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HYDROGEOLOGIC INVESTIGATION OF FLORIDA CITRUS CORPORATION SECTION 26

MISSIMER AND ASSOCIATES, INC.

CONSULTING HYDROLOGISTS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS.

CAPE CORAL, FLORIDA

HYDROGEOLOGIC INVESTIGATION
OF
FLORIDA CITRUS CORPORATION
SECTION 26

Prepared for

Florida Citrus Groves Corporation
P. O. Box 2503
Bonita Springs, Florida 33923

October, 1983

By

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October 5, 1983

Mr. Jon Tenbruggencate
Florida Citrus Groves Corporation
P. O. Box 2503
Bonita Springs, Florida 33923

Re: Section 26, Hydrogeologic Study

Dear Jon:

We are pleased to submit a report of the hydrology and geology of Section 26. This document is the end result of an investigation to determine the availability of an adequate frost protection source.

The study included test drilling, an aquifer test and testing of the existing production wells. The aquifer test indicated more than adequate water is available; however, the test drilling showed a variable geology. This variable geology could cause larger drawdowns in some areas. As described in more detail in the report, you should keep accurate records on each well and test the complete system annually.

We are ready to assist you in completion of Section 26, establishment of your monitoring system, and future expansions.

Very truly yours,

MISSIMER AND ASSOCIATES, INC.

Larry K. Holland
Senior Hydrologist

LKH:sm

Enclosure

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I. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

The following conclusions are made:

1) Adequate water is available to supply the frost protection system the required water from Tamiami Aquifer System-Zone I assuming homogeneous geology.

2) Aquifer coefficients determined for the Tamiami Aquifer System-Zone I are:

   Transmissivity = 1×10^6 gpd/ft

   Storage Coefficient = 1×10^{-3}

   Leakance = 2×10^{-2} gpd/ft^3

3) The quality of water in Tamiami Zone I is excellent. Total dissolved chlorides range from 40-60 mg/l.

4) The production zone has variable lenticular unconsolidated sands. These sand lenses can reduce the producing capabilities of the effected well.

5) There is no known local source of salt water contamination.

2. Recommendations

1) As the remaining sections are developed, an additional aquifer test should be conducted on the southernmost section.
2) Approximately 8 monitor wells should be constructed to verify lithology for the next aquifer test.
3) All wells should be pumped simultaneously and water levels measured yearly as described in Chapter VI.
4) Detailed and organized water level and water quality records should be maintained.

II. INTRODUCTION

1. Authorization

Missimer and Associates was authorized on May 23, 1983, by the Florida Citrus Groves Corporation to complete a hydrogeologic investigation of Section 26, Township 48S, Range 29E in Collier County. The location of the investigation area is shown in Figure 2-1. The section, being planted as an experimental pineapple plot, requires one-fourth inch of water per acre per hour for frost protection. Emphasis was to be placed on minimizing the required number of wells while still conservatively insuring an adequate water supply. The investigation was to be based on information collected during test drilling and an aquifer test. A final report assessing the gathered information for impacts to the resource, environment, and other users was to be prepared.

2. Scope of Work

The scope of work was to: 1) review existing data on the area, 2) coordinate with the South Florida Water Management District, 3) coordinate with the drilling contractor, 4) drill three observation wells, 5) collect geologic, geophysical and hydrologic data, 6) perform an aquifer test, and 6) analyze and interpret data, 7) determine

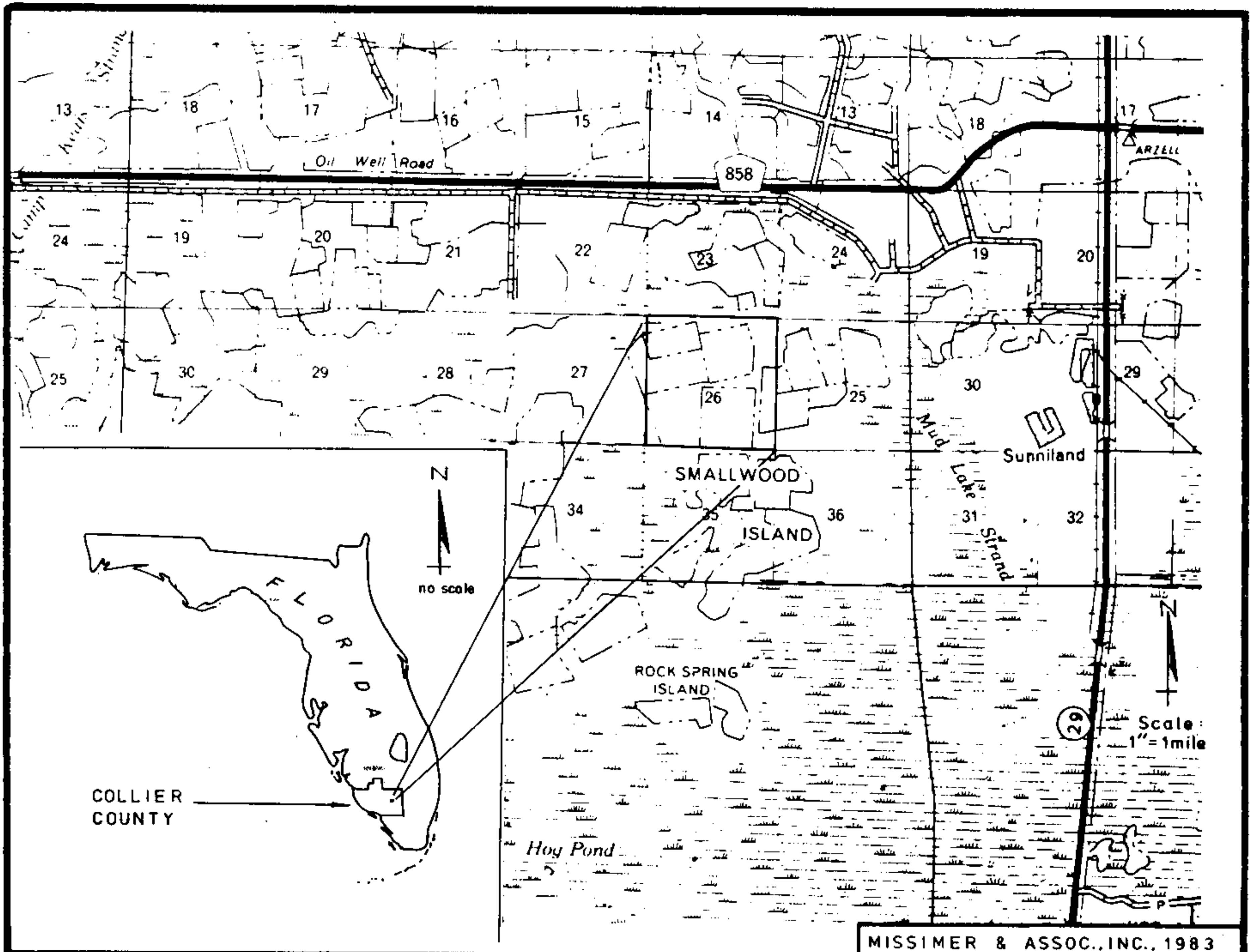

FIGURE 2-1. LOCATION OF INVESTIGATION SITE.

the maximum amount of water available and the impacts of such withdrawals, and 8) prepare a final report including conclusions, recommendations and a wellfield layout and withdrawal plan.

3. Acknowledgments

We wish to thank Mr. Jan TenBruggencate and Mr. Jim Shine for their assistance in initial information collection, work coordination and carefully outlining the goals of their citrus group. They were particularly effective with suggestions for specific problems that should be addressed to satisfy the needs of the Florida Citrus Grove Corporation.

III. INVESTIGATION OF THE GEOLOGY AND HYDROLOGY OF THE SITE

1. Introduction

The area investigated lies south of County Road 858 in Collier County. The investigation area is Section 26 of Township 48 South, Range 29 East.

The investigation site has three existing production wells, which are used for irrigation and frost protection. No water level data has been gathered during general operation of these wells. A typical driller's log is available on the production wells.

2. Test Drilling and Well Construction

Three observation wells were constructed on the investigation site; CO-743, CO-744, and CO-745. Well locations on the site are shown in Figure 3-1. The observation wells were constructed to confirm geologic information and to record water level fluctuations during production well discharges.

The production wells were constructed by the cable-tool method. The monitor wells were constructed by the mud-rotary method. Difficulty keeping the open-hole portion of the well open due to running sand occurred in wells CO-744, CO-751, and CO-752.

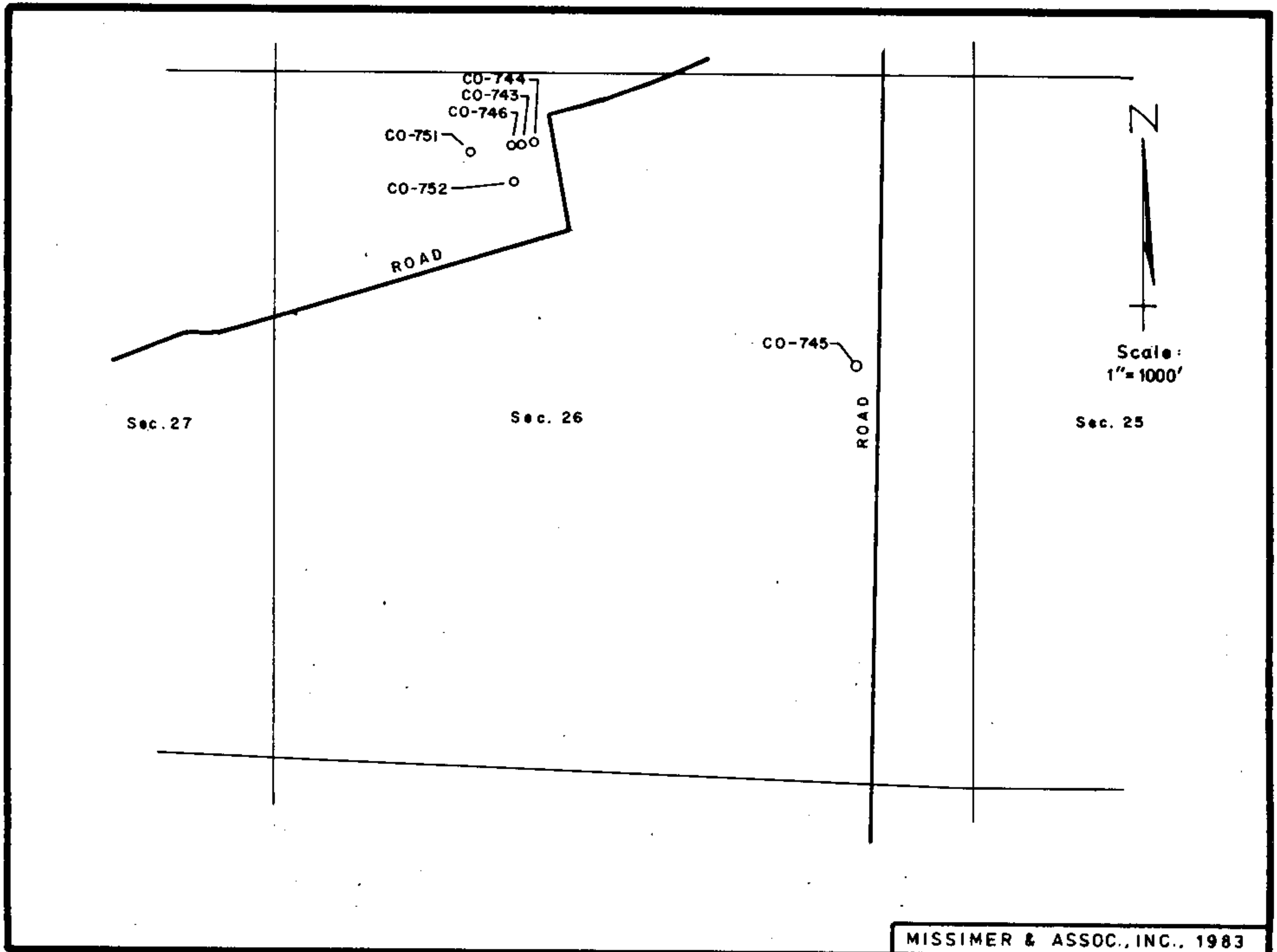

FIGURE 3-1. LOCATION OF PRODUCTION AND OBSERVATION WELLS.

During the drilling of the observation wells, drill cuttings were collected every 5 feet. Some loss of circulation occurred at approximately 22-25 feet in wells CO-743 and CO-744. Gamma-ray logs were completed on wells CO-743, CO-744, CO-745, and CO-752.

3. Step Drawdown Test

A step drawdown test was completed with the same pumping and discharge set-up used for the aquifer test. The well was discharged at rates of 654 gpm, 800 gpm, 950 gpm, and 1,050 gpm. Each discharge rate was maintained for only 30 minutes because the well equilibrated in less than 5 minutes each step. Table 3-1 lists the specific capacities for each pumping step. The specific capacity of the well is unusually high for the region.

The specific capacity of production wells CO-751 (2) and CO-752 (3) were measured for varying discharges. The calculated values were 128 gpm/ft at approximately 1,000 gpm for CO-751 and 120 gpm/ft at 1,227 gpm for CO-752. These values are considerably lower than the 484 gpm/ft at 1,050 gpm for well CO-746 (1). These different specific capacities result from the variable lithology. The variable lithology also causes varying casing depths.

TABLE 3-1. CALCULATED SPECIFIC CAPACITIES FOR VARYING DISCHARGE RATES OF WELL CO-746

Discharge Rate(gpm)	Drawdown(feet)	Specific Capacity(gpm/ft)
654	1.05	622.8
800	1.39	575.5
950	2.14	443.9
1,050	2.17	483.9

4. Aquifer Test

The production well was pumped continuously at a rate of 1,050 gpm for 24 hours. Pump discharge was monitored with a manometer tube and 6-inch x 8-inch orifice. Drawdown in the pump well was monitored with an electric tape. Drawdowns in the three observation wells were monitored with Steven's Type-F water level recorders, which were manually checked. Drawdowns approached equilibrium in the two nearer observation wells after 12 hours. Rain started approximately 16 hours after the start of the test with almost immediate recovery recorded in the observation wells.

A schematic diagram of the aquifer test set-up is given in Figure 3-2. The pumped water was discharged into a ditch with 350 feet of plastic liner. The discharge rate remained steady throughout the testing period.

5. Water Use Assessment

Within five miles or more of the test site, the only water use is for agriculture. All known wells have a casing depth of 35 to 55 feet. Most of the wells are equipped with turbine pumps.

These wells are pumped occasionally for irrigation. Maximum pumpage in the region is for frost protection. Maximum groundwater withdrawals occur for only 6 to 7 hours.

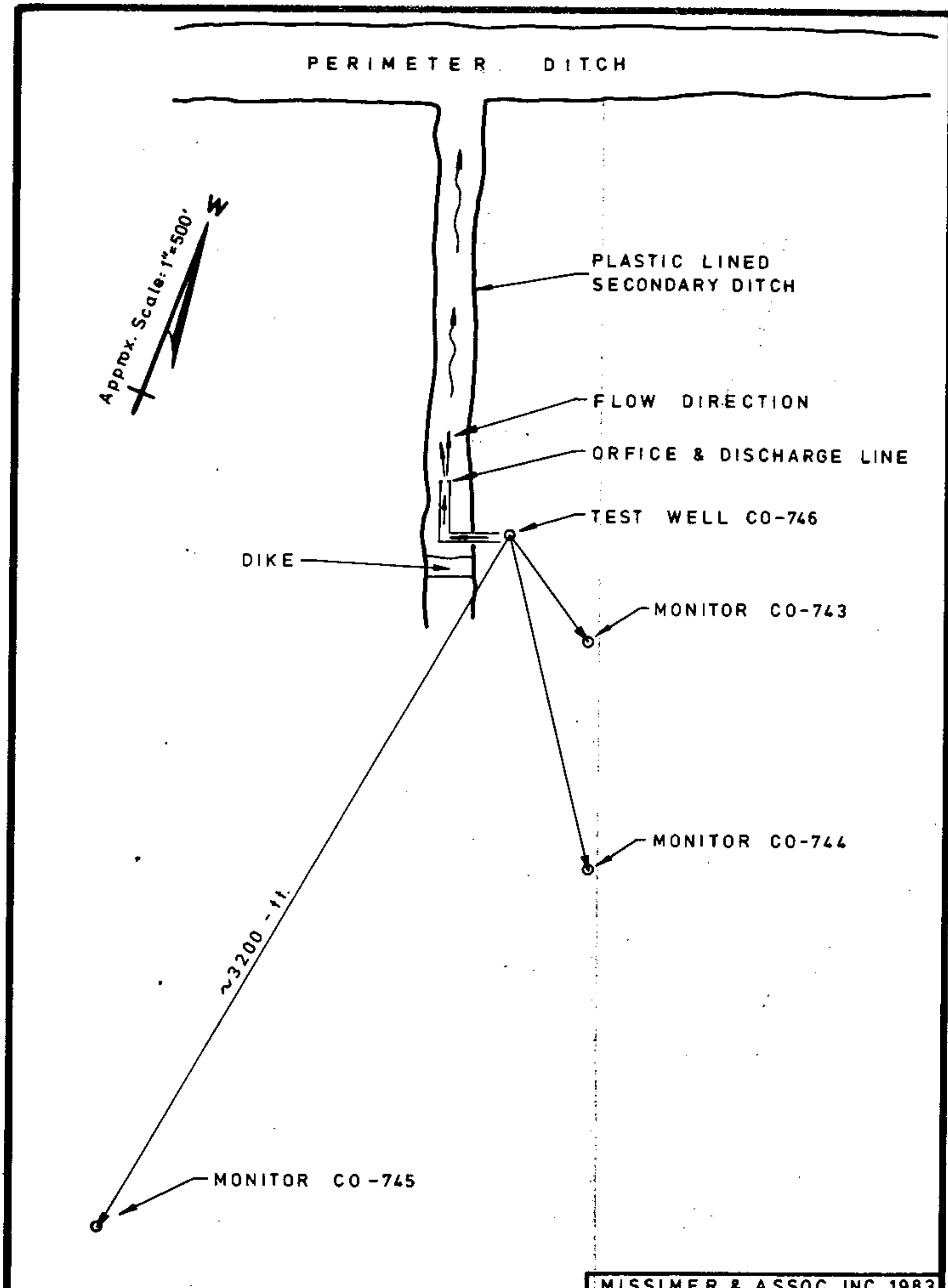

FIGURE 3-2. SCHEMATIC DIAGRAM SHOWING THE AQUIFER TEST SET-UP

A large percentage of the water pumped recharges the pumped aquifer. During the wet season, surface water is pumped out of the fields and discharged into natural and improved drainageways. The regional wet season flow of surface water is generally toward the south.

IV. HYDROLOGY AND GEOLOGY

1. Regional Geology

The shallow known geological profile of the region consists of surficial sands and clays of the Pamlico Sand Formation and complex underlying sandy limestones and marls of the Tamiami Formation. Available information is from the Silver Strands Grove (south) site and sketchy data from driller's logs of a few scattered wells. All the hydrogeologic terminology used in this report follows Missimer and Associates, Inc. (1980, 1981) with minor modifications given in Missimer and Banks (1981). A typical geologic section is shown in Figure 4-1. Information from other sites in the region show a similar geologic section.

2. Geology of the Site

The full thickness of the Tamiami Formation was not explored on site. Only three of its members were recognized in the drill cuttings collected. The Bonita Springs Marl Member, so prominent in the regional information, was not penetrated on the investigation site. Figure 4-2 shows a geologic cross section across the investigation site.

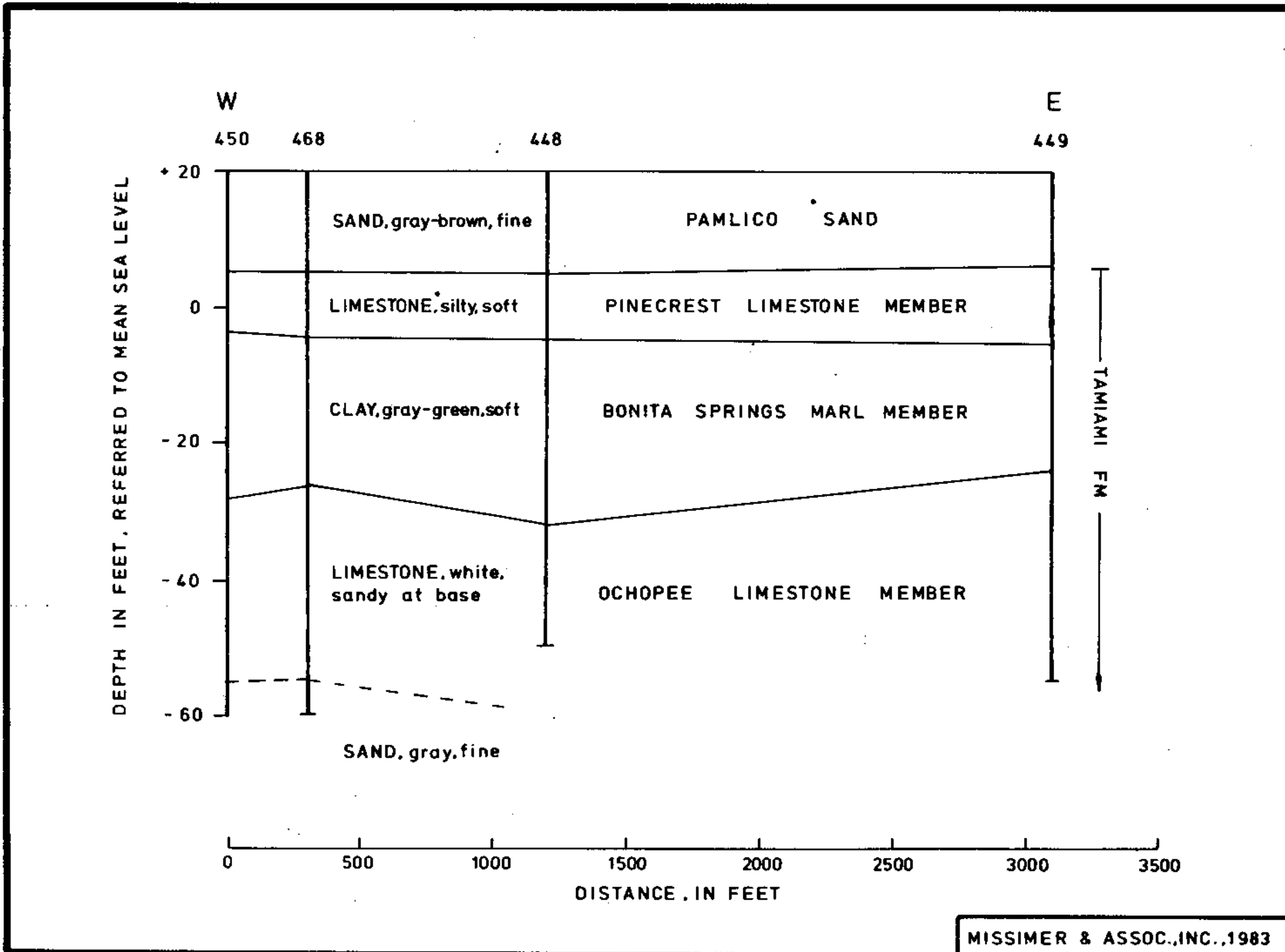

FIGURE 4-1. GEOLOGIC CROSS SECTION W-E ACROSS SILVER STRAND GROVES SITE.

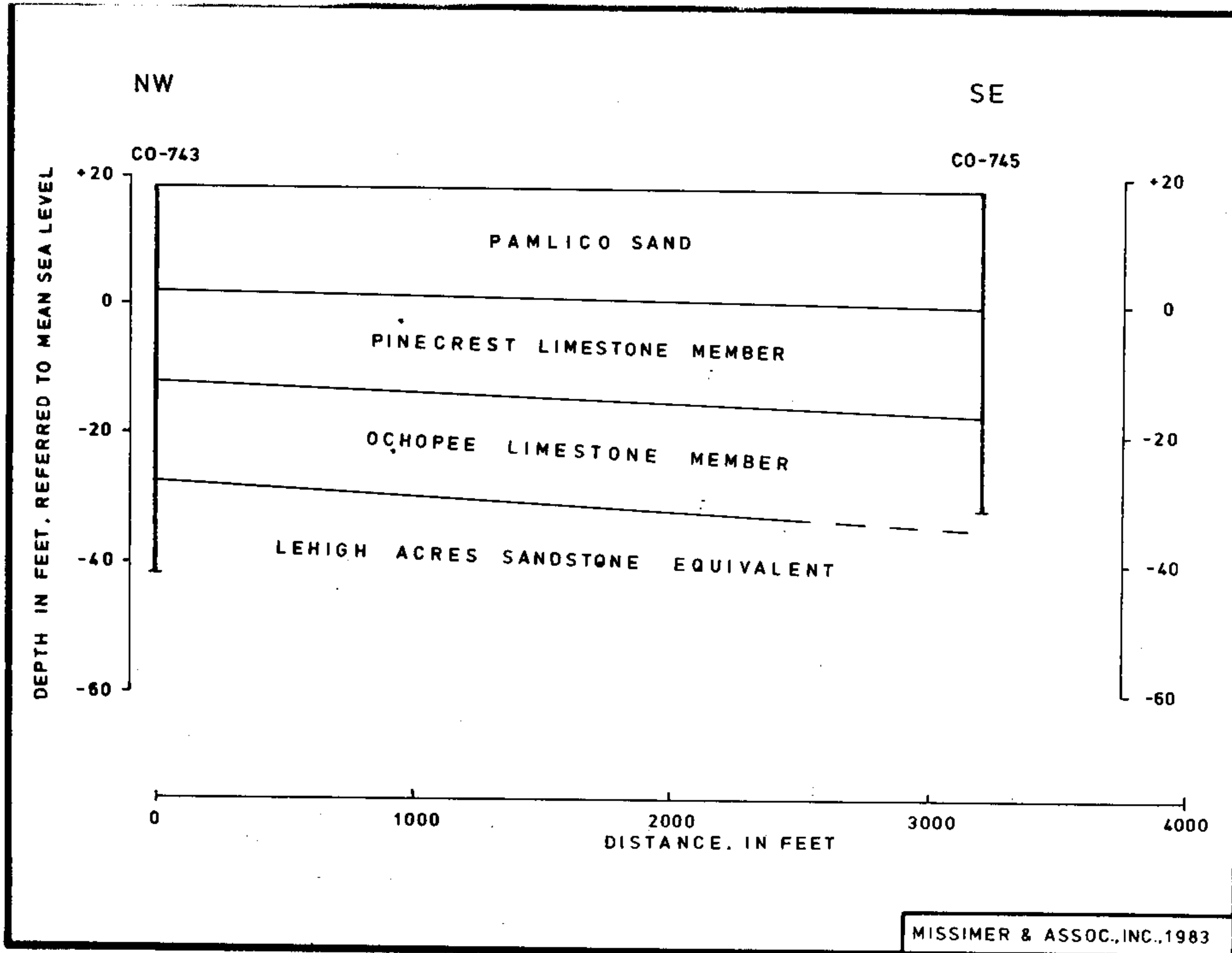

FIGURE 4-2. GEOLOGIC CROSS SECTION ACROSS THE INVESTIGATION SITE.

Pamlico Sand Formation

Stratigraphically, the Pamlico Sand Formation, deposited in the Pleistocene age, is the uppermost lithologic unit observed. On site, the Pamlico is represented by 16 to 18 feet of fine to medium quartz sands and sandy clays. The sand is a clean quartz sand, subangular to subrounded in shape with uniform sized grains. Traces of organics (primarily root pieces) were observed in the soil horizon at the surface. The unit grades from a medium to fine to clayey unit near the base. A distinct green clay unit, one to two feet thick, was found as the basal lithology. The Pamlico was found to be similar, both in thickness and lithology, at both drilling locations in the project area. Geologist's logs of wells at both drilling locations are included (see Tables A-1 and A-2) along with a geologic cross section across the investigation site.

Tamiami Formation

Lying stratigraphically beneath the Pamlico is the uppermost member of the Pliocene aged Tamiami Formation, the Pinecrest Limestone. The Pinecrest consists of several lithologies which vary in thickness and complexity. Generally, the unit is characterized as a biomicritic limestone. Lithofacies recognized on the site include a hard, beige, highly porous fossiliferous, micrite; a medium hard, beige to light gray, sandy biomicrite; and a soft, white marl or marly limestone. The first lithofacies mentioned above is 7 to 9 feet thick on the project site. Beneath this very hard layer lies a medium hard, beige to light gray unit 5 to 10 feet thick. It contains numerous small scale vugs and molds. Beneath this, a marly unit approximately 5 feet thick was recognized in well CO-745; however, this lithofacies is absent in well CO-743. The overall thickness of this unit is variable in the project area, but ranges from 15 to 20 feet thick at the two drilling locations.

Underlying the Pinecrest Limestone is the Ochopee Limestone Member. The Ochopee is a gray to white, medium hard, sandy, biomicritic limestone with good moldic porosity produced by selective removal of shell material, mostly bivalves. The unit was not fully penetrated in well CO-745, but was found to be 15 feet thick in well CO-743. A distinctive green dolosilt known as the Bonita Springs Marl in Collier County is noticeably absent in this area, though it occurs several miles to the northwest of the property, where it is found to underlie the Pinecrest. Wells CO-744 and CO-752 had unconsolidated sand stringers in this interval.

Beneath the Ochopee, at a depth of 45 feet, in well CO-743 was found a light green to light gray limestone unit. Similar lithologically to the above Ochopee, it is dissimilar in both color and degree of induration. In this report it will be considered a time equivalent unit of the Lehigh Acres Sandstone Member. The Lehigh Acres is found beneath the Ochopee in western Collier County.

3. Aquifer Descriptions

The major on-site aquifer is from the Ochopee Limestone Member and the Lehigh Acres Sandstone Member equivalent. The aquifer has high permeability and is capable of producing large quantities of water. The full thickness of this aquifer is not penetrated in the local area due to the high yield of the upper portion of the aquifer.

The aquifer is poorly confined from the water-table aquifer by a variable thin silt and clay layer. The confining layer thickens to the eastern portion of the site.

The aquifer is not homogeneous and contains areas with unconsolidated sand stringers. The unconsolidated sand commonly decreases the local well yield due to reduction of formation permeability and the associated well construction complications.

4. Characteristics of the Aquifer

The aquifer system beneath the site is hydraulically and geologically complex. Accurate determinations of the hydraulic properties of the stressed zones is required to meaningfully predict the aquifer response to long term pumping. Determination of the hydraulic properties of the aquifer requires the following information:

1) Detailed geologic data.

2) Aquifer test (pump test) data.

3) Water level data.

The geologic information and detailed aquifer delineation have been presented in the previous sections of this chapter and potentiometric surface data in the following section.

There are four basic aquifer types. These types, using the terminology of Kruseman and DeRidder (1970), are:

1) Unconfined aquifer

2) Semi-unconfined aquifer

3) Semi-confined aquifer

4) Confined aquifer

Unconfined or water-table aquifers occur in permeable sediments where the sequence is open at land surface to the atmosphere and the pressure at the water table is also atmospheric. Aquifer response to an induced stress (e.g., pumping) is from gravity drainage. Vertical and horizontal permeability are about equal.

Semi-unconfined aquifers occur where some sediments of lower permeability occur between land surface and the upper surface of the aquifer. The base of the aquifer is formed by sediments of low permeability. The pressure in these aquifers is close to atmospheric. When a semi-unconfined aquifer is stressed, water is first yielded from a horizontal plane and then vertically. Continued pumping of a semi-unconfined aquifer will eventually cause the system to convert to unconfined.

Semi-confined aquifers occur where continuous beds having low permeability fully confine the aquifer from the atmosphere. During pumping, water is yielded from the aquifer by expansion of water and/or compaction of the aquifer. When the aquifer is stressed, water is yielded from a horizontal direction until the potentiometric head is lowered to a point where vertical flow of water occurs from the confining beds (downward and/or upward).

Confined aquifers occur where beds of very low permeability completely enclose the aquifer. Theoretically, no leakage of water through confining beds occur. These aquifers respond to pumping stress by yielding water from a horizontal direction. A true long-term confined aquifer is extremely rare.

There are typically three hydraulic coefficients determined in aquifer tests:

Transmissivity (T)	- The ability of an aquifer to transmit water in gpd/ft or m^2/day
Storage Coefficient (S)	- The volume of water an aquifer can release from storage, dimensionless
Leakage Coefficient (k'/b')	- The effective vertical permeability of a confining layer divided by the thickness of the confining bed, gpd/ft^3

A step drawdown test and an aquifer test were completed on the Tamiami Aquifer. Four 30-minute pumping steps of 654 gpm, 800 gpm, 950 gpm, and 1,050 gpm were completed for the step drawdown test. It was determined to run the primary aquifer test at a discharge rate of approximately 1,050 gpm.

The primary aquifer test was performed with continuous pumping for 24 hours. Drawdown in the production well nearly stabilized after three minutes. The production well drew down .15 foot the remainder of the test.

Drawdowns measured in observation wells CO-743 and CO-744 stabilized after approximately 720 minutes. Drawdown data from the production well were not used for calculation of hydraulic coefficients. Time and drawdown data for the pumped well and observation wells are given in Tables A-3, A-4, A-5 and A-6.

A preliminary analysis of the time and drawdown data was made with the Jacob and Cooper (1946) and Jacob (1950) straight line method. The calculated hydraulic coefficients are listed in Table 4-1.

The Jacob straight line method yields accurate values only for early pumping data. A leakance value for the confining layer cannot be calculated with this analysis technique.

More revealing analysis techniques were applied to the data. The drawdown data were plotted on log-log paper and the resultant curve was matched to the appropriate type curve (Jacob, 1950; Hantush, 1956; and Cooper, 1946). The match point values were substituted into the following equations:

TABLE 4-1. CALCULATED AQUIFER COEFFICIENTS

Analysis Method	T(gpd/ft)	S	k'/b'(gpd/ft^3)
Well CO-743			
1. Jacob	1,788,000	7×10^{-2}	
2. Hantush-Jacob	1,505,000	4×10^{-3}	2.5×10^{-2}
Well CO-744			
1. Jacob	2,132,000	5×10^{-3}	
2. Hantush-Jacob	1,980,000	5×10^{-4}	4×10^{-3}
Distance Drawdown			
1. Cooper - 60 min.	1,650,000	1×10^{-3}	

$$T = \frac{Q\ L\ (u,v)}{4\ s} \quad (1)$$

$$S = 4T\ tr^{2/1/u} \quad (2)$$

$$\frac{K'}{b'} = 4T\ \frac{u2}{r2} = S\ \frac{(u2/u)}{T} \quad (3)$$

where,

T = transmissivity (ft^2/day)

Q = discharge (ft^3/day)

L (u,v) = Hantush curve function

s = drawdown (feet)

S = storage coefficient (dimensionless)

u = Hantush curve function

t = time (days)

r = distance from pumped well (feet)

K = permeability of confining layer (ft/day)

b' = thickness of confining layer (feet)

u = Hantush curve function

(7.48 gal/ft^3) (ft^2/day) = 1 gpd/ft

(7.48 gal/ft^3) (1/days) = 1 gpd/ft^3

The log-log data plot of time versus drawdown data for observation wells CO-743 and CO-744 are shown in Figures 4-3 and 4-4. Substitution of the match data into the above listed equations yielded the coefficients listed in Table 4-1. Drawdown in observation well CO-745 (see Figure 4-5) was erratic and not

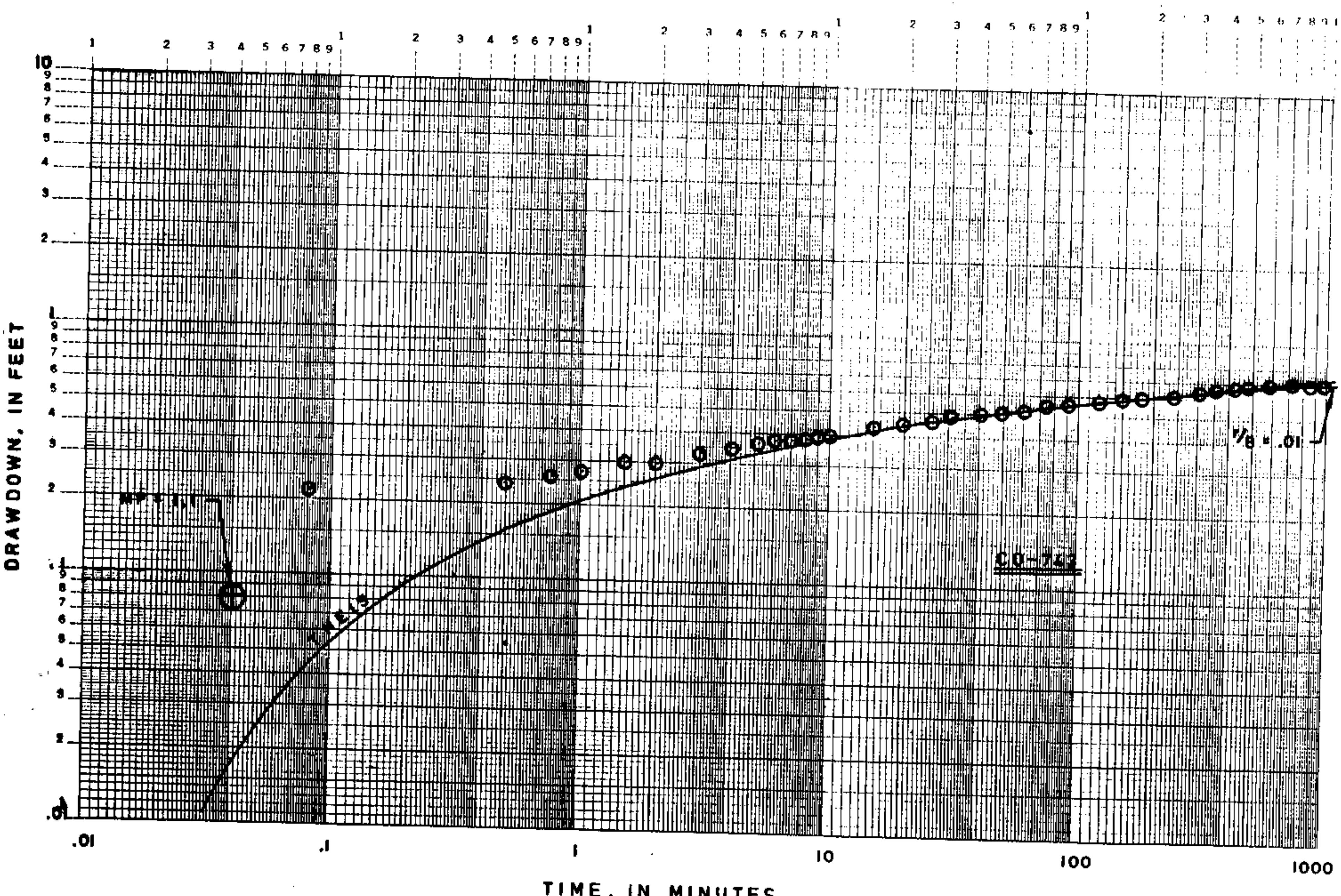

FIGURE 4-3. LOG-LOG PLOT OF DRAWDOWN VS. TIME FOR OBSERVATION WELL CO-743.

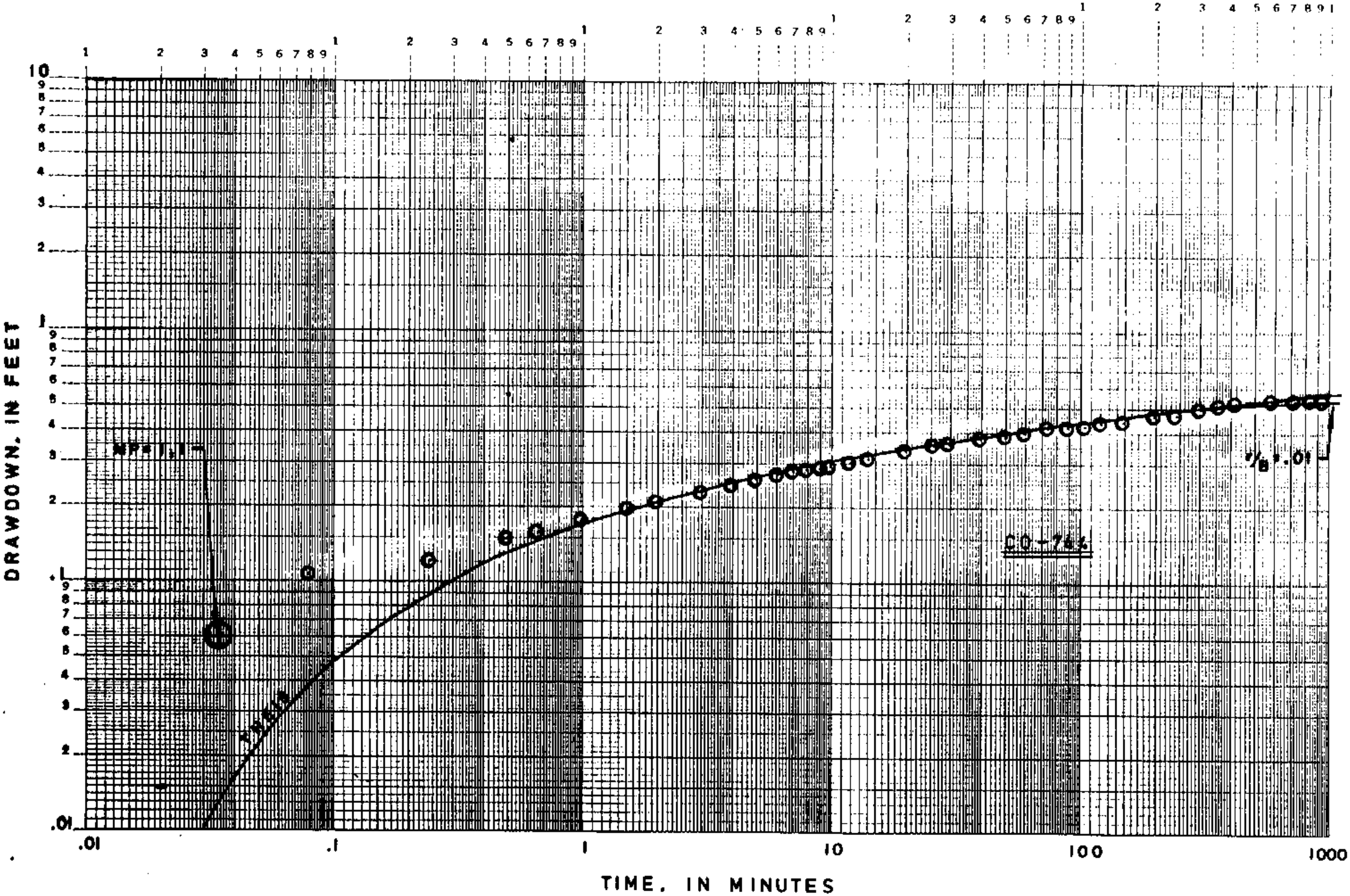

FIGURE 4-4. LOG-LOG PLOT OF DRAWDOWN VS. TIME FOR OBSERVATION WELL CO-744.

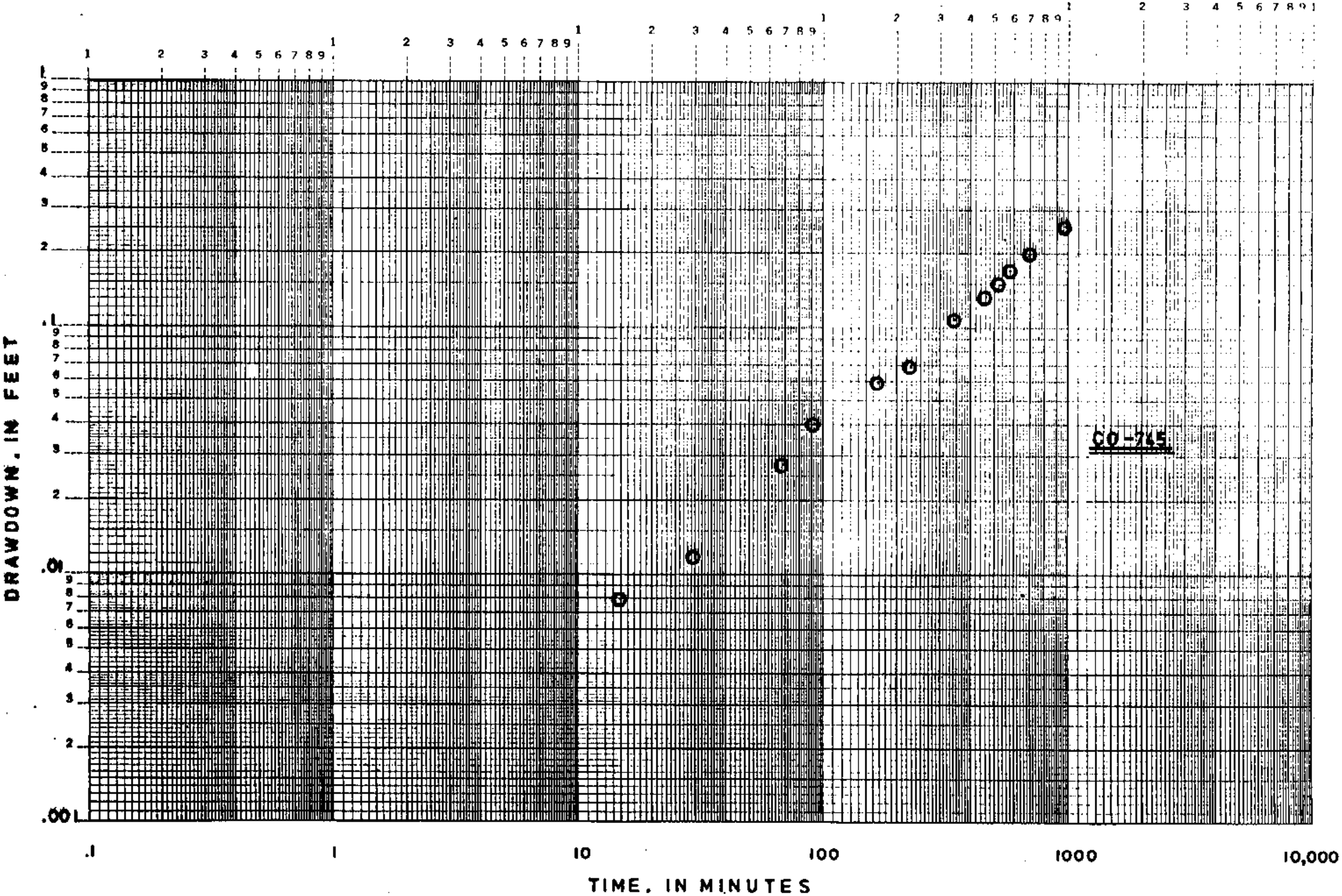

FIGURE 4-5. LOG-LOG PLOT OF DRAWDOWN VS. TIME FOR OBSERVATION WELL CO-745.

suitable for analysis. The skewed drawdown is apparently from varying geology and/or pumping on adjacent property.

For assessment of regional impacts, the following aquifer coefficients are used:

Transmissivity	=	1,000,000 gpd/ft
Storage Coefficient	=	.001
Leakance	=	1.0×10^{-3} gpd/ft^3

These values are conservative compared to the calculated coefficients. Due to the variable geology on site, these lower values for predictive modeling are necessary. The variability of the confining layer makes determining if the aquifer derives water from delayed yield or leakance difficult. Modeling will be done with the worst-case situation of a semi-confined aquifer.

5. Water Levels and Recharge

Water level in the tested Tamiami Aquifer System respond as a semi-confined aquifer during pumping; however, the confinement is so poor that the aquifer response to rainfall approaches the behavior of an unconfined aquifer. The water level fluctuates in response to recharge and discharge. These are naturally controlled by climatic conditions, drainage and vegetation. The aquifer on-site is recharged by lateral flow and rainfall. The water level naturally fluctuates 3 to 4 feet from wet to dry season.

Water levels in the aquifer respond immediately to rainfall on-site.

6. Water Quality

The water quality of the Tamiami Aquifer System is excellent. Total dissolved chloride concentration is consistently 40-60 mg/l. There was no fluctuation of total dissolved chlorides during the aquifer test.

There is no known local source of contamination for this aquifer. There are no known deeper wells located in the area that might serve as a source of more mineralized water. The only surface water in the area is in agricultural drainage ditches or cypress strands.

Table A-7 list various analyzed water quality parameters for a water sample collected from well 3 (CO-751).

V. IMPACT ASSESSMENTS

1. Impact on the Aquifer System

Impacts to the Tamiami Aquifer System were assessed for a withdrawal rate of 52,470 gpm and steady state pumping conditions. Maximum pumping duration should not exceed eight hours because it is for frost protection. The simulated equilibrium drawdowns of this section will not be established in eight hours. Drawdowns are modeled for 48 production wells pumping at 1,200 gpm and for 30 production wells pumping at 1,800 gpm.

Drawdowns in the aquifer were calculated using the following assumptions: aquifer transmissivity is 1,000,000 gpd/ft, the storage coefficient is .001, leakance is 2×10^{-2} gpd/ft^3, and the aquifer receives no lateral recharge during pumping. A key assumption is that the aquifer is homogeneous. Figures 5-1 and 5-2 show the equilibrium drawdowns for a withdrawal rate of 52,470 gpm from respectively 48 wells and 30 wells. Most wells in Figure 5-2 are not located on nodal printout points.

2. Impact on Neighboring Users

The nearest major user of Tamiami Aquifer System-

drawdown at equilibrium

t= 1000000 gpd/ft

l= 0.02000000000

grid spacing = 700 ft

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	6.90	7.68	8.47	9.21	9.83	10.27	10.50	10.50	10.27	9.83	9.21	8.47	7.68	6.90
2	7.60	8.58	9.62	10.62	11.46	12.05	12.36	12.36	12.05	11.46	10.62	9.62	8.58	7.60
3	8.29	9.51	10.89	12.31	13.47	14.25	14.64	14.64	14.25	13.47	12.31	10.89	9.51	8.29
4	8.89	10.36	12.14	15.69	17.24	18.23	18.71	18.71	18.23	17.24	15.69	12.14	10.36	8.89
5	9.34	11.00	13.08	17.00	18.82	19.96	20.52	20.52	19.96	18.82	17.00	13.08	11.00	9.34
6	9.58	11.34	13.56	17.63	19.58	20.81	21.40	21.40	20.81	19.58	17.63	13.56	11.34	9.58
7	9.58	11.34	13.56	17.63	19.58	20.81	21.40	21.40	20.81	19.58	17.63	13.56	11.34	9.58
8	9.34	11.00	13.08	17.00	18.82	19.96	20.52	20.52	19.96	18.82	17.00	13.08	11.00	9.34
9	8.89	10.36	12.14	15.69	17.24	18.23	18.71	18.71	18.23	17.24	15.69	12.14	10.36	8.89
10	8.29	9.51	10.89	12.31	13.47	14.25	14.64	14.64	14.25	13.47	12.31	10.89	9.51	8.29
11	7.60	8.58	9.62	10.62	11.46	12.05	12.36	12.36	12.05	11.46	10.62	9.62	8.58	7.60
12	6.90	7.68	8.47	9.21	9.83	10.27	10.50	10.50	10.27	9.83	9.21	8.47	7.68	6.90

FIGURE 5-1. EQUILIBRIUM DRAWDOWNS IN SECTION 26 FOR A 75.5 MGD WITHDRAWAL FROM 48 WELLS.

t= 1000000 gpd/ft

I= 0.02000000000

grid spacing = 700 ft

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	6.97	7.79	8.61	9.36	9.98	10.40	10.59	10.53	10.22	9.69	9.00	8.20	7.37	6.58
2	7.69	8.72	9.81	10.85	11.69	12.26	12.50	12.42	12.02	11.30	10.34	9.26	8.19	7.21
3	8.37	9.67	11.15	12.65	13.81	14.55	14.87	14.77	14.24	13.28	11.92	10.39	9.00	7.79
4	8.96	10.52	12.47	16.94	16.39	17.15	17.62	17.98	17.06	15.56	13.67	11.44	9.70	8.28
5	9.35	11.10	13.36	18.21	17.91	18.81	19.32	19.67	18.67	16.98	14.76	12.16	10.17	8.61
6	9.49	11.31	13.66	18.62	18.40	19.35	19.88	20.23	19.19	17.43	15.12	12.41	10.34	8.72
7	9.35	11.10	13.36	18.21	17.91	18.81	19.32	19.67	18.67	16.98	14.76	12.16	10.17	8.61
8	8.96	10.52	12.47	16.94	16.39	17.15	17.62	17.98	17.06	15.56	13.67	11.44	9.70	8.28
9	8.37	9.67	11.15	12.65	13.81	14.55	14.87	14.77	14.24	13.28	11.92	10.39	9.00	7.79
10	7.69	8.72	9.81	10.85	11.69	12.26	12.50	12.42	12.02	11.30	10.34	9.26	8.19	7.21
11	6.97	7.79	8.61	9.36	9.98	10.40	10.59	10.53	10.22	9.69	9.00	8.20	7.37	6.58
12	6.28	6.92	7.54	8.11	8.57	8.89	9.02	8.98	8.75	8.36	7.84	7.24	6.60	5.96

FIGURE 5-2. EQUILIBRIUM DRAWDOWNS IN SECTION 26 FOR A 75.5 MGD WITHDRAWAL FROM 30 WELLS.

Zone I is the Silver Strand Grove South, located approximately 2 miles northwest of the investigation site. Figure 5-3 shows the regional cone of depression resulting from a 75.5 MGD withdrawal from Section 26. The resultant drawdown on the Silver Strand Groves site is less than 1 foot.

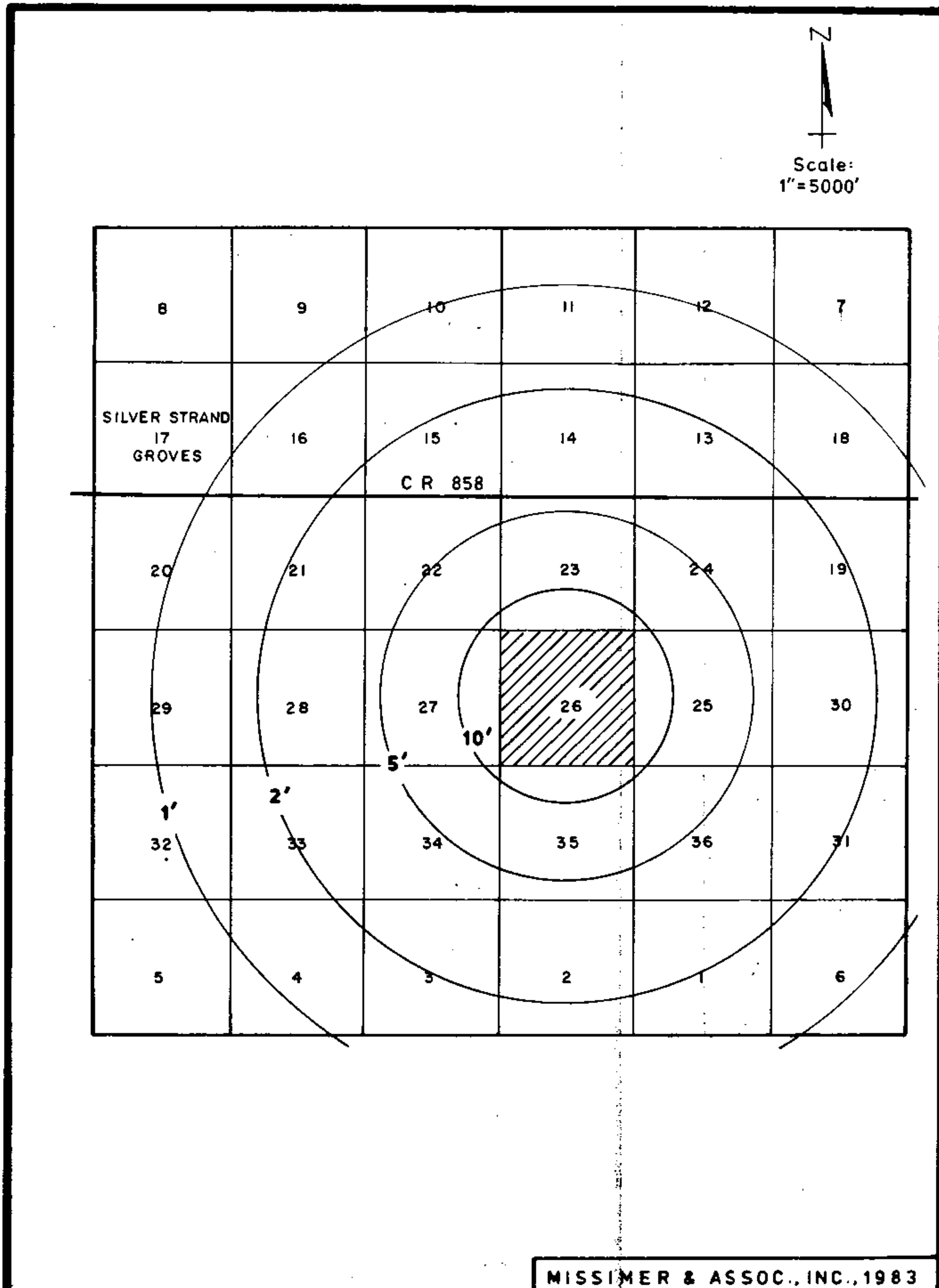

FIGURE 5-3. THE REGIONAL CONE OF DEPRESSION IN THE POTENTIOMETRIC SURFACE OF TAMIAMI AQUIFER-ZONE I AT EQUILIBRIUM

VI. PROPOSED SITE PLAN

1. Production Well Locations and Recommended Withdrawal Rates

Each 10 acre plot will have a well or wells to supply the required water. Figure 6-1 shows the layout of these plots. The maximum water demand will be during frost protection intervals when a withdrawal rate of 1,140 gpm will be required for up to eight hours.

The pumping level in the well results from the static water level (seasonal fluctuation), withdrawal drawdown for the individual well, interference drawdown from other pumping wells, and well inefficiency losses. The varying lithology will particularly impact the individual well drawdown (specific capacity) and well efficiency.

Table 6-1 lists various useful parameters for each production well. At present, only information on three wells is listed. As each new well is completed, this list should be updated. This list will be used to establish baseline data for each well and to pinpoint individual wells and groups of wells which could experience excessive drawdown during large withdrawal periods. Specific capacity values for each well should be entered on Figure 6-1.

Based on the aquifer test completed on well CO-746 (1), the required 1,140 gpm can be withdrawn from one 13-inch

TABLE 6-1. USEFUL PARAMETERS FOR EACH WELL

Well No.	Total Depth (feet)	Casing Depth (feet)	Casing Diameter (inches)	Specific Capacity (gpd/ft)	Pumping Level (feet)	Total Dissolved Chlorides (mg/l)
1 (CO-746)	58	33	13	484 (@ 1,050 gpm)		42
2 (CO-751)	100	53	13	128 (@ 1,000 gpm)		49
3 (CO-752)	38	32	13	120 (@ 1,227 gpm)		59

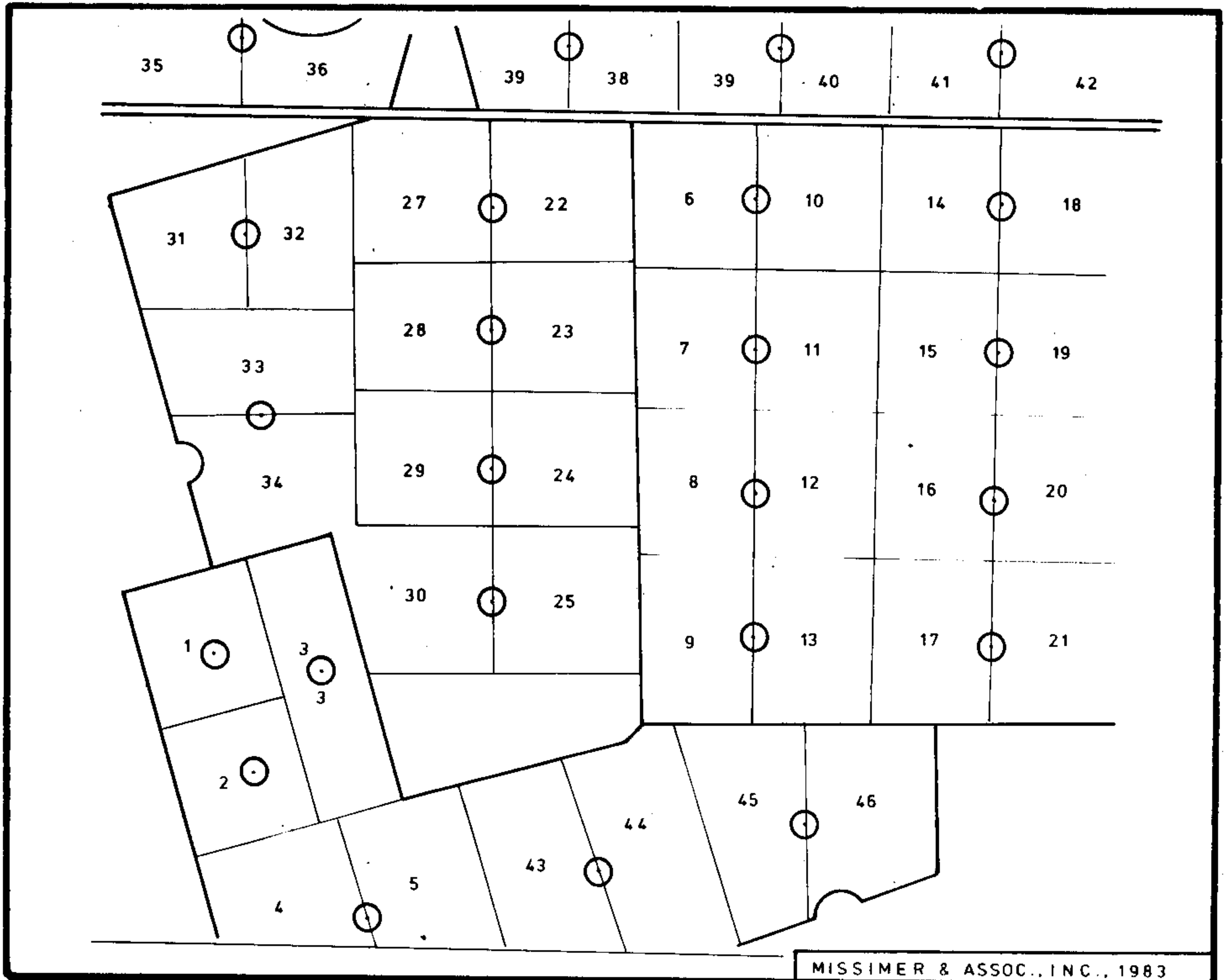

FIGURE 6-1. MAP SHOWING THE PLOTS TO BE DEVELOPED IN SECTION 26.

production well per 10 acre plot. Due to the variable geology some wells may have lower yields. Should this happen, more smaller yield wells may be required or deeper wells into the Hawthorn Formation. Little specific information is known about the Hawthorn Formation in the subject area. Poorer water quality and lower yield wells can regionally be expected from this aquifer.

2. Monitoring Procedures

Both water quality and water levels should be monitored annually. As each well is completed, a baseline total dissolved chloride value should be established. Each well should then be sampled yearly for this parameter.

The pumping level for each well should be measured annually. This should be done as a test just prior to the cold season. These levels should be taken while all wells are discharging at their design rate. Any increases in pumping levels should be reviewed to insure the water will actually be available when required by a dangerous frost. An increase could indicate a modified pumping regime or well maintenance.

VII. REFERENCES

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APPENDIX

TABLE A-1. GEOLOGIST'S LOG OF WELL CO-743

Depth(feet)	Lithology
0-12	Sand, light gray-brown, fine to medium, subangular to subrounded, minor organics.
12-16	Sand, clayey, light brown-gray, very fine to clay sized grains, thin green clay lense at 15'.
16-22	Limestone, light gray-beige, hard, biomicritic, occasional small vugs, quartz sand (5-10%), minor shell.
22-25	Limestone, hard, lost circulation, no sample.
25-40	Limestone, gray and beige, interbedded hard micritic lense and quartz rich biomicritic limestone, good secondary porosity, fine quartz sand (5-10%).
40-45	Limestone, gray, medium hard, biosparitic, numerous molds and vugs - very high secondary porosity, crystalline.
45-50	Limestone, light green, medium, biosparitic-biomicritic, numerous vugs as above, very good secondary porosity, fossiliferous, microspar common in vugs, crystalline.
50-60	Limestone, light green-light gray, medium, biomicritic, minor quartz sand, vugs still abundant, shell fragments common.

TABLE A-2. GEOLOGIST'S LOG OF WELL CO-745

Depth(feet)	Lithology
0-16	Sand, light brown-gray, fine to medium, subangular to subrounded, minor organics.
16-18	Clay, green, soft, sandy, fine quartz sand and silt (30-40%), limestone fragments and shell common.
18-25	Limestone, beige, hard, biomicritic, numerous small molds and vugs, occasional microspar lining vugs, large shell fragments frequent.
25-30	Limestone, beige, medium, biomicritic, numerous vugs and molds, not as well indurated as above, traces of fine quartz sand.
30-35	Marl, white, soft, limestone fragments and shell in a clayey matrix, calcareous.
35-40	Limestone, gray and beige, medium to hard, biomicritic, occasional small molds and vugs, minor quartz sand and silt.
40-50	Limestone, beige and gray, hard, biomicritic, beige is biomicritic with good secondary porosity, gray is dense micritic, shell common.

TABLE A-3. TIME AND DRAWDOWN DATA FOR PRODUCTION WELL CO-746 DURING THE AQUIFER TEST

Time(minutes)	Drawdown(feet)
1	1.58
3	1.70
8	1.75
18	1.77
40	1.85
60	1.87
90	1.90
120	1.92
150	1.94
180	1.97
240	1.97
360	2.03
420	2.06
480	2.07
720	2.08
960	2.06
1200	2.07
1440	2.07

TABLE A-4. TIME AND DRAWDOWN DATA FOR OBSERVATION WELL CO-743 DURING THE AQUIFER TEST

Time(minutes)	Drawdown(feet)
.08	.22
.50	.243
.75	.26
1	.278
1.5	.297
2	.30
3	.33
4	.35
5	.361
6	.375
7	.38
8	.385
9	.393
10	.40
12.5	.413
15	.43
20	.445
25	.46
30	.48
40	.493
50	.505
60	.525
75	.542
90	.555
120	.57
150	.585
180	.595
240	.61
300	.635
360	.655
420	.67
480	.68
600	.69
720	.69
840	.70
1020	.61
1200	.58
1440	.54

TABLE A-5. TIME AND DRAWDOWN DATA FOR OBSERVATION WELL CO-744 DURING THE AQUIFER TEST

Time(minutes)	Drawdown(feet)
.08	.106
.25	.121
.50	.149
.66	.153
1	.175
1.5	.195
2	.21
3	.23
4	.245
5	.258
6	.27
7	.279
8	.286
9	.29
10	.296
12	.309
14	.319
20	.342
26	.356
30	.36
40	.38
50	.389
60	.40
75	.415
90	.42
105	.422
120	.44
150	.449
192	.463
244	.472
307	.498
362	.514
420	.525
478	.53
540	.538
600	.54
720	.545
840	.55
1020	.48
1200	.46
1440	.45

TABLE A-6. TIME AND DRAWDOWN DATA FOR OBSERVATION WELL CO-745 DURING THE AQUIFER TEST

Time(minutes)	Drawdown(feet)
15	.008
30	.015
60	.028
93	.04
168	.06
348	.11
432	.137
525	.15
585	.17
645	.18

TABLE A-7. VARIOUS ANALYZED WATER QUALITY PARAMETERS

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lient: Missimer and Associates
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Cape Coral, Fl 33909

ample: Well water collected August 16, 1983 by Jim Shine
Pineapple Plantation Immokalle, Florida
Recieved at laboratory August 18, 1983 Job No: 83-8-18-M-31

nalysis and Comments:

Analyses:	Results:	Tech/Date:
Iron, mg/l Fe	1.6	8/19LS
Sodium, mg/l Na	31	8/25LS
Magnesium, mg/l Mg	5.6	8/25/LS
Calcium, mg/l Ca	136	8/25/LS
Manganese, mg/l Mn	0.03	8/19/LS
Chloride, mg/l Cl	59	8/18/HW
Total Dissolved Solids, mg/l	746	8/18/HW
Total Alkalinity, mg/l as $CaCO_3$	324	8/18/HW
pH, units	6.6	8/18/HW
Total Hardness, mg/l as $CaCO_3$	362	8/18/HW
Sulfates , mg/l SO_4	12.8	8/18/HW

Laboratory I.D. NO. 86140

THESE SAMPLES WERE NOT COLLECTED BY McGINNES LABORATORIES PERSONNEL AND THE RESULTS ARE WARRANTED TO REPRESENT SAMPLES ONLY AS RECEIVED BY McGINNES LABORATORIES.