WELL RRGE-1 GL073116

A list of all well tests run at RRGE-1 are in table 1-1. A discussion of all those tests $\geq$ 24-hr. in duration follows.

A short-term artesian flow test was conducted between November 5-6, 1975. After making observations on background reservoir pressure for about 18 hours, the well was artesian flowed at an average discharge of 1.7 lps. for a period of 30 hours. After shutting down flow, pressure buildup was monitored for approximately 19 hours. During the test, the downhole pressure instrument was positioned at a depth of 731.5m within the well. The time history of pressure change is graphically presented in figure 1. The reservoir parameters for the drawdown phase are: Q/s_{10} = 1.2 Lps/kPa 1 log cycle, $kH_a \simeq$ 47,300 md.m, Ta = 2×10^{-3} m^2/sec. Recovery is graphically presented in figure 2. The break in the slope was attributed by Narasimhan et al (1977) as masking effects of earth tides. The reservoir parameters for the recovery phase are: Qs_{10} = 0.63 Lps/kPa 1 log cycle, kHa $\approx$ 24,000 md.m, Ta = 1×10^{-3} m^2/sec. The reservoir parameters for the recovery phase are of questionable value. No time vs. temperature data was recorded at the surface. The maximum pressure drawdown at the end of 30 hours of production was approximately 7.6 kPa. Additional details of the test are described by Narasimhan et al (1977).

A longer-duration test was conducted between February 2-6, 1976. The well was pumped at an average discharge of 55.5 Lps for a period of 99 hours. During the test, drawdown was recorded by bubbler tube pressure. The time history of pressure change is graphically presented in figure 3. The reservoir parameters for the drawdown phase are: Q/s_{10} = 0.5 Lps/kPa/log cycle, kHa = 20,600 md.m,

WELL RRGE-1

DESCRIPTION	DATE	DURATION (Hours)	RATE (lps)	TYPE
Short term well test*	11/~~5~~/75	30	1.~~78~~	Artesian flow
Sustained well test	2/2/76	99	55 ~~44~~	Pumping test
Attempted long term Production/ Injection Test, RRGE-1 to RRGI-7	10/12/79	8	75.6	Pulse pumping test
	10/15/79	80	63	Pumping test
Production - Injection test RRGE-1 to RRGJ-6 and RRGJ-7	~~8~~ 8/18/80 to ~~9~~/~~10~~/80	500	56.8	Pumping test

* T.D. well 1825 m. at this time.

Table 1-1

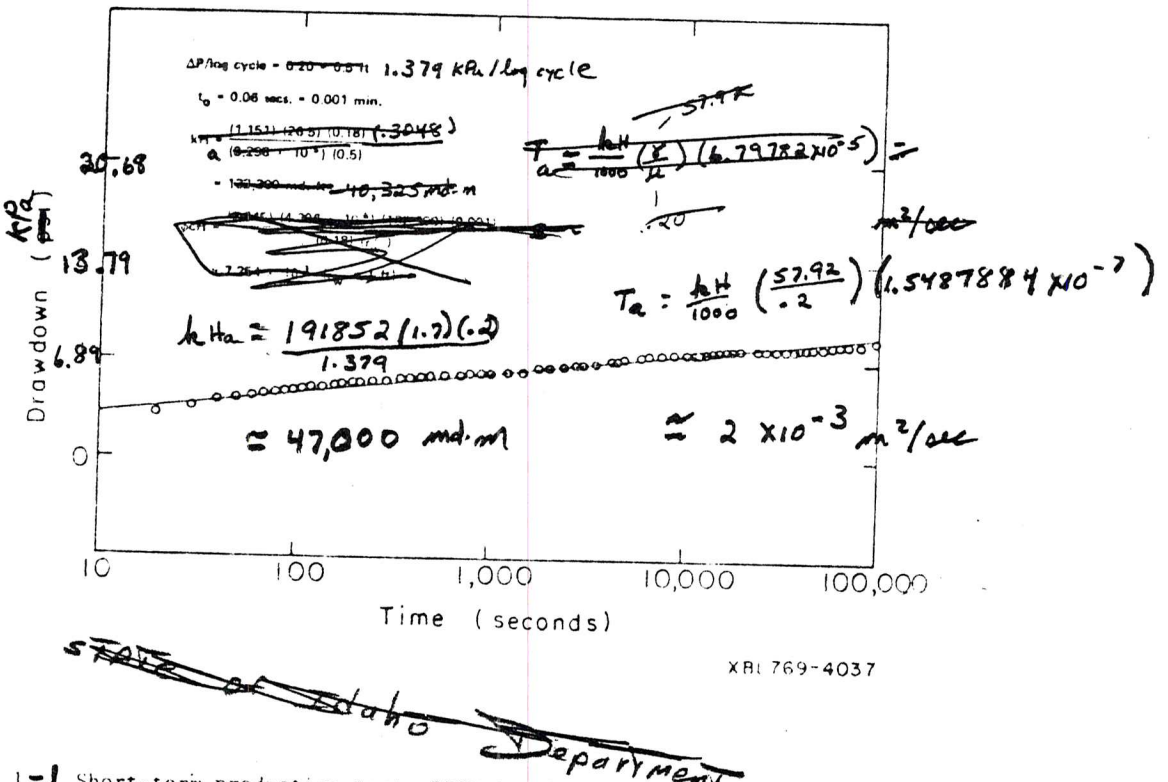


Fig. 1-1 Short-term production test, RRGE 1: Semi-log plot of drawdown versus time.

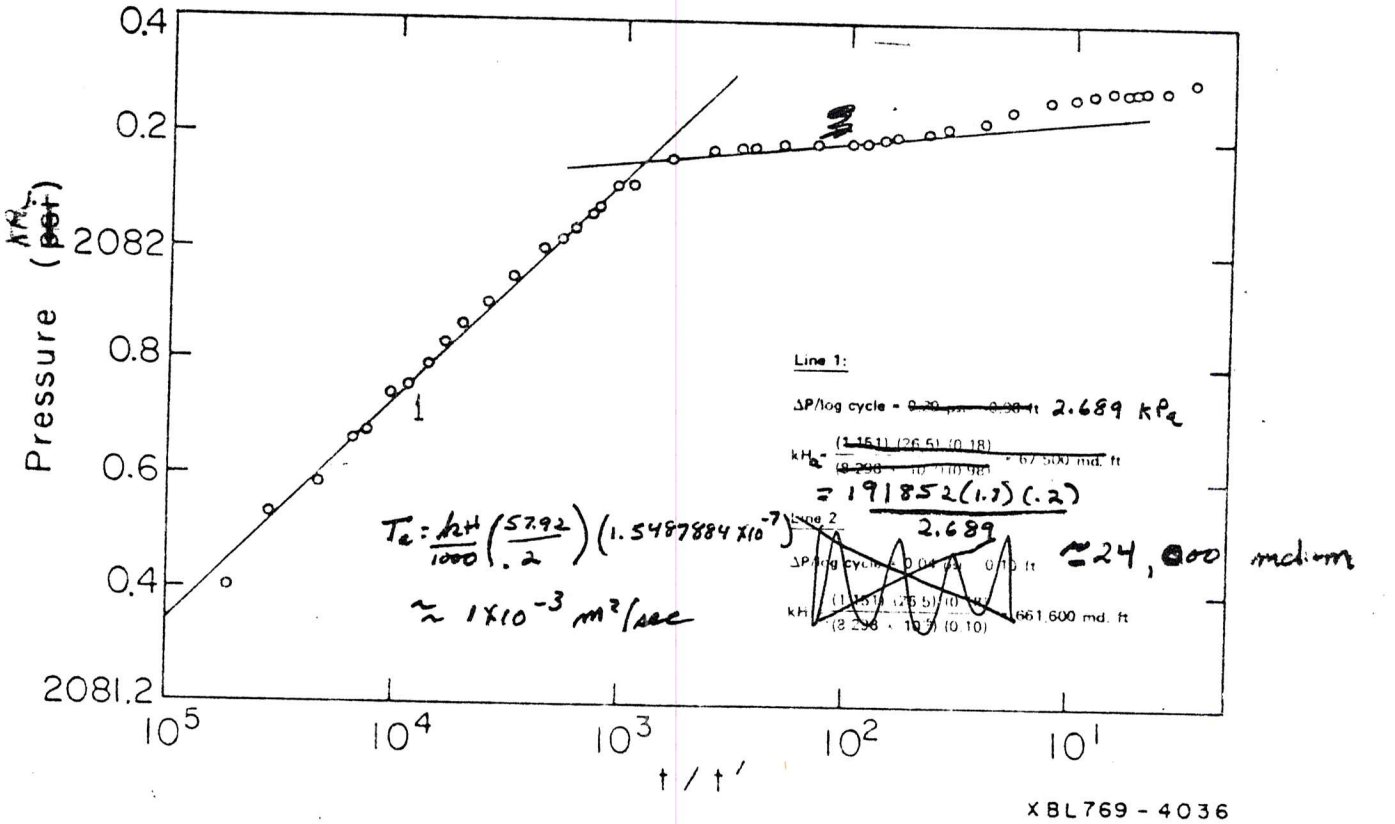


Fig. 1-2: Short-term production test, RRGE 1. Build up as a function of log t/t'.

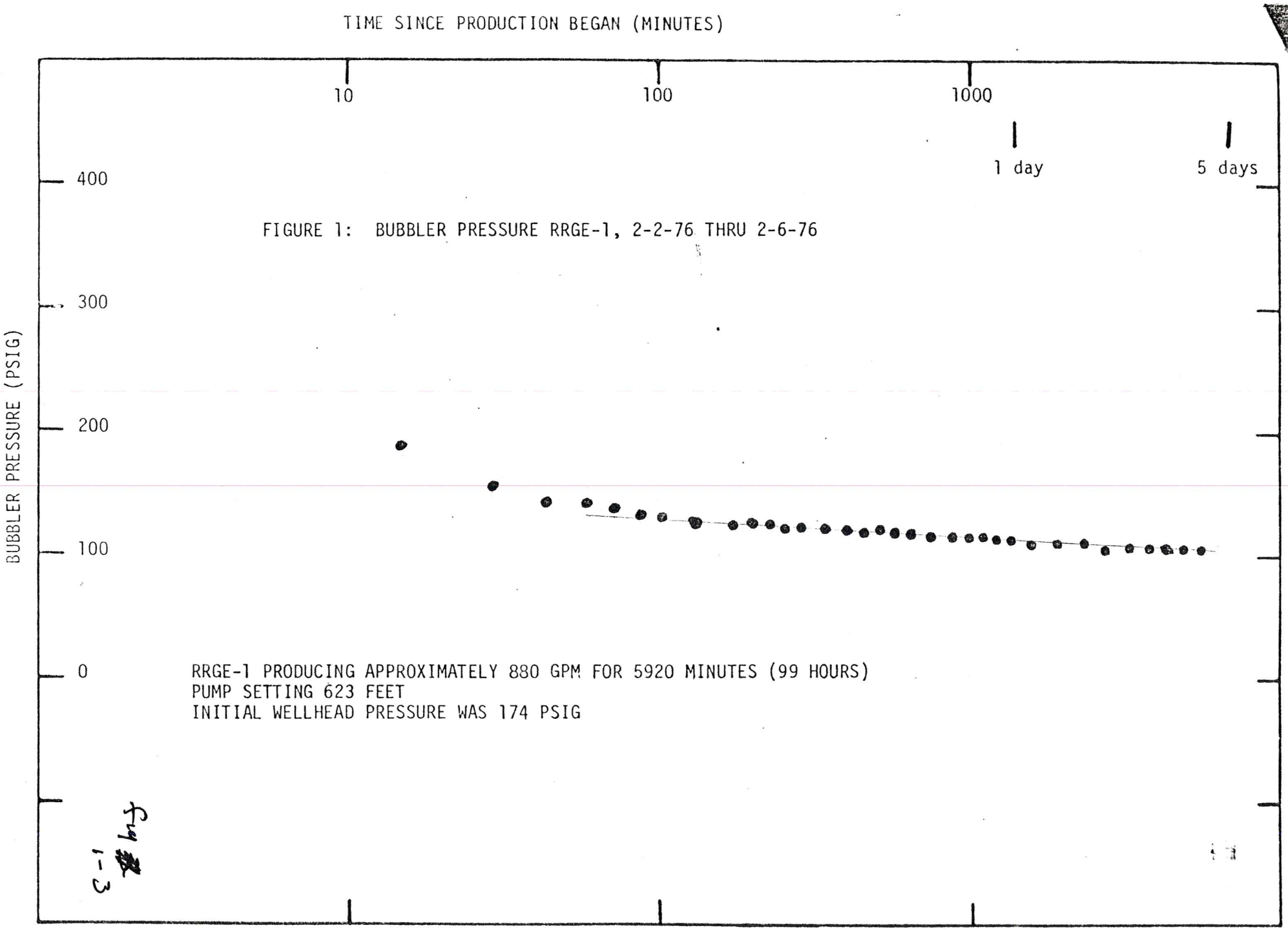


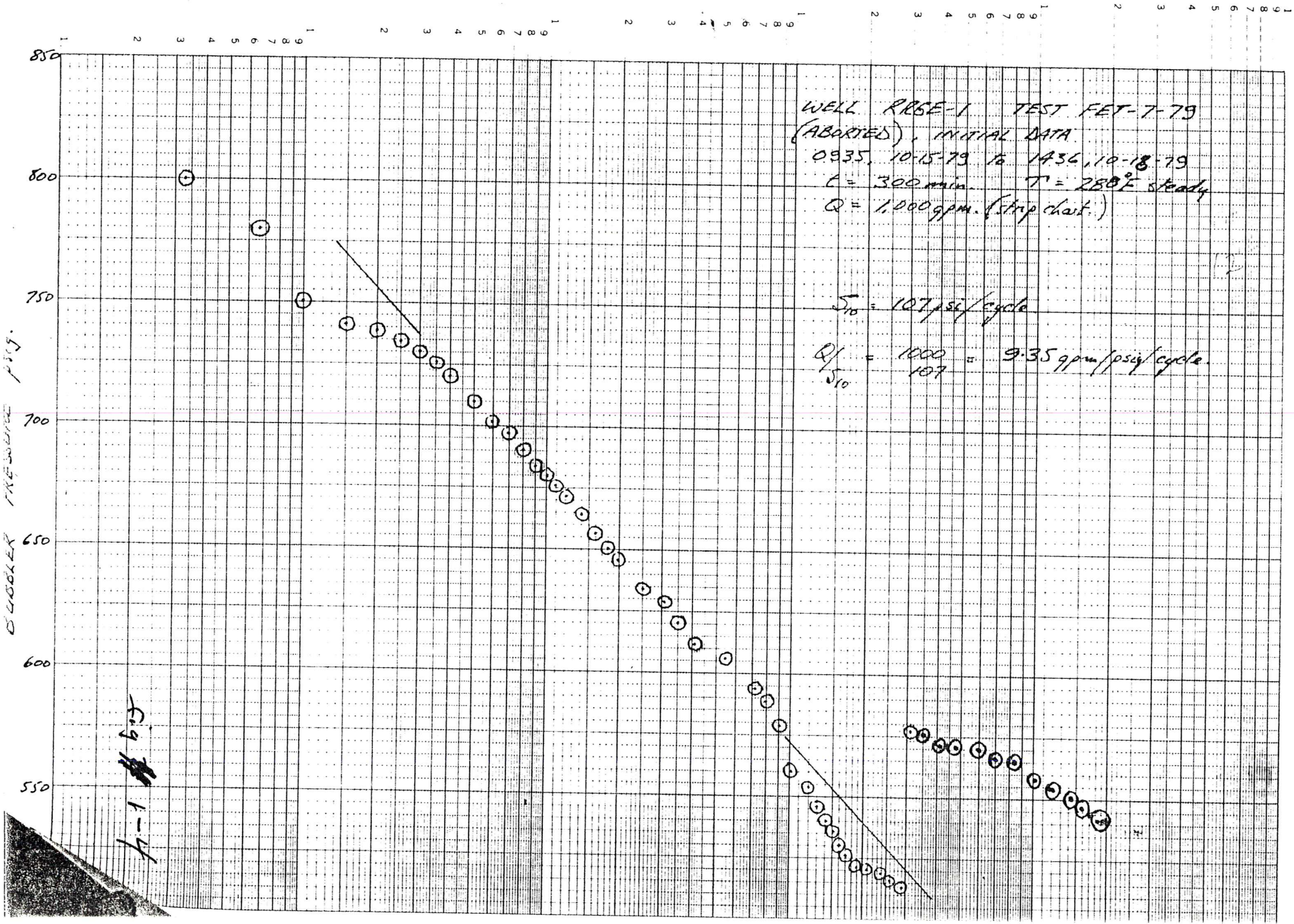
FIGURE 1: BUBBLER PRESSURE RRGE-1, 2-2-76 THRU 2-6-76

Fig # 1-3

and Ta = 9.2×10^{-2} m^2/sec. Neither recovery data nor time vs. discharge temperature were analyzed. The data and analysis appear questionable.

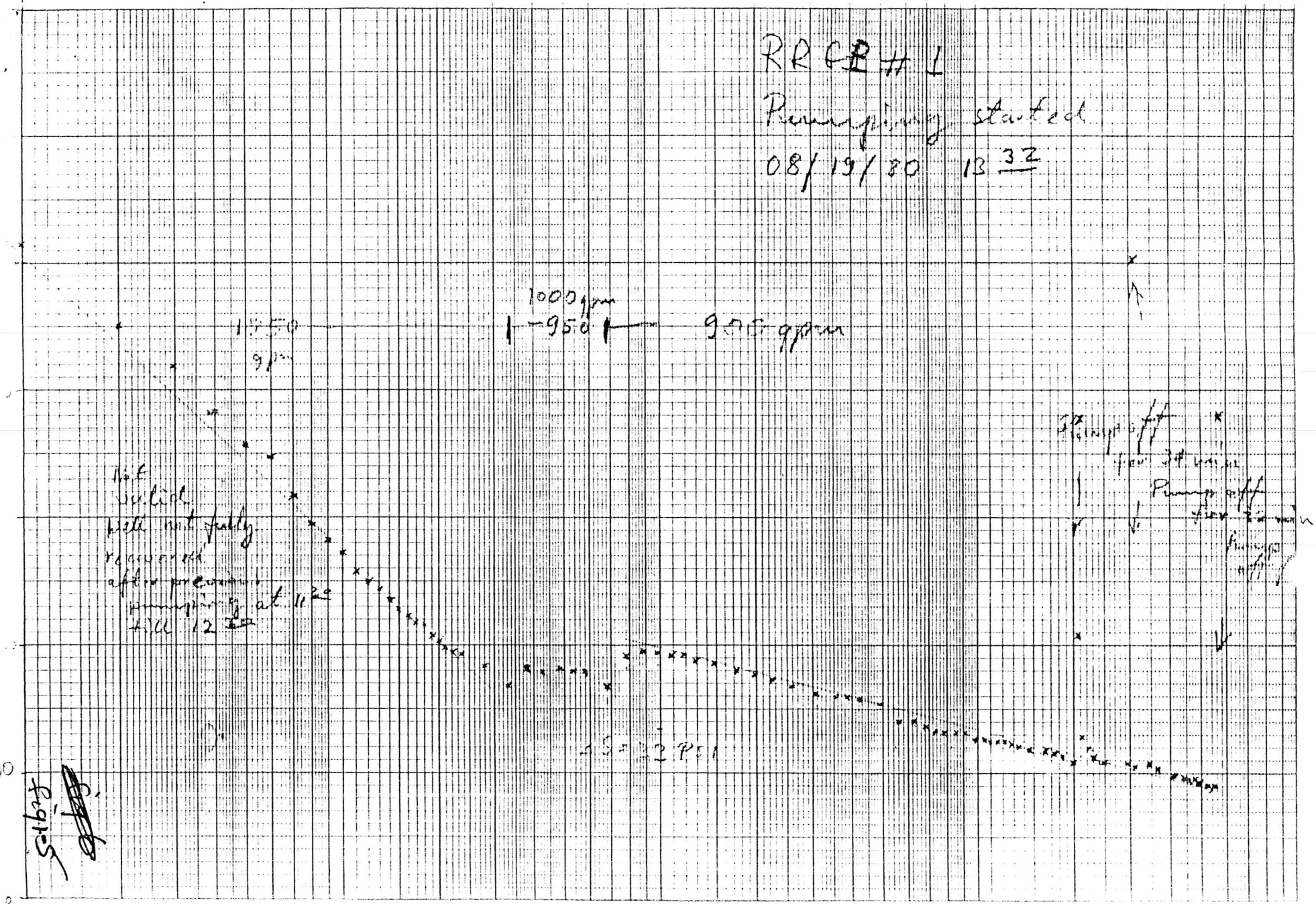
Another intermediate duration test was conducted between October 15-18, 1979. The well was pumped at an average discharge of 63 Lps for a period of 80 hours. During the test, drawdown and recovery was obtained by bubbler tube pressure. The initial bubbler tube pressure was 6136 kPa. After 300 minutes of testing, pump difficulties caused a 14 minute period of recovery. The time history of pressure change during the drawdown phase is graphically presented in figure 4. The reservoir parameters for drawdown phase are: Q/s_{10} = 0.086 Lps/kPa / log cycle, kHa = 3,300 md.m, and Ta = 1.5×10^{-4} m^2/sec. The recovery phase is graphically presented in figure 5. Reservoir parameters for the recovery phase are: Q/s_{10} = 0.21 Lps/kPa 1 log cycle, kHa = 8,200 md.m, and Ta = 3.7×10^{-4} m^2/sec. No wellhead temperature vs. time was reported. The maximum bubbler tube drawdown of 2.6×10^3 kPa is reached before the pump difficulties at 300 minutes.

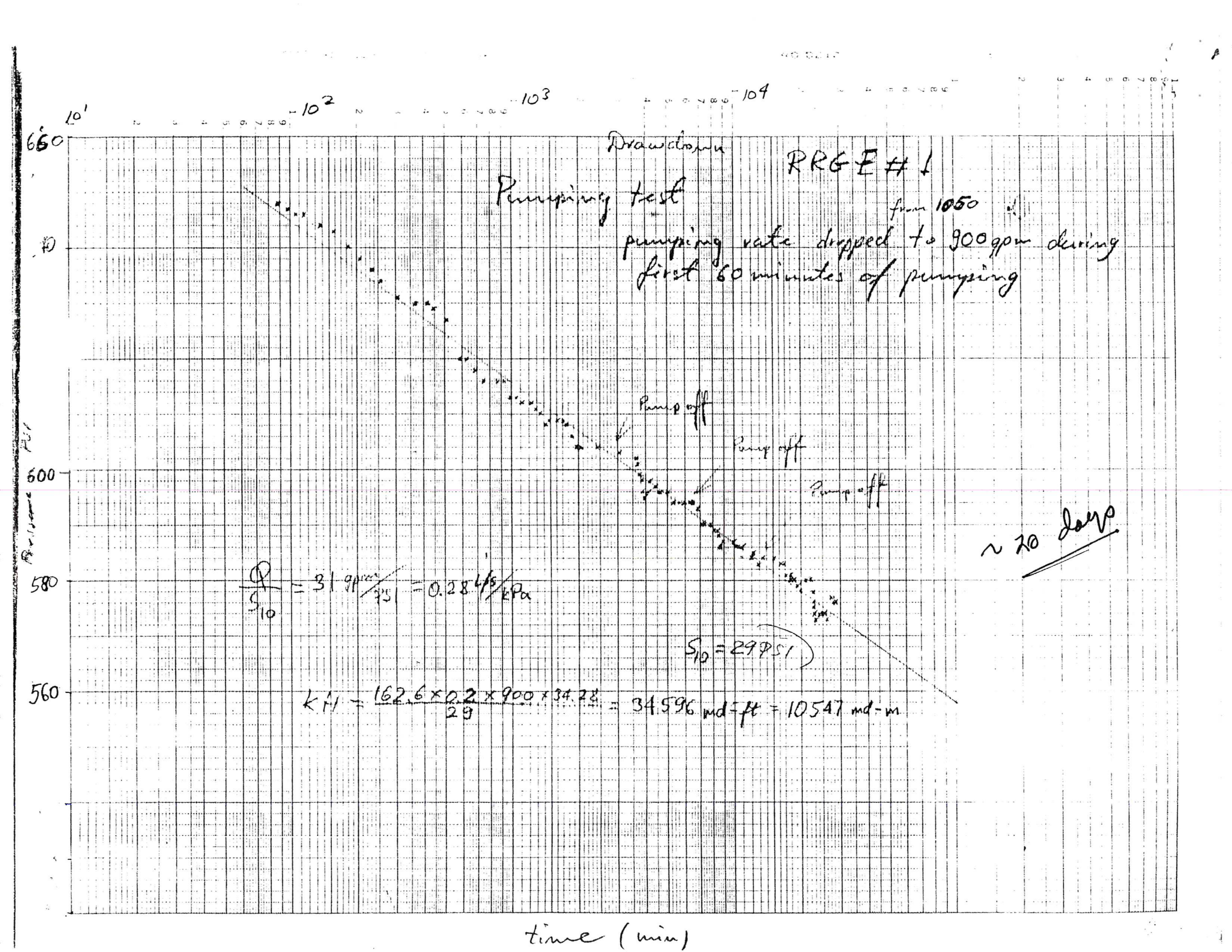
A long duration test was conducted between August 18, 1980 and September 10, 1980. The well was pumped initially at a rate of 66.2 Lps but declined to 56.8 Lps within the first 100 minutes of the test. Drawdown and recovery data were recorded by use of a bubbler tube and heisi pressure gage. The initial bubbler tube pressure was not recorded, but is estimated to be about 6.1×10^3 kPa (hot). During the test there were several pump outages of short duration. The time history of pressure change during drawdown is graphically presented in figure 6. Reservoir parameters for the drawdown phase are: Q/s_{10} = 0.28 Lps/kPa, log cycle, kHa = 10,900 md.m, and Ta = 4.9×10^{-4} m^2/sec. Recovery is graphically presented in figure 7. Reservoir parameters for the recovery phase are: Q/s_{10} = 0.24 Lps/kPa/ log cycle, kHa = 9,300 md.m, and Ta = 4.2×10^{-4} m^2/sec. No time vs. discharge temperature was reported. The maximum bubbler tube drawdown was about 2068 kPa.

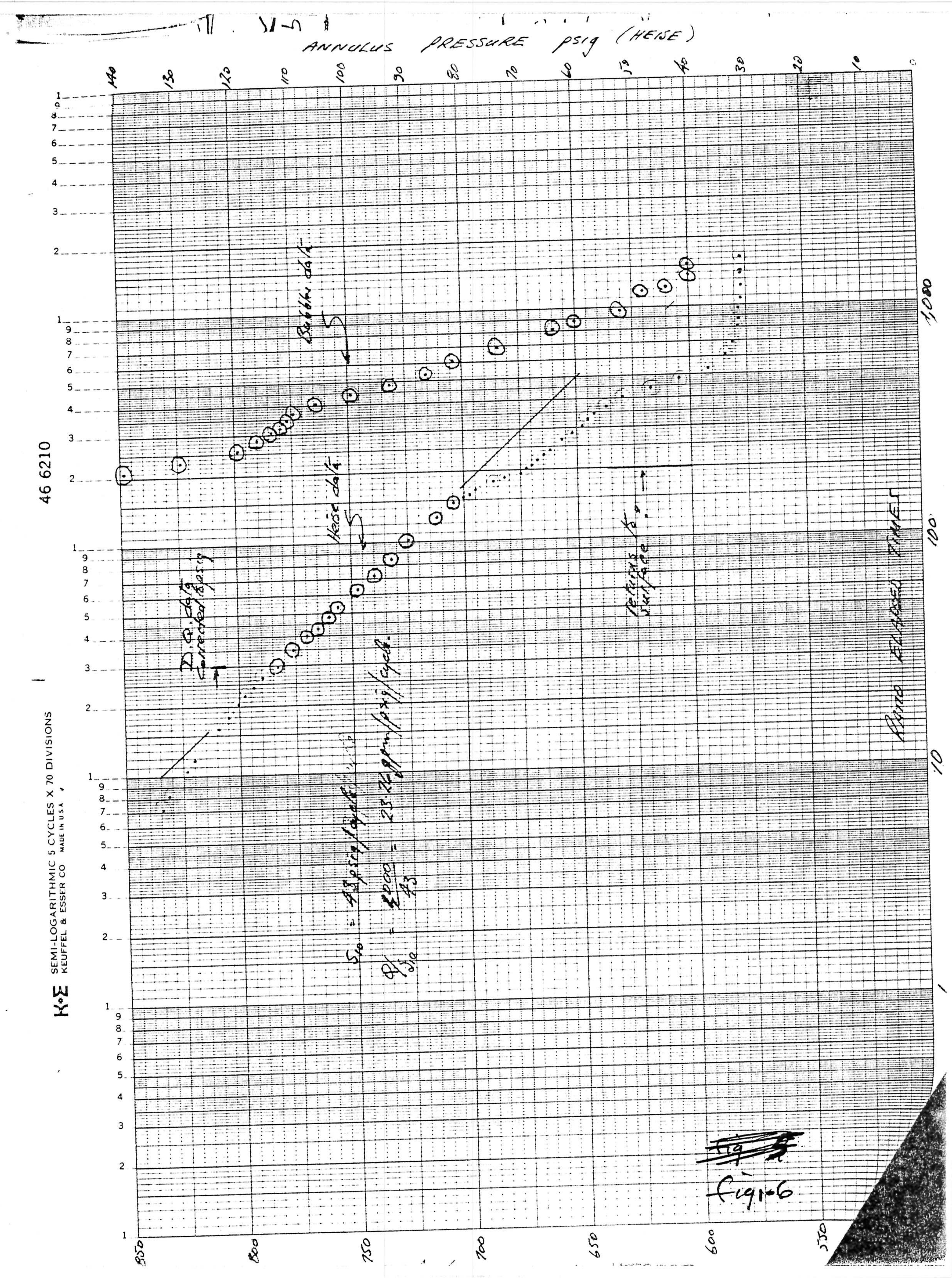


K·E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

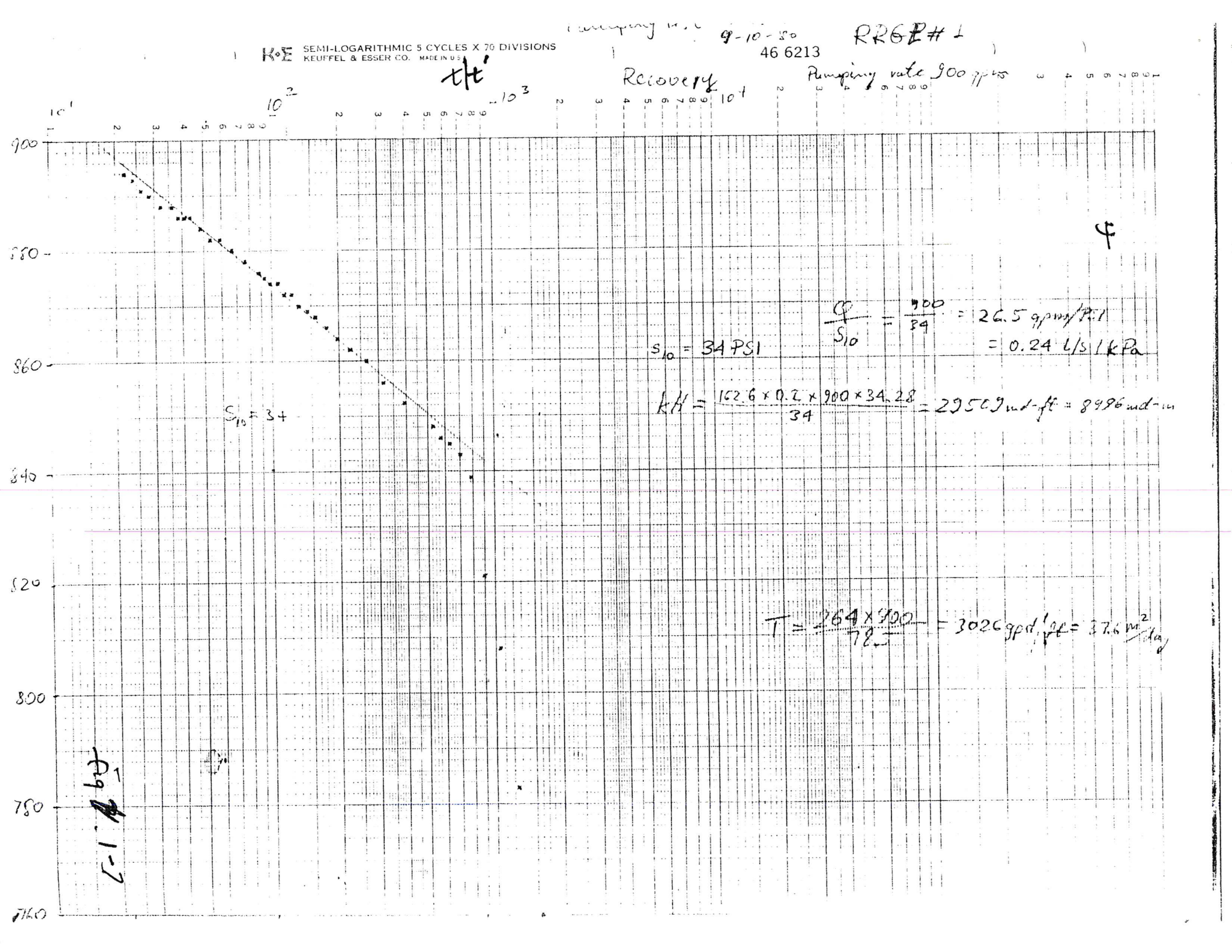
46 6012




Drawdown
RRGE #1
Pumping test
from 1050
pumping rate dropped to 900 gpm during
first 60 minutes of pumping
Pump off
Pump off
Pump off
~ 20 days
$\frac{Q}{s_{10}} = 31 \frac{gpm}{ft} = 0.28 \frac{l/s}{kPa}$
$s_{10} = 29.51$
$kH = \frac{162.6 \times 0.2 \times 900 \times 34.28}{29} = 34596 \text{ md-ft} = 10547 \text{ md-m}$
660
600
580
560
10^1
10^2
10^3
10^4
time (min)



ANNULUS PRESSURE psig (HEISE)
Bubble data
Heise data
D.P. data corrected to psig
Returns to surface
Prod ELAPSED TIME
K&E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO MADE IN USA
46 6210
Fig. 6


K&E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6213
9-10-80
RR6E#1
t/t'
Recovery
Pumping rate 900 gpm
900
880
860
840
820
800
780
760
$S_{10} = 34$
$S_{10} = 34$ PSI
$\frac{Q}{S_{10}} = \frac{900}{34} = 26.5$ gpm/PSI
$= 0.24$ l/s/kPa
$kH = \frac{162.6 \times 0.2 \times 900 \times 34.28}{34} = 29509$ md-ft $= 8996$ md-m
$T = \frac{264 \times 900}{78} = 3026$ gpd/ft $= 37.6$ m²/day

A summary of the calculated reservoir parameters for those well tests 724-hours duration is presented in table 1-2. If the data from the 2/2/76, 55 Lps test is not considered, then J appears that at low discharge rates the apparent reservoir parameters are considerable higher than at the high discharge rates. Although reservoir parameters should be a constant, this may not hold in the case of a factured reservoir.

The 24-hour specific capacity ranged from 0.24 Lps/kPa at a dishcarge rate of 1.7 Lps to 0.03 Lps/kPa at a discharge rate of 56.8 Lps. The specific capacity is apparently progressively smaller with higher rates. The productivity curve is plotted in figure 8. Evaluation of the line between the two plotted points results in the equation $y = 34.17x-51.10$. However, implications from 24-hour data suggests that the curve is a quadratie of the form $y = 0.23x^2+13.37x-15.05$. It is likely that the productivity index curve is a quadratic due to the fractured nature of the reservoir.

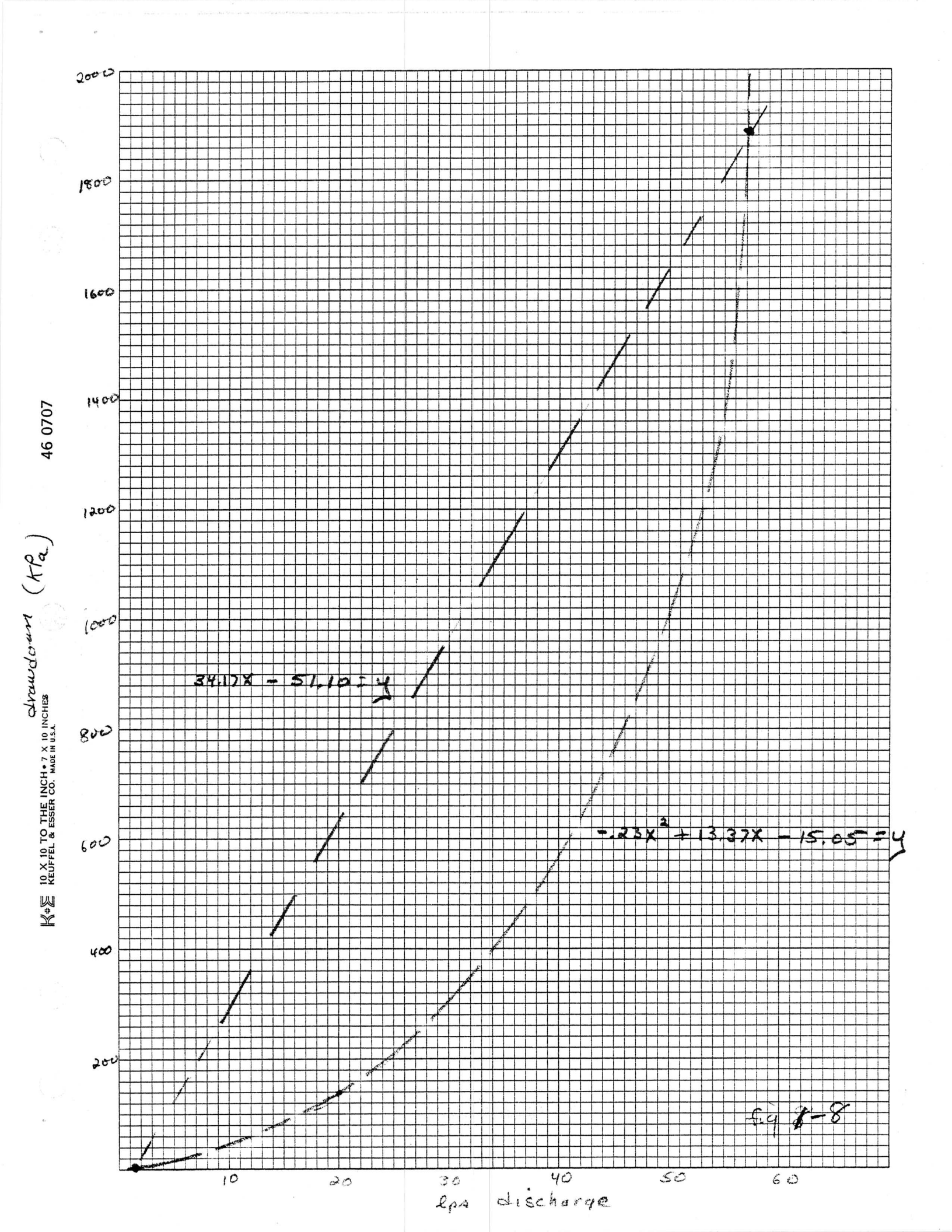
The interval open to production in RRGE-1 is 1104-1521 m. During drilling, fluid was lost to the formation in the interval 1100-1220 m.

Temperature gradient changes, noted after cooler water had been injected into the well, occur at depths of 1201, 1230, 1300 m. and in the interval 1406-1423 m. Caliper logs indicate hole enlargement through the interval 1140-1175 m. and several thin zones of hole enlargement in the interval 1406-1415 m. No flow-meter surveys are available to assess producing zones. Fractured zones, interpreted from the available U.S.G.S. televiewer logs occur at approximately 1300 m. and through the interval 1400-1496 m.

date	Q	Q/Q_{10}	kH_a	T_a	Test
11/5/75	1.7	1.2	47,000	2×10^{-3}	dd
		.63	24,000	1×10^{-3}	recovery
2/2/76	55	.5	20,600	92×10^{-3}	dd
10/12/79	63	.086	3,300	1.5×10^{-4}	dd
		.21	8,200	3.7×10^{-4}	recovery
8/18/80	56.8	.28	10,900	4.9×10^{-4}	dd
		.24	9,300	4.2×10^{-4}	recovery

Summary of Reservoir Parameters of well RRGE-1

Table 1-2


2000
1800
1600
1400
1200
1000
800
600
400
200
drawdown (kPa)
10
20
30
40
50
60
lps discharge
34.17X - 51.10 = Y
-.23X² + 13.37X - 15.05 = Y
Eq 8-8
46 0707
10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

From the available information, the most significant producing zones in RRGE-1 appear to be probable fractured intervals occuring at approximately 1190-1230 m., 1300-1320 m., and 1400 m. in the borehole. Figure 9 summarizes the available information from which the probable producing intervals have been identified.

RRGE-1 has not been adequately tested at a sufficient range of artesian flow rates to predict its artesian capability with confidence. From its history of flow to support experiments, it is estimated that the well should be capable of supporting a sustained artesian flow of approximately 12-15 Lps for a three-year period. Wellhead flowing temperature is 135°C.

An estimation of well discharge vs. wellbore drawdown from static conditions is given in figure 10. At the higher rates (30 Lps) the discharge temperature will be between 132-138°C.

WELL ... 1, ... ZONES

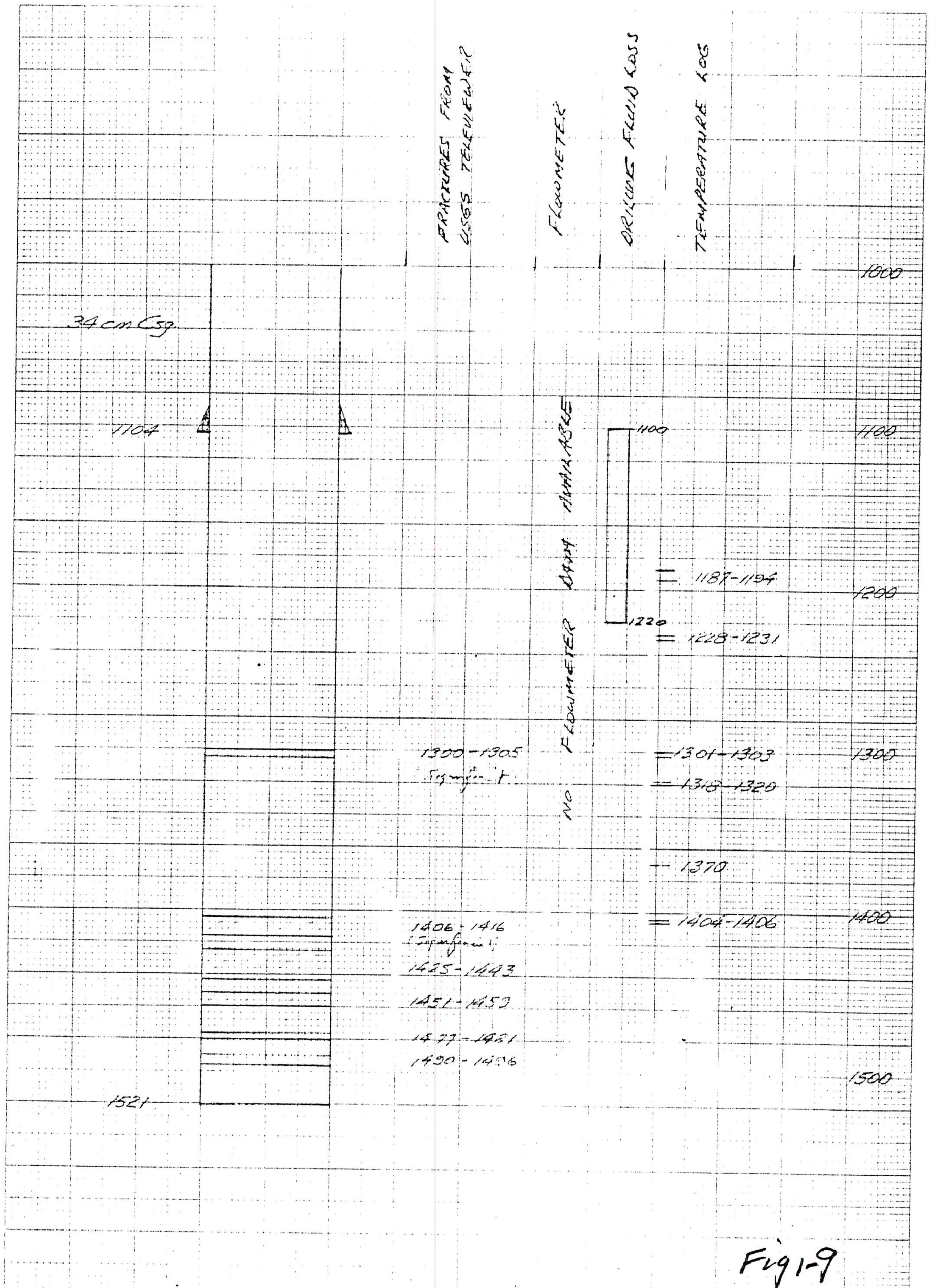


Fig 1-9

46 1323

The well loss "constant" (Jacob, 1946) is extremely high. It ranges from 5^4,700 sec^2/m^5 to greater than 200,000 sec^2/m^5. This value is apparently meaningless, but suggests that standard techniques may not apply to fracture flow conditions and/or time-dependent density changes. The skin effects can not be calculated as we do not know the reservoir thickness (h), the reservoir porosity (ϕ). In addition early time-dependent density effects make the pressure in the borehole after one hour (P_{1hr}) and the initial pressure (P_i) not correlatable.

in RRGE-1

The interval open to production is 1104-1521 m. During drilling, fluid was lost to the formation in the interval 1100-1220 m.

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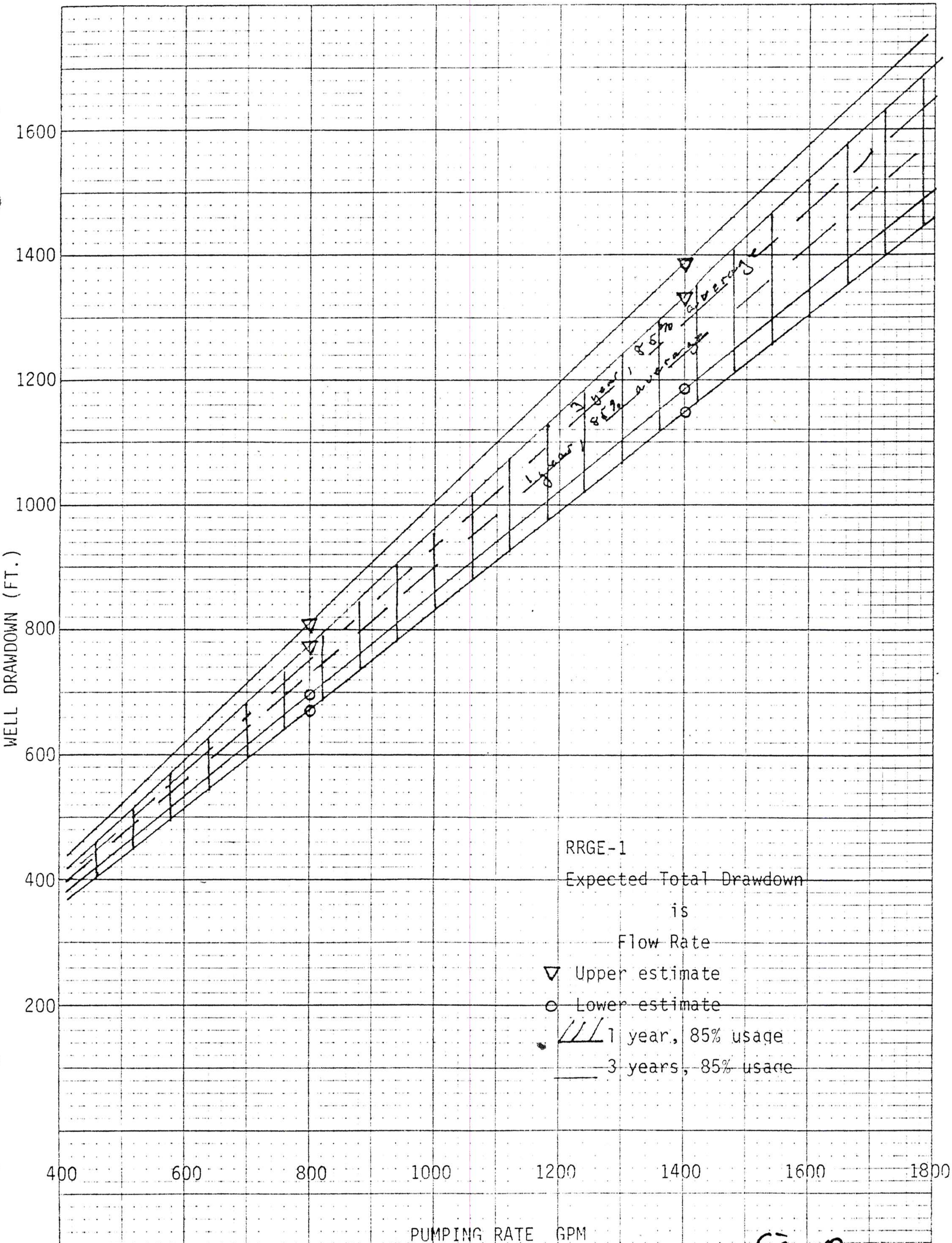

Fig 1-10