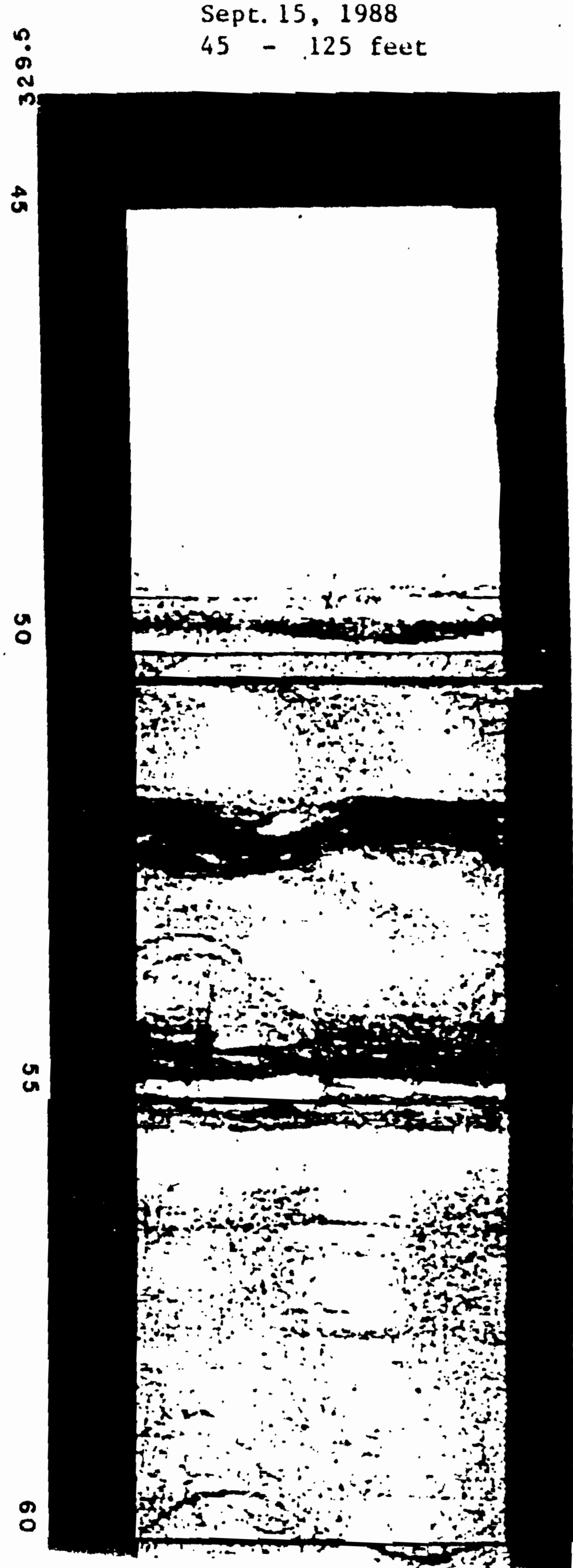
* SONY RECORDINGS

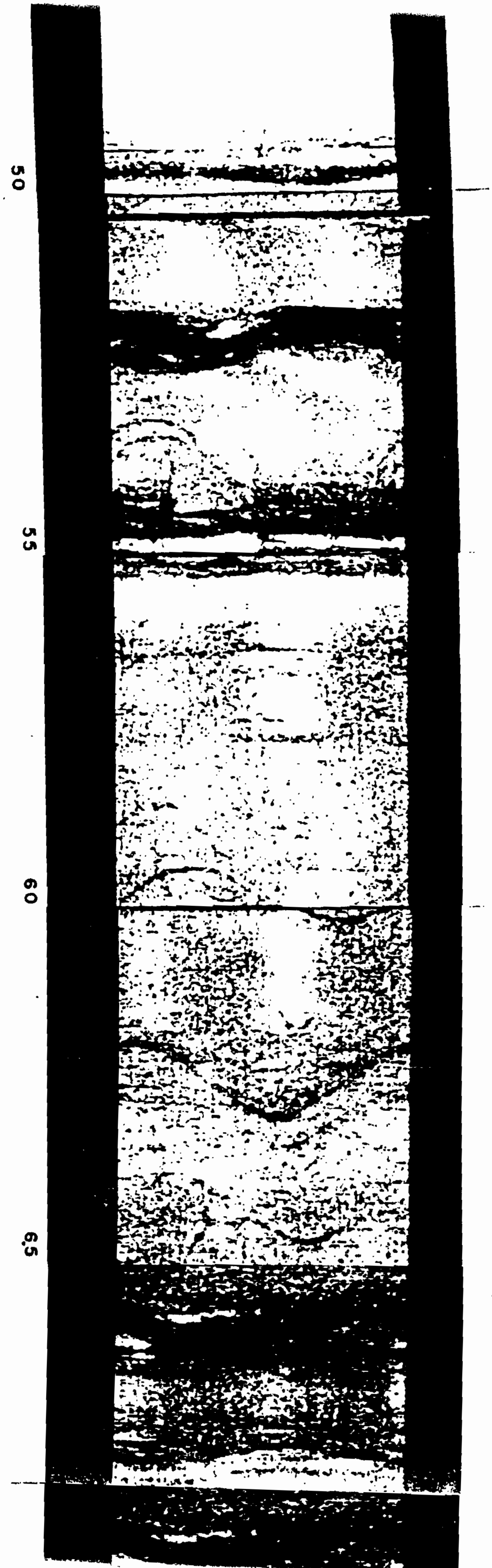


U.S. GEOLOGICAL SURVEY
ACOUSTIC TELEVIEWER LOG

MAHOPAC N.Y.
MW2D

Sept. 15, 1988
45 - 125 feet



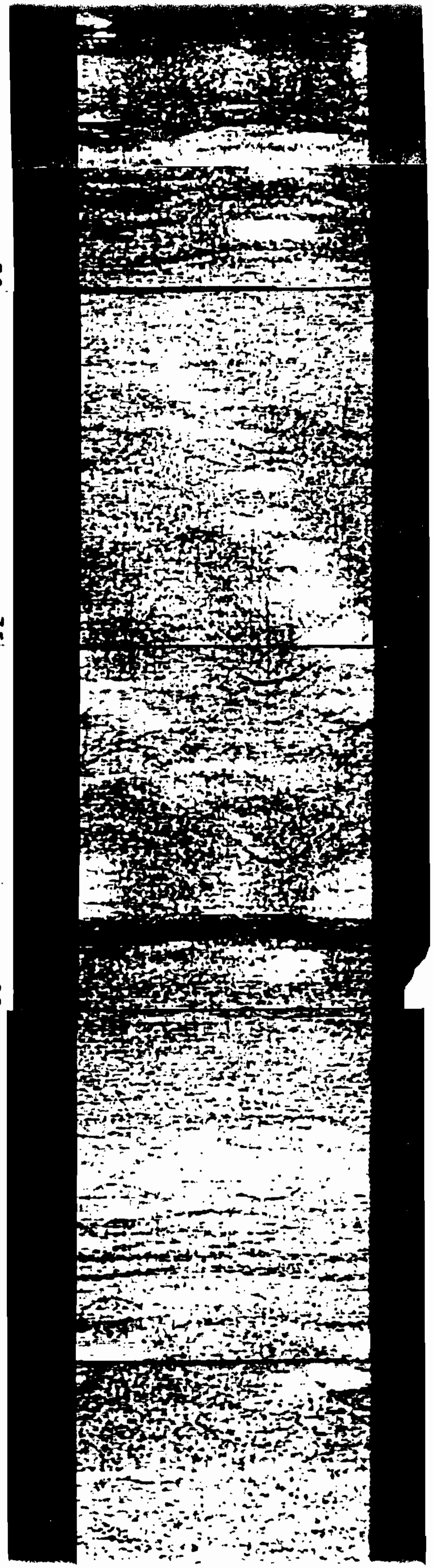

50
55
60
65

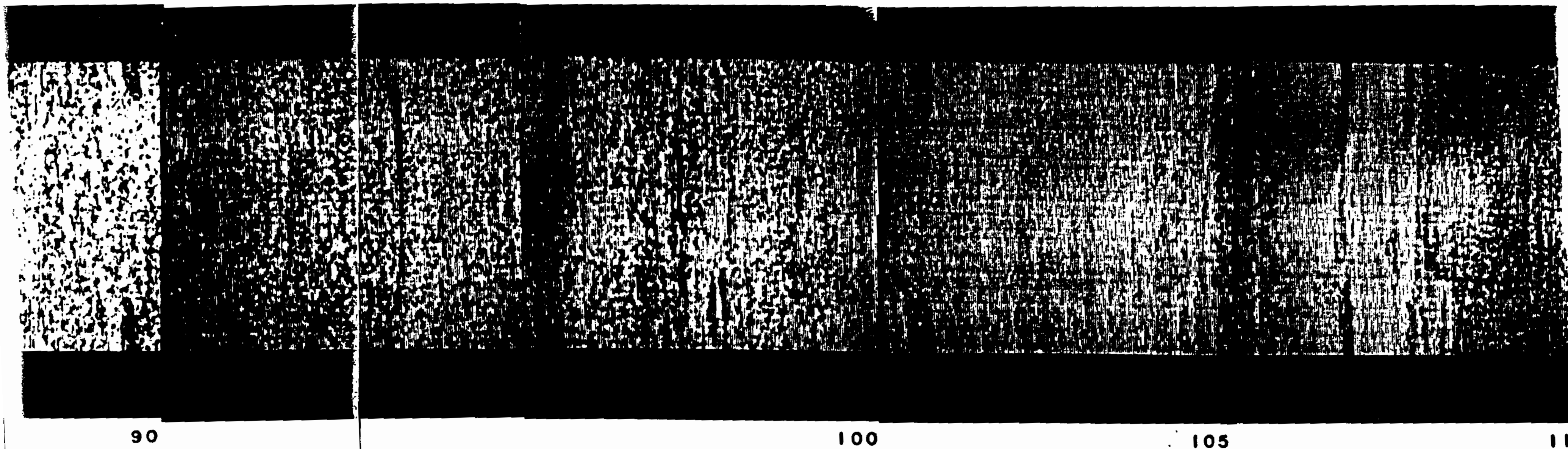
70

75

80

85

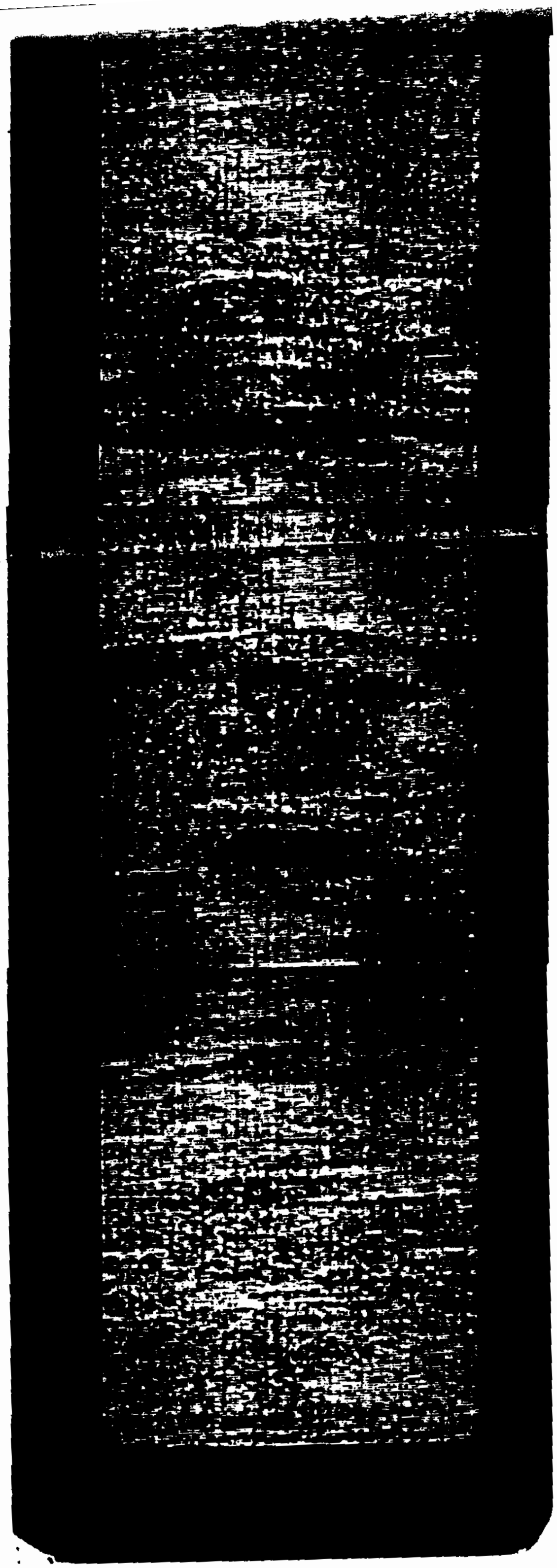



90
100
105

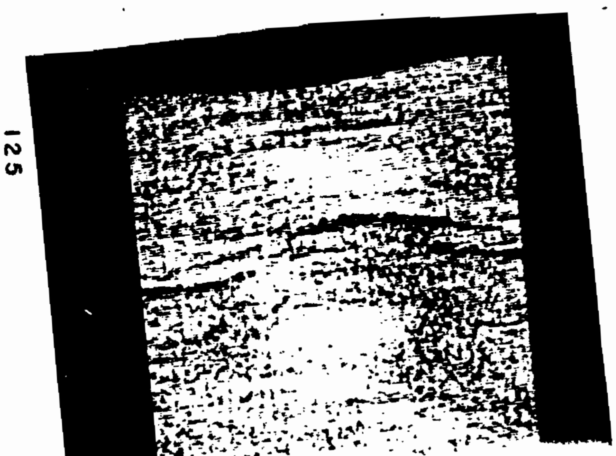
115

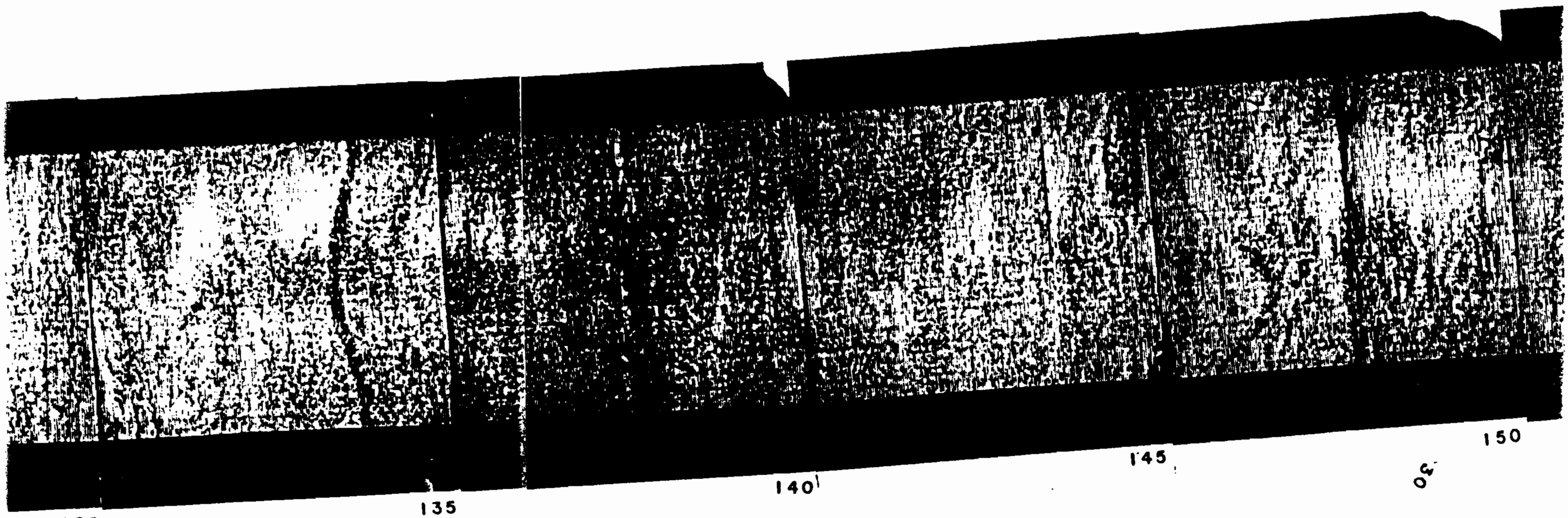
120

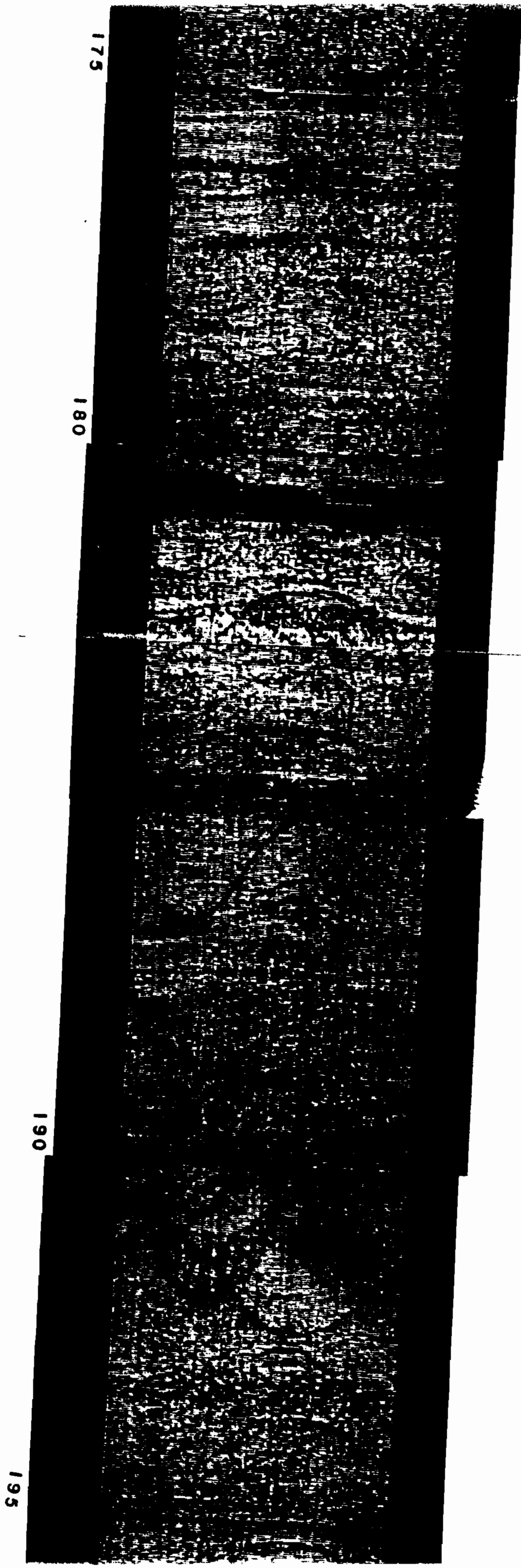
125

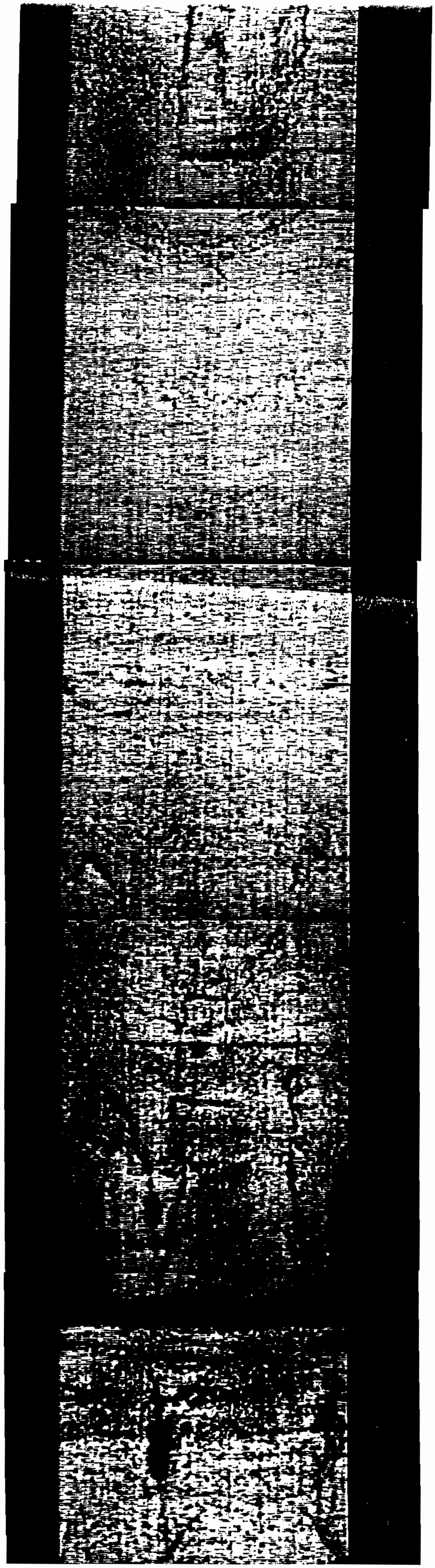


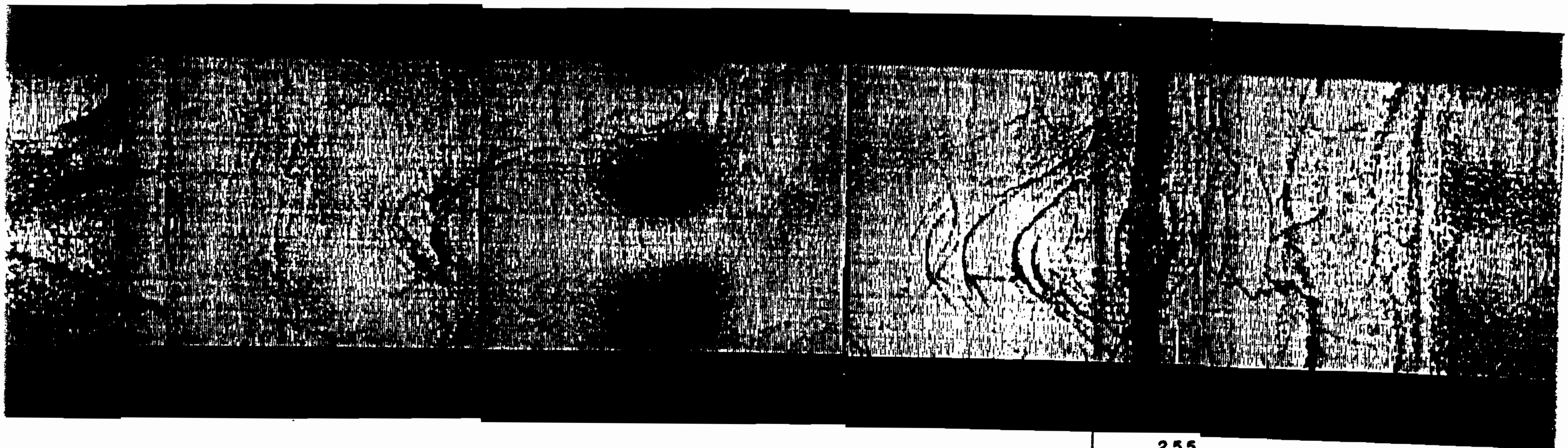
125




130
135
140
145
150


175
180
190
195

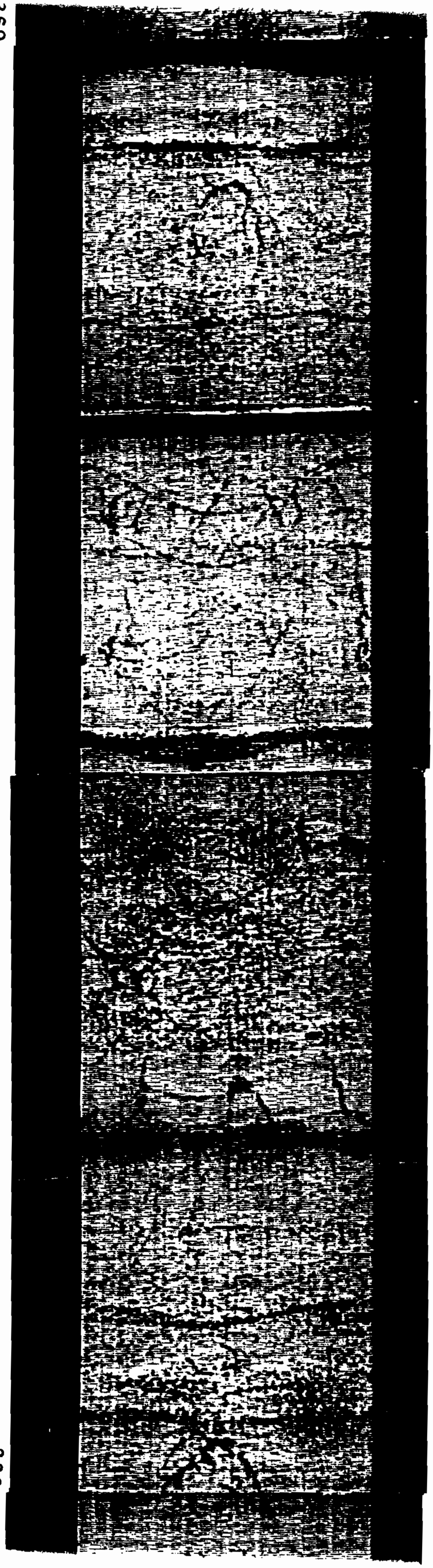




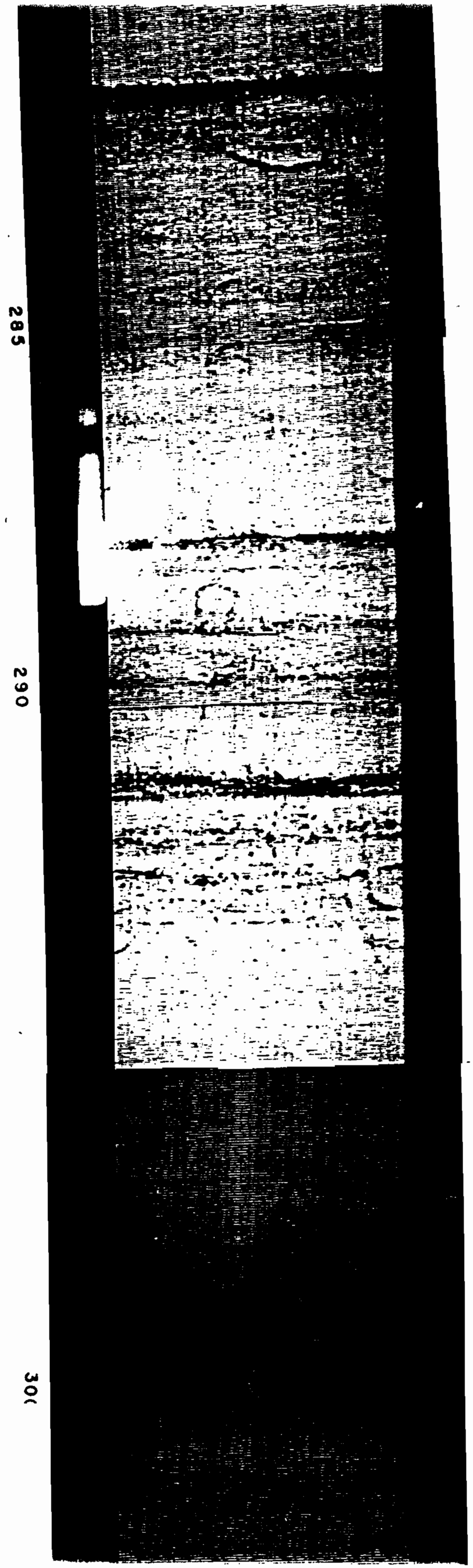
255

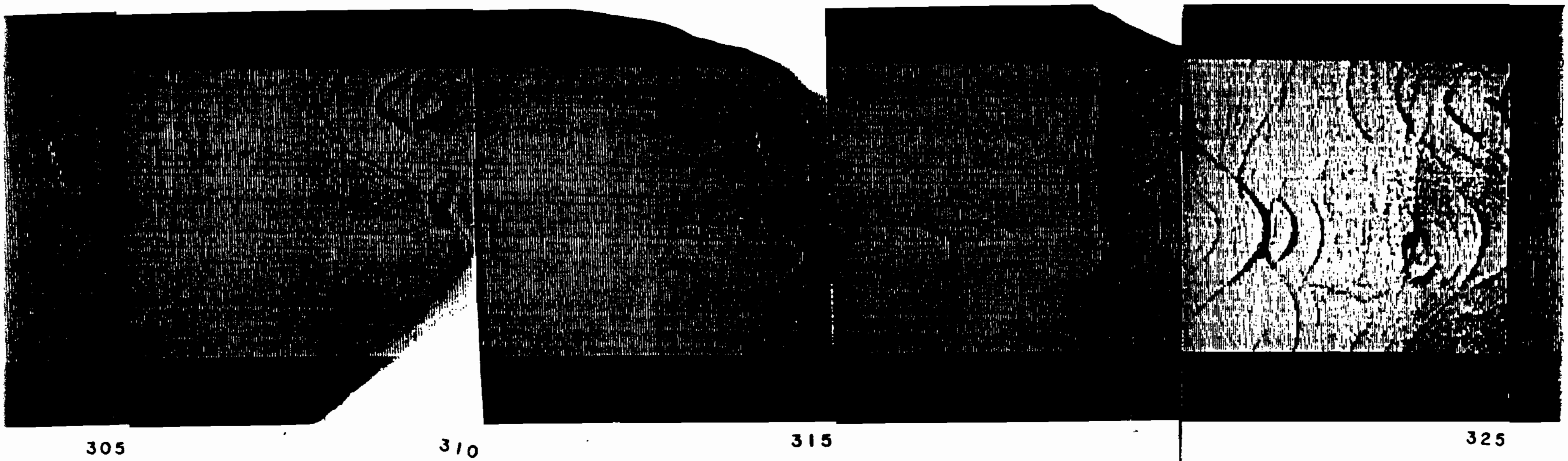
260

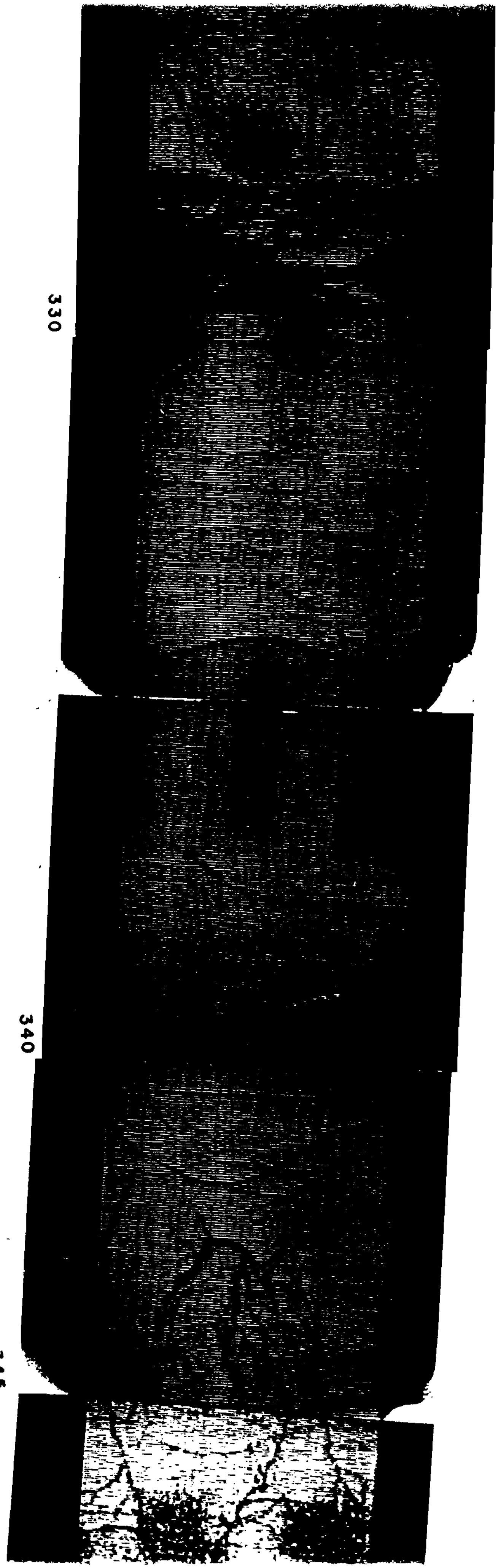
260



280


285
290
30(


305
310
315
325


330
340
345

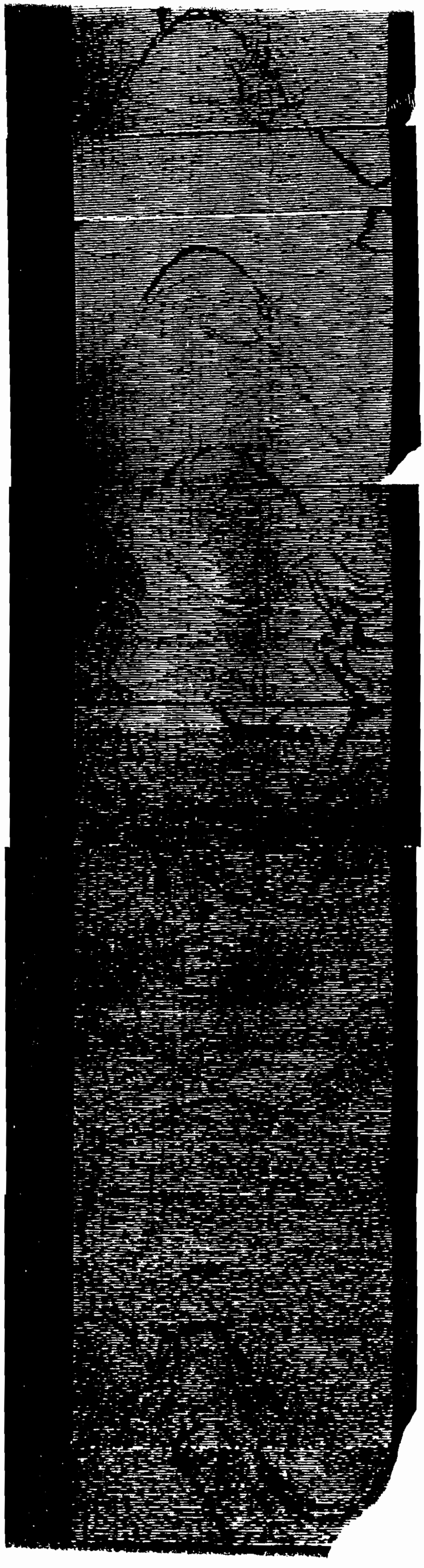
350

355

360

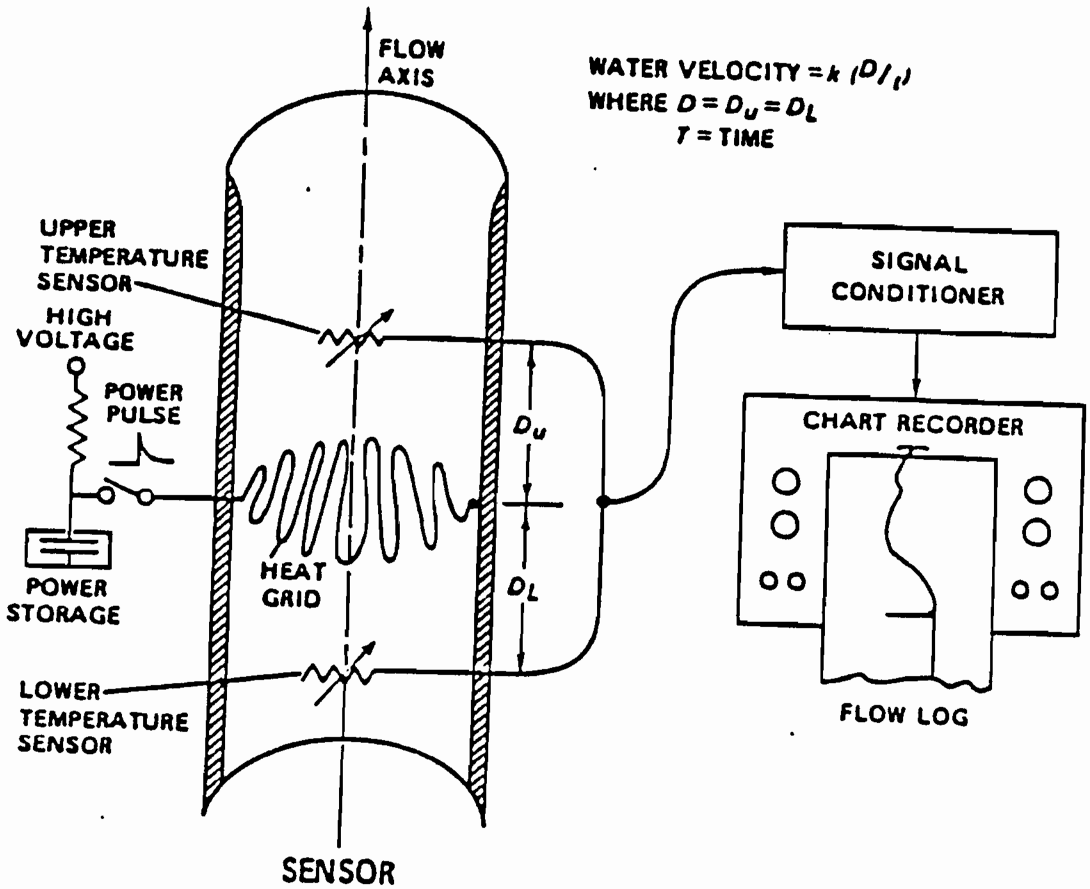
365

370



375
380
385
390

HEAT PULSE FLOWMETER SCHEMATIC



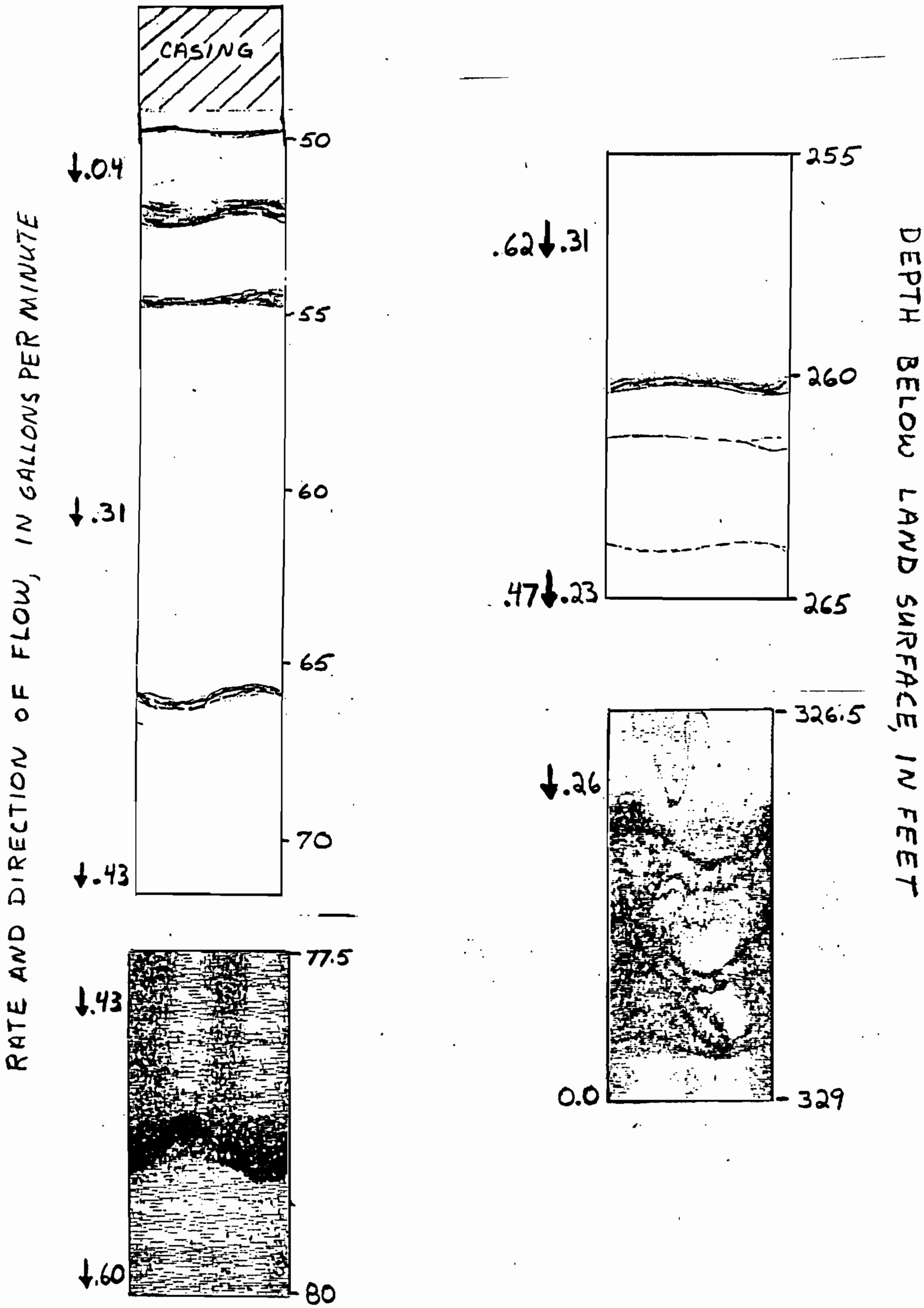
SOURCE: USGS BOREHOLE GEOPHYSICAL RESEARCH TEAM, '88.

MAHOPAC BUSINESS DISTRICT RI/FS
HEAT PULSE FLOWMETER DATA
OBTAINED FROM MW-2D OPEN BEDROCK BOREHOLE

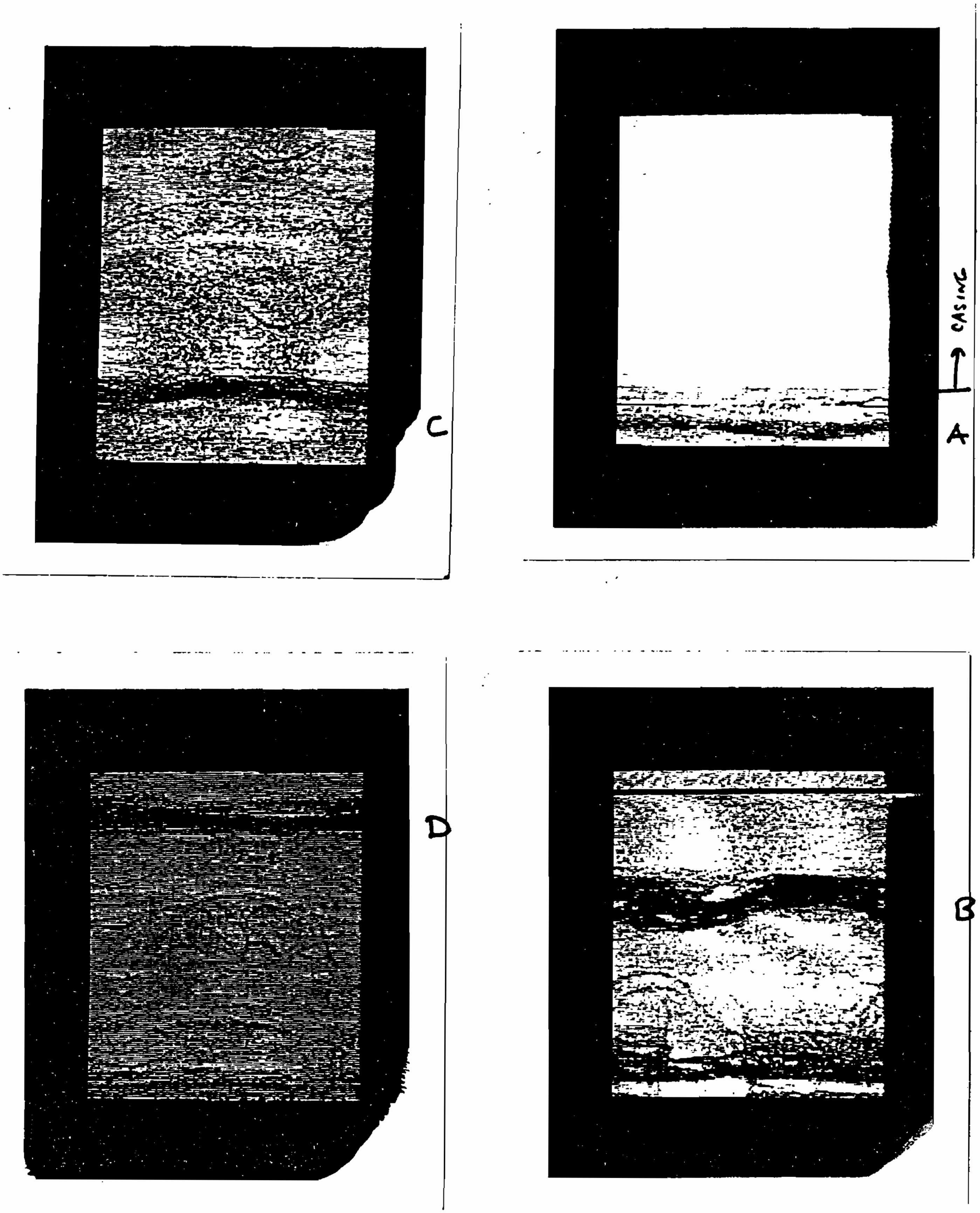
Depth (ft BGS)	Time	Averaged Pulse Arrival (Seconds)	Flowrate (GPM up or down)
95	18:10	− 2.1	− 0.65
78	18:15	− 1.9	− 0.68
63	18:17	− 2.3	− 0.50
50.5	18:22	varies (− 4.3 to + 7.0)	0 to − .16
46	18:30	varies (− 5.8 to + 7.9)	0 to − .10
78	18:41	− 2.5	− 0.43
82	18:45	− 2.4	− 0.43
185	18:50	− 2.0	− 0.60
265	18:55	− 2.8	− 0.35
332	19:03	90	0.00
327	19:12	− 3.6	− 0.26
328	19:14	− 3.8	− 0.23
329	19:18	>90	0.00
326	19:23	− 4.7	− 0.18
265	19:28	− 3.8	− 0.23
257	19:32	− 3.0	− 0.31
182	19:37	− 1.9	− 0.68
178	19:43	− 2.0	− 0.62
228	19:48	− 2.1	− 0.60
215	19:51	− 2.0	− 0.62
247	19:54	− 1.8	− 0.70
257	19:58	− 2.0	− 0.62
265	20:03	− 2.6	− 0.47
81	20:08	− 2.1	− 0.60
78	20:11	− 2.5	− 0.43
70	20:15	− 2.5	− 0.43
62	20:18	− 3.0	− 0.31
51	20:22	varies (+ 60 to − 18.0)	0 to − 0.04

Notes:

- Data collectd by USGS Borehole Geophysical Research Team on September 15, 1988.
- Heat Pulse Flowmeter designed by Al Hess, USGS Patent Pending.



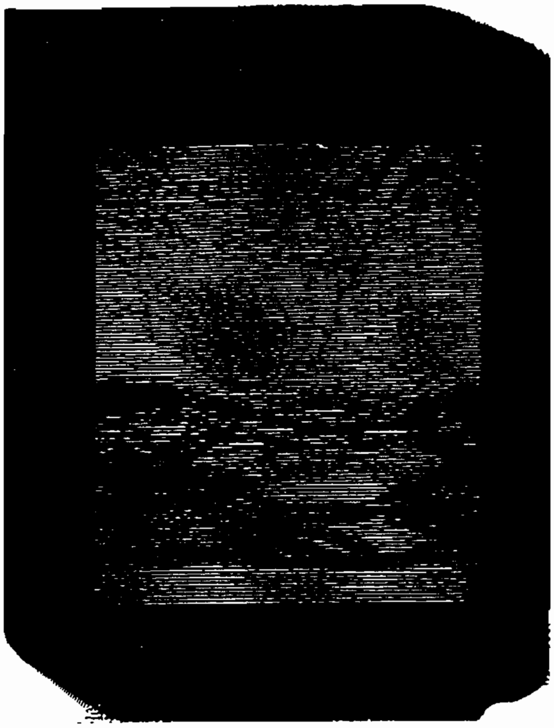
CASING
50
55
60
65
70
77.5
80
255
260
265
326.5
329
.04
.31
.43
.43
.60
.62
.31
.47
.23
.26
0.0
RATE AND DIRECTION OF FLOW, IN GALLONS PER MINUTE
DEPTH BELOW LAND SURFACE, IN FEET



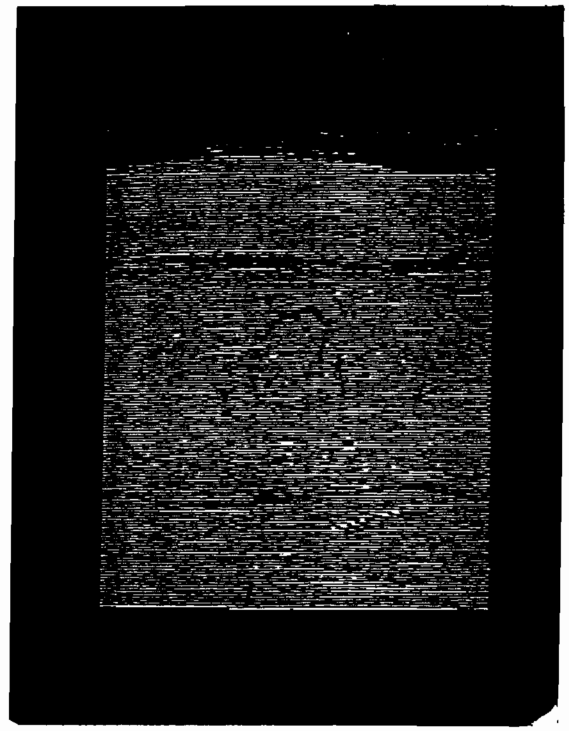
TELEVIEWER - MAJ. FRAC ZONES
VERTICAL SCALE = 5 FT
HORIZ. SCALE = HOLE CIRCUMF

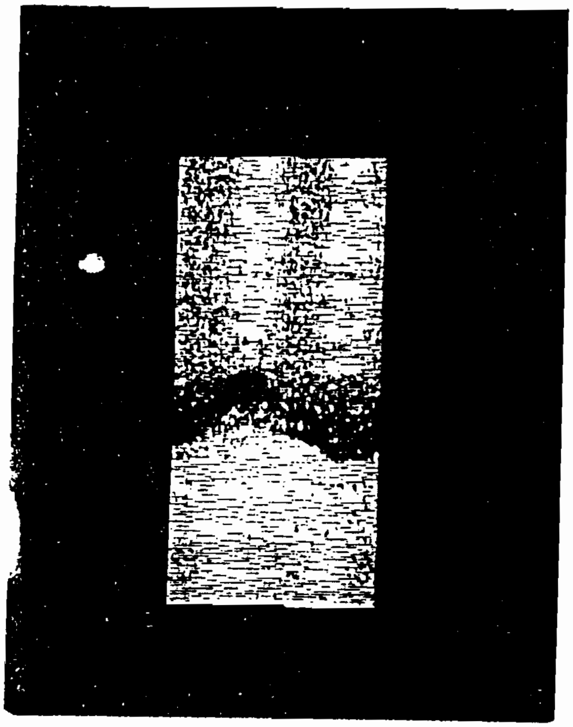
LETTERS DENOTE FRACS
ON COMPOSITE

F

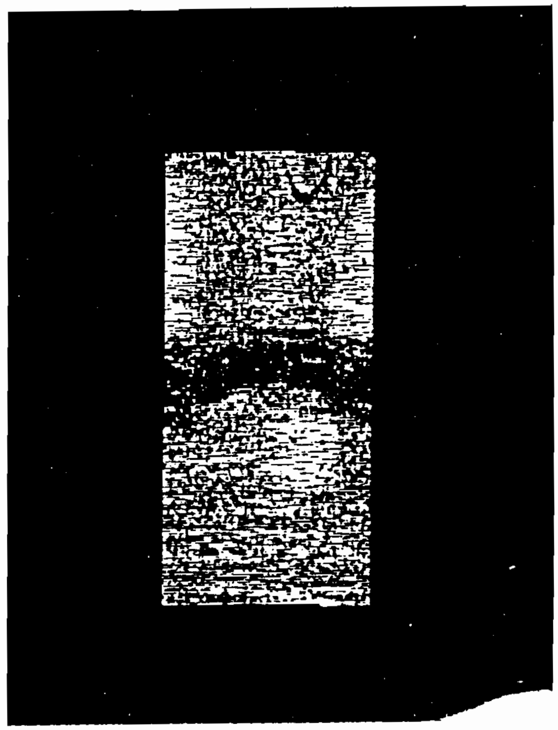


E





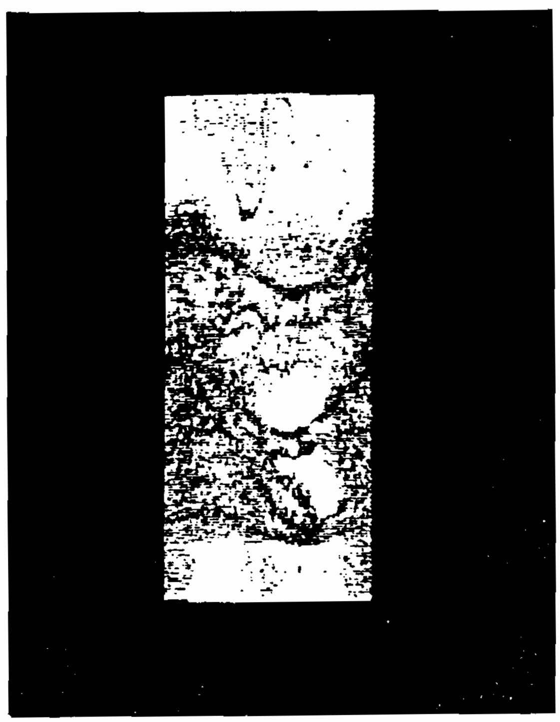
C



D

HIGH-
RESOLUTION
ATV DATA

F



VERTICAL SCALE = 2.5 FT
HORIZONTAL SCALE = HOLE CIRCUMF.

United States Department of the Interior

GEOLOGICAL SURVEY
BOX 25046 M.S. 403
DENVER FEDERAL CENTER
DENVER, COLORADO 80225-0046

IN REPLY REFER TO

November 15, 1988

MEMORANDUM

TO: John Williams, District Office-Albany

FROM: Project Chief, Borehole Geophysics Research Project, CR, MS 403

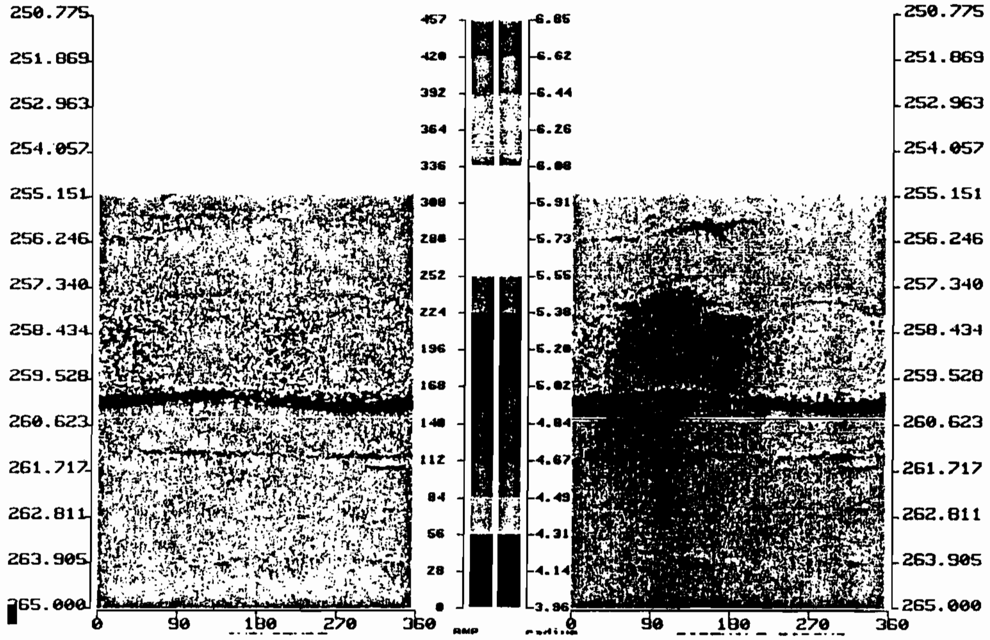
SUBJECT: MAHOPAC TELEVIEWER LOGS -- Three-dimensional plots of fracture zones from televiewer data

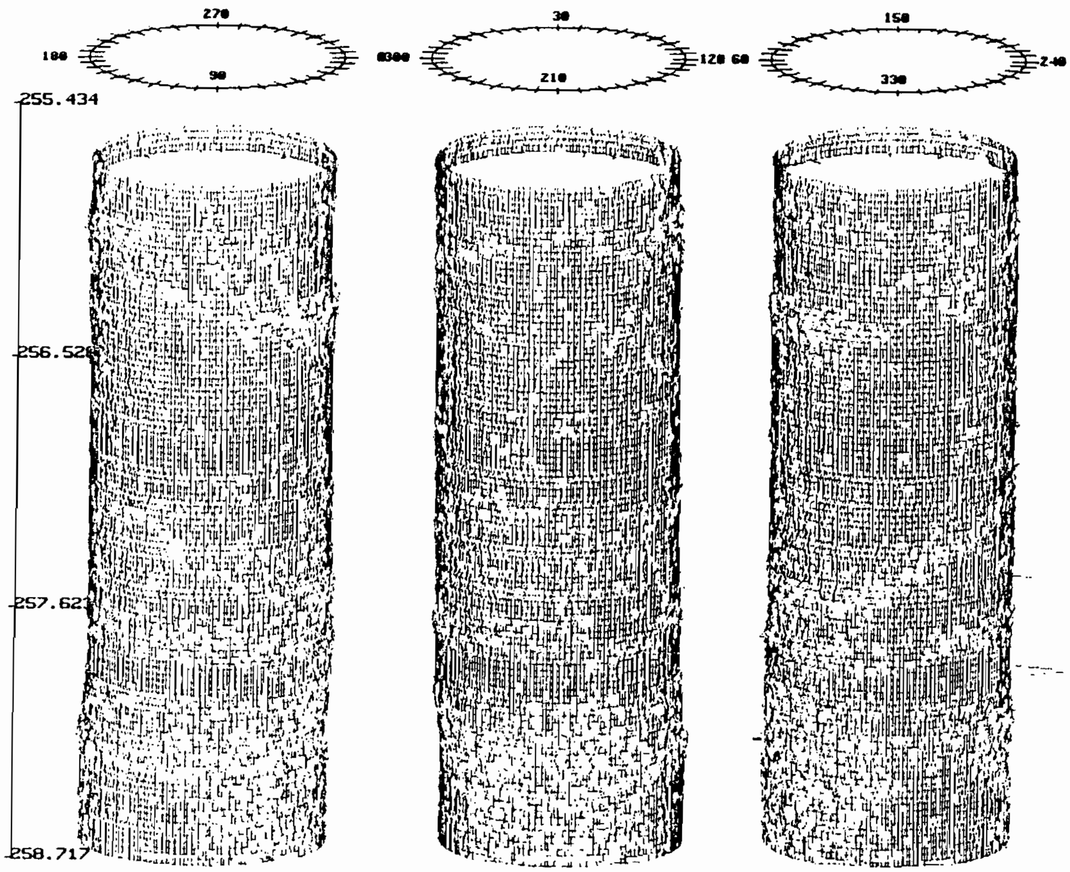
Enclosed are the plots of the fracture zones we sent on tape to colleagues at Stanford. These are the two zones (262 and 328-330 feet) where water was entering fractures towards the bottom of the Mahopac well. Something seems to be seriously wrong with the depth scales on the two black-and-white side-view plots. My inspection suggests that the images are close to proper scale (perhaps the borehole diameter has been made to large), so it is probably best just to discard the depth scale on the plots. My interpretation of the televiewer is that the 328-330 ft zone intersects the borehole over 1.5 or 2 feet. Using that as a scale, the borehole diameter comes out to be between 6 and 12 inches. Not so far off that the plots don't make a good representation for the data. Hope the plots are of some use.

F. L. Paillet

enclosures

MW2d
Mahopac, NY

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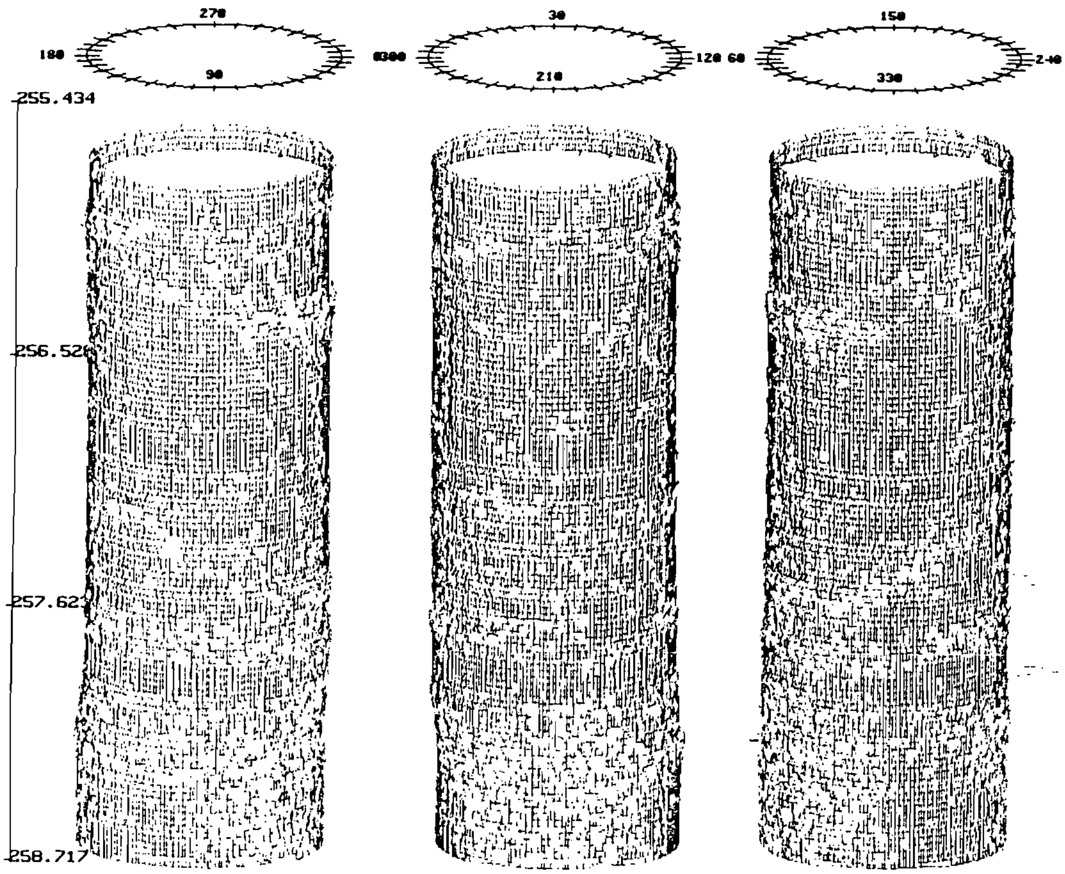
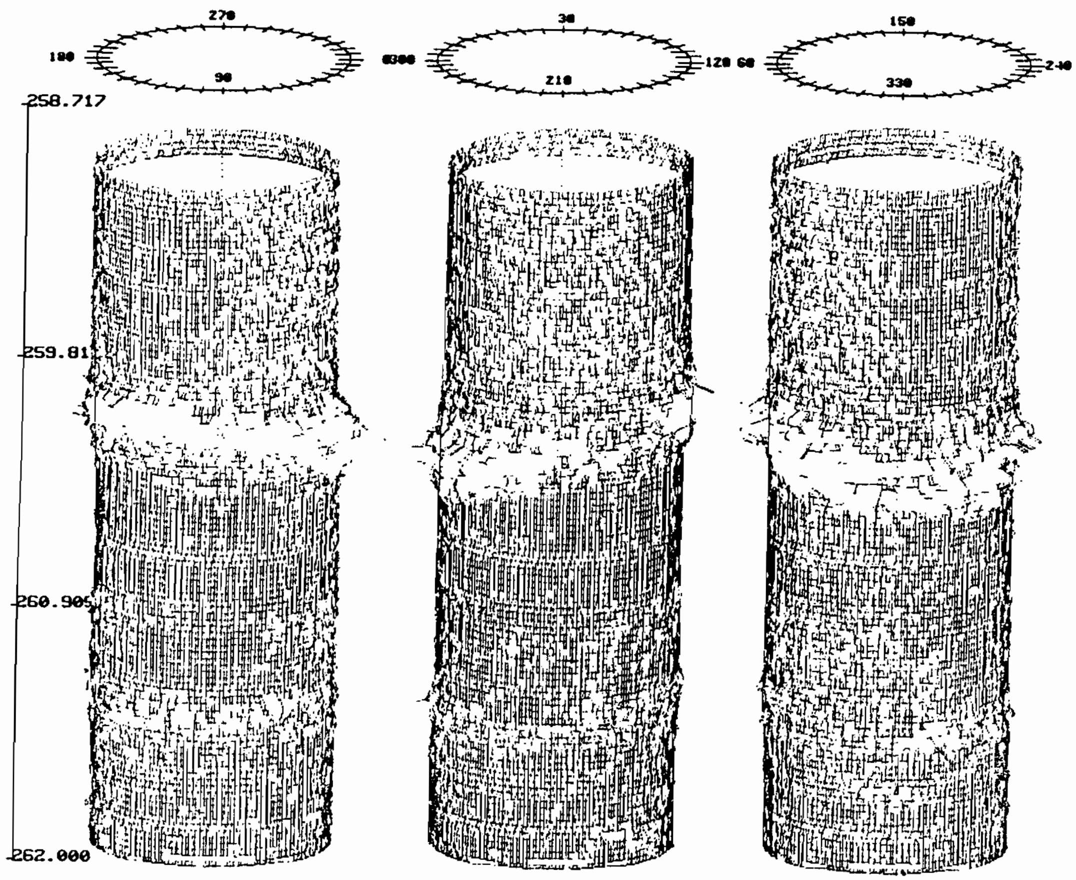
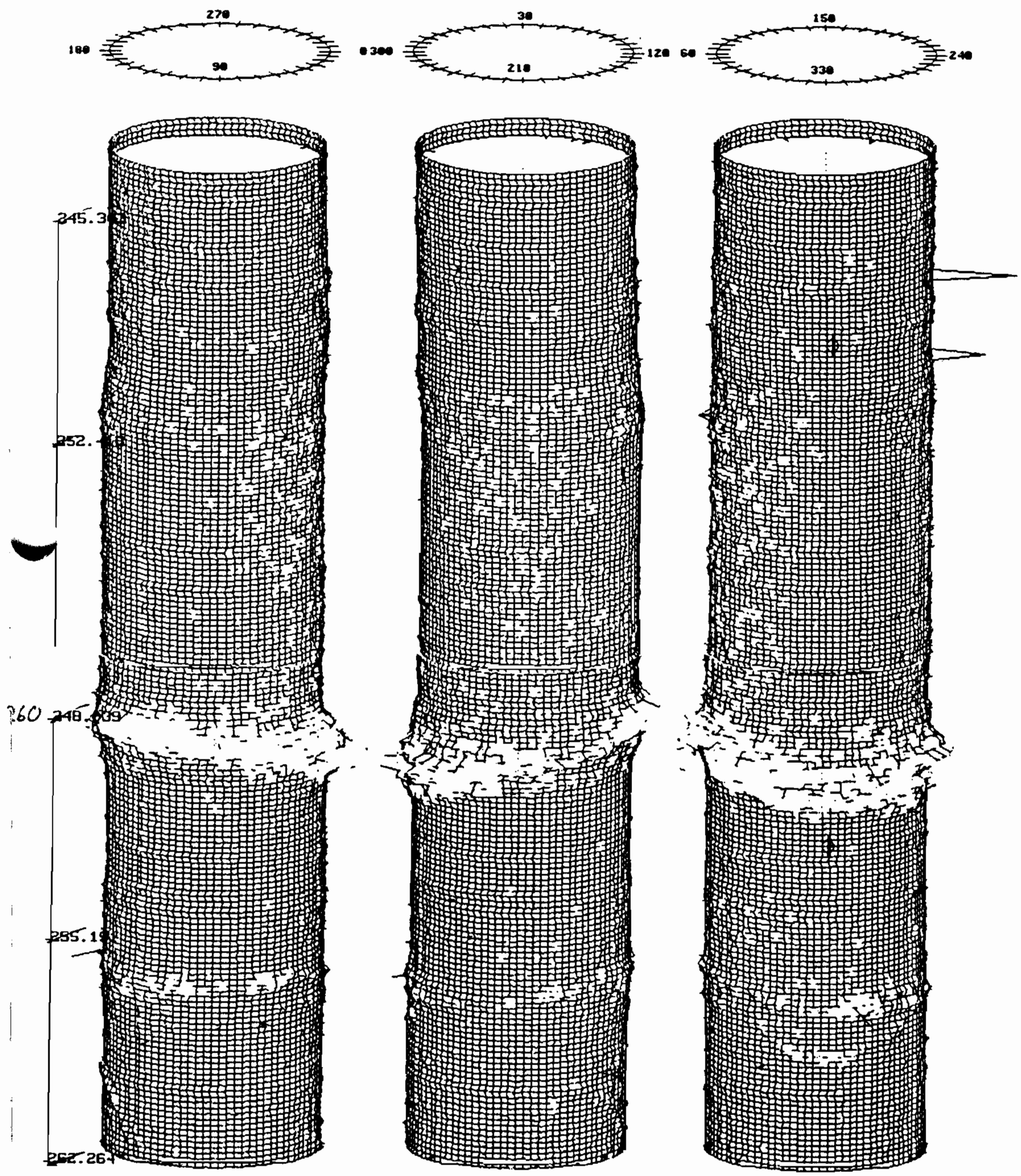
180
90
30
0300
210
120 60
150
240
330
255.434
256.528
257.623
258.717



270
180
90
30
0300
120 60
210
150
240
330
255.434
256.526
257.622
258.717



270
180
90
30
0300
120 60
210
150
240
330
258.717
259.81
260.905
262.000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180
90
0 300
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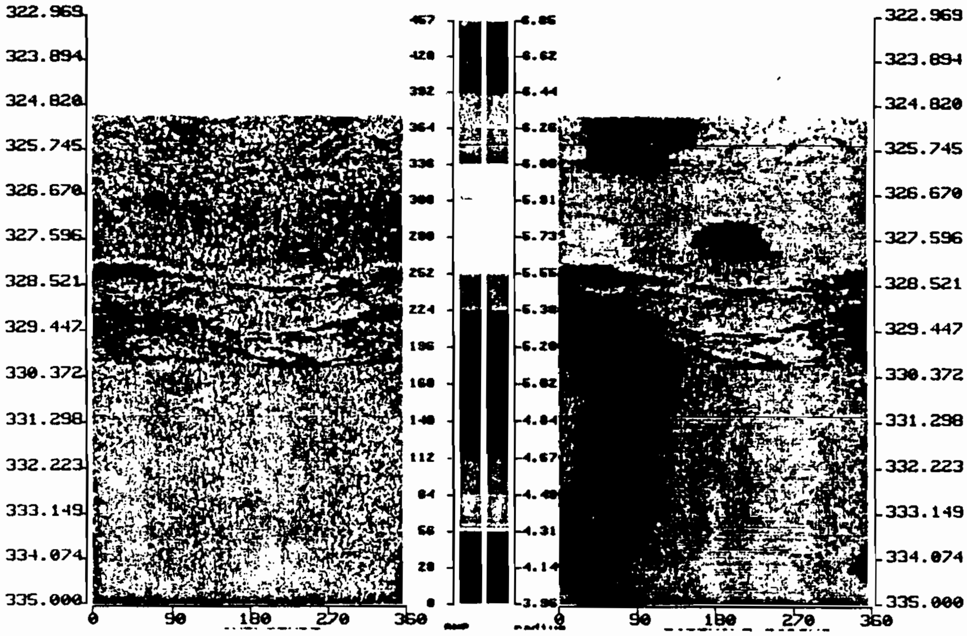
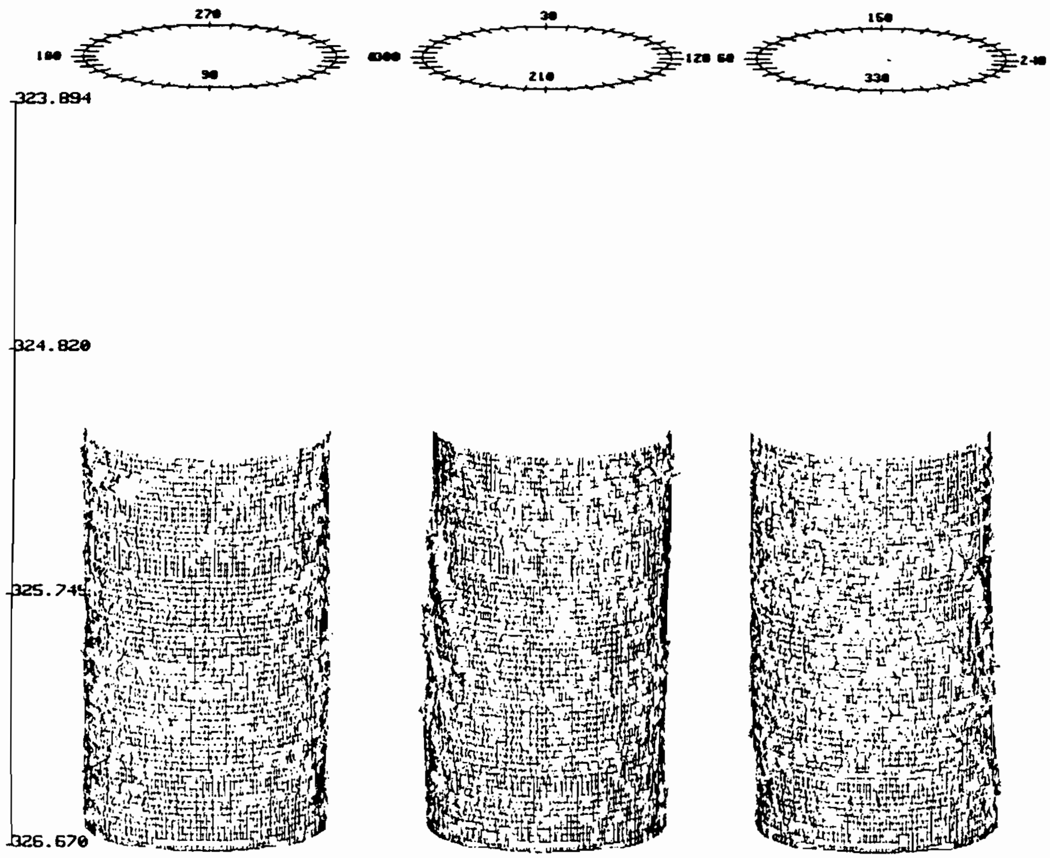
210
120 60
150
330
240
245.3
252.
260
248.
255.1
262.264

MW2d
Mahopac, NY

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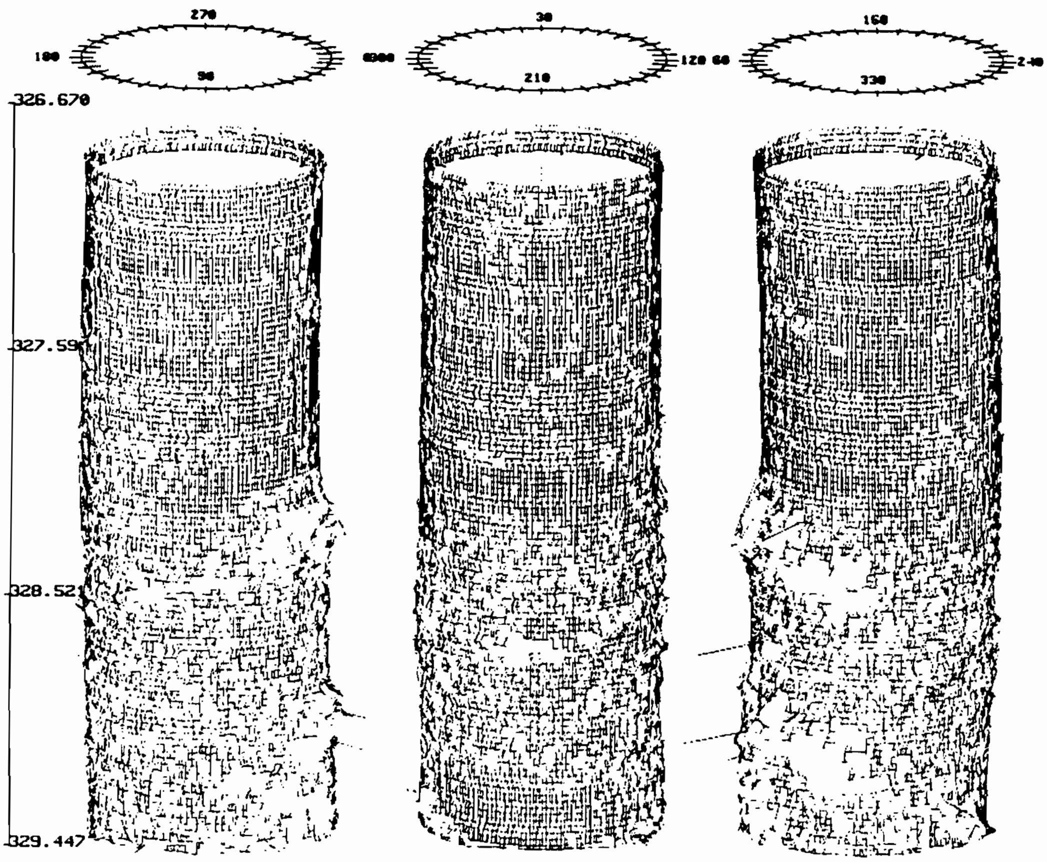
325.745
326.670



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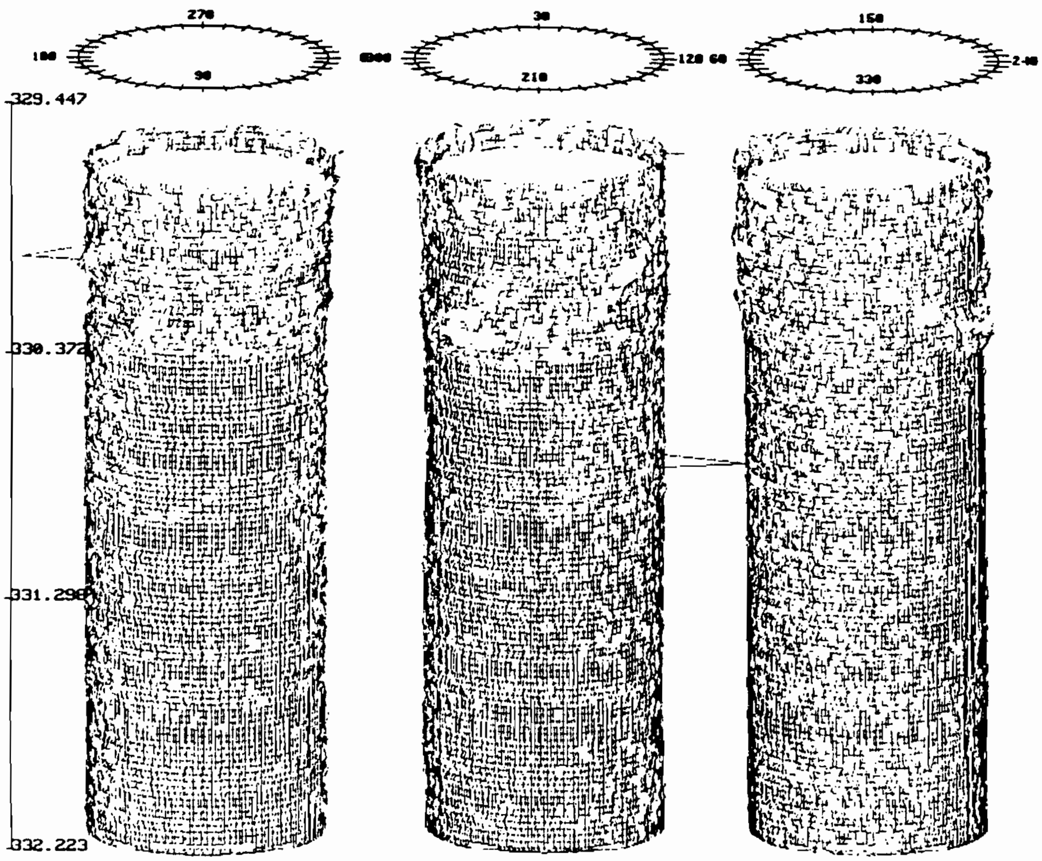
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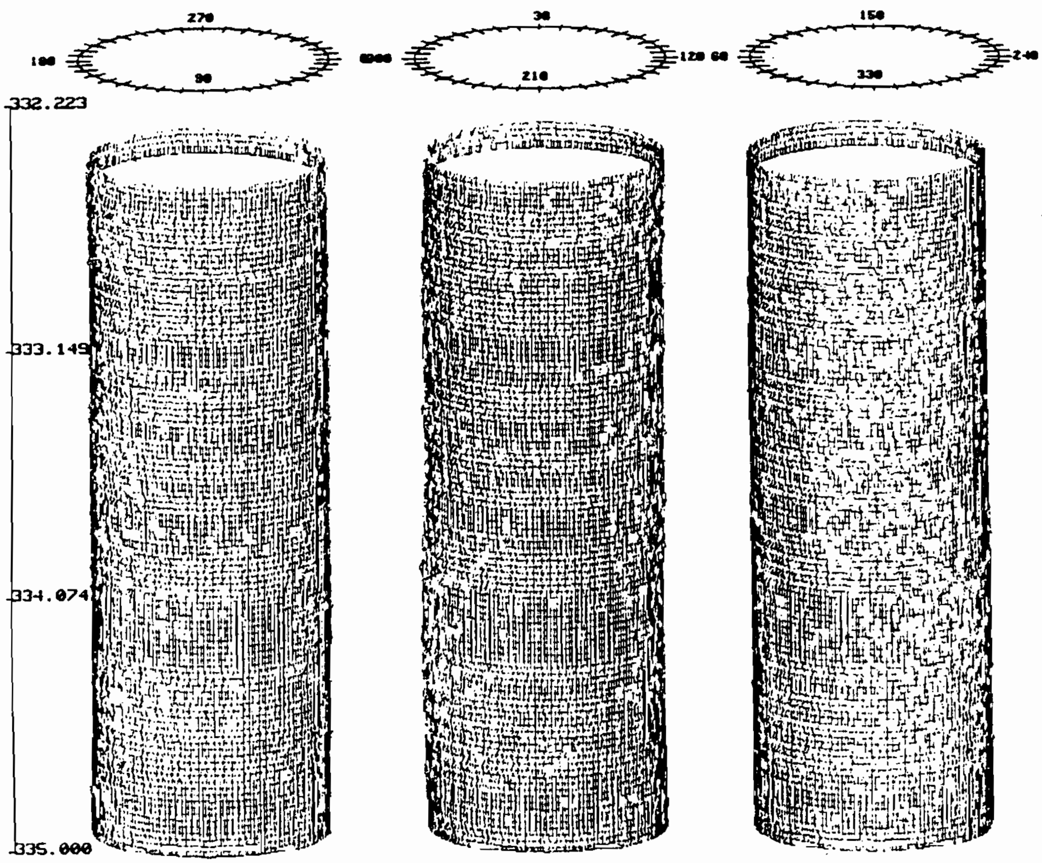

270
180
90
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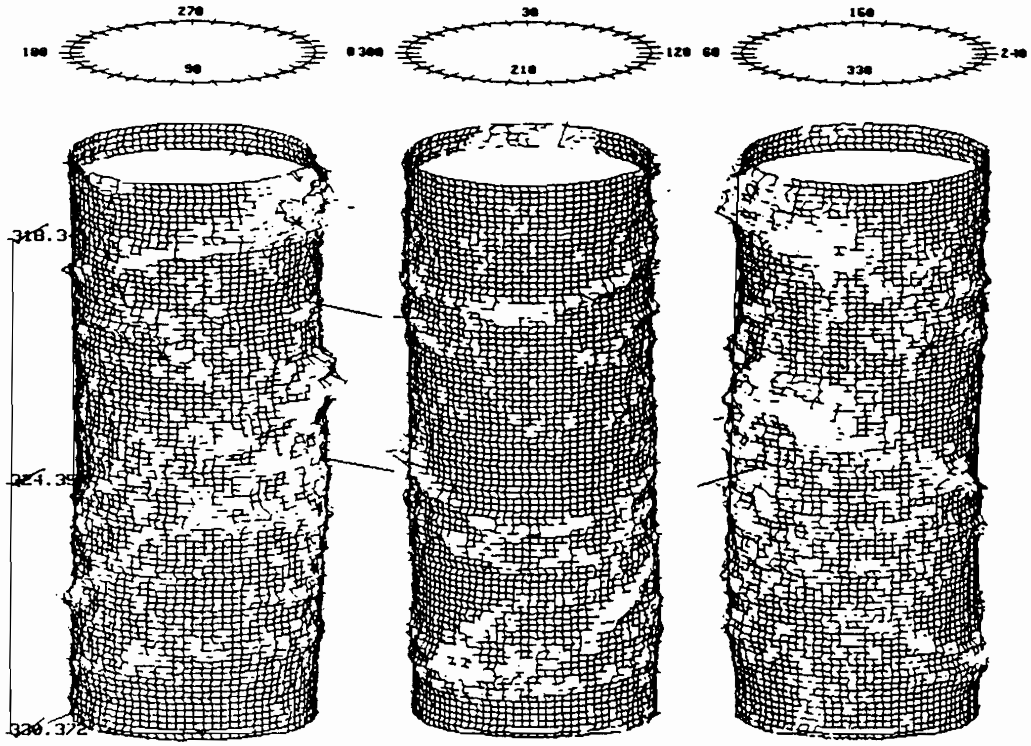
60
150
330
240
332.223
333.149
334.074
335.000

~328



PROVISIONAL DRAFT
Subject to Revision
Pending Approval by Director,
U. S. Geological Survey

DELINEATION OF CONTAMINATED WATER-BEARING FRACTURES INTERSECTED BY OPEN-HOLE BEDROCK WELLS IN SOUTHEASTERN NEW YORK

By John H. Williams and Randall W. Conger

ABSTRACT

Contaminated water-bearing fractures intersected by open-hole, bedrock wells were delineated by a combination of geophysical logging, vertical-flow measurements, and downhole point sampling as part of remedial site investigations in southeastern New York. The investigated wells range from 100 to 450 feet in depth, have only shallow surface casing, and intersect multiple water-bearing fracture zones. The distribution of water-bearing zones intersecting the wells was determined from single-point resistance, caliper, fluid-resistivity, and temperature logs. Measurable flow in the wells was downward from upper producing zones that are poorly connected in the aquifer and have differing hydraulic head as a result of nearby pumping. According to the distribution of vertical flow in the wells, a downhole point sampler was used to collect discrete and composite water samples from self-purging producing zones for analysis of volatile organic compounds.

A supply well completed in Mesozoic sandstone and conglomerate at the Spring Valley wellfield intersected water-bearing zones at a depth of 195 to 245 feet, which produced contaminated water that was received by a zone at 278 feet. A deeper zone intersected by the supply well at 345 feet produced uncontaminated water that was received by a zone at 403 feet. Correlation of data from the supply well, geophysical logs and drill cores from nearby monitoring wells, and a bedrock outcrop indicate that the most of water-bearing zones are bedding-plane separations that probably provide direct pathways for contaminant transport in the bedrock aquifer along bedding strike.

A deep test well completed in Precambrian gneiss in the Mahopac business district intersected shallow water-bearing zones at 50 to 79 feet that produced contaminated water, which was received by deep zones at 260 to 328 feet. An acoustic-televiewer log indicated that the water-bearing zones consist of a single or multiple, closely spaced fractures with dips of 5 to 50 degrees. By analogy with the investigated test well, the many deep open-hole wells in the area probably serve as short circuits in the ground-water flow system and allow direct downward transport of contaminants in the fractured-bedrock aquifer.

INTRODUCTION

Contamination by volatile organic compounds is a major problem in many fractured-bedrock aquifers in northeastern United States. Most water-supply supply wells completed in fractured-bedrock aquifers have only shallow surface casing and are open to multiple water-bearing zones. Vertical flow commonly occurs in the wells between zones of differing hydraulic head due to natural head differences or gradients caused by nearby pumping. Water-quality sampling of open-hole, bedrock wells by standard pumping or bailing methods may indicate the presence of volatile organic compounds but provides little information on the vertical distribution of contaminants in the aquifers. In 1988, the U.S. Geological Survey used a combination of geophysical logging, vertical-flow measurements, and downhole point sampling in open-hole wells completed in Mesozoic sandstone and conglomerate and Precambrian gneiss to delineate contaminated water-bearing fractures as part of remedial site investigations by the New York State Department of Environmental Conservation (NYSDEC) in southeastern New York. This report describes the methods used and presents the results obtained at two of the study sites-- Spring Valley in Rockland County and Mahopac in Putnam County (fig. 1).

Figure 1. near here

Figure 1.-- Location of study sites and physiographic provinces in southeastern New York.

METHODS

A suite of geophysical logs was completed in the wells to determine the bedrock lithology, distribution of water-bearing fractures, and the occurrence of vertical flow. Vertical-flow measurements were made to determine the rate and direction of flow between water-bearing fractures intersecting the wells. According to the location of water-bearing fractures and flow between them, a point sampler was used to collect water samples from the wells for analysis of volatile organic compounds.

The geophysical logs completed on the wells included gamma, single-point resistance, caliper, fluid resistivity, and temperature. The geophysical logs were recorded simultaneously on an analog chart and on digital tape at 0.1 or 0.5-foot sampling intervals. Gamma logs record the amount of naturally occurring gamma radiation emitted by the rocks surrounding the borehole. Most of the gamma radiation from rocks is emitted by potassium-40 (Keys and MacCary, 1971). Clay-bearing rocks emit relatively high gamma radiation because clays typically have a high potassium content. Feldspathic zones in crystalline rocks, such as potassium-rich pegmatites, also emit relatively high gamma radiation.

Single-point resistance logs record the electrical resistance from points within the borehole to an electrical ground at land surface. In general, resistance increases with grain size and decreases with borehole diameter, density of water-bearing fractures, and dissolved-solids concentration of the water water (Keys and MacCary, 1971). Single-point resistance logs are useful in the determination of subsurface lithology, water quality, and location of fracture zones.

By	Date	WEHRAN ENGINEERING Engineers & Scientists	Job No.
Chkd. by	Date		Sheet No. of
Subject			

WELL NAME : TEST # 4 DATE OF TEST : 7-27-88

WELL NUMBER : MW-2D

CHANGE IN VOLUME OF WATER: 0.1075 FT^3

EFFECTIVE RADIUS OF WELL : 0.25 FT

RAD CASING : 0.0621 FT

ENTRY	TIME	HEAD		TIME	HEAD
1		0	41	9.75	2.4923
2	0	12.6000	42	10.00	2.3632
3	0.25	12.0923	43	10.25	2.1692
4	0.50	11.6307	44	10.50	1.9846
5	0.75	11.2153	45	10.75	1.7384
6	1.00	10.8000	46	11.0	1.7538
7	1.25	10.4307	47	11.25	1.6615
8	1.50	10.0615	48	11.50	1.4769
9	1.75	9.7384	49	11.75	1.3384
10	2.00	9.4153	50	12.00	1.2461
11	2.25	9.0923	51	12.25	1.200
12	2.50	8.7230	52	12.50	1.1077
13	2.75	8.4461	53	12.75	1.0153
14	3.00	8.0769	54	13.00	0.8769
15	3.25	7.8461	55	13.25	0.7846
16	3.50	7.5692	56	13.50	0.6923
17	3.75	7.2461	57	13.75	0.6000
18	4.0	7.0153	58	14.00	0.5077
19	4.25	6.7384	59	14.25	0.4153
20	4.50	6.4615	60	14.50	0.3692
21	4.75	6.2769	61	14.75	0.2307
22	5.00	6.000	62	15.0	0.1384
23	5.25	5.7692	63	15.25	0.1384
24	5.50	5.5384	64	15.50	0.0000
25	5.75	5.3077			
26	6.0	5.0769			
27	6.25	4.8923			
28	6.50	4.7077			
29	6.75	4.4769			
30	7.0	4.2923			
31	7.25	4.1538			
32	7.50	3.8769			
33	7.75	3.7384			
34	8.0	3.5538			
35	8.25	3.3692			
36	8.50	3.2307			
37	8.75	3.0461			
38	9.0	2.9538			
39	9.25	2.7692			
40	9.50	2.5846			

C: TEST 4. ~~DTA~~ ~~DAT~~

By ______ Date ______ WEHRAN ENGINEERING Engineers & Scientists Job No. ______
Chkd. by ______ Date ______ Sheet No. ______ of ______
Subject ______

WELL NAME: TEST #5 DATE: 7-27-88
WELL NUMBER: MW-2D
CHANGE VOL. WATER: 0.1174 FT³
EFFECTIVE WELL RADIUS: 0.25 FT
RADIUS CASING: 0.0521 FT

ENTRY NO	TIME	HEAD	ENTRY	TIME	HEAD
1	.	0	41	19.5	5.4049
2	0	13.7652	42	20.0	5.2202
3	0.5	13.5342	43	20.5	5.0816
4	1.0	13.2109	44	21.0	4.8968
5	1.5	12.9338	45	21.5	4.7583
6	2.0	12.6566	46	22.0	4.5735
7	2.5	12.4257	47	22.5	4.4349
8	3.0	12.1486	48	23.0	4.3887
9	3.5	11.8746	49	23.5	4.1578
10	4.0	11.6405	50	24.0	4.0654
11	4.5	11.4095	51	24.5	3.9269
12	5.0	11.0862	52	25.0	3.7883
13	5.5	10.8091	53	25.5	3.6959
14	6.0	10.6243	54	26.0	3.5573
15	6.5	10.3934	55	26.5	3.3726
16	7.0	10.1624	56	27.0	3.2802
17	7.5	9.9315	57	27.5	3.0954
18	8.0	9.7005	58	28.0	3.0031
19	8.5	9.5158			
20	9.0	9.2848			
21	9.5	9.1001			
22	10.0	8.8691			
23	10.5	8.6382			
24	11.0	8.4534			
25	11.5	8.2687			
26	12.0	8.0377			
27	12.5	7.8529			
28	13.0	7.622			
29	13.5	7.4372			
30	14.0	7.2525			
31	14.5	7.1139			
32	15.0	6.9754			
33	15.5	6.7444			
34	16.0	6.5596			
35	16.5	6.3287			
36	17.0	6.1901			
37	17.5	6.0516			
38	18.0	5.8668			
39	18.5	5.6820			
40	19.0	5.5435			

C:TEST5. ~~DTA~~ DAT

By	Date	WE WEHRAN ENGINEERING Engineers & Scientists	Job No.
Chkd. by	Date		Sheet No. of
Subject			

WELL NAME: TEST #6 — 7-29-88

WELL NUMBER: MW-2D — 16.402

CHANGE VOL. WATER: 0.1399

EFFECTIVE RADIUS OF WELL: 0.25 FT

RAD. OF CASING: 0.0521 FT

ENTRY NO	TIME	HEAD
1		0
2	0	16.4020
3	0.5	15.1545
4	1.0	14.8311
5	1.5	14.4153
6	2.0	14.0457
7	2.5	13.7223
8	3.0	13.4450
9	3.5	13.1678
10	4.0	12.9368
11	4.5	12.7058
12	5.0	12.6606
13	5.5	12.2438
14	6.0	12.0590
15	6.5	11.7817
16	7.0	11.5969
17	7.5	11.3197
18	8.0	11.1349
19	8.5	10.9501
20	9.0	10.6729
21	9.5	10.5805
22	10.0	10.3495
23	10.5	10.1184
24	11.0	9.8874
25	11.5	9.7488
26	12.0	9.6102
27	12.5	9.4254
28	13.0	9.1944
29	13.5	9.0558
30	14.0	8.8710
31	14.5	8.6862
32	15.0	8.5475
33	15.5	8.3627
34	16.0	8.1779
35	16.5	7.9931
36	17.0	7.9007
37	17.5	7.6697
38	18.0	7.5311
39	18.5	7.3001
40	19.0	7.2007

ENTRY	TIME	HEAD
41	19.5	20229
42	20.0	6.8380
43	20.5	6.6994
44	21.0	6.5608
45	21.5	6.4222
46	22.0	6.2374
47	22.5	6.0526
48	23.0	5.9602
49	23.5	5.7754
50	24.0	5.6830
51	24.5	5.4520
52	25.0	5.3134
53	26.5	5.1747
54	26.0	5.0361
55	26.5	4.8975
56	27.0	4.8051
57	27.5	4.5741
58	28.0	4.5279
59	28.5	4.3431
60	29.0	4.2507

C:TEST6.DAT

By ________ Date ______ **WEHRAN ENGINEERING** Engineers & Scientists Job No. ________
Chkd. by ________ Date ______ Sheet No. ______ of ______
Subject ________

WELL NAME : TEST # 7 DATE : 17-28-58
WELL NUMBER : MW-2D
CHANGE VOL. WATER : 0.0803 FT^3
EFFECTIVE WELL RADIUS : 0.25 FT
RAD. OF CASING : 0.0521

ENTRY	TIME	HEAD
1		0
2	0	9.4191
3	0.25	8.3571
4	0.50	7.5722
5	0.75	6.7873
6	1.00	6.1871
7	1.25	5.7253
8	1.50	5.3098
9	1.75	4.9404
10	2.00	4.5249
11	2.25	4.2478
12	2.50	4.0170
13	2.75	3.7400
14	3.00	3.5553
15	3.25	3.3244
16	3.50	3.0936
17	3.75	2.9084
18	4.00	2.7703
19	4.25	2.6318
20	4.50	2.5395
21	4.75	2.4010
22	5.00	2.2625
23	5.25	2.1239
24	5.50	2.0316
25	5.75	1.9393
26	6.00	1.8469
27	6.25	1.7084
28	6.50	1.6622
29	6.75	1.5699
30	7.00	1.4314
31	7.25	1.3852
32	7.50	1.3390
33	7.75	1.2467
34	8.00	1.1543
35	8.25	1.1082
36	8.50	1.0600
37	8.75	0.9696
38	9.00	0.9235
39	9.25	0.8311
40	9.50	0.7850

ENTRY	TIME	HEAD
41	9.75	0.7388
42	10.00	0.6926
43	10.25	0.6003
44	10.50	0.5541
45	10.75	0.5079
46	11.00	0.4618
47	11.25	0.4156
48	11.50	0.3694
49	11.75	0.3232
50	12.00	0.2771
51	12.25	0.2309
52	12.50	0.1847

C: TEST 7.DAT

By ____________ Date ______ | **WEHRAN ENGINEERING** Engineers & Scientists | Job No. ____________

Chkd. by ________ Date ______ | Sheet No. ______ of ______

Subject ____________________

WELL NAME: TEST #8
WELL NUMBER: MW-2D
CHANGE VOL. WATER: 0.2315 FT^3
EFFECTIVE WELL RADIUS: 0.25 FT
RAD. CASING = 0.0521 FT

ENTRY	TIME	HEAD	ENTRY	TIME	HEAD
1		0	41	.6500	.9696
2	0	5.4480	42	.6667	.9696
3	0.0167	5.3557	43	.6833	.9234
4	.0333	5.2633	44	.7000	.8311
5	.0500	5.0786	45	.7167	.8311
6	.0667	4.9401	46	.7333	.8311
7	.0833	4.8016	47	.7500	.7849
8	.1000	4.5708	48	.7667	.7849
9	.1167	4.4323	49	.7833	.7387
10	.1333	4.3399	50	.8000	.6464
11	.1500	4.2113	51	.8167	.6002
12	.1667	4.0168	52	.8333	.6464
13	.1833	3.8321	53	.8500	.5541
14	.2000	3.7397	54	.8667	.5541
15	.2167	3.6474	55	.8833	.6002
16	.2333	3.4627	56	0.9000	.5541
17	.2500	3.3242	57	.9167	.4617
18	.2667	3.0934			
19	.2833	3.0472			
20	.3000	2.9087			
21	.3167	2.7240			
22	.3333	2.6317			
23	.3500	2.4470			
24	.3667	2.4008			
25	.3833	2.2623			
26	.4000	2.1238			
27	.4167	2.1238			
28	.4333	1.9391			
29	.4500	1.9391			
30	.4667	1.7545			
31	.4833	1.6621			
32	.500	1.6166			
33	.5167	1.5236			
34	.5333	1.4774			
35	.5500	1.3851			
36	.5667	1.3389			
37	.5833	1.2466			
38	.6000	1.1543			
39	.6167	1.2004			
40	.6333	1.0619			

C: TEST8.DAT

By	Date	**WEHRAN ENGINEERING** Engineers & Scientists	Job No.
Chkd. by	Date		Sheet No. of
Subject			

WELL NAME : TEST # 9
WELL NUMBER : MW-2D
CHANGE IN VOL. WATER : 0.0547939 FT^3
EFFECTIVE WELL RADIUS : 0.25 FT
CASING RADIUS : 0.0521 FT

ENTRY	TIME	HEAD
1		0
2	0	6.4255
3	0.05	6.0048
4	0.10	5.5458
5	0.15	5.0868
6	0.20	4.6661
7	0.25	4.2454
8	0.30	3.8629
9	0.35	3.5570
10	0.40	3.1745
11	0.45	2.8685
12	0.50	2.5625
13	0.55	2.2948
14	0.60	1.9888
15	0.65	1.7594
16	0.70	1.6064
17	0.75	1.4916
18	0.80	1.2621
19	0.85	1.1474
20	0.90	0.9562
21	0.95	0.8797
22	1.00	0.7267
23	1.05	0.6884
24	1.10	0.6119
25	1.15	0.4972
26	1.20	0.4207
27	1.25	0.4207
28	1.30	0.3442
29	1.35	0.3442
30	1.40	0.3060
31	1.45	0.2677
32	1.50	0.2295
33	1.55	0.2295
34	1.60	0.1912
35	1.65	0.1912
36	1.70	0.1530
37	1.75	0.1147
38	1.80	0.1147
39	1.85	0.0765 END
40	1.90	0.1530

ENTRY	TIME	HEAD
41	1.95	
42	2.00	
43	2.05	

C: TEST9.DAT

By	Date		Job No.
Chkd. by	Date	WEHRAN ENGINEERING Engineers & Scientists	Sheet No. of
Subject			

WELL NAME : TEST #10 DATE 7-29-88

WELL NUMBER : MW-2D

CHANGE IN VOL. WATER : 0.1055 FT^3

EFFECTIVE WELL RADIUS : 0.25 FT

RADIUS OF CASING : 0.0521 FT

ENTRY	TIME	HEAD	ENTRY	TIME	HEAD
1		0	41	9.75	6.412
2	0	12.368	42	10.00	6.298
3	.25	12.141	43	10.25	6.146
4	.50	12.027	44	10.50	5.994
5	.75	11.837	45	10.75	5.919
6	1.00	11.647	46	11.0	5.843
7	1.25	11.420	47	11.25	5.729
8	1.50	11.230	48	11.50	5.615
9	1.75	11.078	49	11.75	5.501
10	2.00	10.889	50	12.00	5.387
11	2.25	10.737	51	12.25	5.274
12	2.50	10.509	52	12.50	5.160
13	2.75	10.395	53	12.75	5.084
14	3.00	10.244	54	13.0	5.046
15	3.25	10.054	55	13.25	4.932
16	3.50	9.092	56	13.50	4.856
17	3.75	9.750	57	13.75	4.742
18	4.00	9.561	58	14.0	4.591
19	4.25	9.409	59	14.25	4.515
20	4.50	9.2192	60	14.50	4.477
21	4.75	9.105	61	14.75	4.363
22	5.00	8.954	62	15.0	4.287
23	5.25	8.764	63	15.25	4.249
24	5.50	8.650	64	15.50	4.098
25	5.75	8.498	65	15.75	4.060
26	6.00	8.385	66	16.0	3.946
27	6.25	8.195	67	16.25	3.832
28	6.50	8.043			
29	6.75	7.967			
30	7.00	7.816			
31	7.25	7.664			
32	7.50	7.550			
33	7.75	7.398			
34	8.00	7.246			
35	8.25	7.171			
36	8.50	7.057			
37	8.75	6.867			
38	9.00	6.753			
39	9.25	6.677			
40	9.50	6.526			

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37
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07

By ________ Date ______ **WEHRAN ENGINEERING** Engineers & Scientists Job No. ________
Chkd. by ________ Date ______ Sheet No. ____ of ____
Subject ________

WELL NAME: TEST #11 DATE 7-29-88
WELL NUMBER: MW-2D
CHANGE IN VOL. WATER: 0.1118 FT^3
EFFECTIVE WELL RADIUS: 0.25 FT
CASING RADIUS: 0.0521 FT

ENTRY	TIME	HEAD	ENTRY	TIME	HEAD
1		0	41	9.75	5.972
2	0	13.1153	42	10.00	5.858
3	0.25	12.284	43	10.25	5.745
4	0.50	11.981	44	10.50	5.670
5	0.75	11.792	45	10.75	5.518
6	1.00	11.604	46	11.00	5.405
7	1.25	11.339	47	11.25	5.329
8	1.50	11.112	48	11.50	5.178
9	1.75	10.885	49	11.75	5.103
10	2.00	10.696	50	12.00	5.027
11	2.25	10.525	51	12.25	4.876
12	2.50	10.318	52	12.50	4.800
13	2.75	10.129	53	12.75	4.725
14	3.00	9.940	54	13.00	4.573
15	3.25	9.751	55	13.25	4.573
16	3.50	9.563	56	13.50	4.460
17	3.75	9.374	57	13.75	4.347
18	4.00	9.260	58	14.00	4.271
19	4.25	9.109	59	14.25	4.158
20	4.50	8.882	60	14.50	4.120
21	4.75	8.769	61	14.75	3.931
22	5.00	8.616	62	15.00	3.893
23	5.25	8.429	63	15.25	3.817
24	5.50	8.240	64	15.50	3.666
25	5.75	8.088	65	15.75	3.666
26	6.00	7.975	66	16.00	3.591
27	6.25	7.862	67	16.25	3.477
28	6.50	7.711	68	16.50	3.402
29	6.75	7.559	69	16.75	3.364
30	7.00	7.408	70	17.00	3.288
31	7.25	7.257	71	17.25	3.213
32	7.50	7.144	72	17.50	3.099
33	7.75	6.992	73	17.75	3.062
34	8.00	6.841	74	18.00	2.986
35	8.25	6.766	75	18.25	2.910
36	8.50	6.614	76	18.50	2.797
37	8.75	6.501	77	18.75	2.797
38	9.00	6.350	78	19.00	2.721
39	9.25	6.236	79	19.25	2.646
40	9.50	6.085	80	19.50	2.608

STOP TEST

MAHOPAC BUSINESS DISTRICT RI/FS
MW-2D BOREHOLE PACKER TEST SAMPLING RESULTS

Sample ID	Packed Off Interval (ft. BGS)	Test Results in ppb		
		1,2 Dichloroethene	Tri-Chloroethene	Tetra-Chloroethene
MBD-MW-02D-01	50 – 75	3.8	BDL	32
MBD-MW-02D-02	75 – 400	3.8	BDL	31
MBD-MW-02D-03	75 – 100	3.8	2.1	40
MBD-MW-02D-04	200 – 225	3.4	BDL	24
MBD-MW-02D-05	200 – 225	3.0	BDL	24
MBD-MW-02D-06	250 – 275	3.4	BDL	27
MBD-MW-02D-07	310 – 335	3.0	BDL	27
MBD-MW-02D-08	0 – 400	3.4	BDL	27

Notes:

BDL = Below Detection Limit
Detection Limit = 2.0 ppb
Values reported for 1,2 dichloroethene include CIS and/o Trans Isomers

GHR

FINAL REPORT

Wehran Engineers & Scientists
666 East Main Street
P.O. Box 2006
Middletown, NY 10940

Attention: Mr. Terrance R. Haelen

PROJECT: P.O. #07467

GHR ANALYTICAL JOB NUMBER: 36-825

PREPARED BY: GHR Analytical

DATE PREPARED:

GHR ANALYTICAL
26 MAIN STREET
LAKEVILLE MA
02347
617 947 5077
617 763 8404

GHR ANALYTICAL
A [illegible]IVISION OF GHR ENGINEERING ASS[illegible] ATES, INC.
26 MAIN STREET
LAKEVILLE, MA 02347
(508) 947-5077

HNU 301 Scan - Volatile Organics Analysis

Client: Wehran Engineers & Scientists
Project: P.O. 07467

Job No.: 36-825
Date: August 5, 1988

Date Received: August 4, 1988
Collected by: Client

Date Analyzed: August 4, 1988
Analyzed by: PMC

Test Results in ug/l(ppb)

PACKED INTERVAL	Sample ID	Matrix	GHR Lab No.	1,2 Dichloroethene*	Tri Chloroethene	Tetra Chloroethene
50-75'	MBD-MW-02D-01	groundwater	83781	3.8	BDL(1)	32
75-100'	MBD-MW-02D-02	groundwater	83782	3.8	BDL	31
75-100'	MBD-MW-02D-03	groundwater	83783	3.8	2.1	40
200-225'	MBD-MW-02D-04	groundwater	83784	3.4	BDL	24
200-225'	MBD-MW-02D-05	groundwater	83785	3.0	BDL	24
250-275'	MBD-MW-02D-06	groundwater	83786	3.4	BDL	27
310-335'	MBD-MW-02D-07	groundwater	83787	3.0	BDL	27
0-400	MBD-MW-02D-08	groundwater	83788	3.4	BDL	27

(1) BDL = Below Detection Limit.
Detection Limit = 2.0 ug/l (ppb).

*Note: Values reported for 1,2 Dichloroethene include cis and/or trans isomers.

Approved by: [signature]
Quality Assurance Supervisor

Jot ɔ. 36-825

GAS CHROMATOGRAPHY ANALYTICAL PROCEDURE

Type of Instrument: HNU Model 301

Column: 3% SP-2100 on 100/120 Supelcoport, 6' x 1/8" stainless steel

Detector 1: Photoionization Detector (PID)

Detector 2: Flame Ionization Detector (FID)

Chromatographic Conditions:

Injector Temperature: 180°C
Detector Temperature: 180°C
Column Temperature: 60°C isothermal

Carrier gas: Nitrogen at 10 ml/min.

Analyte Concentration determined by External Standard, Peak Area Response

Sample Preparation:

Water: A 30 ml sample is collected in a 40 ml glass vial sealed with a teflon-lined silicone septum is brought to room temperature. 100 ul of the headspace is sampled and injected into the gas chromatograph at above conditions. Peak heights are compared to a chlorinated standard spiked into organic-free water.

Soil: Approximately 20 g of soil was placed in a 40 ml vial and brought to room temperature. 100 ul of the headspace was sampled and injected onto the gas chromatograph at above conditions. Peak heights are compared to a chlorinated standard spiked into an empty 40 ml vial.

WE

36-825

RWA

CHAIN OF CUSTODY RECORD

PROJECT: Mahopac RI/FS

CLIENT: NYSDEC

JOB No.: 07509.03

SAMPLE IDENTIFICATION:

LOCATION No.	LAB SAMPLE No.	CONTAINERS: NUMBER/TYPE	CONTAINER CONDITION
83781	MBD-MW-020-01	1 VOA	
82	MBD-MW-020-02		
83	MBD-MW-020-03		
84	MBD-MW-020-04		
85	MBD-MW-020-05		
86	MBD-MW-020-06		
87	MBD-MW-020-07		
88	MBD-MW-020-08		

CHAIN OF CUSTODY CHRONICLE:

COLLECTED BY:

1. NAME: Terry Hhabry DATE: 8/1/88
   SIGNATURE: Terry Hhabry SEALS PLACED ON CONTAINERS? ☐ YES ☒ NO

CUSTODY TRANSFERRED TO:

2. NAME: ______ DATE: ______ TIME: ______
   SIGNATURE: ______ ARE SEALS INTACT? ☐ YES ☐ NO ☐ N/A

CUSTODY TRANSFERRED TO:

3. NAME: ______ DATE: ______ TIME: ______
   SIGNATURE: ______ ARE SEALS INTACT? ☐ YES ☐ NO ☐ N/A

RECEIVED IN LABORATORY BY:

4. NAME: ______ DATE: ______ TIME: ______
   SIGNATURE: ______ ARE SEALS INTACT? ☐ YES ☐ NO ☐ N/A

DISPOSED BY:

5. NAME: ______ DATE: ______
   SIGNATURE: ______

REFER TO "WATER QUALITY SAMPLING FIELD DATA SHEET" FOR SPECIFIC SAMPLING DETAILS.

WERE ANY SAMPLES SPLIT WITH ANOTHER PARTY? ☐ YES ☐ NO

IF YES, IDENTIFY: ______

REVISED

WEHRAN ENGINEERING
Engineers & Scientists
100 Milk Street
Methuen, MA 01844

FAX TRANSMITTAL COVER SHEET

Please deliver the following pages to:

NAME: TERRY HAELEN

COMPANY/LOCATION: MIDDLETOWN (ENVIRONMENTAL SECTIO

TELEPHONE NUMBER:

This transmittal is being sent from:

NAME: PETE CROTEAU DATE: 8/3/88 TIME: 2:00

NOTE:

Job #: 01509.03

Number of pages being transmitted, including cover sheet: 9

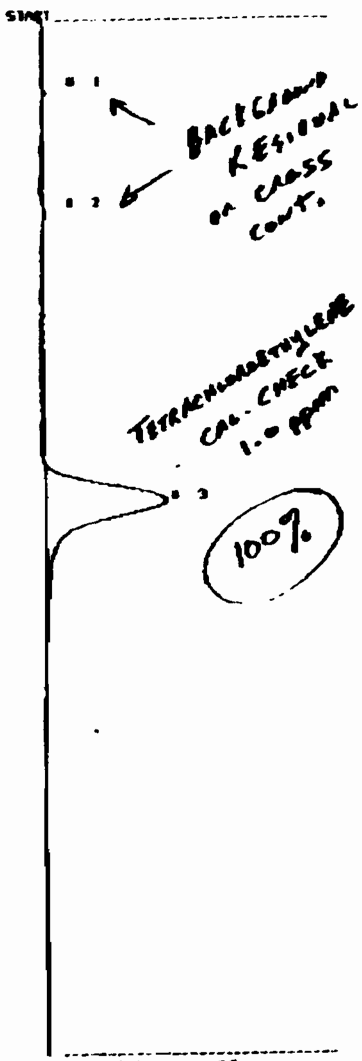
IF YOU DO NOT RECEIVE ALL PAGES, PLEASE NOTIFY THE SENDER AS SOON AS POSSIBLE AT (617) 682-1980

SENT BY:Methuen ; 7-14-88 2:41PM ; 2055→ 9143430660:# 3

(1)

MANOPAC BUSINESS DISTRICT

SAMPLE RUNS



STOP @ 800.0

SAMPLE RUN		37	JUL 1988 14:??
ANALYSIS #	18	MANOPAC SITE	
TEMPERATURE	32	CAL. REFRESH (TOTAL)	
GAIN	2	TETRACHLOROE[illegible]	

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRANS-DICHLOROETHENE	1	52.5	0.000 PPM
TRICHLOROETHENE	2	153.7	0.013 PPM
UNKNOWN	3	325.7	12.3 VS

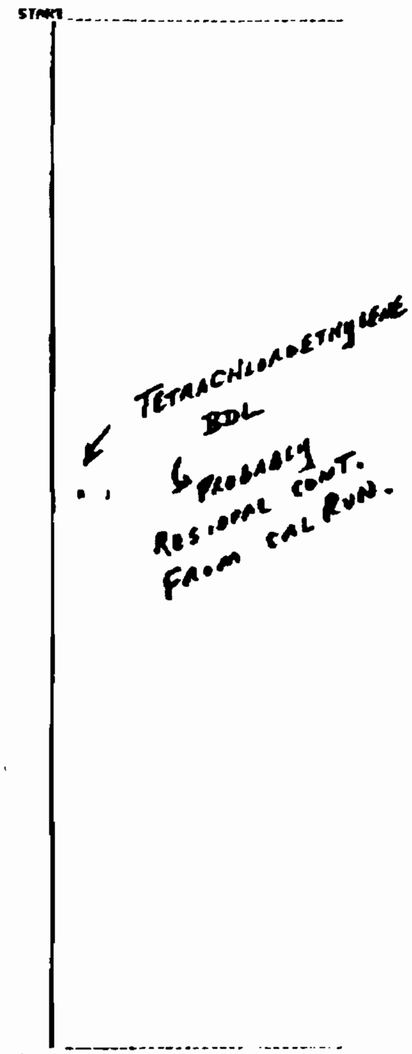
PHOTOVAC

CALIBRATED PEAK 3.TETRACHLOROETHENE

SAMPLE RUN		37	JUL 1988 14:27
ANALYSIS #	18	MANOPAC SITE	
TEMPERATURE	32	CAL. REFRESH	
GAIN	2	TETRACHLOROETHENE	

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRANS-DICHLOROETHENE	1	52.5	0.000 PPM
TRICHLOROETHENE	2	153.7	0.013 PPM
TETRACHLOROETHENE	3	325.7	1.002 PPM

PHOTOVAC

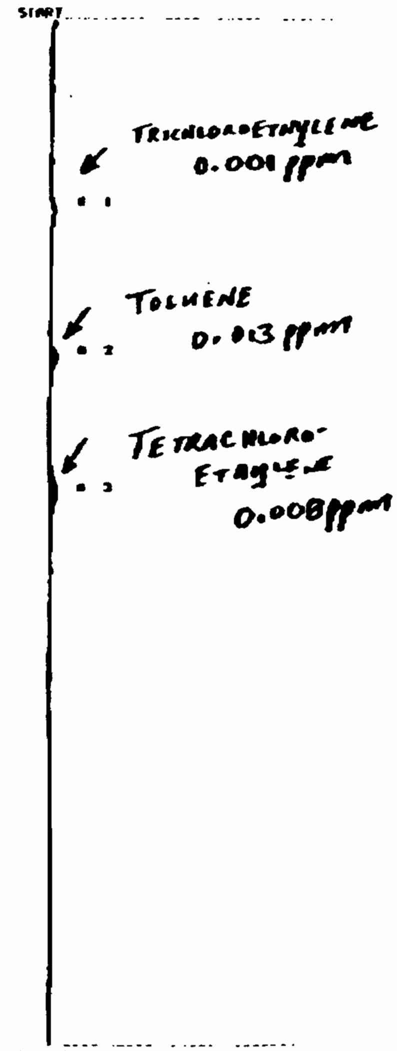


STOP @ 800.0

SAMPLE RUN		37	JUL 1988 14:51
ANALYSIS #	37	[illegible]-01	
TEMPERATURE	38	INTERVAL 30-25	
GAIN	5		

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TETRA. LOROENE	1	325.7	0.000 PPM

PHOTOVAC



STOP @ 800.0

SAMPLE RUN		37	JUL 1988 15:??
ANALYSIS #	18	[illegible]-07	
TEMPERATURE	30	INTERVAL 75-100	
GAIN	10		

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRICHLOROETHENE	1	153.7	0.001 PPM
TOLUENE	2	260.9	0.013 PPM
TETRACHLOROETHENE	3	325.7	0.008 PPM

By ______ Date ______
Chkd. by ______ Date ______
Subject

WEHRAN ENGINEERING
Engineers & Scientists

Job No. ______
Sheet No. ______ of ______

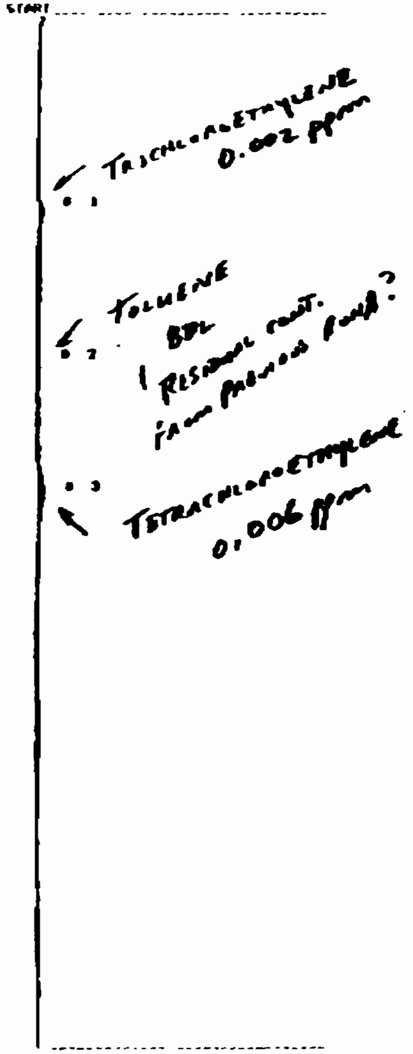
TABLE 2
MAHOPAC BUSINESS DISTRICT
GROUNDWATER SCREENING SAMPLE RESULTS (PPM)
PHOTOVAC 10S50 - JULY 27, & AUGUST 1 & 2, 1988

SAMPLE NUMBER	INTERVAL DEPTH (FT)	TRANS-1,2-DICHLOROETHYLENE	1,1,1 TRICHLOROETHANE	BENZENE	TRICHLOROETHYLENE	TOLUENE	TETRACHLOROETHYLENE
CALIBRATION CHECK ([illegible]) TOTAL	NA.						1.002
MBD-MW-02D-01	50-75						
MBD-MW-02D-02	75-100				0.001	0.013	0.008
MBD-MW-02D-03	75-100				0.002	BDL	0.006
POST CALIBRATION CHECK (TETRA)	NA						0.704
CALIBRATION TOTAL	N.A.	1.000	15.000	1.000	1.000	1.000	1.000
CALIBRATION CHECK							~0.800 (1)
MBD-MW-02D-04	200-225						
MBD-MW-02D-05	200-225						
MBD-MW-02D-06	250-275						
MBD-MW-[illegible]D-07	310-335						
MBD-MW-02D-08	0-100			0.151			
POST CALIBRATION CHECK (BENZENE)				0.728			

(2)

MANUFAC BUSINESS DISTRICT
SAMPLE RUNS

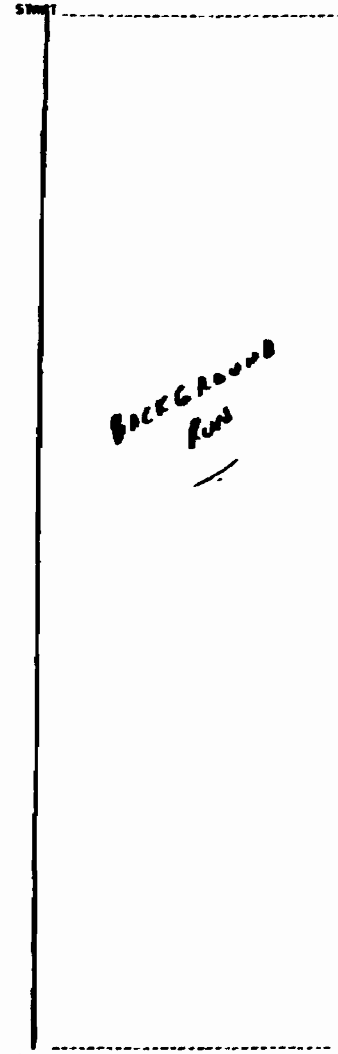
PHOTOVAC



STOP 0 900.0
SAMPLE RUN JUL 08 1988 15:30
ANALYSIS # 30 ...
TEMPERATURE 30 INTERVAL 25-300
GAIN 10

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRICHLOROETHENE	1	154.1	0.002 PPM
TOLUENE	2	271.7	0.000 PPM
TETRACHLOROENE	3	375.7	0.006 PPM

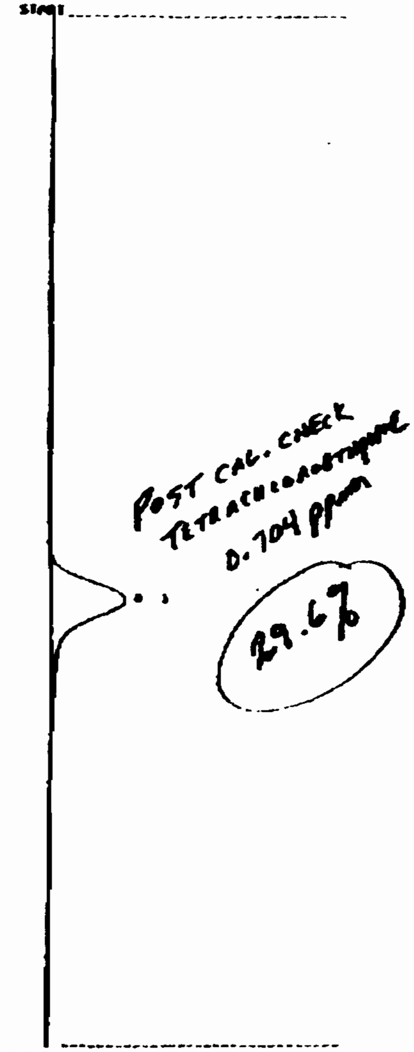
PHOTOVAC



STOP 0 900.0
SAMPLE RUN JUL 08 1988 17:45
ANALYSIS # 1 MANUFAC SITE
TEMPERATURE 35 BACKGROUND RUN
GAIN 3

COMPOUND NAME	PEAK	R.T.	AREA/PPM

PHOTOVAC



STOP 0 900.0
SAMPLE RUN JUL 08 1988 18:27
ANALYSIS # 3 MANUFAC SITE
TEMPERATURE 30 POST CAL. RUN
GAIN 3 TETRACHLOROENE

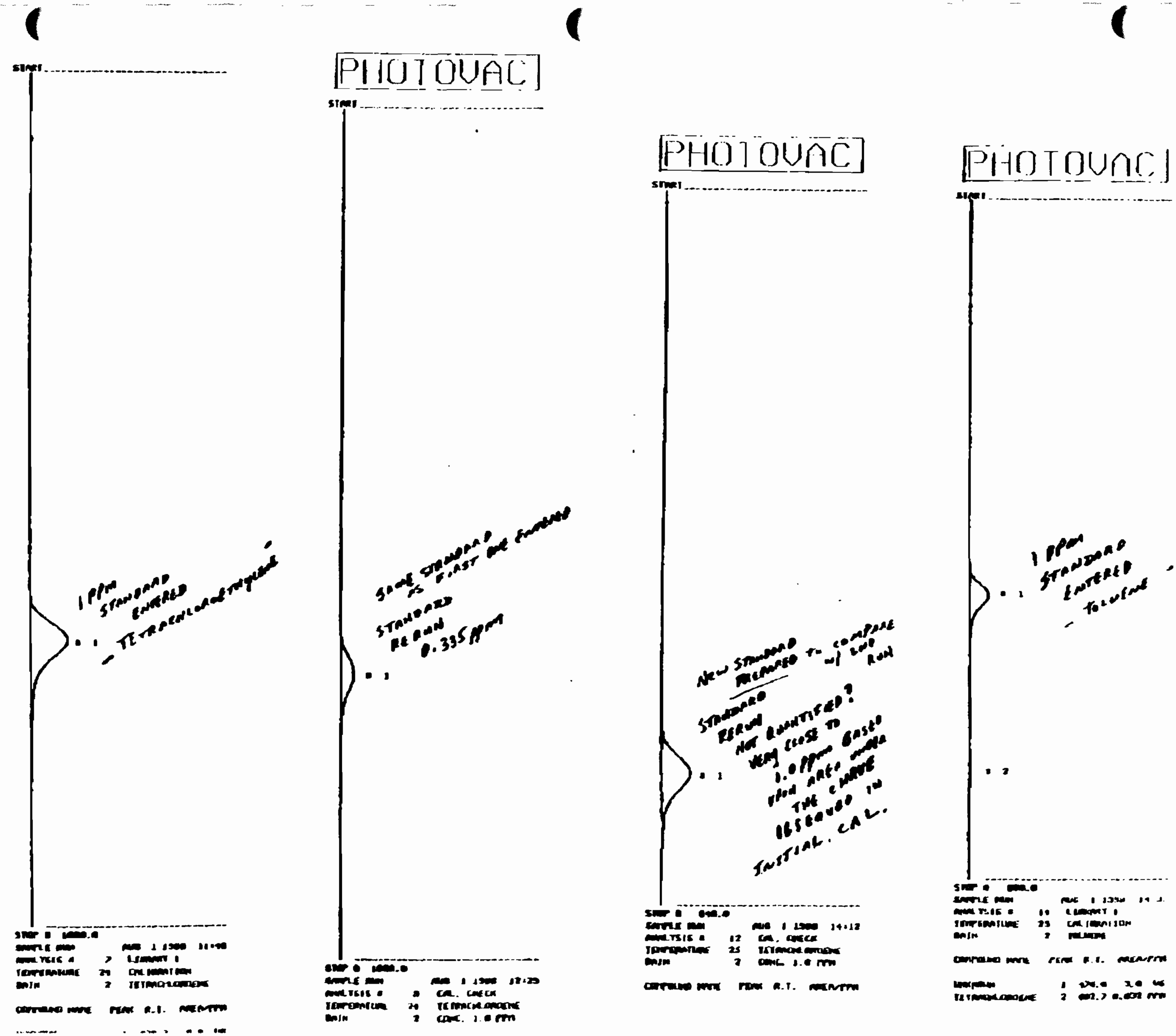
COMPOUND NAME	PEAK	R.T.	AREA/PPM
UNKNOWN	1	400.0	0.0 US

PHOTOVAC

CALIBRATED PEAK 1,TETRACHLOROENE
#7
SAMPLE RUN JUL 08 1988 18:20
ANALYSIS # 3 MANUFAC SITE
TEMPERATURE 32 POST CAL. RUN
GAIN 3 TETRACHLOROENE

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TETRACHLOROENE	1	400.0	0.704 PPM

(3)



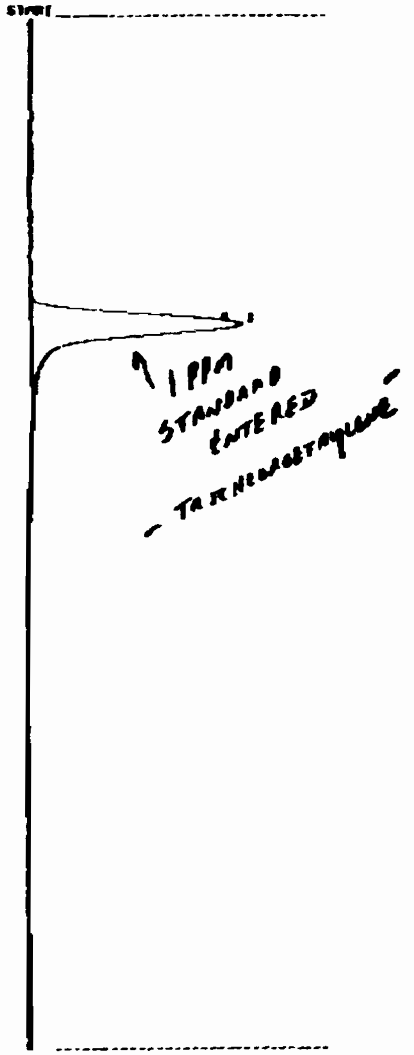
HANDING BUSINESS DISTRICT CALIBRATION RUNS

(4)

1,1,1 TRICHLOROETHANE WAS
ENTERED @ 75.0 ppm BECAUSE
IT IS A HEAVIER SATURATED
HYDROCARBON COMPARED TO OTHERS.
↓ (RECOMMENDED by PHOTOVAC)

NIANOTAC DUSINESS DISTRICT
CALIBRATION RUNS

PHOTOVAC

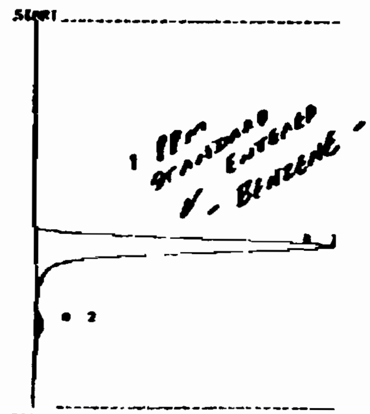


STOP @ 900.0
SAMPLE RUN AUG 1 1388 15: 0
ANALYSIS # 16 CALIBRATION
TEMPERATURE 20 LIBRARY 1
GAIN 2 TRICHLOROETHENE

COMPOUND NAME PEAK R.T. AREA/PPM

UNKNOWN 1 245.5 13.8 US

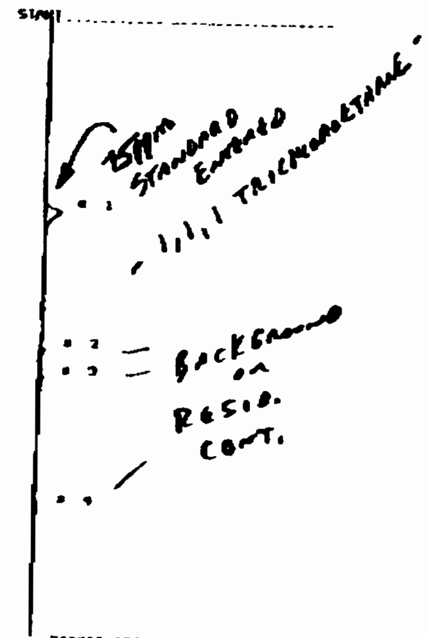
PHOTOVAC



STOP @ 300.0
SAMPLE RUN AUG 1 1388 15:10
ANALYSIS # 17 CALIBRATION
TEMPERATURE 25 LIBRARY 1
GAIN 2 BENZENE

COMPOUND NAME PEAK R.T. AREA/PPM

UNKNOWN 1 128.1 17.5 US
TRICHLOROETHENE 2 248.6 0.012 PPM

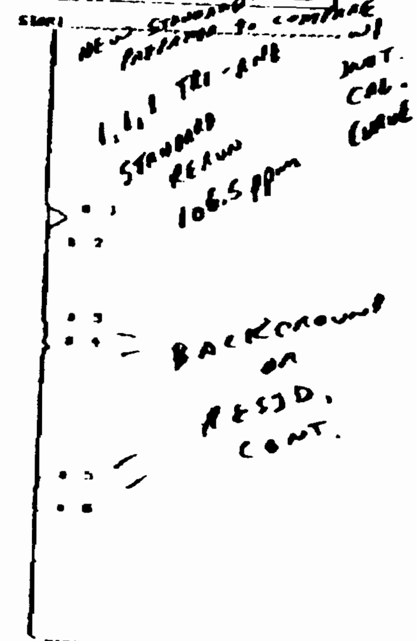


STOP @ 900.0
SAMPLE RUN AUG 2 1388 13:34
ANALYSIS # 11 LIBRARY 1
TEMPERATURE 20 CALIBRATION
GAIN 10 1,1,1 TRICHLORAN

COMPOUND NAME PEAK R.T. AREA/PPM

UNKNOWN 1 152.5 412.0 AUS
TRICHLOROETHENE 2 248.5 0.000 PPM
UNKNOWN 3 282.5 22.5 AUS

PHOTOVAC



STOP @ 900.0
SAMPLE RUN AUG 2 1978 14:12
ANALYSIS # 15 LIBRARY 1
TEMPERATURE 28 CALIBRATION
GAIN 10 1,1,1 TRICHLORAN

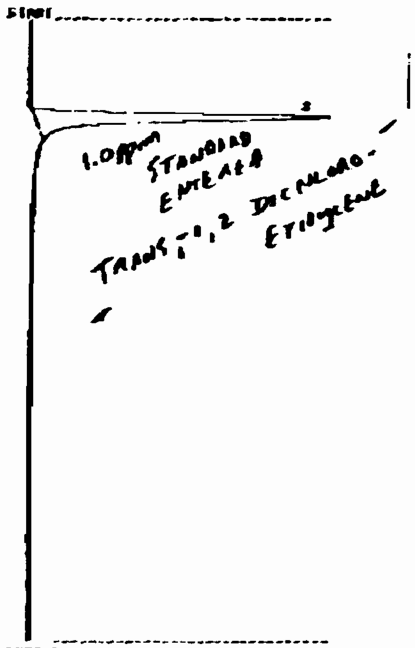
COMPOUND NAME PEAK R.T. AREA/PPM

1,1,1 TRICHLORANE 1 151.2 106.5 PPM
TRICHLOROETHENE 3 231.0 0.000 PPM
TRICHLOROETHENE 4 253.2 0.000 PPM
UNKNOWN 6 363.2 21.2 AUS
UNKNOWN 8 388.5 7.0 AUS

(5)

MANOVAC BUSINESS DISTRICT
CALIBRATION RUNS

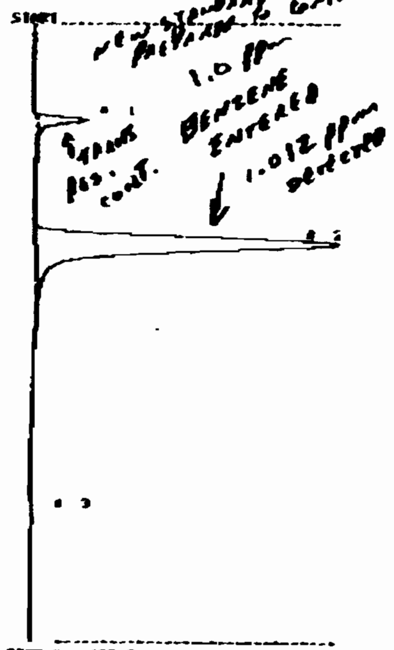
PHOTOVAC



STOP 0 600.0
SAMPLE RUN AUG 2 1988 15:38
ANALYSIS # 20 LIBRARY 1
TEMPERATURE 28 CALIBRATION
GAIN 2 ~~[illegible]~~
TRANS-1,2

COMPOUND NAME	PEAK	R.T.	AREA/PPM
UNKNOWN	1	28.3	7.0 VS

PHOTOVAC



STOP 0 600.0
SAMPLE RUN AUG 2 1988 16:0
ANALYSIS # 1 LIBRARY 1
TEMPERATURE 28 ~~CALIBRATION~~ Sample Run
GAIN 2 ~~[illegible] DETECTION~~
1.0 PPM.

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRANS. 1,2 DIENE	1	28.7	0.153 PPM
BENZENE	2	172.7	1.012 PPM
UNKNOWN	3	702.9	11.5 VAC

LIBRARY 1

RETENTION TIME

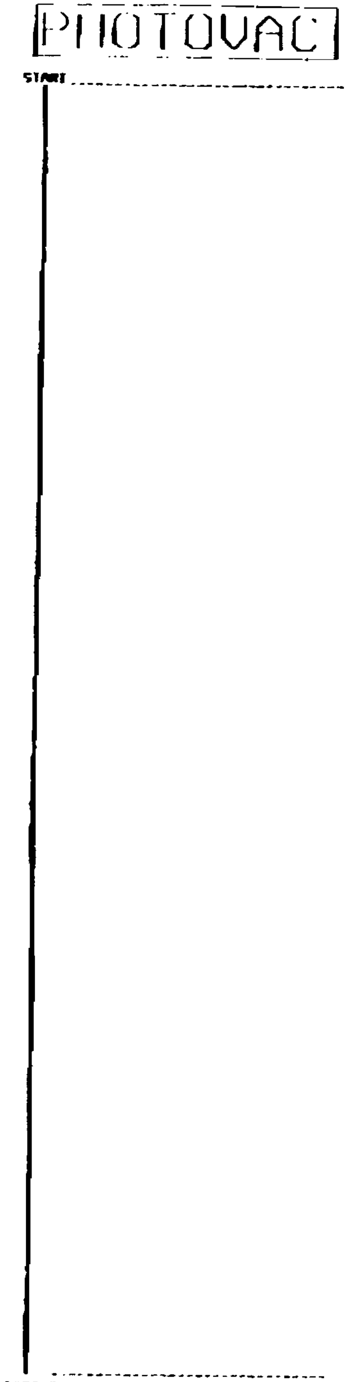
PHOTOVAC

CONC. (ppm)	I COMPOUND	ID #	R.T.	LIMIT
1.0	TETRACHLOROETHENE	1	675.7	24.00 PPM
1.0	TOLUENE	2	670.0	25.00 PPM
1.0	TRICHLOROETHENE	3	245.3	20.00 PPM
1.0	BENZENE	4	170.1	25.00 PPM
75.0	1,1,1 TRICHLANE	5	152.5	20.00 PPM
1.0	TRANS. 1,2 DIENE	6	28.3	20.00 PPM

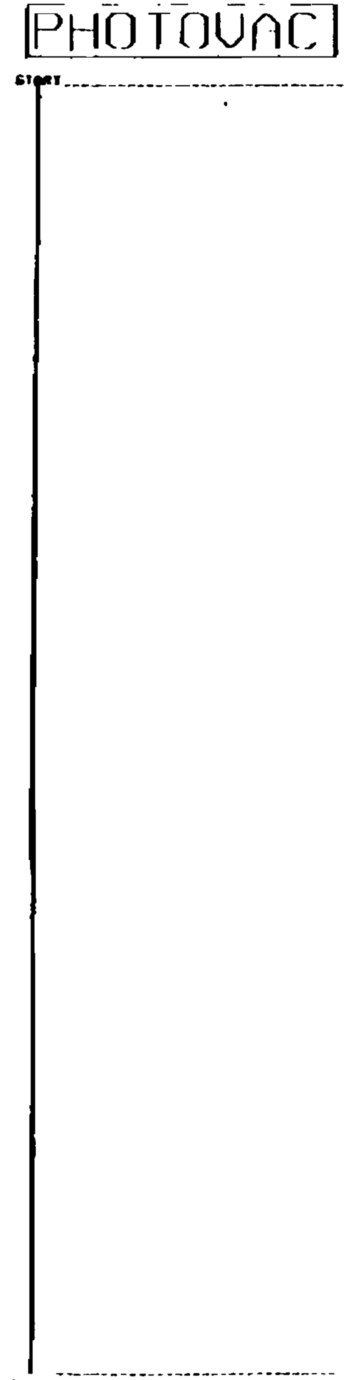
TEMPERATURE OF COLUMN DURING CALIBRATIONS

SENT BY:Methuen ; 7-14-88 2:44PM ; 2055→ 9143430650;# 3

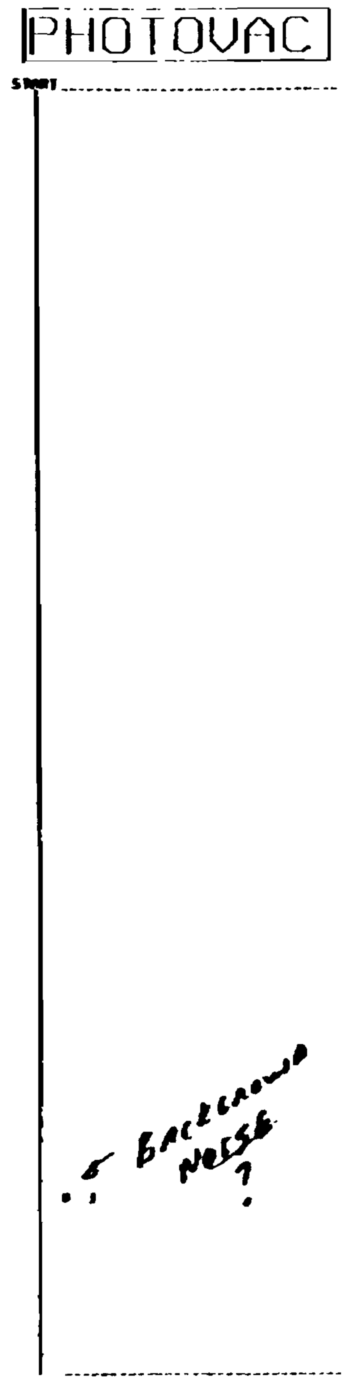
Illinois Business District
Sample Runs



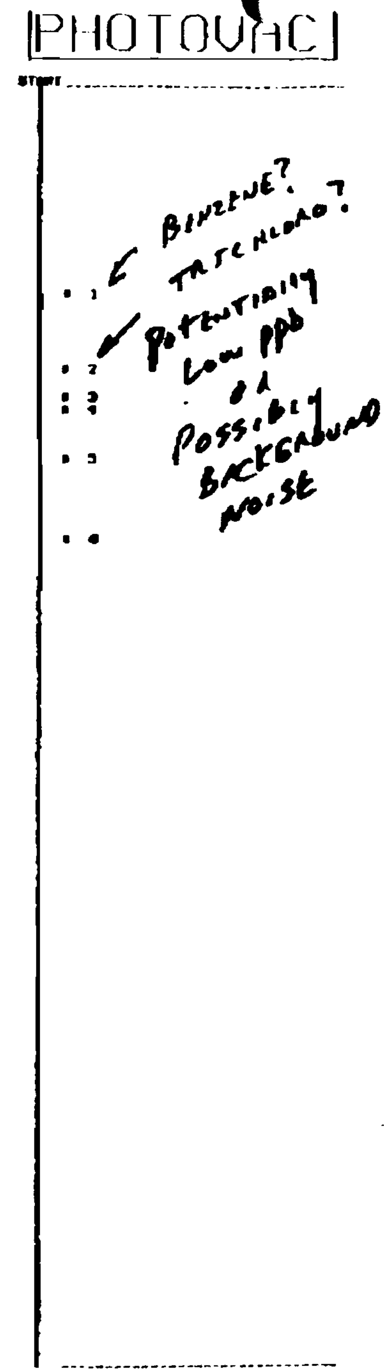
STOP @ 1000.0
SAMPLE RUN AUG 1 1988 16:21
ANALYSIS # 20 HBO-HU 020 04
TEMPERATURE 22 INTERVAL 200-225
GAIN 7



STOP @ 1000.0
SAMPLE RUN AUG 1 1988 16:15
ANALYSIS # 21 HBO-HU-020-05
TEMPERATURE 22 INTERVAL 200 225



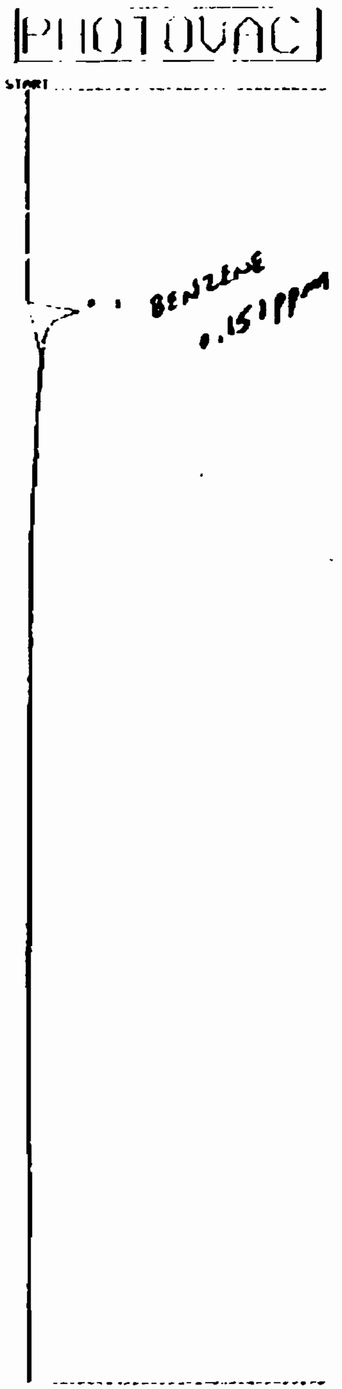
STOP @ 1000.0
SAMPLE RUN AUG 1 1988 16:10
ANALYSIS # 22 HBO-HU 020-08
TEMPERATURE 22 INTERVAL 210-225
GAIN 7



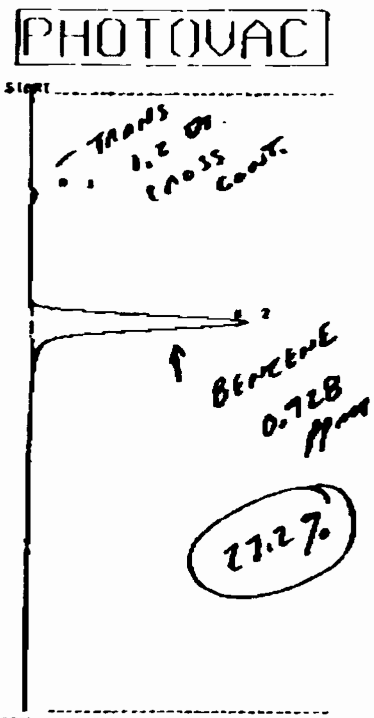
STOP @ 1000.0
SAMPLE RUN AUG 1 1988 17:11
ANALYSIS # 23 HBO-HU 020 07
TEMPERATURE 22 INTERVAL 210-225
GAIN 2

COMPOUND NAME PEAK R.T. AREA/PPM

Sample Runs



STOP @ 1000.0
SAMPLE RUN AUG 1 1988 17:31
ANALYSIS # 24 [illegible]
TEMPERATURE 22 INTERVAL 0-400
GAIN 2 OPEN [illegible]



STOP @ 400.0
SAMPLE RUN AUG 8 1988 [illegible]
ANALYSIS # 2 CAL. CHECK
TEMPERATURE 22 BENZENE 1.0 PPM
GAIN 2

COMPOUND NAME	PEAK	R.T.	AREA/PPM
TRANS, 1,2 DICHE	1	20.6	0.000 PPM
BENZENE	2	101.3	0.728 PPM

APPENDIX E
PACKER TESTING RESULTS

MAHOPAC BUSINESS DISTRICT RI/FS

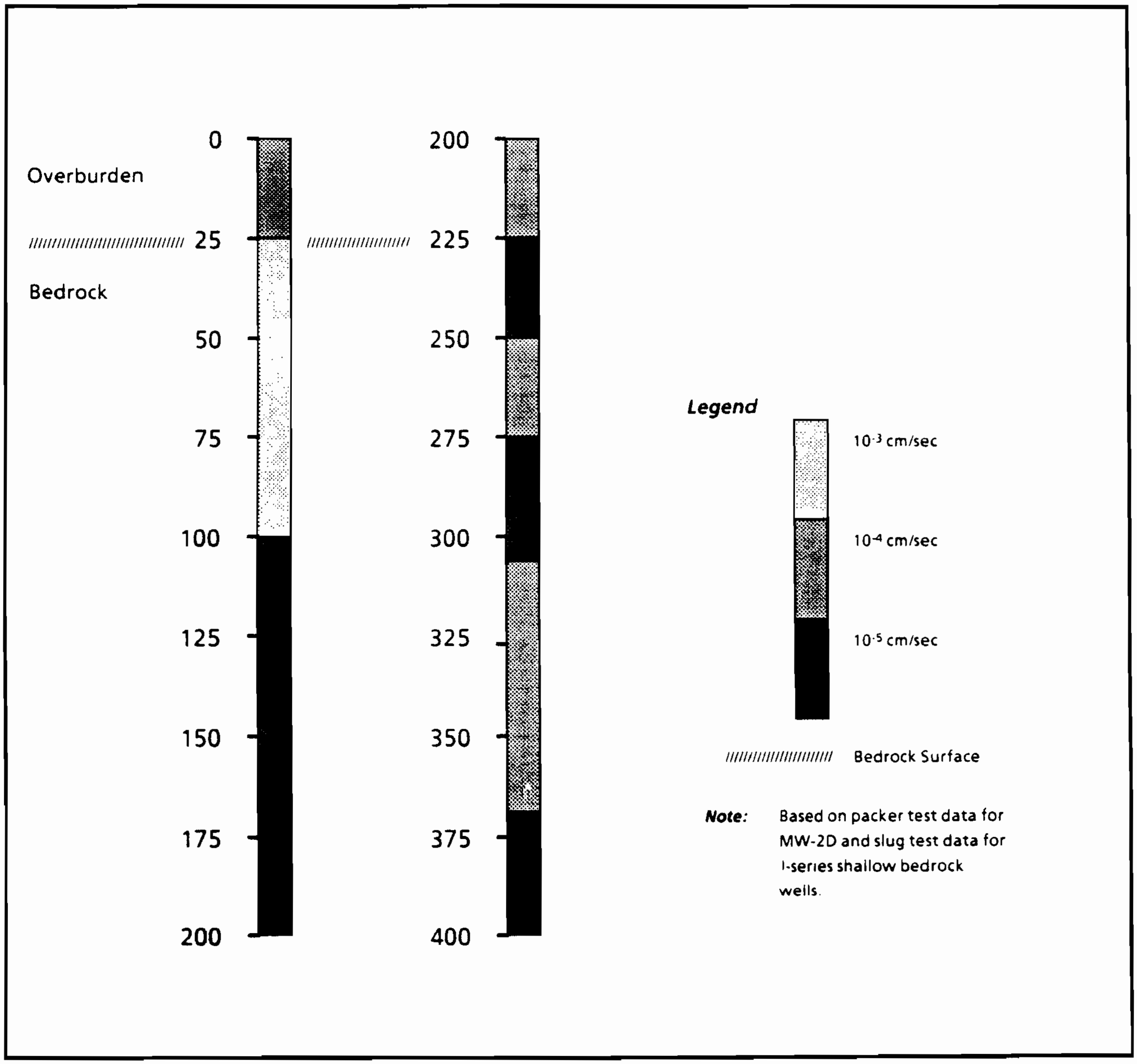
RESULTS OF SLUG TESTS PERFORMED DURING PACKER TESTING AT THE MW-2D OPEN BEDROCK BOREHOLE

Test No.	Depth Interval (ft bgs)	Slug Test Recorded	(T) Transmissivity (ft²/min)	Sat. Thickness (6)	(K) Permeability	
					Ft/Min	Cm/S
1	50 – 75	No	(Instantaneous Recovery)	25'	$\geq 1.0 \times 10^{-3}$	$\geq 1.0 \times 10^{-3}$
2	75 – 400	No	(Instantaneous Recovery)	325'	$\geq 1.0 \times 10^{-3}$	$\geq 1.0 \times 10^{-3}$
3	75 – 100	No	(Instantaneous Recovery)	25'	$\geq 1.0 \times 10^{-3}$	$\geq 1.0 \times 10^{-3}$
4	100 – 125	Yes	2.280×10^{-3}	25'	9.12×10^{-5}	4.633×10^{-5}
5	125 – 150	Yes	6.426×10^{-4}	25'	2.57×10^{-5}	1.31×10^{-5}
6	150 – 175	Yes	6.886×10^{-4}	25'	2.75×10^{-5}	1.40×10^{-5}
7	200 – 225	Yes	4.988×10^{-3}	25'	2.00×10^{-4}	1.02×10^{-4}
8	250 – 275	Yes	3.296×10^{-2}	25'	1.32×10^{-3}	6.71×10^{-4}
9	310 – 335	Yes	2.805×10^{-2}	25'	1.12×10^{-3}	5.69×10^{-4}
10	340 – 365	Yes	1.018×10^{-3}	25'	4.07×10^{-4}	2.07×10^{-4}
11	365 – 400	Yes	1.312×10^{-3}	35'	3.75×10^{-5}	$1,91 \times 10^{-5}$
12	Open	No	(Instantaneous Recovery)		$\geq 1.0 \times 10^{-3}$	1.0×10^{-3}

MAHOPAC BUSINESS DISTRICT RI/FS

GENERALIZED GEOLOGIC COLUMN

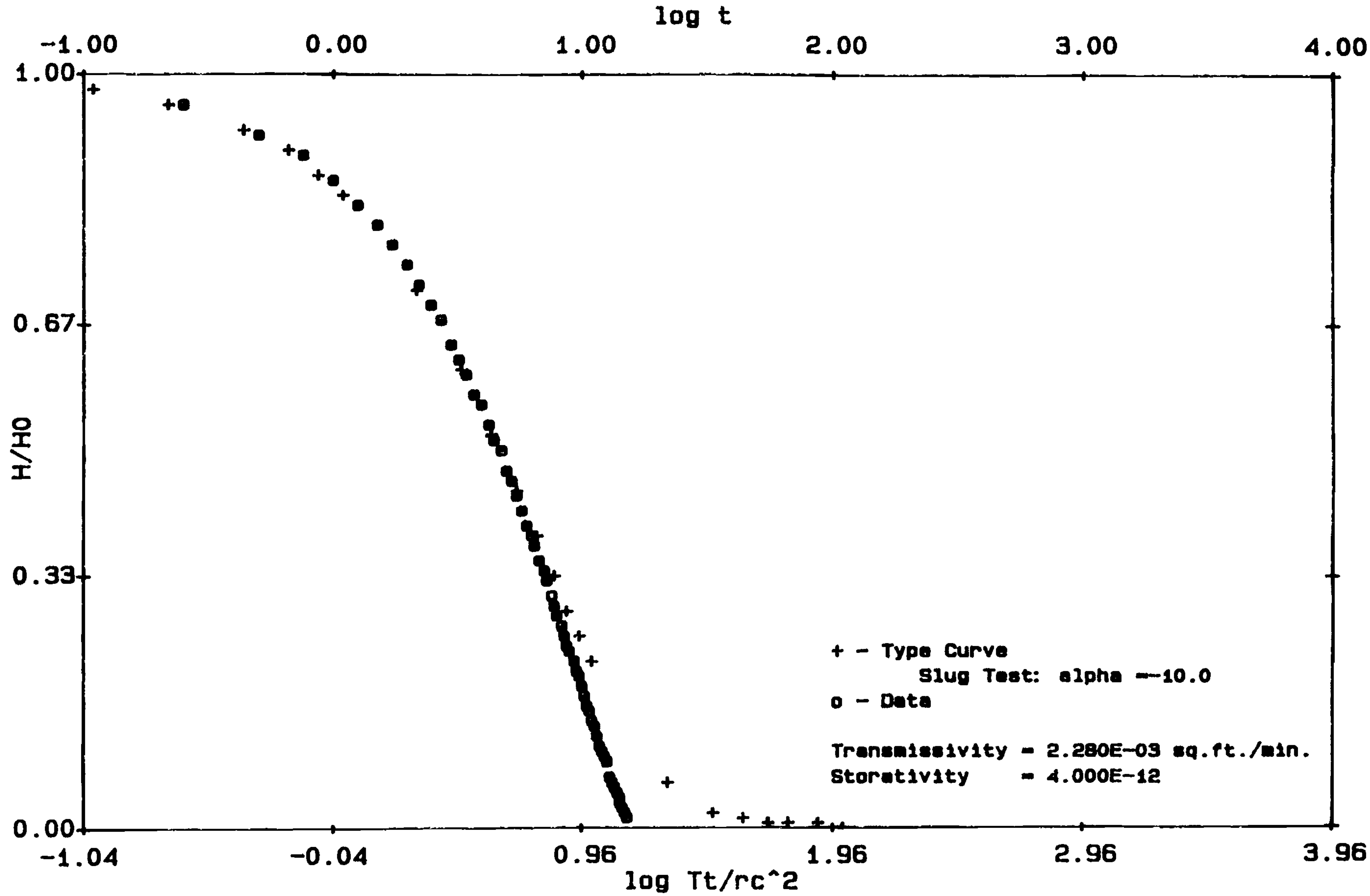
DEPICTING VARIOUS VERTICAL ZONES OF PERMEABILITY



10 6/89 07509

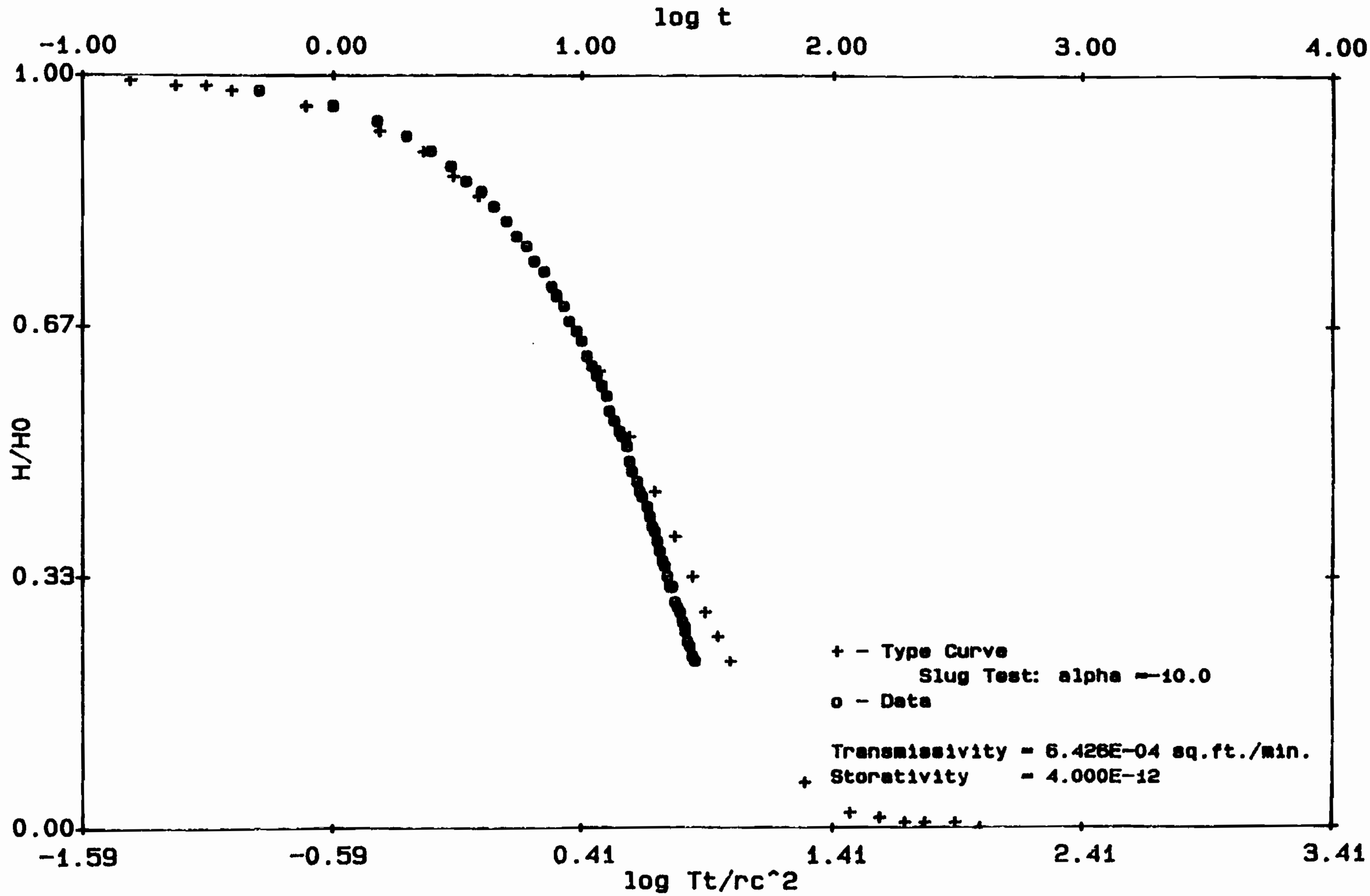
TEST #4
100-125'

SLUG TEST DATA



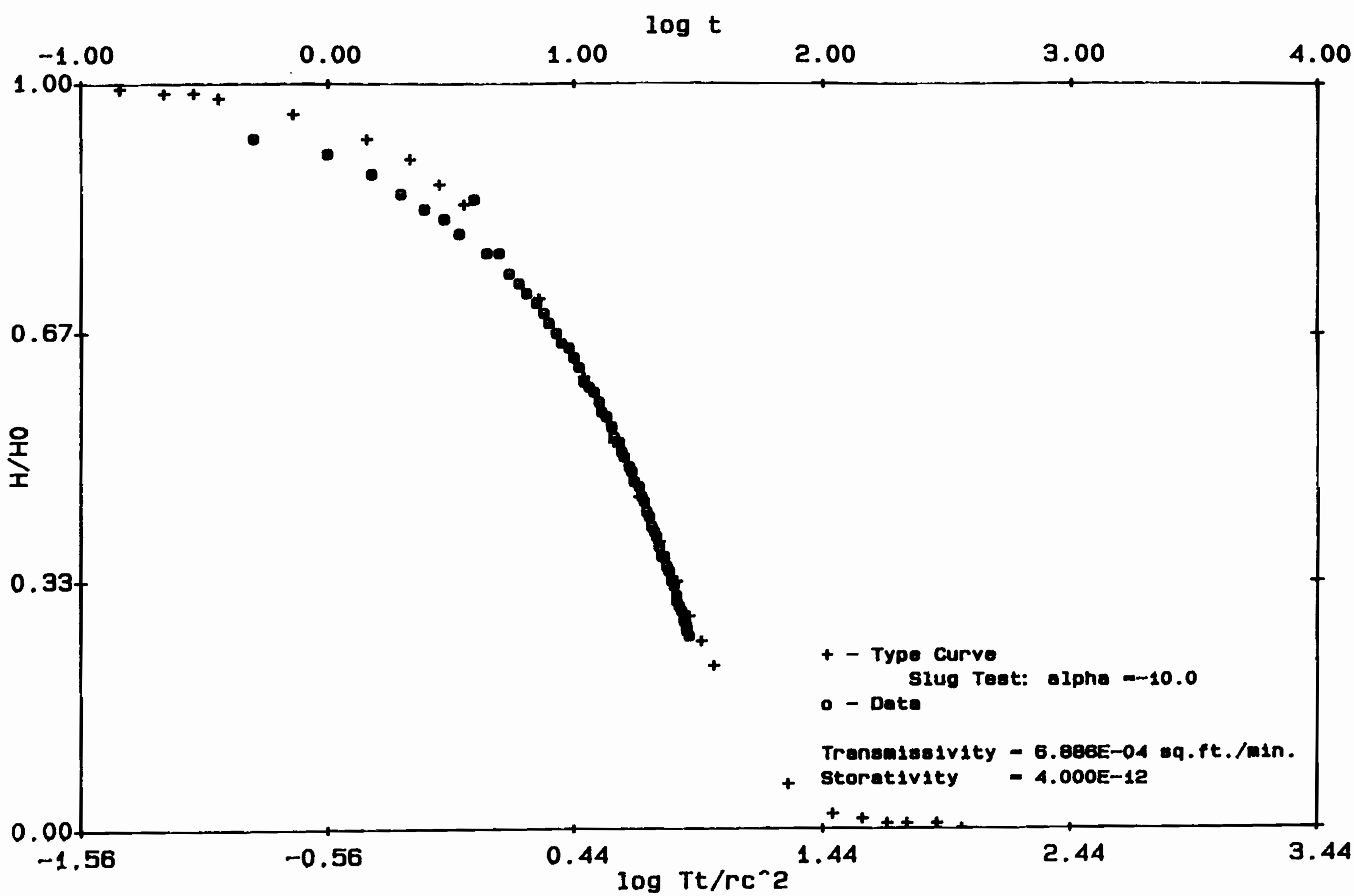
TEST # 5
125 - 150'

SLUG TEST DATA

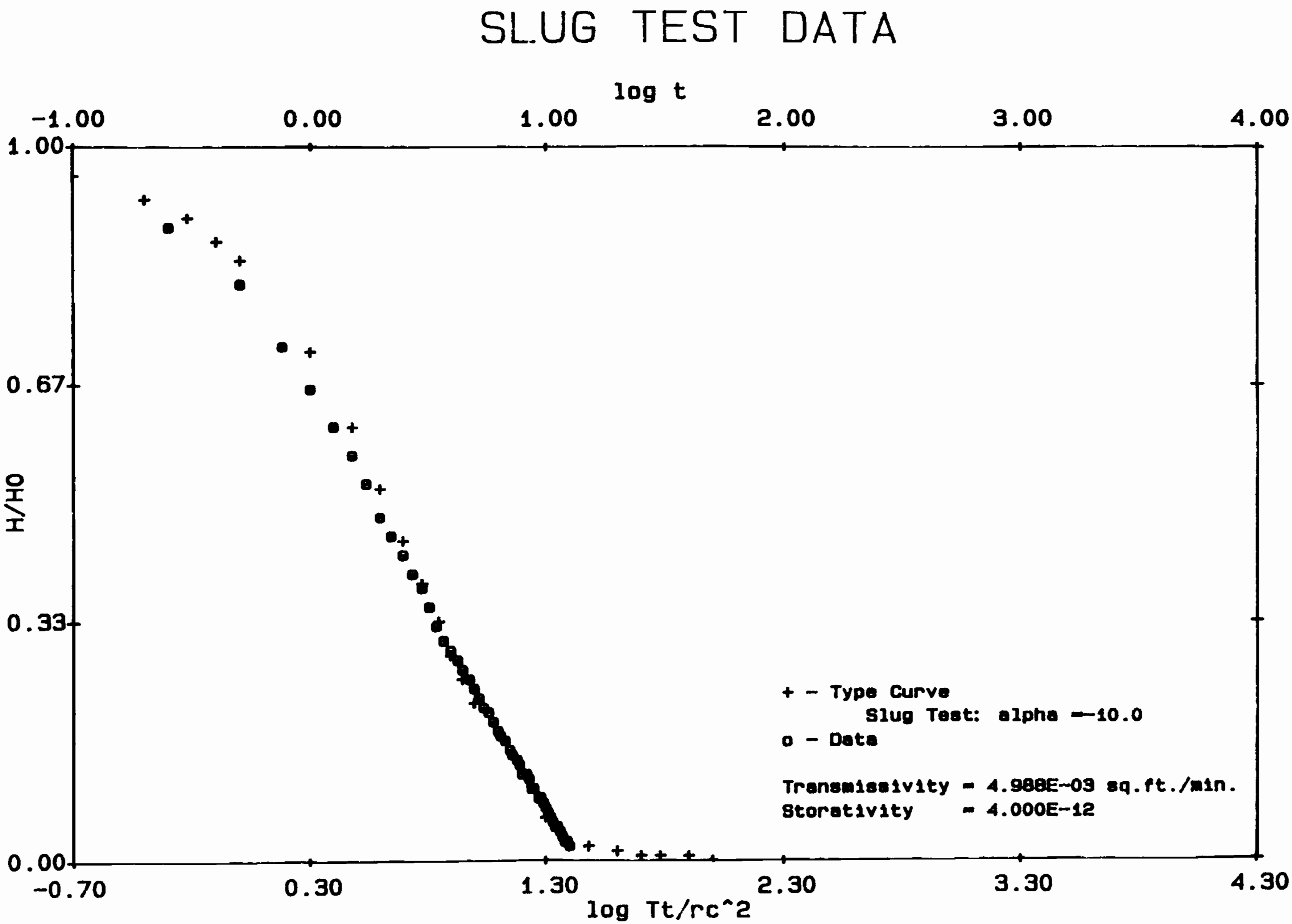


TEST # 6
150-175'

SLUG TEST DATA

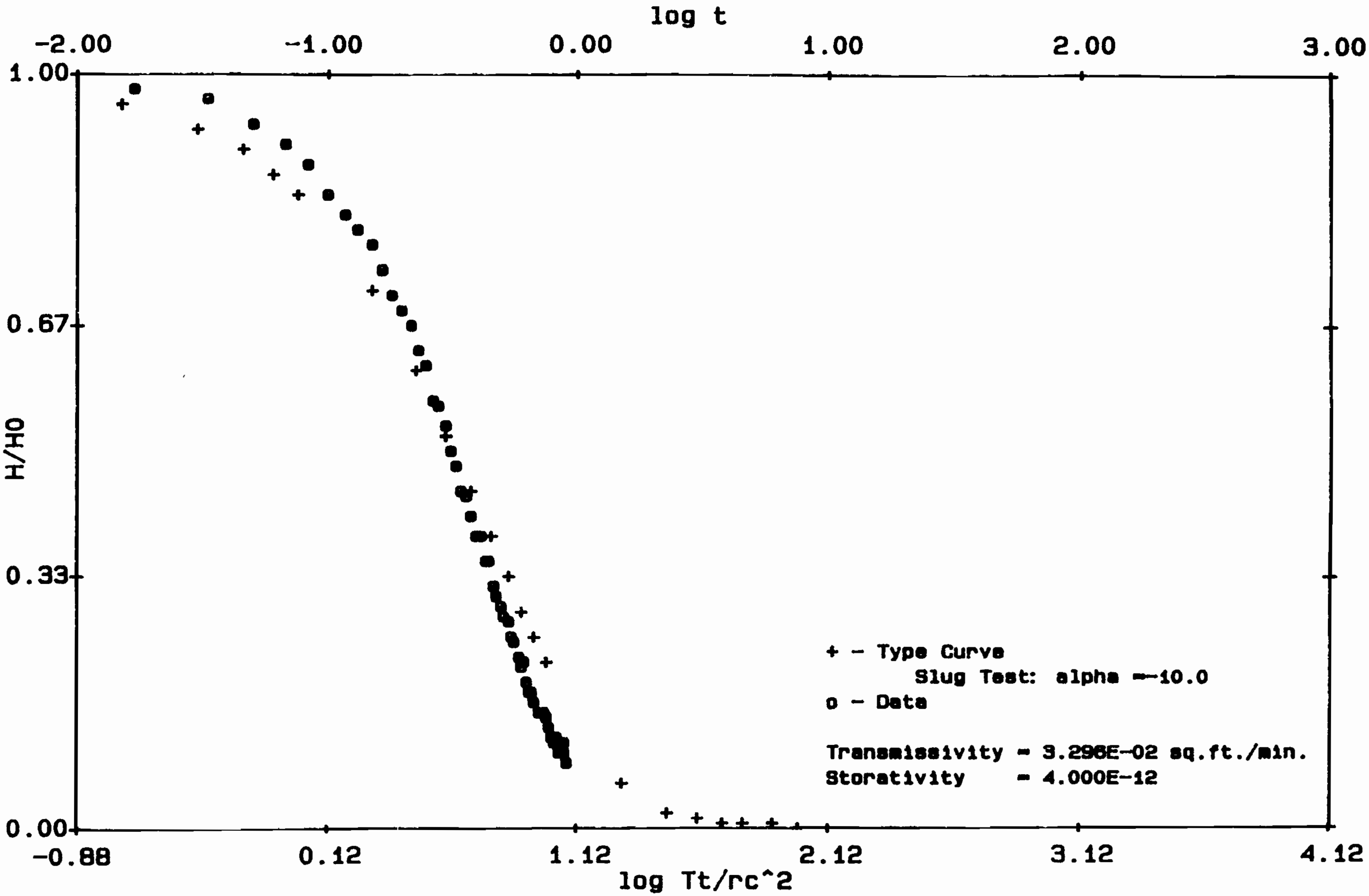


TEST # 7
200-225'



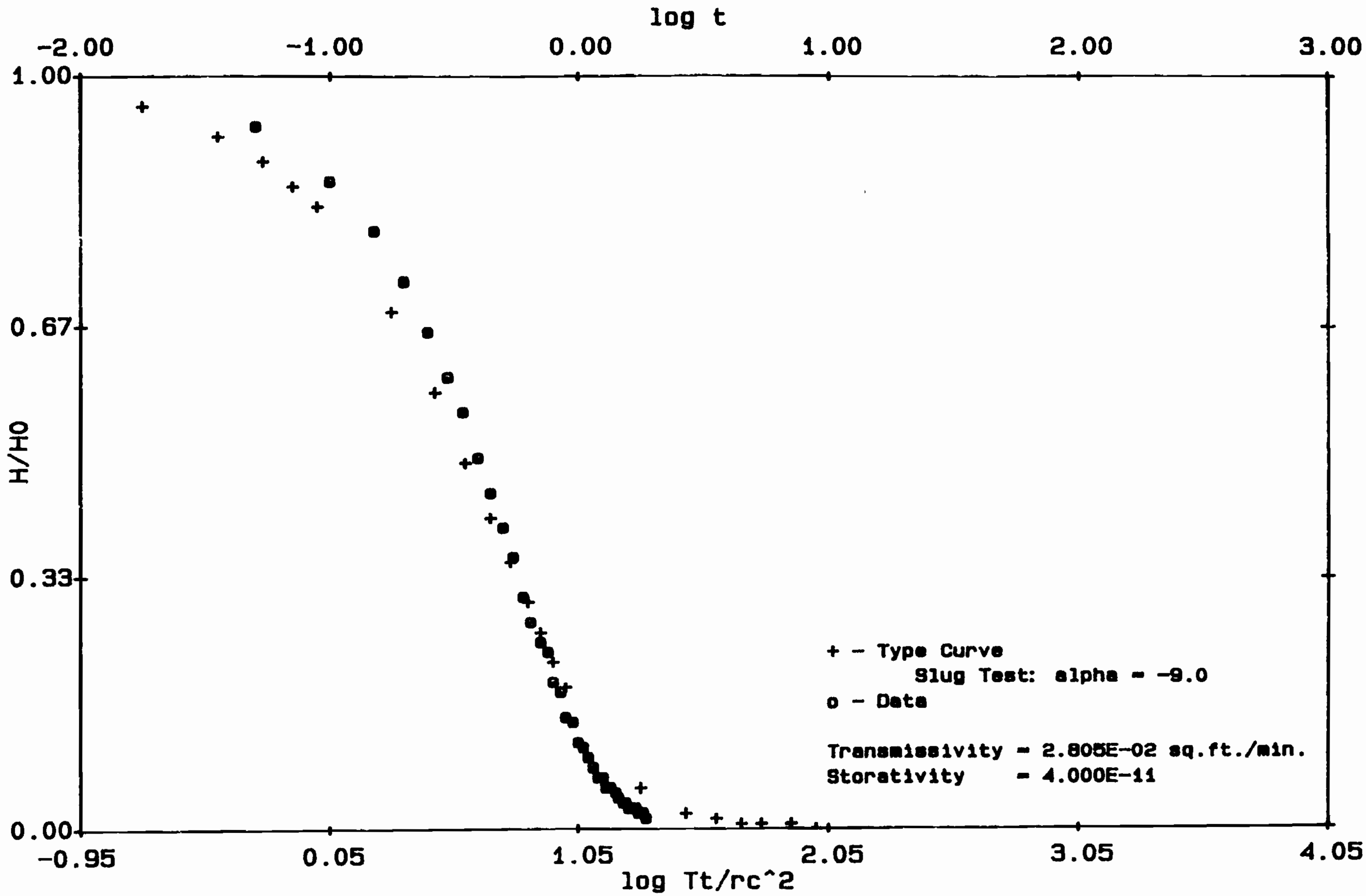
TEST # 8
250-275'

SLUG TEST DATA



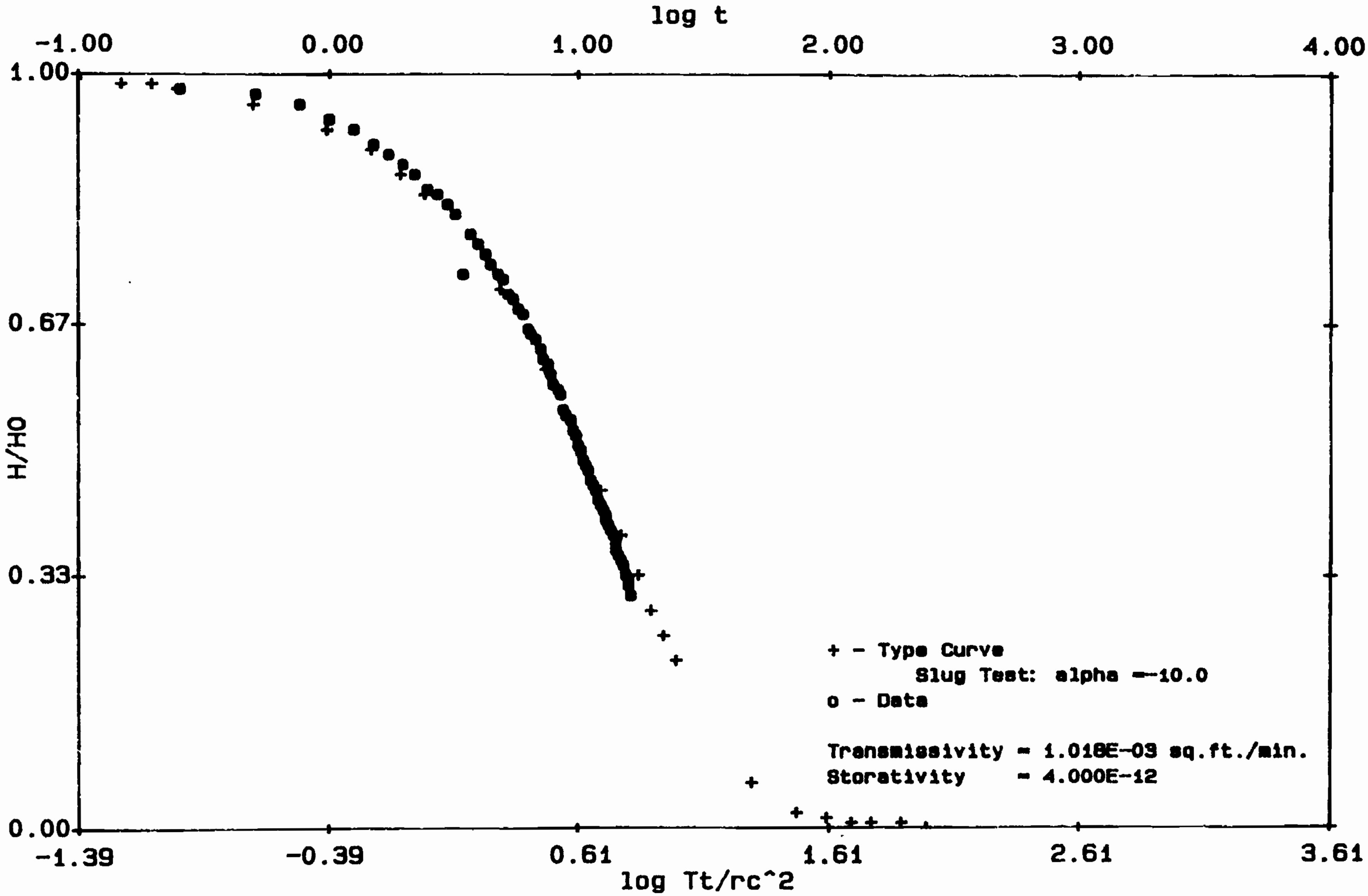
TEST #9
310-336'

SLUG TEST DATA



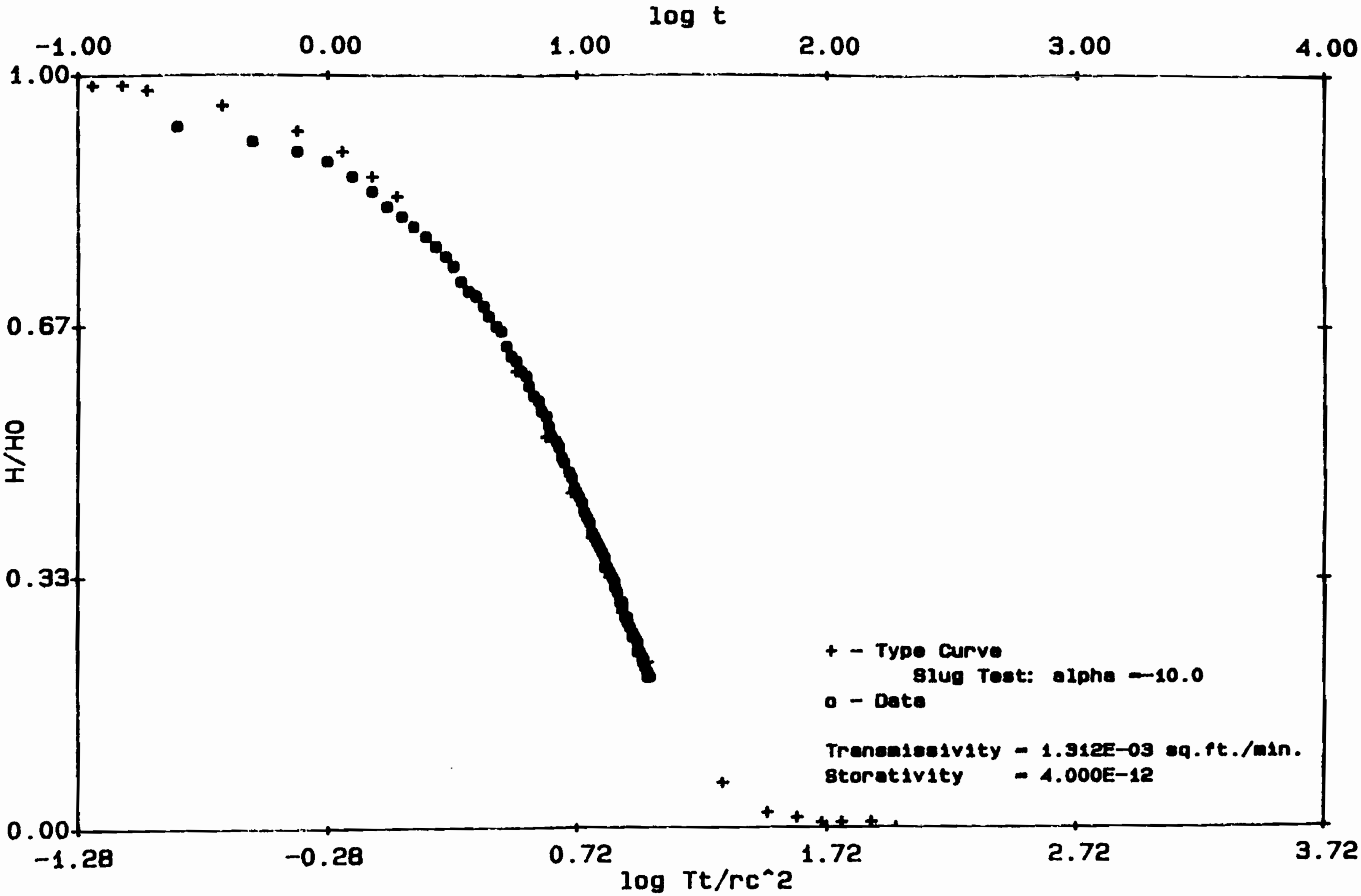
TEST # 10
340-365'

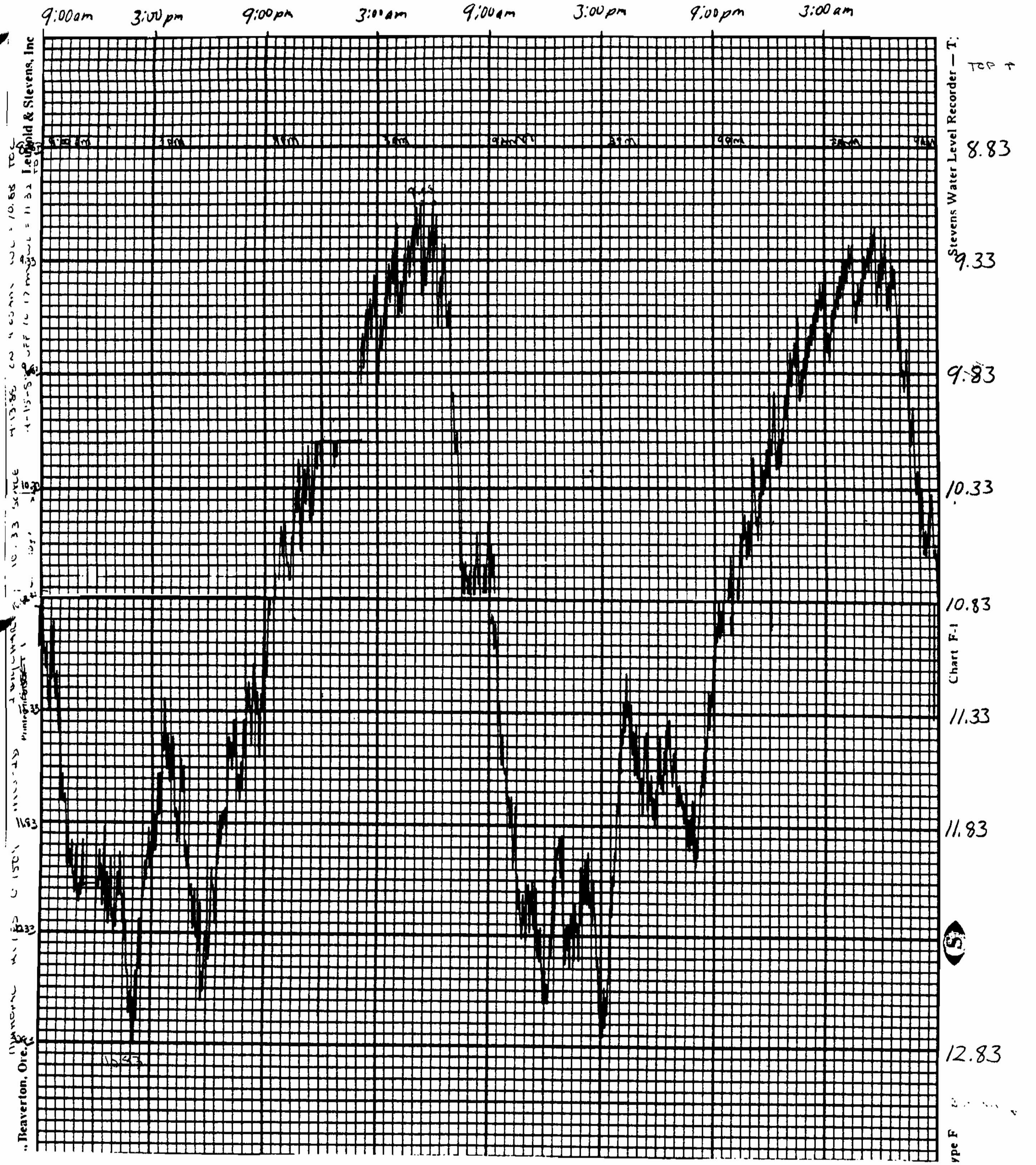
SLUG TEST DATA



TEST # 11
365-400'

SLUG TEST DATA

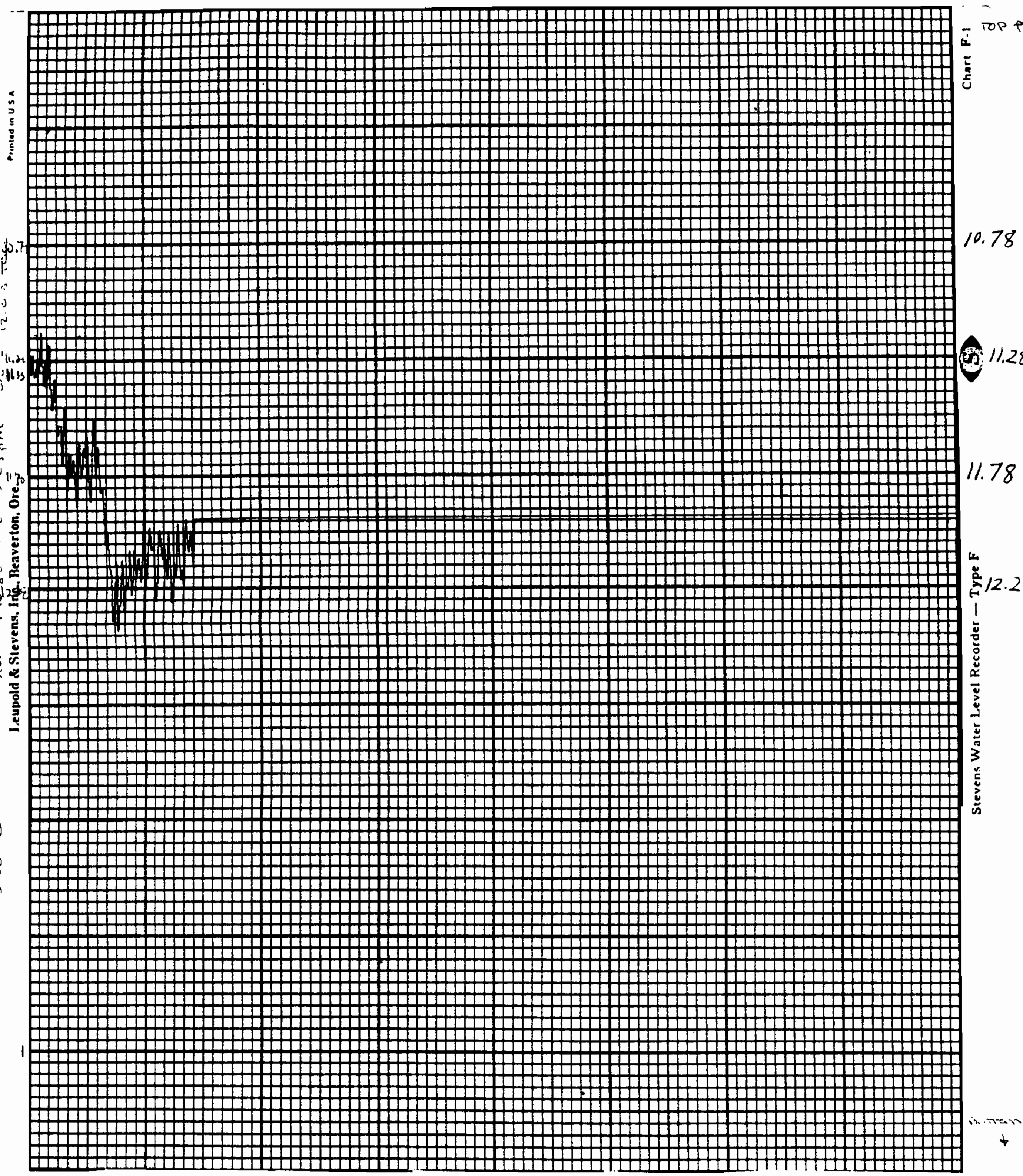




MAHOPAC RI/FS 07504 MW-2D SHEET 1 2 DAY CHART

SCALE 10:33 ON 4-13-88 9:00 AM W.L. = 10.88 below reference

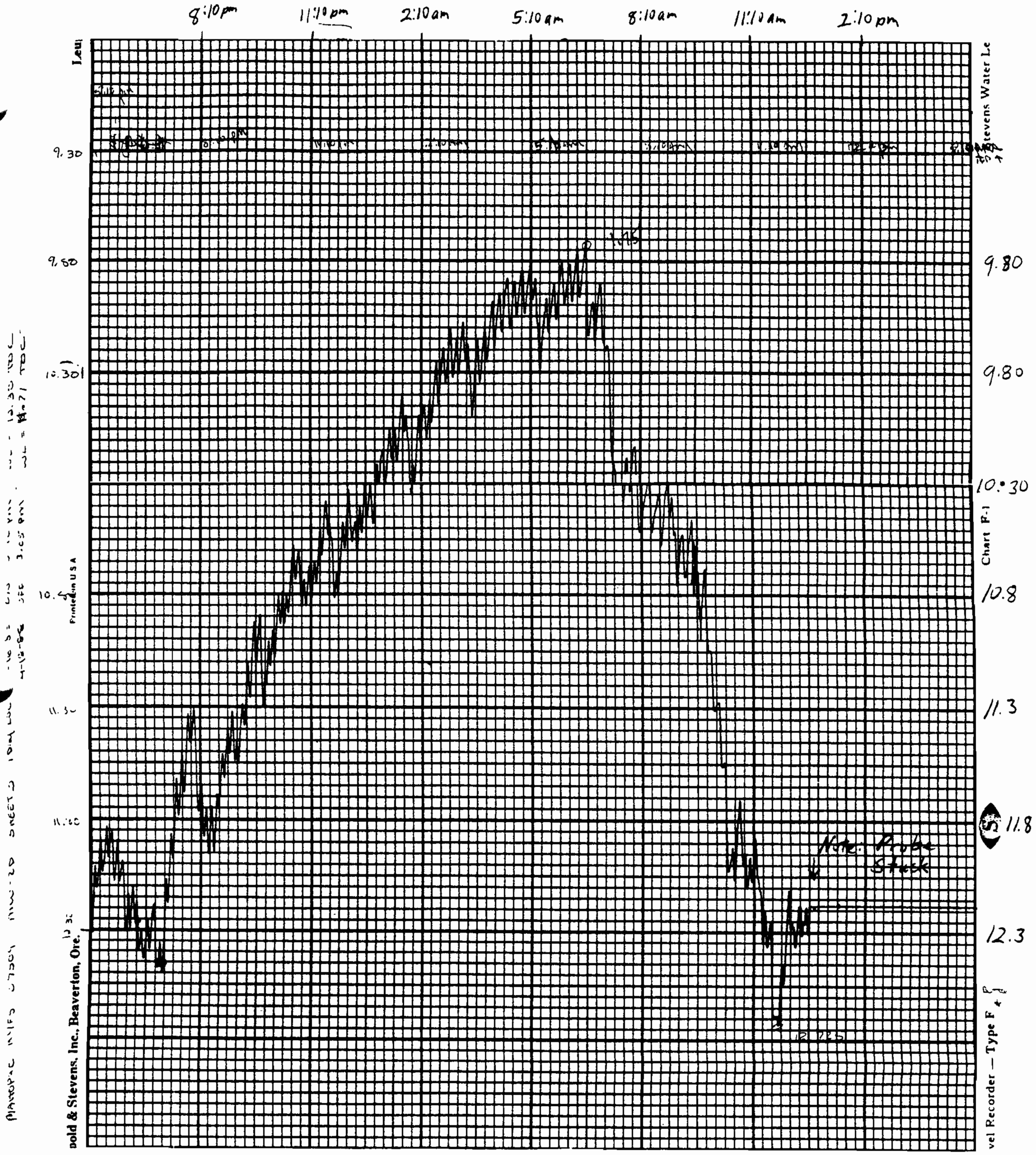
OFF 4-15-88 10:17 AM W.L. = 11.32 below reference



MAHOPAC RI/FS 07504 MW-2D SHEET 2 2 DAY CYCLE

SCALE 110:33 ON 4-15-88 10 35 A.M W.L. = 11.33 below referenc

OFF 4-16-88 5:05 PM W.L. = 12.03 below referenc



MAHOPAC RI/FS 07509 MW-2D SHEET 3 1 DAY LOG

ON 4-16-88 5:10PM W.L. = 12.30 below reference

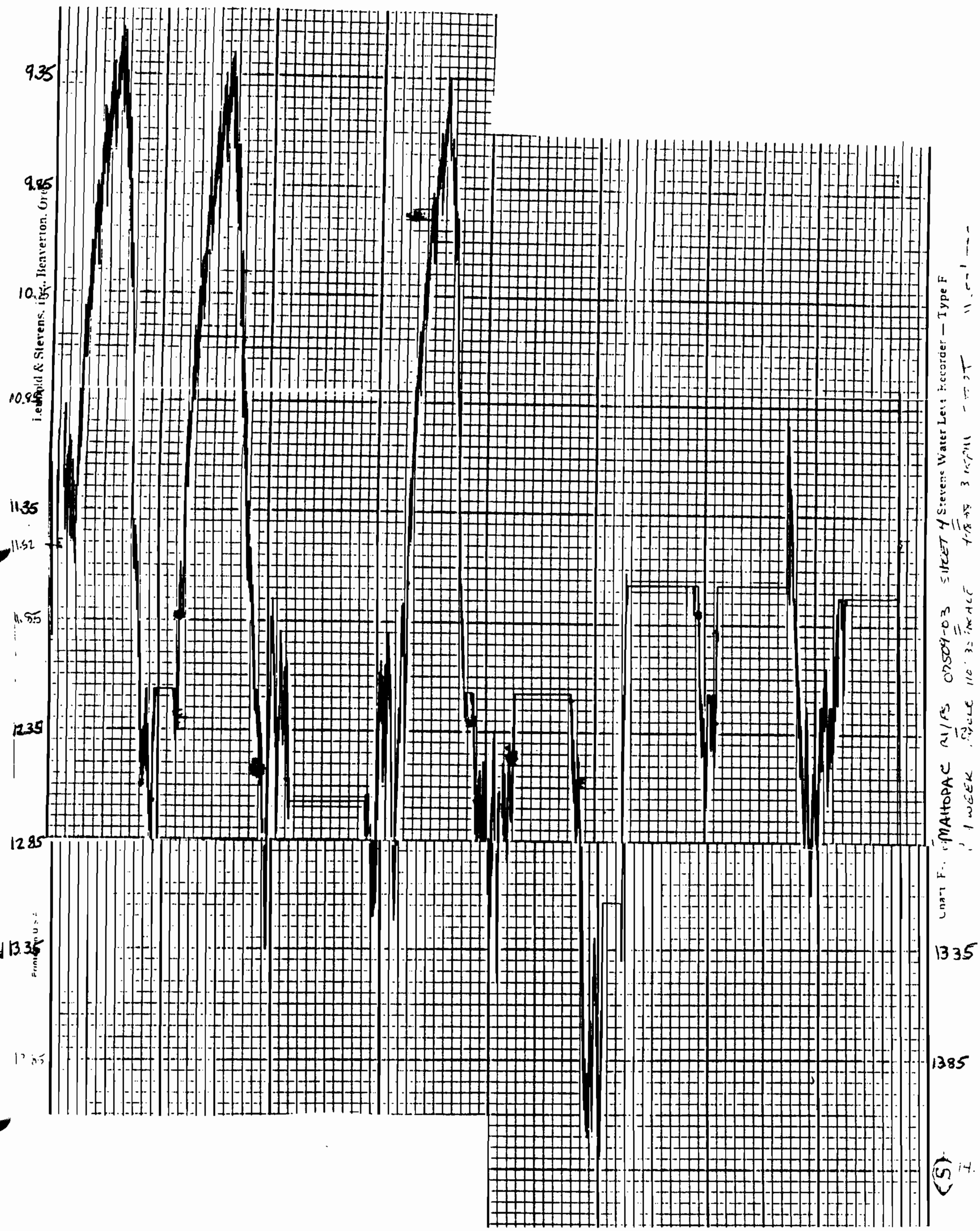
OFF 4-18-88 3:05PM W.L. = 11.71 below reference

MAHOPAC R1/FS 07509 07509 SHEET 4 1 WEEK CYCLE

SCALE 110:30 ON 4-18-88 3:15 PM W.L. = 11.52' TOC

OFF 4-25-88

W.L. = 11.70' TOC



By LEC Date 7-19-88 **WEHRAN ENGINEERING** Engineers & Scientists Job No. 02509.03
Chkd. by ____ Date ____ Sheet No. 1 of 1
Subject MAHOPAC RI/FS CONTINUOUS WATER LEVEL DATA

** APRIL 14, 1988 THURSDAY

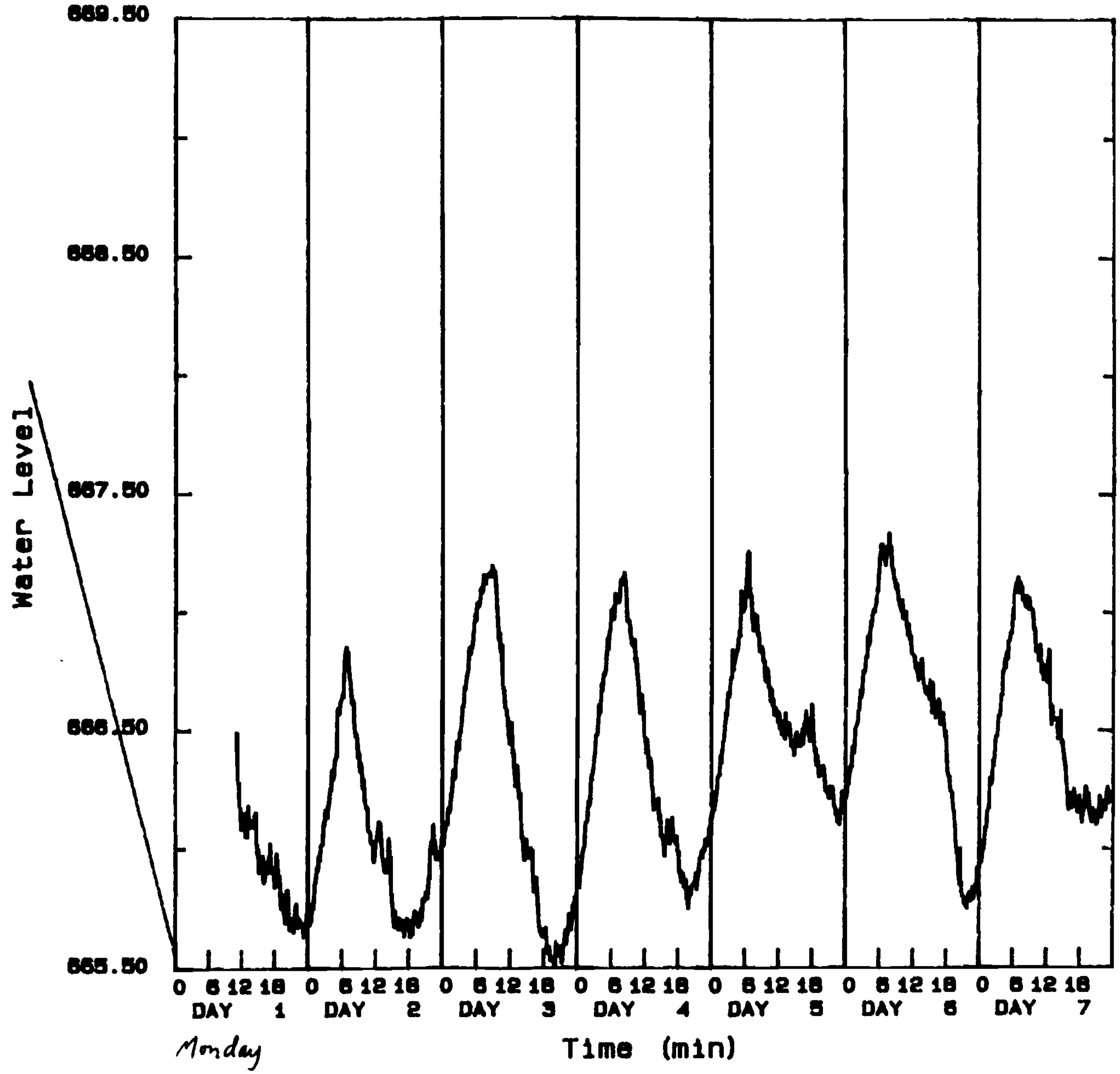
TIME	WATER LEVEL TOC	* ELEV MSL
12:00 AM	10.13	658.04
1:00 AM	9.98	658.19
2:00 AM	9.83	658.34
3:00	9.58	658.59
4:00	9.17	659.00
5:00	9.28	658.89
6:00	9.08	659.09
7:00	9.63	658.54
8:00	10.75	657.42
9:00	10.48	657.69
10:00	11.58	656.59
11:00	12.11	656.06
12:00 pm	12.51	655.66
1:00 pm	12.03	656.14
2:00	12.08	656.09
3:00	12.78	655.39
4:00	11.58	656.59
5:00	11.58	656.59
6:00	11.58	656.59
7:00	11.48	656.69
8:00	11.98	656.19
9:00	11.08	657.09
10:00	10.83	657.34
11:00	10.48	657.69
12:00 AM	10.13	658.04

* REFERENCE ELEVATION = 668.17 TOP OF 6" STEEL CASING

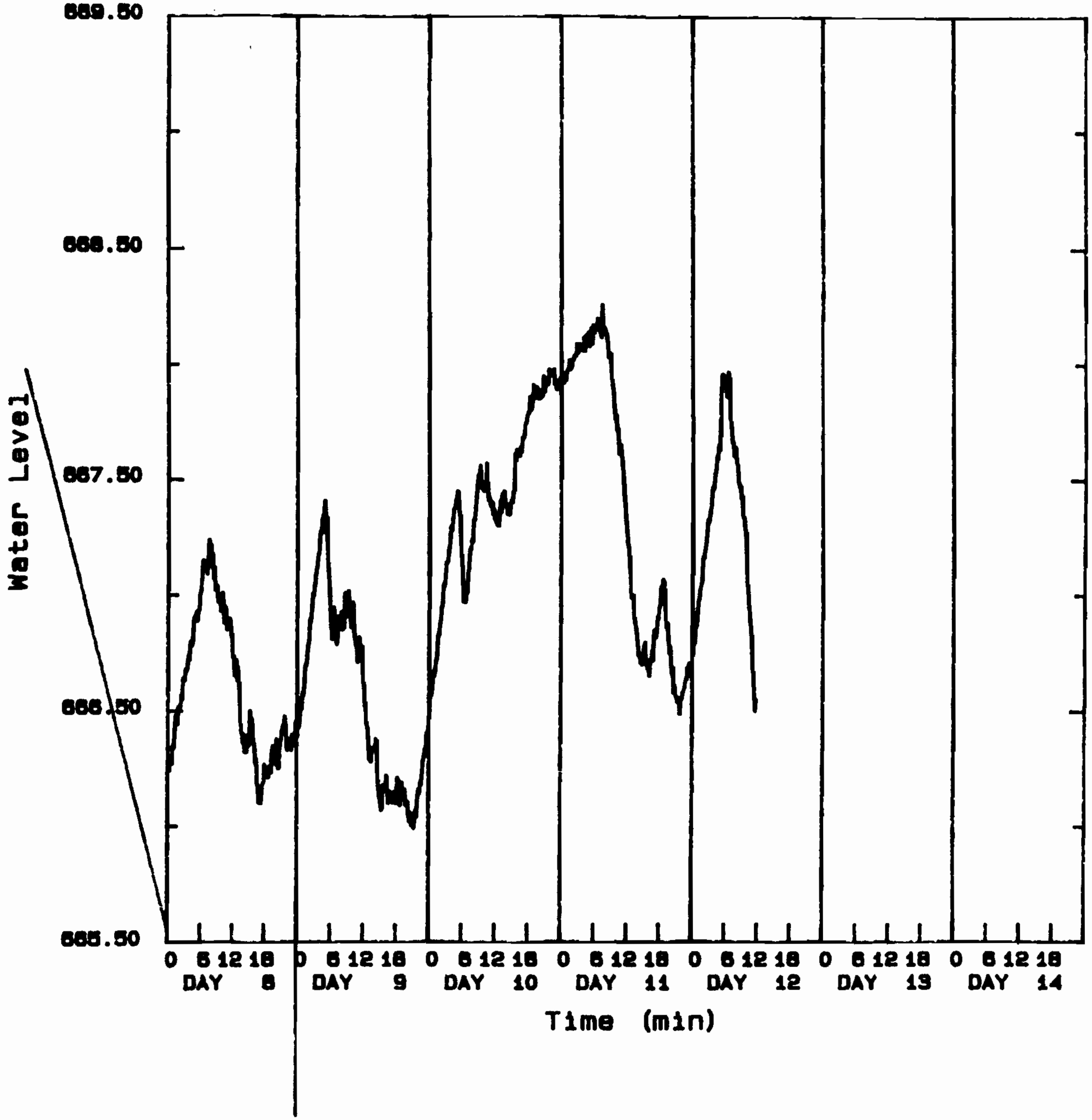
** 24 HR PERIOD TAKEN FROM 2 DAY CONTINUOUS RECORDING PERIOD: 4-13 TO 4-15-88

SHEET 1

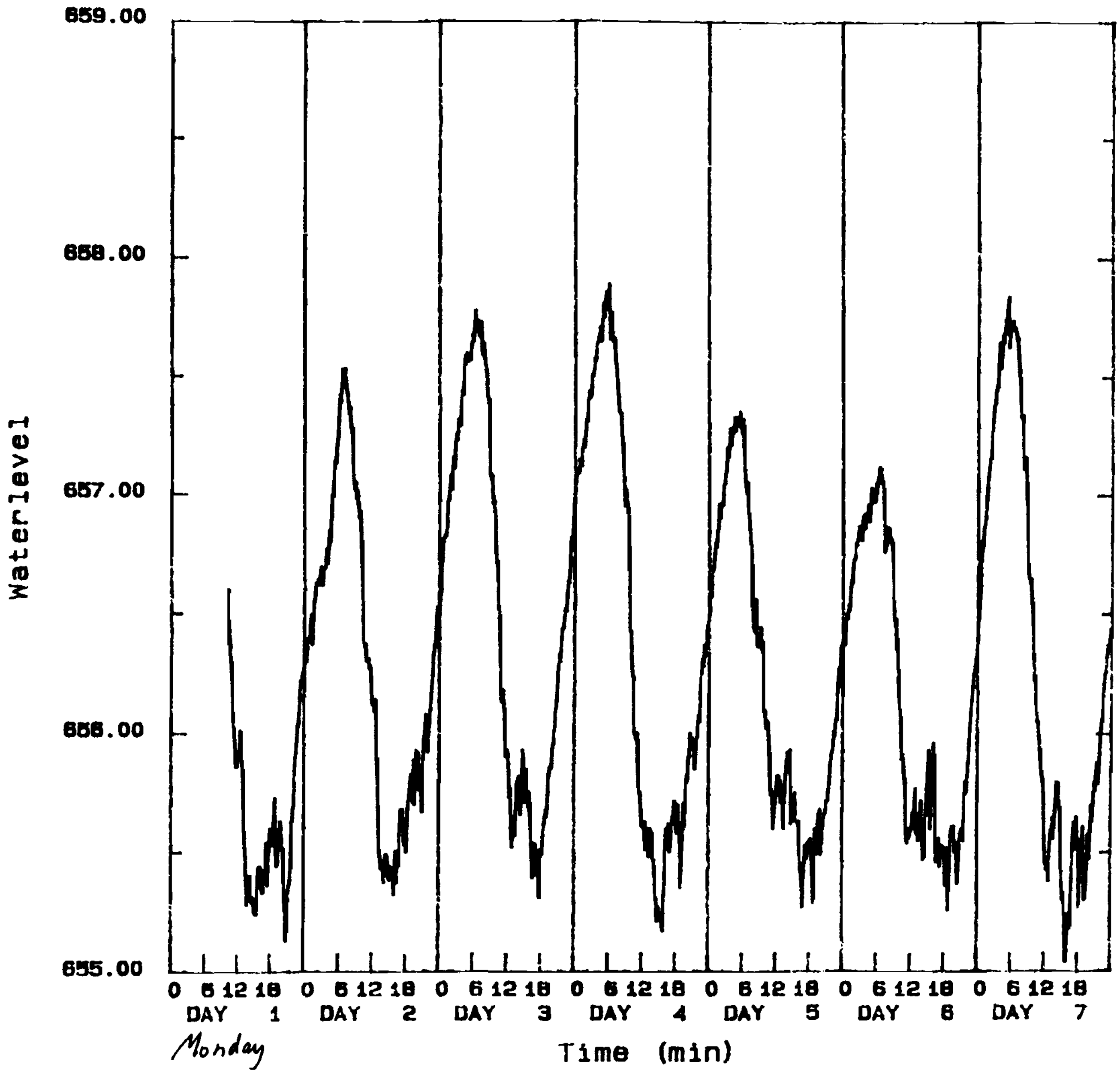
Mahopac RI/FS MW-1I Water Level Elevations

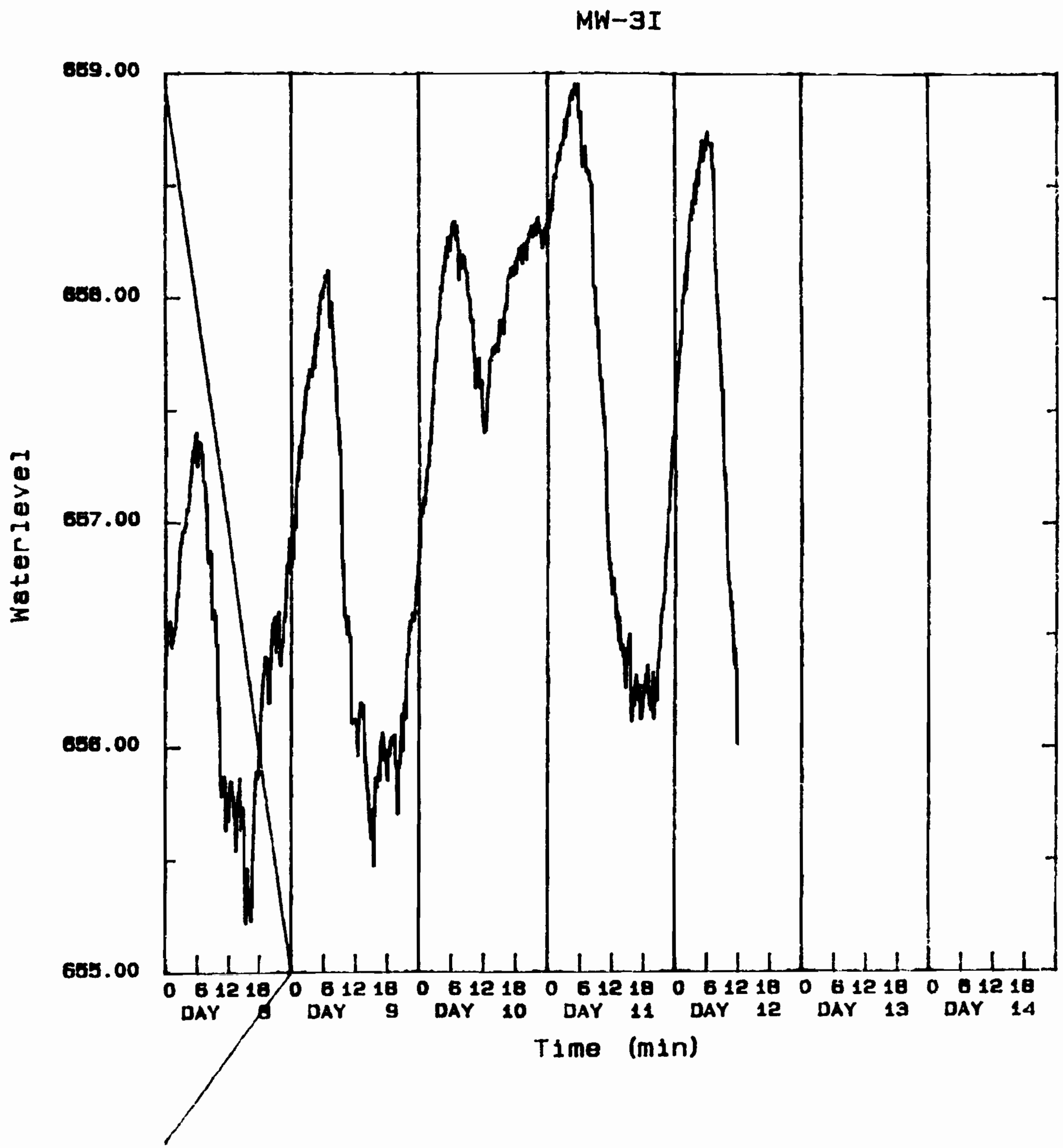


Mahopac RI/FS MW-1I Water Level Elevations

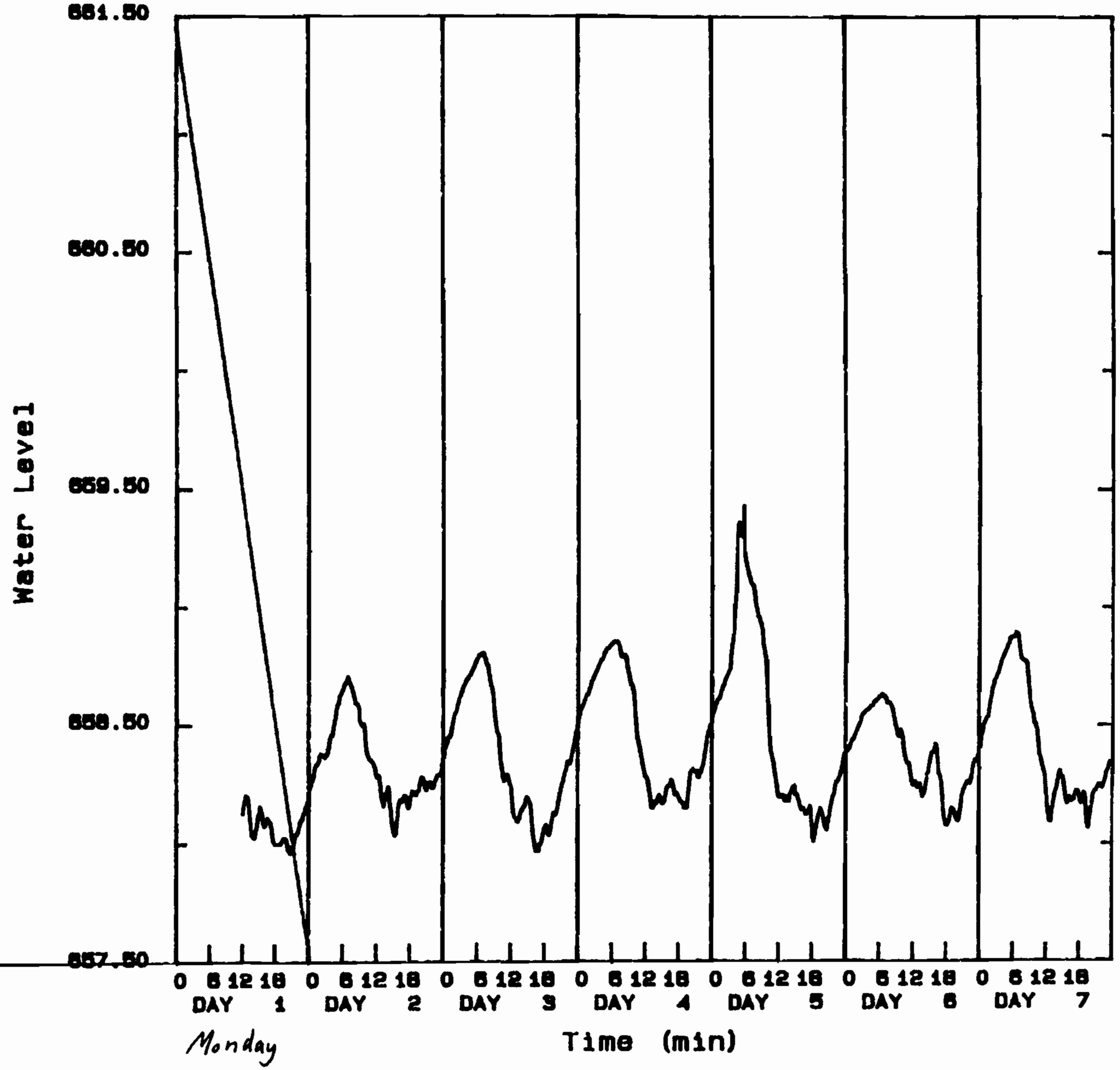


MW-3I

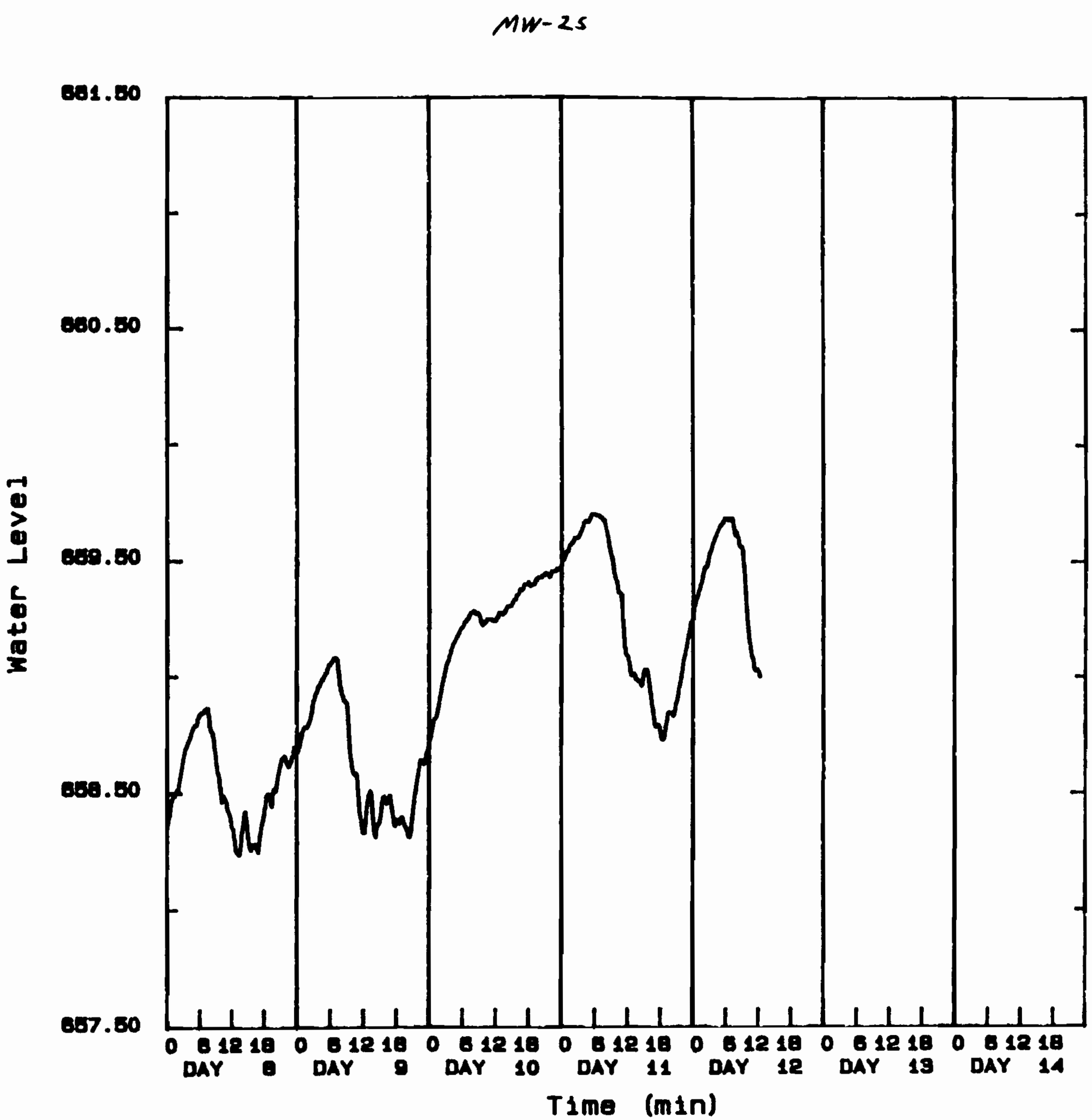

659.00
658.00
657.00
656.00
655.00
Waterlevel
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18
DAY 1 DAY 2 DAY 3 DAY 4 DAY 5 DAY 6 DAY 7
Monday
Time (min)

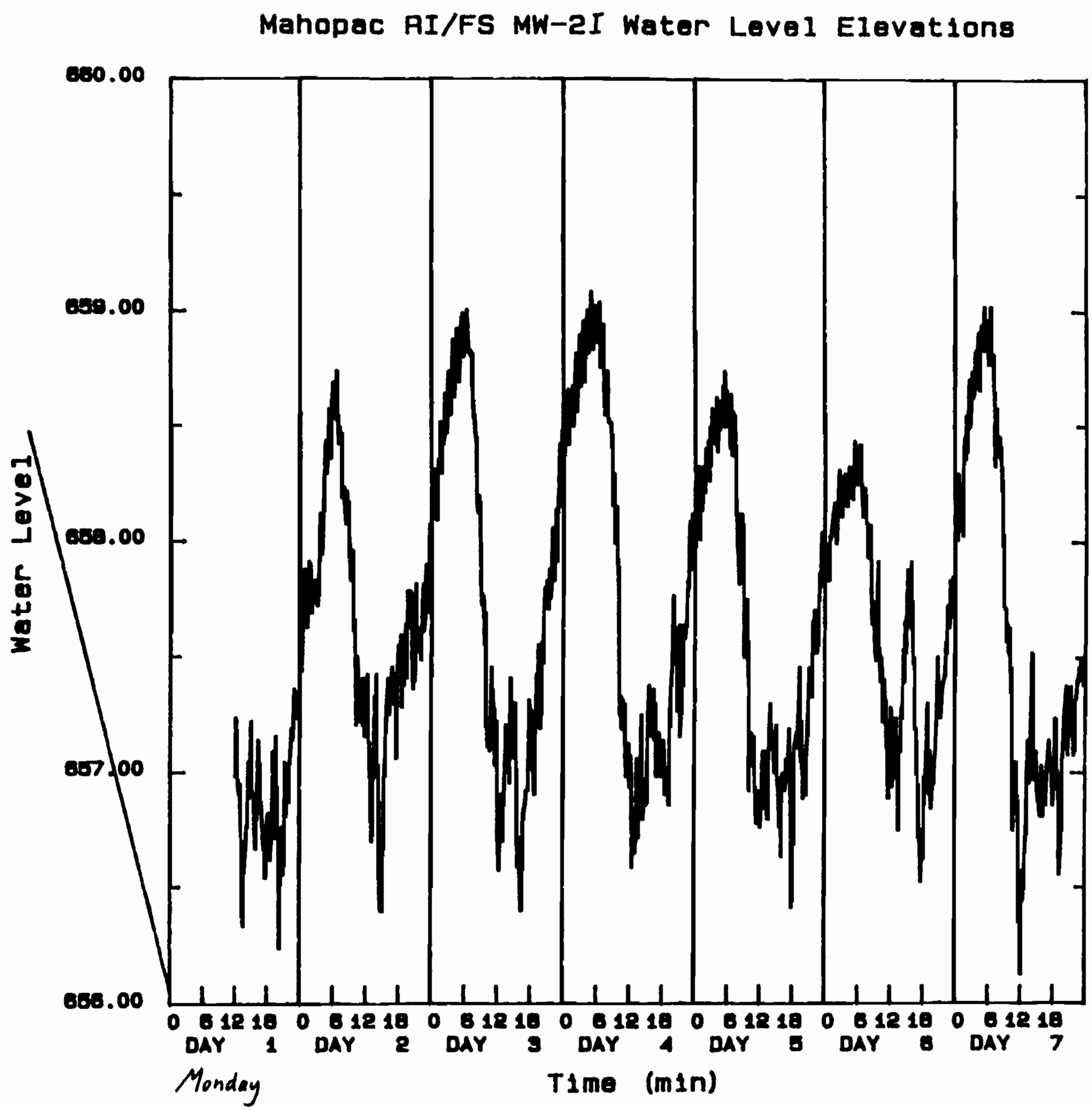

MW-3I
659.00
658.00
657.00
656.00
655.00
Waterlevel
0 6 12 18
DAY 8
0 6 12 18
DAY 9
0 6 12 18
DAY 10
0 6 12 18
DAY 11
0 6 12 18
DAY 12
0 6 12 18
DAY 13
0 6 12 18
DAY 14
Time (min)

MW-2S

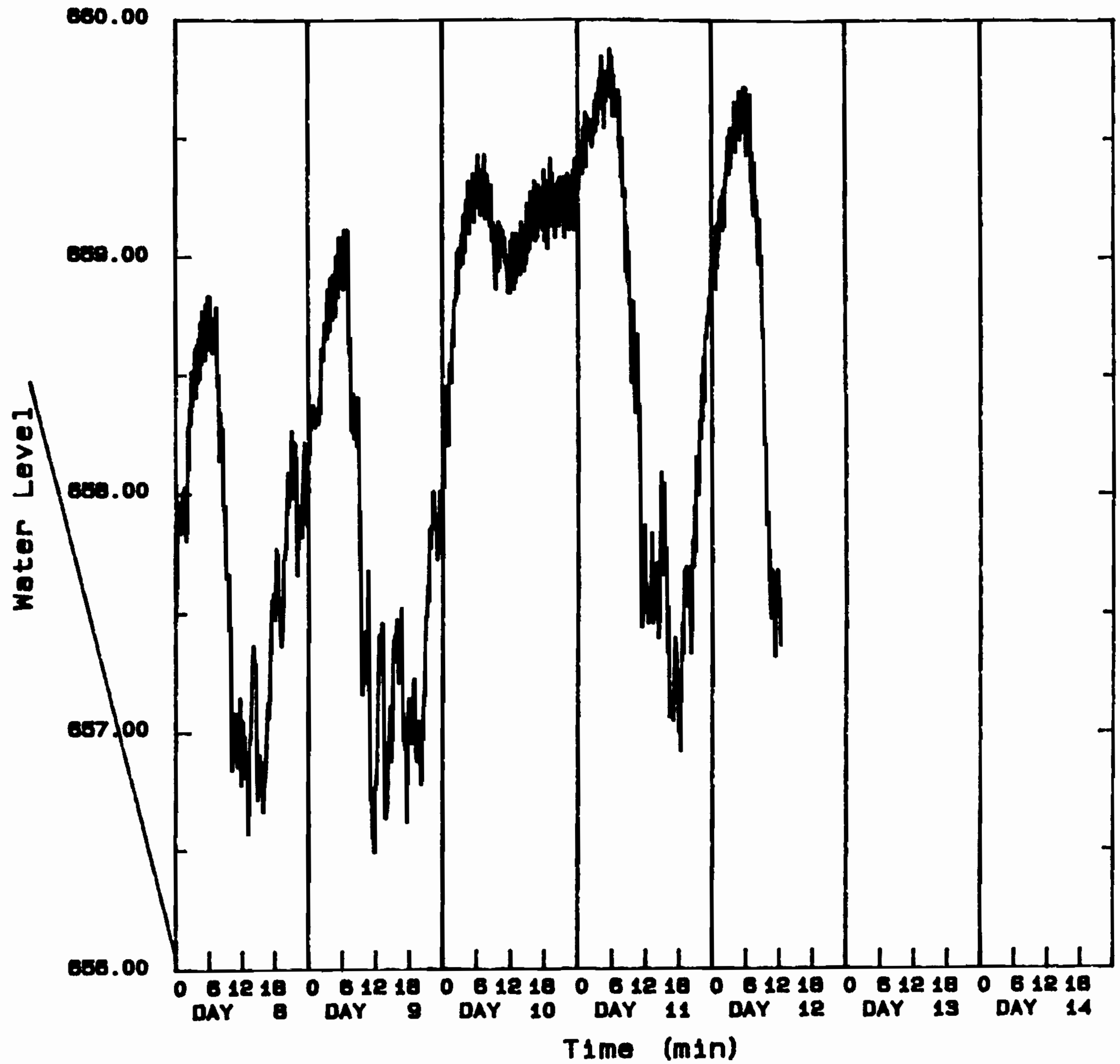


661.50
660.50
659.50
658.50
657.50
Water Level
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18
DAY 1
DAY 2
DAY 3
DAY 4
DAY 5
DAY 6
DAY 7
Monday
Time (min)

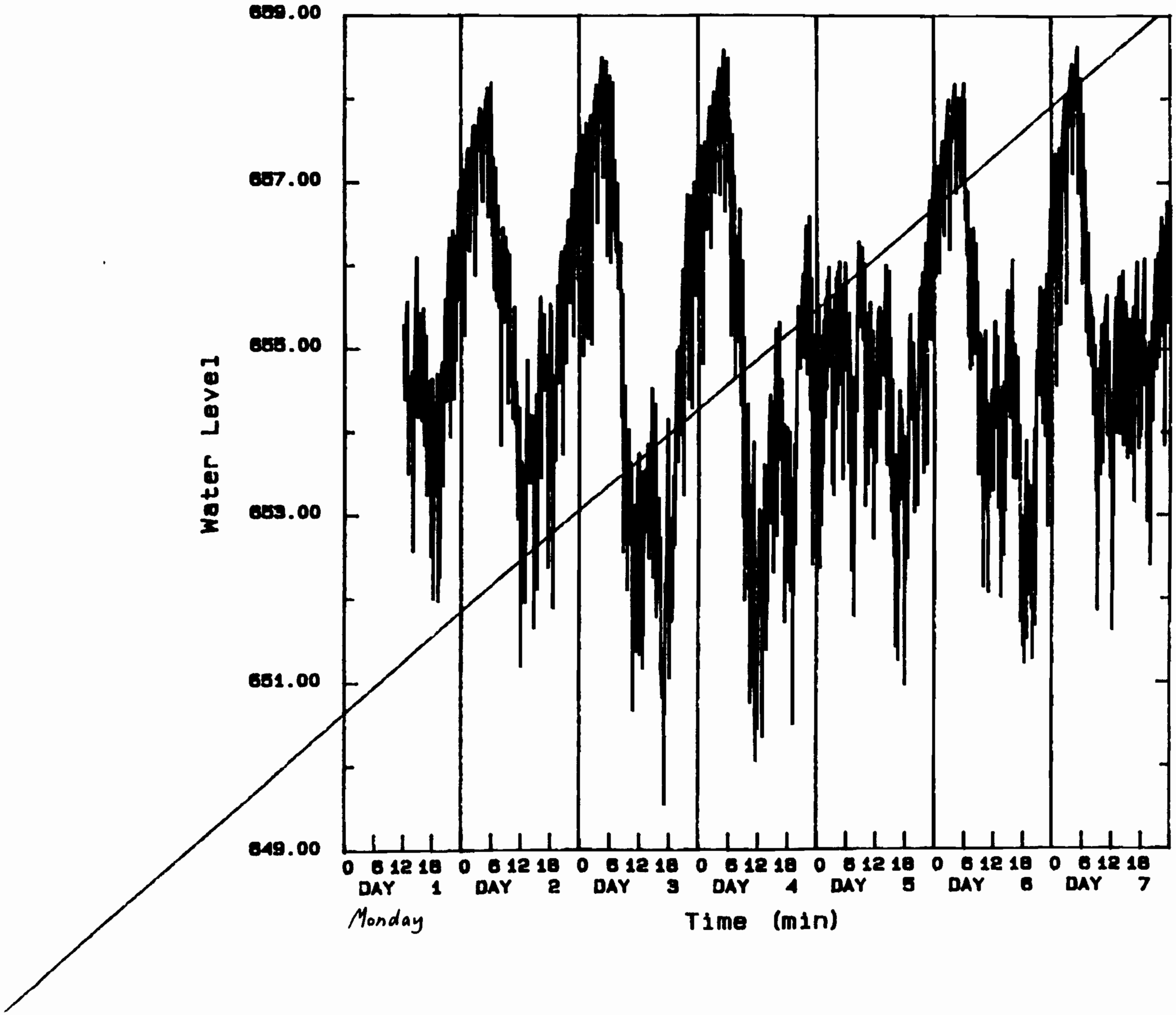

MW-2S
661.50
660.50
659.50
658.50
657.50
Water Level
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18
DAY 8
DAY 9
DAY 10
DAY 11
DAY 12
DAY 13
DAY 14
Time (min)


Mahopac RI/FS MW-2I Water Level Elevations
660.00
659.00
658.00
657.00
656.00
Water Level
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18
DAY 1
DAY 2
DAY 3
DAY 4
DAY 5
DAY 6
DAY 7
Monday
Time (min)

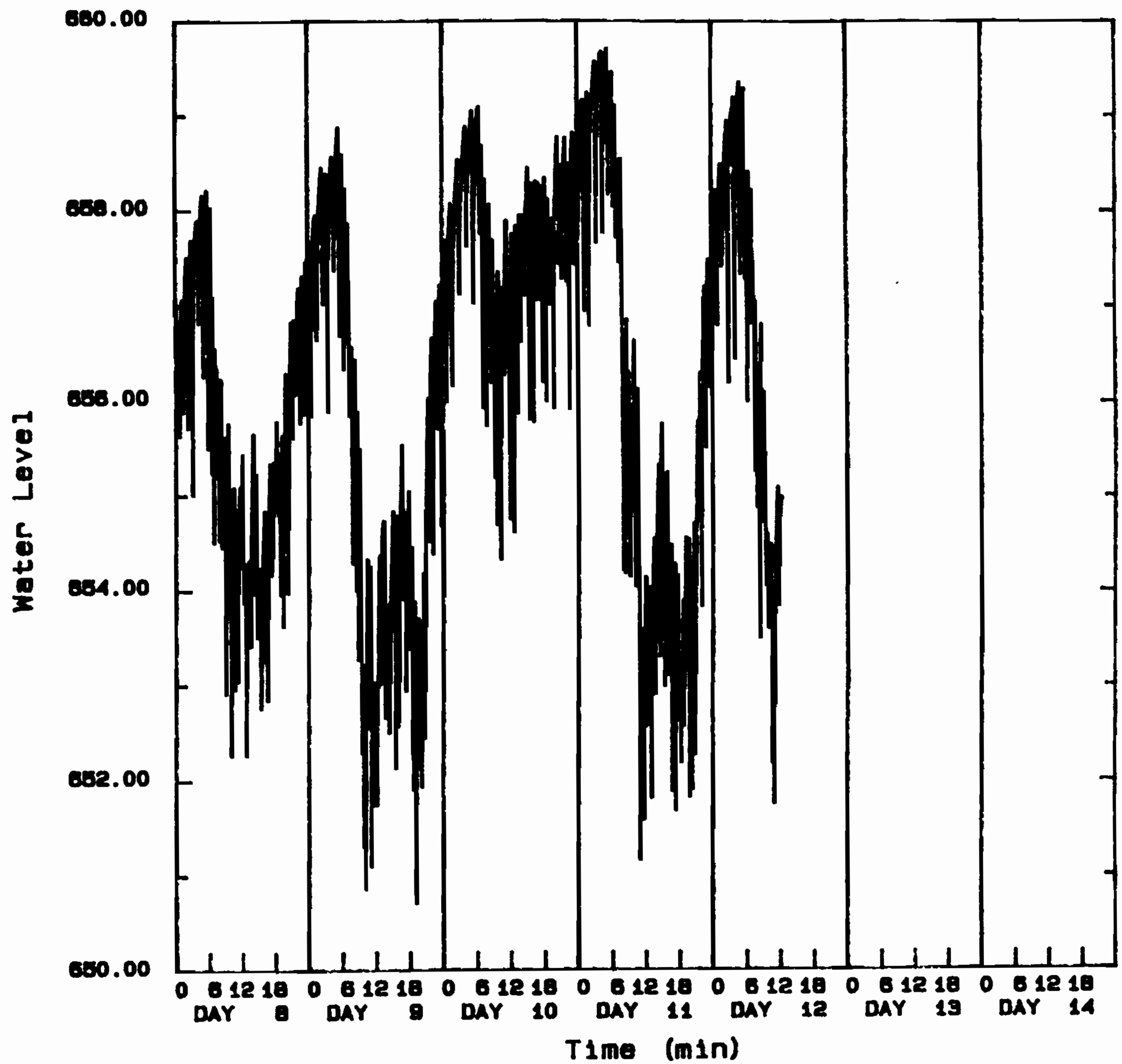
Mahopac RI/FS MW-2I Water Level Elevations



Mahopac RI/FS MW-2D Water Level Elevations



Mahopac RI/FS MW-2D Water Level Elevations



MAHOPAC BUSINESS DISTRICT RI/FS
VERTICAL HYDRAULIC GRADIENTS

Couplet	Hydraulic Gradient	Direction
MW-1S and MW-1I	0.0227	Downward
MW-2S and MW-2I	0.0230	Downward
MW-2S and MW-2D	0.0099	Downward
MW-2I and MW-2D	0.0086	Downward
MW-6S and MW-6I	0.0133	Downward

By LFC Date 12-1-88 WEHRAN ENGINEERING Engineers & Scientists Job No. 07509
Chkd. by ______ Date ______ Sheet No. 1 of 3
Subject CALCULATIONS OF VERTICAL GRADIENT

MW-1 COUPLET (MW-1S & MW-1I)

$$I_v = \frac{\Delta h_v}{\Delta X_v} = \frac{h_S - h_I}{X_S - X_I}$$

					TIME
①	$I_v = \frac{666.13 - 664.13}{654.92 - 553.34}$	$= \frac{2.00}{101.58}$	$= 0.0197 \downarrow$		6:35 AM
②	$I_v = \frac{666.12 - 664.01}{101.58}$	$= \frac{2.11}{101.58}$	$= 0.0208 \downarrow$		8:45 AM
③	$I_v = \frac{666.09 - 663.96}{101.58}$	$= \frac{2.13}{101.58}$	$= 0.0210 \downarrow$		10:25 AM
④	$I_v = \frac{665.99 - 663.58}{101.58}$	$= \frac{2.41}{101.58}$	$= 0.0208 \downarrow$		11:25 AM
⑤	$I_v = \frac{666.12 - 663.85}{101.58}$	$= \frac{2.27}{101.58}$	$= 0.0224 \downarrow$		1:30 pm
⑥	$I_v = \frac{666.20 - 663.65}{101.58}$	$= \frac{2.55}{101.58}$	$= 0.0251 \downarrow$		3:15 pm
⑦	$I_v = \frac{666.53 - 663.58}{101.58}$	$= \frac{2.95}{101.58}$	$= 0.0290 \downarrow$		5:10 pm

MW-2 COUPLET (MW-2S & MW-2I)

				TIME
①	$I_v = \frac{656.97 - 657.04}{650.75 - 611.20}$	$= \frac{-0.07}{39.55}$	$= 0.0018 \uparrow$	6:05 AM
②	$I_v = \frac{656.91 - 656.58}{39.55}$	$= \frac{0.33}{39.55}$	$= 0.0083 \downarrow$	8:25 AM
③	$I_v = \frac{656.79 - 656.15}{39.55}$	$= \frac{0.64}{39.55}$	$= 0.0162 \downarrow$	9:50 AM
④	$I_v = \frac{656.69 - 655.50}{39.55}$	$= \frac{1.19}{39.55}$	$= 0.0301 \downarrow$	10:50 AM
⑤	$I_v = \frac{656.62 - 655.73}{39.55}$	$= \frac{0.89}{39.55}$	$= 0.0225 \downarrow$	12:50 pm
⑥	$I_v = \frac{656.55 - 655.30}{39.55}$	$= \frac{1.25}{39.55}$	$= 0.0316 \downarrow$	2:35 pm
⑦	$I_v = \frac{656.53 - 655.37}{39.55}$	$= \frac{1.16}{39.55}$	$= 0.0293 \downarrow$	4:00 pm

MW-2 COUPLET (MW-2I & MW-2D)

① $I_v = \frac{657.04 - 655.13}{611.20 - 342.6} = \frac{1.91}{268.60} = 0.0071 \downarrow$ 6:10 AM

② $I_v = \frac{656.58 - 654.35}{268.60} = \frac{2.23}{268.60} = 0.0083 \downarrow$ 8:25 AM

③ $I_v = \frac{656.15 - 654.25}{268.60} = \frac{1.9}{268.60} = 0.0071 \downarrow$ 9:50 AM

④ $I_v = \frac{655.50 - 652.30}{268.60} = \frac{3.20}{268.60} = 0.0119 \downarrow$ 10:55 AM

⑤ $I_v = \frac{655.73 - 653.07}{268.60} = \frac{2.66}{268.60} = 0.0099 \downarrow$ 12:55 pm

⑥ $I_v = \frac{655.30 - 652.78}{268.60} = \frac{2.52}{268.60} = 0.0094 \downarrow$ 2:40 pm

⑦ $I_v = \frac{655.37 - 653.73}{268.60} = \frac{1.64}{268.60} = 0.0061 \downarrow$ 4:00 pm

MW-6 COUPLET (MW-6S & MW-6I)

① $I_v = \frac{661.26 - 660.41}{659.43 - 629.50} = \frac{0.85}{29.93} = 0.0284 \downarrow$ 7:00 AM

② $I_v = \frac{659.91 - 659.80}{29.93} = \frac{0.11}{29.93} = 0.0037 \downarrow$ 8:50 AM

③ $I_v = \frac{659.64 - 659.14}{29.93} = \frac{0.50}{29.93} = 0.0167 \downarrow$ 10:05 AM

④ $I_v = \frac{659.39 - 658.63}{29.93} = \frac{0.76}{29.93} = 0.0254 \downarrow$ 11:00 AM

⑤ $I_v = \frac{659.47 - 659.32}{29.93} = \frac{0.15}{29.93} = 0.0050 \downarrow$ 1:05 pm

⑥ $I_v = \frac{659.67 - 659.35}{29.93} = \frac{0.32}{29.93} = 0.0107 \downarrow$ 2:50 pm

⑦ $I_v = \frac{659.73 - 659.63}{29.93} = \frac{.10}{29.93} = 0.0033 \downarrow$ 4:30 PM

By LFC Date 12-1 WEHRAN ENGINEERING Engineers & Scientists Job No. 07509
Chkd. by ______ Date ______ Sheet No. 3 of 3
Subject CALCULATIONS OF VERTICAL GRADIENT

MW-2 COUPLET (MW-2S & MW-2D)

$$I_v = \frac{\Delta h_v}{\Delta X_v} = \frac{h_s - h_I}{X_s - X_I}$$

TIME

(1) $I_v = \frac{656.97 - 655.13}{650.75 - 342.6} = \frac{1.84}{308.15} = 0.00597$ 6:05 AM

(2) $I_v = \frac{656.91 - 654.35}{308.15} = \frac{2.56}{308.15} = 0.00831$ 8:25 AM

(3) $I_v = \frac{656.79 - 654.25}{308.15} = \frac{2.54}{308.15} = 0.00824$ 9:50 AM

(4) $I_v = \frac{656.69 - 652.30}{308.15} = \frac{4.39}{308.15} = 0.01425$ 10:55 AM

(5) $I_v = \frac{656.62 - 653.07}{308.15} = \frac{3.55}{308.15} = 0.01152$ 12:50 PM

(6) $I_v = \frac{656.55 - 652.78}{308.15} = \frac{3.77}{308.15} = 0.01223$ 3:10 PM

(7) $I_v = \frac{656.53 - 653.73}{308.15} = \frac{2.80}{308.15} = 0.00909$ 4:00 PM

By LFC Date 11-2-88 WEHRAN ENGINEERING Engineers & Scientists Job No. 07509.04
Chkd. by ______ Date ______ Sheet No. 1 of 3
Subject WATER LEVEL ELEVATION DATA FOR PLOTS

	REFERENCE ELEVATION (TOC)	WATER LEVEL	ELEVATION	TIME
MW-1S	679.10	12.97	666.13	6:34 AM
		12.98	666.12	8:45 am
		13.01	666.09	10:24 am
		13.11	665.99	11:24 am
		12.98	666.12	1:30 pm
		12.90	666.20	3:13 pm
		12.57	666.53	5:07 pm
	(BRASS)			
MW-2S	665.79	8.82	656.97	6:05 AM
		8.88	656.91	8:23 AM
		9.00	656.79	9:47 AM
		9.10	656.69	10:51 AM
		9.17	656.62	12:51 PM
		9.24	656.55	2:35 PM
		9.26	656.53	3:59 PM
	(BRASS)			
MW-3S	660.38	1.75	658.63	6:41 AM
		1.76	658.62	8:38 AM
		1.78	658.60	10:17 AM
		1.77	658.61	11:18 AM
		1.77	658.61	1:25 PM
		1.90	658.48	3:07 PM
		1.64	658.74	4:58 PM
	(BRASS)			
MW-4S	673.31	14.16	659.15	6:48 AM
		14.15	659.16	8:32 AM
		14.14	659.17	10:14 AM
		14.16	659.15	11:12 AM
		14.13	659.18	1:16 PM
		14.15	659.16	3:02 PM
		14.11	659.20	4:48 AM
	(BRASS)			
MW-6S	666.06	4.80	661.26	6:20 AM
		6.15	659.91	8:51 AM
		6.42	659.64	10:07 AM
		6.67	659.39	10:01 AM
		6.59	659.47	1:05 PM
		6.39	659.67	2:51 PM
		6.33	659.73	4:27 PM

By LFC Date 11-2-88 **WE** WEHRAN ENGINEERING Engineers & Scientists Job No. 07509.04
Chkd. by ____ Date ____ Sheet No. 2 of 3
Subject WATER LEVEL ELEVATION DATA FOR PLOTS

	REFERENCE ELEVATION (TOC)	WATER LEVEL	ELEVATION	TIME
MW-1I	679.43	15.30	664.13	6:35 AM
		15.42	664.01	8:46 AM
		15.47	663.96	10:22 AM
		15.55	663.88	11:25 AM
		15.58	663.85	1:32 PM
		15.78	663.65	3:15 PM
		15.85	663.58	5:10 PM
	(6" STEEL)			
MW-2I	665.86	8.82	657.04	6:07 AM
		9.28	656.58	8:26 AM
		9.71	656.15	9:49 AM
		10.36	655.50	10:53 AM
		10.13	655.73	12:54 PM
		10.56	655.30	2:37 PM
		10.49	655.37	4:00 PM
	(6" STEEL)			
MW-3I	663.49	7.65	655.84	5:55 AM
		8.20	655.29	8:30 AM
		8.80	654.69	10:10 AM
		8.99	654.50	11:09 AM
		9.16	654.33	1:12 PM
		9.35	654.14	2:58 PM
		9.51	653.98	4:42 PM
	(6" STEEL)			
MW-5I	663.35	4.35	659.00	6:25 AM
		5.12	658.23	8:56 AM
		5.24	658.11	10:02 AM
		6.05	657.30	10:58 AM
		5.51	657.84	12:59 PM
		5.95	657.40	2:41 PM
		5.70	657.65	4:19 PM
	(6" STEEL)			
MW-6I	666.26	5.85	660.41	6:58 AM
		6.46	659.80	8:53 AM
		7.12	659.14	10:06 AM
		7.63	658.63	11:03 AM
		6.94	659.32	1:07 PM
		6.91	659.35	2:52 PM
		6.63	659.63	4:30 PM

By LFC Date 11-2-88 WEHRAN ENGINEERING Engineers & Scientists Job No. 02509.04
Chkd. by ______ Date ______ Sheet No. 3 of 3
Subject WATER LEVEL ELEVATION DATA FOR PLOTS

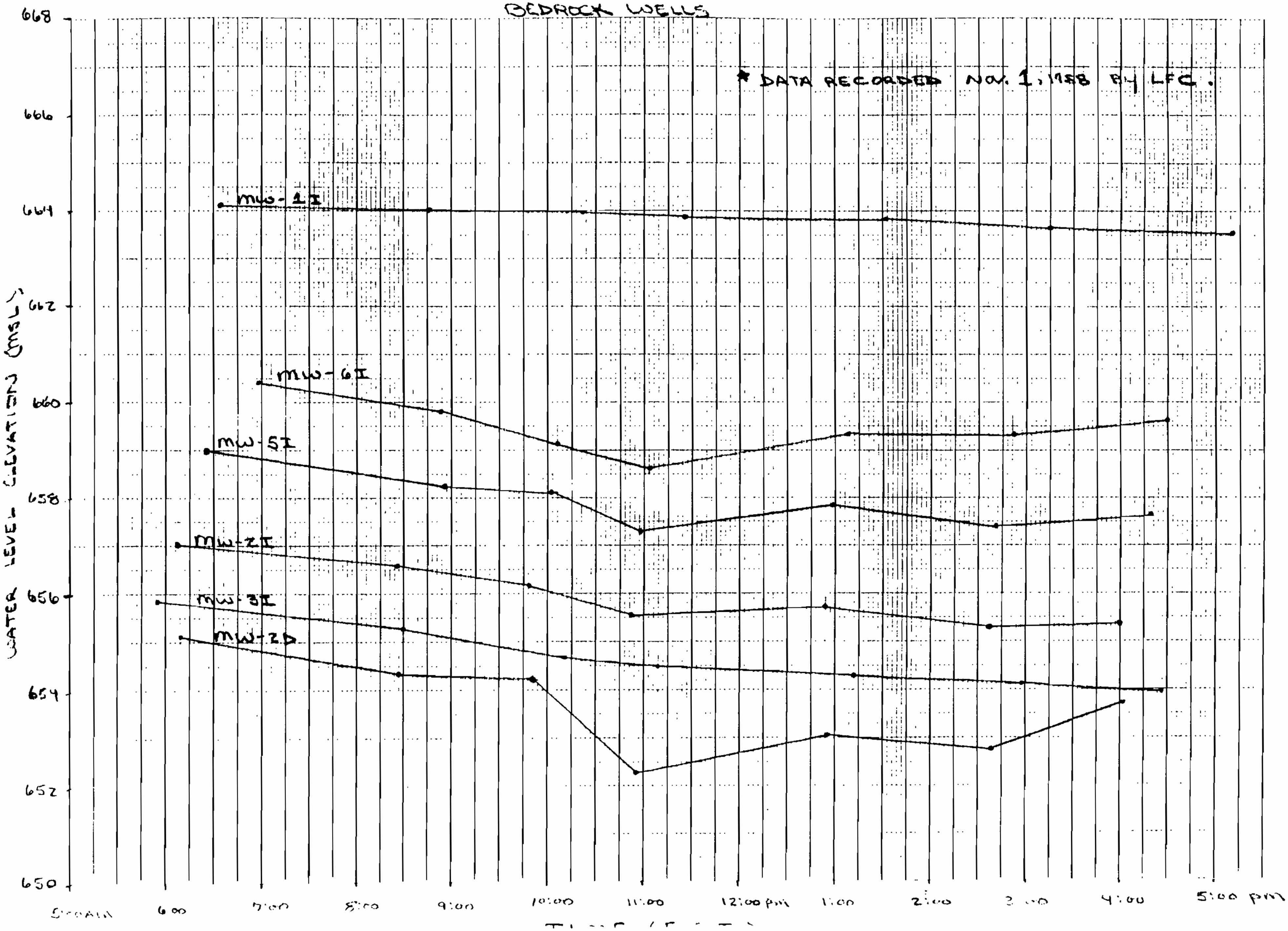
	REFERENCE ELEVATION (6")	WATER LEVEL	ELEVATION	TIME
MW-2D	665.70	10.57	655.13	6:09 AM
		11.35	654.35	8:27 AM
		11.45	654.25	9:51 AM
		13.40	652.30	10:55 AM
		12.63	653.07	12:55 PM
		12.92	652.78	2:39 PM
		11.97	653.73	4:02 PM
	(TOP)			
SG-1	662.38	3.38	659.00	6:43 AM
		3.36	659.02	8:39 AM
		3.36	659.02	10:19 AM
		3.36	659.02	11:19 AM
		3.32	659.06	1:26 PM
		3.31	659.07	3:09 PM
		3.30	659.08	5:01 PM

★ NOTE: WATER LEVELS TAKEN ON NOV. 1, 1988 BY LFC. ★

WEATHER: CONSTANT RAIN THROUGHOUT DAY, SIGNIFICANT RECHARGE EVENT.

461510

MAHOPAC RI/FS WATER LEVEL ELEVATIONS
BEDROCK WELLS



K+E 10 X 10 TO THE CENTIMETER KEUFFEL & ESSER CO.

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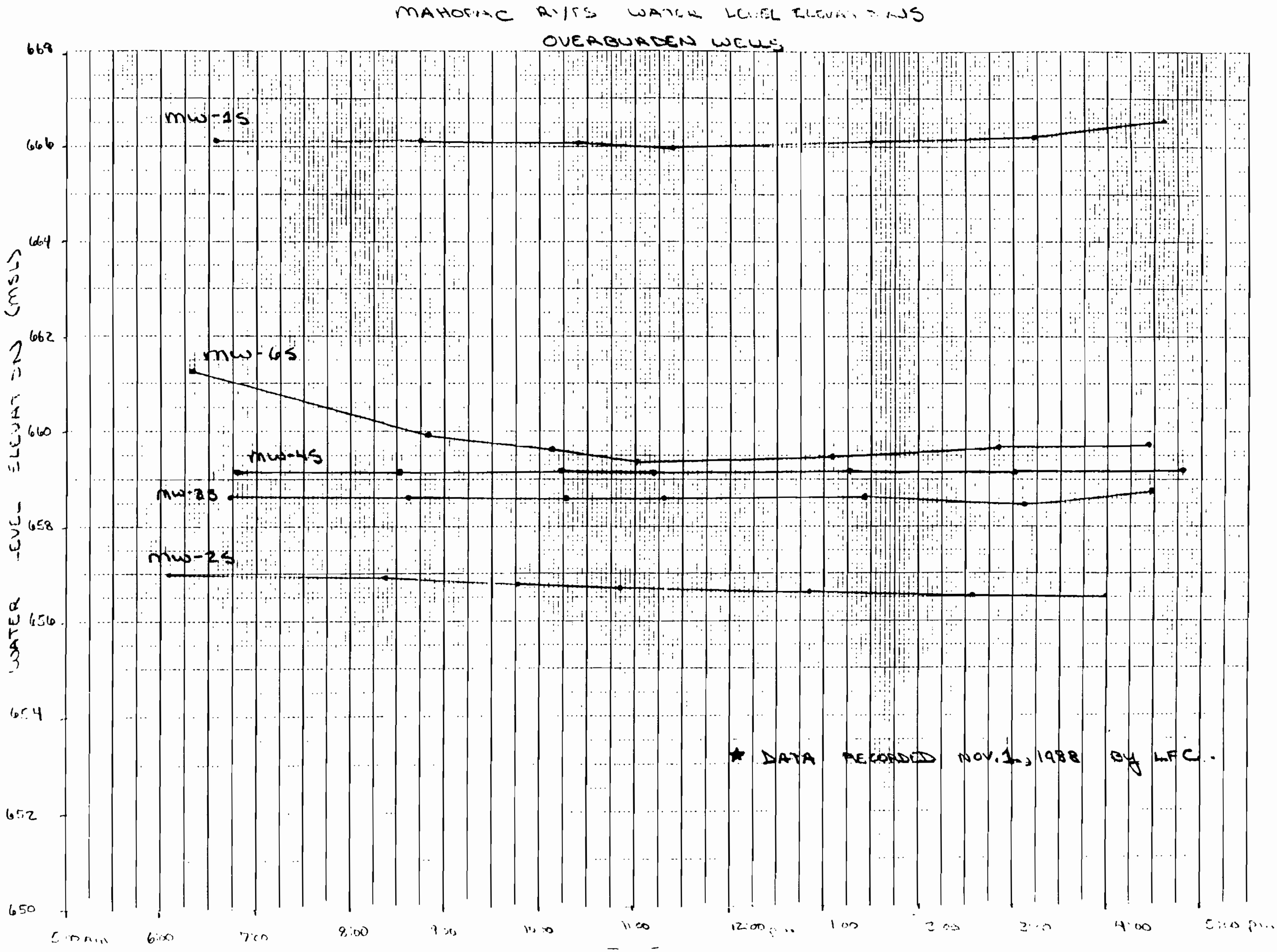

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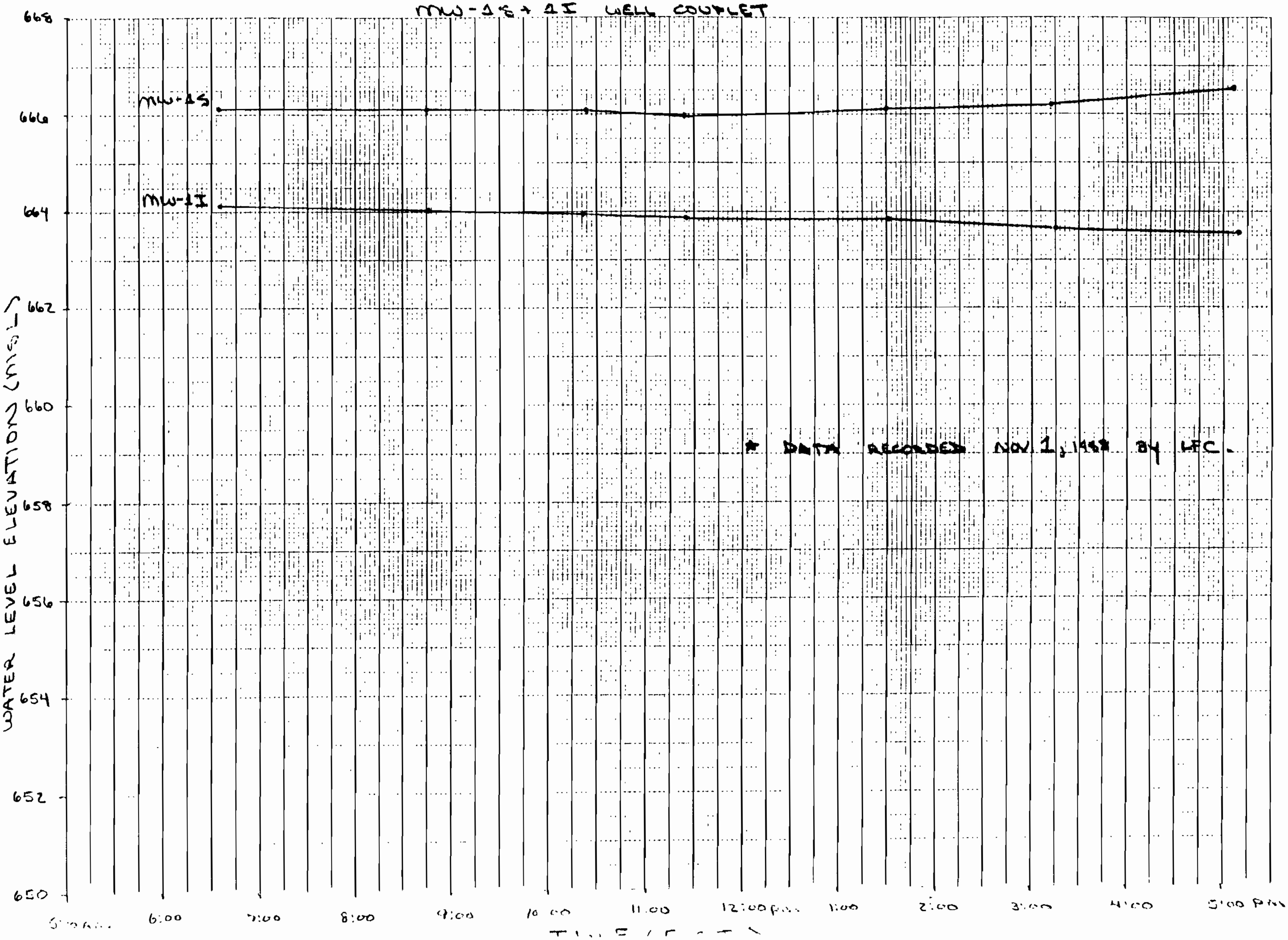
MAHOPAC RI/FS WATER LEVEL ELEVATIONS
MW-1S + 1I WELL COUPLET



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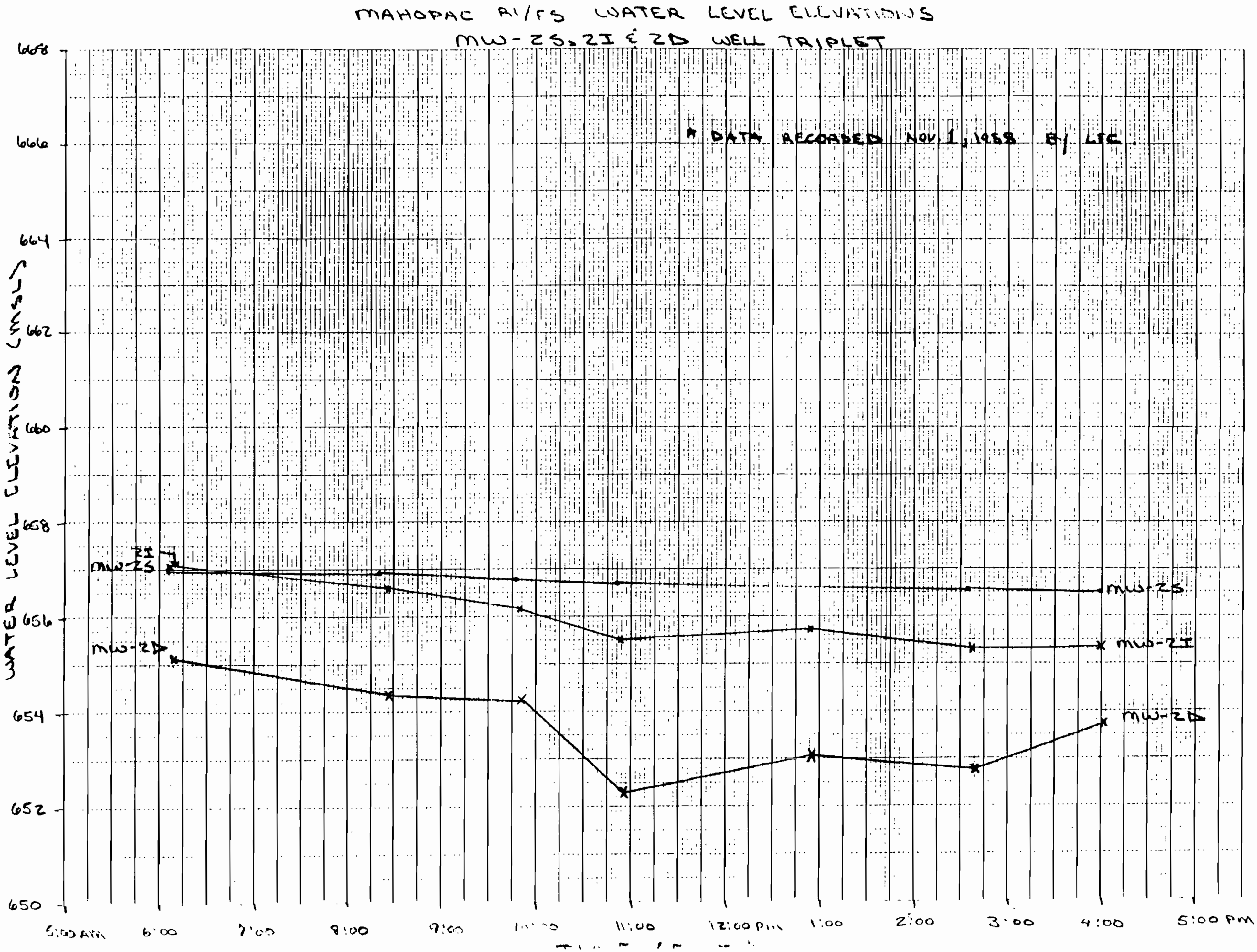

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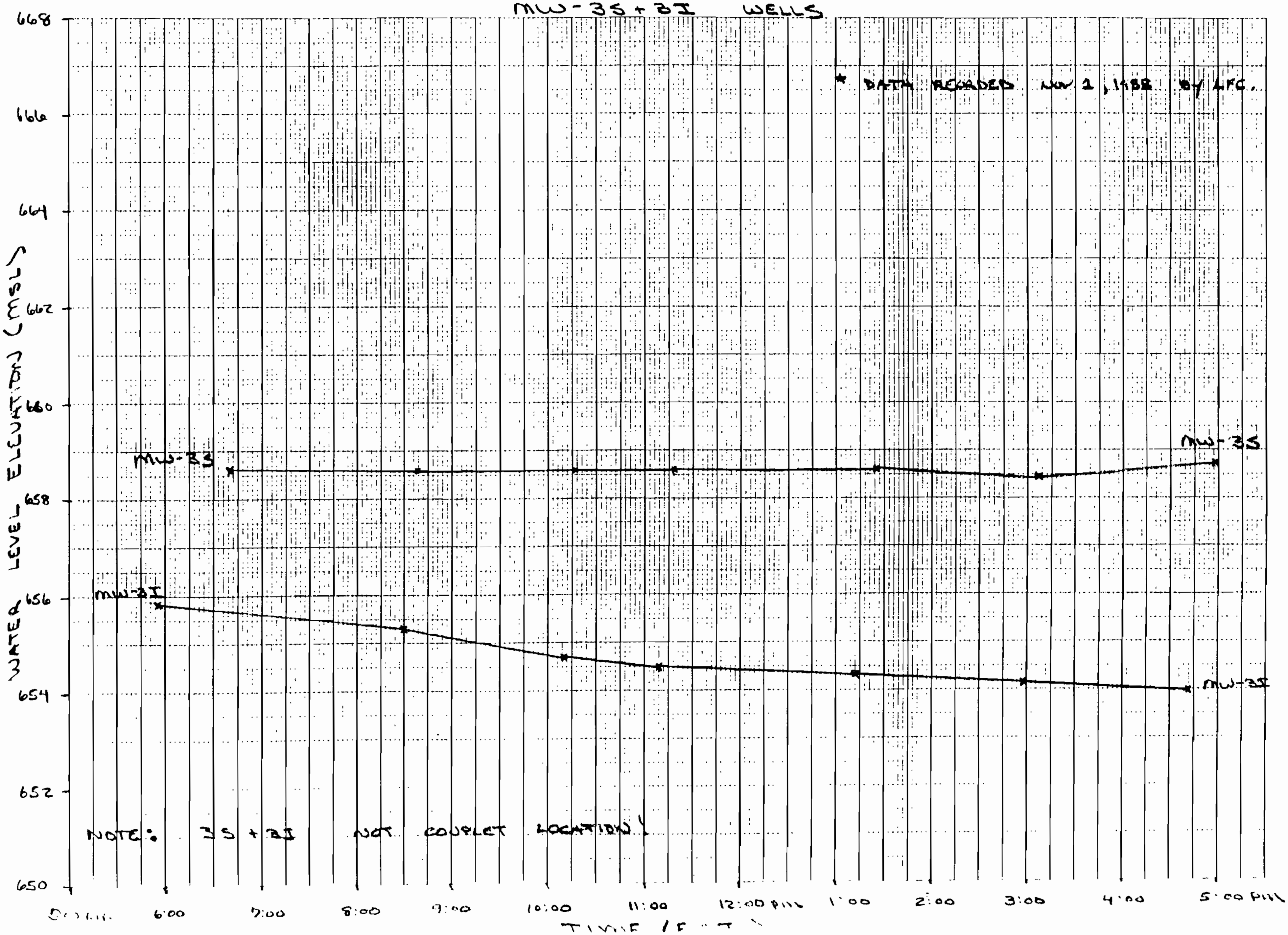
MAHOPAC RI/FS WATER LEVEL ELEVATIONS

MW-3S + 3I WELLS



K+E 10 X 10 TO THE CENTIMETER
KEUFFEL & ESSER CO.

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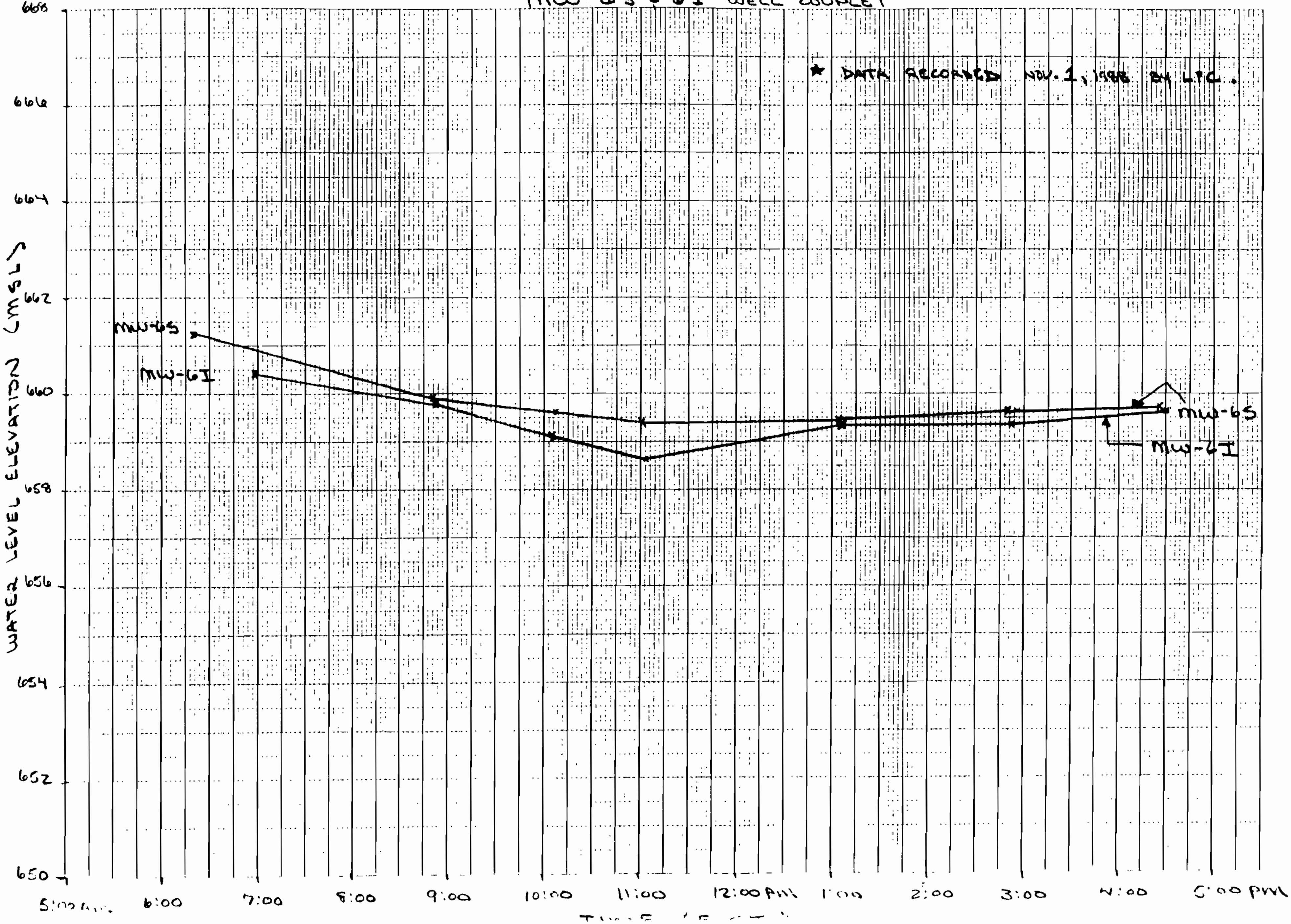
MAHOPAC RI/FS WATER LEVEL ELEVATIONS
MW-6S & 6I WELL COUPLET



APPENDIX F

LONG-TERM WATER LEVEL MONITORING RESULTS

In a study of a crystalline-bedrock aquifer in Canada, Paillet and Hess (1987) reported that the single-point resistance log provided the most unambiquous indication of fracture zones of any of the conventional logs. Single-point resistance logs could not be completed at some well sites due to electrical interference from overhead or buried lines.

Caliper logs record borehole diameter. The logs are useful indicators of of changes in borehole diameter related to construction, such as casing or drilling-bit size, and the distribution of opening caused by fracturing and caving of rocks along the sides of the borehole. Correlation of caliper logs with fluid-resistivity and temperature logs indicates the location of water-bearing fractures.

Fluid-resistivity logs record the electrical resistance of water in the well. Changes in fluid resistivity reflect differences in dissolved-solids concentration of water in the borehole. Because water produced from one fracture zone in a well commonly differs chemically from that in another zone, fluid-resistivity logs are useful in the delineation of water-bearing fractures.

Temperature logs record the water temperature in the borehole. Temperature logs are useful in the delineation of water-bearing zones and identification of vertical flow between zones of differing hydraulic head. Flow between producing and receiving zones is indicated by temperature gradients of less than about 1 degree Fahrenheit (0.56 degrees Celsius) per 100 feet (Carswell and Lloyd, 1979; Williams and others, 1984).

An acoustic-televiewer log was completed at Mahopac well site. The acoustic televiewer is an ultrasonic technique that produces a photographic image of the acoustic reflectivity of the borehole wall. The technique was developed by the petroleum industry (Zemanck and others, 1969) and more recently has been applied to ground-water investigations in fractured bedrock by Keys (1984), Paillet and others (1985), and Paillet and others (1987). The acoustic-televiewer log indicates the location and strike and dip of fractures intersecting a well (fig. 2).

Figure 2 near here

The direction and rate of vertical flow in the well was determined from velocity measurements and borehole diameter recorded by the caliper log. Velocity measurements were made by using the brine-tracing method described by Patten and Bennett (1962). At the Mahopac well site, a heat-pulse flowmeter survey was completed. The high-resolution flowmeter shown in figure 3 was developed by Hess (1982) based on a design by Dudgeon and others (1975) and has been applied to the determination of low-velocity, vertical flow in open-hole, bedrock wells by Hess (1984, 1986), Keys (1984) and Paillet and others (1987).

Figure 3 near here

A downhole point sampler was used to collect discrete and composite samples from self-purging producing zones defined by the geophysical logging and flow measurements for analysis of volatile organic compounds.
Where flow was downward from a producing zone and a no-flow boundary was present above the zone, a discrete sample of water produced by the zone was collected by sampling below the zone. Were flow was upward and a no-flow boundary was present below the producing zone, a discrete sample was collected above the zone. Composite samples were collected from intervals in the wells where more than one producing zone contributed flow. Water-quality analysis were completed by the NYSDEC laboratory or by NYSDEC contractors in the field with a portable gas chromatograph.

Figure 2.— Fracture intersecting a borehole and corresponding acoustic-televiewer log and determination of strike and dip (adapted from Zemanck and others, 1969 and Paillet, 1985).

Figure 3.—High-resolution heat-pulse flowmeter (from Hess, 1984).

CASE STUDIES

Spring Valley

The Spring Valley Water Company has a major wellfield in the town of Spring Valley in south-central Rockland County (fig. 1). The wellfield lies within the Newark Basin, which is underlain by Mesozoic sedimentary bedrock consisting of interbedded conglomerate, sandstone, and shale. Regional strike and dip of of bedding is north to N45°E and westerly 4 to 20°, respectively (Perlmutter, 1959). The wellfield includes six open-hole wells, 250 to 500 feet deep, which have produced over 2 million gallons per day--the largest pumpage from a bedrock aquifer in the State. After decades of reliable production, the volatile organic compounds, trichloroethylene (TCE) and perchloroethylene (PCE), were found in the supply wells in the late 1970's (Slayback and Rothenberg, 1984). Supply well 2, located near the center of the wellfield, was logged and sampled to help define the vertical distribution of contamination in the fractured-bedrock aquifer. Two deep and three shallow bedrock monitoring wells, located between the suspected contamination source and the wellfield, also were logged. The monitoring wells were installed in 1987-88 by Dunn Geoscience and GHR Engineering Associates as part of NYSDEC remedial work.

Supply well 2, which is 445 feet deep and has a reported yield of 350 gallons per minute (gal/min), was retired from regular service in the early 1980's when the deepening of other supply wells to 500 feet resulted in an increase in drawdown interference. At that time, average TCE and PCE concentrations at supply well 2 were about 40 and 10 microgrms per liter (µg/L) respectively; and the other supply wells were 5 to 55 and 3 to 15 µg/L, respectively (Slayback and Rothenberg, 1984).

Gamma, caliper, fluid-resistivity, and temperature logs were completed in supply well 2 (fig. 4). At the time of logging, pumpage from the wellfield

Figure 4--Belongs near hear

was about 2 million gallons per day and the water level in the supply well was 179 feet below land surface. Although no geologic log of supply well 2 was available, the driller's log from a nearby supply well and drill-core logs of the bedrock monitoring wells (G.M. Stevens, Dunn Geoscience, written commun.; 1988) indicate that the Mesozoic bedrock in the area consists of sandstone and conglomerate. Peaks on the gamma log for supply well 2 at 169, 180, 246, 340, 404, and 413 feet below land surface indicate 1- to 3- foot thick clayey zones.

Mesozoic sandstone and conglomerate are exposed in the general strike direction two miles southwest of the wellfield at a roadcut along Interstate 87. The bedrock generally is massive except for bedding-plane separations ranging from 3 to more than 10 feet apart. The dipping bedding-plane separations appear to be continuous along their length of exposure of more then 200 feet. Friable, clayey sandstone is discontinuously present below some bedding-plane separations. Seepage from fracture zones along the bedding-plane separations was observed in several areas along the roadcut.

Correlation of spikes on the caliper log with slope changes on the fluid-resistivity and temperature logs indicates that supply well 2 intersects water-bearing fractures zones at 188, 190, 195, 204, 220, 245, 278, 340, 345, and 403 feet below land surface (fig. 2). Most of the fracture zones probably are bedding-plane separations. As indicated by the gamma log, the fractures at 245, 278, and 403 feet appear to be associated with clayey zones. Several of the fracture zones in the bedrock monitoring wells also are associated with clayey zones. Selected logs of the two deep bedrock monitoring wells are presented in figure 5. Monitoring well 8 is about 1,500 feet southwest of supply well 2 in the general strike direction and monitoring well 9 is about 700 feet downdip

Figure 5 near here

Figure 4.--Gamma, caliper, fluid-resistivity, and temperature logs of supply well 2 at Spring Valley.

Figure 5.--Gamma, single-point resistance, and caliper logs for monitoring well 8 and gamma and caliper logs for monitoring well 9 at Spring Valley.

of monitoring well 8. Drill-core recovery from fracture zones in the bedrock monitoring wells generally was poor, although friable, clayey sandstone similar to that below some of the bedding-plane separations exposed in the roadcut was recovered from two fracture zones.

Intervals of isothermal slope on the temperature log indicate that vertical flow occurs in supply well 2 (fig. 4). Slope changes on the temperature and(or) fluid-resistivity logs indicate that major changes in flow conditions occur at 278, 345, and 403 feet below land surface. Flow measurements were made in the well by the brine-tracing method at 210, 255, 310, 375, and 425 feet below land surface (fig. 6). Flow at 255 feet was downward at a rate of 2.3 gal/min. Flow at 210 feet, although below the reliable measurement limit, also

Figure 6 near here

appeared to be downward. Slope changes are present on the fluid-resistivity log at 188, 190, 195, 204, 220, 241, 245, and 278 feet and no flow was detected at 310 feet. These data suggest that several fracture zones above 250 feet are the producing zones of the downward flow and the fracture zone at 278 feet is the receiving zone. Flow at 375 feet was downward at a rate of 0.8 gal/min and no flow was detected at 425 feet. Slope changes on the fluid-resistivity log at 345 and 403 feet and the lack of flow at 310 and 425 feet indicate that the fractures zone at 345 feet is the producing zone of the downward flow and the fracture zone at 403 feet is the receiving zone.

Water samples were collected for field analysis of volatile organic compounds with the downhole point sampler in the supply well at 192, 205, 223, 247, 270, 355, 400, and 440 feet below land surface (fig. 6). Samples from 205, 223, 247, and 270 feet had TCE concentrations of 64, 50, 54 and 110 μg/l and PCE concentrations of 15, 10, 12, and 28 μg/L respectively (F. B. Stevenson, GHR Engineering Associates, written commun.; 1988). These results indicate that several

Figure 6.--Vertical-flow rate and direction and TCE and PCE concentrations in supply well 2 at Spring Valley (NF indicates no measurable flow; ND indicates no TCE or PCE detected at detection limits of 2 and 3 μg/L, respectively).

fracture zones between 195 and 250 feet probably produced water with TCE and PCE concentrations of about 55 and 12 μg/L, respectively, and that the fracture zone at 278 feet is the receiving zone of the contaminated water.

The source of elevated TCE and PCE concentrations in the 270-foot sample was not defined. Possibly fracture zones at 250, 252, 244, and (or) 257 feet produced water that is even more highly contaminated. However, the fluid-resistivity and temperature logs do not indicate flow from any of these zones. The source of uncontaminated water at 192 feet also was not clearly defined. Fracture zones at 188 and 190 feet may produce uncontaminated water or they may be receiving zones for cascading uncontaminated water from zones above the water level in the well. Additional flow measurements and sampling would be needed to resolve these details.

The water sample collected at 355 feet was a discrete sample of the downward flow from the producing zone at 345 feet because of the no-flow interval between 278 and 345 feet. No volatile organic compounds were detected in this sample nor in samples collected at 400 and 440 feet. The fracture zone at 345 feet apparently produces uncontaminated water that is received by the zone at 403 feet.

Results of the logging, flow measurements, and sampling indicate that the volatile organic contamination in supply well 2 is at depth of 195 to 278 feet below land surface. The vertical distribution of fracture zones penetrated by monitoring well 8 at a depth of 91 to 174 feet is similar to that of zones penetrated by supply well 2 at a depth of 195 to 278 feet (figs. 4 and 5). A composite pumped sample from monitoring well 8, which is located about 1500 feet from supply well 2 in the general strike direction, had contaminant concentrations similar to those in samples from the contaminated interval of supply well 2. Water-bearing fracture zones along bedding-plane separations that are continuous along bedding strike for significant distances probably provide direct pathways for contaminant transport in the fractured-bedrock aquifer.

Mahopac

The Mahopac business district, in south-central Putnam County, is supplied by private and shared wells completed as open hole in fractured bedrock (fig. 1). Mahopac lies within the Hudson Highlands, an area underlain by highly resistant, metamorphic bedrock of Precambrian age, predominantly gneiss with some amphibolite, marble, and quartzite. Feldspathic intrusions are common in the gneiss.

PCE and TCE contamination was found in several supply wells in the Mahopac business district during 1978-79. In 1988, Wehran Engineering installed a deep test well by air-rotary drilling method as part of NYSDEC remedial work to investigate the vertical distribution of contamination in the fractured-bedrock aquifer. The test well was logged at a completion depth of 220 feet during a temporary shutdown of drilling operations and was logged and sampled at its final completion depth of 400 feet. At the time of logging, the water level in the test well fluctuated between 8 to 11 feet below the land surface in response to local pumping. Continuous records of water levels in the test well (L. F. Coddington, Wehran Engineering, written commun; 1988) show several feet of drawdown during morning hours, recovery-drawdown cycles of 0.5 feet in the afternoon and early evening, and then recovery after business hours at night.

Gamma, single-point resistance, caliper, fluid resistivity, and temperature logs were completed in the test well (fig. 7). The test well reportedly

Figure 7 near here

Figure 7.--Gamma, single-point resistance, caliper, fluid-resistivity, temperature, vertical-flow, and specific-capacity logs of the deep test well at Mahopac.

yielded more than 50 gal/min, penetrated 23 feet of glacial drift and 2 feet of weathered bedrock, and is cased to 50 feet. The bedrock penetrated by the test well consists of foliated to banded granitic gneiss. Peaks on the gamma log indicate 1- to 5- foot thick feldspathic zones, which have relatively high radioactivity and are most prevalent between 250 to 400 feet below land surface. Notable gamma peaks are at 253, 260, 340, 366, and 377 feet. In a down-hole video survey of the test well completed by Earth Data for Wehran Engineering, the feldspathic zones appeared as white to light-pink colored intervals. Lower gamma counts were associated with the more mafic zones, which appeared as darker intervals on the videotape. Banded gneiss, which appeared as alternating light- and dark-banded intervals, had intermediate gamma counts.

The acoustic-televiewer, single-point resistance, and caliper logs indicate that the test well intersects fracture zones at 50, 52, 55, 66, 79, 115, 180, 220, 260, and 328 feet below land surface. The fractures zones consist of a single fracture or a series of closely spaced fractures. The acoustic-televiewer log of selected fracture zones is shown in figure 8. The videotape from the down-hole survey shows the fractures as distinctive breaks that cut across the borehole. Slug-recovery and specific-capacity data collected by

Figure 8 near here

Earth Data with a 25-foot straddle-packer system packer indicates the more permeable intervals penetrated by the test well are between 50 to 75 feet (50,52,55, and 66-foot zones), 75 to 100 feet (79-foot zone), 250 to 275 feet (260-foot zone), and 310 to 335 feet (328-foot zone). The specific capacity of the 50 to 75 foot interval is more than 14, 56, and 48 times that of the 75 to 100, 250 to 275, and 310 to 335 foot intervals, respectively (fig. 7).

Figure 8.--Acoustic-televiewer logs of selected water-bearing fractures and vertical-flow direction and rate in the deep test well at Mahopac.

At a completion depth of 220 feet, the brine-tracing method revealed no vertical flow in the test well. At a completion depth of 400 feet, the fluid-resistivity and temperature logs indicate vertical flow and a major change in flow conditions at 328 feet (fig. 7). A heat-pulse flowmeter survey (F.L. Paillet, U.S. Geological Survey, written commun; 1988) defined downward flow from shallow producing zones to deep receiving zones (figs. 7 and 8). Maximum downward flow during the survey, which was completed in the early evening, ranged from 0.31 to 0.70 gal/min apparently in response to intermittent pumping. Fracture zones at 50 to 55 feet produced about 50 percent of the downward flow and those at 66 to 79 feet produced about 20 to 30 percent, respectively. About 25 percent of the downward flow was received by the fracture zone at 261 feet; the rest was received by fractures between 327 and 329 feet. The change from downward flow to no flow correlates with the sharp break in the fluid-resistivity temperature logs at 328 feet.

Water samples were collectd with the downhole point sampler for laboratory analysis of volatile organic compounds in the test well at depths of 57, 82, 140, 180, 230, 340, and 380 feet below land surface. At the time of sampling, which was during late morning and early afternoon, downward flow from the producing zones as measured by brine tracing was greater than that measured during the heat-pulse flowmeter survey (figs. 8 and 9). Some of the measured increase

Figure 9 near here

in downward flow may be related to increased local pumping but most is probably measurement error introduced by the less accurate brine-tracing method. Analysis of the sample collected at 57 feet (S. Rodabaugh, NYSDEC, written commun; 1988) indicates that the fractures at 50 to 55 feet produced water with a PCE concentration of 17 μg/L. The sample collected at 82 feet had a PCE concentration

Figure 9.--Direction and rate of vertical flow and PCE concentration in the upper part of the deep test well at Mahopac.

25 μg/L, which suggests that the fractures at the 66- and 79- foot depth also probably produced similarly contaminated water. As would be expected with the downward flow from the shallow producing to deep receiving zones, water samples collected at 140, 180, and 230 feet had PCE concentrations similar to the sample from the 82-foot depth, 24 to 33 μg/L. Water samples collected at 340 and 380 feet, which is below the receiving zone at 328 feet and in a no-flow interval, also had similar PCE concentrations, 24 and 27 μg/L, respectively. This contamination probably was residual caused by mixing of borehole water during drilling.

To determine whether the fractures at 66 and 79 feet produced contaminated water, a submersible pump was set at 50 feet and the well was pumped at 9.7 gal/min. Repeated flow measurements were made until the flow stabilized and a no-flow boundary was created between the two fracture zones (fig. 9). Analysis of samples collected at 60 and 85 feet after borehole purging indicated that the 66- and 79-foot zones produced water with PCE concentrations of 25 and 26 μg/L, respectively.

The fractures at 50 to 55, 66, and 79 feet produced contaminated water with similar contaminant concentrations that flowed downward to deep receiving zones at 260 and 328 feet. As would be expected from the flow conditions in the test well, water sampled during straddle-packer pumping tests, which were 0.5 hour in duration and completed for depth intervals of 55 to 75, 75 to 100, 250 to 275, and 310 to 335 feet, had contaminant concentrations similar to the downhole point samples from the shallow producing zones (L. F. Coddington, Wehran Engineering, written commun.; 1988).

The shallow bedrock aquifer penetrated by the test well consists of an interconnected network of fractures at a depth of 50 to 79 feet that dip 5 to 50 degrees (fig. 8). Deep aquifer zones were penetrated by the test well at 260 and 328 feet. The 260-foot zone is a single fracture that dips about 25 degrees northwestward. The 328-foot zone consists of four subparallel fractures between 327 and 329 feet that dip 20 to 50 degrees southwestward. In the absence of open-hole wells, the deep fracture zones probably would not be connected with the contaminated part of the shallow bedrock aquifer.

Subsequent to the logging and sampling, a shallow monitoring well open to the fracture zones at 50, 52, 55, and 66 feet and a deep monitoring well open to the zone at 328 feet were installed by Wehran Engineering at the test-well site. Repeated water-level measurements made during daytime business hours (L. F. Coddington, Wehran Engineering, written commun; 1988) indicate that the head in the 328-foot zone is 1.5 to 3 feet lower than that in the shallow zones and that most of the variation in the head difference is due to fluctuations in the deep zone. Drawdown associated with pumping of nearby wells open to the deep zones apparently was a major cause of the downward flow in the test well. By analogy, information from the test well suggests that the many deep open-hole wells in the Mahopac business district serve as short circuits in the ground-water flow system that connect shallow and deep aquifer zones. Local pumping from deep aquifer zones causes lowered heads at depth, which results in direct downward transport of contaminants in these open-hole wells.

CONCLUSIONS AND APPLICATIONS

A combination of geophysical logging, vertical-flow measurements, and downhole point sampling proved to be an efficient method for the investigation of volatile organic contamination in open-hole bedrock wells in southeastern New York. The method involves 1 to 2 days of field work per well site and provides on-site information concerning the distribution of water-bearing fractures and the rate and direction of vertical flow between fractures. On-site analysis of water samples with a portable gas chromatograph allows for preliminary delineation of contaminated fracture zones in the field. Digital recording of the geophysical-log data facilitiates subsequent analysis and presentation of information by use of computer-generated graphics.

The method presented in this paper can be applied in existing open-hole wells at bedrock contamination sites to increase the data base before test drilling and monitoring-well construction to ensure efficient design of these costly programs. Much information can be collected without disturbing the existing ground-water flow system or creating problems with the disposal of large volumes of contaminated water or drill cuttings. The method also can be applied during the construction of monitoring wells to help determine completion depths and open intervals and ensure that the monitoring wells are not serving as short circuits for the flow of contaminated water. The downhole information collected by this method is indispensible in the design and interpretation of straddle-packer tests.

The addition of the acoustic-televiewer log to a conventional suite of geophysical logs greatly enhances fracture delineation and characterization in the open-hole, bedrock wells. Measurement of vertical flow in the wells by the brine-tracing method is more time consuming than the logging and sampling operations and is unreliable at lower flow velocities. The inefficiency of the method makes synoptic measurement difficult under transient flow conditions. The use of the high-resolution, heat-pulse flowmeter developed by Hess (1982) provides more efficient and accurate measurement.

ACKNOWLEDGEMENTS

The acoustic-televiewer log and heat-pulse flowmeter survey at the Mahopac well site were completed by personnel of the U.S. Geological Survey Borehole Geophysics Research Project. The authors thank F. L. Paillet and A. E. Hess of the Borehole Geophysics Research Project for their invaluable contribution. We also acknowledge the technical and logistical support of contractors to the NYSDEC at the study sites, Dunn Geoscience, GHR Engineering Associates, and Wehran Engineering.

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Fig. 1

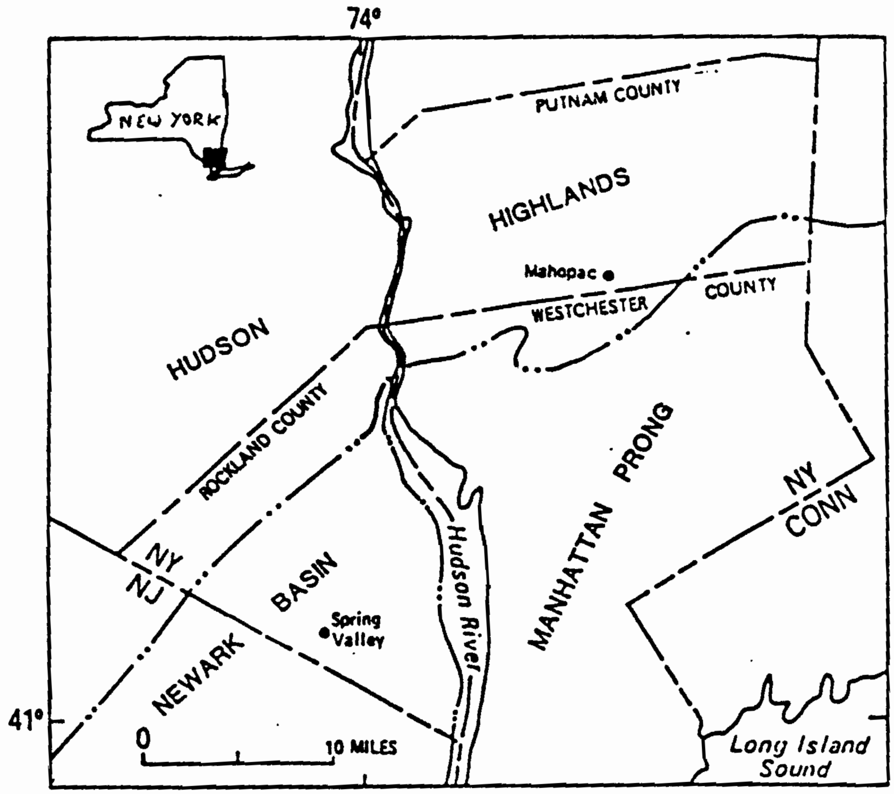
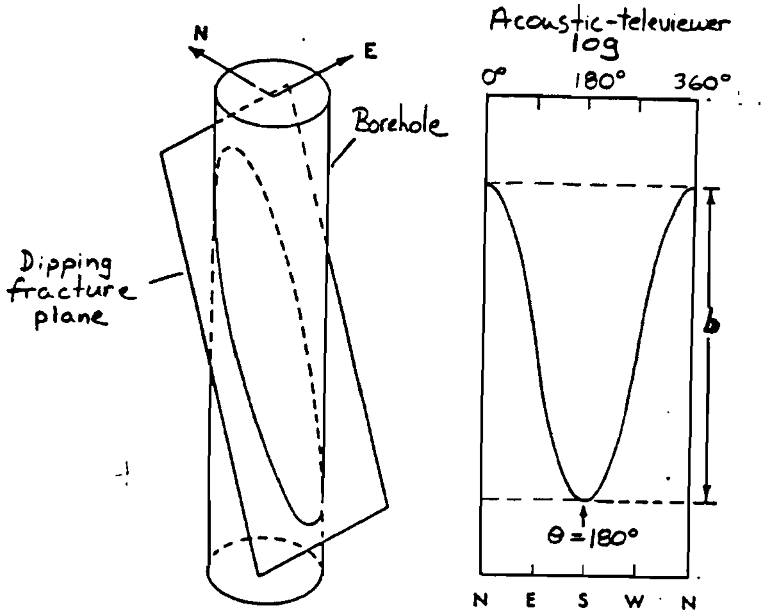

74°
NEW YORK
PUTNAM COUNTY
HIGHLANDS
Mahopac
WESTCHESTER
COUNTY
HUDSON
ROCKLAND COUNTY
MANHATTAN PRONG
NY
CONN
NY
NJ
BASIN
Spring Valley
NEWARK
Hudson River
41°
0
10 MILES
Long Island Sound

Fig. 2



Strike = θ - 90°

Dip = $\tan^{-1} \frac{b}{\text{diameter}}$

Fig. 3 s

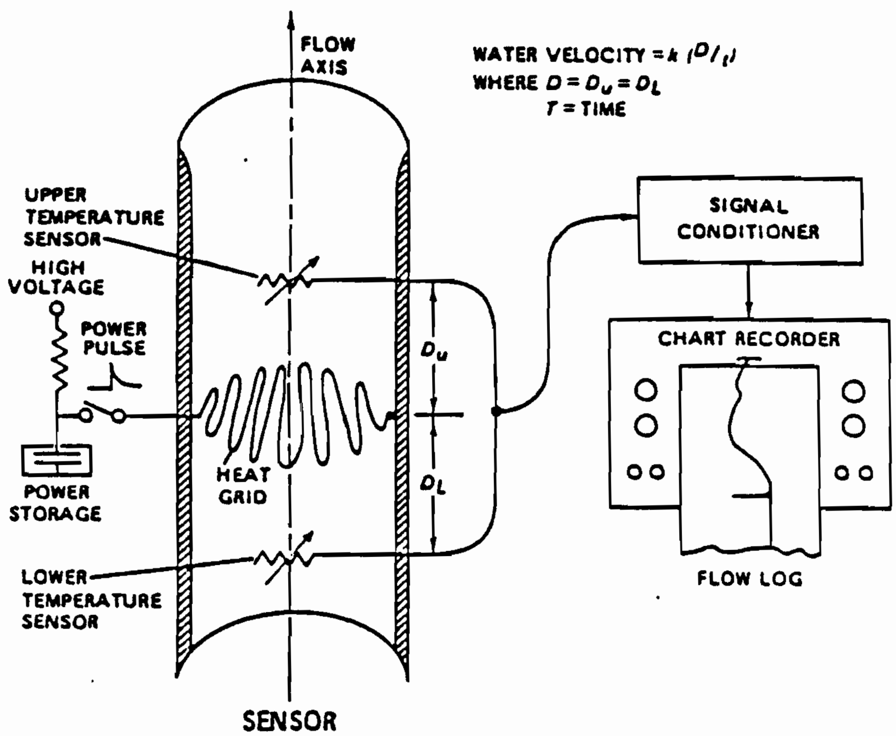
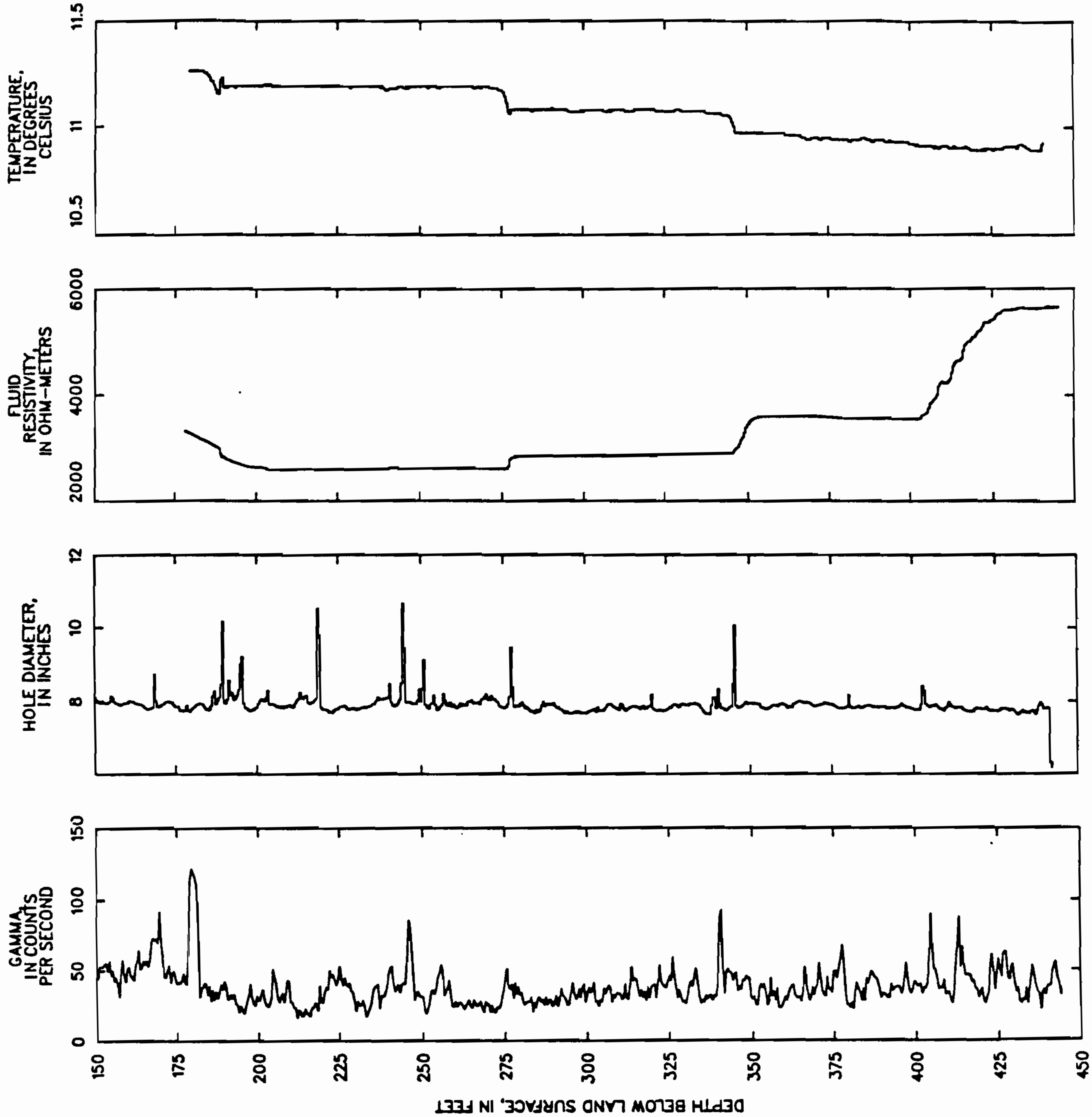

FLOW
AXIS
WATER VELOCITY = k (D/t)
WHERE D = Du = DL
T = TIME
UPPER
TEMPERATURE
SENSOR
HIGH
VOLTAGE
POWER
PULSE
POWER
STORAGE
HEAT
GRID
Du
DL
LOWER
TEMPERATURE
SENSOR
SIGNAL
CONDITIONER
CHART RECORDER
FLOW LOG
SENSOR

Fig. 4



TEMPERATURE, IN DEGREES CELSIUS
10.5
11
11.5
FLUID RESISTIVITY, IN OHM-METERS
2000
4000
6000
HOLE DIAMETER, IN INCHES
8
10
12
GAMMA, IN COUNTS PER SECOND
0
50
100
150
150
175
200
225
250
275
300
325
350
375
400
425
450
DEPTH BELOW LAND SURFACE, IN FEET

Fig.5

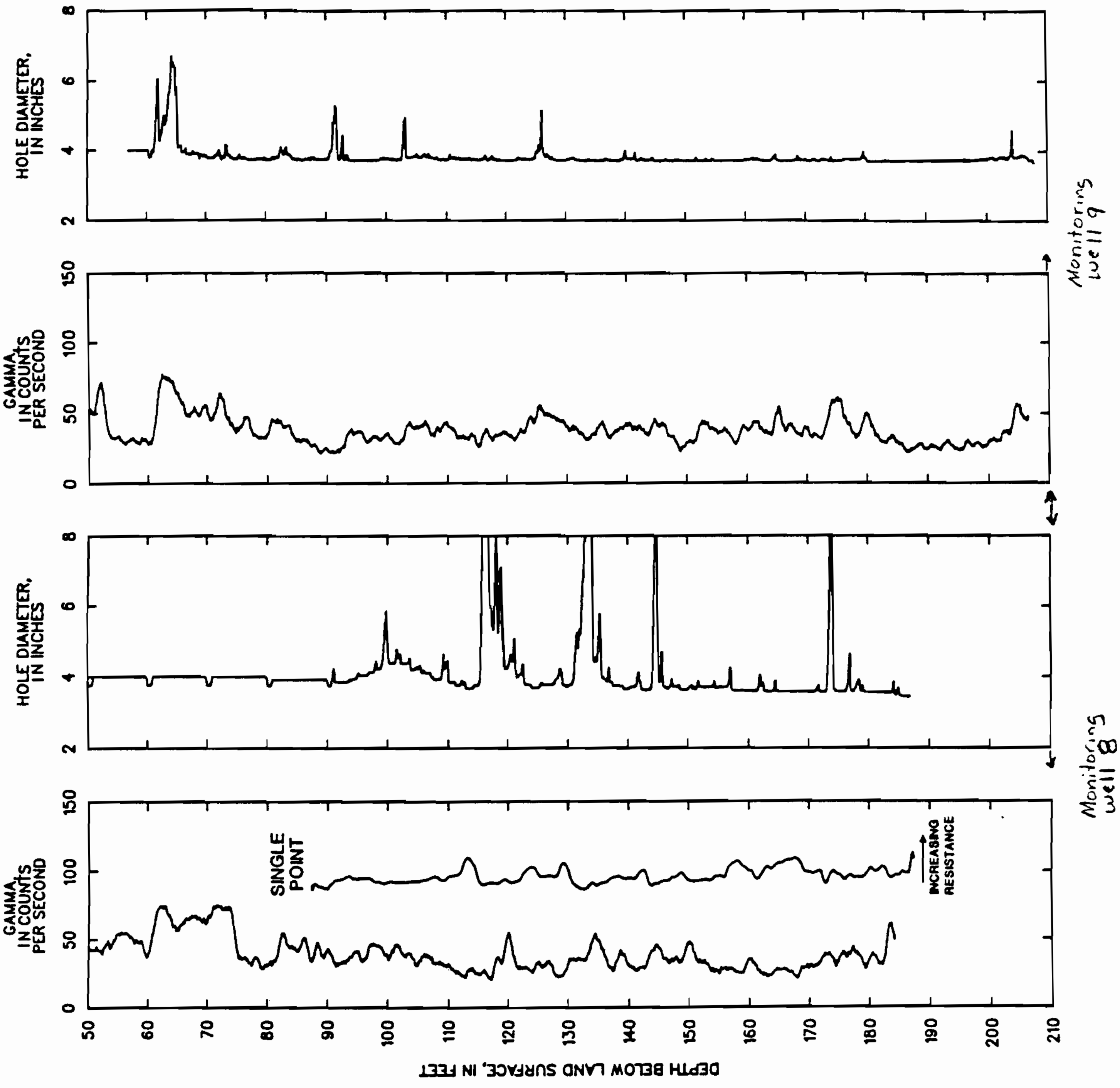
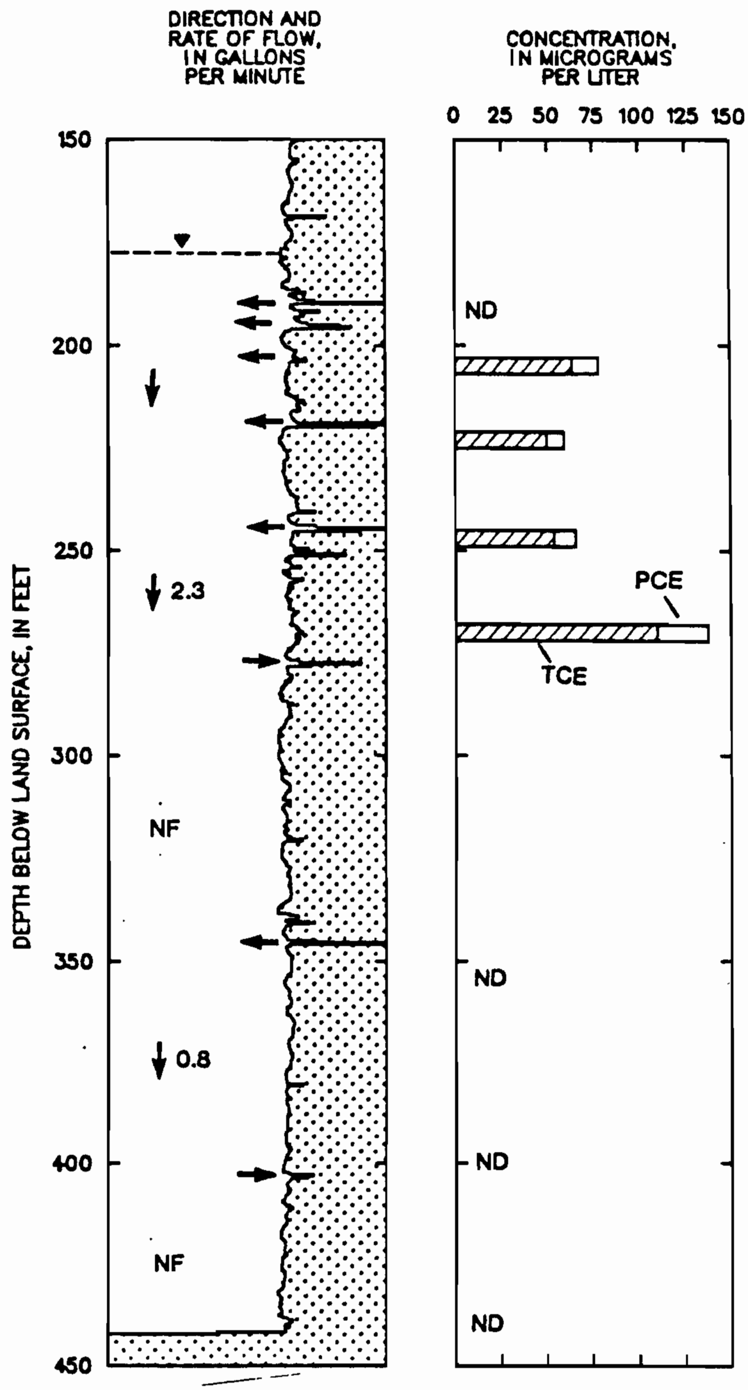
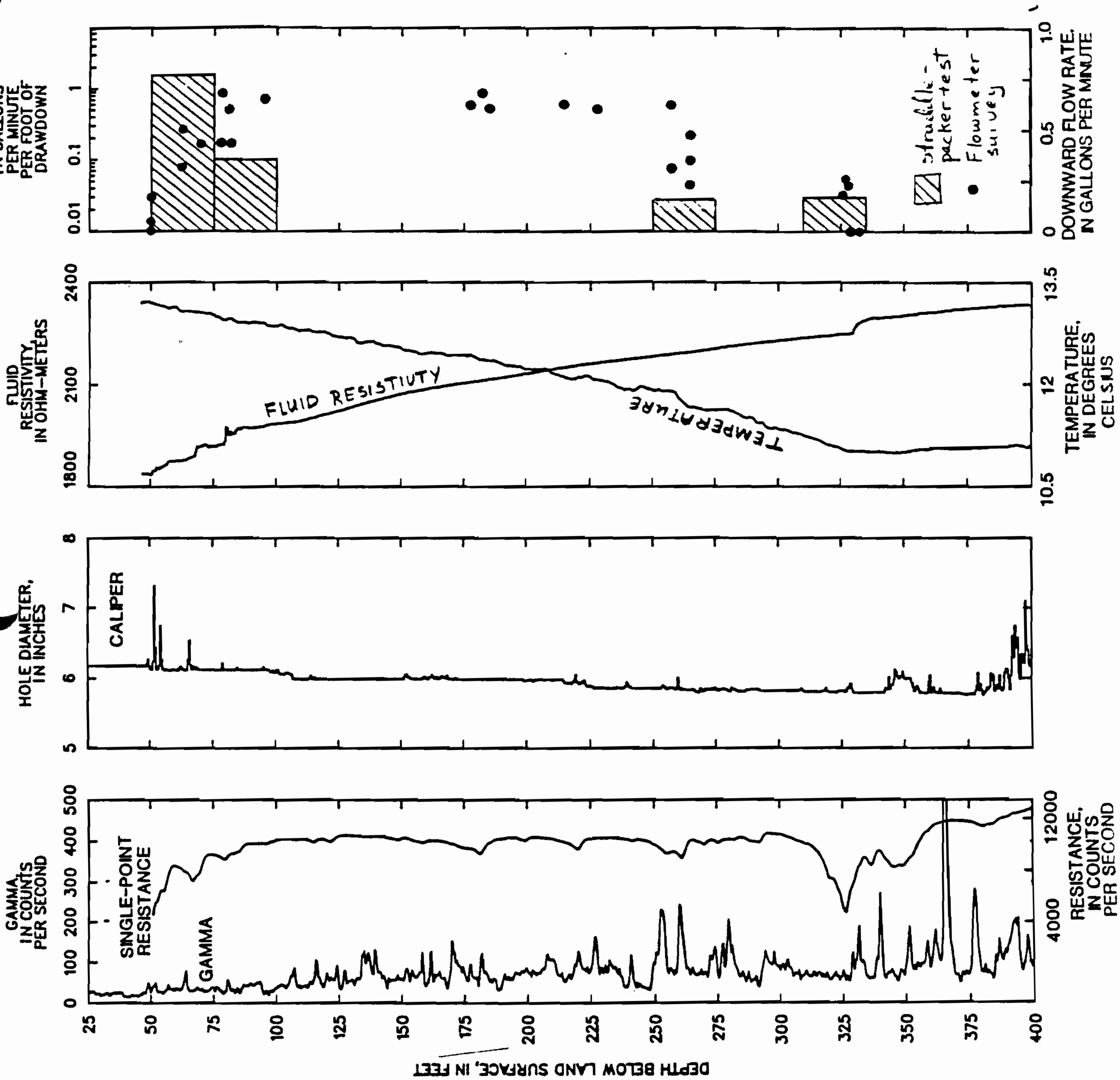

HOLE DIAMETER, IN INCHES
GAMMA, IN COUNTS PER SECOND
HOLE DIAMETER, IN INCHES
GAMMA, IN COUNTS PER SECOND
SINGLE POINT
INCREASING RESISTANCE
DEPTH BELOW LAND SURFACE, IN FEET
Monitoring well 9
Monitoring well 8

Fig. 6



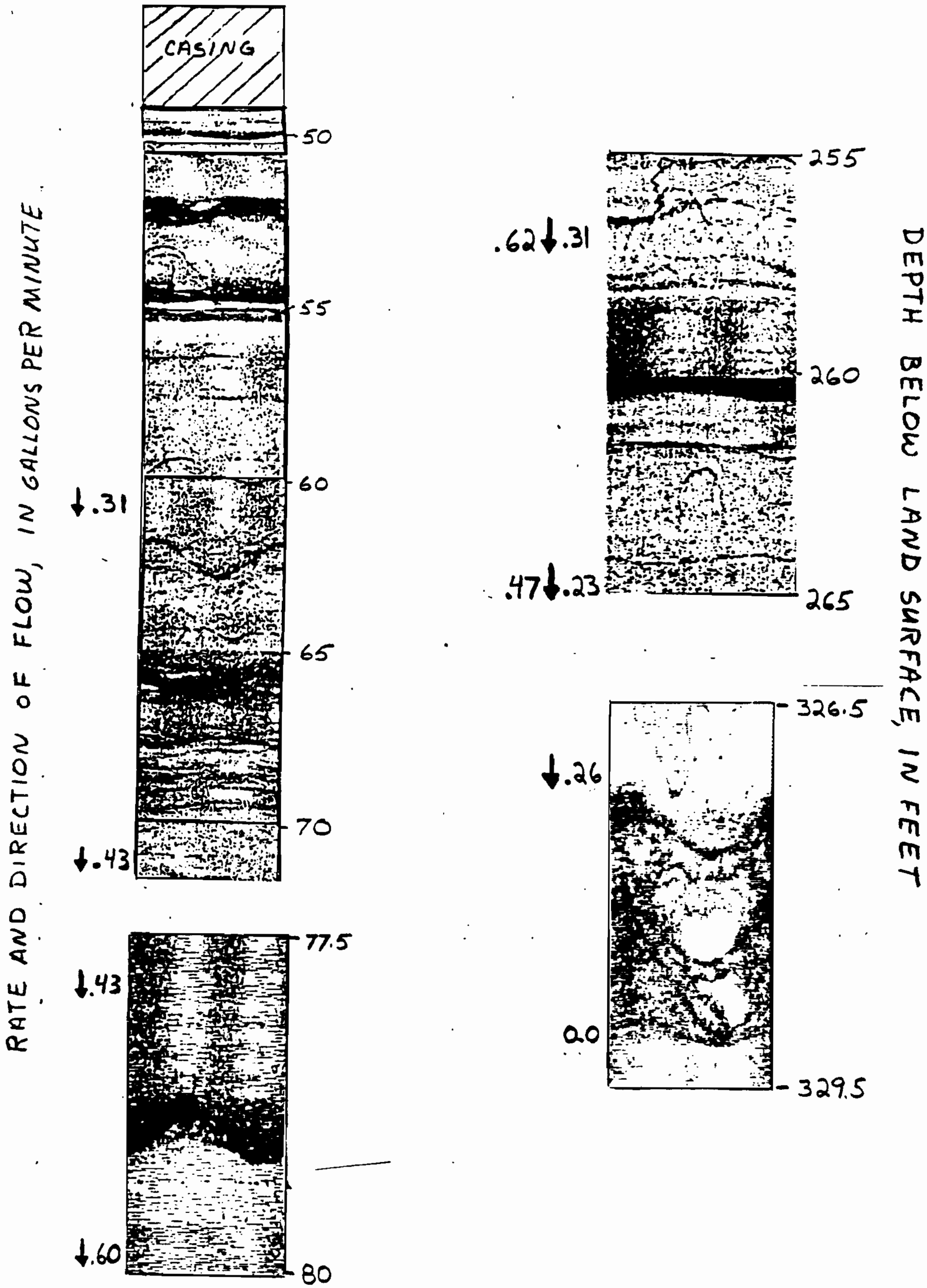
DIRECTION AND RATE OF FLOW, IN GALLONS PER MINUTE
CONCENTRATION, IN MICROGRAMS PER LITER
0 25 50 75 100 125 150
DEPTH BELOW LAND SURFACE, IN FEET
150
200
250
300
350
400
450
2.3
NF
0.8
NF
ND
PCE
TCE
ND
ND
ND

Fig. 7

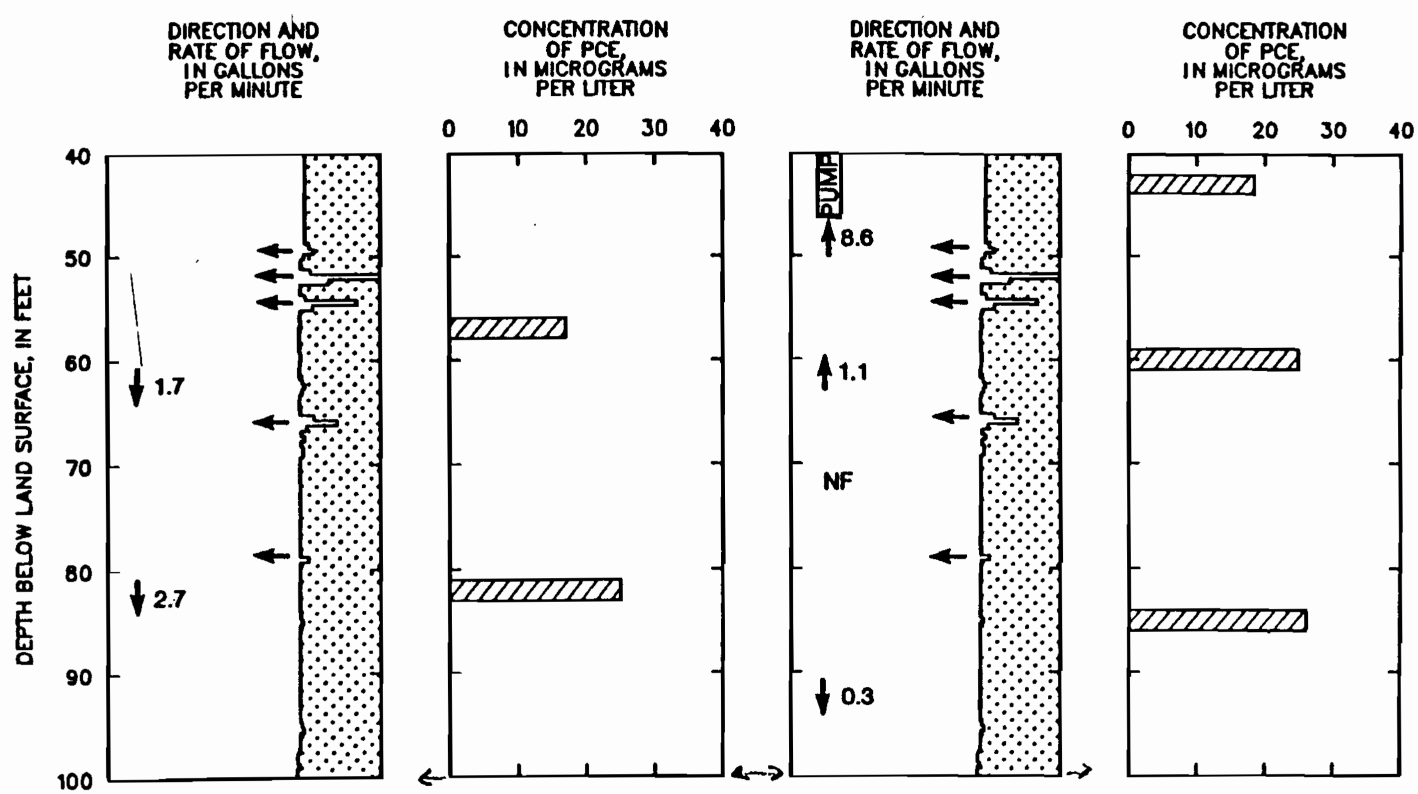


CAPACITY, IN GALLONS PER MINUTE PER FOOT OF DRAWDOWN
straddle-packer test
Flowmeter survey
DOWNWARD FLOW RATE, IN GALLONS PER MINUTE
FLUID RESISTIVITY, IN OHM-METERS
FLUID RESISTIVTY
TEMPERATURE
TEMPERATURE, IN DEGREES CELSIUS
HOLE DIAMETER, IN INCHES
CALIPER
GAMMA, IN COUNTS PER SECOND
SINGLE-POINT RESISTANCE
GAMMA
RESISTANCE, IN COUNTS PER SECOND
DEPTH BELOW LAND SURFACE, IN FEET

Fig. 6



RATE AND DIRECTION OF FLOW, IN GALLONS PER MINUTE
DEPTH BELOW LAND SURFACE, IN FEET
CASING
50
55
60
65
70
.31
.43
77.5
80
.43
.60
255
260
265
.62
.31
.47
.23
326.5
329.5
.26
0.0



DIRECTION AND RATE OF FLOW, IN GALLONS PER MINUTE
CONCENTRATION OF PCE, IN MICROGRAMS PER LITER
DIRECTION AND RATE OF FLOW, IN GALLONS PER MINUTE
CONCENTRATION OF PCE, IN MICROGRAMS PER LITER
DEPTH BELOW LAND SURFACE, IN FEET
40
50
60
70
80
90
100
0
10
20
30
40
1.7
2.7
PUMP
8.6
1.1
NF
0.3

Fig. 9