APT REANALYSIS

SITE: ACME Improvement District
Section 25, Township 44S, Range 46E

REPORT: Gee & Jenson, Supplementary Engineering Report, Water Supply Development, Section 25, for ACME Improvement District, November, 1980.

GEOLOGIC DATA: Appendix A, pp. 5, 6

Lithologic descriptions included for wells PW 18, 18-1D, 18-2D, 18-3D, TW-13, TW-14, and TW-15. A generalized site lithology based on these descriptions is as follows:

0-5	sand, fine to very fine
5-15	limestone
15-65	sand, fine to very fine
65-115	limestone and sand interlayered
115-125	clayey sand (considered a semi-confining bed)
125-130	limestone with silty clay

Water quality becomes highly mineralized in lowest limestone unit.

Base of the Surficial aquifer estimated at -166 feet NGVD from Miller (1987).

Site elevation is approximately 18 feet NGVD.

Depth to water is approximately 4 feet.

WELL DESCRIPTIONS:

Well	Diam. (in)	Total Depth (ft)	Cased Depth (ft)	Screen /Open	r (ft)
PW-18	12"	90	70	screen	pumped
TW-13	2"	100	60	screen	
TW-14	2"	100	60	screen	
TW-15	2"	100	55	screen	
18-1S	2"	10	60	screen	33
18-1D	2"	90	70	screen	33
18-2D	2"	90	70	screen	130
18-3D	2"	90	70	screen	200

Wells TW-13, TW-14, and TW-15 were not used in the APT.

INFLUENCING FACTORS: Figures 2 and 3

1) There is a drainage ditch located within 10 feet of PW-18 and wells 18-1S and 18-1D. No information is given on the ditch.

2) There is a canal located approximately 150 feet south of PW-18 and another canal located about 400 feet west of PW-18. No further information is given on either canal.

APT: pp. 6-8

Start: 9/24/80
Discharge: 900 GPM to canal 450' away
Duration: 72 hrs.
Recovery: 4 hrs.

Water levels were measured in observation wells 18-1S, 18-1D, 18-2D, 18-3D and in the ditch and two canals.

CONSULTANT'S ANALYSIS: pp. 9-13

Method: Boulton Method (Boulton 1963)

Results:

	Early Time		Late Time	
Well	T(GPD/FT)	S	T(GPD/FT)	S
18-1D	33,816	1.6×10^{-2}	-	-
18-2D	49,114	2.5×10^{-4}	46,881	0.26
18-3D	49,114	5.4×10^{-3}	49,114	0.21
Avg.	44,015	5.4×10^{-3}	47,998	0.23

Comments:

1) The consultant was unable to fit a late time curve to data from 18-1D. Although data for 18-2D and 18-3D show possible delayed yield, it would also appear difficult to fit.

2) Data for 18-1S was collected but not analyzed. A plot of drawdown for 18-1S shows.

3) Consultant found poor comparison between actual drawdowns and drawdowns predicted using average values of T, 46,000 GPD/FT, and S, .23.

4) Partial penetration and canal leakance were not accounted for.

REANALYSIS:

Method: Neuman (1975)

Results:

Early Time

Well	T(FT2/DAY)	S	K_D
18-1S	20,000	.0010	.01
18-2D	12,500	.0011	.01
18-3D	12,500	.00065	.01
Avg.	15,000	.0009	.01

Comments:

1) Data was used as measured. No canal or drainage ditch recharge corrections were made due to lack of data.

2) The time-drawdown curve for well 18-1D was quite flat. Therefore, it was not used in the curve matching.

3) Drawdown curves were matched to Neuman curves with beta values chosen so that K_D would be the same for all wells. Curves were matched for several K_D's. A K_D value of .01 gave the most consistent results between wells.

RECOMMENDED VALUES:

REFERENCES:

Miller, W. L., 1986. Lithology and Base of the Surficial Aquifer System, Palm Beach County, Florida. USGS Water Resources Investigation Report 86-4067.

Neuman, S. P., 1975. Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response. Water Resources Research, Vol. 10, No. 2.

Acme Improvement District APT Well 18-10

Match Point

$t = 1$ ft $s_d = 2.7$

$s = (10)$ min $t_s = 57.5$

$Q = 900$ gpm $= 120.32$ ft³/min

$r = 33'$

$\beta = .004$

$b = h = 114'$

$T = \frac{114.6\ Q\ s_d}{s}$

$= \frac{(114.6)(900)(2.7)}{10}$ ✓

$= 27,847$ gpd/ft

Neuman Analysis

(3,723 FT²/day)

$S = \frac{Tt}{2693 r^2 t_s}$

$= \frac{(27847)(1)}{(2693)(33^2)(57.5)}$

$= 1.65 \times 10^{-4}$ ✓

$K_h = T/b$

$= \frac{27,848}{114}$

$= 244.3$ gpd/ft²

$K_d = \frac{\beta b^2}{r^2}$

$= \frac{(.004)(114)^2}{33^2} = .048$

$K_z = K_h/K_d$

$= (244.3)(.048)$

$= 11.66$ gpd/ft²

Very Good Match (4) but flat curve

Streltsov II

$\rho' = .1$

✓ $s = 10$ ft $W = .56$ ✓

✓ $t = 1$ min $\theta = 14$ ✓

→ 30,852 gpm/ft ÷ 7.48 g/ft³ = 4.125 ft³/min-ft ✓

$T = \frac{W Q}{4\pi s (l' - l_1')}$

$= \frac{.56 (900 gpm)}{4\pi (10)(.74 - .61)}$ .13

$= \frac{504}{16.336}$

$= 30.85 \times 1440$

$= 44427$ gpd/ft ✓

$S = \frac{4Tt}{\theta r^2}$

$= \frac{4 (4.125)(1)}{14 (33^2)}$

$= \frac{16.498}{15246}$

$= .00108$ ✓

$K_h = T/b$

$= \frac{44427}{114'}$

$= 389.71$ gpd/ft² ✓

$\rho = \rho' b$

$= .1 (114)$

$= 11.4$

$\rho = \sqrt{K_v/K_h}\ (r)$

$\frac{11.4}{33} = \sqrt{\frac{K_v}{K_h}}$

$.345 = \sqrt{K_v/K_h}$ ✓

$.119 = K_v/K_h$ ✓

$K_v = (K_v/K_h)(K_h)$

$= .119 (389.7)$

$= 46.4$ gpd/ft²

Excellent Match but flat curve

Acme Improvement District APT   Well 18-1D

Streltsova Analysis

$t = 180$ min $\sigma = 10^4$ ✓
$\sqrt{s} = 7.5$ ft $W = 1$ ✓

$r = 33'$
$Q = 900$ gpm $= 120.32\ ft^3/min$
$\gamma' = .8$
$\ell' = .8$
$\rho' = .1$
$b = 114$

$$T = \frac{WQ}{4\pi s \ell'}$$

$$= \frac{(1)(120.32)}{(4)(\pi)(7.5)(.8)}$$

$= 1.59\ ft^3/min\text{-}ft \times 7.48\ g/ft^3 = 11.94\ gpm/ft \times 1440\ m/d = 17{,}189\ gpd/ft$ ✓ ✓ ✓
$(2290\ FT^2/DAY)$

$$S = \frac{4Tt}{\sigma r^2}$$

$$= \frac{(4)(1.59)(180)}{(10^4)(33^2)}$$

$= 1.05 \times 10^{-4}$ ✓

$$K_h = T/b$$

$$= \frac{17189}{114}$$

$= 150.8$

$\rho = \rho' h$
$= (.1)(114)$
$= 11.4$

$$\rho = \sqrt{K_v/K_h}\ r$$

$$11.4/33 = \sqrt{K_v/K_h}$$

$K_v/K_h = .12$ ✓

$K_v = (K_v/K_h)(K_h)$
$= (.12)(150.8)$
$= 17.99$ ✓

Excellent Match (5) but flat curve

Acme Improvement District | APT - Well 18-20

Neuman Analysis

$r = 130'$
$Q = 900\,GPM$
$b = 114'$
$\beta = .004$

✓ $z = 1$ $S_d = .56$ ✓
✓ $s = 1$ $t_s = 7$ ✓

(discounted 4 early data points)

$$T = \frac{114.6\,Q\,S_d}{s}$$

$$= \frac{(114.6)(900)(.56)}{1}$$

$= 57,758$ GPD/FT (7722 FT²/DAY)

$$S = \frac{Tt}{2693\,r^2\,t_s}$$

$$= \frac{(57,758)(1)}{(2693)(130^2)(7)}$$

$= 1.81 \times 10^{-4}$ ✓

$K_h = T/b$
$= 57758/114$
$= 506.65$ GPD/FT² (67.7 FT/DAY)

$K_d = \beta b^2 / r^2$

$$= \frac{(.004)(114^2)}{(130^2)}$$

$= .0031$ ✓

$K_z = K_h K_d$
$= (506.65)(.0031)$
$= 1.56$ ✓

Good Match (3) Early data ~ < 1 min off

Acme Improvement | APT - Well 18-2D | r = 130'

Streltsova Analysis

$Q = 900$ gpm $= 120.32$ ft³/min
$y' = .74$
$\ell' = .74$
$\rho' = .3$
$b = 114'$

Match Points

✓ $t = .37$ min ✓ $\omega = 1$ $\ell' = .8$
✓ $s = 5.9$ ft ✓ $\sigma = 1$ $y' = .8$

$$T = \frac{\omega Q}{4\pi s \,\sigma'} = \frac{1\,(120.32\ ft^3/m)}{4\pi(5.9)(0.8)}$$

$= 2.028$ ft³/min-ft ✓ (2923 ft²/DAY)

× 7.48 g/ft³ = 15.17 gpm/ft

× 1440 m/d = 21,850 gpd/ft ✓

$$S = \frac{4tT}{\sigma r^2} = \frac{4(.37)(2.028)}{1\,(130)^2}$$

$= 1.78 \times 10^{-4}$ ✓

$\rho = \rho' h = (.3)(114) = 34.2$

$\rho = \sqrt{K_v/K_h}\,(r)$

$34.2 = \sqrt{K_v/K_h}\,(130')$

$.263 = \sqrt{K_v/K_h}$

$.069 = K_v/K_h$ ✓

$K_h = T/b = \frac{21850}{114} = 192$ ✓

$K_v = .069\,(192) = 13.2$ ✓

Fair Match (2)

Streltsova II

✓ $t = 1$ $\sigma = 2.0$ ✓
✓ $s = 1$ $\omega = .124$ ✓

$r = 130'$
$Q = 900$ gpm $= 120.32$ ft³/min
$\rho' = .1$

$\ell' = .74$
$z' = .74$
$\ell_1' = .61$

$$T = \frac{\omega Q}{4\pi s(\ell' - \ell_1')} = \frac{.124\,(120.32)}{4\pi(1)(.74 - .61)}$$

$= 9.13$ ft³/ft-min (13,147 ft²/DAY)

× 7.48 g/ft³

$= 68.31$ gpm/ft

× 1440 m/d $= 98,371$ gpd/ft ✓

$$S = \frac{4Tt}{\sigma r^2} = \frac{4(9.13)(1)}{2.0\,(130)^2}$$

$= .1.08 \times 10^{-3}$ ✓

$K_h = T/b = \frac{98410}{114} = 863$ gpd/ft² ✓

$\rho = \rho' b = .1\,(114) = 11.4$

$\rho = \sqrt{K_v/K_h}\ r$

$\frac{11.4}{130} = \sqrt{\frac{K_v}{K_h}}$

$.007689 = K_v/K_h$ ✓

$K_v = (K_v/K_h)(K_h) = .007689\,(863) = 6.636$ gpd/ft² ✓

Good Match (3) but early data, ~2 (min) off

Neuman Analysis

$t = 1$
$S = 1$

$S_d = .58$ ✓
$t_s = 3.2$? ✓

$Q = 900$
$r = 200$
$\beta = .01$
$b = 114\ ft$

$$T = \frac{114.6\ Q\ S_d}{S}$$
$$= \frac{114.6(900)(.58)}{1}$$
$$= 59{,}821\ GPD/FT \quad (7997\ FT^2/DAY)$$

$$S = \frac{Tt}{2693 r^2 t_s}$$
$$= \frac{(59821)(1)}{2693(200)^2(3.2)}$$
$$= \frac{59821}{344704000}$$
$$= .00017$$ ✓

$$S_y = \frac{C_2 T t}{r^2 t_y}$$
$$= \frac{(.1337)(59{,}821)(1)}{(200^2)(.005)}$$
$$= 39$$
??

$$K_h = T/b$$
$$= \frac{59{,}821}{114}$$
$$= 524.7\ gpd/ft^2$$

$$K_d = \frac{\beta b^2}{r^2}$$
$$= \frac{(.01)(114^2)}{200^2}$$
$$= .0032$$

$$K_z = K_d K_h$$
$$= (.0032)(524.7)$$
$$= 1.70\ gpd/ft^2$$ ✓

Good Match (3) but early data < 2 min off

Acme Improvement District | Well 18-3D

Streltsova Analysis

✓ $s = 3.4$ ft $\theta = 1$ ✓
✓ $t = .43$ min $W = 1$ ✓

$r = 200$ ft
$Q = 900$ GPM
$y' = .74$, $l' = .74$ } use .8, .8 to match curves
$\rho' : .2$
$b : 114$

Very Good Match (4) but early data < 1 min off

$$T = \frac{WQ}{4\pi s l'} \times 1440$$
$$= \frac{(1)(900)}{4\pi(3.4)(.8)} \times 1440$$
$$= \frac{900}{34.18} \times 1440$$ ✓
$$= (26.33) \times 1440$$
$$= 37{,}917 \text{ gpd/ft} = 26.33 \text{ gpm/d} \div 7.48 \text{ g/ft}^3 = 3.52 \text{ ft}^3\text{/min-ft}$$ ✓
(5072 FT²/DAY)

$$S = \frac{4Tt}{\theta r^2}$$
$$= \frac{4(3.52)(.43)}{(1)(200)^2} = 1.5 \times 10^{-4}$$ ✓

$$K_h = T/b = \frac{37917}{114} = 332.6 \text{ GPD/FT}^2$$ ✓

$$\rho = \rho' h = .2(114) = 22.8$$

$$\rho = \sqrt{K_v/K_h}\,(r)$$
$$\frac{22.8}{200} = \sqrt{\frac{K_v}{K_h}}$$
$$(.114)^2 \quad K_v/K_h$$
$$.013 = K_v/K_h$$ ✓

$$K_v = (K_v/K_h)(K_h)$$
$$= .013(332.6)$$
$$= 4.324 \text{ GPD/FT}^2$$

Streltsova II (the sequel)

✓ $t = 1$ $\theta = 1.9$ ✓
✓ $s = 1$ $W = .25$ ✓

$z' = .74$ $\rho' = .05$
$l' = .74$ $l_1' = .61$

Very Good Match (4) but early data < 1 min. off

$$T = \frac{(.25)(900)}{(4)(\pi)(1)(.74-.61)} = 137.73 \text{ gpm/ft} \times 1440 \text{ m/d} = 198{,}331 \text{ gpd/ft}$$ ✓ (26,528 FT²/DAY)
$$137.73 \div 7.48 \text{ g/ft}^3 = 18.41 \text{ ft}^3\text{/min/ft}$$

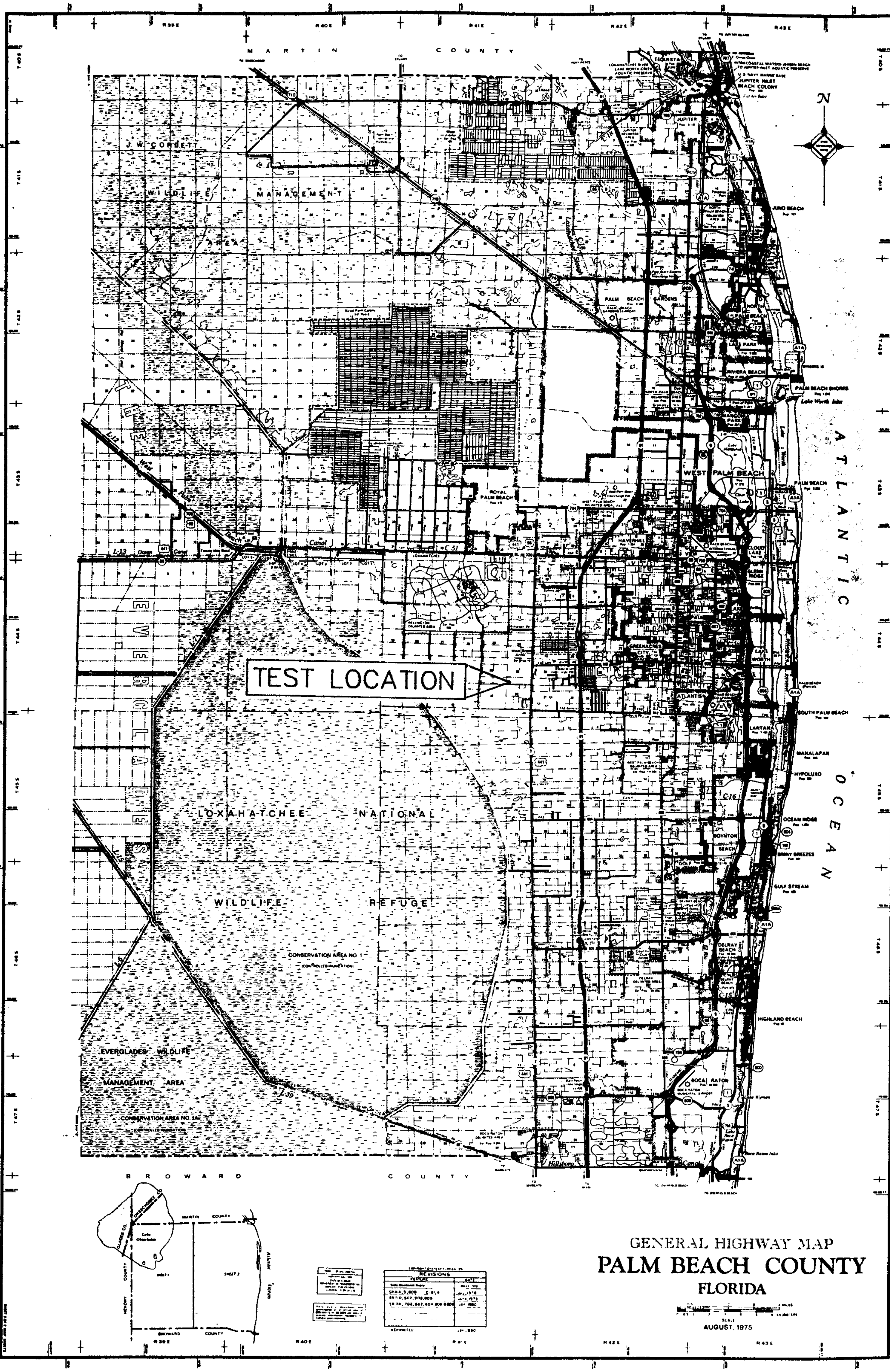
$$S = \frac{(4)(18.41)(1)}{(1.9)(200^2)} = 9.7 \times 10^{-4}$$ ✓

$$K_h = T/b = \frac{198331}{114} = 1740 \text{ gpd/ft}^2$$ ✓

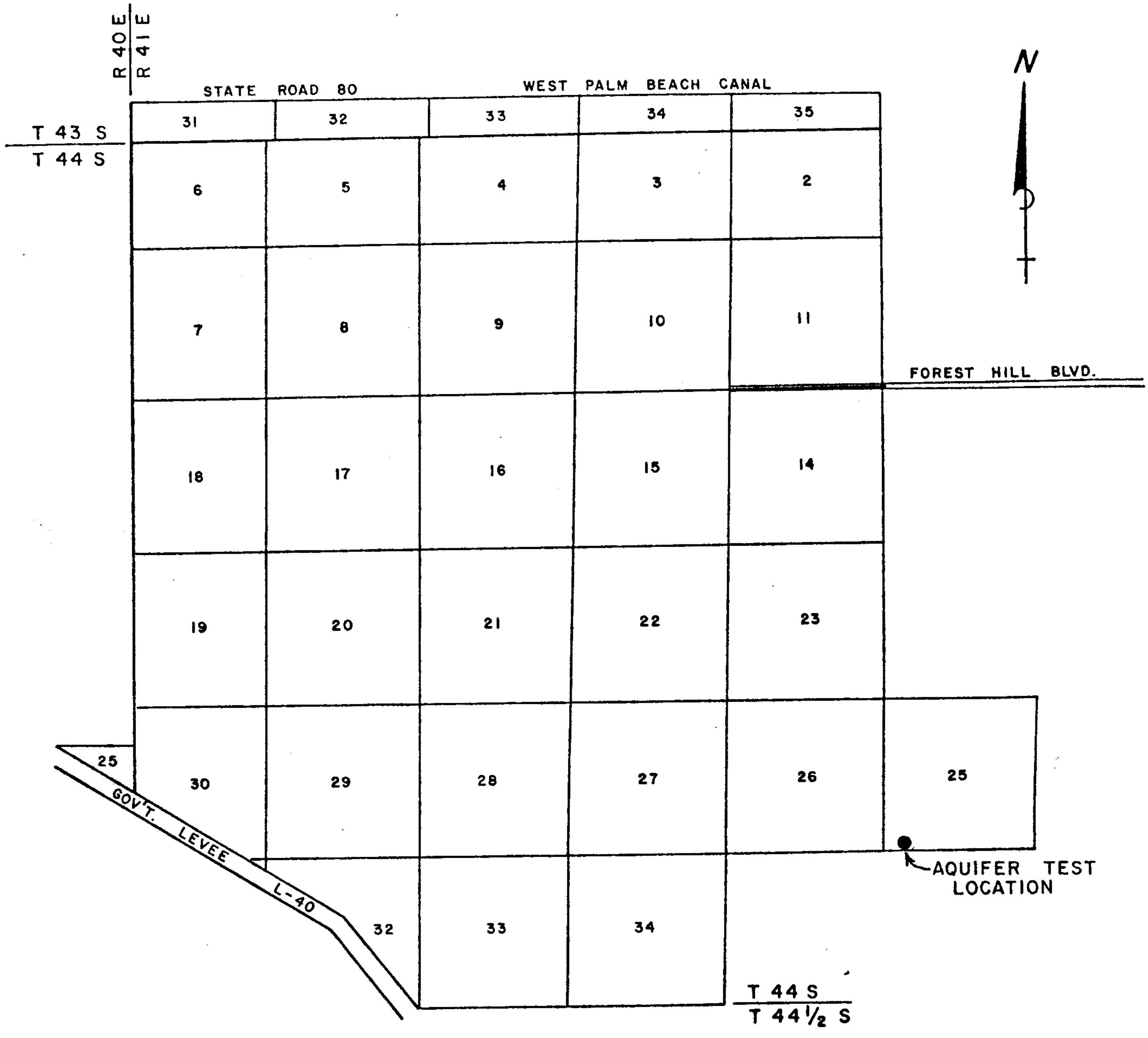
$$\rho = \rho' h = (.05)(114) = 5.7$$

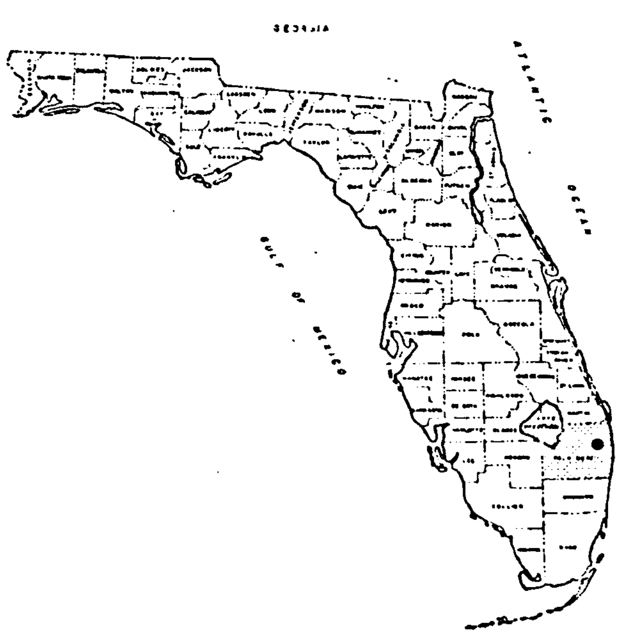
$$\rho = \sqrt{K_v/K_h}\; r$$
$$\frac{5.7}{200} = \sqrt{K_v/K_h}$$
$$K_v/K_h = .000812$$ ✓

$$K_v = (K_v/K_h)(K_h)$$
$$= (.000812)(1740)$$
$$= 1.41 \text{ GPD/FT}^2$$ ✓



MARTIN COUNTY
BROWARD COUNTY
J. W. CORBETT WILDLIFE MANAGEMENT AREA
TEST LOCATION
LOXAHATCHEE NATIONAL WILDLIFE REFUGE
CONSERVATION AREA NO. 1
EVERGLADES WILDLIFE MANAGEMENT AREA
CONSERVATION AREA NO. 2A
ROYAL PALM BEACH
WEST PALM BEACH
PALM BEACH GARDENS
JUPITER
TEQUESTA
JUNO BEACH
RIVIERA BEACH
PALM BEACH SHORES
PALM BEACH
LAKE WORTH
GREENACRES CITY
ATLANTIS
LANTANA
SOUTH PALM BEACH
MANALAPAN
HYPOLUXO
BOYNTON BEACH
OCEAN RIDGE
BRINY BREEZES
GULF STREAM
DELRAY BEACH
HIGHLAND BEACH
BOCA RATON
ATLANTIC OCEAN
N
R 39 E
R 40 E
R 41 E
R 42 E
R 43 E
GENERAL HIGHWAY MAP
PALM BEACH COUNTY
FLORIDA
AUGUST, 1975





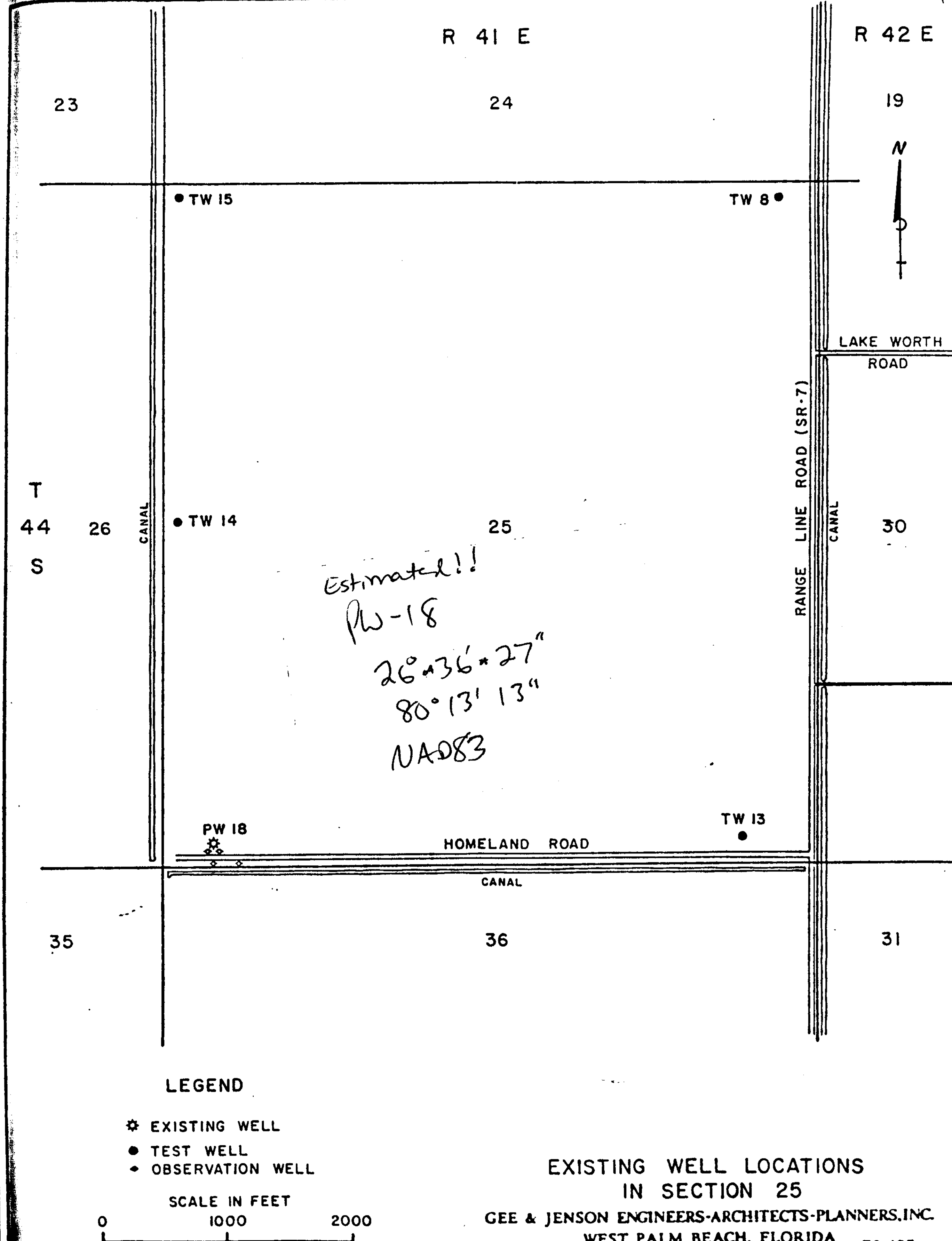
ACME IMPROVEMENT DISTRICT LOCATION MAP

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLORIDA

79-183

PB120

FIGURE 1



EXISTING WELL LOCATIONS IN SECTION 25

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLORIDA

79-183

FIGURE 2

WELL CONSTRUCTION

Well No. Observation 18-2D

Driller: Alsay-Pippin

Samples: Cuttings X, Core

Casing: Depth 70 feet

Diameter 2 inches

Material Schedule 40

Location: Acme Improvement District

Recorded by: GR

Date Drilled: September 15, 1980

Screen: Depth 70-90 feet

Diameter 2 inches

Material Schedule 40, PVC #40 Slot

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-15	Shell-white, gastropods and pelecypods, whole fragmental, poorly consolidated, 80%.
	Sand-silica, light brown, fine grained, 10%.
	Limestone-intrabiosparite, light gray to gray, composed of medium to fine grained silica sand and shell fragments, lithified, 10%.
15-45	Sand-silica, light brown, fine to very fine grained, trace of fine fragmented white shell fragments, unconsolidated.
45-62	Sand-silica, brownish white, fine grained to silt sized grains, trace of black fine grained phosphate particles, unconsolidated.
62-80	Limestone-intrabiosparite, dark gray, composed of fine grained silica sand and white shell fragments, lithified concretions, 60%.
	Sand-silica and carbonate, very fine to fine grained, abundant, very fine grained, black phosphate particles, unconsolidated, 40%.
80-90	Limestone-intrabiosparite, dark gray, composed of fine grained silica sand and white shell fragments with a sparry calcite cement, lithified, 70%.
	Sand and Shell-fine grained silica and carbonate sand, and light brown pelecypod fragments, unconsolidated, 30%.

PB 120

WELL CONSTRUCTION

Well No. Observation Well 18-3D   Location Acme Improvement District

Driller: Alsay-Pippin   Recorded by: GR

Samples: Cuttings X, Core ____   Date Drilled: September 16, 1980

Casing: Depth 70 feet   Screen: Depth 70-90 feet

Diameter 2 inches   Diameter 2 inches

Material Schedule 40 PVC   Material Schedule 40 PVC, #40 S

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-15	Shell-white, gastropods and pelecypods, whole and fragmental, poorly consolidated, 80%
	Sand-silica, light brown, fine grained, 10%.
	Limestone - intrabiosparite, light gray to gray, composed of medium to fine grained silica and shell fragments, lithified , 10%.
15-45	Sand-silica, light brown, fine to very fine grained, trace of fine fragmented white shell fragments, unconsolidated.
45-62	Sand-silica, brownish white, fine grained to silt sized grains, trace of black fine grained phosphate particles, unconsolidated.
62-80	Limestone-intrabiosparite, dark gray, composed of fine grained silica sand and white shell fragments, lithified concretions, 60%.
	Sand-silica and carbonate, very fine to fine grained abundant very fine grained black phosphate particles, unconsolidated 40%.
80-90	Limestone-intrabiosparite, dark gray, composed of fine grained silica sand and white shell fragments with a sparry calcite cement, lithified 70%.
	Sand and Shell-fine grained silica and carbonate sand and light brown pelecypod fragments, unconsolidated 30%.

80-196

PB 120

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS,INC.

WELL CONSTRUCTION

Well No. Test Well #13 (TW-13)

Driller: Alsay-Pippin

Samples: Cuttings ____, Core ____

Casing: Depth 130 filled to 100 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: July 28, 1980

Screen: Depth 60-130 feet

Diameter 2 inches

Material Schedule 40 PVC #40 Slot

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-20	Sand-silica, brown, fine grained, abundant white pelecypods and gastropods, some small limestone fragments, unconsolidated.
20-30	Sand-silica, light brown, fine to medium grained, 70 percent fines, trace of white shell fragments, unconsolidated.
30-50	Sand-silica, very fine to fine grained, light brown, trace of white shell fragments, unconsolidated.
50-62	Sand-silica, very fine to fine grained, light brown, off white shell fragments, unconsolidated, trace of very fine grained phosphate sand.
62-68	Limestone-phosphatic intrabiosparite with lenses of micrite, dark gray to very light brown, some recrystalization and trace of white shell fragments, lithified.
68-79	Limestone-phosphatic intrabiosparite, dark gray abundant recrystalization, abundant pelecypod and gastropod fragments, well lithified.
79-95	Limestone-same as above, but no gastropods and more dense.
95-110	Limestone-phosphatic intrabiosparite, dark gray, abundant recrystalization, abundant pelecypod and gastropod fragments, well lithified, with lens of micrite (3') at 100 feet and an increase in recrystallization of pelecypods.

PB 120

WELL CONSTRUCTION

Well No. Test Well 13 (TW-13)

Driller: Alsay-Pippin

Samples: Cuttings ________, Core ________

Casing: Depth 130 filled to 100 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: July 28, 1980

Screen: Depth 60-130 feet

Diameter 2-inches

Material Schedule 40 PVC #40 S

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
110-120	Limestone-dark gray intrabiosparite interbedded with micrite, abundant shell and silty white clay, barnacle fragments, coral polyps and Echinoderm spines.
120-130	Silty clay, lime mud, carbonate sand, grayish white, trace of phosphate particles with some sparite and micrite.

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

WELL CONSTRUCTION

Well No. Test Well #15 (TW-15)

Driller: Alsay-Pippin

Samples: Cuttings ________, Core ________

Casing: Depth 130 filled to 100 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: July 31, 1980

Screen: Depth 60-130 feet

Diameter 2 inches

Material Schedule 40 PVC #40 Slot

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-14	Sand-silica, dolomitic limestone and micrite and abundant shell, light brown, (fill from adjacent canal).
14-50	Sand-silica, light brown, fine to very fine grained, trace of fine to medium grained shell fragments, unconsolidated.
50-56	Sand-silica, light gray, fine to very fine grained, abundant fine grained phosphate, trace of shell fragments, unconsolidated.
56-70	Limestone-gray intrabiosparite, phosphatic, trace of micritic limestone, (bio), lithified.
70-79	Limestone-gray intrabiosparite, phosphatic, trace micritic limestone (bio), lithified; trace of silty white clay and micrite.
80-	Shell-lense, gastropods, pelecypods and abundant clay.
81-90	Limestone: gray intrabiosparite, phosphatic, trace of micritic limestone lithified, with a trace of shell fragments.
90-98	Same as above with an increase in shell fragments, pelecypods and gastropods.
98-100	Sand-silica, carbonate sand, fine grained shell fragments, abundant phosphate, light gray, trace of silty clay, unconsolidated.
100-107	Sand-silica, some carbonate, fine grained shell fragments, abundant phosphate, light gray, trace of silty clay, unconsolidated.
107-110	Shell-white to light brown, pelecypod and gastropod fragments, poorly consolidated.

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

WELL CONSTRUCTION

Well No. Test Well #15 (TW-15)

Driller: Alsay-Pippin

Samples: Cuttings ____, Core ____

Casing: Depth 130 filled to 100 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: July 31, 1980

Screen: Depth 60-130 feet

Diameter 2 inches

Material Schedule 40 PVC #30 Sl

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
110-120	Limestone-biointramicrite, light brown, abundant pelecypods and gastropods, abundant silty clay, poorly lithified, trace of phosphate.
120-132	Limestone-intrabiomicrite, light gray, abundant phosphate and silty white clay, trace of pelecypods, poorly lithified.

80-196

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

WELL CONSTRUCTION

Well No. Test Well #14 (TW-14)

Driller: Alsay-Pippin

Samples: Cuttings ______, Core ______

Casing: Depth 130 filled to 100 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: July 30, 1980

Screen: Depth 60-130 feet

Diameter 2 inches

Material Schedule 40 PVC #40 Slot

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-26	Sand-silica, shell, white, fine grained, abundant carbonate sand, 60 percent pelecypods, minor gastropods, fill from adjacent ditch, unconsolidated.
26-40	Sand-silica, brown, fine to very fine grained, minor fine grained shell fragments, unconsolidated.
40-67	Sand-silica, light brown, fine to very fine grained, minor fine grained shell fragments, unconsolidated.
67-69	Dolomitic limestone and limestone, brown and gray, some silica sand.
69-75	Limestone-intrabiosparite, gray, phosphatic grains, hardness increases, well lithified.
75-80	Limestone-same as above, but calcite crystals and calcite replacement in pelecypods is minor, also had an increase in fluid loss.
80-85	Limestone-same as above, but harder and fluid loss.
85-90	Limestone-same as above, but hit a 2 foot seam of micrite.
90-109	Limestone-same as above, but a little darker due to phosphate in a few spots.
109-120	Limestone-biosparite, shell fragments and Echinoderm fragments lithified with a sparite/calcite cement, white, density increases and much less fluid loss; abundant white silty clay and micrite.
120-130	Sand-silty, lime mud, shell fragments (mainly pelecypods) minor phosphate and micrite and sparite, loosely consolidated, in places.
80-196	

PB 120

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

WELL CONSTRUCTION

Well No. Observation Well 18-1D

Driller: Alsay-Pippin

Samples: Cuttings X , Core

Casing: Depth 70 feet

Diameter 2 inches

Material Schedule 40 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: September 15, 1980

Screen: Depth 70-90 feet

Diameter 2 inches

Material Schedule 40 PVC, #40 Sl

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-2	Sand-silica, light brown, fine grained, trace of very fine grained shell fragments, unconsolidated.
2-10	Limestone-intrabiomicrite, grayish brown, fine grained silica sand and micritic cement matrix surrounding abundant pelecypods and gastropods, poorly lithified.
10-20	Sand-silica, brown, fine to very fine grained, subangular, unconsolidated, 70%.
	Shell-white pelecypods and gastropods, large to small, whole and fragmented, 30%.
20-35	Sand-silica, light brown, fine to very fine grained, subangular, abundant pelecypod fragments, unconsolidated.
35-60	Sand-silica, very light brown, fine to very fine grained, subangular to subrounded, trace of white shell fragments, unconsolidated.
60-65	Sand-silica, very light gray brown, fine to very fine grained, subangular to subrounded, trace of black fine grained phosphate particles, unconsolidated.
65-70	Limestone-intrabiosparite, dark gray, pelecypod fragments incorporated in limestone, very fine grained phosphate particles present in silica sand matrix, lithified.
70-85	Limestone-intrabiosparite, same as above but minor large (less than 1 mm) calcite crystals present.
85-90	Limestone-intrabiosparite, light gray, same as 65-70 but surrounded by a matrix of pelecypod and gastropod fragments and carbonate sand, the limestone occurs as individual concretionary bodies, limestone is lithified but the sand and shell matrix is consolidated.

PB 120

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

WELL CONSTRUCTION

Well No. PW 18 (Test Supply Well #18)

Driller: Alsay-Pippin

Samples: Cuttings X , Core

Casing: Depth 70 feet

Diameter Outer - 18 inches, Inner - 12 inches

Material Outer - Steel, Inner - Schedule 80 PVC

Location: Acme Improvement District

Recorded by: GR

Date Drilled: August 15, 1980

Screen: Depth 70-90 feet

Diameter 12 inches

Material Telescope Size SS, #100 Slot

DEPTH BELOW LAND SURFACE (FEET)	LITHOLOGY DESCRIPTION
0-5	Sand-silica, white, very fine to silt sized grains, trace of organics, unconsolidated.
5-10	Limestone-intrasparite, light gray, cemented fine grained silica sand with pelecypod fragments, abundant, consolidated.
10-15	Limestone-same as above but increase in unconsolidated sand fraction and calcite crystals.
15-20	Sand-silica light brown very fine grained, abundant white pelecypod shellds, 15% intraspartie limestone.
20-25	Same as above.
25-60	Sand-silica, light brown, fine to silt sized grains, trace of white shell fragments, unconsolidated.
60-62	Sand-silica, and intramicritic limestone, white, consolidated and unconsolidated layers.
62-66	Limestone-intrabiosparite, gray, phosphatic, trace of shell fragments, well lithified.
66-68	Limestone-intrabiosparite, gray, mixed with a intra-micrite, much softer, poorly lithified.
68-85	Limestone-intrabiosparite, gray, phosphatic, hard, trace of shell fragments, trace of dolomitic lime-stone, increase in hardness at 80 feet, well lithified.
85-90	Limestone and shell-intrabiosparite, gray with shell lenses, shell is composed of pelecypods and gastropods, trace of medium grained silica sand, limestone is lithified and shell if poorly consolidated.

5.3 Results

Observed water levels in the observation wells were collected, reduced and plotted on double logarithmic drawdown vs. time plots for matching the Boulton type curves (Figures 6, 7, and 8). All raw field data has been included in Appendix B. Transmissivity and storage coefficient determinations were made for each of the deep observation wells. Table 2 summarizes the results. Early time results show confined and semi-confined storage coefficient values with an average value of 5.4×10^{-2} due to incomplete dewatering. During this early period of pumping, water is released instantaneously from storage by the compaction of the water and the curve conforms to the Theis curve. During the second segment, the effects of gravity drainage are felt and the slope of the curve decreases relative to the Theis curve due to dewatering of the falling water table. The third segment occurring at later times, once again conforms to the Theis curve. Late time data gave average storage coefficient values of 0.23 which is as expected for an unconfined system. The average transmissivity value for all analyses is about 46,000 gpd/ft. It must be recognized that a considerable range may exist, between 34,000 gpd/ft and 50,000 gpd/ft depending on specific conditions and the method of analysis utilized.

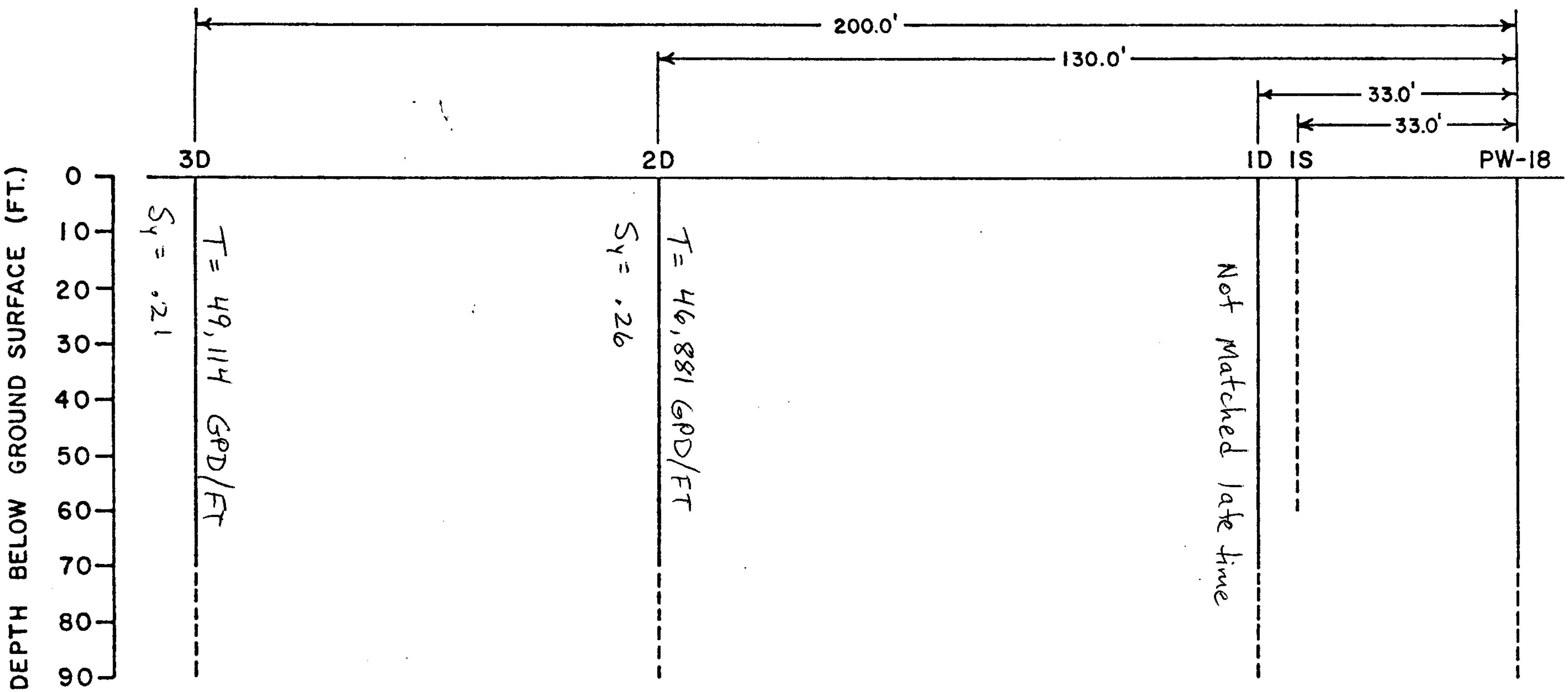
Drawdowns can be calculated based upon the calculated values of T = 46,000 gpd/ft and S = 0.23. These drawdowns were found to be a poor match with the actual drawdowns measured in the field. The lithology in the area indicated water table conditions (refer to Section 4.0 and Appendix A for descriptions). In designing well field systems, conservative values for the aquifer parameters are generally chosen. In this case T = 34,000 gpd/ft and S = 0.1 were found to give reasonably close approximations to field data after three days of pumping. Table 3 shows a comparison of the calculated vs. field drawdowns.

Carrying the analysis further, drawdowns for various intervals of time were calculated. The intervals used were 1 day, 3 days and 30 days, assuming continuous pumping at 900 gpm and no recharge to the system. This extrapolated data is used in a later section to design the wellfield and determine impacts. The drawdown vs. distance data is then plotted in Figure 9 giving a graphical representation of the cone of influence at 900 gpm. In Table 3 it should be noted that although the calculated data after three days of pumping closely resembles the field drawdown data, the system appears to have reached near equilibrium after one day of pumping according to the field data. This is further indication that the projected drawdowns are very conservative and represent worst case conditions for design purposes.

6.0 WATER QUALITY

Four test wells (Test Wells 8, 13, 14 and 15) had been drilled in Section 25 prior to construction of Test Supply Well No. 18. Each of these wells showed potable water extending to a depth of approximately 120 feet. Below 120 feet, these test wells produced highly mineralized water under artesian pressure. A low permeability clayey sand (at 100 to 120 feet below lsd appears to act as a confining or semi-confining bed, maintaining this highly mineralized water below it. To avoid vertical migration of this saline water, each of these wells were plugged with grout to 100 feet. Conductivities of 500 to 700 umhos/cm was produced from each of these wells after plugging.

PW 18 was constructed with screen from 70 to 90 feet. Water quality samples were collected from the discharge during the 72 hour aquifer performance test and analyzed for standard potable mineral concentrations (Appendix C). One sample was taken one hour after pumping began at a rate of 900 gpm.



Boulton Analysis (No accounting for nearby canal or partial pen.)

Raw data available

LEGEND

2D WELL NO.

CASED INTERVAL

SCREENED INTERVAL

$\bar{T}$ = 47,998 GPD/FT

$\bar{S}_y$ = .23

SCALE IN FEET

0 20 40

Q = 900 GPM

72 hour test

SCHEMATIC OF AQUIFER TEST WELL LOCATIONS AND CONSTRUCTION CROSS SECTION

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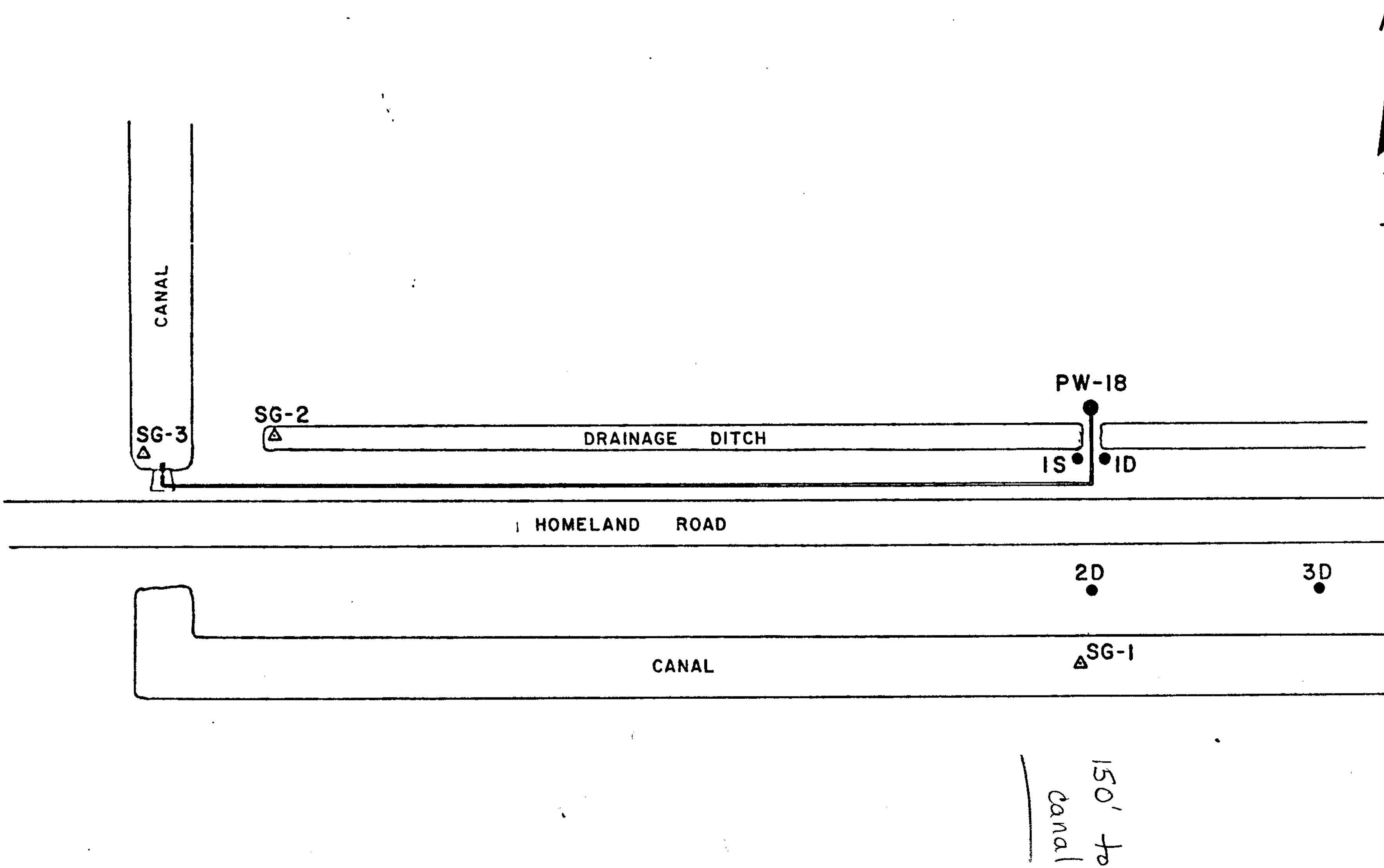
WEST PALM BEACH, FLORIDA

79-183

PB120

FIGURE 5



PB120

LEGEND

● DISCHARGING WELL

• OBSERVATION WELL (D=DEEP, S=SHALLOW)

△ STAFF GAGE

▬ DISCHARGE LINE

SCALE IN FEET

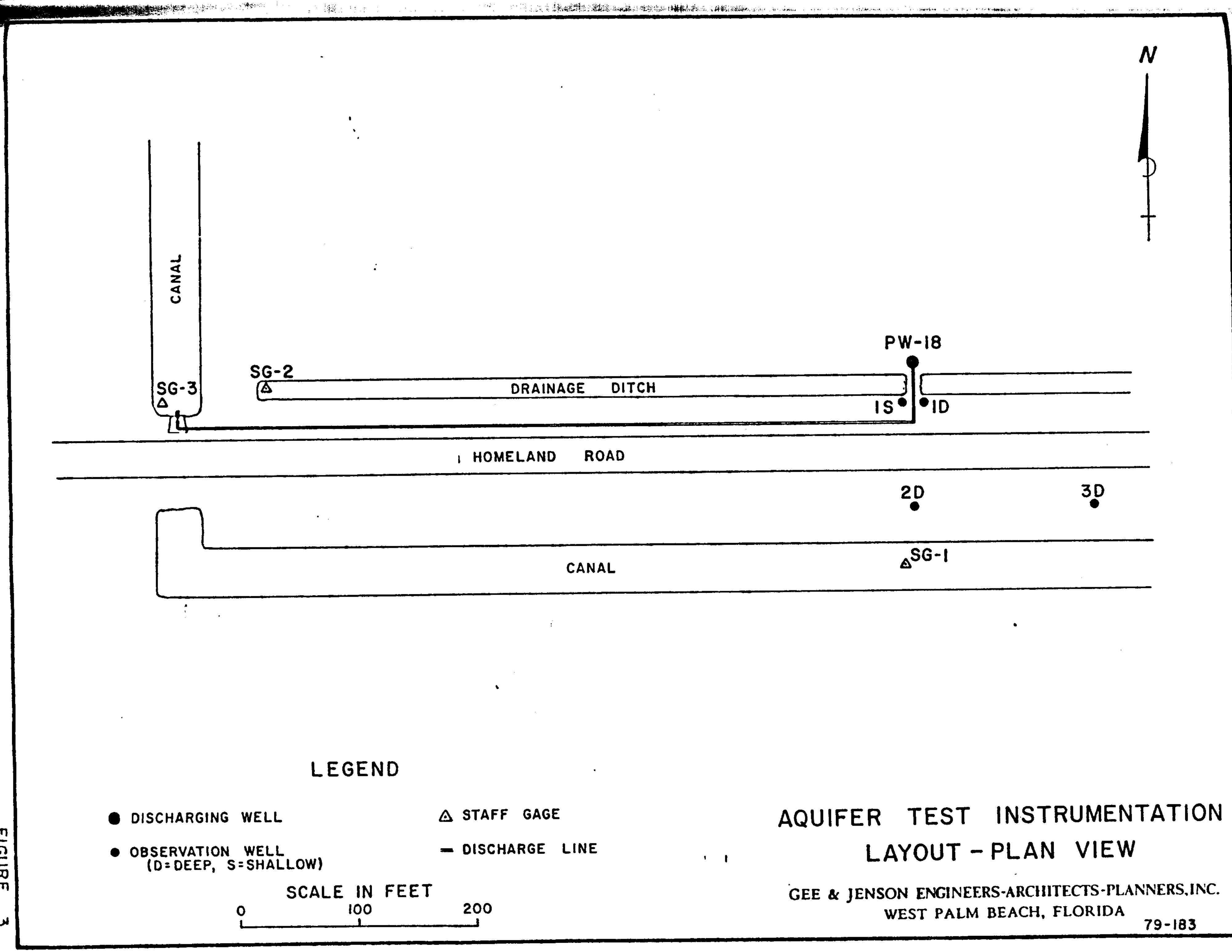
0 100 200

AQUIFER TEST INSTRUMENTATION LAYOUT - PLAN VIEW

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLORIDA

79-183

FIGURE 3


N
CANAL
PW-18
SG-2
SG-3
DRAINAGE DITCH
IS
ID
HOMELAND ROAD
2D
3D
SG-1
CANAL
LEGEND
DISCHARGING WELL
STAFF GAGE
OBSERVATION WELL
(D=DEEP, S=SHALLOW)
DISCHARGE LINE
SCALE IN FEET
0
100
200
AQUIFER TEST INSTRUMENTATION
LAYOUT - PLAN VIEW
GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
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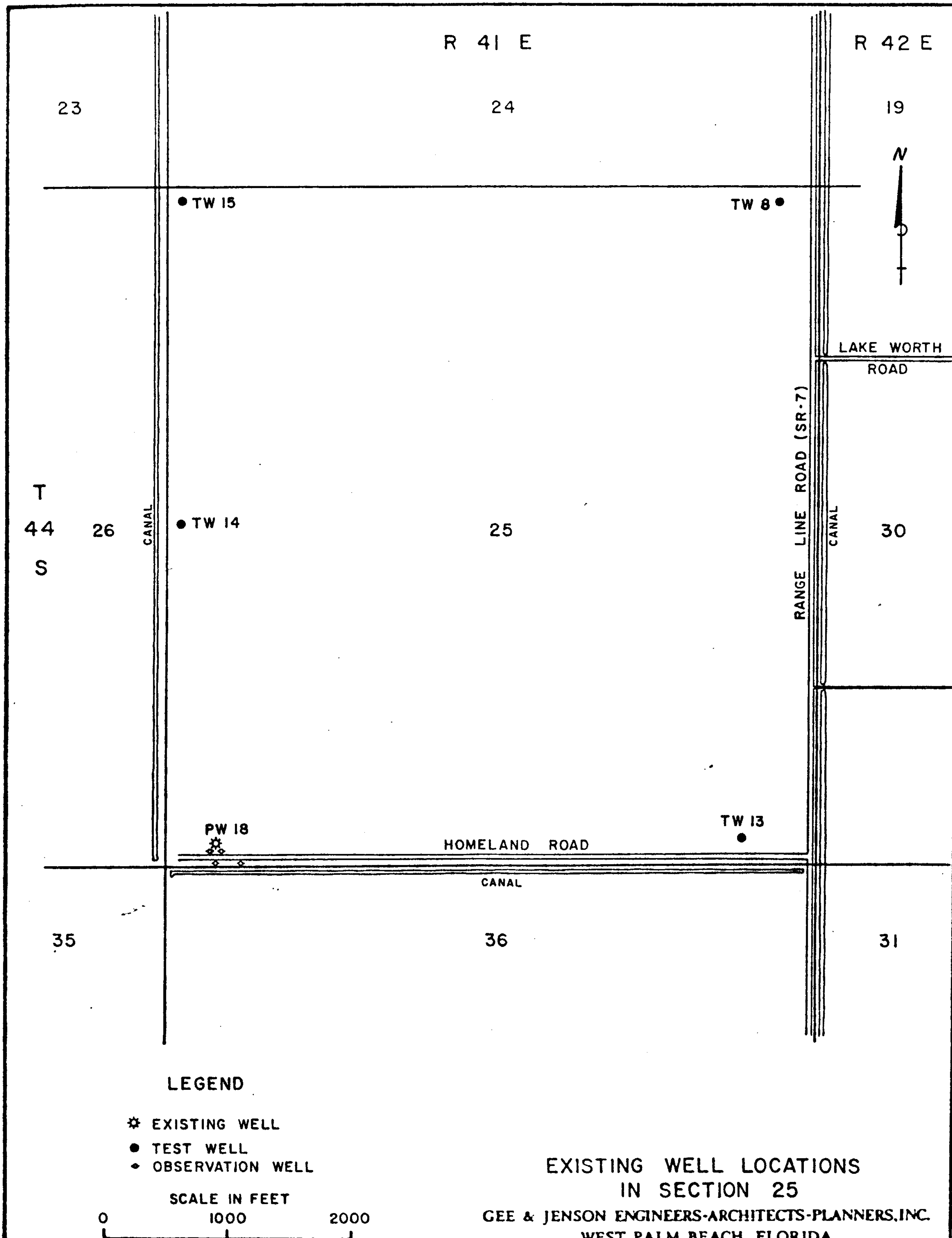
79-183

FIGURE 3



EXISTING WELL LOCATIONS
IN SECTION 25

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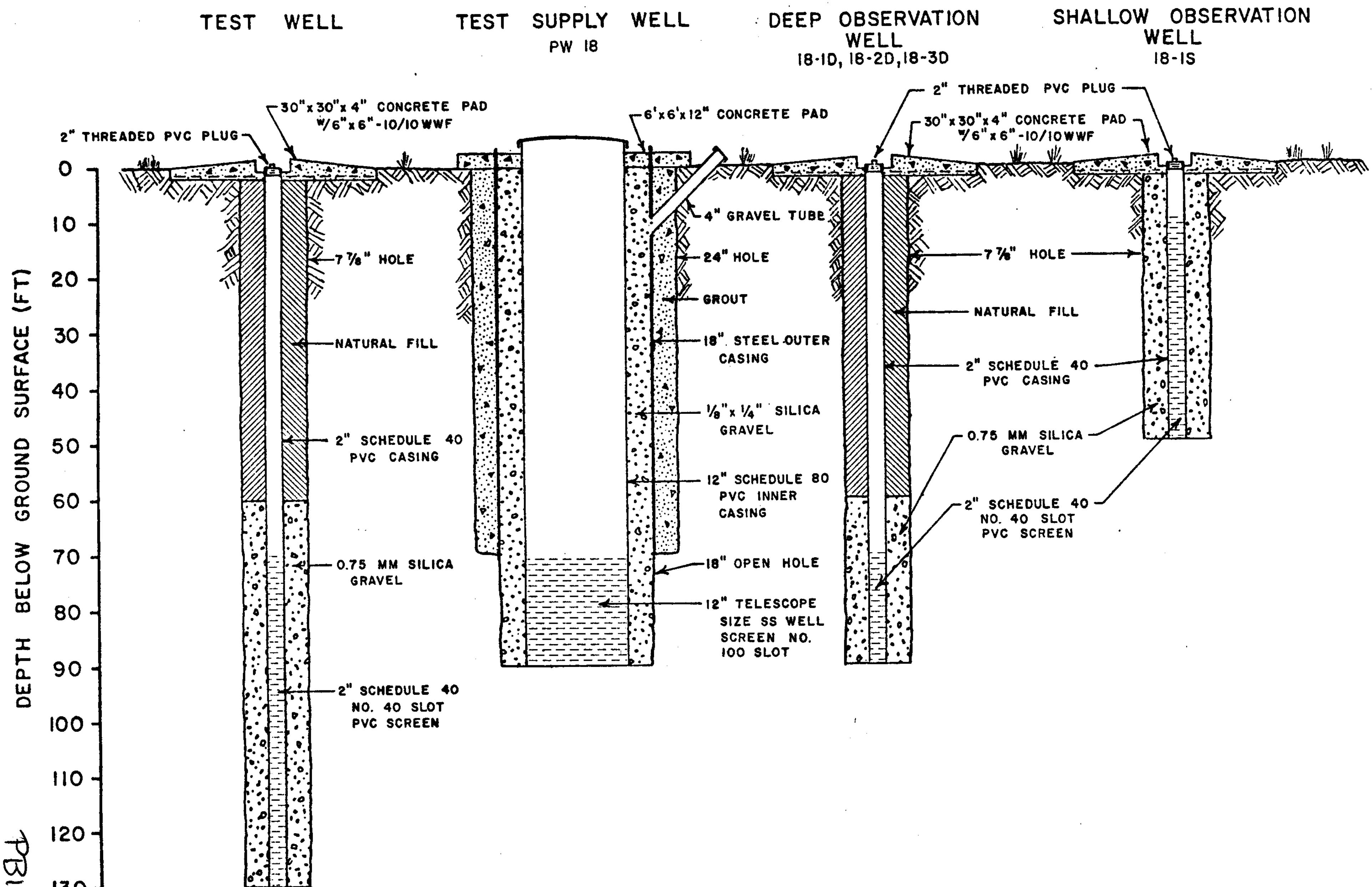
FIGURE 2

TABLE 1

WELL CONSTRUCTION DATA

Well No.	Diameter (in.)	Cased Depth (ft.)	Screened Interval (ft.)	Total Depth (ft.)	Date Drilled
TW 13	2	60	60-130	100*	7-28-80
TW 14	2	60	60-130	100*	7-30-80
TW 15	2	55	55-130	100*	7-31-80
18-1S	2	10	10-60	60	9-12-80
18-1D	2	70	70-90	90	9-11-80
18-2D	2	70	70-90	90	9-15-80
18-3D	2	70	70-90	90	9-16-80
PW-18	outer 18 inner 12	outer 71 inner 70	70-90	90	9-10-80

* grouted up to 100 feet



PB120

FIGURE 4

TYPICAL WELL CONSTRUCTION

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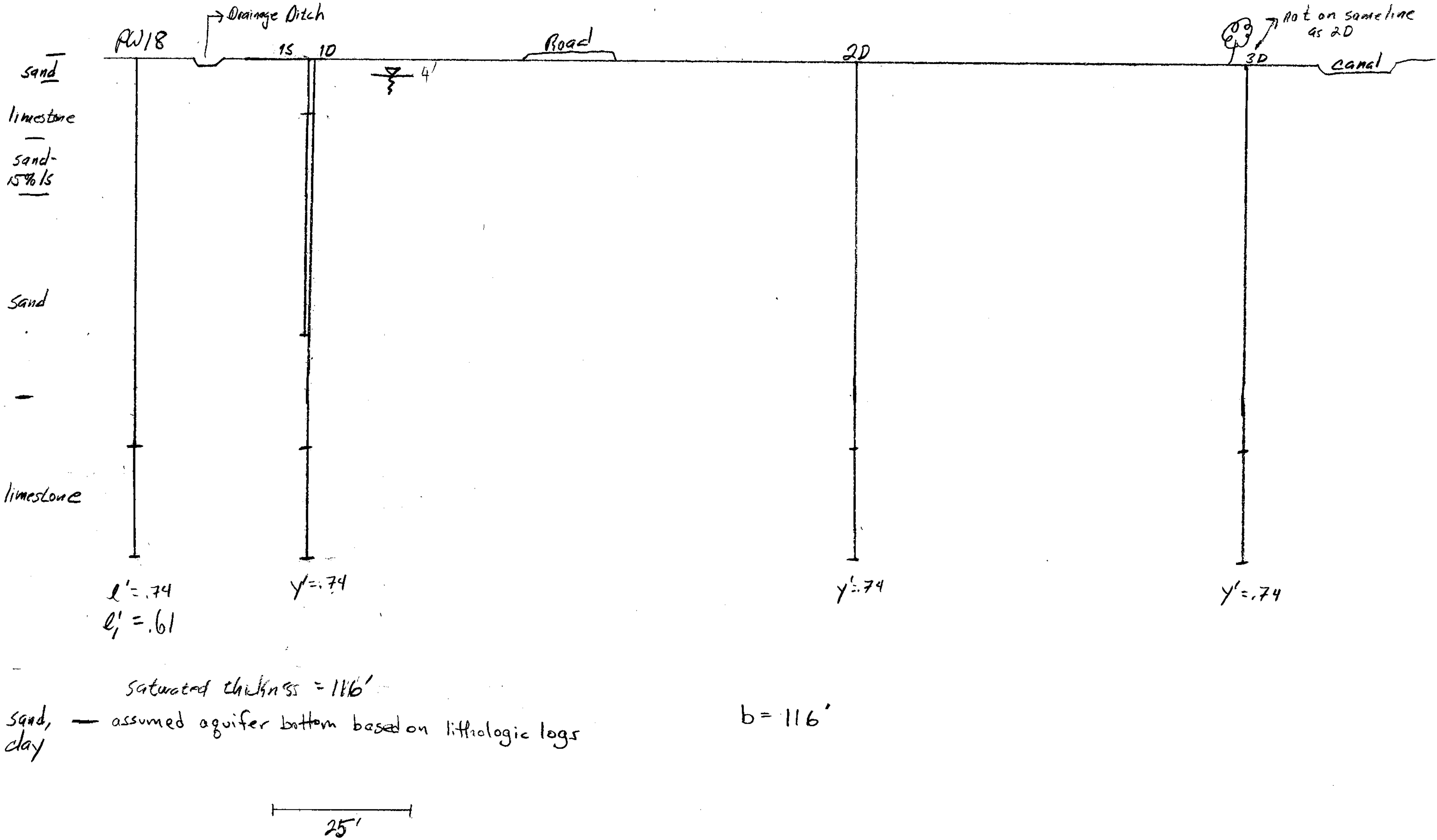
79-183

Acme Improvement APT

Q = 900 gpm   Duration = 72 hrs.



ACME Improvement APT

Well	β	T (FT²/DAY)	S	K_D
18-1S	.009			.1
18-2D	.14			.1
18-3D	.3	No Match		.1

Well	β	T (FT²/DAY)	S	K_D
18-1S	.0009	20,000	.0010	.01
18-2D	.014	12500	.0011	.01
18-3D	.03	12500	.00065	.01

Well	β	T (FT²/DAY)	S	K_D
18-1S	.045			.05
18-2D	.07			.05
18-3D	.15			.05

TABLE 2

SUMMARY OF AQUIFER PARAMETERS

Boulton Method of Analysis

	Early Time	
Well No.	Transmissivity (gpd/ft)	Storage Coefficient
18-1D	33,816	1.6×10^{-2}
18-2D	49,114	2.5×10^{-4}
18-3D	49,114	1.1×10^{-5}
Average	44,015	5.4×10^{-3}

	Late Time	
Well No.	Transmissivity (gpd/ft)	Storage Coefficient
18-1D	*	*
18-2D	46,881	0.26
18-3D	49,114	0.21
Average	47,998	0.23

Average transmissivity (Early Time and Late Time) = 46,000 gpd/ft

*Late Time could not be calculated

(Card 10) PB 120

TABLE 3

COMPARISON OF CALCULATED VERSUS FIELD DRAWDOWN DATA

$$u = \frac{1.87^2 S}{Tt} \qquad s = \frac{114.6\ Q}{T} W(u)$$

T = 34,000
S = 0.1
Q = 900 gpm

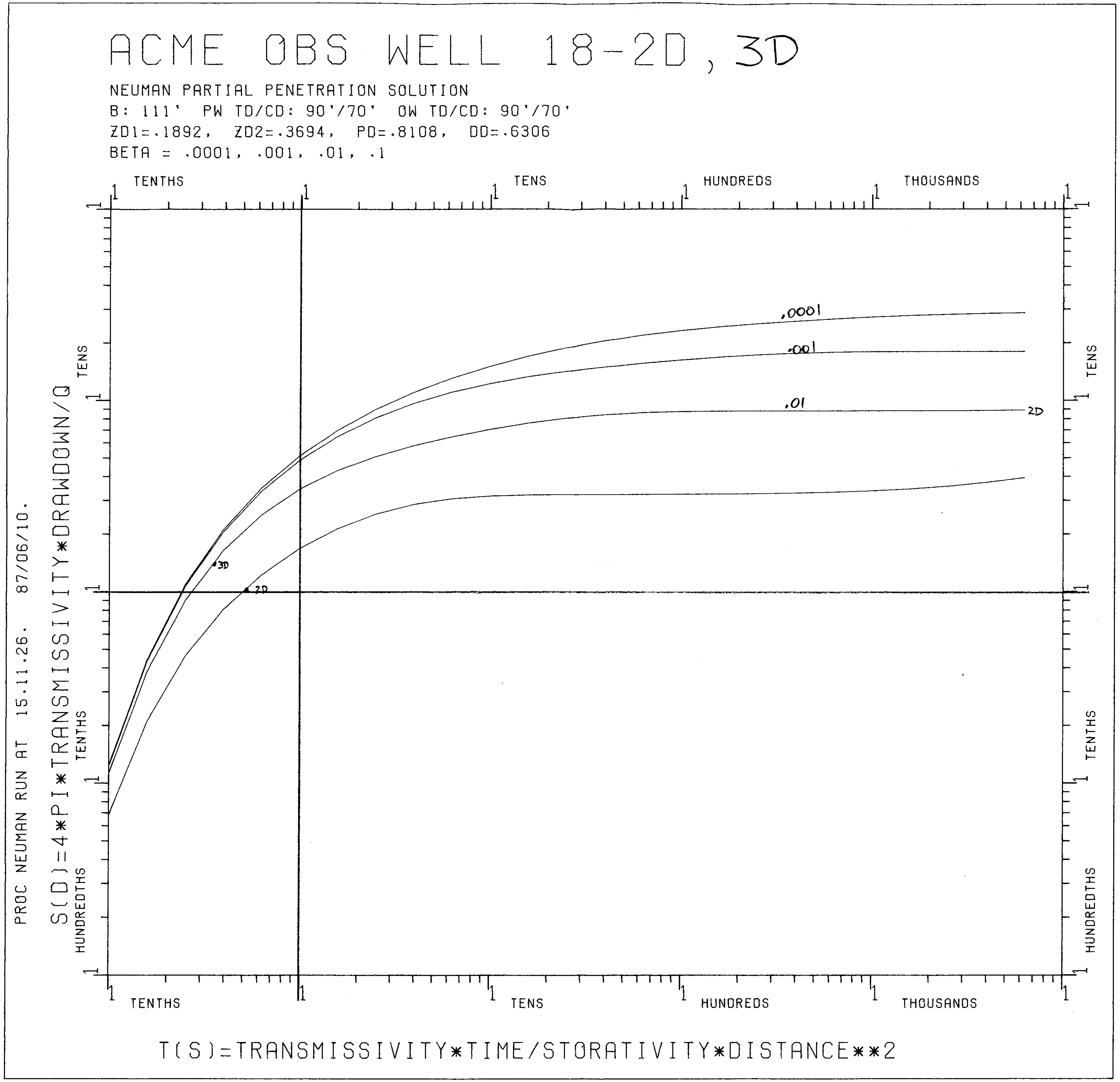
t (days)	18-1D r = 33 ft	18-2D r = 130 ft	18-3D r = 200 ft	r = 500 ft	r = 1,000 ft	r = 2,000 ft
1	$u = 6.0 \times 10^{-3}$ W(u) = 4.55 s = 13.80ft(16.34)*	$u = 9.3 \times 10^{-2}$ W(u) = 1.89 s = 5.73ft(7.96)*	$u = 1.6 \times 10^{-1}$ W(u) = 1.41 s = 4.28ft(6.02)*	u = 1.38 W(u) = 0.12 s = 0.36 ft	u = 5.5 W(u) = 0.0006 $s = 1.82 \times 10^{-3}$ ft	-
3	$u = 1.5 \times 10^{-3}$ W(u) = 5.93 s = 18.00ft(16.80)*	$u = 2.3 \times 10^{-2}$ W(u) = 3.22 s = 9.77ft(8.22)*	$u = 5.4 \times 10^{-2}$ W(u) = 2.40 s = 7.28ft(6.30)*	$u = 4.58 \times 10^{-1}$ W(u) = 0.61 s = 1.85ft	u = 1.83 W(u) = 0.06 s = 0.18 ft	-
30	$u = 2.0 \times 15^{-4}$ W(u) = 7.94 s = 24.09ft	$u = 3.1 \times 10^{-3}$ W(u) = 5.2 s = 15.77ft	$u = 7.3 \times 10^{-3}$ W(u) = 4.35 s = 13.19ft	$u = 4.58 \times 10^{-2}$ W(u) = 2.55 s = 7.74ft	$u = 1.83 \times 10^{-1}$ W(u) = 1.31 s = 3.97 ft	u = 1.36 W(u) = 0.12 s = 0.36ft

* Field drawdown data obtained from data sheets in Appendix B.

Run Neumas using site averages for
18-15
18-2D, 3D, 1D $K_h = 150$
Run Neumas using site averages
and .1 anisotropy / .01 anisotropy
Vary anisotropy in Neumas

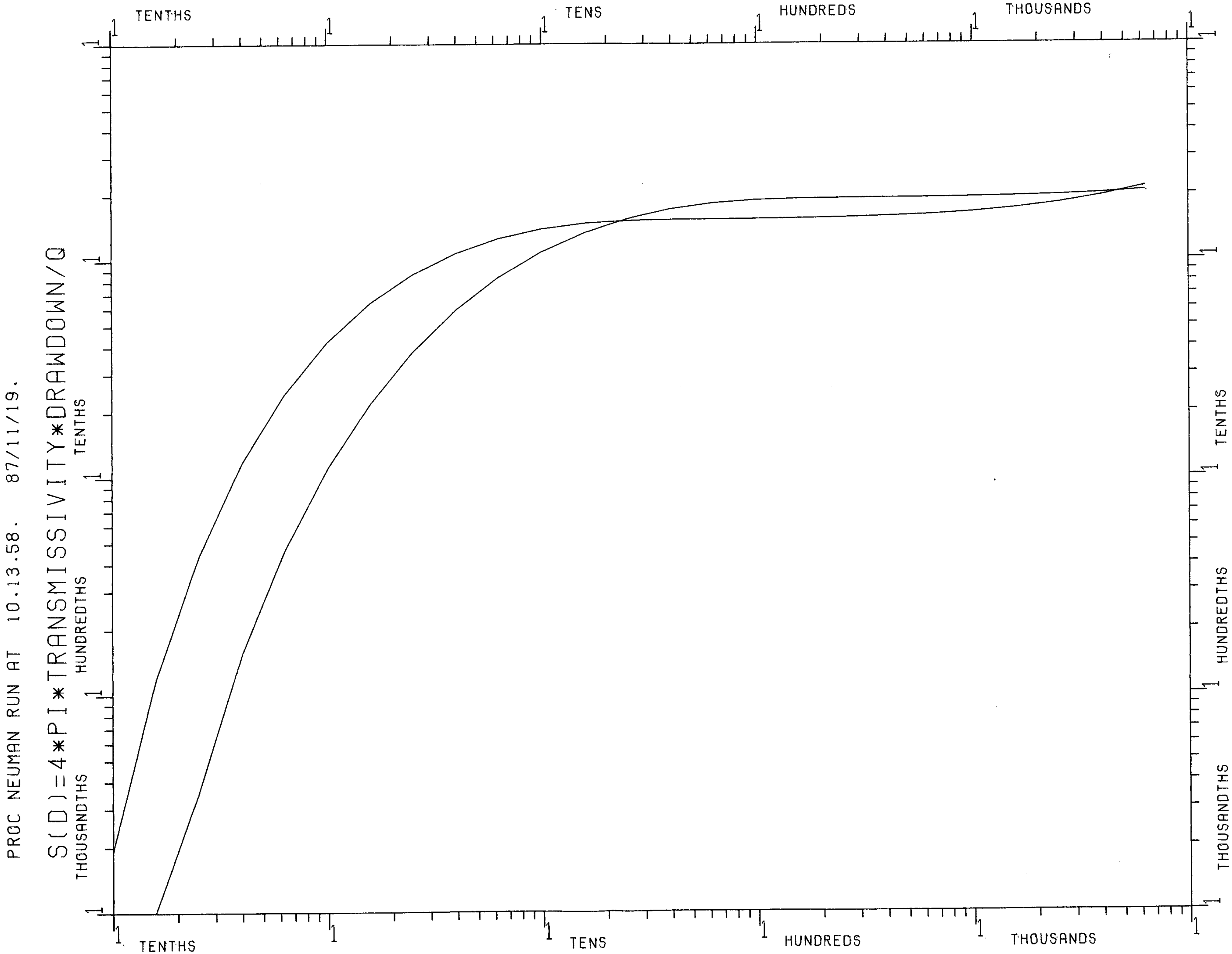
TAPENO 6108 PLOT NO 0057
USER NO PALM3D DATE 87/06/10 TIME 16:13

WMD



ACME 18-1S

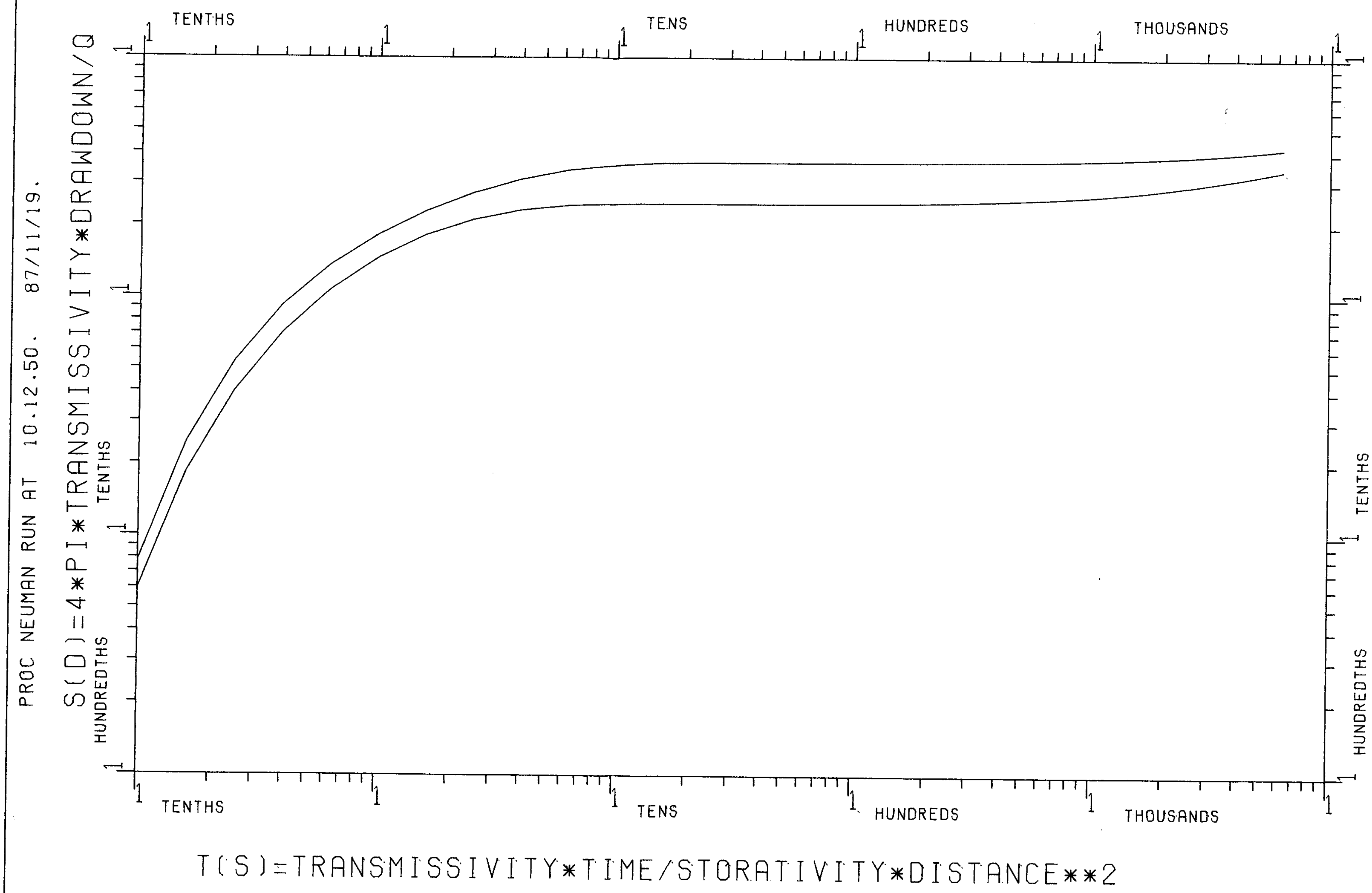
NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 56'/6'
ZD1=.4955, ZD2=.9459, PD=.7748, DD=.5946
BETA = .045, .009



TAPENO 6350 PLOT NO 0032 TIME 10:29
USER NO SHINE DATE 87/11/19

ACME DEEP OBS WELLS

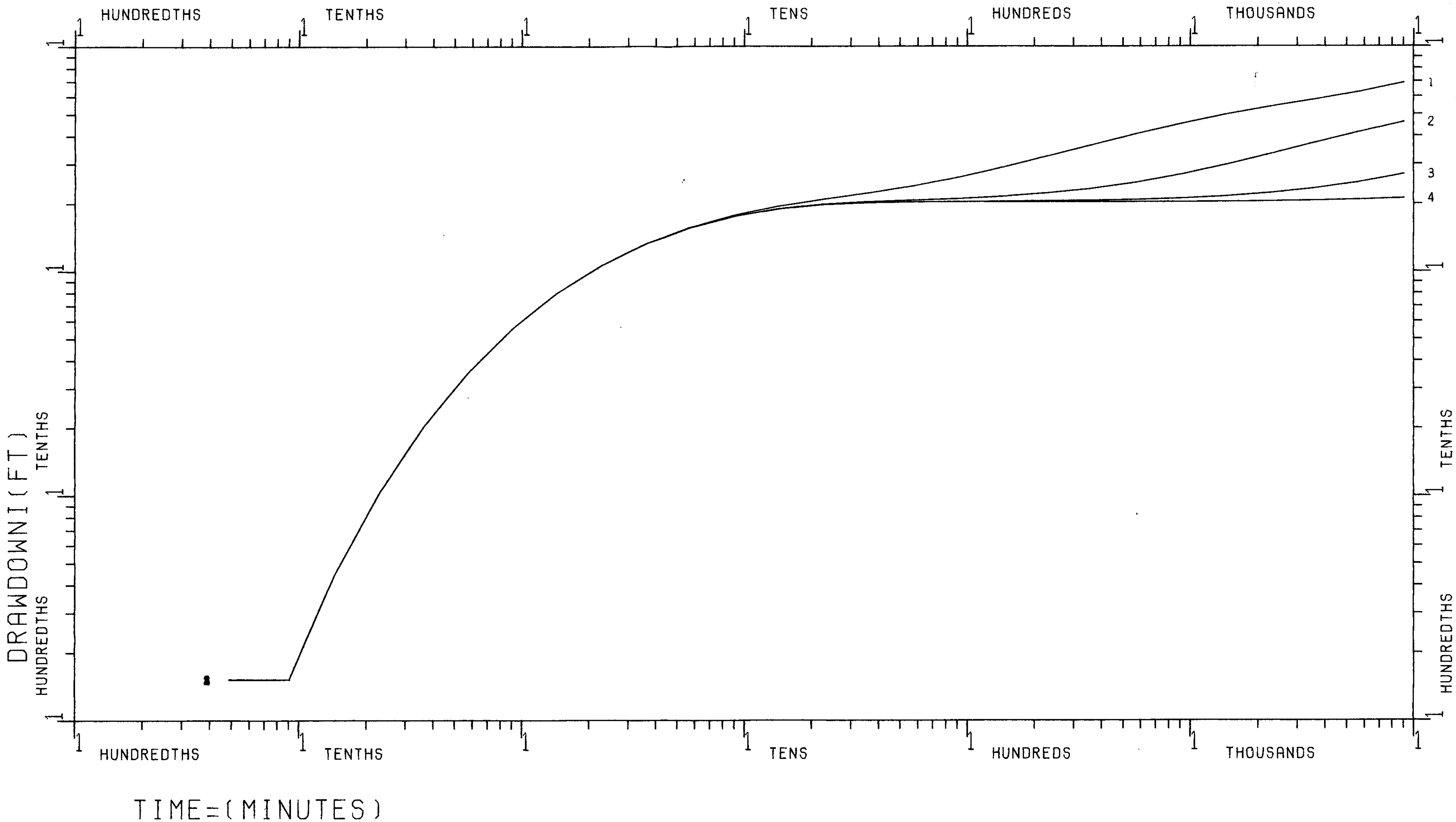
NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 86'/66'
ZD1=.2252, ZD2=.4054, PD=.7748, DD=.5946
BETA = .07, .15



WMD TAPENO 6350 PLOT NO 0029 TIME 10:25
USER NO SHINE DATE 87/11/19

ACME IMPROVEMENT

NEUMAN PARTIAL PENETRATION SOLUTION
Q: 173260 FT3/DAY PW TD/CD: 86'/66' R: 33 FT OW TD/CD: 56'/6' B: 111 FT
KH: 122 FT/DAY KD: .041 S: .001 S/SY: 0
RATIO S TO SY = .1, .01, .001, .0001



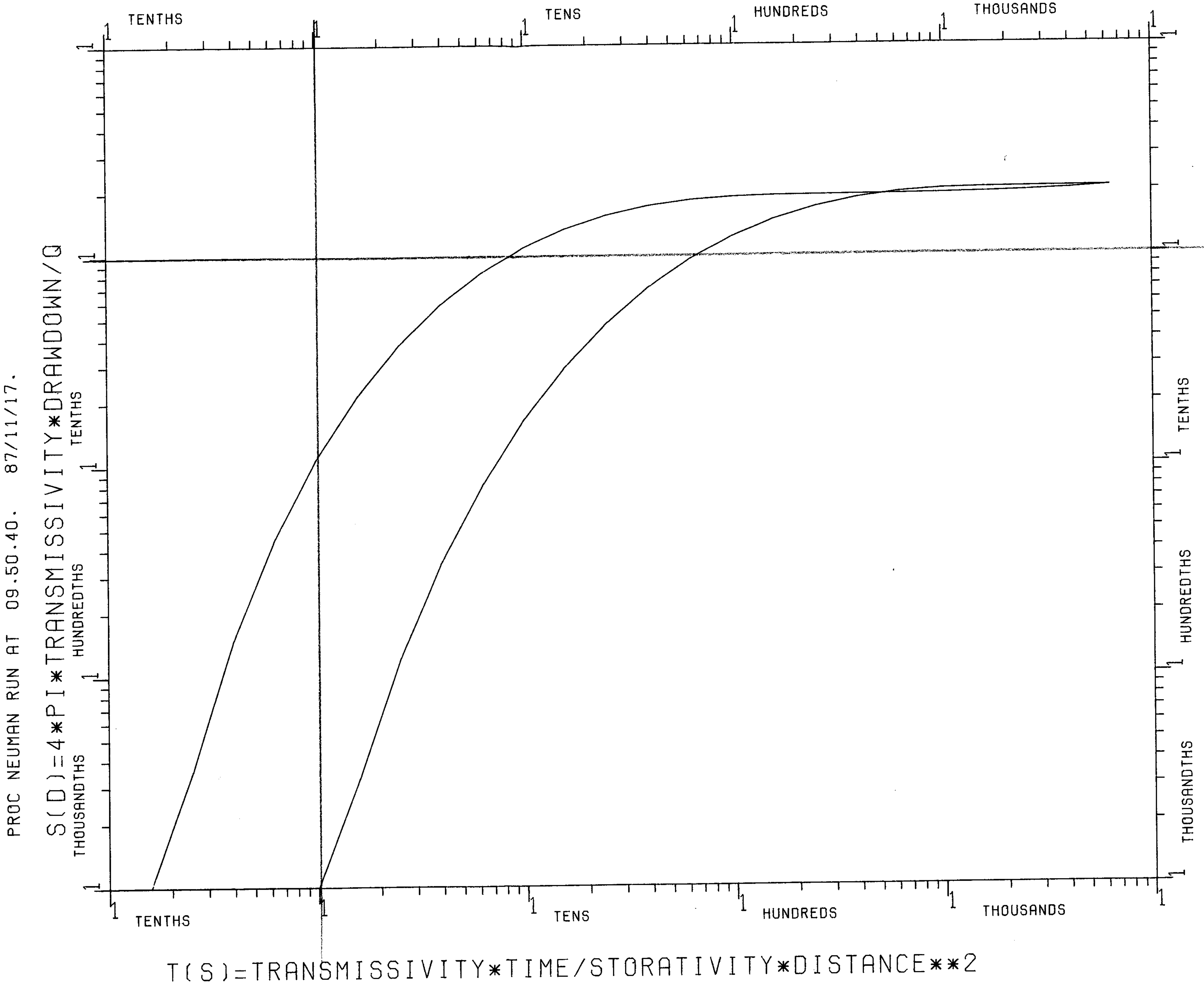
PROC NEUMAS RUN AT 14.16.09. 87/08/31.

TAPENO 6230 PLOT NO 0036 TIME 15:12
USER NO SHINE DATE 87/08/31

WMD

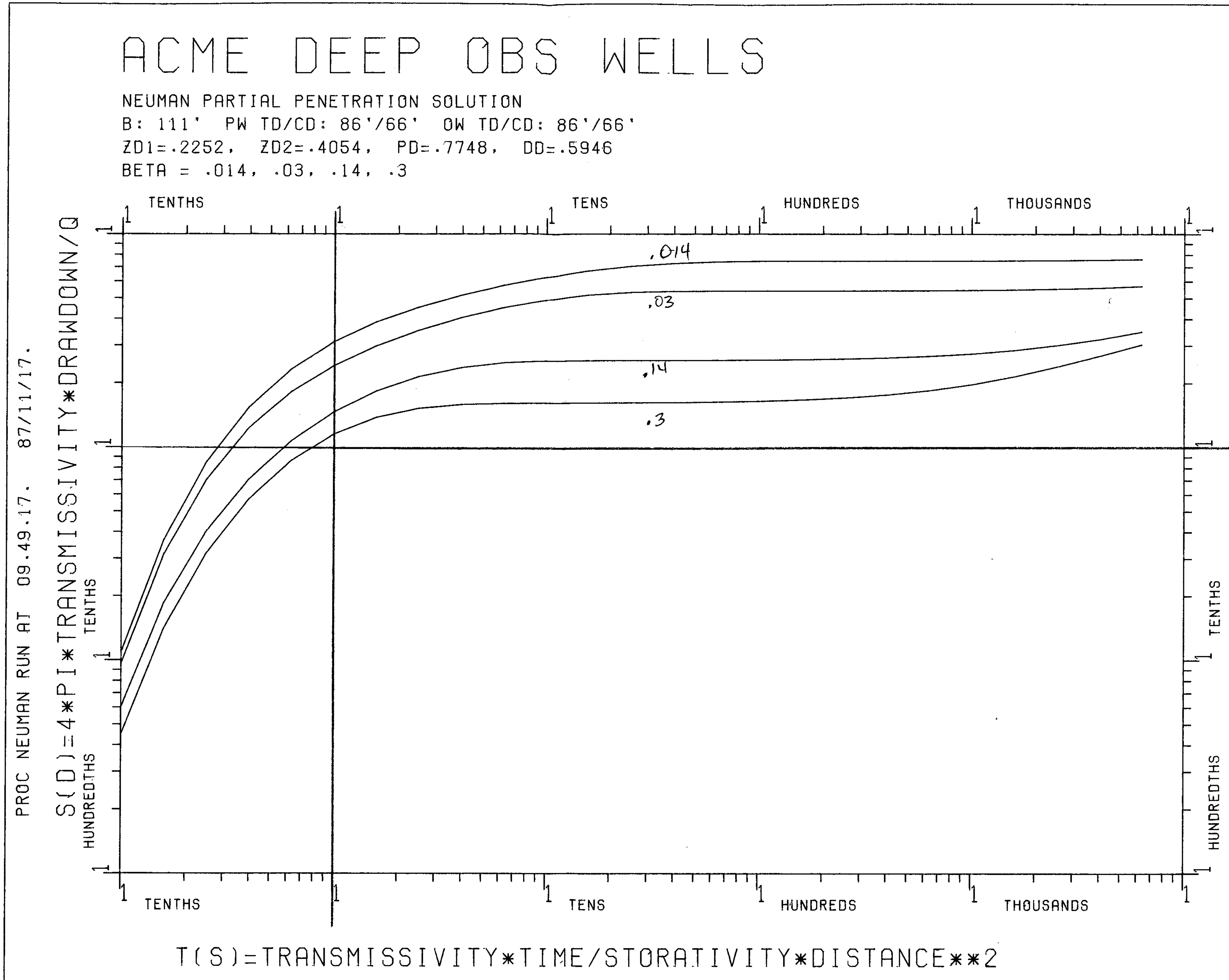
ACME 18-1S

NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 56'/6'
ZD1=.4955, ZD2=.9459, PD=.7748, DD=.5946
BETA = .0009, .009



TAPENO 6230 PLOT NO 0027 TIME 10:12
USER NO SHINE DATE 87/11/17

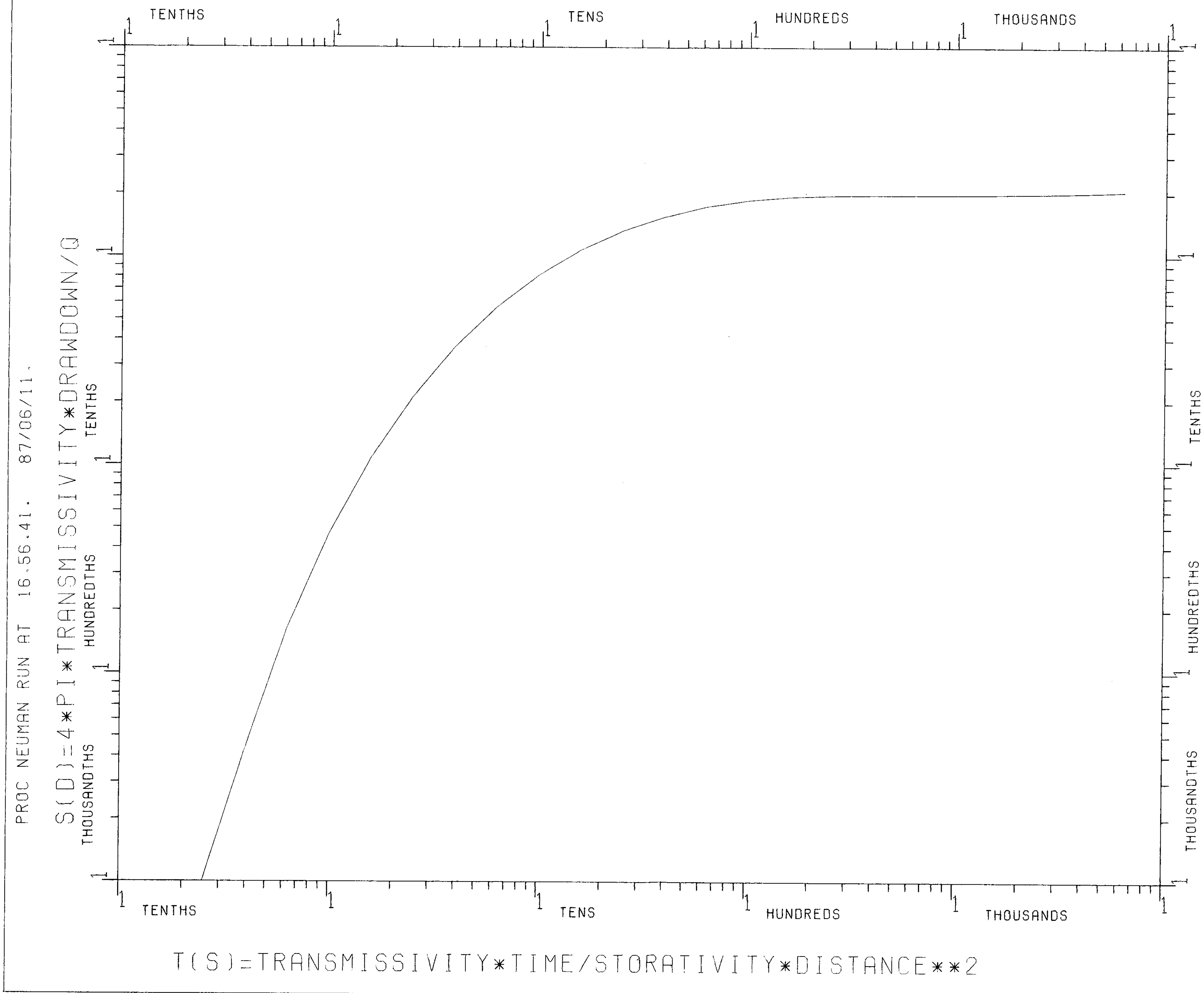
WMD



WMD TAPENO 6230 PLOT NO 0030 TIME 10:16
USER NO SHINE DATE 87/11/17

ACME OBS WELL 18-1S

NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 56'/6'
ZD1=.4955, ZD2=.9459, PD=.7748, DD=.5946
BETA = .005



TAPENO 6355 PLOT NO 0132
USER NO PALM3D DATE 87/06/11 TIME 17:08

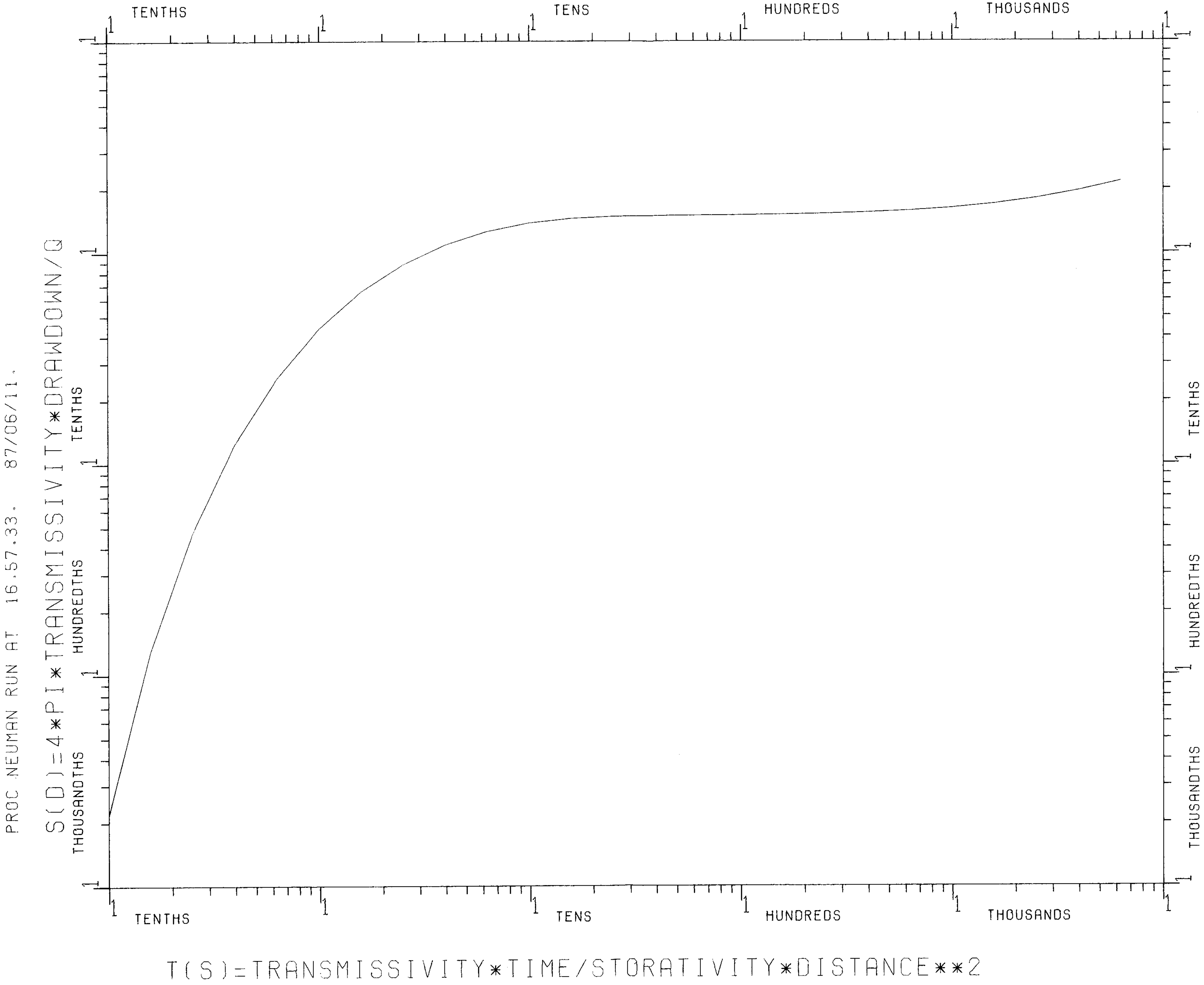
WMD

WMD

TAPENO 6355 PLOT NO 0129
USER NO PALM3D DATE 87/06/11 TIME 17:07

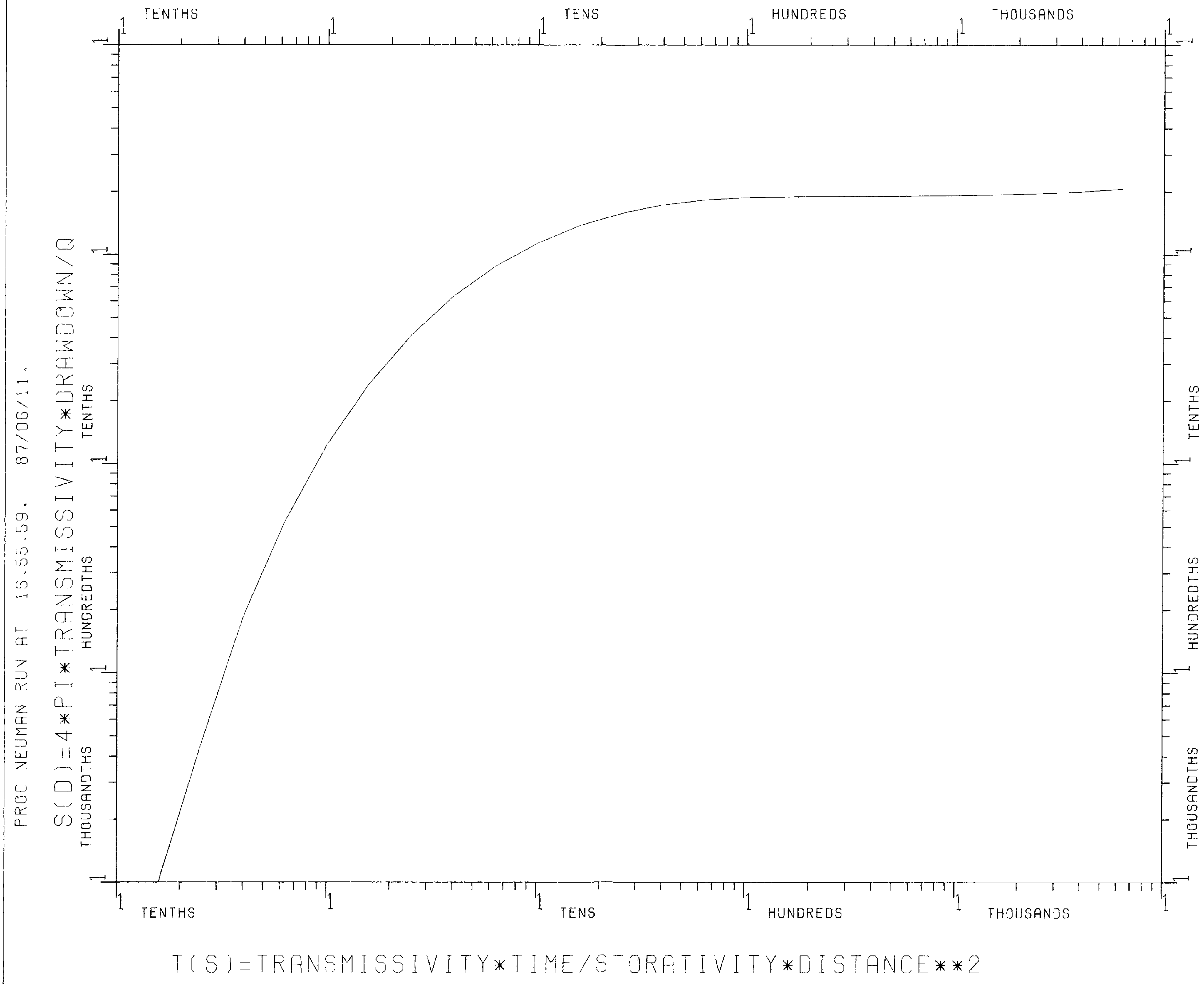
ACME OBS WELL 18-1S

NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 56'/6'
ZD1=.4955, ZD2=.9459, PD=.7748, DD=.5946
BETA = .05



ACME OBS WELL 18-1S

NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 86'/66' OW TD/CD: 56'/6'
ZD1=.4955, ZD2=.9459, PD=.7748, DD=.5946
BETA = .01

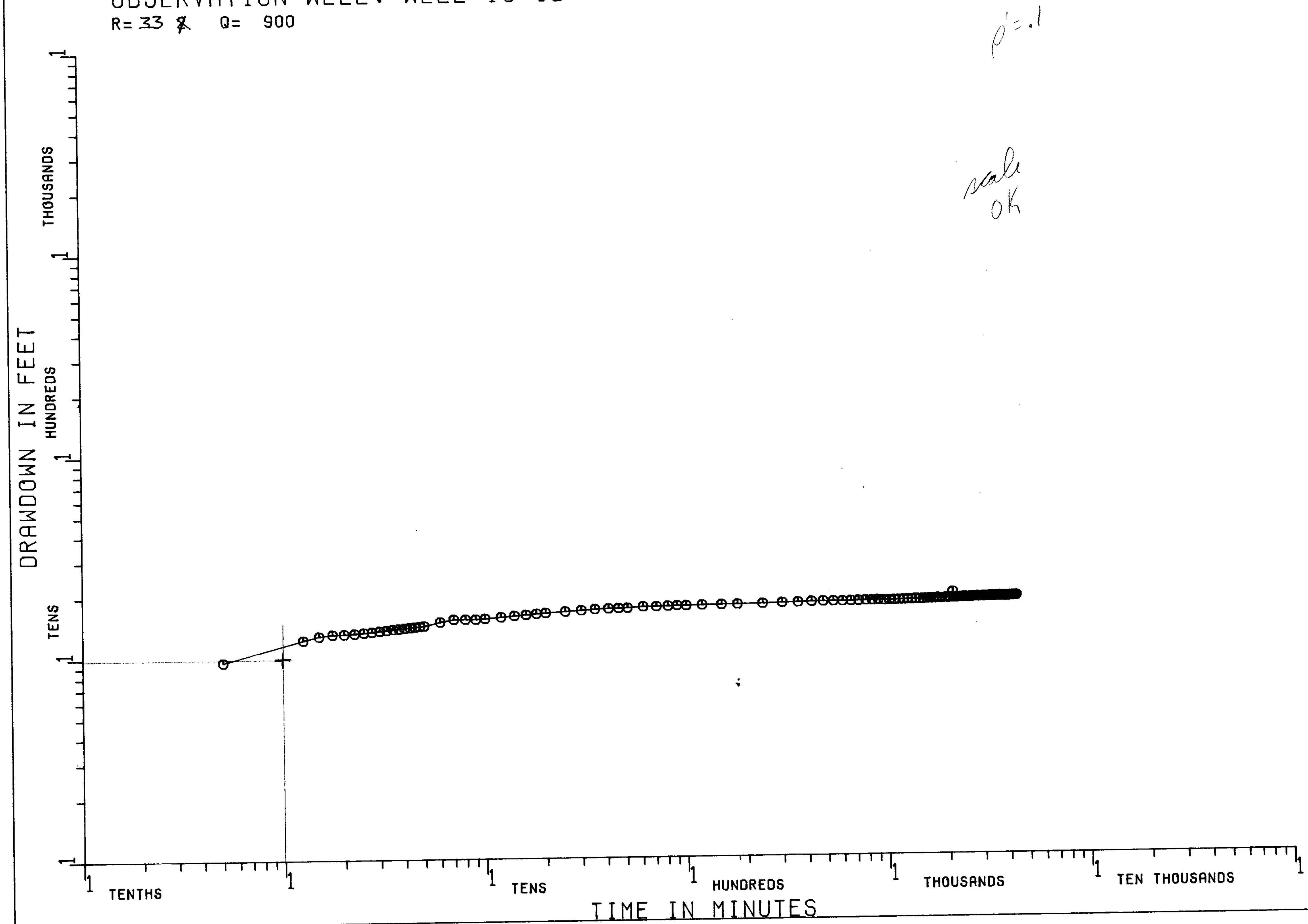


TAPENO 6355 PLOT NO 0126
USER NO PALM3D DATE 87/06/11 TIME 17:07

WMD

OBSERVATION WELL: WELL 18-1D

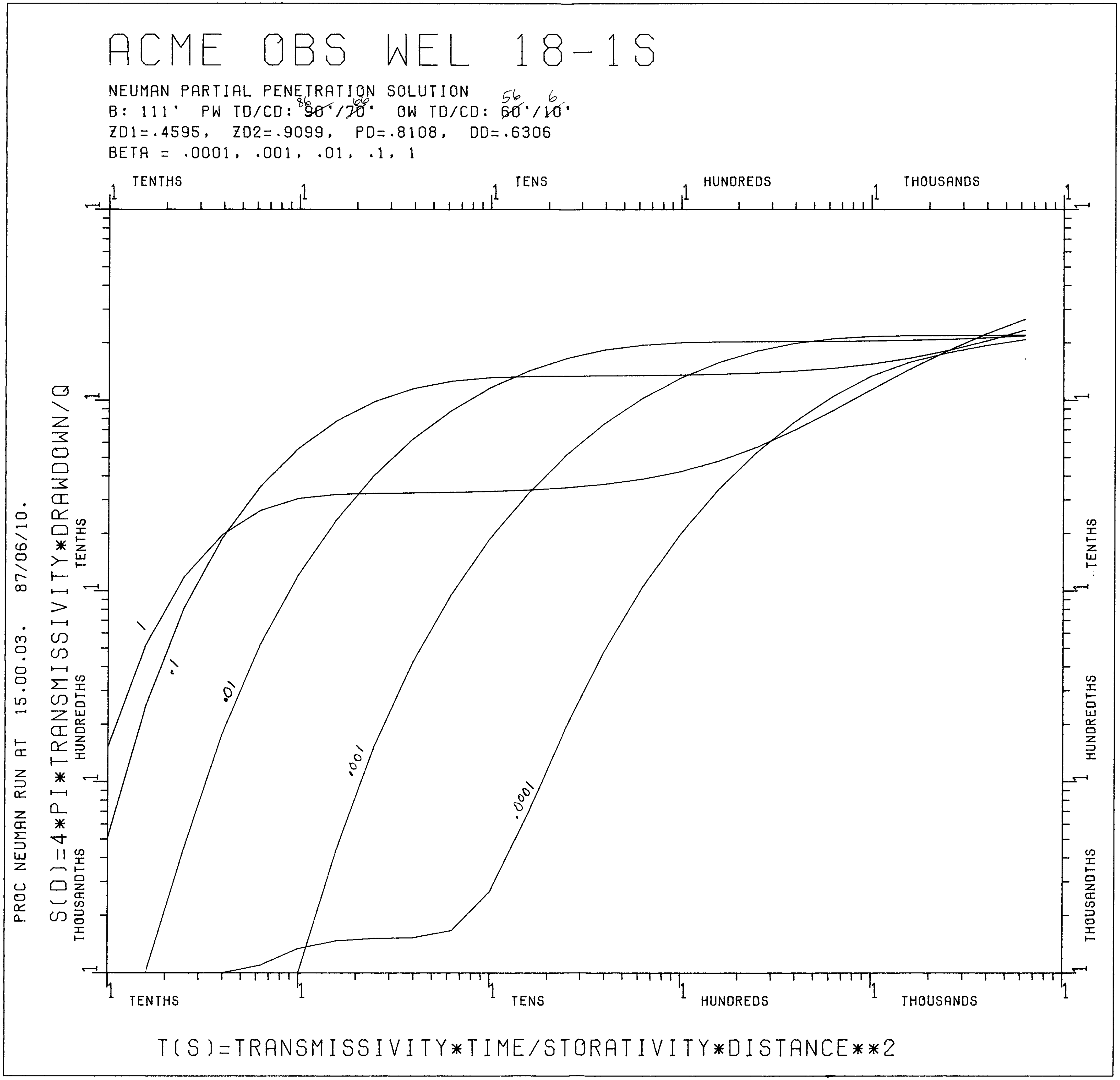
R= 33 Q= 900



ACME IMPROVEMENT DISTRICT

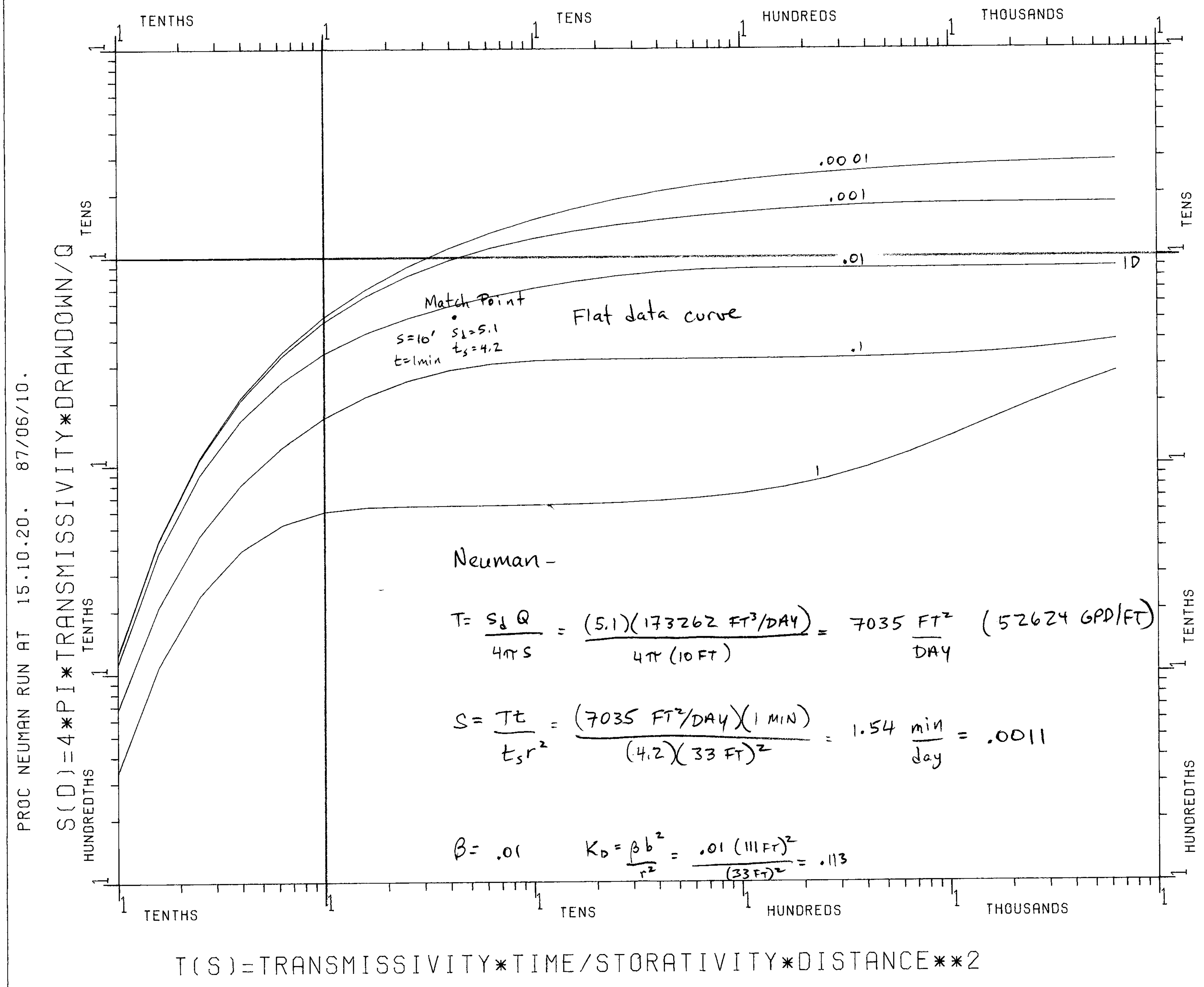
WMD

TAPENO 6230 PLOT NO 0004
USER NO RBOWER DATE 87/06/10 TIME 16:35



ACME OBS WELL 1D

NEUMAN PARTIAL PENETRATION SOLUTION
B: 111' PW TD/CD: 90'/70' OW TD/CD: 90'/70'
ZD1=.1892, ZD2=.3694, PD=.8108, DD=.6306
BETA = .0001, .001, .01, .1, 1



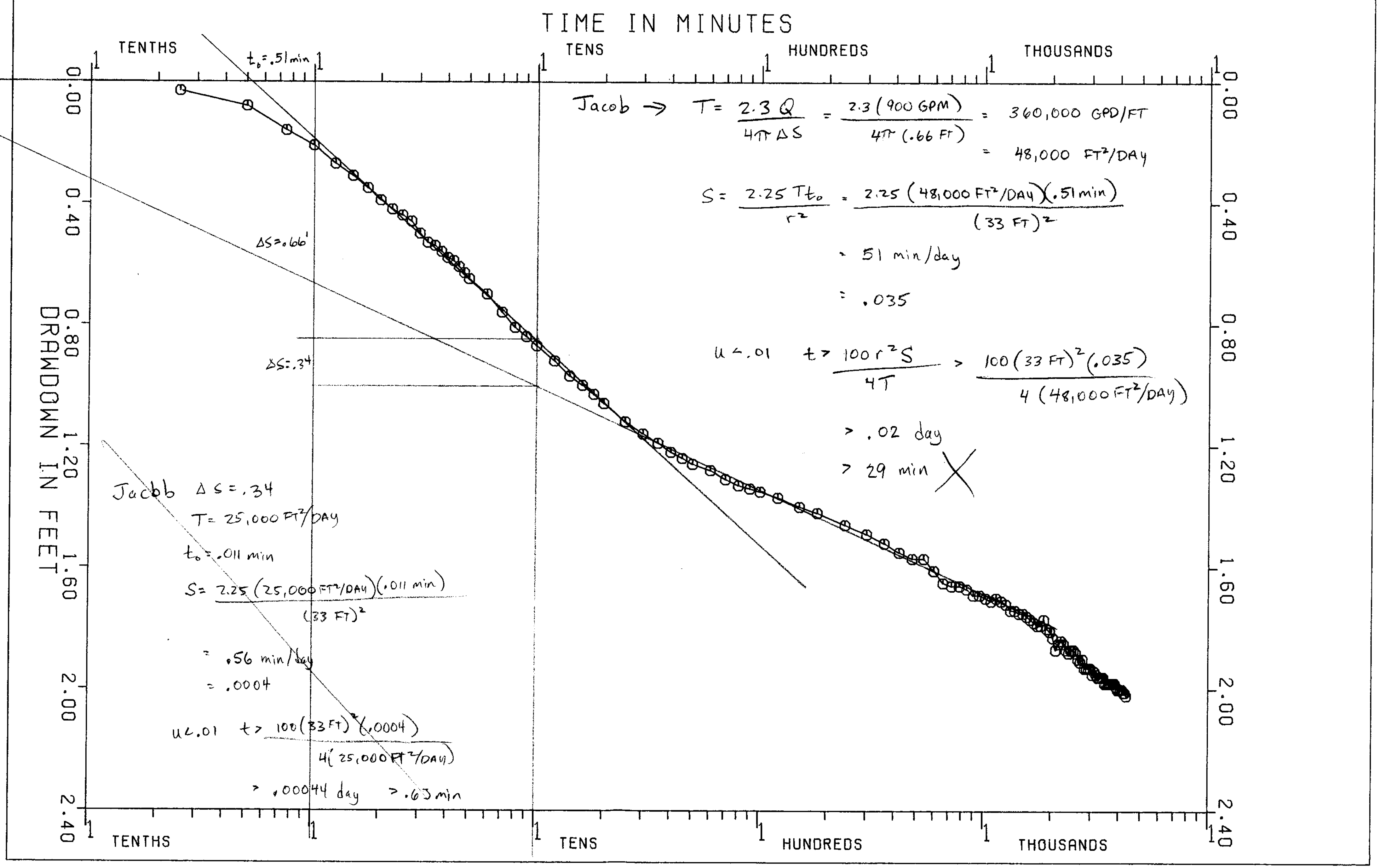
TAPENO 6230 PLOT NO 0001
USER NO PALM3D DATE 87/06/10 TIME 16:29

WMD

ACME IMPROVEMENT TIME DRAWDOWN

OBSERVATION WELL: WELL 18-1S

R= 33 Q= 900



TAPENO 6153 USER NO SHINE PLOT NO 0035 DATE 87/07/31 TIME 09:25

WMD

Neuman –

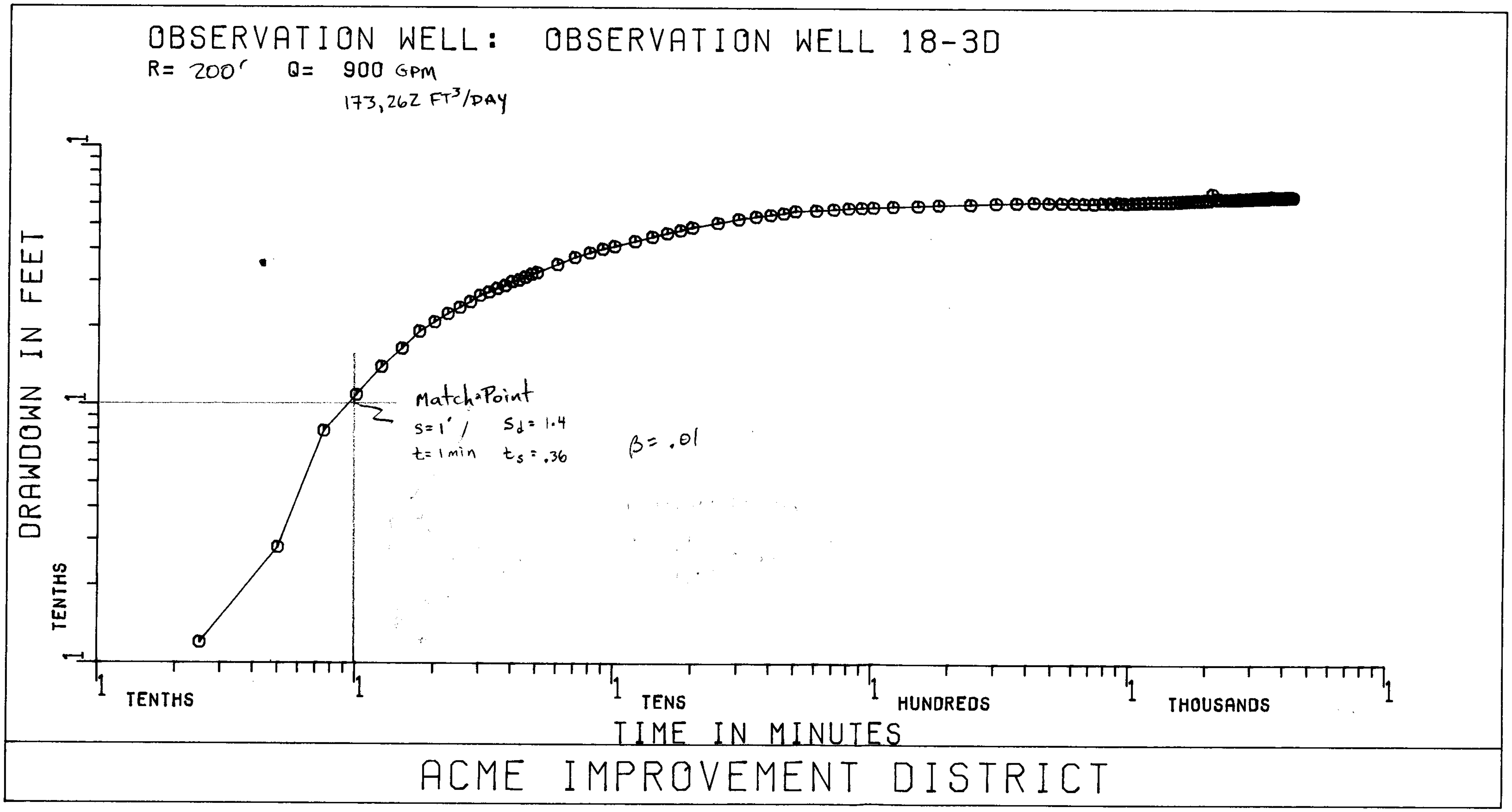
$$T = \frac{s_d Q}{4\pi s} = \frac{1.4\,(173262\ \text{FT}^3/\text{DAY})}{4\pi\,(1\ \text{FT})} = 19{,}313\ \text{FT}^2/\text{DAY} \quad (144{,}459\ \text{GPD/FT})$$

$$S = \frac{Tt}{t_s r^2} = \frac{(19313\ \text{FT}^2/\text{DAY})(1\ \text{min})}{.36\,(200\ \text{FT})^2} = 1.341\ \frac{\text{MIN}}{\text{DAY}} = .00093$$

$$K_D = \frac{\beta b^2}{r^2} = \frac{.01\,(111\ \text{FT})^2}{(200\ \text{FT})^2} = .003$$

TAPENO 6265 USER NO NELMS PLOT NO 0412 DATE 86/05/05 TIME 12:57

WMD



OBSERVATION WELL: WELL 18-2D

R= 130 FT Q= 900 GPM

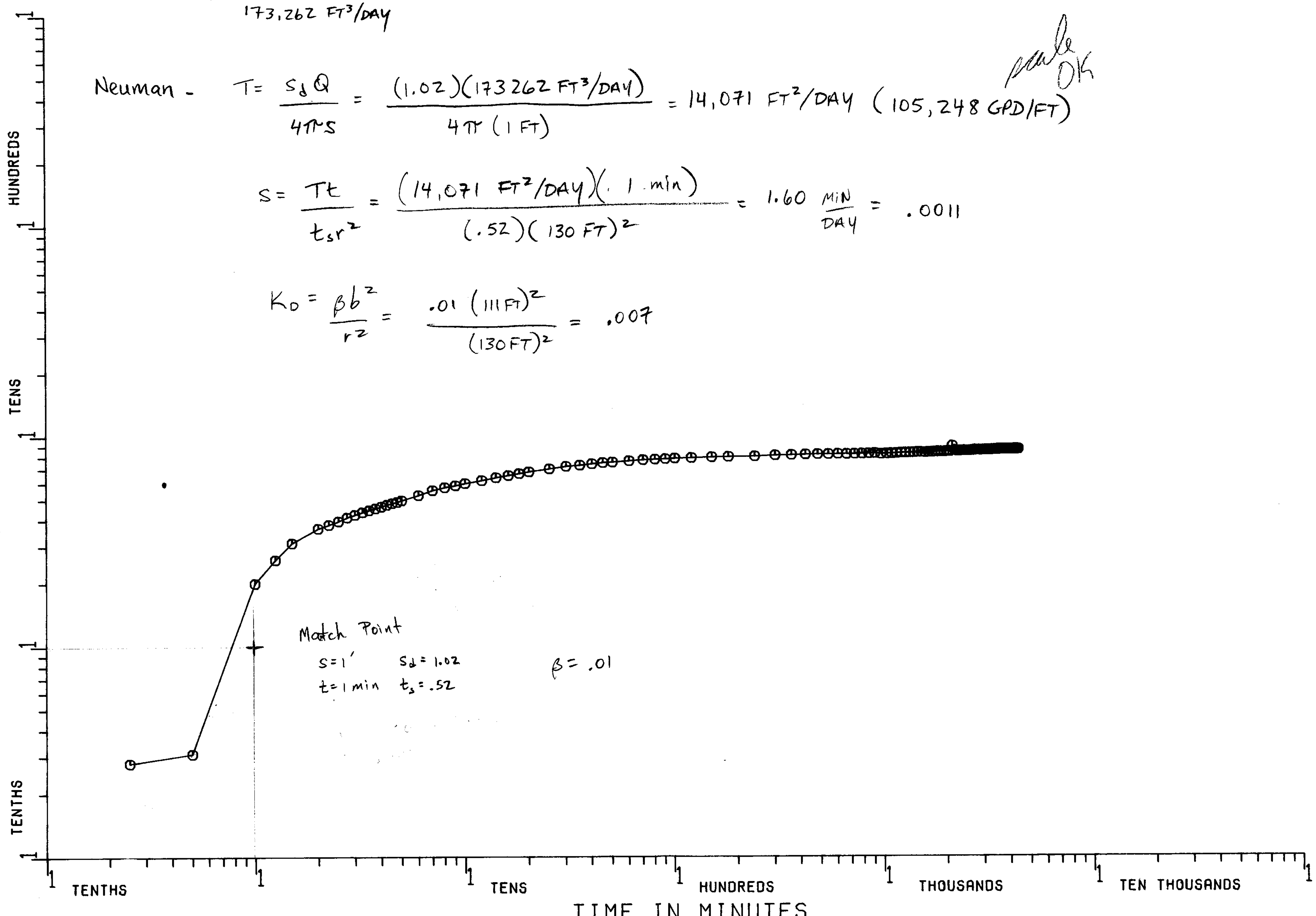
173,262 FT³/DAY

Neuman - $T = \frac{s_d Q}{4\pi s} = \frac{(1.02)(173262\ FT^3/DAY)}{4\pi\ (1\ FT)} = 14{,}071\ FT^2/DAY$ (105,248 GPD/FT)

OK

$S = \frac{Tt}{t_s r^2} = \frac{(14{,}071\ FT^2/DAY)(1\ min)}{(.52)(130\ FT)^2} = 1.60\ \frac{MIN}{DAY} = .0011$

$K_D = \frac{\beta b^2}{r^2} = \frac{.01\ (111\ FT)^2}{(130\ FT)^2} = .007$



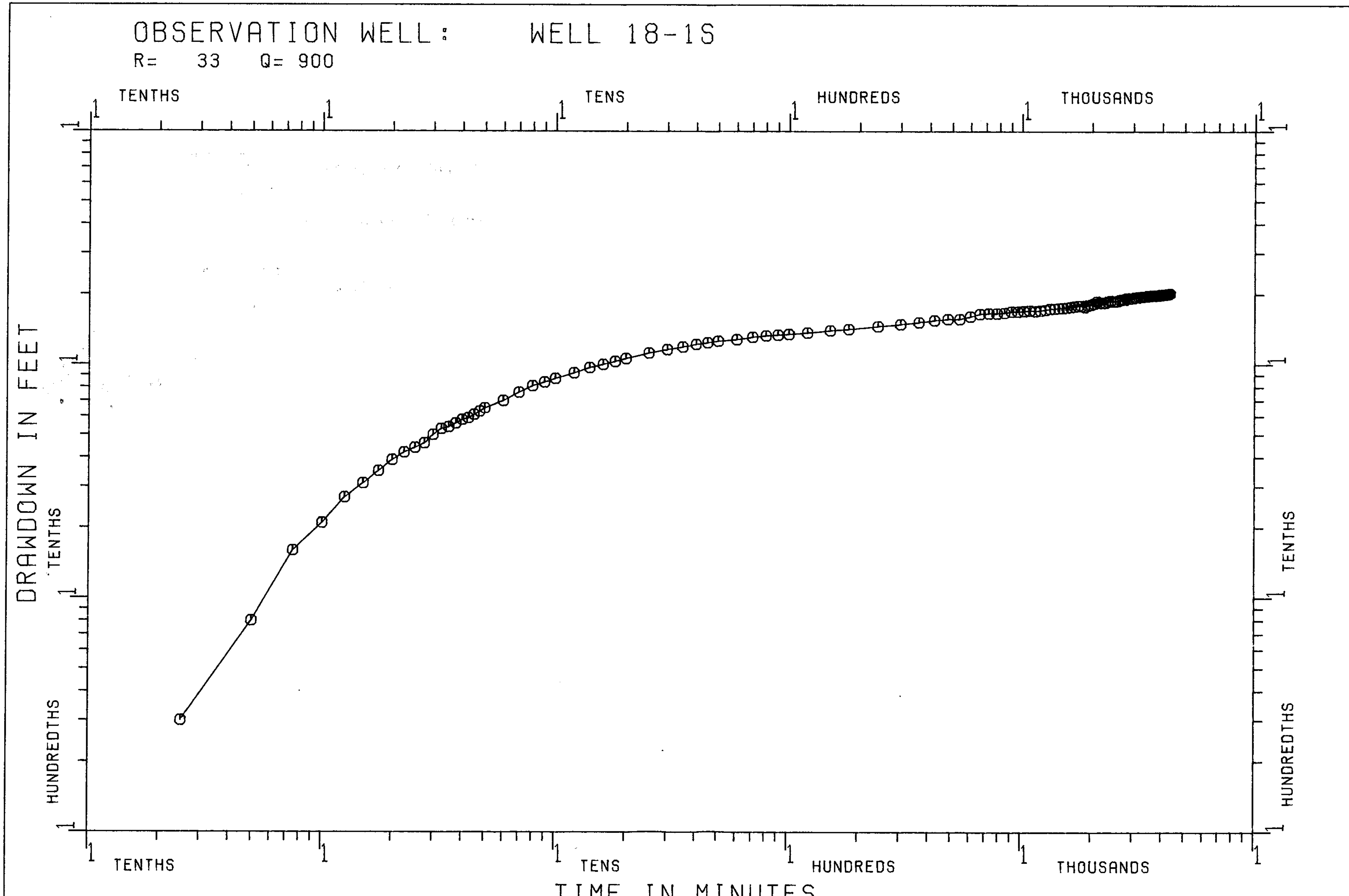
ACME IMPROVEMENT DISTRICT

WMD TAPENO 6097 USER NO NELMS PLOT NO 0093 DATE 86/04/21 TIME 12:36

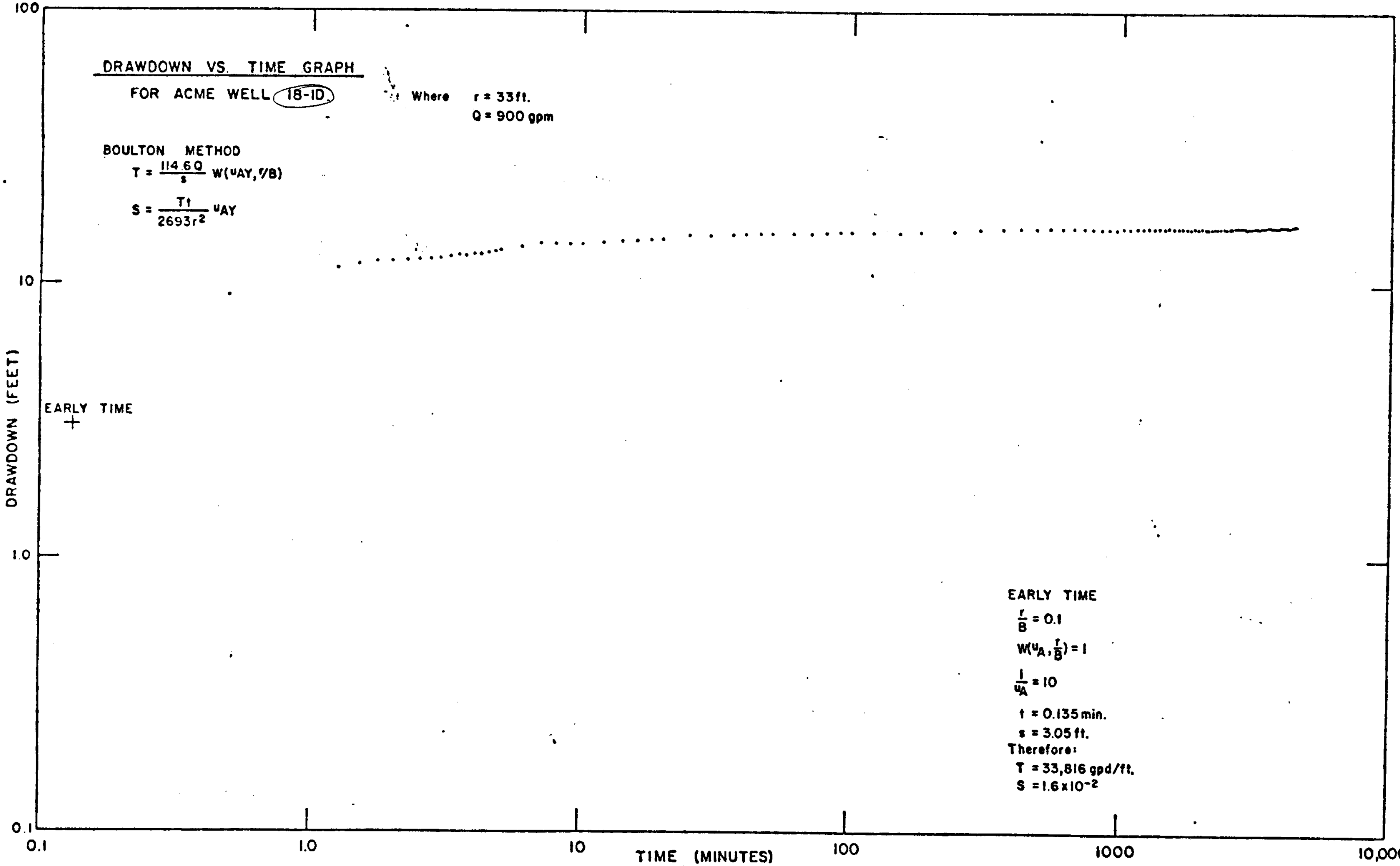
WMD TAPENO 6097 USER NO NELMS PLOT NO 0096 DATE 86/04/21 TIME 12:36

WMD

TAPENO 6350 PLOT NO 0009 TIME 09:24
USER NO SHINE DATE 87/05/20



ACME IMPROVEMENT TIME DRAWDOWN



GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLORIDA

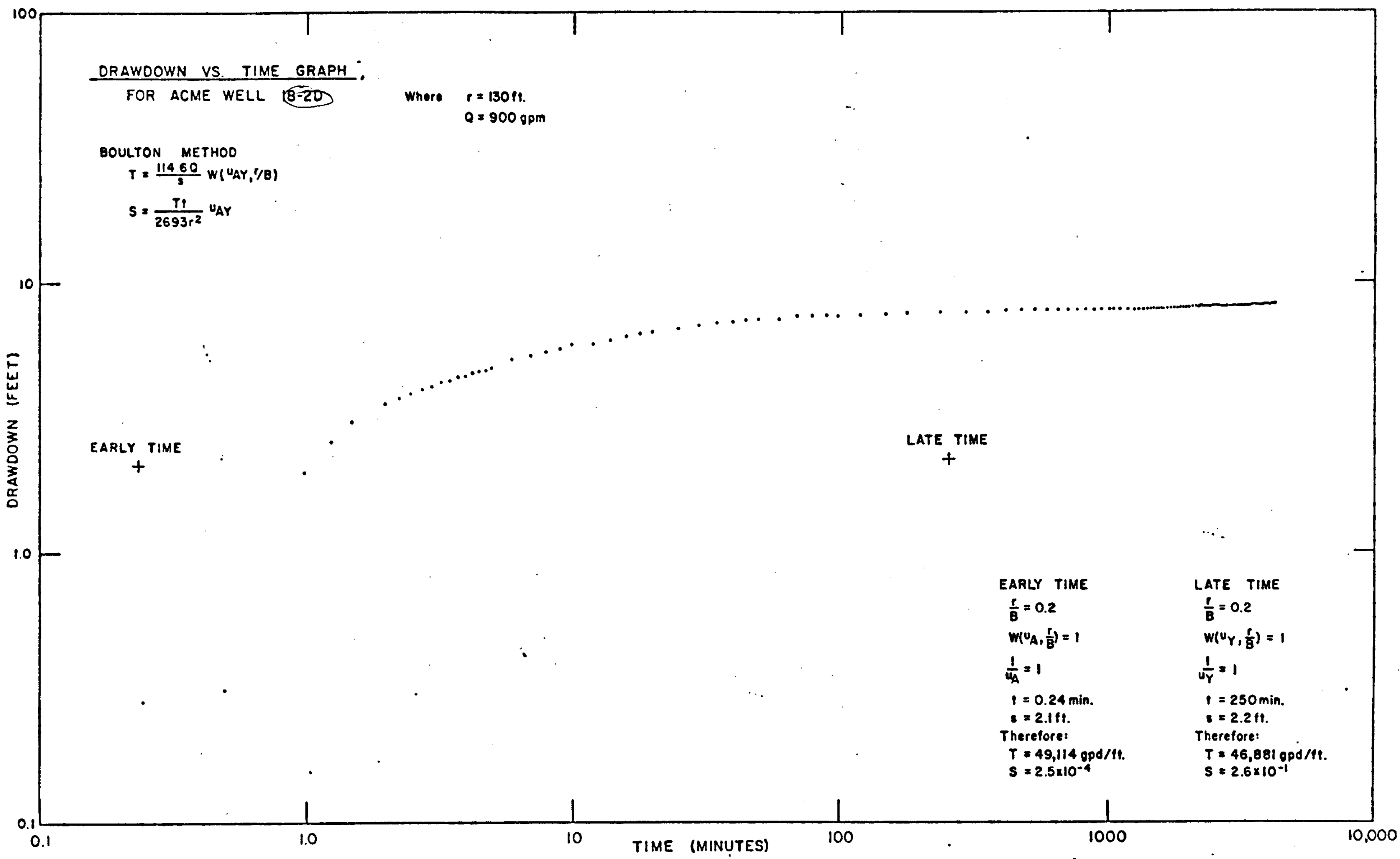


FIGURE 7

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLORIDA

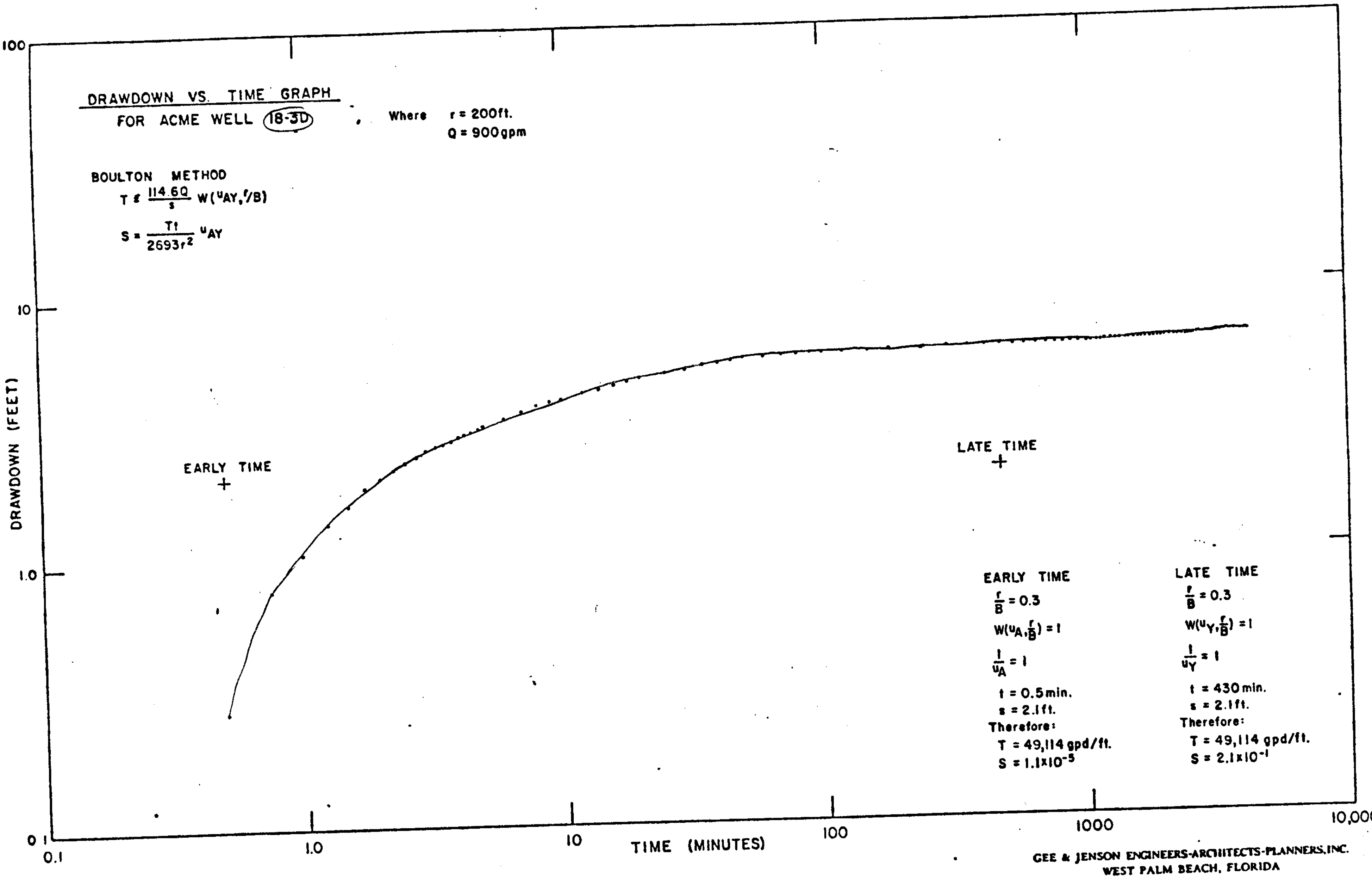


FIGURE 8

PB120

WMD TAPENO 6404 PLOT NO 5009
USER NO RICK-BO DATE 86/06/12 TIME 13:37