Chris Swenzy

EVALUATION OF PUMPING TEST RESULTS
CHULUOTA WELL SITE

SEMINOLE COUNTY, FLORIDA

JAMMAL & ASSOCIATES, INC. Consulting Engineers

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EXECUTIVE SUMMARY

Southern States Utilities (SSU) has proposed to install and operate a back-up potable supply well to the existing supply wells currently servicing residents within SSU's service area in Chuluota, Florida. An investigation was performed to evaluate the potential impacts of groundwater withdrawals from the proposed Well #1 located at the corner of Brumley Road and Avenue H. The investigation included installation of two (2) test wells, conducting a 72-hour aquifer pumping test, laboratory analysis of collected water samples and interpretation of the resultant hydrologic data.

Analysis of water samples collected at selected time intervals during the 72-hour pumping test indicated that water produced from the well is of the transitional water type (TW) as defined by Frazee (1982). Time-related samples were collected to detect changes in water quality with time during the test. Sample analysis showed that the concentration levels of most ions decreased during the 72-hour period of the pump test suggesting that the pumped aquifer was receiving freshwater recharge from overlying hydrologic units.

Analysis of the pump test data indicates that the upper portion of the Floridan aquifer behaves as a leaky artesian aquifer. Observations made in the field indicate that a drawdown of approximately 14 feet may be expected within the pumping well at a discharge of 500 gpm. Subsequent model simulations of pumpage from the well indicate that less than one (1) foot of drawdown of the potentiometric surface of the Floridan aquifer will be seen at distances greater than 600 feet from the well.

A well inventory did not locate individuals using the same aquifer within this 600 foot radius. The model simulation indicates that a maximum drawdown of 0.3 feet is expected in the well of the nearest adjacent user as a result of the proposed pumpage from Southern States Utilities Well #1.

Based upon the results of the aquifer performance test and analysis of the resultant hydrologic data, Jammal & Associates, Inc., concludes the following: 1 Groundwater of suitable quality for drinking purposes is available from Southern States Utilities Well #1 at the design pumping rate of 500 gpm.
2 Time-dependent water quality test results strongly suggest that pumpage from Southern States Utilities Well #1 at the design pumping rate will not have an adverse impact on water quality in the Floridan aquifer or on adjacent water wells.

1 ____________

2 ____________

INTRODUCTION

Purpose and Scope

A drinking water supply facility proposed for construction by Southern State Utilities, Inc., is located in an area designated as a special condition zone by the St. Johns River Water Management District (SJRWMD) because of its proximity to an area where water quality in the upper Floridan aquifer has characteristics of relict sea water. The facility exists in an area labeled as a transitional zone where water quality for the upper Floridan indicates mixing of fresh water recharge with more mineralized water. Published literature indicates that water quality in the Floridan aquifer generally deteriorates towards the east, in the direction of the St. Johns River.

Two test/production wells were constructed at the proposed Chuluota Well Field to provide a means of collecting certain hydrologic data in the immediate vicinity of the proposed well site. One of the wells will be designated as a stand-by well to the existing Southern States Utilities Chuluota water supply facility while the other well will be used as a permanent observation well, providing an avenue to obtain hydrologic information from the upper Floridan aquifer.

An aquifer performance test was conducted to estimate aquifer hydraulic characteristics in the vicinity of the proposed wells. The aquifer coefficients determined from the pump tests were employed to construct a model to simulate the effects of withdrawals from the proposed back-up well.

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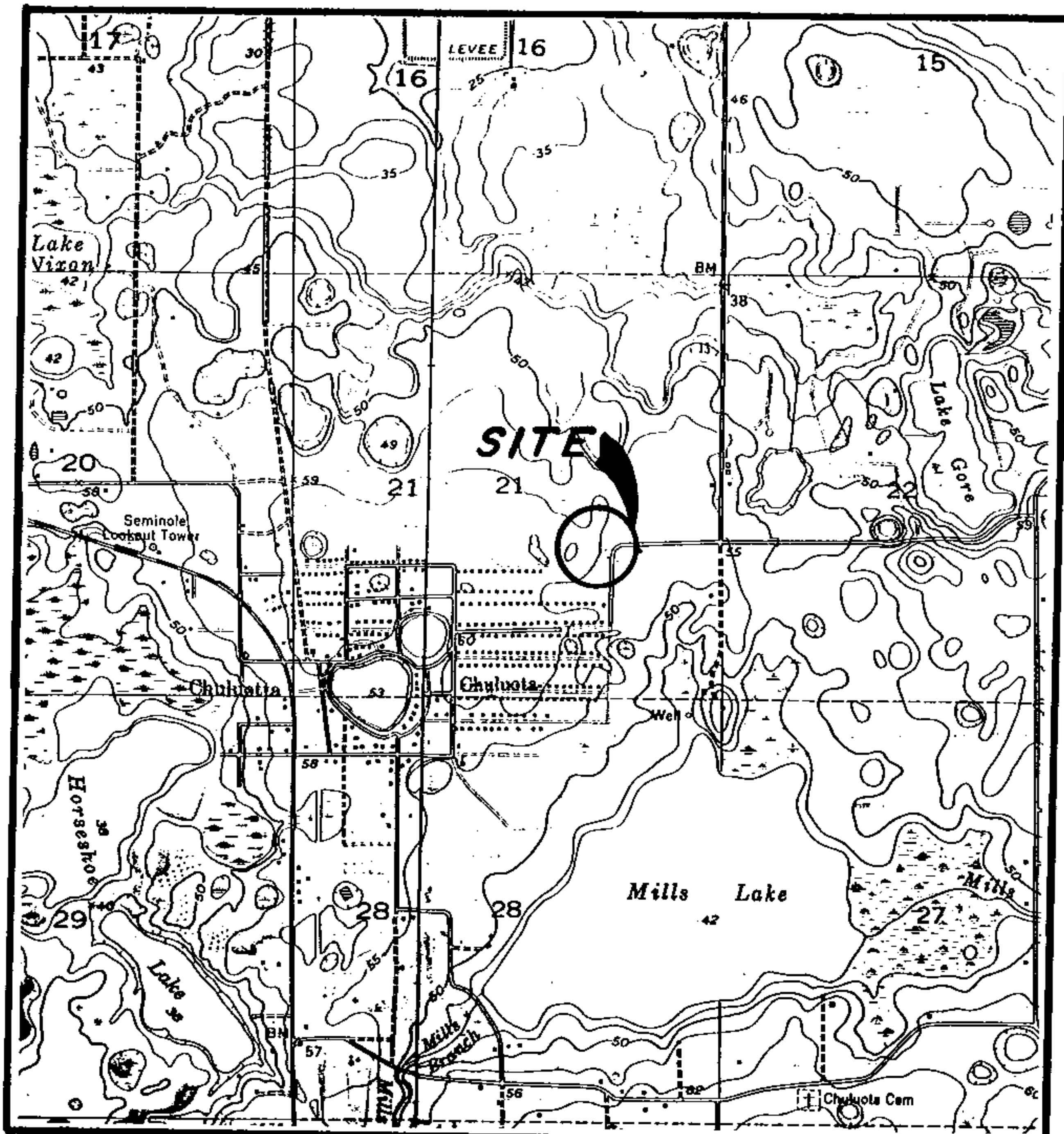


N

Site Location
CHULUOTA WELL FIELD
Seminole County, Florida

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DRAWN: MG	SCALE: 1" = 2000'	PROJ NO: 86-03082
CHKD: CLS	DATE: 5-4-88	FIGURE: 1

T21S, R32E

Water samples were collected at selected intervals during the course of the aquifer performance test and submitted to an independent chemical laboratory for analysis. A geochemical pattern analysis was conducted on each of the collected samples in order to isolate trends in water stability with time.

Based upon collected geologic and hydrologic information, conclusions regarding the availability and quality of potable water from the proposed site are presented.

Project Location and Site Description

The proposed Chuluota Well site is located approximately one mile east of S.R. 419 in southeast Seminole County. Figure 1 shows the location of the proposed site. Well #1, designated as stand-by well, is a 10-inch well located approximately 75 feet west of the intersection of Brumley Road and Avenue H. Well #2, designated as an observation well, is a 10-inch well located 200 feet west of Well #1.

The surficial land surface features surrounding the proposed well site are characterized by low relief with an estimated 1% to 2% grade toward a depression located approximately 300 feet to the north. Residential housing exists approximately 700 feet to the south and west and approximately one-quarter of a mile to the east.

GEOLOGIC AND HYDROLOGIC CONDITIONS

Geology

The regional geology for the site consists of thick marine limestone and dolostone deposits overlain by sand, clays and silts (Lichtler, 1972). Far below those units are the crystalline rocks of the basement complex. In the site vicinity, wells typically penetrate only the upper 200 feet of stratum.

Geologic logs from wells drilled in the area typically contain sections including deposits from Eocene Age limestones to Recent Age fine sands. Penetrated Eocene limestone deposits consist of soft, cream colored, shelly limestones known as the Ocala Formation. Geologic logs from the completed test/production wells indicate that the top of the Ocala is at a depth of approximately 160 feet.

Unconformably overlying the Ocala Formation are deposits of sand, silt, clay and limestones collectively known as the Hawthorn Formation. The clayey sands of the Miocene Age Hawthorn deposits effectively retard the vertical movement of water into the lower Floridan aquifer. Lower portions of the Hawthorn Formation many times contain limestone sections that when in direct hydraulic contact with the lower Eocene limestones are considered part of the Floridan aquifer

(Lichtler, et al, 1968). Geologic logs from the constructed test/production wells indicate that the Hawthorn is approximately 140 feet thick in the site vicinity.

Overlying the Hawthorn are more recent Pleistocene to Recent undifferented deposits. These deposits generally make up the upper 20 feet of sediments as shown by the geologic logs of the on-site wells. These deposits are composed of layers of fine sands differentiated only by color and minor trace constituents.

Hydrogeology

Within the project area, principal aquifer systems exist under artesian and non-artesian conditions. The non-artesian or unconfined aquifer in Seminole County is composed of a series of sand and clay deposits varing in thickness from 75 to over 150 feet thick (Barraclough 1972). Collective deposits of the Hawthorn Formation and overlying Pleistocene to Recent sands compose portions of non-artesian aquifer. Groundwater within this aquifer exists under atmospheric conditions and is directly affected by climatic factors such as rainfall and evapotranspiration. In the areas of the proposed well field, the non-artesian aquifer yields relatively small amounts of water.

The primary aquifer in Seminole County is the artesian, or Floridan aquifer. In the area of the proposed well field, the Floridan consists of the Eocene limestone and dolostone deposits as well as the lower limestone deposits of the overlying Hawthorn Formation which are in direct hydraulic contact with the lower Eocene units. The geologic logs from the test wells suggest the top of the Floridan is approximately 120 feet below land surface (bls). The constructed test/production wells tap approximately the upper 90 feet of this aquifer.

Existing fresh groundwater supplies are derived primarily from rain that falls in recharge areas of Polk and Orange Counties (Barraclough, 1962). However, it is suspected that considering the numerous occurrence of sinkholes and depressions surrounding the proposed well site, that local recharge is also significant. Maps presented by Barraclough, 1962 suggest a moderately effective recharge area located directly south of the well field. Lichtler, 1972, suggests that the well field may be included in the recharge areas.

Surface soils consist of Blanton, Lakewood and Plummer fine sands which are typically moderately well drained. Average rainfall is approximately 7.0 inches per month in summer and 2.5 inches per month in the winter. Annual totals approximate 53 inches during an average year. Although rainfall and surface soil conditions are conducive to vertical infiltration, numerous clay layers within the underlying Hawthorn Formation retard downward movement locally.

Water quality in the upper Floridan aquifer in the vicinity of the wells is termed transitional, meaning that water quality data show characteristics of both fresh recharge and connate waters (Barraclough, 1962). These characteristics may be the result of the mixing of fresh water recharge with connate water. The connate water is believed to exist as a reminant of the Pleistocene Epoch interglacial period or by the entrapment of sea water during the formation of the rock unit. The source for the poorer quality water is likely the lower portion of the Floridan aquifer.

Analysis of water from wells tapping the upper Floridan aquifer north and eastward from the proposed well field indicate increasingly poor water quality in those directions. Maps presented by Barraclough, (1962), show water with total dissolved solids and chloride concentrations in excess of Florida drinking water standards from wells tapping the upper Floridan aquifer 2 to 3 miles east of the proposed well field. This area is generally comparable to areas of artesian flow.

FIELD INVESTIGATIONS

Well Construction

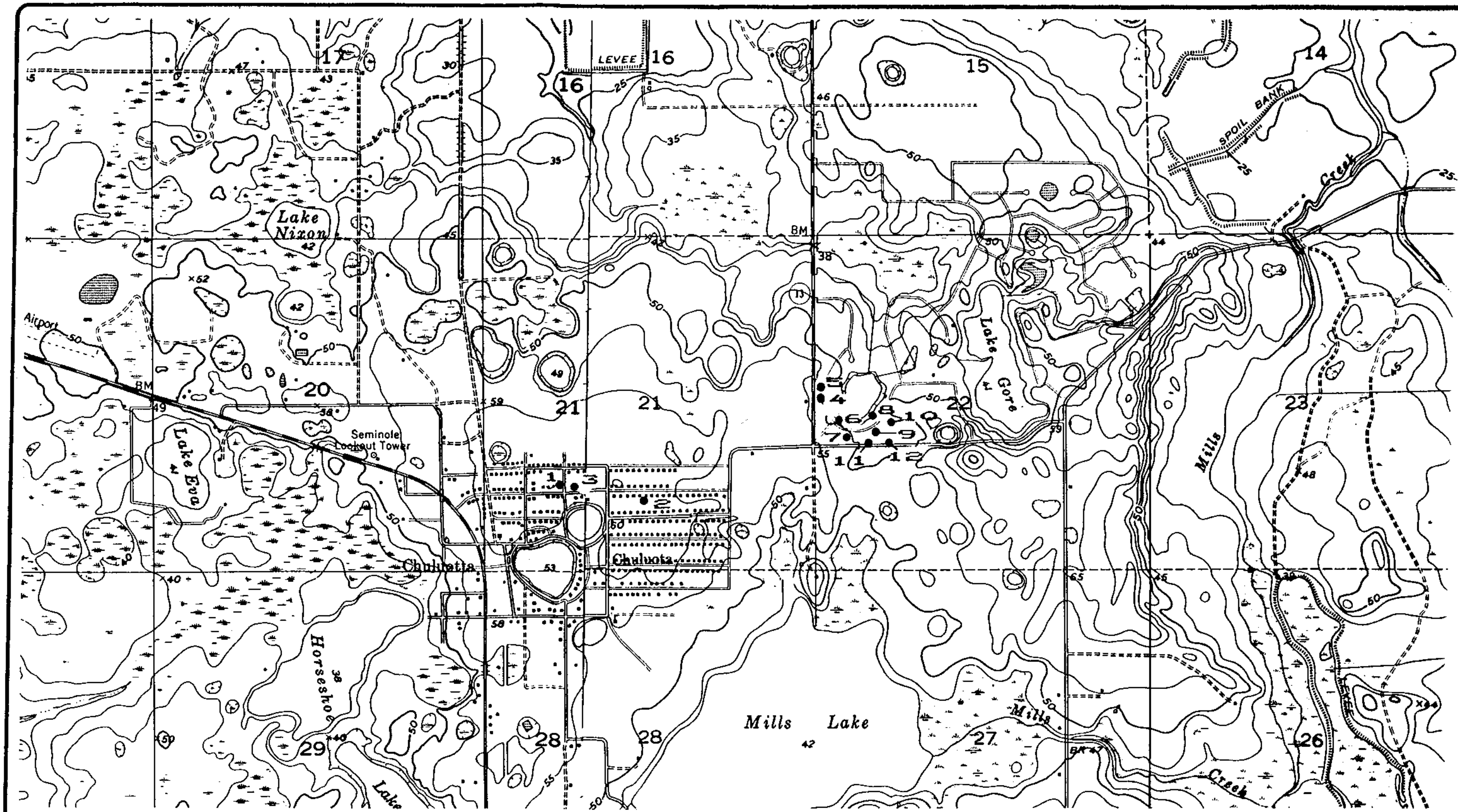
During the construction of Well #1, Jammal & Associates, Inc., was present to conduct on-site geologic logging of rock cuttings from the well. Field tests for chlorides, pH and hydrogen sulfide were completed during construction of Well #1 to monitor water quality with depth. Based upon the field tests and analysis of the well cuttings retrieved during drilling, a completion depth of 218 was determined for Well #1. Casing in this well was set to a depth of 122 feet bls. Well #2 was completed in a similar manner to Well #1.

Area Well Inventory

A field survey was conducted to identify permitted and/or non-permitted Floridan aquifer wells within the predicted radius of influence caused by pumpage from the proposed well. Figure 2 shows the locations of identified adjacent users within a 1/4 mile to 1/2 mile radius from the proposed well. The identification of the adjacent users was limited by the availability and cooperation of the individual homeowners. A table listing the names, addresses, depth of well, map identification and use of each well is presented as an Appendix.

Aquifer Performance Test

In order to determine estimates for the aquifer coefficients in the area adjacent to the proposed back-up supply well, a constant rate discharge test was conducted utilizing the two (2) recently constructed test/production wells. The test consisted of pumping Well #1 at a constant rate of 514 gallons per minute (gpm) for a period of 72-hours. Prior to the start of the test, a Stephens F-Type water level recorder was installed on the observation well (Well #2) to monitor changes in the water level before, during and after the constant discharge test. Water levels were recorded for a period of one (1) week prior to the start of the test to observe natural



LEGEND

2● LOCATION AND IDENTIFICATION OF ADJACENT USER

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DRAWN:	FNI
CHKD:	CLS
APPVD:	NEA
SCALE:	1"=1,500'

LOCATION OF ADJACENT FLORIDAN USERS

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DATE: 5-4-88 PROJ. NO: 86-03082 FIGURE 2

DRAPHIX #247093

fluctuations of the potentiometric surface over time. The first four hours of drawdown and recovery were measured manually. The time/drawdown and time/recovery data obtained during the course of the test are presented in the tables attached in the Appendix to this report.

Water Quality Tests

During the course of the aquifer performance test water samples were collected and taken to an independent chemical laboratory for analysis. A total of 8 samples were collected during the 72-hour period that the test was conducted. Seven of the collected samples were analyzed for cations and anions necessary for the completion of a geochemical pattern analysis. The eighth sample, collected after 72-hours of pumpage, was analyzed for National Interim Primary and State of Florida Secondary Drinking Water Standards. The table below indicates the time since the start of pumpage that each of the samples was collected.

TABLE 1

Water Sampling Intervals

SAMPLE IDENTIFICATION	SAMPLING TIME (HOURS)*
Sample 1	0.2
Sample 2	3.9
Sample 3	8.2
Sample 4	20.7
Sample 5	29.7
Sample 6	44.9
Sample 7	54.7
Sample 8	72.0

*Time since start of pumpage on 72-hour test.

RESULTS

Water Quality Testing

Water samples collected during the aquifer performance test (APT) were analyzed by Bionomics Laboratory, Inc. of Orlando, Florida. Results of the tests indicate that all analyzed parameters are within standards for potable water as stipulated in Chapter 17-22, F.A.C.. The results of the laboratory analyses are presented in the Appendix.

A geochemical pattern analysis was completed on each of the eight (8) water samples collected during the aquifer performance test. Analysis of the samples indicated that Well #1 is withdrawing water of the transitional water type (TW) as described by Frazee (1982).

The time-related results of the analyzed water samples show that water quality over the course of the test was stable. Figures 3, 4 and 5 show the progression of concentrations for selected indicator ions during the course of the 72-hour pump test. Examination of these figures and the laboratory data from which they were constructed suggests that in general, the concentration of minerals in the water withdrawn from Well #1 decreased slightly with time of pumpage.

Aquifer Performance Test

Time/drawdown and time/recovery data collected during the 72-hour constant rate test were evaluated to determine estimates

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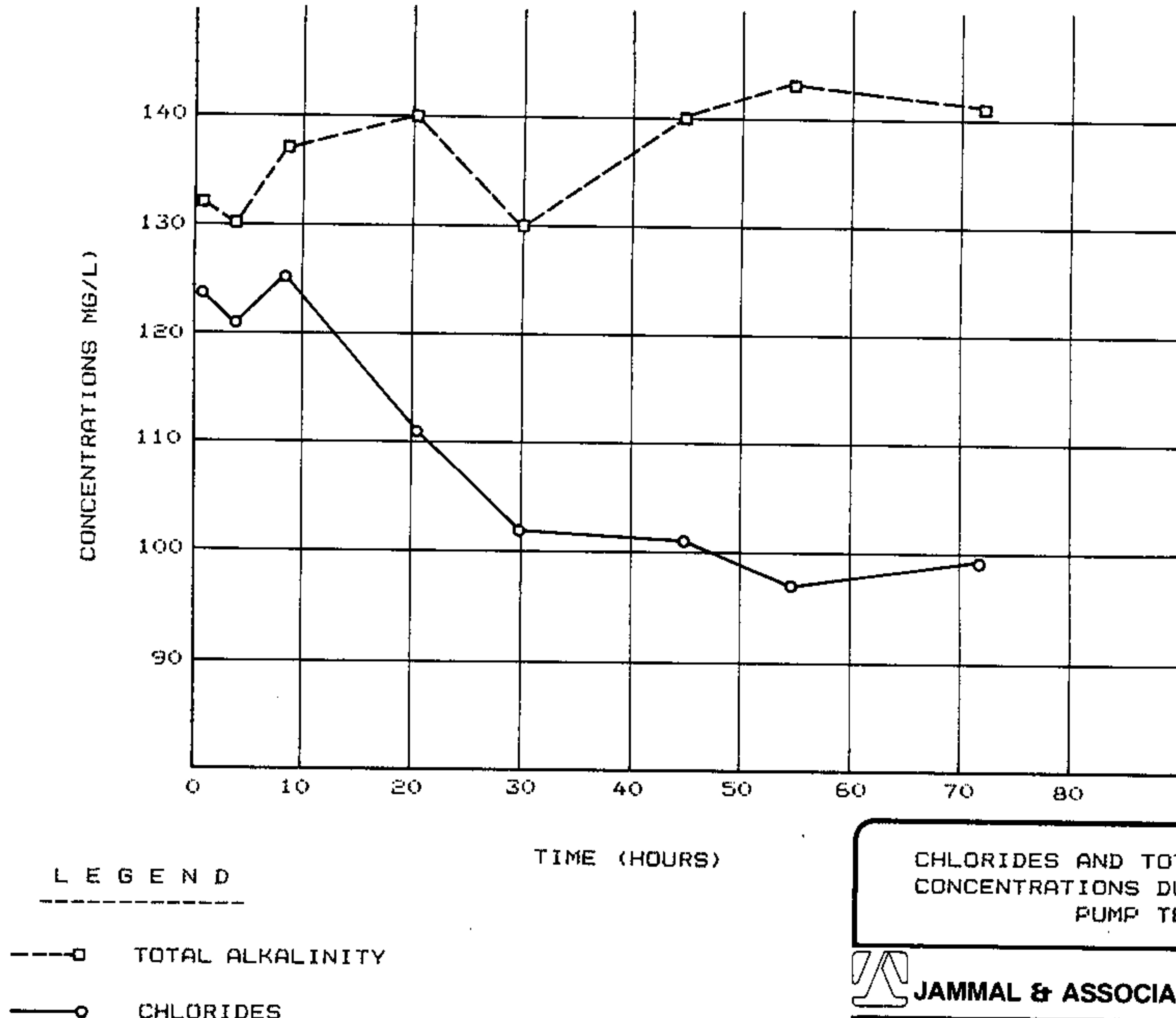

CHLORIDES AND TOTAL ALKALINITY CONCENTRATIONS DURING 72-HOUR PUMP TEST

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DRAWN: FNI		PROJ NO.: 86-03082
CHKD: CLS	DATE: 5-4-88	FIGURE 3

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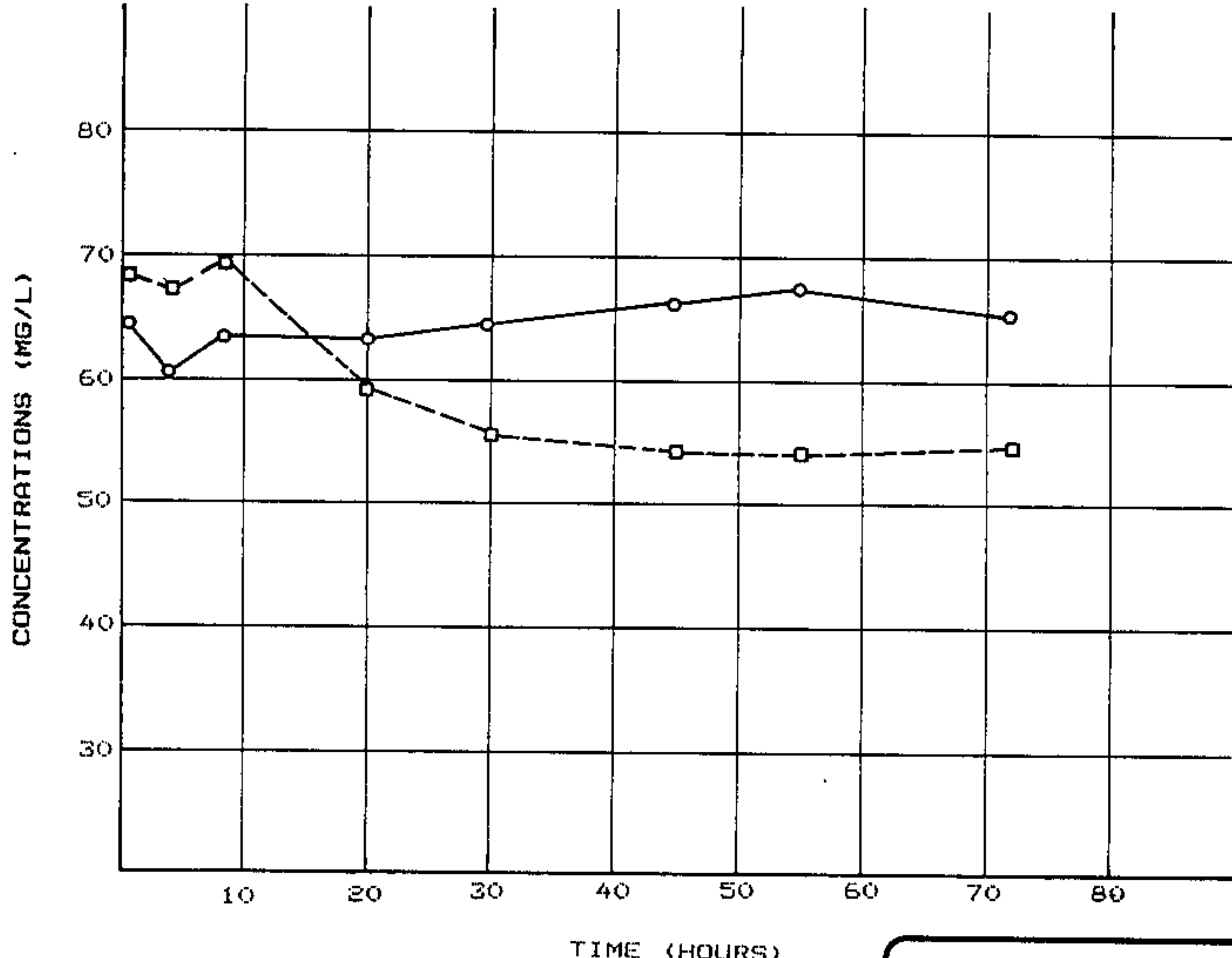

LEGEND

CALCIUM

SODIUM

CALCIUM AND SODIUM CONCENTRATIONS DURING THE 72-HOUR PUMP TEST

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DRAWN: FNI		PROJ. NO: 86-03082
CHKD: CLS	DATE: 5-4-88	FIGURE 4

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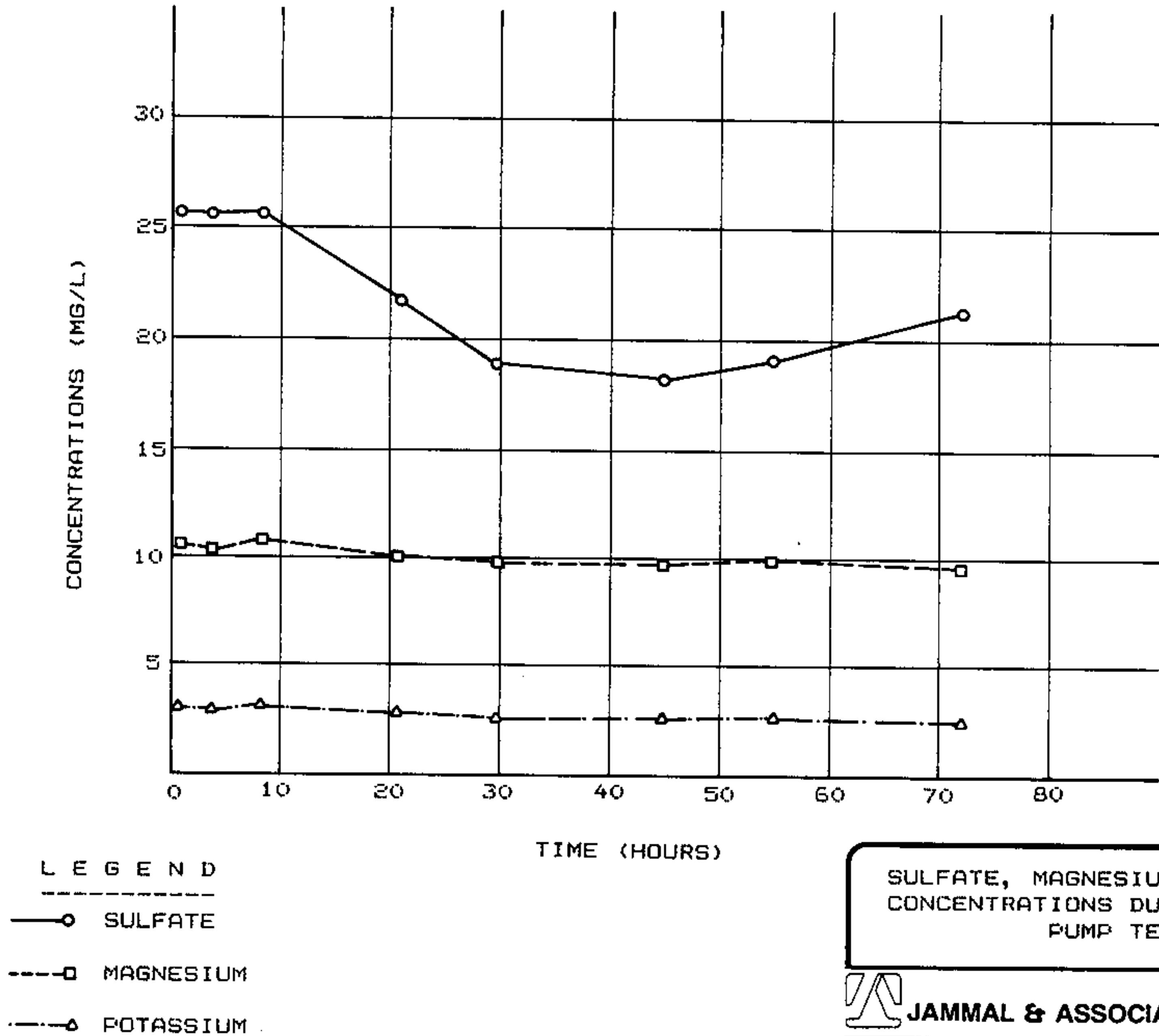

SULFATE, MAGNESIUM AND POTASSIUM CONCENTRATIONS DURING THE 72-HOUR PUMP TEST

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DRAWN: FNI		PROJ. NO 86-03082	
CHKD CLS	DATE: 5-4-88	FIGURE 5	

for certain hydraulic parameters necessary to assess the impacts of withdrawals from proposed Southern States Utilities Production Well #1. The data were evaluated using graphical and computer-simulated curve-matching techniques for a leaky artesian aquifer. Figures 6 and 7 graphically present the drawdown and recovery curves used for the type curve analysis described by Hantush and Jacob (Lohman, 1972). This method assumes that the aquifer is a homogenous, isotropic, semi-confined aquifer of infinite aerial extent with recharge from adjacent hydrologic units.

The basis of the curve matching technique requires matching the recorded time/drawdown and time/recovery data to a set of pre-defined "type" curves. Upon a match of the two curves, a match point is selected. The match points selected for each curve are shown on Figures 6 and 7. The values associated with each match point are applied to calculations which yield values for transmissivity, storage and leakance.

In addition to the manual curve-matching technique, a computer automatch technique was used. The computer simulated automatch works on much the same principle as the manual curve matching technique, however, the curves are matched by a mathematical least-squares fit to determine the hydraulic parameters.

Analysis of the drawdown and recovery data produced the results presented in Table 2.

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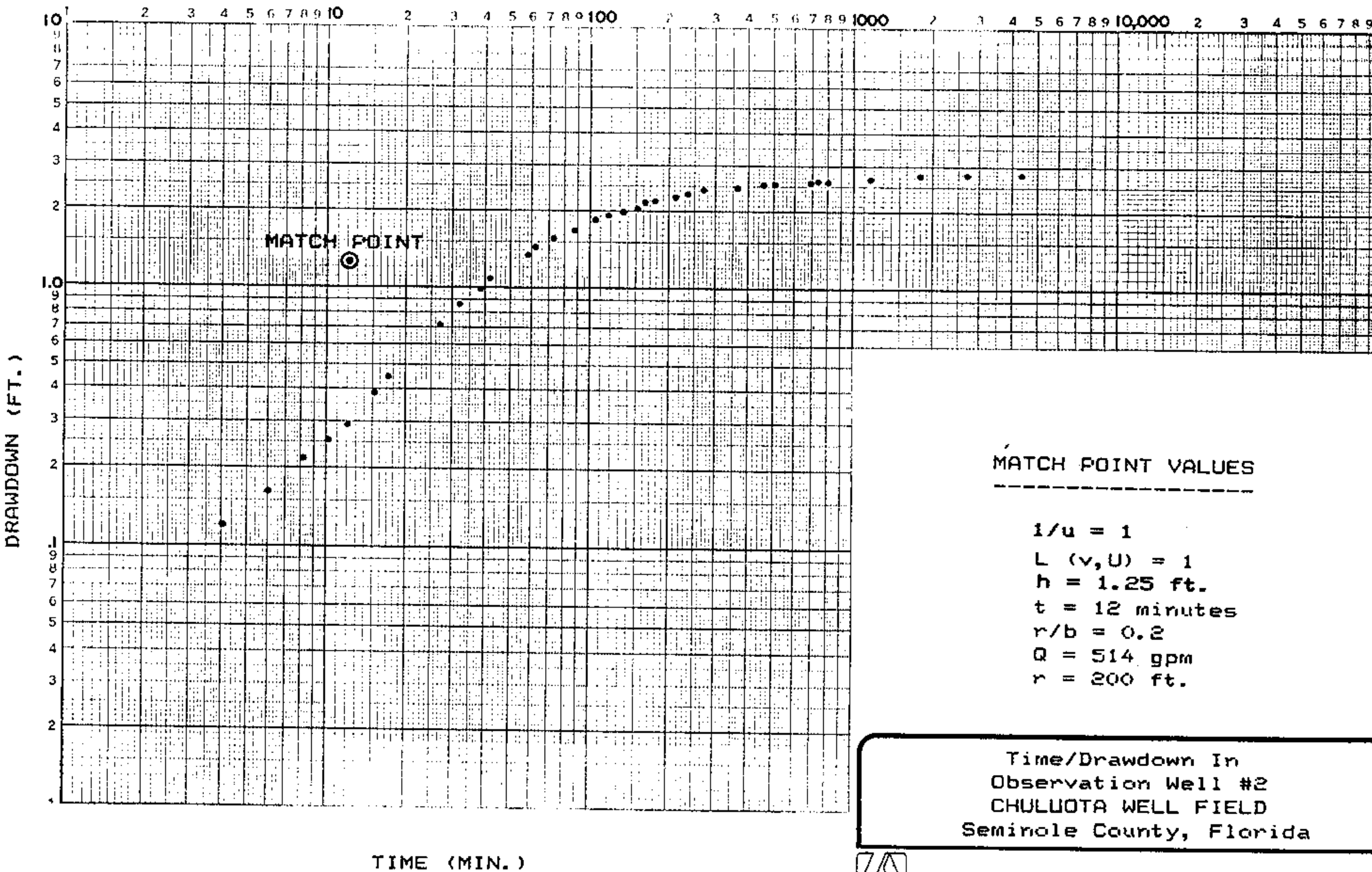

MATCH POINT VALUES

1/u = 1

L (v,U) = 1

h = 1.25 ft.

t = 12 minutes

r/b = 0.2

Q = 514 gpm

r = 200 ft.

Time/Drawdown In
Observation Well #2
CHULUOTA WELL FIELD
Seminole County, Florida

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DRAWN: FNI		PROJ NO: 86-03082
CHKD: CLS	DATE: 5-4-88	FIGURE 6

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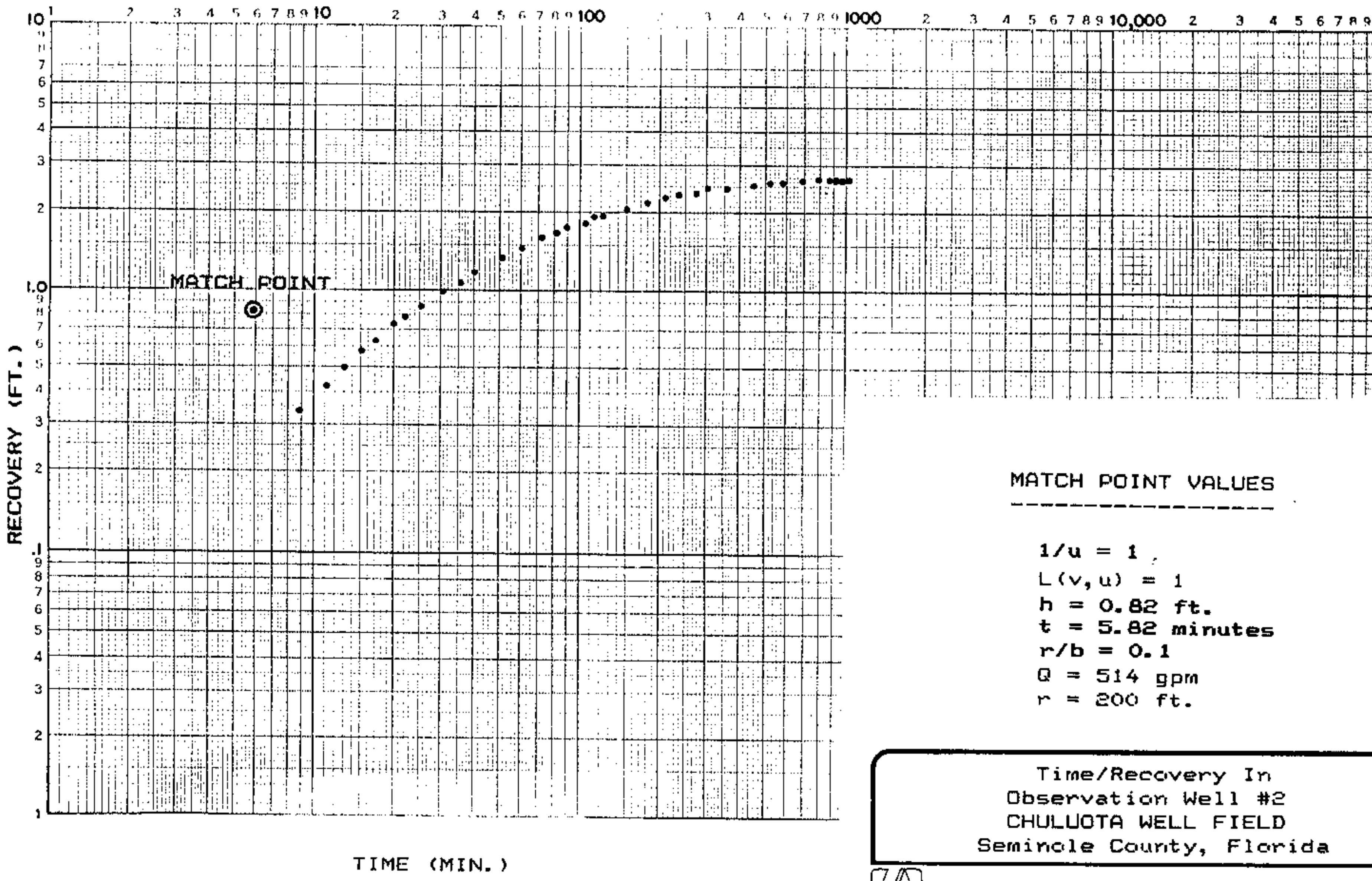


MATCH POINT VALUES

$1/u = 1$
$L(v,u) = 1$
$h = 0.82$ ft.
$t = 5.82$ minutes
$r/b = 0.1$
$Q = 514$ gpm
$r = 200$ ft.

Time/Recovery In
Observation Well #2
CHULUOTA WELL FIELD
Seminole County, Florida

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DRAWN: FNI		PROJ NO: 86-03082
CHKD: CLS	DATE: 5-4-88	FIGURE 7

TABLE 2

Aquifer Performance Test Results

Parameter	Graphic Drawdown	Graphic Recovery	Automatch Drawdown	Automatch Recovery	Average
Transmissivity (gpd/ft)	47,125	71,830	68,020	64,770	62,940
Storage (dimensionless)	5X10-3	4X10-3	4X10-3	5X10-3	4.5X10-3
Leakance (gpd/ft3)	1.9X10-1	7X10-2	1.0X10-1	1.0X10-1	1.1X10-1

The average value calculated for aquifer transmissivity determined from the APT appears reasonable considering the depths of the open hole sections of the two (2) test wells and the apparent specific capacity of Well #1. This value is not considered representative of the entire thickness of the Florida aquifer as only a small percentage of the aquifer is penetrated by the Southern States Utilities test/production wells.

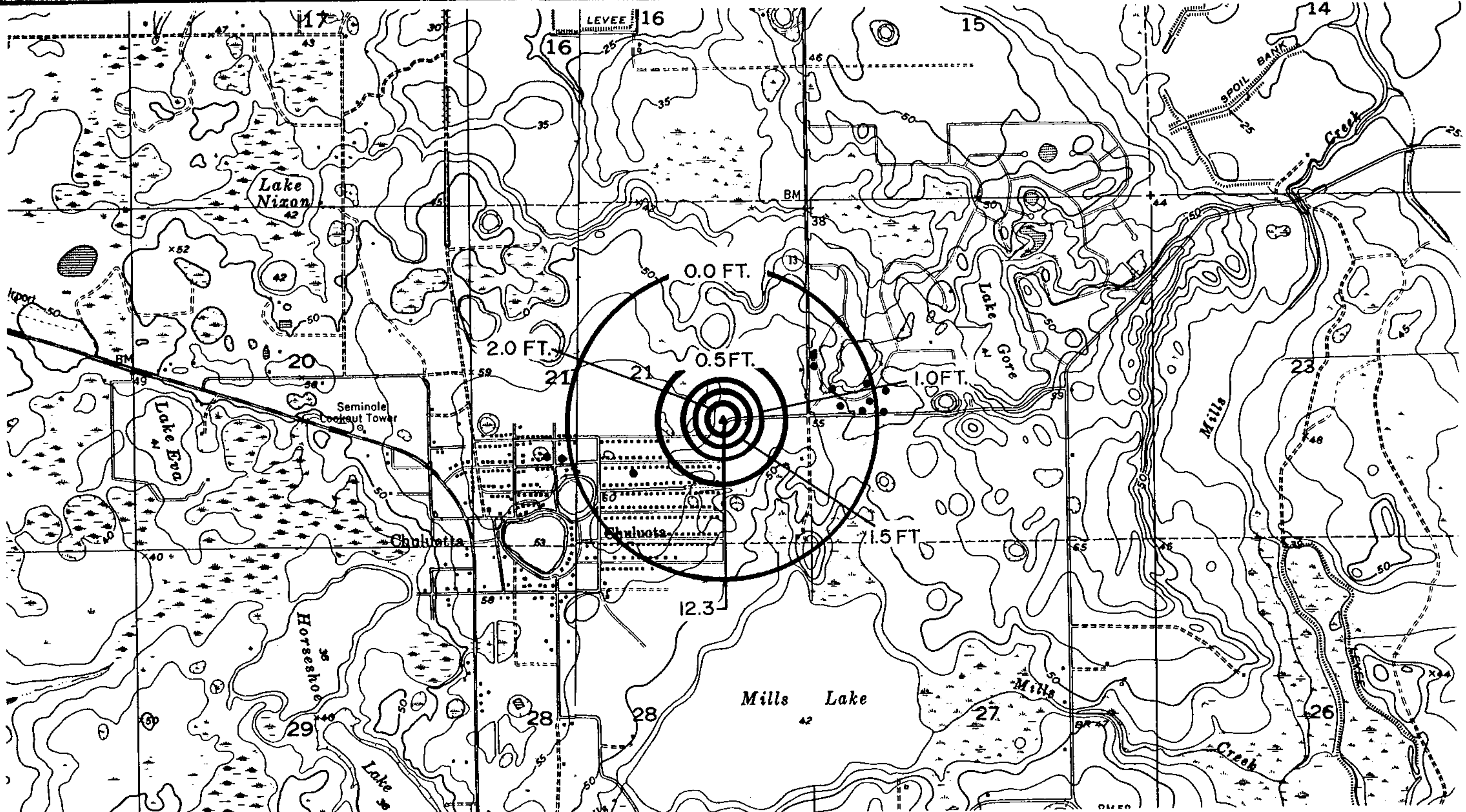
The range of storage coefficients determined from the APT data and the calculated average value appear reasonable for a semi-confined, artesian aquifer. The leakance values presented above suggest that significant quantities of water recharge the portion of the Floridan tested when the potentiometric surface is lowered by well withdrawals.

Model Simulation

Using the aquifer characteristics determined from the curve matching exercise, a model was created to simulate the impacts of withdrawals from Well #1 at the design discharge rate of 500 gpm. The model used for the simulation utilizes the Hantush-Jacob (1955) solution for a leaky artesian aquifer. Assumptions for this model are similar to those described earlier for the curve matching technique.

The model was first run and calibrated to match head conditions seen in the field during the APT. The model required no modification of the parameters determined by the curve matching exercise to produce conditions similar to those seen in the field. After the calibration run, the model was adjusted to simulate withdrawals at a rate of 500 gpm. The results of this model simulation are graphically depicted on Figure 8.

Figure 8 illustrates the predicted drawdown resulting from pumpage of Well #1 at a rate of 500 gpm continuously for 365 days, given the determined aquifer characteristics. The location of identified adjacent Floridan aquifer users is also presented on this figure to illustrate the relative impact to each. The model simulation indicates that drawdowns of less than one foot on the potentiometric surface can be expected by the residential units to the south and east of the proposed well site. It is anticipated that the largest impact to an identified local Floridan user is approximately 0.3 feet.



LEGEND

▲ 12.3 LOCATION OF WELL AND SIMULATED DRAWDOWN AT WELL

—1.0— LINE OF EQUAL DRAWDOWN (FT.)

● LOCATION OF ADJACENT USERS

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DRAWN:	FNI
CHKD:	CLS
APPVD:	NEA
SCALE:	1"=1,500'

HYDRAULIC PARAMETERS

TRANSMISSIVITY = 62,940 GPD/FT.
STORAGE = .0045
LEAKANCE = .11 GPD/FT.
DISCHARGE = 500 GPM
TIME = 365 DAYS

Simulated Drawdown Associated With Pumpage At 500 gpm
CHULUOTA WELL FIELD
Seminole County, Florida

JAMMAL & ASSOCIATES, INC. Consulting Engineers

DATE: 5-4-88 PROJ. NO.: 86-03082 FIGURE 8

DRAPHIX #247093

Anticipated impacts to other users will be substantially less. The drawdown shown at the pumping well on Figure 8 reflects drawdown directly adjacent to the well. Recorded water levels in the pumping well during the APT suggests that drawdown in the well at 500 gpm will be on the order of 14 feet.

CONCLUSIONS (SEE ERRATA PGS)

The pumping test performed for this investigation indicates that the upper portion of the Floridan aquifer in the site vicinity behaves as a leaky artesian aquifer. Estimates of aquifer transmissivity determined from the pumping test indicate low to moderate values, most likely a direct function of partial penetration of the aquifer by the Southern States Utilities test/production wells.

Observations of the drawdown during the aquifer performance test indicate that expected drawdown at the pumping well (Well #1) will be approximately 14 feet at the design discharge rate of 500 gpm. The top of casing elevation for Well #1 was estimated from U.S.G.S. topographic maps at about 57 feet MSL. The static water level in the discharge well prior to the start of the APT was 28.1 feet below top of casing. The anticipated water level during pumping from Well #1 at 500 gpm is expected to be approximately 15 feet above MSL.

Analysis of collected water samples from Well #1 during the APT indicate that water produced from the well is of the transitional water type (TW) as described by Frazee (1982). The time related sampling indicates stable water quality during the course of the test. Concentration levels of most ions decreased slightly with time. Chloride concentrations decreased from 124 mgl to below 100 mgl for samples collected 72-hours apart. Similar decreases were noted for several other ions.

Analyses of time/drawdown and time/recovery data collected during the 72-hour pump test and subsequent model simulations indicate that drawdowns of less than one foot will be seen in the potentiometric surface at a radius greater than 600 feet from the discharge well. A field intensive well inventory indicated that no adjacent Floridan aquifer wells were located within this 600 foot radius. The model simulations indicate that approximately 0.3 feet of drawdown will occur in the nearest adjacent Floridan aquifer well as a result of the proposed pumpage from Southern States Utilities Well #1.

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APPENDICES

ADJACENT FLORIDAN USERS

ADJACENT FLORIDAN USERS

Map Identification	Owner*	Well Depth (ft) bls	Use	Comments
1	Mr. Cross, corner of Ave. E and 2nd Street	Unknown	Domestic	
2	Unknown 300 2nd Street	Unknown	Unknown	
3	Mr. & Mrs. Bishop 321 2nd Street	225	Domestic	Good Tasting Water
4	Doug Wilson 285 Snow Hill Road	160	Domestic	Complaints of iron and bacteria
5	Hazel Johnson 293 Snow Hill Road	Unknown	Domestic	
6	Mr. Killen 163 Overlook Drive	178	Domestic	Complaints of bad taste
7	Mr. & Mrs. Diest 156 Overlook Drive	Unknown	Unknown	
8	Tate Buntz 153 Overlook Drive	Unknown	Domestic	Complaints of darkened color with extended use
9	Mr. Rancourt 160 Overlook Drive	Unknown	Domestic	
10	Unknown 152 Overlook Drive	Unknown	Unknown	
11	Unknown 900 Brumley Road	Unknown	Unknown	
12	Unknown 930 Brumley Road	Unknown	Unknown	

*Contacted 4/13/88

AQUIFER PERFORMANCE TEST DATA

TIME/RECOVERY DURING THE CONSTANT RATE
PUMP TEST

	TIME	MINUTES/SINCE START	DEPTH TO WATER*(ft)	Δh(FT)
4/7	12:09	9	34.9	.33
	12:11	11	34.81	.42
	12:13	13	34.74	.49
	12:15	15	34.66	.57
	12:17	17	34.60	.63
	12:20	20	34.50	.73
	12:22	22	34.45	.78
	12:25	25	34.37	.86
	12:30	30	34.24	.99
	12:35	35	34.16	1.07
	12:40	40	34.05	1.18
	12:51	51	33.90	1.33
	1:00	60	33.77	1.46
	1:12	72	33.63	1.60
	1:21	87	33.56	1.67
	1:30	90	33.48	1.75
	1:45	105	33.39	1.84
	1:55	115	33.33	1.90
	2:00	120	33.30	1.93
	2:30	150	33.15	2.08
	3:00	180	33.05	2.18
	3:30	210	32.98	2.25
	4:00	240	32.91	2.32
	4:30	270	32.85	2.38
	5:00	300	32.81	2.41
	6:00	360	32.75	2.46
	7:30	450	32.70	2.51
	8:30	510	38.68	2.54
	9:30	570	32.67	2.56
	11:30	690	32.64	2.60
4/8	1:15	795	32.60	2.63
	2:15	855	32.58	2.65
	3:00	900	32.57	2.66
	4:00	960	32.56	2.67
	4:30	990	32.56	2.67

* Initial Depth to Water= 35.23 Feet

TIME/DRAWDOWN DURING THE CONSTANT RATE
PUMP TEST

	TIME	MINUTES/SINCE START	DEPTH TO WATER*(ft)	Δh(FT)
4/4	11:50 AM	2	32.46	0
	11:52	4	32.58	.12
	11:54	6	32.62	.16
	11:56	8	32.67	.21
	11:58	10	32.71	.25
	12:00 PM	12	32.75	.29
	12:03	15	32.84	.38
	12:05	17	32.90	.44
	12:15	27	33.18	.72
	12:20	32	33.32	.86
	12:25	37	33.45	.99
	12:30	42	33.54	1.08
	12:45	57	33.81	1.35
	12:50	62	33.88	1.42
	1:00	72	34.00	1.54
	1:15	82	34.15	1.69
	1:31	103	34.27	1.81
	1:45	117	34.36	1.90
	2:00	132	34.45	1.99
	2:30	162	34.57	2.11
	2:46	178	34.62	2.16
	3:15	207	34.70	2.24
	3:45	237	34.76	2.30
	4:00	252	34.78	2.32
	4:30	282	34.82	2.36
	5:00	312	34.87	2.41
	6:00	372	34.91	2.45
	7:00	432	34.96	2.50
	8:00	492	34.99	2.53
	9:00	552	35.03	2.57
	10:00	612	35.07	2.61
	11:00 PM	672	35.09	2.63
4/5	12:15 AM	747	35.11	2.65
	2:00	852	35.13	2.67
	3:30	942	35.13	2.67
	6:30	1122	35.14	2.68
	8:30	1242	35.15	2.69
	12:30 PM	1482	35.17	2.71
	3:30	1662	35.18	2.72
	5:34	1786	35.19	2.73
	6:30	1842	35.20	2.74
	9:30	2022	35.22	2.76
4/6	12:30 AM	2202	35.23	2.77
	3:30	2382	35.24	2.78
	6:30	2562	35.24	2.78
	8:40	2688	35.22	2.76
4/7	9:10 AM	4158	35.25	2.79

* Static water level prior to test = 32.46 ft DTW.
** Change in water level.

WATER QUALITY

Bionomics Laboratory, Inc.

4310 EAST ANDERSON ROAD P.O. BOX 8011 ORLANDO, FLORIDA 32806
(305) 851-2560 RICHARD ALT, PRESIDENT

April 20, 1988

FOR: Jammal & Associates, Inc.
1675 Lee Road
Winter Park, FL 32789

ATTN: Chris Sweazy

RE: Samples Received 4/5/88, submitted by client

LABORATORY REPORT

Lab I.D. No. / Marks	881565 Chulwota #1	881566 Chulwota #2	881567 Chulwota #3	881568 Chulwota #4
pH, lab	7.52	7.34	7.40	7.30
Alkalinity, total as CaCO3, mg/l	132	130	137	140
Chlorides as Cl, mg/l	124	121	125	111
Sulfates as SO4, mg/l	25.7	25.6	25.6	21.2
Total dissolved solids, mg/l	396	400	413	372
Metals				
Calcium as Ca, mg/l	64.5	60.5	63.8	63.4
Magnesium as Mg, mg/l	10.6	10.4	10.9	10.1
Potassium as K, mg/l	2.99	2.92	3.08	2.82
Sodium as Na, mg/l	68.1	67.4	69.9	59.4
Total hardness as CaCO3, mg/l	205	194	204	200
Carbonate hardness as CaCO3, mg/l	132	130	137	140
Non-carbonate hardness as CaCO3, mg/l	73	64	67	60
Bicarbonate alkalinity as CaCO3, mg/l	132	130	137	140
Carbonate alkalinity as CaCO3, mg/l	0.41	0.77	0.32	0.26
Hydroxide alkalinity as CaCO3, mg/l	0.1*	0.1*	0.1*	0.1*

* Less than

Signed Richard Alt
Richard Alt, Chemist

Bionomics Laboratory, Inc.
4310 EAST ANDERSON ROAD P.O. BOX 8011 ORLANDO, FLORIDA 32806
(305) 851-2560 RICHARD ALT, PRESIDENT

April 20, 1988

FOR: Jammal & Associates, Inc.
1675 Lee Road
Winter Park, FL 32789

ATTN: Chris Sweazy

RE: Samples Received 4/6-7/88, submitted by client

LABORATORY REPORT

Lab I.D. No. Marks	881574 Chulucta #5	881575 Chulucta #6	881625 Chulucta #7	881626 Chulucta #8
pH, lab	7.40	7.25	7.40	7.30
Alkalinity, total as CaCO3, mg/l	130	140	143	141
Chlorides as Cl, mg/l	102	101	97	99
Sulfates as SO4, mg/l	18.9	18.3	19.2	21.3
Total dissolved solids, mg/l	369	344	348	348
Metals				
Calcium as Ca, mg/l	64.8	66.3	67.5	65.5
Magnesium as Mg, mg/l	9.75	9.61	9.91	9.63
Potassium as K, mg/l	2.51	2.47	2.49	2.49
Sodium as Na, mg/l	55.5	54.4	54.1	54.6
Total hardness as CaCO3, mg/l	202	203	209	203
Carbonate hardness as CaCO3, mg/l	130	140	143	141
Non-carbonate hardness as CaCO3, mg/l	72	63	66	62
Bicarbonate alkalinity as CaCO3, mg/l	130	140	143	141
Carbonate alkalinity as CaCO3, mg/l	0.31	0.24	0.34	0.26
Hydroxide alkalinity as CaCO3, mg/l	0.1*	0.1*	0.1*	0.1*

* Less than

Signed ______________
Richard Alt, Chemist

Bionomics Laboratory, Inc.

4310 EAST ANDERSON ROAD P.O. BOX 8011 ORLANDO, FLORIDA 32806
(305) 851-2560 RICHARD ALT, PRESIDENT

April 27, 1988

FOR: Jammal & Assoc.
1765 Lee Road
Winter Park, FL 32789

ATTN: Chris Sweazy

RE: Sample received 4/7/88 for analysis.

LABORATORY REPORT

LAB I.D. NO. MARKS	MCL FDER 17-22	METHOD	881626 Chuluota No. 8
I. Secondary Parameters			
Chlorides as Cl, mg/l	250	EPA 325.3	39
Color, Pt/Co units	15	EPA 110.2	5*
Copper as Cu, mg/l	1	EPA 220.1	0.005*
Corrosivity (Langelier Saturation Index)	-0.2/+0.2	Std. Mtd 203	-0.19
Foaming Agents, MBAS, mg/l	0.5	EPA 425.1	0.05*
Iron as Fe, mg/l	0.3	EPA 236.1	0.03*
Manganese as Mn, mg/l	0.05	EPA 243.1	0.03*
Odor, T.O.N.	3	EPA 140.1	2
pH	6.5(min)	EPA 150.1	7.30
Sulfate as SO4, mg/l	250	EPA 375.4	21.4
Total Dissolved Solids, 180 C, mg/l	500	EPA 160.1	348
Zinc as Zn, mg/l	5	EPA 289.1	0.03*
II. Primary Inorganics			
Arsenic as As, mg/l	0.05	EPA 206.2	0.005*
Barium as Ba, mg/l	1.0	EPA 208.2	0.024
Cadmium as Cd, mg/l	0.010	EPA 213.2	0.0005*
Chromium as Cr, mg/l	0.05	EPA 218.2	0.005*
Lead as Pb, mg/l	0.05	EPA 239.2	0.005*
Mercury as Hg, mg/l	0.002	EPA 245.1	0.0005*
Nitrate as N, mg/l	10	EPA 352.1	0.023
Selenium as Se, mg/l	0.01	EPA 270.2	0.005*
Silver a Ag, mg/l	0.05	EPA 272.1	0.03*
Sodium as Na, mg/l	160	EPA 273.1	54.6
Fluoride as F, mg/l	1.4-2.4	EPA 340.2	0.16
Turbidity as N.T.U.	5.0	EPA 180.1	0.26
Total Coliform per 100 ml (MF)	--	Std. Meth. 909 A.	23

* Less than

LABORATORY REPORT
Jammal & Assoc.
Page two

LAB I.D. NO.			881626
MARKS	MCL FDER 17-22	METHODS	Chuluota No. 8
III. Primary Organic Parameters			
Endrin, mg/l	0.0002	EPA 608	0.00001*
Lindane, mg/l	0.004	EPA 608	0.000002*
Methoxychlor, mg/l	0.1	EPA 608	0.0002*
Toxaphene, mg/l	0.005	EPA 608	0.0004*
2,4,D, mg/l	0.1	EPA	0.00005*
2,4,5, TP Silvex, mg/l	0.01	EPA	0.00001*
IV. Volatile Organics			
Trichloroethylene, ug/l	3.0	EPA 601	1*
Tetrachloroethylene, ug/l	3.0	EPA 601	1*
Carbon Tetrachloride, ug/l	3.0	EPA 601	1*
Vinyl Chloride, ug/l	1.0	EPA 601	1*
1,1,1 -Trichloroethane, ug/l	200.0	EPA 601	1*
1,2 -Dichloroethane, ug/l	3.0	EPA 601	1*
Benzene, ug/l	1.0	EPA 602	1.0*
Ethylene Dibromide, ug/l	0.02	DER	0.02*
V. Radiology			
Gross Alpha pCi/l	15	EPA 900	~~To follow~~ 3.6 ±1.2 pci/l

* less than

Signed *Richard Alt*
Richard Alt, Chemist

CONCLUSIONS

The pumping test performed for this investigation indicates that the upper portion of the Floridan aquifer in the site vicinity behaves as a leaky artesian aquifer. Estimates of aquifer transmissivity determined from the pumping test indicate low to moderate values, most likely a direct function of partial penetration of the aquifer by the Southern States Utilities test/production wells.

Observations of the drawdown during the aquifer performance test indicate that expected drawdown at the pumping well (Well #1) will be approximately 14 feet at the design discharge rate of 500 gpm. The top of casing elevation for Well #1 was estimated from U.S.G.S. topographic maps at about 57 feet MSL. The static water level in the discharge well prior to the start of the APT was 28.1 feet below top of casing. The anticipated water level during pumping from Well #1 at 500 gpm is expected to be approximately 15 feet above MSL.

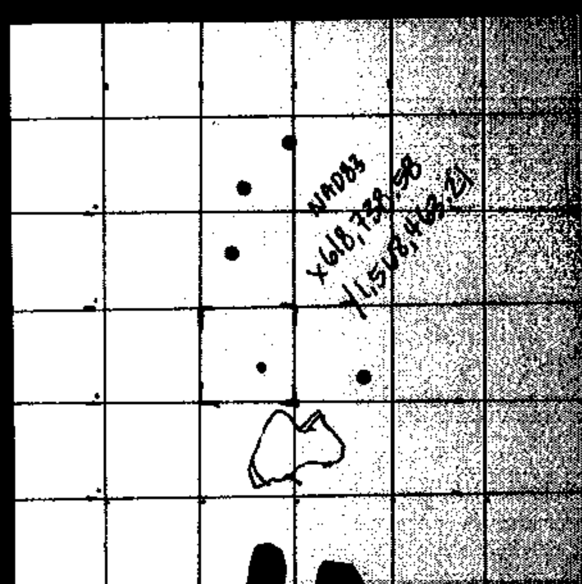
Analysis of collected water samples from Well #1 during the APT indicate that water produced from the well is of the transitional water type (TW) as described by Frazee (1982). The time related sampling indicates stable water quality during the course of the test. Concentration levels of most ions decreased slightly with time. Chloride concentrations decreased from 124 mgl to below 100 mgl for samples collected 72-hours apart. Similar decreases were noted for several other ions.

Analyses of time/drawdown and time/recovery data collected during the 72-hour pump test and subsequent model simulations indicate that drawdowns of less than one foot will be seen in the potentiometric surface at a radius greater than 600 feet from the discharge well. A field intensive well inventory indicated that no adjacent Floridan aquifer wells were located within this 600 foot radius. The model simulations indicate that approximately 0.3 feet of drawdown will occur in the nearest adjacent Floridan aquifer well as a result of the proposed pumpage from Southern States Utilities Well #1.

Based upon the results of the aquifer performance test and analysis of the resultant hydrologic data, Jammal & Associates, Inc., concludes the following:

1. Groundwater of suitable quality for drinking purposes is available from Southern States Utilities Well #1 at the design pumping rate of 500 gpm.

2. Time-dependent water quality test results strongly suggest that pumpage from Southern States Utilities Well #1 at the design pumping rate will not have an adverse impact on water quality in the Floridan aquifer or on adjacent water wells.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