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24 HOUR PUMPING TEST OF PRODUCTION WELL 905-120P (U)

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DISCLAIMER

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EXECUTIVE SUMMARY

This report presents the results of a 24 hour pumping test run on a new water supply well located in P-Area. The well (905-120P) installed by the US Army Corps of Engineers is screened in the lowermost aquifer zone within the Cretaceous section. The performance test was conducted in April 1990. The analysis utilized measurements collected from observation well P-24 located approximately 584 feet from the pumped well. Analysis of these data indicate transmissivity and storage coefficient values, for the hydrogeologic zone pumped, of approximately 86,600 gpd/ft and 0.00015, respectively. These values are in the range of other pumping tests conducted at SRS.

INTRODUCTION

As part of the Savannah River Site (SRS) Aquifer Characterization Program, the Environmental Sciences Section (ESS) of the Savannah River Laboratory (SRL) is attempting to determine the water transmitting characteristics of the different aquifer units underlying the SRS by conducting single well pumping tests on wells installed as part of the SRS Baseline Hydrogeologic Investigation. In April 1990, while performing the single well pumping test, an opportunity became available to collect data on aquifer properties utilizing a production well and observation wells. At this time the US Army Corps of Engineers (COE) was completing a new production well (well 905-120P) in P-Area. This well, located in close proximity to well cluster P-24, was to undergo a 24-hour performance test by the COE. ESS arranged with the subcontractor working on the Single Well pumping Test project, Dames & Moore, to instrument the appropriate observation wells and to coordinate data collection with the COE.

HYDROGEOLOGIC SETTING

Well 905-120P and observation well cluster P-24 are located in P-Area, approximately as shown on Figure 1. The test well (905-120P) is screened in what is termed **Aquifer Unit IA** (Bledsoe et. al., 1990 and Aadland and Bledsoe, 1990). A comparison the proposed hydrostratigraphic nomenclature for use at SRS to the terminologdy used in past is presented on Figure 2. **Aquifer Unit IA** is the lower most aquifer found within Cretaceous age sediments at the Savannah River Site. This aquifer corresponds to the Middendorf Formation, but may also include sand zones within the lower 1/3 of the Black Creek Formation. This Aquifer Unit collectively represents what has been referred to as the "lower Tuscaloosa" aquifer. **Aquifer Unit IA** overlies **Confining System I** which correlates generally with the Cape Fear Formation and represents the bottom of the Cretaceous section at SRS. **Aquifer Unit IA** is separated from **Aquifer Unit IB** by **Confining Unit IA-IB**. **Confining Unit IA-IB** consists of the silty and clayey sediments found mainly within the middle 1/3 of the Black Creek Formation and corresponds basically to the "mid Tuscaloosa clay" in

previous terminology. **Aquifer Unit IB** includes sandy sediments found generally within the upper 1/3 of the Black Creek and the overlying Peedee Formations. This unit corresponds generally to the "upper Tuscaloosa" in previous terminology. The hydrostratigraphy associated with the P-24 cluster, which consists of eight individual wells completed within the different aquifer units, is presented on Figure 3.

Since characteristically each Aquifer or Confining Unit consists of a multilayered sequence of sediments with relatively higher or lower water transmitting properties, these units may be further divided into aquifer or confining zones, as appropriate. For this analysis, **Aquifer Unit IA** has been divided into three zones; **aquifer zone IA_1** and **aquifer zone IA_2** separated by **confining zone IA_1-IA_2**, Figure 4.

TEST PROCEDURES

Production Well 905-120P is located in P-Area approximately 584 feet from SRS Baseline well cluster P-24, Figure 1. The production well was drilled to a total depth of 1007 ft below ground surface and 50 feet of 6-inch diameter No. 50 slot screen was set from 930 to 980 feet below ground surface. The well was gravel packed from 730 ft to the total depth of 1007 feet. Figure 4 shows the general relationship of Well 905-120P to the overall hydrostratigraphy and to the two observation wells (P-24TA and P-24TB) completed within the same Aquifer Unit (**Aquifer Unit IA**). Additionally, Figure 4 shows the subdivision of **Aquifer Unit IA** into the three zones mentioned above. Wells 905-120P and P-24TA are both screened in **aquifer zone IA_1**, while observation well P-24TB is completed in **aquifer zone IA_2**. The two observation wells are separated by **confining zone IA_1-IA_2**.

Pressure transducers were placed in each of the observation wells screened in **Aquifer System I** (P-24TA, P-24TB, P-24TC, ands P-24TD). Wells P-24TC and P-24TD did not respond to pumping of 905-120P; however, these wells show some response to other supply wells (905-93P) in P-Area that are completed higher in the section in **Aquifer Unit IB**.

Data from the observation wells were collected via HERMIT^R data loggers manufactured by In-Situ Inc. Water levels for the pumping well (905-120P) were collected by the COE, but were not used in the analysis of aquifer properties. The pumping rate varied from approximately 750 to 764.6 gpm during the test, except for a brief decrease to 595.5 gpm at approximately one hour into the test. An average rate of 755.6 gpm was used for the analysis.

TEST ANALYSIS

The static water level in the pumping well and observation wells immediately prior to beginning the test are shown on Figure 4. During pumping the water level in 905-120P stabilized at approximately 177.4 feet, producing a total drawdown of 45.9 feet. The final drawdown in P-24TA was about 4.6 feet and in P-24TB slightly less than one foot. Field plots of drawdown vs time for P-24TA and P-24TB are presented on Figures 5 and 6, respectively.

On the plot of the P-24TA data, Figure 5, a small increase in the water level which corresponds to a brief drop in the pumping rate, is noted around 60 minutes into the test. P-24TB begins responding to pumpage at about 10 minutes into the test, Figure 6, and the drawdown trend continues to become steeper throughout the duration of the test. The steepening trend indicates that either water was leaking at an increased rate through the semiconfining zone (**confining zone IA_1-IA_2**) into the aquifer zone being pumped (**aquifer zone IA_1**), or more water was being withdrawn from **aquifer zone IA_2** over time as flow through the gravel pack. Also noted on Figure 6 is the brief and abrupt rise in the TB water level around 1100 minutes which corresponds to a very brief accidental shutdown of the pump suggesting hydraulic connection between the pumped zone (**aquifer zone IA_1**) and **aquifer zone IA_2**.

Water level measurements from observation well P-24TA were entered into the Graphical Well Analysis Package (GWAP), a computer program developed by GROUNDWATER GRAPHICS, San Diego, CA for analysis. GWAP plots the field data and allows the user to superimpose one of 73 different type curves on the field data. Once the appropriate type curve has been chosen, based on the type of test

conducted and the aquifer conditions, transmissivity and storage properties are calculated.

Aquifer Unit IA, in which both the pumping well and the observation wells are screened, is considered a leaky artesian aquifer with no storage in the confining layer. For the analysis of semiconfined conditions, GWAP utilizes leaky aquifer type curves taken from Hantush (1956).

The equations used to generate the solution for transmissivity and storage coefficient are as follows:

$$T = \frac{QW(u,r/B)}{4\pi s}$$

$$S = \frac{4uTt}{r^2}$$

where:

r	Distance from pumped well to observation well (584')
Q	Pumping rate (755.6 gpm)
t	Time since pumping began
T	Transmissivity
S	Storage coefficient
W(u,r/B)	Leaky well function
B	Leakage factor
b'	Thickness of semiconfining layer (50')
K'	Vertical hydraulic conductivity of leaky layer

Figure 7 is the graphical output from the GWAP program showing a plot of the data from P-24TA with the matched type curve. This curve match produces a transmissivity (T) of 8.038 ft^2/min and a storage coefficient (S) of 1.5×10^{-4}.

From the curve matching, r/B = 0.10 (Figure 7), and from Figure 4, b' is estimate to be about 50 feet. The vertical hydraulic conductivity of the leaky layer (**confining zone IA_1-IA_2**) can be estimated by substituting in the Hantush-Jacob equation:

$$K' = [Tb'(r/B)^2]/r^2$$

$$= [8.04\ (50)(.10)^2\ ]/584^2$$

$$= 1.2 \times 10^{-5}\ ft/min$$

$$= 1.7 \times 10^{-2}\ ft/day$$

CONCLUSIONS

Collection of data from observation wells screened in the same zone as a production well during a 24-hour performance pumping test presented the opportunity to obtain more accurate data on aquifer properties than could be obtained from a single well test.

Based on the analysis of data from P-24TA, the computed transmissivity and storage coefficient of 86,600 gpd/ft and 0.00015 , respectively, for **aquifer zone IA_1** are reasonable values for aquifers of similar lithology and are within the range of values reported for other aquifer tests at SRS, Table 1. Assuming that **aquifer zone IA_1** is approximately 100 feet in thickness as indicated on Figure 4, the hydraulic conductivity of the zone is approximately 860 gpd/ft^2.

The computed vertical hydraulic conductivity of the semiconfining zone (**confining zone IA_1-IA_2**) of 1.7×10^{-2} ft/day is a reasonable value for a zone composed of interfingered and interbedded clays, sands and silts. The actual hydraulic conductivity of this zone may be somewhat smaller due to potential interconnection of **aquifer zones IA_1** and **IA_2** through the gravel pack of the pumping well.

Observation well P-24TB screened in **aquifer zone IA_2** responded to pumpage approximately 10 minutes into the test and showed a continuing decline in water level with a maximum drawdown of slightly less than one foot indicating leakage through the semiconfining zone (**confining zone IA_1-IA_2**). Wells P-24TC and P-24TD, screened in **Aquifer Unit IB** did not respond to pumpage of well 905-120P, but were affected by pumpage from another nearby supply well.

ACKNOWLEDGEMENTS

William Porter and Martin Shields of Dames & Moore coordinated the test with the Corps of Engineers and collected the field data from the observation wells and provided field data plots. Jim Bolen of the Corps of Engineers provided data on the pumping well.

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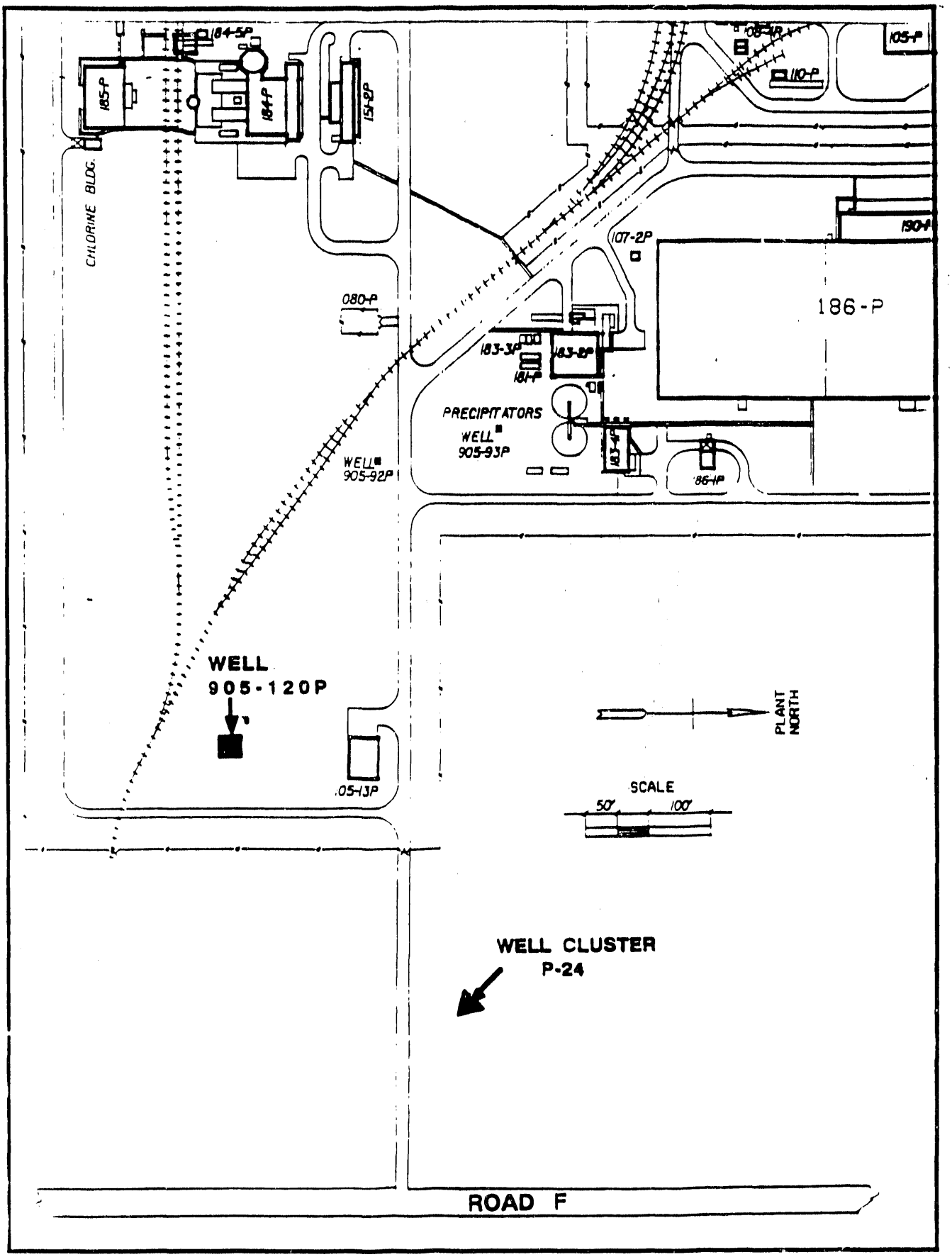

Figure 1. Location of Test Site

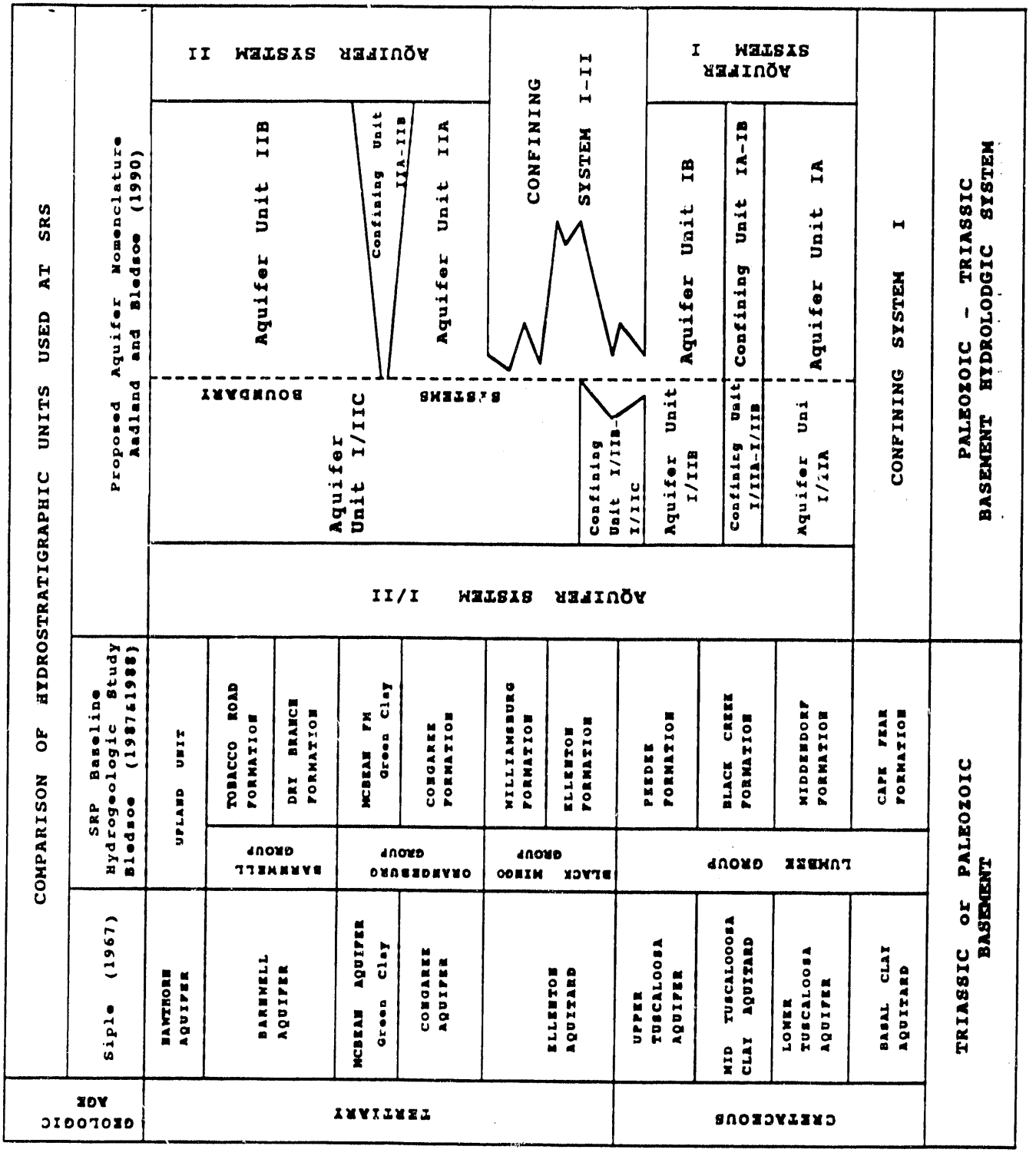

Figure 2. Generalized Correlation between Stratigraphic and Hydrostratigraphic Units at SRS

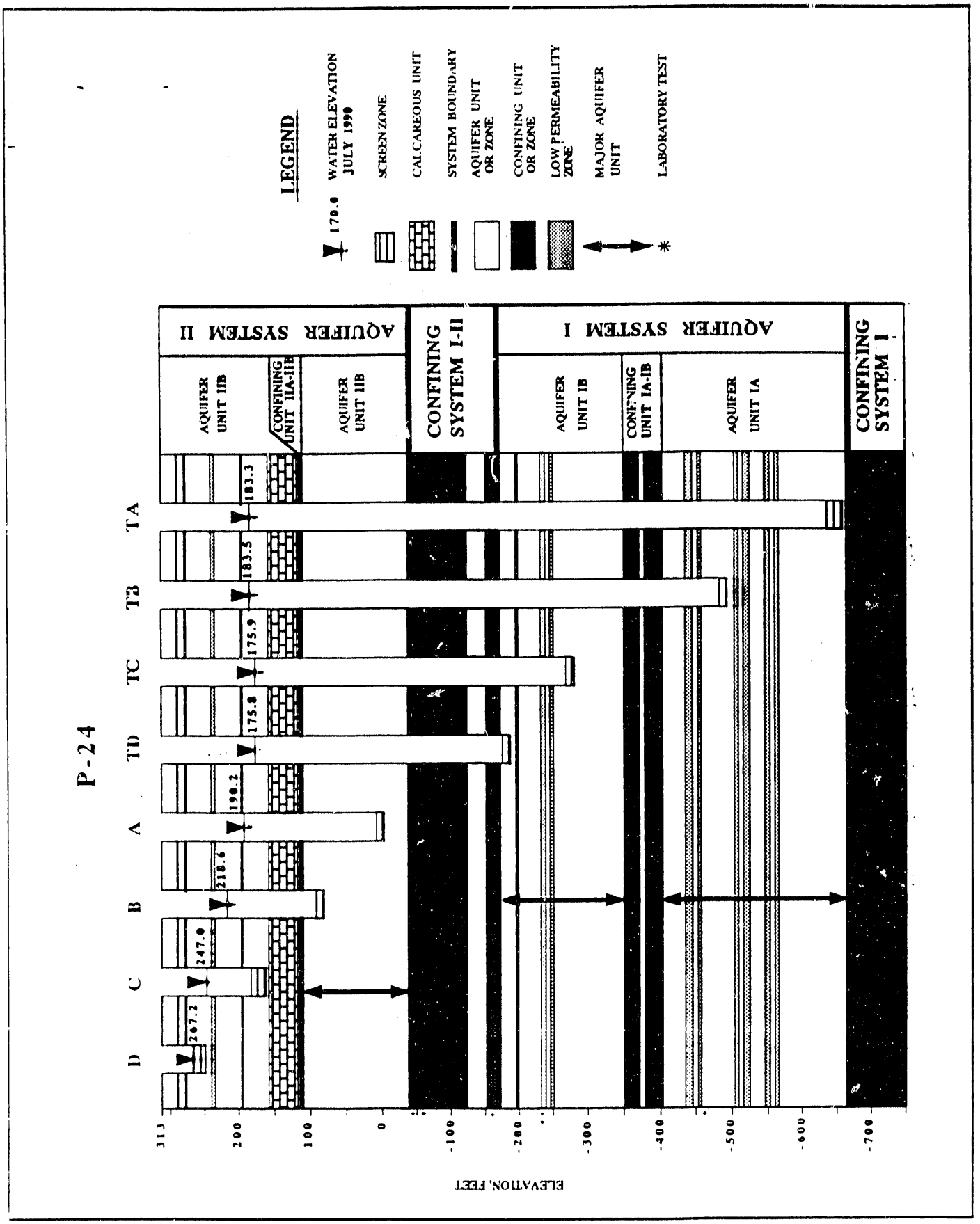

Figure 3. Profile of P-24 Well Cluster

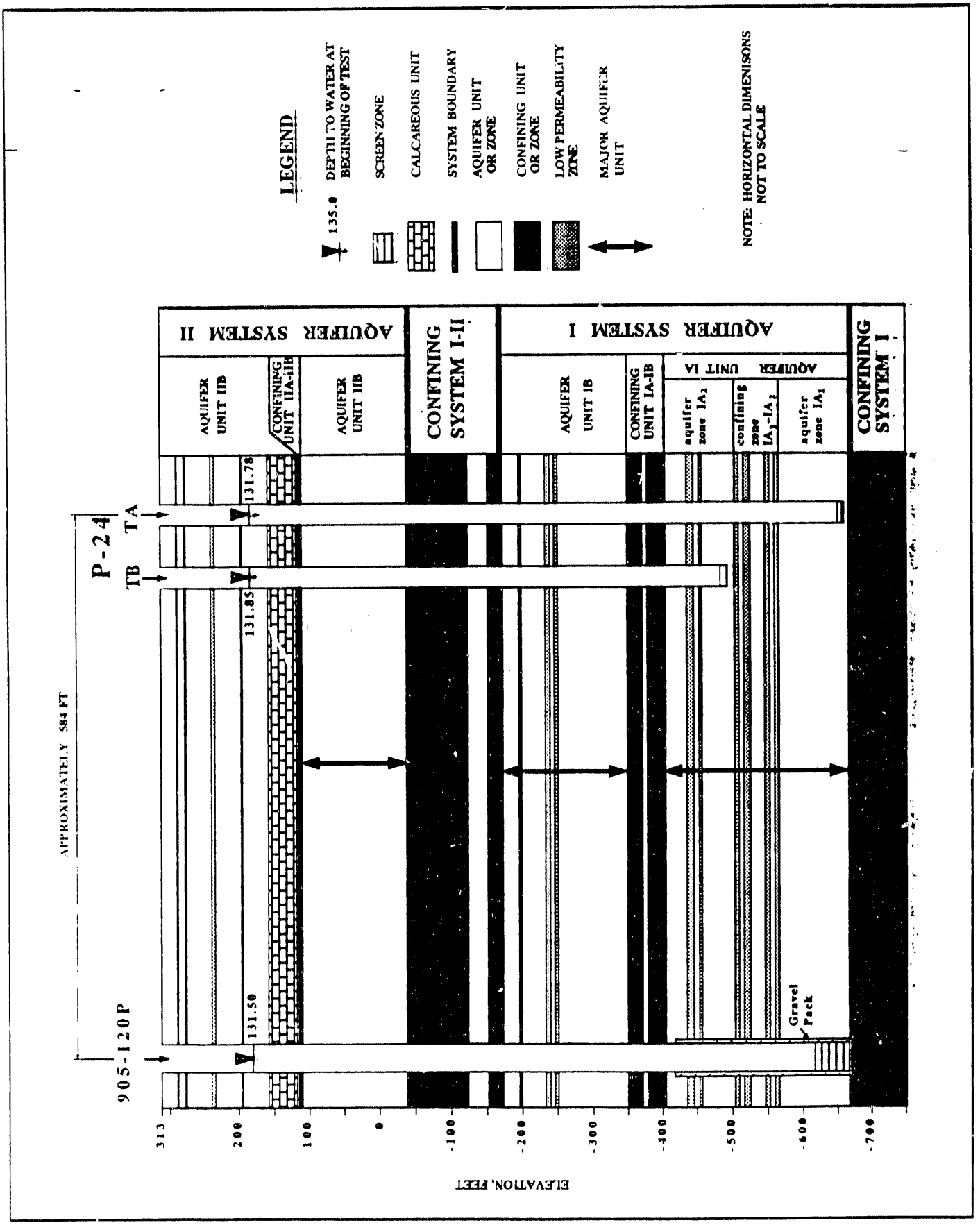

Figure 4. Hydrogeologic Relationship of Pumped Well to Observation Wells

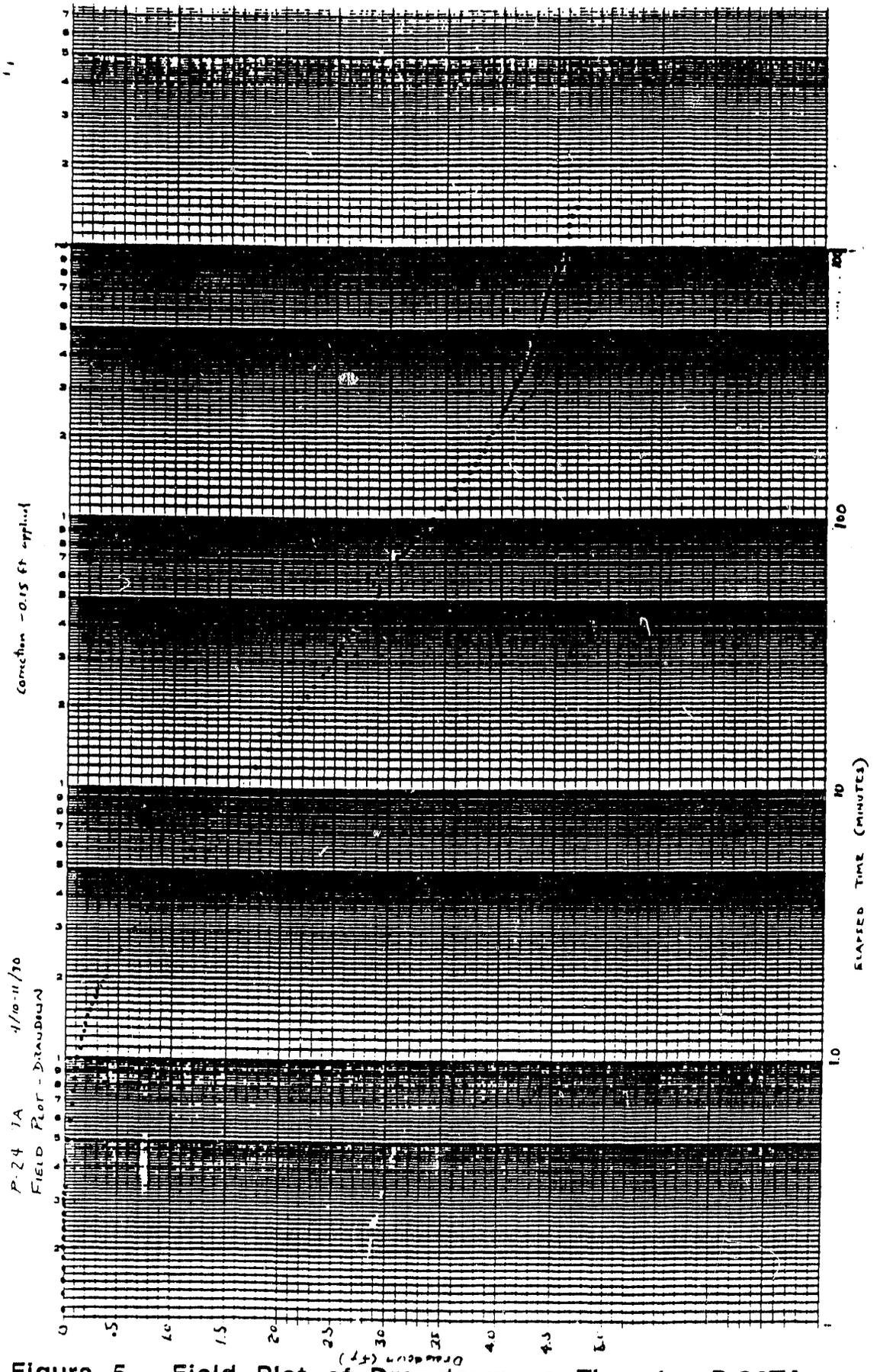

Figure 5. Field Plot of Drawdown vs Time for P-24TA

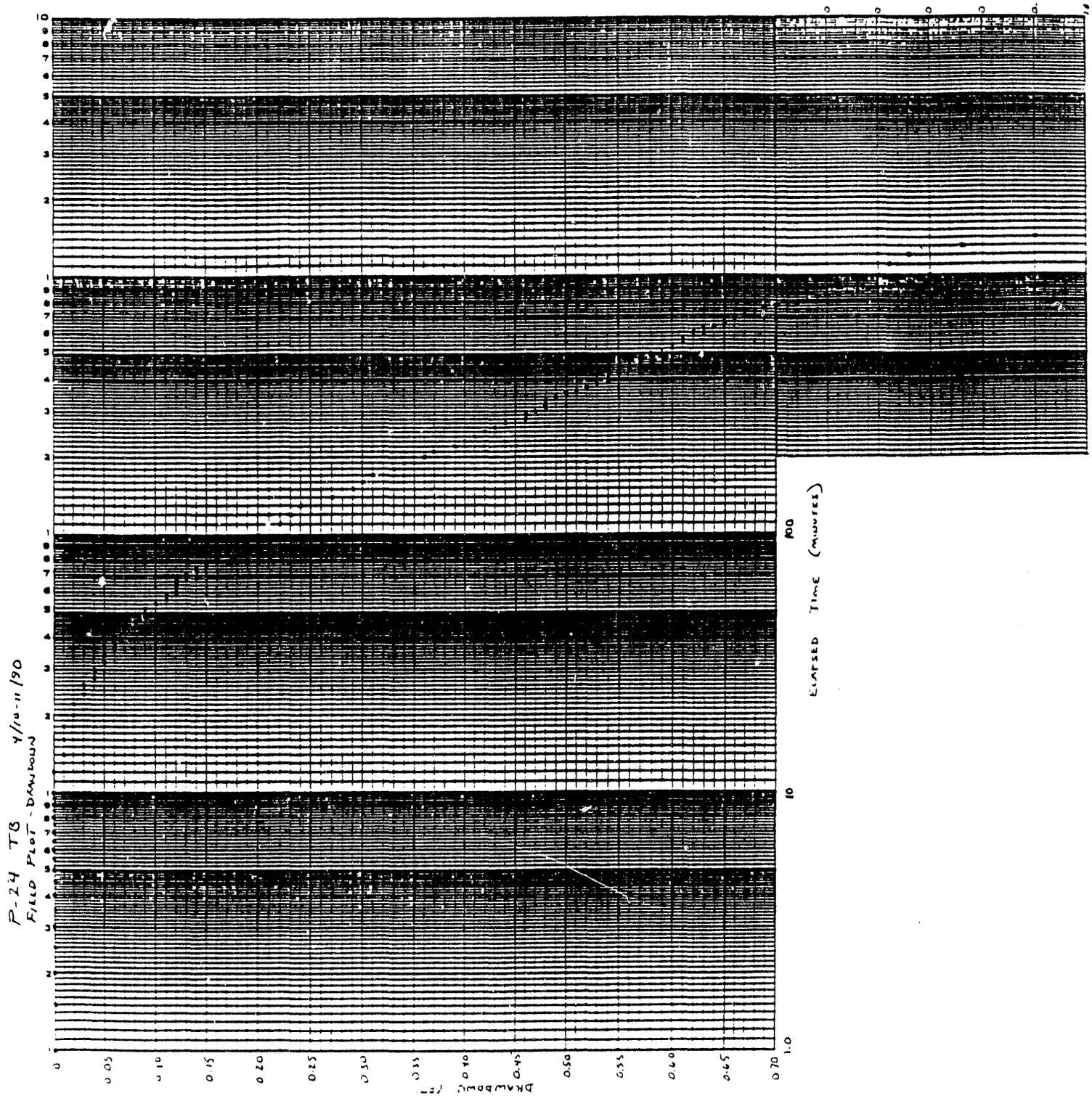

Figure 6. Field Plot of Drawdown vs Time for P-24TB

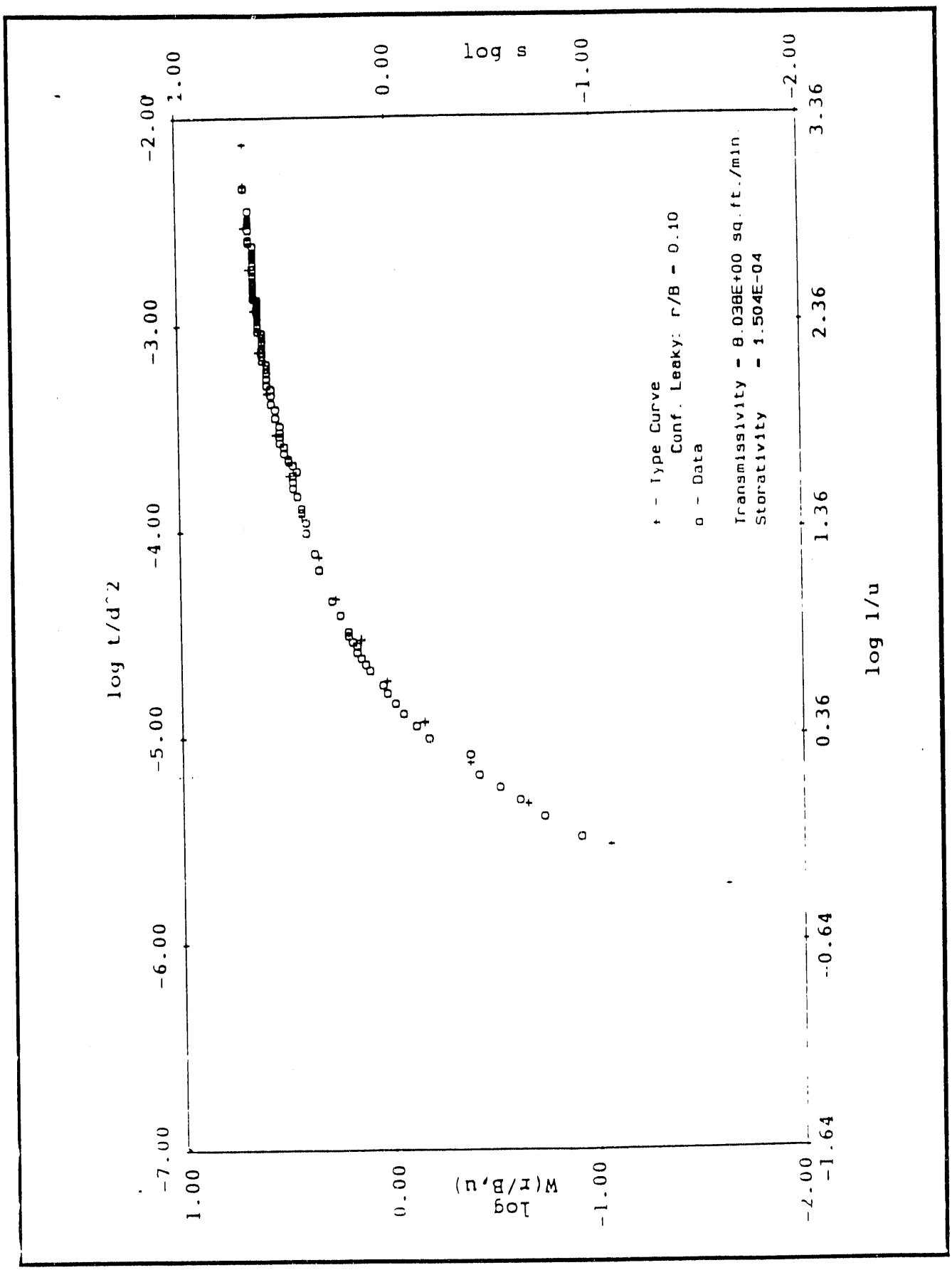

Figure 7. Plot of P-24TA Data with Matched Type Curve

Table 1. Hydrologic Data from Other Aquifer Test at SRS

Aquifer Unit	Date Sampled	Area	Well Pumped	Well Observed	Average Pumping Rate (gpm)	Sand Thickness (ft)	Transmissivity (gpd/ft)	Hydraulic Conductivity (gpd/ft^2)	Storage Coefficient
Aquifer IB	09/20/51	P	25-P	25-P	540	219	63,500	290	—
Aquifer IB	11/03/51	P	30-P	30-P	540	144	52,000	361	—
Aquifer IB	08/10/52	R	27-R	105-R	440	103	90,000	874	0.0004
Aquifer IB	12/31/51	K	33-K	33-K	578	154	109,000	708	—
Aquifer IB	05/26/52	C	51-C	51-C	589	—	95,000	—	—
Aquifer IB	06/16/52	C	52-C	52-C	567	136	140,000	1,029	—
Aquifer IB	08/03/52	P	25-P	105-P	370	219	46,000	210	0.0004
Aquifer IB	11/28/51	L	29-L	29-L	525	124	71,000	573	—
Aquifer I/IIB	04/23/51	M	15-M	15-M	450	160	33,500	209	—
Aquifer IA	04/28/52	F	49-F	49-F	562	267	105,000	393	—
Aquifer IA	11/16/51	F	21-F	24-F	1,870	237	252,000	1,065	0.0007
Aquifer IA	05/08/52	H	35-H	35-H	1,350	273	196,000	720	—
Aquifer IA	01/03/52	H	35-H	35-H	560	273	198,000	725	—
Aquifer IA	02/23/52	H	43-H	43-H	560	277	204,000	736	—
Aquifer IA	05/06/52	H	48-H	48-H	600	260	198,000	762	—
Aquifer IA	03/17/52	H	44-H	44-H	570	239	375,000	1,569	—
Aquifer IA	02/29/52	F	37-F	37-F	589	213	178,000	836	—
Aquifer I/IIA	01/19/52	M	31-M	4-M, 20-M	1,500	181	147,000	812	0.0003

Reference: Siple (1967)

END

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