GROUND WATER HYDROLOGY STUDY
GREEN MEADOWS ANALOG MODEL
FLORIDA CITIES WATER COMPANY
FT. MYERS, FLORIDA

APRIL, 1979

Layne

Well Drilling • Water and Waste Water Treatment • Well and High Service Pumps • Special Drilling Service and Maintenance • Hydrological Services • Soil Mechanics Investigations

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FLORIDA CITIES WATER COMPANY
FT. MYERS, FLORIDA

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INTRODUCTION

The Hydrology Division of Layne-Western Company, Inc. has conducted numerous studies identifying ground water conditions in Lee County, Florida. It was recognized nearly ten years ago that the Cypress Lakes plant well field was not capable of meeting the water supply growth for the Florida Cities Water Company franchise area. At approximately the same time, a similar study was being conducted for GAC Utilities for the Cape Coral area. Rapid growth and development was occurring in the coastal fringe area that would exceed locally available water supplies.

In 1971, the Hydrologist began a study for the potential water supply in what was then called the Green Meadows area. The primary purpose of initiating the Green Meadows water supply study was to furnish water for the then proposed land development project that was contemplated to be similar to Lehigh Acres. It was anticipated that the findings of such a study may prove to be equal to the local demands as well as being capable of transmitting fresh water to supplement the local sources of supply for both the Cypress Lakes system and Cape Coral. In January of 1973, GAC Utilities contracted to sell the Green Meadows property. However, sufficient investigation had been made to that time that a very preliminary study utilizing a mathematical model on digital computer was made to determine the approximate spacing and location of potential wells to supplement the Cypress Lakes and Cape

Coral systems. As the result of that study, 26 - one acre well sites were selected and withheld from the deed of transmittal with these sites designated for water supply production. In July of 1974, the first test water production well was constructed in the southwest corner of Section 33, Township 45S, Range 26E in Lee County, Florida on a tract of land designated for a water treatment plant site. To date, three production wells each capable of pumping approximately 700 gallons per minute or 1 million gallons per day, have been constructed on the tract of land designated for the water treatment plant. Water levels in both the shallow and deeper aquifers have been monitored by the U. S. Geological Survey. This data is available upon request.

The purpose of this report is to conclude the study that was started in 1971. The study was originally conceived and has been conducted in accordance with the phases of work considered appropriate for ground water hydrologic studies. The first phase consisted of wide spaced test holes constructed in both the shallow and deeper aquifers in the vicinity to obtain definition of the geology for the general Green Meadows area. Water levels were measured and elevations made to each of the piezometers to construct a water table hydraulic gradient map of the area. Water samples were taken from each of the piezometers and analyzed to determine the general chemical characteristics of the water. The second phase of the study was the test pumping of the test production wells. Water level data was observed in the piezometers and the wells constructed in the area in order to ascertain the appropriate coefficients of transmissivity and storativity in the vicinity. These datum are attached to the Appendix of this report for their information. The third

phase, which is the subject of this report, is the actual modeling of the aquifer system based on the data collected through the years. It is in this phase that the leakage rate and the safe yield of the aquifer system is determined utilizing both electric analog and digital computer modeling techniques. The findings of this model study are presented.

REVIEW OF DATA

The first test drilling in the Eastern Lee County area was conducted by some mineral exploration companies. Some scattered data was available from land surface to the fresh water producing formations in the vicinity. It was found early in the investigation that there was a very shallow aquifer utilized by agricultural interests in the area for irrigation. This water was usually colored by the development of tannic acid from natural vegetation. Because of the color, it was undesirable in its appearance for public water supply use. Treatment for total color removal was considered too expensive by conventional methods.

It was the experience in Lehigh Acres that an aquifer did exist from approximately 80 to 100 feet or more in depth below land surface that could be utilized for public water supply purposes. Therefore the investigation procedure designed for Green Meadows was to construct piezometers in pairs with the first shallow piezometer terminating in the shallowmost water bearing material. A second test boring then within a foot or two of the first one, was carried to the first satisfactory water producing formation occurring usually at 100 foot depth or greater, suitable for public water supply purposes. Various samples were collected from the test holes, both shallow and deep, and were analyzed by various laboratories for its mineral content.

Geology

The primary source of ground water in Eastern Lee County are the permeable sediments in the upper 200 feet of the subsurface. The surficial sands in Eastern Lee County may have been deposited on the ocean floor

during the Pleistocene Epoch when sea level was approximately 42 feet higher than at present. During a particular stand of the sea level, sands from rivers and streams settled in the shallow water near the shore. These ancient sea floors are known as terraces and are recognizable throughout the area. Other surface sands may also be found when the sea level was only about 25 feet higher than at present. These areas appear to lie just to the west of the Green Meadows area.

The upper soil profile consists mostly of coarse sand, marl, shell beds, and consolidated and semi-consolidated limestones. Some of the marl and clay lenses that occur in the upper portion of the profile limit vertical infiltration. The soil materials from approximately 100 feet in depth to about 250 feet in depth appear to be material of the Tamiami formation. It is this formation that is the principle aquifer for municipal and public water supplies. The shallow near surface aquifers of sand and shell are used primarily for irrigation in the local area. These two distinct aquifers are separated by extremely low permeability marls and clays.

The aquitard between the shallow aquifer and the deeper Tamiami formation is both beneficial and detrimental, depending upon the point of view and interest involved. The aquiclude is detrimental in that it limits the leakage into the underlying aquifer and thereby limits the actual amount of pumping that should be sustained on a long term yield basis. The aquiclude however acts as a filter in conditioning of water and results in development of a higher quality of water than would be available from the shallow surface aquifer. The aquiclude is therefore limiting the yield, but improving the

quality of water from natural sources.

The most beneficial effect of the aquitard is that local irrigators in the area can utilize the shallow aquifer system for agricultural purposes and not have any major detrimental effect on the lower aquifer system. Likewise, the lower aquifer can be pumped without affecting appreciably the water table in the shallow aquifer. This has been vividly demonstrated in the SW 1/4 of Section 33, where shallow irrigation wells have continued to operate even though the lower aquifer water level decline has been significant due to the initial pumpage of the Green Meadows well field. This comes about by the high recharge rate from local precipitation to the shallow aquifer far exceeds the amount of leakage out of the bottom of the shallow aquifer through the aquitard into the lower Tamiami formation. From the present data available, the aquitard between the two aquifer systems has been found in every boring in the general vicinity.

Climate

The average annual rainfall in Eastern Lee County is approximately 52 inches per year. It is common for 15% or more of this amount of water to be contributed to the shallow aquifer system. This is the equivalent to 7.8 inches per year of precipitation that contributes to the shallow aquifer. Converting this to the average recharge rate per square mile results in approximately 372,000 gallons per day per square mile to the shallow aquifer.

In conducting leakage studies of the Upper Hawthorn aquifer in both the Cape Coral and Cypress Lakes well fields, it was found from previous studies that an average of 150,000 gallons per day per square mile

may actually be contributed to the Upper Hawthorn aquifer. Therefore it appears that only 40% of the recharge to the shallow aquifer is transmitted through the aquitards to the Tamiami formation below. This transfer only occurs in areas of pumpage where the water table has been depressed sufficiently for the infiltration to occur. There remains approximately 60% of the recharge still available to the local shallow aquifer system for irrigation purposes. In the area immediately to the south of the Green Meadows area, this has been observed to be satisfactory for continuation of irrigation without any appreciable loss or damage to the agricultural system as indicated by the absence of any claim for damages from the adjacent farmer.

Test Hole Drilling

In the Appendix of the report are copies of test hole logs that have been constructed for both Florida Cities Water Company and GAC Utilities. In addition to these were logs furnished by the U. S. Geological Survey and the approximate location along Corkscrew Grade, in Estero and other areas located in Central and Eastern Lee County. These datum are attached to the Appendix for the information provided. Where water quality samples were available, these have been included.

In 1972, a special surface water study was being conducted in addition to the shallow aquifer study for the Green Meadows area. Crest stage gauges were established in several areas to obtain the maximum water height from local precipitation. Water quality samples were taken of both surface water and from the shallow aquifer in preparation for a comprehensive study of the Green Meadows water supply system. Attached to the January 19,

1973 letter, is an illustration of the near surface and shallow aquifer water table as well as the water table elevation of the deeper Tamiami formation. Some differences in hydraulic gradient were observed.

WELL DEVELOPMENT

In early 1973, it was contemplated selling the Green Meadows property by GAC Utilities. At that time, a computer run was made based on estimates of the aquifer properties obtained from the first phase of study. It was proposed to develop approximately 21 wells with the wells spaced on one-half mile intervals in a rectangular grid pattern. The data was examined on the basis of no recharge and developing water only from the internal storage capacity of the aquifer. It was found that pumping only 5 million gallons per day resulted in a useful life of the aquifer in excess of 50 years with no recharge. Increasing pumping to approximately 10 million gallons per day, leakage from the shallow aquifer would have to be present onan order of magnitude similar to that experienced for the Upper Hawthorn aquifer. This was considered to be a reasonable expectation for the area and the recommendation was made to select approximately 20 some well sites through the center portion of the Green Meadows area that could be developed and accessible to the Florida Cities Water Company water supply system and to the City of Cape Coral. The resulting one acre well sites selected as a result of the study are shown on the attached drawing and are a part of the application pending before the South Florida Water Management District.

In July of 1974, contracts were let for the construction of the first two wells located at the water treatment plant site in the southwest corner of Section 33. These wells were constructed by McGreggor Pump Company and the logs and pumping test data are shown in the Appendix. Test Well No. 1 showed an initial value of transmissivity of 13,133 gallons per day per foot

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ALVA SW QUADRANGLE
FLORIDA—LEE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

Lehigh Acres

PROPOSED WATER PLANT SITE

U.S.G.S. OBSERVATION WELL

GM-1 GM-2 GM-3 GM-4 GM-5 GM-6 GM-7 GM-8 GM-9 GM-10 GM-11 GM-12 GM-13 GM-14 GM-15 GM-16 GM-17 GM-18 GM-19 GM-20 GM-21 GM-22 GM-23 GM-24 GM-25 GM-26 GM-27 GM-28

Flowing Well

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Culture and drainage in part compiled from aerial photographs taken 1951. Topography by planetable surveys 1957-1958

Polyconic projection. 1927 North American datum
10,000-foot grid based on Florida coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks,
zone 17, shown in blue

Revisions shown in purple compiled from aerial photographs taken 1973. This information not field checked

Purple tint indicates extension of urban areas

UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

GREEN MEADOWS WELL FIELD
LEE COUNTY

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

LEGEND
- EXISTING WELL
- FUTURE WELL

DATE OCT. 1977

QUADRANGLE LOCATION

ROAD CLASSIFICATION
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
State Route

ALVA SW, FLA.
N2630—W8137.5/7.5

1958
PHOTOREVISED 1973
AMS 4637 II SW-SERIES V847

width of aquifer and increased to approximately 42,955 gallons per day per foot width of aquifer after 100 minutes of pumping. This is an indication of the leakage beginning to develop through the aquitard separating the shallow and deeper aquifer of the Tamiami formation. Near the end of 25 hours of pumping, the rate of drawdown appeared to stabilize at a pumping rate of 781 gallons per minute. The well's specific capacity was approximately 21 gallons per minute per foot decline in water level.

In a few weeks the second well was completed and test pumped at a rate of 948 gallons per minute for 25 hours, which had a well specific capacity of 23.7 gallons per minute per foot of drawdown. Prior to the pumping test, well development work on each of the wells showed pumping rates in excess of 1,100 gallons per minute from less than a 50 foot depth. This was an exceptional yield capacity from wells in Lee County. The coefficient of transmissivity for Well No. 2 appeared to stabilize at approximately 36,805 gallons per day per foot width of aquifer. The coefficient of storativity appeared to be .0016 for Well No. 2. No direct calculation of leakance through the aquitard was made for the pumping test. Prior values of from 150,000 gallons per day to approximately 180,000 gallons per day per square mile of aquifer appeared realistic for the area.

Approximately a year later in 1975, a third well was constructed on the water treatment plant site. No detailed pumping test was made on this well.

The operation of the three wells at the water treatment plant site has been extremely satisfactory from a yield production basis. Water levels

in the group of piezometers constructed on the site showing levels in both the shallow aquifer, and in the Tamiami formation, responded as expected. No appreciable lowering of the shallow aquifer used for irrigation in the area was found. The water table did decline in the production aquifer zone of the Tamiami formation in accordance with projected water levels.

The only operational problem encountered to date with the Green Meadows water supply system has been the unusually high amount of hydrogen sulfide gas contained in the water production formation. It is thought that the present location of these wells is near the subcrop of the aquifer system and may be in contact with some natural deterioration of organic matter or sulfur reducing bacteria contributing to the development of the hydrogen sulfide gas in the water supply. This water was initially used into the distribution system with only aeration and chlorination. Excessive amounts of chlorine did have to be added to reduce the chemical oxygen demand and provide a proper residual for municipal purposes. Conditioning of this water through full lime softening as presently under construction, will provide an excellent quality of water for the area. Conventional water treatment will eliminate the hydrogen sulfide from the raw water supply.

AQUIFER MODEL SYSTEM

An electric analog model was made of the entire Lee County area including the Upper Hawthorn aquifer of the Cypress Lakes and Cape Coral systems. The transmissivity of the aquifer was simulated by electrical resistor network. Only the Tamiami or Tamiami-Upper Hawthorn aquifer system, where combined, was modeled on the network. No attempt was made to model the shallow aquifer or the leakage between the two aquifers.

A passive element steady-state electric analog network was constructed for the Tamiami and Upper Hawthorn aquifers in Lee County. No capacitors were added to the model or induction coils to simulate transient response conditions. The steady-state model is an excellent tool to define the flow rate through the aquifer and the resulting drawdown from transmission by the aquifer transmissivity coefficient. No changes in the internal storage capacity of the aquifer can be made in the steady-state system. Leakance or leakage resulting from precipitation sources can be modeled by adding a separate induction grid to the model network. Since the actual leakance rate is difficult to simulate, an arbitrary resistance value more than ten times greater than the base network resistance was selected. In the case of the Lee County model, the leakance network model was actually 100 times greater than the base resistance so that no modification to the aquifer transmissivity would result by the network addition. In later analysis work, this caused some problems in that the voltage level became too high to simulate the amount of leakage for maximum water production.

The electric analog model was calibrated based on 1971 data in which there was essentially no pumpage in the area. Only the natural water table gradient for the Tamiami aquifer formation was modeled. It was found that the leakance from the shallow aquifer was approximately 0.23 milliamps, which is the equivalent of 230,000 gallons per day for the entire model area. It was further found that the aquifer transmissivity was conducting approximately 570,000 gallons per day originating in the northeastern portion of the area. Total water discharge towards the gulf side of the aquifer was approximately 790,000 gallons per day. Voltage levels reflect the actual head condition directly. To the instrument voltage readings was added 100 feet or 100 volts of electrical potential so that all values were well above sea level elevation. To model water table elevation with respect to sea level would have required some special instrumentation that was not considered necessary for this particular model study. Therefore a voltage of 123 volts represents a water table elevation of 23 feet above sea level. Voltage readings can be added and subtracted to obtain the change in head expected for the condition.

In December, 1976, some pumpage was being maintained in the initial start up of the Green Meadows well field area. Simulating a pumpage of approximately 400,000 gallons per day, voltage levels were compared to some observed water levels in the immediate vicinity of the well field. It was found that leakance had increased to approximately 490,000 gallons per day for the aquifer system as well as an increase to approximately 700,000 gallons per day being transmitted through the aquifer from the northeasterly

direction. There continued to be an outflow of approximately 790,000 gallons per day from the aquifer while 400,000 gallons was being pumped. A reasonable simulation of water table elevation was considered to be achieved by the model system.

Having achieved a reasonable simulation of water table conditions in the area, the electric analog model was then stressed to determine the possible drawdown effects for various rates of pumping with recharge from natural precipitation leakage through the aquitard and by transmission through the formation material. As pumpage was increased to 1 million gallons per day, the leakance increased to 640,000 gallons per day while the transmission capacity of the aquifer increased to 1.18 million gallons per day. Total output remained approximately the same with the additional pumpage stress from the aquifer.

Increasing pumpage to 2 million gallons per day resulted in an increase of leakance plus an increase of water being transmitted through the aquifer system.

Pumpage was increased to 5 million gallons per day and found that leakance increased to 3.3 million gallons per day for the model area, while the transmission capacity of the aquifer increased to 2.32 million gallons per day.

Pumpage was then increased to approximately 7 million gallons per day and leakance increased to 4.47 million gallons per day while the aquifer transmission increased to 2.97 million gallons per day. Electrical limitations were being approached in the model system as presently set up.

It is presently projected that leakance could increase to approximately 7.5 million gallons per day for the configuration of the well field while the aquifer transmission capacity remained close to the 3 million gallons per day simulated. This gives the total available yield from the aquifer system for the proposed well field of 10.5 million gallons per day.

In reviewing the aquifer pumping test for Well No. 2, it was found that the radius of influence of this well is approximately 5,000 feet. This was the radius indicated at the end of 25 hours of pumping. The radius of influence can increase with pumping time and is expected to increase to a nominal radius of approximately 10,000 feet with nominal steady-state development of the aquifer system. Utilizing a nominal radius of influence of 10,000 feet, the total surface area encompassed by the well field configuration comprises an area of approximately five miles in width and a little more than ten miles in length. This encompasses a total area of approximately 50 square miles, which requires a leakance rate of only 150,000 gallons per day per square mile to satisfy a yield of 7.5 million gallons per day. With the additional input from the aquifer transmissivity itself, there appears to be little doubt but what 10 million gallons per day can be adequately developed from the Green Meadows well field under steady-state conditions. This complies with the safe yield criteria utilized by most administrative agencies. In developing this yield rate, no consideration was made for ground water mining or permanent reduction of water from the storage capacity of the aquifer system.

As development occurs, it may be found that a slightly higher

leakance rate through the aquitard separating the shallow aquifer and the deeper aquifer exists in the area. If this proves to be the case, then higher pumpage rates may be possible from the well field configuration proposed. It has been previously demonstrated that the yield potential of the total aquifer system including both the shallow aquifer and the deeper aquifer from precipitation sources may exceed 372,000 gallons per day per square mile of area. This results in a potential yield of the 50 square miles of area approaching 18.6 million gallons per day. This would be considered the maximum upper limit potential of the Green Meadows well field area as presently laid out consisting of 26 well sites encompassing an area of approximately six square miles.

With regard to the protection of aquifer quality from exterior sources, it was calculated based on an average transmissivity of 36,000 gallons per day per foot width of aquifer with an effective aquifer thickness of 100 feet, formation permeability was approximately 360 gallons per day per square foot of material. This gives the maximum physical velocity of water at the bore hole well of 48 feet per day. This velocity dissipates rapidly towards the edge of the cone of depression and is nearly zero at the radius of influence with respect to the well field. Movement outside of the influence of the wells will follow the natural hydraulic gradient. This rate of flow in the Tamiami aquifer can be measured in inches per day. A review of land use policy should be considered to areas located within one-half mile of any municipal or potable water supply production well in Eastern Lee County. No deterioration effects have been seen from normal

agricultural practices. Sewage treatment plants, land fills, and hazardous chemical areas should be restricted to areas greater than one-half mile from any water production well facility. Further study should be given to the spray irrigation field proposed by Lee County adjacent to the Green Meadows well field. If this is organic materials only in characteristic of normal municipal waste water and since the shallow aquifer does exist with appropriate vegetative uptake of nutrients, there appears to be little problem with deterioration of water quality from this source. Due to the different aquifer layers and aquicludes with normal vegetative conditioning of waste water, no appreciable deterioration of potable water supply is contemplated or visualized at this time. This is based on the assumption of appropriate loading rates that can be properly assimulated by the land surface vegetation. Spray effluent of properly treated sewage effluent should be no different than ordinary irrigation practices conducted in the area.

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
CALIBRATION, 1971

Input

Leakance	0.23	ma
Ground Water In Northeast	0.57	ma
Total Input	0.80	ma

Output

Ground Water Out Southwest	0.79	ma
Total Pumpage	0	ma
		ma
		ma
		ma
		ma
		ma
Total Output	0.79	ma

Voltage

Well #2	123.2	v	T 43, R 22	118.4	v	T 45, R 22	107.8	v
Well #3	123.6	v	T 43, R 23	122.7	v	T 45, R 23	114.1	v
Well #4	123.4	v	T 43, R 24	124.7	v	T 45, R 24	118.4	v
Well #7	121.9	v	T 43, R 25	125.8	v	T 45, R 25	121.9	v
Well #8	121.8	v	T 43, R 26	126.3	v	T 45, R 26	123.6	v
Well #9	120.9	v	T 43, R 27	126.6	v	T 45, R 27	125.5	v
Well #10	122.0	v						
Well #11	122.5	v	T 44, R 22	112.8	v	T 46, R 22	96.3	v
Well #12	122.0	v	T 44, R 23	119.2	v	T 46, R 23	107.9	v
			T 44, R 24	121.8	v	T 46, R 24	115.6	v
			T 44, R 25	123.7	v	T 46, R 25	120.0	v
			T 44, R 26	125.1	v	T 46, R 26	122.6	v
			T 44, R 27	126.2	v	T 46, R 27	124.8	v
						T 47, R 22	87.5	v
						T 47, R 23	96.4	v
						T 47, R 24	109.1	v
						T 47, R 25	118.1	v
						T 47, R 26	121.2	v
						T 47, R 27	123.4	v

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
DEC. 6, 1976
0.4 MGD PUMPAGE

Input

Leakance	.49	ma
Ground Water In Northeast	.70	ma
Total Input	1.19	ma

Output

Ground Water Out Southwest		.79	ma
Total Pumpage		.40	ma
Well #9	.40	ma	
		ma	
		ma	
		ma	
		ma	
Total Output		1.19	ma

Voltage

Well #2	120.8 v	T 43, R 22	118.6 v	T 45, R 22	106.0 v
Well #3	121.8 v	T 43, R 23	123.4 v	T 45, R 23	113.7 v
Well #4	121.2 v	T 43, R 24	124.6 v	T 45, R 24	117.3 v
Well #7	119.3 v	T 43, R 25	125.2 v	T 45, R 25	119.7 v
Well #8	117.4 v	T 43, R 26	125.7 v	T 45, R 26	121.9 v
Well #9	109.13 v	T 43, R 27	126.1 v	T 45, R 27	125.3 v
Well #10	117.5 v				
Well #11	119.0 v	T 44, R 22	113.0 v	T 46, R 22	98.2 v
Well #12	117.4 v	T 44, R 23	118.8 v	T 46, R 23	107.1 v
		T 44, R 24	121.5 v	T 46, R 24	113.6 v
		T 44, R 25	122.9 v	T 46, R 25	114.7 v
		T 44, R 26	124.4 v	T 46, R 26	119.7 v
		T 44, R 27	125.9 v	T 46, R 27	124.4 v
				T 47, R 22	86.7 v
				T 47, R 23	95.5 v
				T 47, R 24	107.4 v
				T 47, R 25	114.8 v
				T 47, R 26	119.2 v
				T 47, R 27	123.1 v

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
1 MGD PUMPAGE

Input

Leakance	0.64	ma
Ground Water In Northeast	1.18	ma
Total Input	1.82	ma

Output

Ground Water Out Southwest			0.77 ma
Total Pumpage			1.05 ma
Wells # 4 & #8	1.05	ma	
		ma	
		ma	
		ma	
		ma	
Total Output			1.82 ma

Voltage

Well #2	115.5	v	T 43, R 22	116.5	v	T 45, R 22	102.9	v
Well #3	114.3	v	T 43, R 23	122.1	v	T 45, R 23	110.8	v
Well #4	104.7	v	T 43, R 24	124.1	v	T 45, R 24	115.2	v
Well #7	113.9	v	T 43, R 25	124.5	v	T 45, R 25	116.8	v
Well #8	111.6	v	T 43, R 26	125.1	v	T 45, R 26	119.3	v
Well #9	104.8	v	T 43, R 27	126.3	v	T 45, R 27	123.5	v
Well #10	112.3	v						
Well #11	112.9	v	T 44, R 22	111.7	v	T 46, R 22	96.5	v
Well #12	111.7	v	T 44, R 23	116.5	v	T 46, R 23	105.2	v
			T 44, R 24	120.2	v	T 46, R 24	111.2	v
			T 44, R 25	121.3	v	T 46, R 25	110.9	v
			T 44, R 26	122.8	v	T 46, R 26	112.3	v
			T 44, R 27	125.1	v	T 46, R 27	121.2	v
						T 47, R 22	85.1	v
						T 47, R 23	93.6	v
						T 47, R 24	104.7	v
						T 47, R 25	111.3	v
						T 47, R 26	114.9	v
						T 47, R 27	120.5	v

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
2 MGD PUMPAGE

Input

Leakance	0.90	ma
Ground Water In Northeast	1.86	ma
Total Input	2.76	ma

Output

Ground Water Out Southwest			0.75 ma
Total Pumpage			2.02 ma
Wells #4, #9, #10 & A	2.02	ma	
		ma	
		ma	
		ma	
		ma	
Total Output			2.77 ma

Voltage

Well #2	105.1	v	T 43, R 22	114.9	v	T 45, R 22	101.7	v
Well #3	103.8	v	T 43, R 23	121.6	v	T 45, R 23	108.9	v
Well #4	94.9	v	T 43, R 24	123.1	v	T 45, R 24	111.1	v
Well #7	105.6	v	T 43, R 25	123.3	v	T 45, R 25	110.2	v
Well #8	99.2	v	T 43, R 26	124.2	v	T 45, R 26	111.7	v
Well #9	94.9	v	T 43, R 27	124.9	v	T 45, R 27	121.0	v
Well #10	94.8	v						
Well #11	97.8	v	T 44, R 22	116.3	v	T 46, R 22	91.0	v
Well #12	98.6	v	T 44, R 23	109.5	v	T 46, R 23	99.9	v
			T 44, R 24	118.2	v	T 46, R 24	106.0	v
			T 44, R 25	116.5	v	T 46, R 25	102.5	v
			T 44, R 26	120.2	v	T 46, R 26	99.1	v
			T 44, R 27	123.9	v	T 46, R 27	117.4	v
						T 47, R 22	82.3	v
						T 47, R 23	90.1	v
						T 47, R 24	99.7	v
						T 47, R 25	105.2	v
						T 47, R 26	108.7	v
						T 47, R 27	117.1	v

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
5 MGD PUMPAGE

Input

Leakance	3.32	ma
Ground Water In Northeast	2.32	ma
Total Input	5.64	ma

Output

Ground Water Out Southwest			0.65 ma
Total Pumpage			4.99 ma
Wells #10, 4, 9, A, & B	2.49	ma	
Wells #C, D, E, F, & G	2.50	ma	
		ma	
Total Output			5.64 ma

Voltage

Well #2	78.9 v	T 43, R 22	118.8 v	T 45, R 22	114.3 v
Well #3	83.1 v	T 43, R 23	117.7 v	T 45, R 23	103.7 v
Well #4	71.4 v	T 43, R 24	116.0 v	T 45, R 24	101.3 v
Well #7	87.6 v	T 43, R 25	114.2 v	T 45, R 25	98.6 v
Well #8	75.8 v	T 43, R 26	110.3 v	T 45, R 26	93.5 v
Well #9	71.5 v	T 43, R 27	101.8 v	T 45, R 27	88.1 v
Well #10	71.5 v				
Well #11	72.8 v	T 44, R 22	117.2 v	T 46, R 22	81.2 v
Well #12	74.5 v	T 44, R 23	113.2 v	T 46, R 23	88.5 v
		T 44, R 24	109.2 v	T 46, R 24	93.4 v
		T 44, R 25	105.1 v	T 46, R 25	93.2 v
		T 44, R 26	95.4 v	T 46, R 26	71.7 v
		T 44, R 27	103.6 v	T 46, R 27	109.6 v
				T 47, R 22	71.6 v
				T 47, R 23	78.6 v
				T 47, R 24	86.4 v
				T 47, R 25	93.5 v
				T 47, R 26	96.9 v
				T 47, R 27	107.7 v

ANALOG MODEL
LEE COUNTY, FLORIDA
HYDROLOGY STUDY
7 MGD PUMPAGE

Input

Leakance	4.47	ma
Ground Water In Northeast	2.97	ma
Total Input	7.44	ma

Output

Ground Water Out Southwest		0.60	ma
Total Pumpage		6.87	ma
Wells #4, 9, 10,A & B	3.73 ma		
Wells #C, D, E, F & G	3.14 ma		
	ma		
Total Output		7.47	ma

Voltage

Well #2	66.3 v	T 43, R 22	116.4 v	T 45, R 22	105.5 v
Well #3	72.4 v	T 43, R 23	112.7 v	T 45, R 23	80.8 v
Well #4	58.1 v	T 43, R 24	111.8 v	T 45, R 24	81.5 v
Well #7	78.5 v	T 43, R 25	112.3 v	T 45, R 25	93.4 v
Well #8	64.4 v	T 43, R 26	110.7 v	T 45, R 26	95.0 v
Well #9	58.7 v	T 43, R 27	104.5 v	T 45, R 27	89.2 v
Well #10	59.1 v				
Well #11	59.1 v	T 44, R 22	111.0 v	T 46, R 22	80.5 v
Well #12	63.0 v	T 44, R 23	103.9 v	T 46, R 23	87.1 v
		T 44, R 24	101.1 v	T 46, R 24	86.2 v
		T 44, R 25	101.7 v	T 46, R 25	72.4 v
		T 44, R 26	98.4 v	T 46, R 26	58.7 v
		T 44, R 27	104.9 v	T 46, R 27	99.8 v
				T 47, R 22	70.5 v
				T 47, R 23	76.2 v
				T 47, R 24	81.2 v
				T 47, R 25	82.4 v
				T 47, R 26	87.9 v
				T 47, R 27	101 v

SUMMARY & CONCLUSIONS

It was found in this study that Eastern Lee County contains tremendous potential water supply for the inhabitants of the area.

It was found that local agricultural irrigation practices from the shallow aquifer can continue as presently practiced without deterioration of that water supply or without adverse influence of the underlying Tamiami aquifer system.

It was found in the study that municipal water supplies can be obtained from the Tamiami aquifer system being recharged by leakage from the shallow aquifer and by transmission through the aquifer transmissivity from more distant recharge areas. Evidence to date indicates that pumpage from the Tamiami aquifer system has not resulted in significant lowering of the shallow water table aquifer.

The analog model study indicates that minimum safe yield pumpage from the 26 well sites owned by Florida Cities Water Company has a minimum safe potential yield of 10 million gallons per day. It is further projected that the maximum potential yield for the well sites may be approximately 18.6 million gallons per day. Development in excess of 10 million gallons per day should proceed cautiously with appropriate monitoring of the water table in both the shallow aquifer and the deeper aquifer areas.

With appropriate respect for present and future planned land uses surrounding the well field area, there appears to be no significant problem with disposition of spray effluent from the sewage treatment plant properly condition. This is based on the assumption that loading rates to the

soil will not exceed the uptake capacity of vegetation in the area. It should also be possible to carry on much of the normal agricultural practices in the area especially the irrigation of gladioulus and pompons. Edible vegetables may need additional care.

Respectfully submitted,

Carl E. Nuzman, P. E.
Hydrology Consultant

mkh

APPENDIX A

AQUIFER PUMPING TEST
GREEN MEADOWS AREA
LEE COUNTY FLORIDA

SEPTEMBER, 1974

by

CARL E. NUZMAN, P. E.
HYDROLOGY CONSULTANT

for

FLORIDA CITIES WATER COMPANY
AND
G. A. C. UTILITIES, INC.
2112 Gulf Gate Drive
Sarasota, Florida

AQUIFER PUMPING TEST
GREEN MEADOWS AREA
LEE COUNTY, FLORIDA

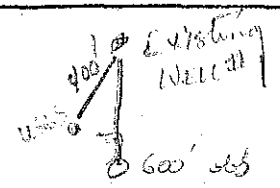
September, 1975

INTRODUCTION

As a result of extensive testing in 1972, exploratory drilling utilizing cable tool methods installing two (2) inch pipe to various depths, was conducted in the Green Meadows Area on a wide spacing basis. These data are included in the Appendix of this report for its information. Also included in the report is the water quality data and analysis available from that study.

As a result of the previous study, it was recommended that sites for future water supply wells be reserved from the Deed of Conveyance, when G.A.C. Corporation sold the property known as "The Green Meadows" area. Within the SW¼ of Sec. 33, a tract of land suitable for water treatment plant of approximately 900 feet square, was reserved from the Deed of Conveyance. Also, approximately 26 other one (1) acre sites were reserved for future well locations. These are shown on Plate 1 attached to the pocket of this report. It was at the water treatment plant site in the SW¼ of S. 33, that the first two (2) test production wells were constructed.

The purpose of this report is to give the findings of the aquifer tests performed on each of the test production wells in the Green Meadows Area.



AQUIFER TEST

On 23 July, 1974, construction was completed by Mr. Al Harmon, President of McGreggor Pump Company on the first production well in the Green Meadows Area at the Green Meadows water treatment plant site. The well was constructed utilizing cemented casing to the top of the sandstone unit at approximately 97 feet below ground level. Open hole was then drilled to the bottom of the unit to approximately 195 feet in depth. Very preliminary development work was accomplished utilizing the test pump. The initial pumping test was started about 5:00 p.m. on the 23rd of July at a rate of approximately 700 gpm. Minor adjustments in the pumping rate were made until the rate was established and stabilized at about 781 gpm for a 25-hour duration test. Periodic observation of water level decline in the test production well was made. A few observations were also made in a two (2) inch diameter piezometer located in the very corner of S. 33, approximately 600 feet south of Test Well No. 1. The total drawdown at the end of 25 hours or 1500 minutes of pumping was 37.3 feet. This measurement converts to a depth of 42.5' below the top of the well casing which is approximately 1.5 feet above the ground level, in the area. The specific capacity of the well was 21 gpm per foot of decline in water level.

All during the test pumping period, the well was developing some small amount of sand and silty material from the formation. At the end of 25 hours, a water sample was collected but still contained considerable amounts of clay and fine sand resulting in a higher turbidity reading than normal. A small hydrogen sulfide odor was detectable from the discharge pipe, but was not considered to be excessive. The transmissivity of Test Production Well No. 1 utilizing only the test well data, shows an initial value of 13,133 gpd per foot width of aquifer and increasing after 100 minutes of pumping to approximately 42,955 gpd per foot width of aquifer. After 1,000 minutes of pumping, there was no additional decline in water level observed during the test pumping period. It appeared the steady-state conditions had been reached and the decline in water level had stabilized to a constant level indicating substantial recharge to the aquifer system. Detailed observation of recovery of water level was made after termination of pumping. It appeared that the water level fully recovered within 1500 minutes which was equivalent to the test pumping period. It therefore appears that for one (1) test production well, the aquifer was not overpumped at a rate of 781 gpm.

On the 14th of August, 1974, the second test production well located some 862 feet in a southeasterly direction from the first well, across the water treatment plant site tract, was completed and testing was commenced. The No. 2 well was pumped at a rate of 948 gpm for the full 1500 minute period (25 hours). The drawdown at the end of this period was 39.96 feet which resulted in a well specific capacity of 23.7 gpm per foot of drawdown. This was slightly greater than Test Well No. 1. During the test pumping period observation in the decline in water level was also made in Test Well No. 1 which is identified as Piezometer No. 1 on the attached data. It was found that 10.32 feet decline of water level occurred in the No. 1 well while Test Well No. 2 was being pumped. The transmissivity in the early portion of the data from Test Well No. 2 was 23,175 gpd per foot width of aquifer, increasing to 35,100 gpd per foot width of aquifer in the period of time between 10 minutes and 100 minutes duration of pumping. After 500 minutes of pumping no additional decline in water level was observed in Test Well No. 2. The recovery of Test Well No. 2 appeared to be complete in approximately 1800 minutes which was just slightly greater than the 1500 minute pumping period. Since stable water level conditions were reached in the latter part of the pumping period, and the recovery was complete and nearly equivalent to the same period of pumping, the aquifer has substantial recharge.

The drawdown data for Test Well No. 1 and Test Well No. 2, while Test Well No. 2 was being pumped, was plotted to determine other characteristics. The apparent radius of Test Well No. 2 for transmissivity of 36,805 gpd per foot width of aquifer, approached 6 foot radius. It appears the effective diameter of this well, due to the type of well construction, is nearly 12 feet. Substantial quantities of loose sand and clay material were pumped from the well during the development period to develop this type of reaction. Thus, the apparent well efficiencies are in excess of 100% based upon the theoretical yield for the diameter of hole drilled. The radius of influence of each well is approximately 4,700 feet.

A water sample was taken from Test Well No. 2, for analysis purpose at the end of the pumping period. This well was better developed at this time, than Well No. 1 and the turbidity units were down to 1.4 Jackson units. Subsequent development work was made on Well No. 2 and Well No. 1, and the latest report run by Florida Cities Water Company laboratory, showed total dissolved solids had declined to 478 mg/l with zero turbidity. A slight odor from hydrogen sulfide could be detected.

As a supplement to the above water supply investigation, an exploratory hole of four (4) inch diameter was drilled through the "so-called" sandstone unit into the upper Hawthorn unit. The top of the upper Hawthorn at the site of these wells, was found at a depth of 321 feet. Drilling continued to approximately 345 feet from which pumping and a water sample obtained for analysis. The results of these tests have not yet been returned to the Hydrologist for inclusion in this report. Although it appeared the water quality from the upper Hawthorn at this location would be satisfactory for public water supply use, the production potential appeared to be minimal.

SUMMARY AND CONCLUSIONS

Two (2) test production wells of nominal 16 inch diameter with casing cemented to the top of the sandstone unit, approximately 100 feet below land surface, and open hole construction continued to approximately 200 feet below land surface, was utilized at the water treatment plant site in the Green Meadows Area.

The Green Meadows water treatment plant site is located approximately nine (9) miles directly south of the old Buckingham Air Field and approximately 8.5 miles east of Tamiami Trail. This is fully described as being located in the SW¼ of the SW¼ of S. 33, T.45S., R.26E., in Lee County, Florida.

Test Well No. 1 was pumped for 25 hours at a rate of 781 gpm with a well specific capacity of 21 gpm per foot of drawdown. Well No. 2 was test pumped at a rate of 948 gpm for 25 hours period with a well specific capacity of 23.7 gpm per foot of drawdown. Prior to the test, well development work was conducted at rates in excess of 1100 gpm from a 50 foot pumping level.

Coefficients of transmissivity varied from a low of 13,133 gpd per foot, during the early portion of the development in Test Well No. 1, to a high of 51,546 gpd per foot for the apparent recovery of Test Well No. 1. Transmissivities for Test Well No. 2 started out at 23,175 gpd per foot during the early data and increased to 35,100 gpd per foot during the latter stages of the pumping. Transmissivity during recovery of Test Well No. 2 appeared to approach 36,805 gpd per foot width of aquifer. This value was considered nominal and the value to be used in subsequent computations involving simulation of the aquifer.

The apparent coefficient of storativity due to confinement of the aquifer appeared to be .0016 for the duration of the test conducted on Well No. 2.

A review of the water quality analysis shows that the magnesium carbonate hardness is much less in this water than that found in the upper Hawthorn aquifer along the west coast of Florida. Therefore, this water should be less complex chemically and not require as much lime for a conventional lime softening

treatment. Also, the water should not require recarbonization after lime softening.

The maximum recommended pumping rate for these two wells for a continuous service production of water, should not exceed 700 gpm each. This is the equivalent of one (1) million gallons per day per well, for a total additional supply of 2 mgd.

From the personal knowledge of this Hydrologist, Green Meadows test production wells No. 1 and No. 2, are the largest capacity, with the highest specific capacity, and the best quality of water of any wells presently known to exist in Lee County, Florida.

APPENDIX

THE LAYNE 1500 AQUIFER TEST

CLIENT: Florida Cities Water Company DATE: 14 August '74 JOB NO.: A-191-C

The Layne Aquifer Test is designed to obtain sufficient data to analyze the operation of a single production water supply well from the aquifer tested for the existing environmental conditions. The test is designed to keep costs to a minimum while obtaining all pertinent data normally used. There could be special conditions in which the number and array of piezometers would be increased and pumping time increased, for example to determine the leakage rate of a stream bed. However a majority of ground-water tests can be handled quickly and efficiently with the Layne Aquifer Test. If a multiple well system, in which a significent portion of potential yield of the aquifer system may be developed, a more complete hydrologic study is required. In this case, the Layne Aquifer Test is a necessary part of the data collection process and may be repeated at intervals depending upon the area involved. Wells in deep multiple aquifers have special problems and the Hydrology Consultant should be advised prior to the test.

The objective of the Layne 1500 minute aquifer test is to provide sufficient data to more fully analyze the aquifer formation coefficients while verifying the quality of well construction. This test may supplement or follow the exploratory Layne 500 minute aquifer test and may be referred to by others as a new well acceptance test. These data can be converted to machine language for computer processing. The aquifer coefficients of transmissivity and storativity will be computed. The well efficiency, apparent safe well yield, and radius of influence will be evaluated. There may follow suggested changes in well design and spacing to more efficiently harvest the available aquifer yield. A recommended well and well screen design can be given if requested. Enclose this completed form with the recorder charts an electric log trace, sieve analysis of both the formation material and gravel pack, if used, and water quality analysis, if available, for evaluation.

TEST WELL LOCATION Green Meadows Test Well No. 2, located approximately 700 feet east and 100 feet north of the S.W. corner of Section 33, Twp 45S, Range 26 East in Lee County, Florida.

TEST WELL CONSTRUCTION

1. Depth from land surface _____ feet. Total depth from casing _____

2. Diameter of drill hole 16 inches. Drilling method Rotary

3. Material in well	LENGTH FT. IN.	DIA. IN.	GAGE NO.	WALL THICK-NESS IN.	MATERIAL	TYPE	NO.
Screen	___ ___	_____	_____	Open Hole	Construction	Shutter Keystone	
Inner Casing	___ ___	_____	_____	_____	_____	Welded Screwed	Openings
Outer Casing	___ ___	_____	_____	_____	_____	Welded Screwed	

4. Gravel pack size None amount of gravel _____

5. Height of casing above ground level 1.60 feet

STATE OF FLORIDA

WATER WELL CONTRACTOR'S NOTIFICATION
OF CONSTRUCITON OR REPAIR OF A WATER WELL
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF INTERIOR RESOURCES
505 Larson Building, Tallahassee, Florida 32304
Telephone: (904) 488-8476

Permit No. 9712 WSW

Owner's Well Identification J.M. #1
USGS #L1966

No 37305

GREEN MEADOWS #2

1. OWNER: FLA. Cities Water Co
12 Gulf Dr. Sarasota Fla
Name / Address / City / State

2. LOCATION OF WELL: Alico Grade Rd.
Street Address/Road
F.M. Myers Lee
City / County
Green Meadows
Subdivision / Lot No.
33 45.5 26E
Section / Township / Range

3. PURPOSE OF WELL
Domestic / Industrial / Irrigation / Stock / X Public Supply / Other

4. TYPE OF WORK
X New Well / Deepening / Plugging / Reconditioning / Other

5. QUALITY
X Clear / Colored / Sulfur / Salty / Other
CHECK TEST MADE
None / Bacteria / Chemical
Chloride 150 PPM (Check X if test was for sodium chloride)
Temperature °F
Test By: County Health Dept. / State Health Dept. / X U.S.G.S. / Other Layne Bowler
Name Kenny City
Address
Well Disinfected X Yes / No

6. EQUIPMENT
X Rotary / Jet / Cable Tool / Reverse Rotary / Other

7. GROUT: None / X Cement / Other

Describe and give number of bags (94 lb.)	From (ft)	To (ft)
105 Bags w/ 6 gal per Bag	-93	Surface
Pumped w/ Tremmy Pipe		
Bottom to top		

8. CASING AND LINER PIPE

Diameter (inches)	Kind	From (ft)	To (ft)
16"	PVC Steel	-95	+2

(Check one) Threaded & Coupled / X Welded Only / T & C & Welded / Other

9. WATER LEVEL
Water level after well completed 3.41 feet
Above / X below land surface
Well Flowing: Yes / No Flow gal/min

10. SCREENS

Make	Materials	Diameter (in)	Slot Size	Location (ft) Below Surface From (ft)	To (ft)

11. UPPER END OF WELL
Pump Installed / Valve / X Cap / Other

12. PUMPING TEST
Date 8-13-74 X Test Pump / Permanent Pump
Measure point is Top of Casing
which is 2 feet X above / below land surface
Static water level 3.41 feet above / X below measure point
4498
Maximum Drawdown feet below measure point
Discharge at maximum drawdown 950 gal/min
After 24 hours

13. PUMP INSTALLED
Type Make Model No.
Motor Power Make H.P.
Capacity Gal/min at ft. of total dynamic head
No. of bowls or stages
Pump setting feet

14. WELL LOG:

Well bore (in)	Depth (feet) From	To	Note each type of material, producing zones, & cavities if any. Give description at not less than 20 foot intervals and at changes
	0	4	SAND
	4	10	SHELL & SAND
	10	22	SHELL & SANDSTONE Layers
	22	36	SANDSTONE TAN & GRAY
	36	47	CLAY & SHELL
	47	72	CLAY Green & Sandy
	72	94	SANDSTONE & SHELL LAYERS
	94	105	LIMESTONE (WHITE)
	105	119	LIMESTONE (GREEN)
	119	131	LIMESTONE (GREEN) & SHELL
	131	145	SANDSTONE & SHELL
	145	150	CLAY & BALL BEARING - SAND
	150	167	CLAY & SANDSTONE LAYERS
	167	184	CLAY (BLUE & GREEN)
	184	185	LIMESTONE (WHITE)
			Back Fill to 160'

15. CONTRACTOR'S CERTIFICATION
This work was done under my jurisdiction and this report is true to the best of my knowledge and belief. The work commenced on 7-25 and was completed on 8-2

McGregor Pump Co. 1018
Contractor / License Number
Al Harmon 6034 McGregor
Signature of Representative / P.O. Box or Street
Ft. Myers Lee Fla.
City / County / State
813 481-0033 Love Joy & Harmon
Phone Number / Driller

LAYNE 1500 AQUIFER TEST

TEST #2

	Test Well	Piezometer 1.	Piezometer 2.
Distance from T. W. to Pz.	xxxx	860 Feet	-
Depth to static water	4.90	4.92	
Height above ground	1.60	1.60	

Time of Day	Elapsed Time In Minutes	Drawdown	Drawdown	Drawdown	Remarks
10:49	0	***	*0*	***	
10:50	1	19.06	0		
	2	23.45	.02		
	3	26.36	.08		
	4	26.86	.16		
	5	28.04	.26		
	7	29.45	.47		
	9	30.84	.68		
	11	31.56	.88		
	15	32.40	1.25		* 948 gpm
	20	33.44	1.66		
	25	33.93	2.01		
	30	34.57	2.33		*
	35	35.19	2.62		
	40	35.56	2.37		
	45	36.07	3.20		
	50	36.18	3.33		
	60	36.42	3.74		* 948 gpm
	70	37.28	4.09		
	80	37.81	4.43		
	90		4.72		
	100	38.23	4.99		
	120	38.56	5.46		*
	150	39.98	6.03		
	180	39.26			*
	210		6.95		
	240	39.41	7.15		*
	270		7.44		
	300	40.62	7.69		* 948 gpm
	330	42.01	7.92		
	360				*
	390	38.74	8.08		
	420				*
	450				
	480	40.22			*
	510				
	540				*
	600	40.31	9.14		
	660		9.33		*
	720	40.28			
	780	40.39	9.53		*
	840	40.31	9.66		
	900				*
	1020				*
	1140				*
	1260	39.99	10.13		* 948 gpm
	1380				*
	1500	39.96	10.32		*

MEASURE AND RECORD PUMPING RATE

Well Specific Capacity 23.7 gpm/ft. d.d.

DRILLERS TEST HOLE LOGS

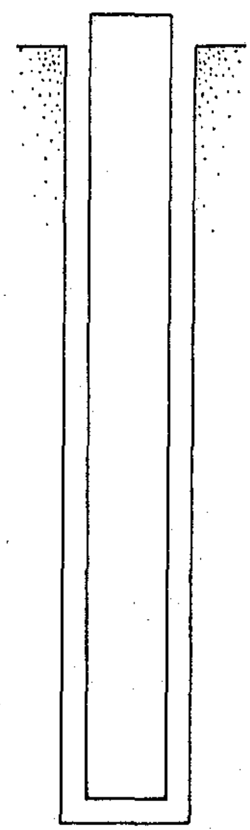
Also L-1961 by USGS Florida

PIEZOMETER NO. 1			
Surface Elevation		Well log	
From	To	Description of Material	Thickness

PIEZOMETER NO. 2			
Surface Elevation		Well log	
From	To	Description of Material	Thickness

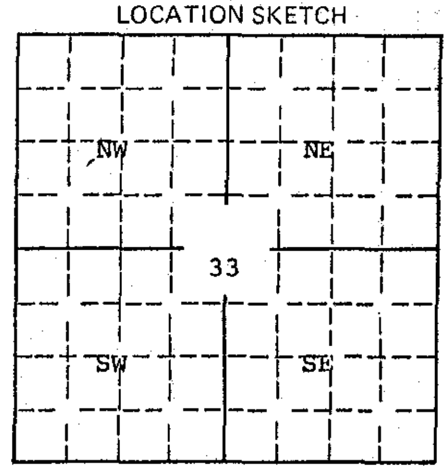
ELECTRIC LOG TEST HOLES AND ATTACH COPY OF TRACES TO THIS FORM.

TEST WELL NO.			
Surface Elevation		Well log	
From	To	Description of Material	Thickness



WELL SKETCH

LOCATION SKETCH



SW ¼ of the SW ¼

Section No. 33

Township 45 N/S

Range 26 E/W

County Lee

State Florida

Country USA

LAYNE 1500 AQUIFER TEST

STOP TEST PUMP AND OBSERVE RECOVERY

4.94 3.33 STATIC

860'

Time of Day	Elapsed Time In Minutes	Test Well Water Level	PZ. No. 1 Water Level	PZ. No. 2 Water Level	Remarks
	0	44.90	13.65		(Last Reading Before Stop)
	5	20.28	13.37		
	10	17.60	12.84		
	15	16.22	12.33		
	20	15.30	11.92		
	30	13.96	11.23		
	40	13.11	10.68		
	50	12.40	10.21		
	60	11.81	9.82		
	90	10.55	8.84		
	120	9.68	8.11		
	150	9.12			
	180	8.62	7.11		
	240				
	300	7.41	6.00		
	360	7.00	5.62		
	420		5.30		
	480		5.05		
	1550		3.66		
	Start		3.32		

General Field Instructions: Select location of the test well by appropriate means such as test hole drilling, boring or geophysical methods. The test well can be of either temporary or permanent type of construction. A temporary test well need not be efficient to obtain good results. The test well must be open or screened in all aquifer horizons to be tested. Observation of drawdown in piezometers is most important for a good analysis.

The location of piezometer number 1 shall be in a direction parallel to the flow path of the aquifer system, or axis of the alluvial valley, at a distance from the test well approximately equal to the depth of the test well but not greater than 100 feet. The test hole should be electric logged if possible prior to the installation of the piezometer pipe, and aquifer samples saved for later laboratory sieve analysis if needed. The piezometer pipe must be open to the same aquifer horizons as the test well and of the same depth. The location of piezometer number 2 shall be located on approximately the same line from the test well as piezometer 1, at a distance four (4) times the depth of the test well but not greater than 400 feet as measured from the test well. This piezometer shall be installed in the same manner as previously given.

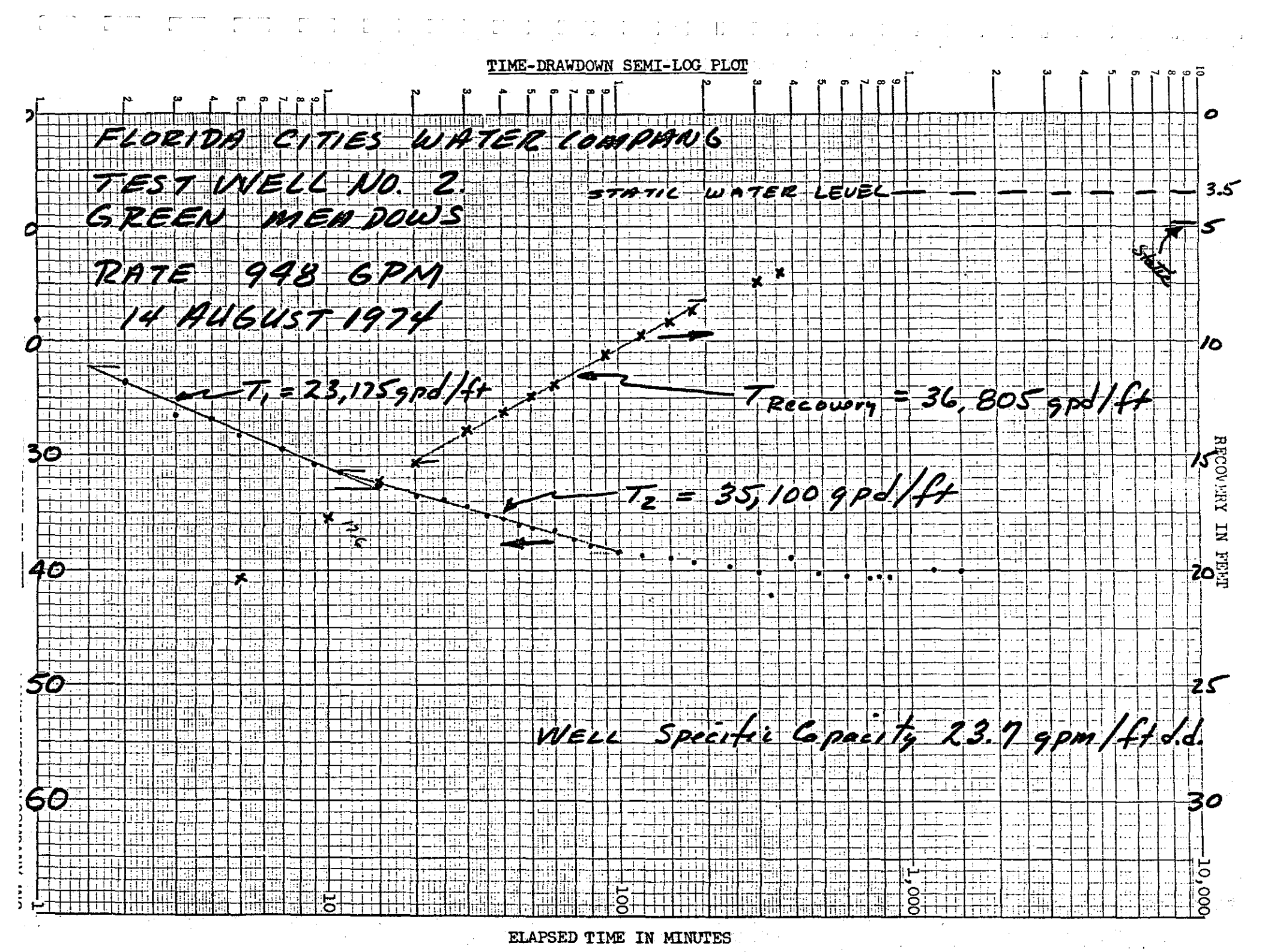
The piezometers will be equipped with automatic water level recording devices to monitor the drawdown and recovery of water level. The data on drawdown and the first 30 minutes of recovery will be read and recorded on this form from the recorder pen position. BE SURE THE FLOAT AND COUNTERWEIGHT ARE FREE TO MOVE to obtain correct readings. At the conclusion of the test, the recorders will be left in place to operate for at least four days to observe full recovery or diurnal fluctions of the static water level.

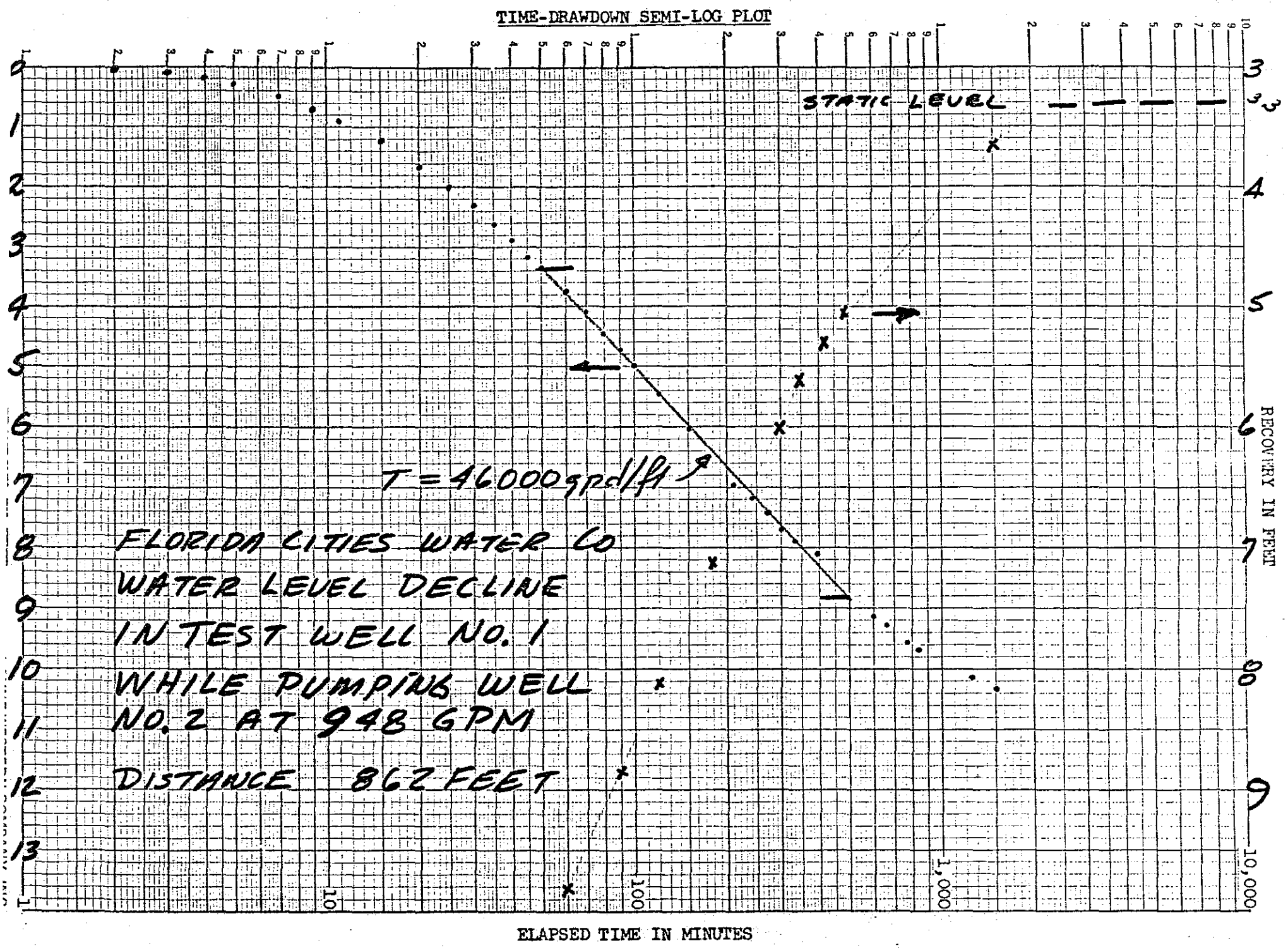
A test pump will be installed in the test well of sufficient capacity to pull the water level down in the test well a depth at least equal to 10% of the saturated thickness but not greater than 70%. A 25% drawdown is considered normal. The pump shall be operated at a constant rate as far as possible for 1500 minutes. Suitable measuring equipment will be used to determine the pumping rate.

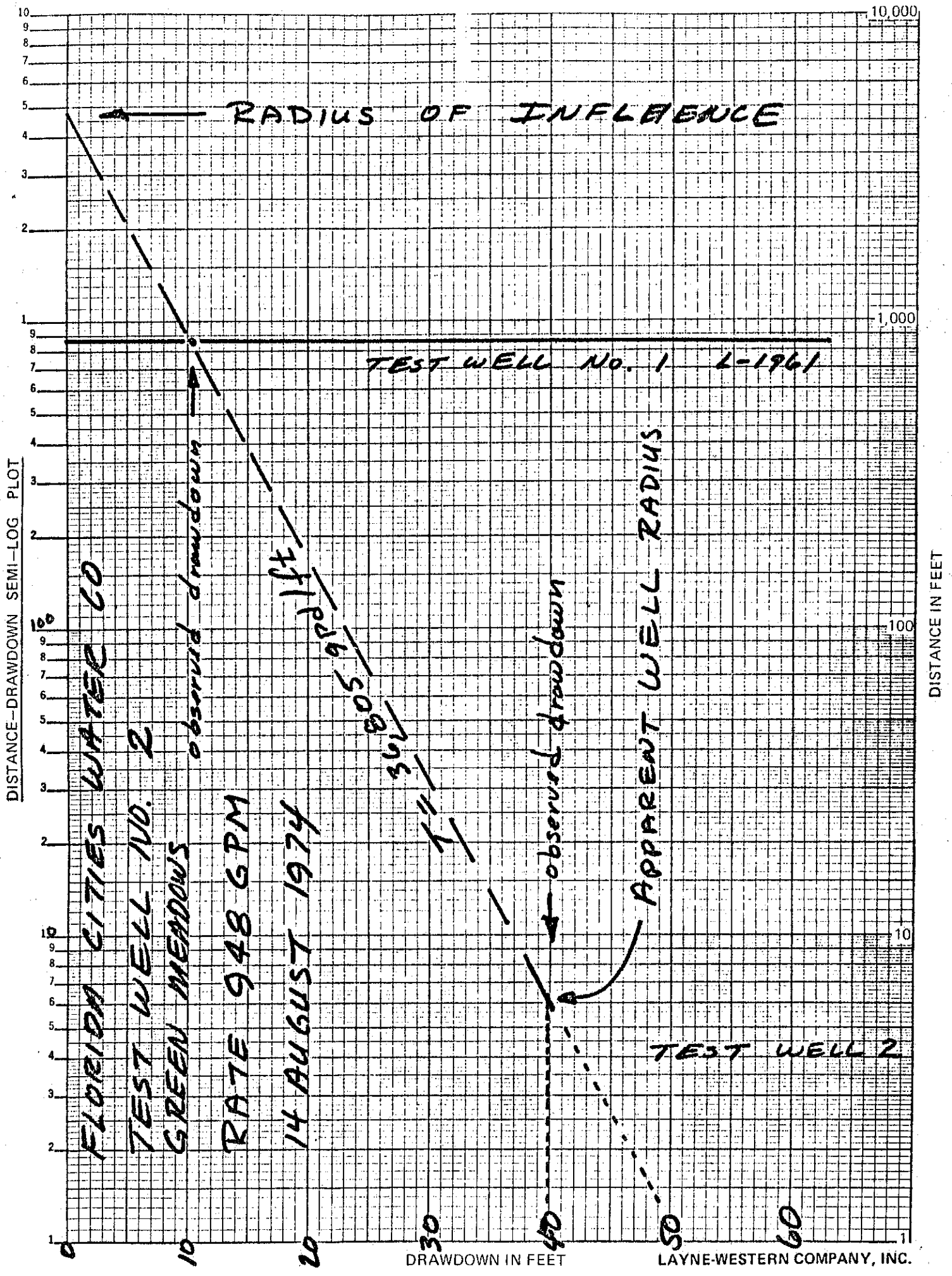
NOTE: COLLECT WATER SAMPLE NEAR END OF PUMPING TEST FOR ANALYSIS.

CHECK RECORDERS FOR PROPER OPERATION JUST PRIOR TO LEAVING JOB SITE.

FROM RECORDER CHARTS TOTAL RECOVERY OCCURRED IN 1800 MINUTES.


TIME-DRAWDOWN SEMI-LOG PLOT
FLORIDA CITIES WATER COMPANY
TEST WELL NO. 2.
GREEN MEADOWS
RATE 948 GPM
14 AUGUST 1974
STATIC WATER LEVEL
T1 = 23,175 gpd/ft
T Recovery = 36,805 gpd/ft
T2 = 35,100 gpd/ft
WELL Specific Capacity 23.7 gpm/ft d.d.
RECOVERY IN FEET
ELAPSED TIME IN MINUTES


TIME-DRAWDOWN SEMI-LOG PLOT
STATIC LEVEL
T = 46000 gpd/ft
FLORIDA CITIES WATER CO
WATER LEVEL DECLINE
IN TEST WELL NO. 1
WHILE PUMPING WELL
NO. 2 AT 948 GPM
DISTANCE 862 FEET
RECOVERY IN FEET
ELAPSED TIME IN MINUTES
1
10
100
1,000
10,000


RADIUS OF INFLUENCE
TEST WELL NO. 1 2-1961
FLORIDA CITIES WATER CO
TEST WELL NO. 2
GREEN MEADOWS
RATE 948 GPM
14 AUGUST 1974
observed drawdown
305 gpd/ft
3 1/2"
1 1/2"
observed drawdown
APPARENT WELL RADIUS
TEST WELL 2
DISTANCE–DRAWDOWN SEMI–LOG PLOT
DISTANCE IN FEET
DRAWDOWN IN FEET
LAYNE-WESTERN COMPANY, INC.

THE LAYNE 1500 AQUIFER TEST

CLIENT: FLORIDA CITIES WATER COMPANY DATE: 23 July, 1974 JOB NO.: A-191-C

The Layne Aquifer Test is designed to obtain sufficient data to analyze the operation of a single production water supply well from the aquifer tested for the existing environmental conditions. The test is designed to keep costs to a minimum while obtaining all pertinent data normally used. There could be special conditions in which the number and array of piezometers would be increased and pumping time increased, for example to determine the leakage rate of a stream bed. However a majority of ground-water tests can be handled quickly and efficiently with the Layne Aquifer Test. If a multiple well system, in which a significent portion of potential yield of the aquifer system may be developed, a more complete hydrologic study is required. In this case, the Layne Aquifer Test is a necessary part of the data collection process and may be repeated at intervals depending upon the area involved. Wells in deep multiple aquifers have special problems and the Hydrology Consultant should be advised prior to the test.

The objective of the Layne 1500 minute aquifer test is to provide sufficient data to more fully analyze the aquifer formation coefficients while verifying the quality of well construction. This test may supplement or follow the exploratory Layne 500 minute aquifer test and may be referred to by others as a new well acceptance test. These data can be converted to machine language for computer processing. The aquifer coefficients of transmissivity and storativity will be computed. The well efficiency, apparent safe well yield, and radius of influence will be evaluated. There may follow suggested changes in well design and spacing to more efficiently harvest the available aquifer yield. A recommended well and well screen design can be given if requested. Enclose this completed form with the recorder charts an electric log trace, sieve analysis of both the formation material and gravel pack, if used, and water quality analysis, if available, for evaluation.

TEST WELL LOCATION Green Meadows Test Well No. 1 located approximately 600 feet north and 100 feet east of the SW corner of S. 33, T.45S., R. 26E. in Lee County, Florida.

TEST WELL CONSTRUCTION

1. Depth from land surface _____ feet. Total depth from casing _____

2. Diameter of drill hole _____ inches. Drilling method _____

3. Material in well	LENGTH FT. IN.	DIA. IN.	GAGE NO.	WALL THICK-NESS IN.	MATERIAL	TYPE	NO.
Screen		OPEN HOLE CONSTRUCTION				Shutter Keystone	
Inner Casing						Welded Screwed	Openings
Outer Casing						Welded Screwed	

4. Gravel pack size none amount of gravel _____

5. Height of casing above ground level 1.60 feet.

STATE OF FLORIDA

WATER WELL CONTRACTOR'S NOTIFICATION
OF CONSTRUCTION OR REPAIR OF A WATER WELL

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF INTERIOR RESOURCES
505 Larson Building, Tallahassee, Florida 32304
Telephone: (904) 488-4476

Permit No. 9713 WSW
Owner's Well Identification F.M. #2
USGS 1-1961
No 37304
GREEN MEADOWS #1

1. OWNER Florida Cities Water Co.
112 Gulf Name Pine Dr. Address SARASOTA City FLA State

2. LOCATION OF WELL Alico Grade Rd. Street Address/Road
Ft Myers City Lee County
Green Meadows Subdivision Lot No.
33 Section T 45S Township 26E Range

3. PURPOSE OF WELL
Domestic Industrial Irrigation Stock X Public Supply Other

4. TYPE OF WORK
X New Well Deepening Plugging Reconditioning Other

5. QUALITY
X Clear Colored Sulfur Salty Other

CHECK TEST MADE
None Bacteria Chemical
Chloride ppm (Check X if test was for sodium chloride)
Temperature °F
Well Disinfected Yes No
Test By: County Health Dept. State Health Dept. X U.S.G.S. Other LAYNE-Bowler
Name KANSAS City Address

6. EQUIPMENT
X Rotary Jet Cable Tool Reverse Rotary Other

7. GROUT None X Cement Other

Describe and give number of bags (94 lb.)	From (ft)	To (ft)
Reinforced bottom top		
80 Bags 6 yd RT per bag	96'	36'
Natural (delivery) Cement	36'	Surface

8. CASING AND LINER PIPE

Diameter (inches)	Kind	From (ft)	To (ft)
16"	blk Steel	96'	+2

(Check One) Threaded & Coupled X Welded Only T & C & Welded Other

9. WATER LEVEL
Water level after well completed 2.91 feet
Above X below land surface
Well Flowing Yes No Flow gal/min

10. SCREENS

Make	Materials	Diameter (in)	Slot Size	Location (ft) Below Surface From (ft)	To (ft)

11. UPPER END OF WELL
Pump Installed Valve Cap Other USGS Recorder

12. PUMPING TEST
Date 7-23 X Test Pump Permanent Pump
Measure point is TOP of CASING
which is 2 feet X above below land surface
Static water level 2.91 feet above X below measure point
40.54
Maximum drawdown feet below measure point
Discharge at maximum drawdown 900 gal/min
After 24 hours

13. PUMP INSTALLED
Type Make Model No.
Motor Power Make H.P.
Capacity Gal/min at ft. of total dynamic head
No. of bowls or stages
Pump setting feet

14. WELL LOG

Well bore (in)	Depth (feet) From	To	Note each type of material, producing zones, & cavities if any. Give description at not less than 20 foot intervals and at changes
	0	3	SAND
	3	20	SHELL & Rock Layers
	20	25	HARD Rock (SANDSTONE) TAN
	25	27	SHELL
	27	41	SANDSTONE (VERY HARD) TAN & Gray
		36'	DRINKING CAVITY
	41	67	GREEN CLAY
	67	87	SAND & SHELL (small returns)
	87	90	SAND & SHELL & CLAY
	96	92	SAND STONE
	92	95	SHELL & SAND
	95	162	HARD SAND STONE
	162	122	LIMESTONE (WHITE)
	122	142	SHELL & LIMESTONE (GREEN)
	142	162	SANDSTONE & SHELL
	162	164	CLAY (GREEN)
	164	167	LIMESTONE (TAN & GREEN)
	167	172	CLAY & LIMESTONE STREAKS
	172	177	WHITE CLAY
	177	182	WHITE CLAY & LIMESTONE
	182	187	LIMESTONE (WHITE)
			BACK FILLED TO 160'

15. CONTRACTOR'S CERTIFICATION
This work was done under my jurisdiction and this report is true to the best of my knowledge and belief. The work commenced on 7-6 and was completed on 7-?

McGregor Pump Co. 0019
Contractor License Number
Signature of Representative
601 Harmon 6034 McGregor
P.O. Box or Street
Ft Myers Lee Fla
City County State
813-481-0033 Leave Soy & Harmon
Phone Number Directions

LAYNE 1500 AQUIFER TEST

TEST #1

	Test Well	Piezometer 1.	Piezometer 2. 600#
Distance from T. W. to Pz.			
Depth to static water	5.25		4.91
23 July, 1974			2" Dia.

Time of Day	Elapsed Time In Minutes	Drawdown	Drawdown	Drawdown	Remarks
17:00	0	***	***	***	
	1				700
	2				
	3				
	4				692
	5				
	7				
	9				770
	11				
	15				* 781
	20				
	25				
	30				* 790
17:35	37	28.70			
	42	28.87			
	45				
	50	30.17			
	60	32.50			* 772
	70	32.96			
	80	33.66			
	90	34.00			
18:50	110	34.42		7.42	
	140	34.75			* 776
	150	35.00			
	180	35.42			* 781
	210	36.10		9.59	
	240	35.92			* 790
	270	36.06			781
	300	36.20			*
	330				
	360	36.48			*
	390				
	420				*
	450				
	480				*
	510				
	540				*
	600				
	660				*
	720				
	780				*
	840				
09:30	990	37.00			*
	1020	37.00		12.13	*
	1140	37.17			*
	1260	37.46		12.46	*
	1380	37.42			*
	1500	37.29			*

*MEASURE AND RECORD PUMPING RATE

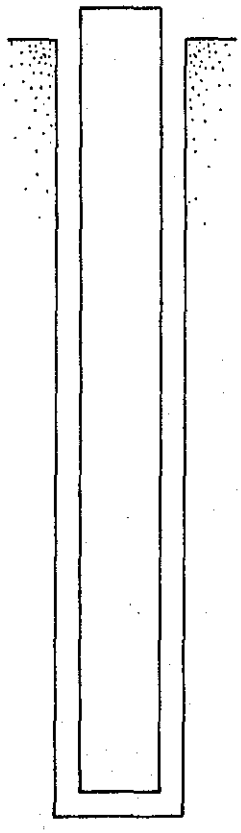
DRILLERS TEST HOLE LOGS

PIEZOMETER NO. 1			
Surface Elevation		Well log	
From	To	Description of Material	Thickness

PIEZOMETER NO. 2			
Surface Elevation		Well log	
From	To	Description of Material	Thickness

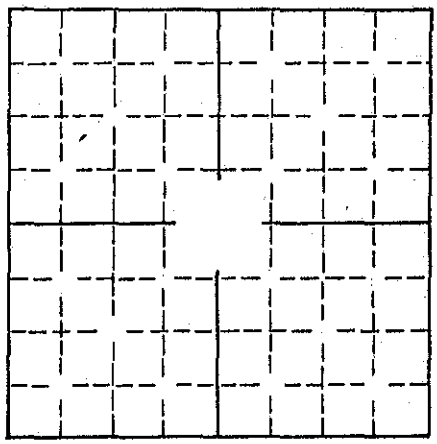
ELECTRIC LOG TEST HOLES AND ATTACH COPY OF TRACES TO THIS FORM.

TEST WELL NO.			
Surface Elevation		Well log	
From	To	Description of Material	Thickness



WELL SKETCH

LOCATION SKETCH



_____¼ of the_____, ¼

Section No._____

Township_____N/S

Range_____E/W

County_____

State_____

Country_____

LAYNE 1500 AQUIFER TEST

STOP TEST PUMP AND OBSERVE RECOVERY

37.29 + 5.25 = 42.54

12.46 + 4.91 = 17.37

2" Pz.

Time of Day	Elapsed Time In Minutes	Test Well #1 Water Level	PZ. No. 1 Water Level	PZ. No. 2 Water Level	Remarks
	0	42.54		17.37	(Last Reading Before Stop)
	5	17.86			
	10	15.75			
	15	15.04			
	20	14.58		13.04	
	30	13.37			
	40	12.69		11.75	
	50	12.14			
	60	11.67		10.91	
	90	10.62		10.25	
	120	9.93			
	150	9.37		9.02	
	180	8.91		8.21	
	240				
	300				
	360				
	420				
	480				

General Field Instructions: Select location of the test well by appropriate means such as test hole drilling, boring or geophysical methods. The test well can be of either temporary or permanent type of construction. A temporary test well need not be efficient to obtain good results. The test well must be open or screened in all aquifer horizons to be tested. Observation of drawdown in piezometers is most important for a good analysis.

The location of piezometer number 1 shall be in a direction parallel to the flow path of the aquifer system, or axis of the alluvial valley, at a distance from the test well approximately equal to the depth of the test well but not greater than 100 feet. The test hole should be electric logged if possible prior to the installation of the piezometer pipe, and aquifer samples saved for later laboratory sieve analysis if needed. The piezometer pipe must be open to the same aquifer horizons as the test well and of the same depth. The location of piezometer number 2 shall be located on approximately the same line from the test well as piezometer 1, at a distance four (4) times the depth of the test well but not greater than 400 feet as measured from the test well. This piezometer shall be installed in the same manner as previously given.

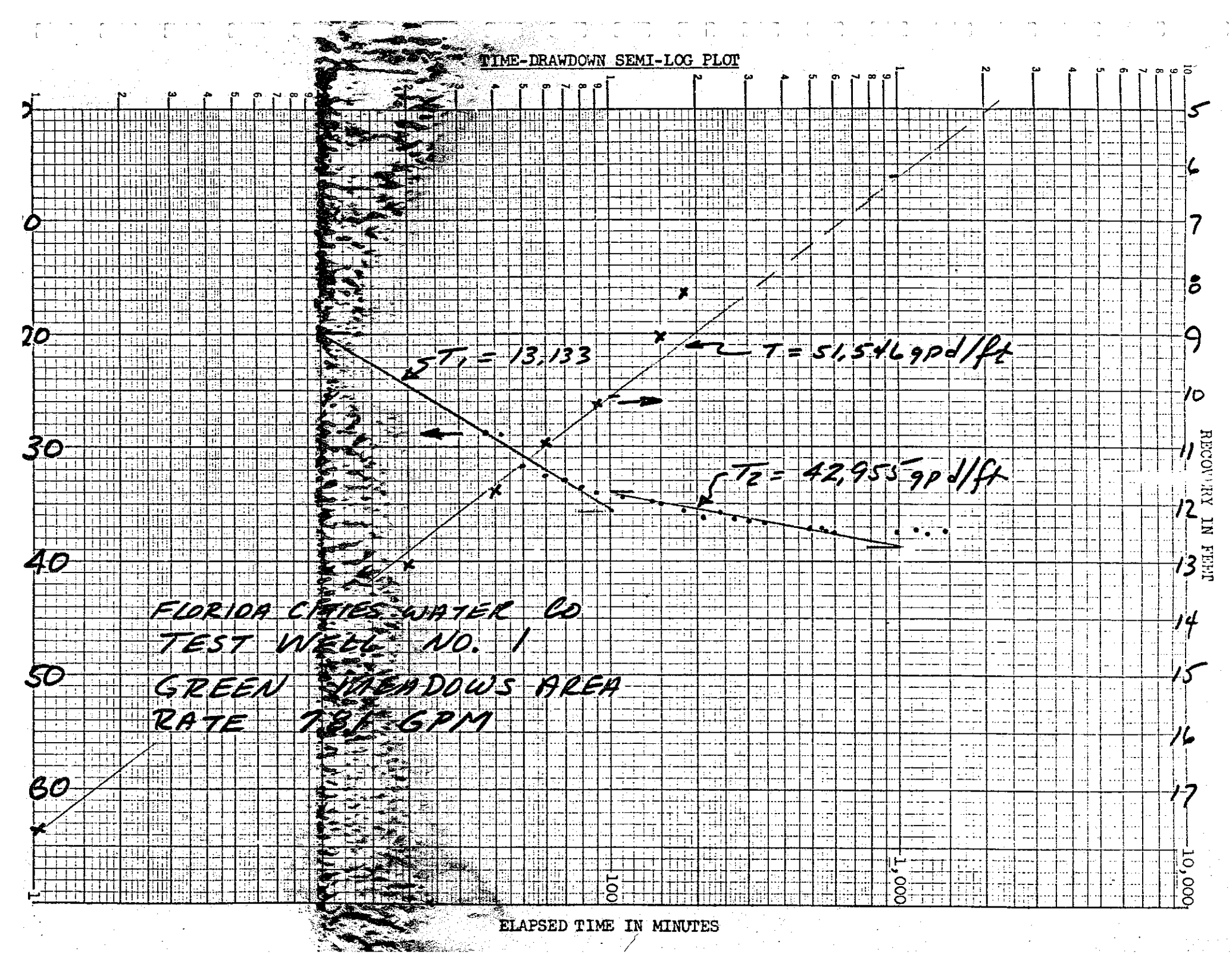
The piezometers will be equipped with automatic water level recording devices to monitor the drawdown and recovery of water level. The data on drawdown and the first 30 minutes of recovery will be read and recorded on this form from the recorder pen position. BE SURE THE FLOAT AND COUNTERWEIGHT ARE FREE TO MOVE to obtain correct readings. At the conclusion of the test, the recorders will be left in place to operate for at least four days to observe full recovery or diurnal fluctions of the static water level.

A test pump will be installed in the test well of sufficient capacity to pull the water level down in the test well a depth at least equal to 10% of the saturated thickness but not greater than 70%. A 25% drawdown is considered normal, The pump shall be operated at a constant rate as far as possible for 1500 minutes. Suitable measuring equipment will be used to determine the pumping rate.

NOTE: COLLECT WATER SAMPLE NEAR END OF PUMPING TEST FOR ANALYSIS.

CHECK RECORDERS FOR PROPER OPERATION JUST PRIOR TO LEAVING JOB SITE.

FROM RECORDER CHARTS TOTAL RECOVERY OCCURRED IN 1500 MINUTES.


TIME-DRAWDOWN SEMI-LOG PLOT
T = 51,546 gpd/ft
T1 = 13,133
T2 = 42,955 gpd/ft
FLORIDA CITIES WATER CO
TEST WELL NO. 1
GREEN MEADOWS AREA
RATE TEST GPM
RECOVERY IN FEET
ELAPSED TIME IN MINUTES
0
20
30
40
50
60
100
1,000
10,000

STANDARD WATER ANALYSIS REPORT

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305/843-1661

Report to: LAYNE-WESTERN CO. INC.

Date: July 27, 1974

Report Number: 9063

Appearance: turbid

Sampled by: client

Identification: GAC Fla Cities Util
Green Meadows TW 1 7/23/74

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	Data Significance	p.p.m.	Determination	Data Significance	p.p.m.
Total Dissolved Solids, @ 105°C.	x.	523	Total Hardness, as $CaCO_3$	x.	240
Phenolphthalein Alkalinity, as $CaCO_3$	x.	0	Calcium Hardness, as $CaCO_3$	x.	196
Total Alkalinity, as $CaCO_3$	x.	246	Magnesium Hardness, as $CaCO_3$	x.	44
Carbonate Alkalinity, as $CaCO_3$	x.	0	Calcium, as Ca	x.	78
Bicarbonate Alkalinity, as $CaCO_3$	x.	246	Magnesium, as Mg	.x	11
Carbonates, as CO_3	x.	0	Sodium, as Na	x.	44
Bicarbonates, as HCO_3	x.	300	Iron, as Fe	.x	0.1
Hydroxides, as OH	x.	0	Manganese, as Mn	.x	0
Carbon Dioxide, as CO_2	x.	20	Copper, as Cu	.x	0
Chloride, as Cl	x.	51	Silica, as SiO_2	x.	24
Sulfate, as SO_4	x.	35	Color, Standard Platinum Cobalt Scale		0
Fluoride, as F	.x	0.94	Odor Threshold	x.	0
Phosphate, as PO_4	.x	3.6	Turbidity, Jackson Units	x.	95
pH (Laboratory)	.x	7.4			
pHs	.x	6.9			
Stability Index	.x	6.4			
Saturation Index	.x	0.5			

Signed: Judy Morley
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1 – p.p.m. = mg/l)

(913)

(183)

STANDARD WATER ANALYSIS REPORT

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305/843-1661

Well #2

Report to: Florida Cities Water Co.

Appearance: clear

Date: August 15, 1974

Sampled by: client

Report Number: 9163

Identification: GREEN MEADOWS WELL Well #2 (off Alico Road)

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	Data Significance	p.p.m.	Determination	Data Significance	p.p.m.
Total Dissolved Solids, @ 105°C.	x.	531	Total Hardness, as $CaCO_3$	x.	240
Phenolphthalein Alkalinity, as $CaCO_3$	x.	0	Calcium Hardness, as $CaCO_3$	x.	198
Total Alkalinity, as $CaCO_3$	x.	243	Magnesium Hardness, as $CaCO_3$	x.	42
Carbonate Alkalinity, as $CaCO_3$	x.	0	Calcium, as Ca	x.	79
Bicarbonate Alkalinity, as $CaCO_3$	x.	243	Magnesium, as Mg	x	10
Carbonates, as CO_3	x.	0	Sodium, as Na	x.	63
Bicarbonates, as HCO_3	x.	296	Iron, as Fe	x	0.1
Hydroxides, as OH	x.	0	Manganese, as Mn	x	0
Carbon Dioxide, as CO_2	x.	20	Copper, as Cu	x	0
Chloride, as Cl	x.	98	Silica, as SiO_2	x.	14
Sulfate, as SO_4	x.	51	Color, Standard Platinum Cobalt Scale		7
Fluoride, as F	x	0.7	Odor Threshold	x.	0
Phosphate, as PO_4	x	2.7	Turbidity, Jackson Units	x.	1.4 dk
pH (Laboratory)	x	7.4			
pHs	x	6.9			
Stability Index	x	6.4			
Saturation Index	x	0.5			

Signed: Judy Morley

U.S. GEOLOGICAL SURVEY (WRD)
[illegible]
FORT MYERS, FLA. 33901

Dan:
Run copy off & send to J.R.P. + Carl N.

June 29, 1972

Mr. J. R. Spratt, President
Alico Land Development Company
La Belle, Florida 33935

Dear Mr. Spratt:

This letter summarizes our discussions of June 23, 1972 concerning supplemental water supplies for the western part of Lee County.

Public water supplies for most of the western part of Lee County, including Cape Coral, Pine Island, Sanibel and Captiva, Fort Myers Beach and adjacent mainland areas, are obtained from a water-bearing formation termed the "upper Hawthorn aquifer". In addition, thousands of small diameter wells obtain water from this aquifer for domestic use or yard irrigation. It is estimated that about 30,000 persons are dependent on water supplies from the public water systems.

The increasing demands for water from the upper Hawthorn aquifer, which occurs at depths of about 100 to 300 feet below the land surface, has resulted in a progressive lowering of water levels in the formation. Studies by others have indicated that water supply shortages in the public supply systems will occur within the next five years; one system has shown evidence of such shortage during the dry season in 1972.

To augment existing water supplies and forestall impending shortages, other sources of supply have been investigated. Plans are currently underway to establish a desalination plant to supply water to Sanibel-Captiva Islands. A similar system was until recently under consideration for Pine Island. Private investigations have been conducted by the Florida Cities Water Company and the GAC Corporation in the area at San Carlos Park near U.S. 41 to the Green Meadows subdivision bordering on State Route 82. These investigations have shown the presence of suitable water-bearing materials beginning about 6.5 miles east of U.S. 41 on the County Road to Corkscrew and Extending eastward to State Route 82.

Two water-bearing formations occur in the area. The uppermost formation, which attains a thickness of 50 feet or more is referred to as the water-table aquifer. This aquifer is separated from the underlying water-bearing formation by about 40 feet of clay marl. The lower water-bearing formation, beginning at a depth of about 90 feet and extending downward to about 250 feet is termed the "sandstone aquifer", although the deposits consist of sand, sandstone, and limestone. Chemical

analyses from this aquifer indicate that the water is suitable for public supply purposes with chloride concentrations less than 100 mg/l (milligrams per liter).

Although a large amount of information has been obtained, the water production capacity of the sandstone aquifer has not been determined. This involves the construction of a large diameter production well with adequate equipment for conducting a pumping test. Several observation wells are also necessary to monitor the effects of pumping. It has been estimated that the cost of construction and testing may range upward from $20,000. The information obtained will provide reliable evidence of the water transmission and storage characteristics of the aquifer, water production capability and required spacing between production wells, and other valuable data. These tests combined with those conducted in other areas may be used to estimate the potential yield of the entire aquifer.

Unfortunately because of relatively high cost of construction and testing, the private corporations are unwilling to proceed unless some reasonable assurance is given that the test facility, if successful, may be used for water production for an interim period (possibly five years) to partially recover the costs of the investment. The preferred location of the test facility is at the site where the aquifer attains sufficient thickness and where water quality has been determined, i.e., near the southeast corner of section 6, Township 465, Range 26E. The land area adjacent to this test well site is owned by your company.

Several alternatives exist for the placement of the test facility including (1) on Alico property, (2) on county road right-of-way, and (3) on property owned by the GAC Corporation at Green Meadows. The first location is preferred because of the information available, the shorter length of pipeline required, and other related factors. If constructed on Alico property, the production well would be cased through the water-table aquifer to a depth of about 90 feet to avoid any effect on existing irrigation wells in the shallower aquifer. As the need for water increases, additional production wells probably will be constructed to the east and the earlier production wells phased out of the system.

I am sure that the information which will be obtained from the production well testing facility and other information obtained from test holes in the area will be supplied on request.

I hope that our discussions have resulted in a better understanding of existing conditions and proposed plans for resolving some

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Green Meadows Project

No. GAC Utilities, Inc. Date February 25,197

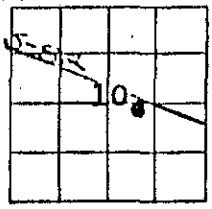
y Lee County State Florida

TEST HOLE
No. 1 and 1-A

Driller Marvin Miller

tion of Test Hole
chwest Corner of Area

¼ SE ¼ Sec. 10 of T 45 S,
26 E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 9.77 (No. 1)
Static Water Level 5.72 (NO. 1-A)
Measured 100+ Hours After Completion

n	To	Description of Strata	Water Bearing	
C	6	Sandy Soil	6	
	9	Marl rock and sand	3	
C	19	Rock	10	
	39	Marl rock and sand, hard	20	Good
9	55	Limestone rock, with clay and sand	16	Poor
	75	Green clay with fragments of shell	20	
5	88	Green clay and shell	13	
	89	Sandstone, hard	1	
9	91	Yellow gravel and sand	2	Fair
	101	Sandstone, shell and coarse sand	10	Good
1	137	Shell, coarse sand and sandstone layers	36	Good
C	153	Coarse sand, less shell and dark clay color	16	Good
	163	Coarse sand, shell with light clay color	10	Good
3	194	Soft limestone	31	Fair
	224	Clay and shell	30	None
4	240	Clay with some sand mixed	16	
	---	Total Depth Drilled		

g of Test Well 1-A located 2 feet from No. 1 was the same to 61 feet depth.

rks: ~~Test Well No. 1 has 2 inch diameter pipe to 89 feet depth.~~
Test pumped 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well No. 1-A has 2 inch diameter pipe to 40 feet and 61 feet of hole depth.
Test Well No. 1-A test pumped 1 hour at 3 gpm for water sample.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ntract Name Green Meadows Project

No. GAC Utilities, Inc. Date February 25, 1971

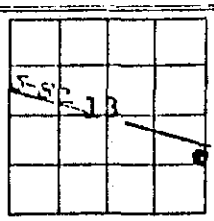
ity Lee County State Florida

TEST HOLE
No. 2 and 2-A

Driller Marvin Miller

cation of Test Hole
orth Center of Area

E ¼ SE ¼ Sec. 13 of T 45 S,
26E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 10.66 (NO. 2)

Static Water Level 5.16 (No. 2-A) Measured 100+ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	11	Sand	11	
1	15	Rock	4	
5	25	Marl with clay	10	
5	29	Very hard marl	4	Fair
29	50	White marl	21	Good
0	51	Hard pan (very hard)	1	None
51	61	Sandy clay, light color	10	None
1	63	Rock	2	None
63	73	Limestone, firm	10	Good
3	85	Limestone, soft	12	Fair
85	87	Rock, gray in color	2	None
7	97	Limestone, loose	10	Good
7	98	Rock, hard	1	None
98	128	Sandstone with hard and soft layers	30	Good
8	143	Coarse sand and shell	15	Good
43	160	Fine gray sand	17	Fair
0	175	Clay	15	None
75	184	Shell	9	Fair
4	234	Shell rock with some clay	50	Fair
34	238	Clay	4	None

arks: Test Well No. 2 has 2 inch diameter pipe to 162 feet depth.
Test pumped for 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well 2-A has 2 inch diameter pipe to 23 feet depth and 50 feet hole depth.
Test pumped for 1 hour for water sample at 60 gpm, full capacity of pump.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ntract Name Green Meadows Project

b No. GAC Utilities, Inc. Date February 15,1971

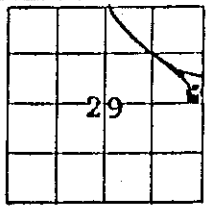
ity Lee County State Florida

TEST HOLE
No. 3 and 3-A

Driller Marvin Miller

cation of Test Hole
Northeast Corner of Area

¼ NE ¼ Sec. 29 of T 45 S,
27 E, Lee Co., Florida



Elevation of Test Hole

Static Water Level 12.60 (No. 3)
Static Water Level 7.00 (No. 3-A)
Measured 100+ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	19	Brown sand	19	
9	29	Limestone, water bearing rock	10	Good
29	31	Rock	2	
1	49	Limestone, light to dark clay color	18	Good
49	59	Limestone and clay	10	Fair
9	75	Limestone, clay and sand	16	Fair
75	85	Limestone, sand and shell	10	Good
5	95	Limestone and sand	10	Good
95	110	Limestone and shell, yellow in color	15	Good
0	111	Shell rock, hard	1	
11	158	Shell and sand	47	Good
8	169	Sandstone with sand in layers	11	Good
9	208	Sand and clay with trace of shell	39	Fair
08	218	Sand and clay	10	Poor
8	235	Sand and clay, very soft	17	None
35	239	Clay	4	
9	---	Total Depth Drilled		

g of Test Well 3-A located 2 feet from No. 3 was the same to 50 feet depth.

arks: Test Well No. 3 has 2 inch diameter pipe to 110 feet in depth.
Test pumped 2 hours for water sample at 60 gpm, pump capacity.
Test Well No. 3-A has 2 inch diameter pipe to 21 feet and 50 foot hole depth.
Test pumped 1 hour for water sample at 60 gpm, pump capacity.

Layne-Western Company, Inc.

—WATER SUPPLY SERVICES SINCE 1924—

TEST DRILLING • WATER WELLS • PUMPS.

ntract Name GAC Utilities, Inc.

b No. Green Meadows Date April 1971

y Ft. Myers State Florida

TEST HOLE No. 4

Driller M. E. Miller

ation of Test Hole

¼ SE ¼ Sec. 32 of T 45S,

27E, Lee Co., Florida

32

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

om	To	Description of Strata	Water Bearing	
	6	Light brown sand		
	7	Hard pan layer		
7	27	Sand and shell		
	29	Hard shell and sand		
9	36	White sand and shell		
	41	Lime rock - hard		
1	50	White sand and shell		
		Location temporarily abandoned - due to difficulty		

marks: Lost one string of tools at 50 feet. Sand would heave in casing and wedge ools. Casing pipe locked to rock by sand wedge. Lost string of casing pipe.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Green Meadows

Job No. KC-998-C Date March 18, 1972

City Green Meadows State Florida

TEST HOLE No. 7

Driller M. Miller

Location of Test Hole Near The Center Of The East Side Of Section.

SE ¼ NE ¼ Sec. 13 of T 46 S., R 26 E., Lee Co., Florida.

13

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
0	4"	Topsoil		
4"	6'	White sand		
6'	9'	Brown sand		
9'	13'	Marl		
13'	17'	Sand		
17'	20'	Shell rock		
20'	40'	Hard rock		
40'	82'	Sand and shell		
82'	86'	Sand rock (hard)		
86'	126'	Sand and shell		
126'	150'	Sand shell and rock		
150'	170'	Green clay		
170'	228'	Lime rock		
228'	230'	Clay		
230'	Total	Depth		

Remarks:

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ntract Name Green Meadows

No. KC-998-C Date March 18, 1972

v Green Meadows State Florida

TEST HOLE No. 8

Driller M. Miller

tion of Test Hole Near The Center
f The West Side Of Section

W ¼ NW ¼ Sec. 11 of T 46 S.,
26 E., Lee Co., Florida.

11

Elevation of Test Hole

Static Water Level

Measured ____ Hours After Completion

rom	To	Description of Strata	Water Bearing	
0	4"	Topsoil		
4"	5'	White sand		
5'	9'	Brown sand		
9'	14'	Marl		
4'	17'	Sand		
7'	43'	Rock		
3'	55'	Sand and shell		
5'	75'	Rock and sand		
75'	85'	Clay and shell		
5'	95'	Clay		
95'	115'	Sand and shell		
5'	125'	Lime rock and sand		
25'	165'	Sand and rock		
5'	Total	Depth		

arks:

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows

b No. KC-998-C Date March 1, 1972

Green Meadows State Florida

TEST HOLE No. 9

Driller M. Miller

ition of Test Hole Near Fence
rner In The Section Corner

¼ SW ¼ Sec. 33 of T 45 S.,
26 E., Lee Co., Florida

33

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	½'	Topsoil		
½'	5'	White sand		
5'	10'	Marl		
'	14'	Clay		
4'	18'	Sand		
'	42'	Rock		
2'	84'	Soft limestone		
4'	105'	Clay, sand, and shell		
'	126'	Sand and limestone		
6'	156'	Sand and rock		
'	168'	Hard rock and sand		
8'	174'	Clay		
'	218'	Lime rock		
8'	223'	Clay		
'	Total	Depth		

marks:

Test Pumped At 60 G.P.M.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Green Meadows

TEST HOLE No. 10

No. KC-998-C Date March 1, 1972

y Green Meadows State Florida Driller M. Miller

tion of Test Hole Near the section
orner of 28, 27, 34, & 33

28

Elevation of Test Hole

Static Water Level

¼ SE ¼ Sec. 28 of T 45 S.,
6 E., Lee Co., Florida.

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
	½'	Topsoil		
½'	6'	White sand		
''	11'	Marl		
'	15'	Sandy clay		
5'	17'	Sand		
'	40'	Rock		
40'	70'	Sandy clay		
'	80'	Coarse sand		
30'	90'	Sand		
'	100'	Sand and shell		
00'	120'	Sand and meal rock		
'	130'	Fine sand		
0'	140'	Coarse sand		
0'	160'	Sand and shell		
0'	170'	Sandy clay		
70'	180'	Sand and lime rock		
'	220'	Lime rock		
20'	230'	Clay		
'	Total	Depth		

arks:

Test Pumped At 50 G.P.M.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ntract Name GAC Utilities, Inc.

No. Green Meadows Date May 1971

ty Ft. Myers State Forida

TEST HOLE

No. 11

Driller M.E. Miller

ation of Test Hole West side of
oad 3004 feet south of section
rner marker.
¼ NE ¼ Sec. 35 of T 45S,
26E, Lee Co., Florida

35

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
	15	Sand		
5	19	White marl rock - hard		
	27	Lime rock and marl		
	45	White marl		
	82	Clay and shell		
	108	Loose sand and limestone		
8	109	Lime rock - hard		
	120	Shell and sand		
0	130	Sand with some shell		
	138	Lime rock with sand layers		
8	148	Lime rock with shell and sand		
	149	Sandstone - hard		
9	155	Sand with trace of shell		
	165	Layers of sand and sandstone - hard		
	203	Gray sand		
3	221	Limestone and sand		
	241	Limestone with shell and sand		
1	255	Clay with trace of shell		
	Total	Depth		

arks: Installed 2-inch diameter casing with drive shoe to 130 feet. Test pumped well at 45 gpm for 2 hours and collected water sample.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Green Meadows Groundwater Study

No. KC 998-C Date 24 Sept. 71

TEST HOLE No. 12

City Ft. Myers State Florida Driller M. Miller

Location of Test Hole

NW ¼ SW ¼ Sec. 35 of T 45S, R 26E, Lee Co., Florida.

35

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
	17	Light colored sand		
7	49	Layers of hard rock and coarse sand	32	good
	69	Clay in limestone and sand	20	poor
9	84	Limestone and sand, clay filled	15	none
4	90	Green clay	6	none
	94	Limestone with green clay	4	none
4	103	Limestone with layers of hard rock, water bearing	9	fair
	140	Limestone (very good water bearing material)	37	V.goo
0	156	Hard rock layers with sand	16	good
	166	Boulders, gray sand (firm) with some shell	10	poor
6	186	Gray sand with trace of shell	20	poor
	196	Gray sand with some limestone	10	poor
6	226	Limestone with some clay	30	poor
	235	Mostly clay with some limestone rock	9	none
	236	Medium rock	1	none
	246	Clay with some shell	10	none
	246	Total depth drilled		

Remarks: Installed 82 feet of 2 inch diameter pipe. Test pumped 60+ gpm with 15 inches of vacuum.

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-621

Driller _____

Test Hole Location SE¼, Sec. 14, T 45 S., R 26 E. in Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	6'0"			Sand, fine to med., white to yellow
6'0"	10'0"			Sand, gray, silty
10'0"	20'0"			Limestone, tan
20'0"	40'0"			Limestone, tan; gray marl
40'0"	60'0"			Clay, green
60'0"	75'0"			Sandstone, gray, calcareous; shell
75'0"	80'0"			Limestone, blue-gray
80'0"	95'0"			Limestone, blue-gray, sandy
95'0"	120'0"			Sandstone, gray, calcareous
120'0"	140'0"			Sandstone, gray, green clay
140'0"	160'0"			Clay and limestone, gray
160'0"	170'0"			Clay, green
170'0"	190'0"			Clay, light gray and limestone
190'0"	200'0"			Limestone, light gray, sandy
Continued----				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data obtained from U.S. Geological Survey - Ft. Myers, Florida. Located Green Meadows Area, Drilled by others several years ago.

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-621

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-621 **TEST LOG**

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
200'0"	220'0"			Clay, gray, some limestone
220'0"	240'0"			Clay, green and gray
240'0"	260'0"			Clay, dark gray, phosphatic; phosphate grains
260'0"	280'0"			Clay, dark gray, phosphatic, sandy
280'0"	320'0"			Limestone, gray-white, phosphatic
320'0"	340'0"			Same
340'0"	360'0"			Limestone, as above, some gray clay

NOTES: Size of Pit _____ X _____ X _____ DEEP

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-619

Driller _____

Test Hole Location NE ¼, Sec. 32, T 45 S., R 27 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	12'0"			Sand, fine to med., tan to brown
12'0"	20'0"			Limestone, tan
20'0"	85'0"			Limestone, ?
85'0"	120'0"			Clay, green, ?
120'0"	200'0"			Limestone, sandy, ?
200'0"	220'0"			Sandstone, gray
220'0"	240'0"			Same
240'0"	260'0"			Clay, dark gray, sandy
260'0"	280'0"			Sand, gray, clayey
280'0"	320'0"			Sand, med. to coarse
320'0"	380'0"			Limestone, gray, casts, molds
380'0"	400'0"			Limestone, gray and tan
400'0"	440'0"			Clay, gray, phosphatic
440'0"	460'0"			Clay, green
Continued-----				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data From U.S. Geological Survey - Ft. Myers, Florida. Drilled By Others In Green Meadows Area Several Years Ago.

5000 3-68

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-619

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-619

TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
460'0"	495'0"			Clay, dark gray, sandy, phosphatic
495'0"	540'0"			Limestone, gray white, phosphatic

NOTES: Size of Pit _____ X _____ X _____ DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-616

Driller _____

Test Hole Location NW ¼ Sec. 13, T 46 S., R 26 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0	15			Sand, med., tan; sandstone; shell
15	30			Sandstone, tan, calcareous; shells
30	45			Sandstone, gray; calcareous; shells
45	60			Same
60	75			Limestone, tan and gray; shells
75	105			Limestone, gray; few shells
105	120			Clay, green; some limestone
120	150			Clay, green
150	165			Limestone, gray, sandy
165	180			Sandstone, gray-tan, calcareous
180	210			Sandstone, gray, calcareous; phosphate
210	225			Clay, dark gray-green, sandy
225	240			Sand, very fine, gray; clayey
240	270			Clay, green and gray
270	295			Clay, dark gray, sandy, phosphatic
295	345			Limestone, gray-white, phosphatic

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data Obtained From U.S. Geological Survey - Ft. Myers, Florida.

Drilled In Green Meadows Area By Others Several Years Ago.

THE KANSAS STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES
Environmental Health Laboratory
801 Harrison Street 66612

TOPEKA
KANSAS

E. D. LYMAN, M. D., M. P. H.
Director of Health

May 26, 1971

Layne Western Company, Inc.
1010 West 39th Street
Kansas City, Missouri 64111

Attention: Mr Nuzman

Dear Mr. Nuzman:

Listed below in milligrams per liter are the results of chemical analyses of two samples of water collected in Florida. The samples may be identified as follows:

No. 1 GM No. 1 240' Hole, 89' pipe, collected 4-30-71.

No. 2 GAC Test Hole No. 11, collected 5-13-71.

* * * * *

		No. 1		No. 2	
pH	=	7.3		7.3	
Total Hardness (as $CaCO_3$)	=	326.	mg/l	262.	mg/l
Calcium (as Ca)	=	104.	mg/l	69.	mg/l
Magnesium (as Mg)	=	16.	mg/l	22.	mg/l
Sodium	=	45.	mg/l	50.	mg/l
Total Alkalinity (as $CaCO_3$)	=	276.	mg/l	250.	mg/l
Chloride	=	88.	mg/l	60.	mg/l
Sulfate	=	18.	mg/l	33.	mg/l
Nitrate (as NO_3)	=	1.8	mg/l	1.5	mg/l
Fluoride	=	0.4	mg/l	0.6	mg/l
Iron	=	0.38	mg/l	0.38	mg/l
Manganese	=	0.00	mg/l	0.00	mg/l

Sincerely,

Nicholas D. Duffett, Ph.D.
Director

Howard A. Stoltenberg

Howard A. Stoltenberg, M.A.
Chief, Water Chemistry Section

HAS:glb

Cape Coral Water Treatment Plant Laboratory

LOCATION DESCRIPTION	CASING DIA.	CASING DEPTH	WELL DEPTH	PH	M.ALK.	T.Hd.	Mg.Hd.	Ca.Hd.	CL	T.D.S
Green Meadows No. 1 2/11/71	2"	89	244	7.4	270	314	66	248	80	430
Green Meadows No. 1 2/25/71	2"	89	244	7.3	272	304	72	232	120	410
Green Meadows No. 1-A 2/11/71	2"	40	61	7.2	189	710	246	464	1200	3100
Green Meadows No. 1-A 2/25/71	2"	40	61						1380	3500
Green Meadows No. 2	2"	162	238	7.2	268	198	110	88	60	440
Green Meadows No. 2-A	2"	23	50	7.2	238	250	22	228	30	300
Green Meadows No. 3	2"	110	239	7.4	284	282	88	194	110	620
Green Meadows No. 3-A	2"	21	50	7.2	214	212	10	204	20	230
Irr. Well NW¼ 10-46S-26E	6"			7.2	212	232	34	198	65	270
Irr. Well SW¼ 25-45S-26E	6"			7.4	188	216	12	204	45	250
Irr. Well SE¼ 14-46S-26E	6"			7.0	218	242	12	230	30	280
Irr. Well SE¼ 35-45S-26E	8"			7.1	234	250	12	238	35	280
Flowing Well NW¼ 9-46S-25E	6"			7.6					1000	2600
Green Meadows No. 7-A	2"		105	7.8	272	264	2	262	40	295
Green Meadows No. 7	2"		230	7.7	256	284	30	254	60	300
Green Meadows No. 8-A	2"		105	7.8	276	226	26	200	40	280
Cape Coral--North Pine Island Road	10"	125	225'	7.3	200	294	156	138	180	460

WATER QUALITY DATA
CAPE CORAL WATER PLANT

Location Description	Casing Dia.	Casing Depth	Well Depth	pH	M. Alk.	T. Hd.	Mg Hd.	Ca Hd.	Cl	T.D.
Green Meadows #12	2"	82'	103'	7.8	186	186	48	138	40	250
Green Meadows #12	2"	82'	136'	7.9	258	272	162	110	40	310
Green Meadows #12	2"	82'	243'	7.8	246	232	72	160	40	330
Green Meadows #9			105'	7.8	290	270		270	80	390
Green Meadows #9			223'	7.6	240	244	88	156	70	350
Green Meadows #10	2"		105'	7.6	254	270	64	206	70	340
Green Meadows #10	2"		230'	7.4	248	158	76	82	70	290
Green Meadows #11-A	2"		50'	7.4	208	230	20	210	170	260
Green Meadows #11	2"	130'	255'	7.6	244	252	92	160	80	370
Green Meadows #3-A	2"	21'	56'	7.2	214	212	10	204	20	235
Green Meadows #3	2"	110'	239'	7.4	284	282	88	194	110	625
Green Meadows #2-A	2"	23'	50'	7.2	238	250	22	228	30	300
Green Meadows #2	2"	162'	238'	7.2	268	198	110	88	60	440
Green Meadows #1-A 2/11/71	2"	40'	61'	7.2	184	710	246	464	1200	3100
Green Meadows 2/25/71	2"	40'	61'						1380	3500
Green Meadows #1	2"	89'	240'	7.4	270	314	66	248	80	430
Green Meadows #1	2"	89'	244'	7.3	280	304	72	232	120	410

LAYNE WESTERN COMPANY, INC.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: LAYNE-WESTERN COMPANY

Appearance: CLEAR

Date: SEPTEMBER 20, 1971

Sampled by: CLIENT

Sample Number: 4809

Identification: GM #12 TEST WELL 82' PIPE 243' DEEP PUMP+60 GPM MOST WATER FROM 90'-155' LEVEL

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	366	Sulfate, as SO_4	16
Total Hardness, as $CaCO_3$	240	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	180	Silica, as SiO_2	37
Magnesium Hardness, as $CaCO_3$	60	Copper, as Cu	0.0
Calcium, as Ca	72	Phosphate (Total), as PO_4	0.7
Magnesium, as Mg	14	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	270	pH (Laboratory)	7.8
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	270	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.9
Carbon Dioxide, as CO_2	9	Turbidity, Silica Scale	20
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	330		
Chlorides, as Cl	39		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: J Hobbs
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

APPENDIX B

Layne-Western Company, Inc.
WATER SUPPLY SERVICES
WATER WELLS • LAYNE PUMPS • TEST DRILLING • WATER TREATMENT EQUIPMENT
1010 West 39th Street • Kansas City, Missouri 64111 • AC 816 931-2353

January 19, 1973

G.A.C. Utilities
P.O. Box 8000
Miami, Florida 33152

Attention Mr. James R. Powell, Vice President

Dear Mr. Powell:

In response to your request of 18 January, 1973, I have reviewed the material obtained from test hole drilling conducted at the Green Meadows project site located in Southern Lee County, Florida. Copies of this information are contained in the previous submitted report, "Water Supply Study -Southern Lee County, Florida" dated April, 1972.

Using the limited available data, two (2) computer runs were made to determine effective spacing required for a projected satisfactory yield to supply Florida Cities and Cape Coral water supplies in the future. In the first computer run, 21 wells were programmed, pumping at a continuous rate of 350 gpm each, spaced on one-half mile intervals, concentrated in land sections No. 33, Section 34, and Section 35, located in the west-center portion of the project area. Using estimated values of transmissivity, storage coefficient, and with no recharge considered, the projected useful life for this well pattern was 13.6 years. Repeating the procedure with the same assumed conditions, only changing to 10 wells, located at approximately one-mile intervals, and encompassing land Section 36 and the adjacent Section 31 to the west, the projected useful life of the aquifer diverting ten million gallons per day with no recharge was 54.5 years. On this basis, the recommended well locations are shown on the folded, attached illustration.

The concept of the original study was to construct a test production well, with surrounding piezometers to determine the exact coefficient and transmissivity for a sampled area,

the computed coefficient of storage for the aquifer system, and then to model the aquifer system on analog computing techniques to compute the actual recharge received from local precipitation in the area. Then, computations would be made that would more accurately predict the safe yield and useful life of the aquifer system. This work under the second phase of the investigative program has not been completed.

The above recommendations are based on the assumption that an 80 foot decline in static water level in the lower aquifer is not an unreasonable amount and further, there would be no appreciable effect on the shallow upper aquifer around the perimeter of the property. The effect on the shallow aquifer was to be a part of the testing program previously identified.

Twenty-six (26) well sites have been shown on the drawing, as recommended locations. From the information presently available, each of the sites should provide a satisfactory water supply of useable quality. It should be anticipated that two or three of the sites will not be available or utilized because of physical conditions existing in the area or other factors. It is suggested that the well sites be a minimum of one (1) acre an area to allow for some loss due to public road right-of-way, and other utility easements that may be required in the future. It is further suggested that one site preferably the site located in the southwest corner of Section 33 near Test Well No. 9, may need to be large enough to accommodate a water treatment plant and water storage facilities.

Should you have any questions or desire additional information, please do not hesitate to contact me.

Respectfully submitted,

Carl E. Nuzman, P.E.
HYDROLOGY CONSULTANT

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 01/18/73. 16.21.51
PROGRAM   LAYNETS


ENTER THE VALUES FOR TMAX,DIML,DIMW
 ? 10000 35 35
ENTER THE VALUES FOR NUMT,QRE,DELT
 ? 33 0. .1
ENTER THE VALUES FOR DELX,DELY,M
 ? 1320 1320 0
ENTER THE VALUES FOR KTH,ISTEP,INDEX
 ? 20 1 4
ENTER THE VALUES FOR ERR,FACS,FACB
 ? .012 .05 -200.
ENTER THE VALUES FOR FACP,FACT,RIVER
 ? 600. 75000. 0.
ENTER THE VALUES FOR SPAC,ELEV,TPAQEL
 ? 5 20. -75.
ALPHANUMERIC PLOT WANTED, YES OR NO ? NO
PRINT INITIAL PARAMETER VALUES, YES OR NO ? NO
PRINT INITIAL VALUES OF MATRIX DATA, YES OR NO ? NO
 GPM OR -GPD ROW COL  ? 350 16 8
 GPM OR -GPD ROW COL  ? 350 16 10
 GPM OR -GPD ROW COL  ? 350 16 12
 GPM OR -GPD ROW COL  ? 350 16 14
 GPM OR -GPD ROW COL  ? 350 16 16
 GPM OR -GPD ROW COL  ? 350 16 18
 GPM OR -GPD ROW COL  ? 350 16 20
 GPM OR -GPD ROW COL  ? 350 18 8
 GPM OR -GPD ROW COL  ? 350 18 10
 GPM OR -GPD ROW COL  ? 350 18 12
 GPM OR -GPD ROW COL  ? 350 18 14
 GPM OR -GPD ROW COL  ? 350 18 16
 GPM OR -GPD ROW COL  ? 350 18 18
 GPM OR -GPD ROW COL  ? 350 18 20
 GPM OR -GPD ROW COL  ? 350 20 8
 GPM OR -GPD ROW COL  ? 350 20 10
 GPM OR -GPD ROW COL  ? 350 20 12
 GPM OR -GPD ROW COL  ? 350 20 14
 GPM OR -GPD ROW COL  ? 350 20 16
 GPM OR -GPD ROW COL  ? 350 20 18
 GPM OR -GPD ROW COL  ? 350 20 20
 GPM OR -GPD ROW COL  ? 0 2 2


TIME STEP NUMBER=                    20

SIZE OF TIME STEP=                104858

DURATION OF PUMPING IN SECONDS=   2.097E+05

                  MINUTES=        3.495E+03

                  HOURS=           58.254

                  DAYS =            2.427

ITERATION STEP NUMBER=          1
```

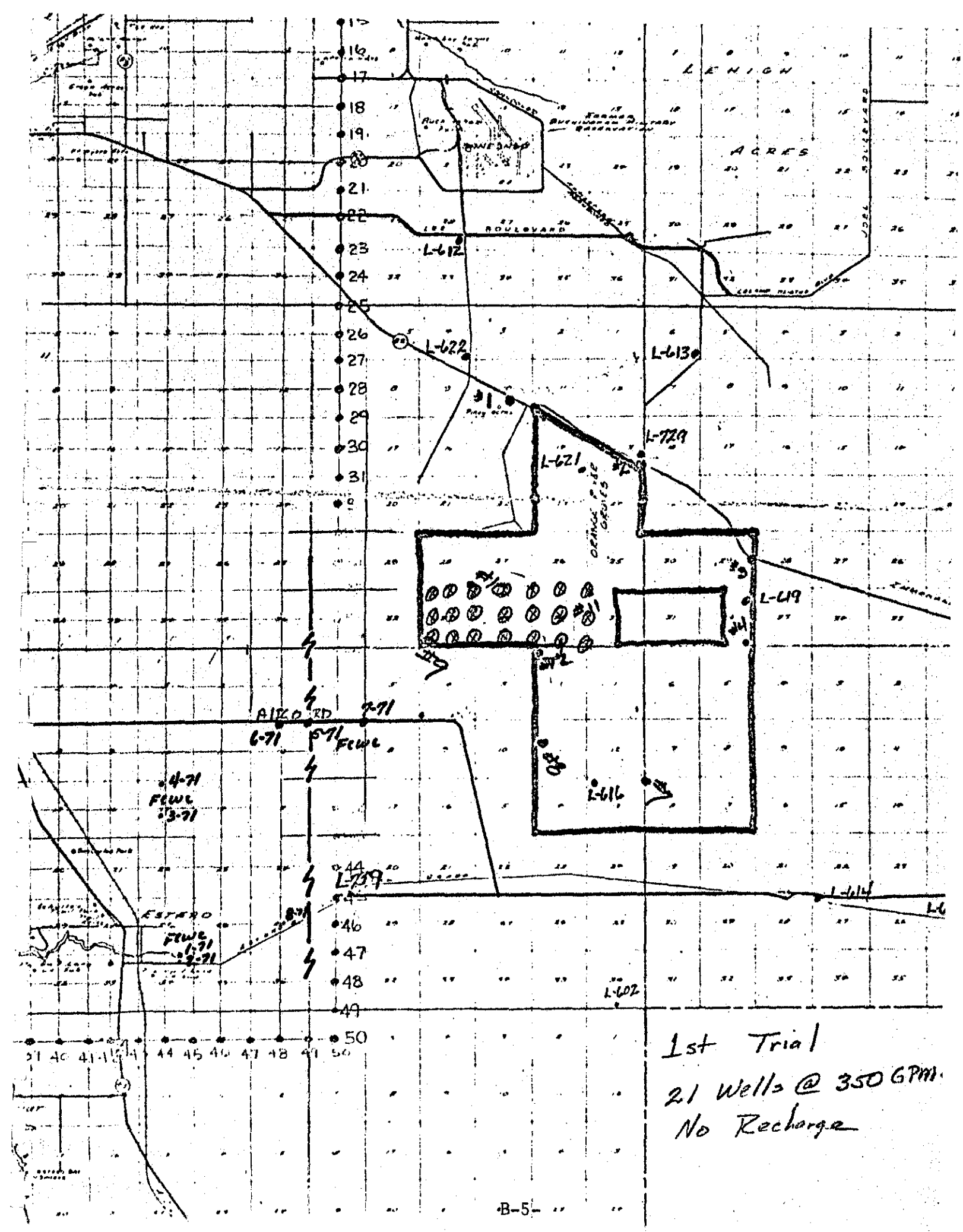
No RECHARGE CONDITION

T = 10,000

35 x 35

QRE = 0 Recharge

10.5 MGD PUMPAGE From 21 WELL LOCATIONS


LENNOX
ACRES
BOULEVARD
L-612
L-622
L-613
L-729
L-621
L-619
L-616
L-759
L-602
AIKO RD
6-71
5-71
FCWC
4-71
FCWC
3-71
ESTERO
FCWC
1-71
2-71
8-71
16
17
18
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44
46
47
48
49
50
21 40 41 42 43 44 45 46 47 48 49 50
1st Trial
21 Wells @ 350 GPM.
No Recharge

TIME STEP NUMBER= 29

SIZE OF TIME STEP= 53687091

DURATION OF PUMPING IN SECONDS= 1.074E+08

MINUTES= 1.790E+06

HOURS= 29826.162

DAYS = 1242.757 → 3.4 years

ITERATION STEP NUMBER= 7

AREA OF INFLUENCE LIMITED TO 68 SQ MILES

DRAWDOWN IN FEET

	2 (1320')	3 (1320')	4 (1320')	5 (1320')	6	7	8	9	10	
13	22.4	22.6	23.0	23.7	24.5	25.4	26.4	27.2	27.9	28.3
	28.6	28.7	28.5	28.2	27.6	26.7	25.7	24.4	23.0	21.4
1320'	19.7	18.2	16.7	15.4	14.2	13.2	12.3	11.6	11.0	10.5
	10.2	9.9	9.8							
14	23.2	23.5	24.1	24.9	26.0	27.2	28.6	29.6	30.5	31.1
	31.5	31.6	31.5	31.1	30.4	29.5	28.3	26.8	25.1	23.1
1320'	21.1	19.2	17.5	16.0	14.7	13.6	12.7	11.9	11.2	10.7
	10.3	10.1	10.0							
15	24.0	24.3	25.0	26.0	27.4	29.2	31.2	32.4	33.7	34.3
	34.9	34.9	35.0	34.3	33.8	32.6	31.4	29.5	27.6	24.9
1320'	22.4	20.2	18.3	16.6	15.2	14.0	13.0	12.1	11.4	10.9
	10.5	10.2	10.1							
16	24.6	25.0	25.8	27.0	28.7	31.1	34.7	35.3	37.8	37.4
	39.2	38.2	39.3	37.6	38.1	35.7	35.5	32.3	31.1	26.7
1320'	23.6	21.0	18.9	17.1	15.5	14.2	13.2	12.3	11.6	11.0
	10.6	10.3	10.2							
17	25.0	25.4	26.2	27.6	29.4	31.9	34.8	36.3	38.1	38.7
	39.7	39.5	39.8	38.9	38.6	37.0	35.8	33.3	31.2	27.5
	24.3	21.5	19.2	17.3	15.7	14.4	13.3	12.4	11.7	11.1
	10.7	10.4	10.3							
18	25.1	25.5	26.4	27.8	29.7	32.5	36.5	37.2	39.9	39.7
	41.5	40.5	41.7	39.9	40.4	37.9	37.6	34.2	32.8	28.1
	24.5	21.7	19.4	17.4	15.8	14.5	13.3	12.4	11.7	11.1
	10.7	10.4	10.3							
19	25.0	25.4	26.2	27.6	29.4	31.9	34.8	36.3	38.1	38.7
	39.7	39.5	39.8	38.9	38.6	37.0	35.8	33.3	31.2	27.5
	24.3	21.5	19.2	17.3	15.7	14.4	13.3	12.4	11.7	11.1
	10.7	10.4	10.3							
20	24.6	25.0	25.8	27.0	28.7	31.1	34.7	35.3	37.8	37.4
	39.2	38.2	39.3	37.6	38.1	35.7	35.5	32.3	31.1	26.7
	23.6	21.0	18.9	17.1	15.5	14.2	13.2	12.3	11.6	11.0
	10.6	10.3	10.2							
21	24.0	24.3	25.0	26.0	27.4	29.2	31.2	32.4	33.7	34.3

TIME STEP NUMBER= 31

SIZE OF TIME STEP= 214748365

DURATION OF PUMPING IN SECONDS= 4.295E+08

MINUTES= 7.158E+06

HOURS= 119304.647

DAYS = 4971.027 → 13.6 years

ITERATION STEP NUMBER= 15

DRAWDOWN IN FEET

	2	1320' 3	1320' 4	1320' 5	1320' 6	7	8	9	10	
13	72.6	72.8	73.2	73.8	74.5	75.3	76.1	76.8	77.4	77.7
	77.7	77.6	77.2	76.6	75.7	74.6	73.3	71.7	70.0	68.1
1320'	66.2	64.3	62.6	61.0	59.6	58.4	57.3	56.4	55.6	55.0
	54.6	54.3	54.1							
14	73.5	73.8	74.3	75.1	76.0	77.2	78.4	79.3	80.1	80.5
	80.7	80.6	80.2	79.5	78.6	77.4	75.9	74.1	72.1	69.8
320'	67.5	65.4	63.4	61.7	60.1	58.8	57.6	56.7	55.9	55.2
	54.8	54.5	54.3							
15	74.3	74.6	75.3	76.2	77.5	79.2	81.1	82.1	83.3	83.7
	84.1	83.9	83.7	82.8	82.0	80.5	79.1	76.9	74.7	71.7
1320'	68.9	66.4	64.2	62.3	60.6	59.2	57.9	56.9	56.1	55.4
	54.9	54.6	54.4							
16	75.0	75.3	76.0	77.2	78.8	81.1	84.6	85.0	87.4	86.9
	88.4	87.2	88.0	86.1	86.3	83.7	83.1	79.7	78.2	73.5
1320'	70.1	67.2	64.8	62.7	61.0	59.5	58.2	57.1	56.2	55.6
	55.1	54.7	54.6							
17	75.3	75.7	76.5	77.8	79.6	82.0	84.7	86.1	87.8	88.1
	88.9	88.5	88.6	87.5	86.8	85.0	83.5	80.7	78.3	74.3
	70.8	67.8	65.2	63.0	61.2	59.6	58.3	57.2	56.3	55.6
	55.1	54.8	54.6							
18	75.5	75.9	76.7	78.0	79.9	82.5	86.4	87.0	89.6	89.1
	90.8	89.5	90.4	88.5	88.7	85.9	85.3	81.6	79.9	74.9
	71.1	67.9	65.3	63.1	61.3	59.7	58.4	57.3	56.4	55.7
	55.2	54.8	54.6							
19	75.3	75.7	76.5	77.8	79.6	82.0	84.7	86.1	87.8	88.1
	88.9	88.5	88.6	87.5	86.8	85.0	83.5	80.7	78.3	74.3
	70.8	67.8	65.2	63.0	61.2	59.6	58.3	57.2	56.3	55.6
	55.1	54.8	54.6							
20	75.0	75.3	76.0	77.2	78.8	81.1	84.6	85.0	87.4	86.9
	88.4	87.2	88.0	86.1	86.3	83.7	83.1	79.7	78.2	73.5
	70.1	67.2	64.8	62.7	61.0	59.5	58.2	57.1	56.2	55.6
	55.1	54.7	54.6							

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PL??62

UCS  01/19/73. 08.31.38  SE030
USER NUMBER:  L033001,WESTERN,LAYNETS
SYSTEM: FOR,OLD,LAYNETS

READY.
RUN,M=15000,T=200

 01/19/73. 08.32.28
PROGRAM   LAYNETS


ENTER THE VALUES FOR TMAX,DIML,DIMW
 ? 10000 35 35
ENTER THE VALUES FOR NUMT,QRE,DELT
 ? 33 .0 .1
ENTER THE VALUES FOR DELX,DELY,M
 ? 2640 2640 0
ENTER THE VALUES FOR KTH,ISTEP,INDEX
 ? 20 1 4
ENTER THE VALUES FOR ERR,FACS,FACB
 ? .012 .05 -200.
ENTER THE VALUES FOR FACP,FACT,RIVER
 ? 600. 75000. 0.
ENTER THE VALUES FOR SPAC,ELEV,TPAQEL
 ? 5 20. -75.
ALPHANUMERIC PLOT WANTED, YES OR NO ? NO
PRINT INITIAL PARAMETER VALUES, YES OR NO ? NO
PRINT INITIAL VALUES OF MATRIX DATA, YES OR NO ? NO
 GPM OR -GPD ROW COL  ? 700 16 11
 GPM OR -GPD ROW COL  ? 700 16 15
 GPM OR -GPD ROW COL  ? 700 16 19
 GPM OR -GPD ROW COL  ? 700 17 21
 GPM OR -GPD ROW COL  ? 700 18 10
 GPM OR -GPD ROW COL  ? 700 18 12
 GPM OR -GPD ROW COL  ? 700 18 14
 GPM OR -GPD ROW COL  ? 700 18 16
 GPM OR -GPD ROW COL  ? 700 18 18
 GPM OR -GPD ROW COL  ? 700 18 20
 GPM OR -GPD ROW COL  ? 0 2 2
```
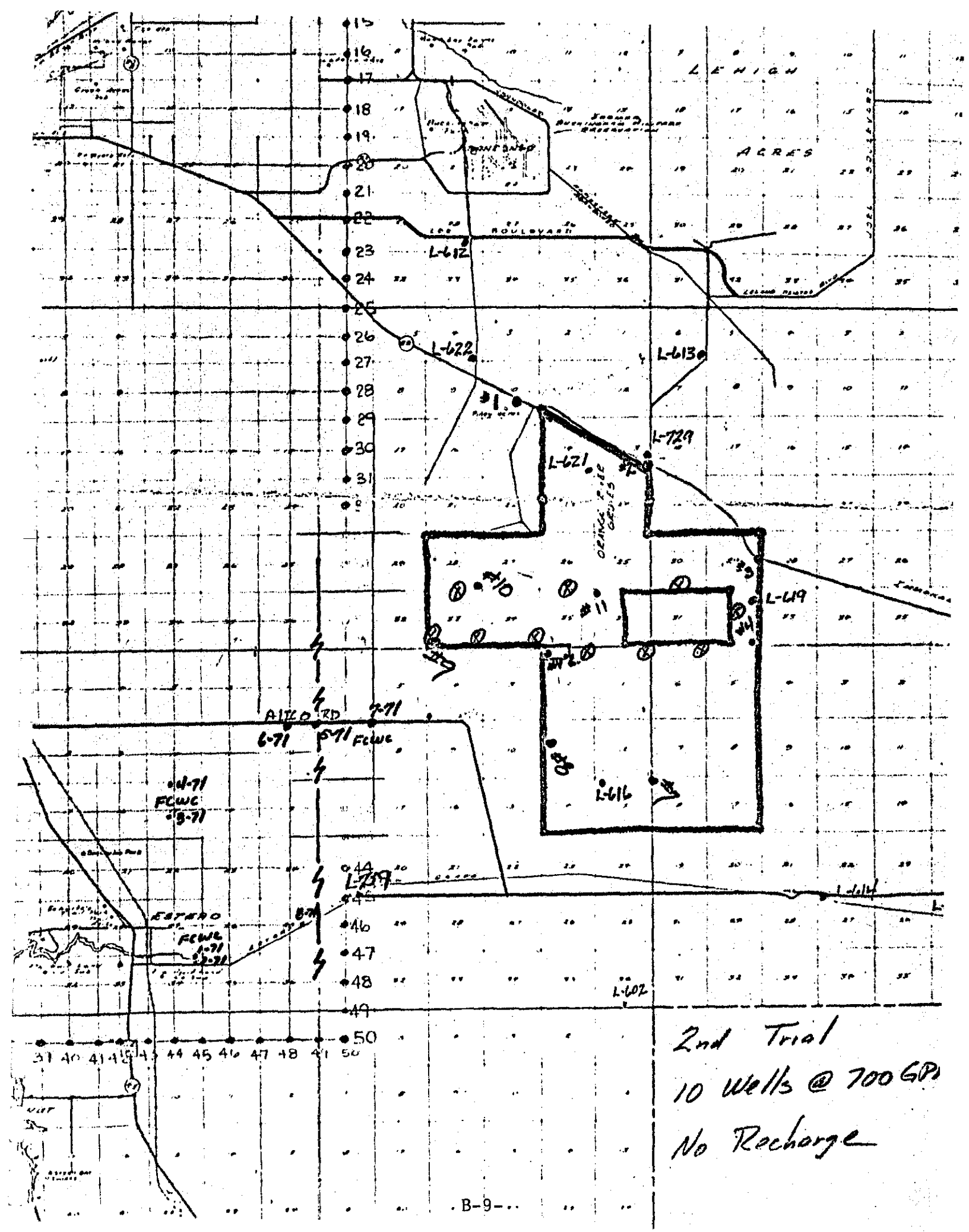

10 mgd from 10 locations

```
TIME STEP NUMBER=                    20

SIZE OF TIME STEP=                104858

DURATION OF PUMPING IN SECONDS=   2.097E+05
```



2nd Trial

10 Wells @ 700 GPM

No Recharge

TIME STEP NUMBER=

SIZE OF TIME STEP= 214748365

DURATION OF PUMPING IN SECONDS= 4.295E+08

MINUTES= 7.158E+06

HOURS= 119304.647

DAYS = 4971.027 → 13.6 years

ITERATION STEP NUMBER= 6

AREA OF INFLUENCE IS 272 SQ miles

DRAWDOWN IN FEET

	2 (2640')	3 (2640')	4 (2640')	5 (2640')	6	7	8	9	10	
13	18.5	18.7	19.1	19.8	20.6	21.6	22.8	24.2	25.5	26.7
	27.6	28.2	28.7	28.9	28.8	28.5	27.9	27.0	25.8	24.3
40'	22.6	20.9	19.2	17.7	16.3	15.2	14.1	13.3	12.6	12.0
	11.6	11.3	11.2							
14	19.0	19.2	19.7	20.4	21.4	22.7	24.2	25.9	27.7	29.4
	30.4	31.1	31.8	32.2	31.9	31.5	30.9	30.1	28.5	26.6
40'	24.4	22.3	20.3	18.5	17.0	15.6	14.5	13.6	12.8	12.2
	11.8	11.5	11.3							
15	19.4	19.6	20.2	21.0	22.2	23.7	25.6	27.8	30.3	32.8
	33.5	34.2	35.2	36.2	35.4	34.7	34.3	34.0	31.8	29.3
10'	26.4	23.7	21.3	19.2	17.5	16.0	14.8	13.8	13.0	12.4
	11.9	11.6	11.4							
16	19.6	19.9	20.5	21.4	22.7	24.4	26.7	29.5	33.1	38.3
	36.8	37.2	38.7	42.1	39.0	37.8	37.9	39.9	35.4	32.4
40'	28.4	24.9	22.1	19.8	17.9	16.3	15.0	13.9	13.1	12.5
	12.0	11.7	11.5							
17	19.7	20.0	20.6	21.6	23.0	24.8	27.3	30.5	34.4	37.1
	38.6	39.0	40.5	41.2	40.9	39.7	39.7	39.0	37.6	36.8
	29.9	25.6	22.4	20.0	18.0	16.4	15.1	14.0	13.1	12.5
	12.0	11.7	11.5							
18	19.6	19.9	20.6	21.5	22.9	24.8	27.3	31.0	37.1	37.4
	41.3	40.1	43.3	41.4	43.6	40.7	42.4	39.0	39.4	33.9
	29.1	25.2	22.2	19.9	17.9	16.3	15.0	13.9	13.1	12.4
	12.0	11.6	11.5							
19	19.4	19.7	20.3	21.2	22.5	24.2	26.4	29.2	32.4	34.1
	36.1	36.7	37.9	37.8	38.1	37.3	36.9	35.3	33.8	30.6
	27.2	24.2	21.6	19.4	17.6	16.1	14.8	13.8	13.0	12.3
	11.9	11.5	11.4							
20	19.0	19.3	19.9	20.7	21.8	23.2	25.0	27.1	29.2	30.8
	32.2	33.1	33.8	34.0	34.0	33.5	32.8	31.5	29.9	27.7
	25.2	22.8	20.6	18.7	17.1	15.7	14.5	13.5	12.8	12.1
	11.7	11.4	11.3							

21	18.6	18.8	19.3	20.0	20.9	22.1	23.5	25.1	26.6	27.9

SIZE OF TIME STEP= 429496730

DURATION OF PUMPING IN SECONDS= 8.590E+08

MINUTES= 1.432E+07

HOURS= 238609.294

DAYS = 9942.054

ITERATION STEP NUMBER= 7

DRAWDOWN IN FEET

	2 2640'	3 2640'	4 2640'	5 2640'	6	7	8	9	10	
13	34.5	34.8	35.2	35.8	36.6	37.6	38.8	40.1	41.4	42.5
	43.4	44.0	44.4	44.5	44.3	43.8	43.1	42.2	40.8	39.2
,40'	37.4	35.5	33.8	32.1	30.6	29.3	28.2	27.3	26.5	25.9
	25.4	25.1	25.0							
14	35.0	35.3	35.8	36.5	37.5	38.7	40.2	41.9	43.6	45.2
	46.1	46.8	47.4	47.7	47.4	46.9	46.2	45.2	43.6	41.5
2640'	39.2	37.0	34.8	32.9	31.3	29.8	28.6	27.6	26.7	26.1
	25.6	25.3	25.1							
15	35.4	35.7	36.2	37.0	38.2	39.7	41.5	43.7	46.2	48.7
	49.3	49.9	50.8	51.7	50.9	50.1	49.6	49.1	46.8	44.2
,40'	41.2	38.4	35.8	33.6	31.8	30.2	28.9	27.8	26.9	26.2
	25.7	25.4	25.2							
16	35.6	35.9	36.5	37.4	38.7	40.4	42.6	45.4	49.0	54.1
	52.6	52.9	54.3	57.6	54.5	53.2	53.2	55.1	50.4	47.3
2640'	43.2	39.6	36.6	34.2	32.1	30.5	29.1	27.9	27.0	26.3
	25.8	25.4	25.3							
17	35.7	36.0	36.6	37.6	39.0	40.8	43.2	46.4	50.3	52.9
	54.3	54.7	56.1	56.7	56.3	55.1	55.0	54.2	52.6	51.7
	44.7	40.2	36.9	34.4	32.3	30.5	29.1	28.0	27.0	26.3
	25.8	25.4	25.3							
18	35.6	35.9	36.5	37.5	38.9	40.7	43.2	46.9	52.9	53.2
	57.1	55.7	58.9	56.9	59.0	56.0	57.6	54.1	54.4	48.8
	43.8	39.8	36.7	34.2	32.1	30.4	29.0	27.9	27.0	26.2
	25.7	25.4	25.2							
19	35.4	35.7	36.2	37.1	38.4	40.1	42.2	45.0	48.1	49.9
	51.8	52.4	53.4	53.3	53.5	52.5	52.1	50.3	48.7	45.4
	41.9	38.8	36.0	33.7	31.8	30.2	28.8	27.7	26.8	26.1
	25.6	25.3	25.1							
20	34.9	35.2	35.7	36.5	37.7	39.1	40.8	42.8	44.9	46.5
	47.9	48.7	49.3	49.4	49.3	48.7	47.9	46.5	44.8	42.5
	39.9	37.3	35.0	33.0	31.2	29.7	28.5	27.4	26.6	25.9
	25.4	25.1	24.9							

21	34.4	34.6	35.1	35.8	36.7	37.9	39.3	40.8	42.3	43.6
	44.6	45.3	45.8	45.9	45.7	45.2	44.4	43.2	41.7	39.9

TIME STEP NUMBER= 33

SIZE OF TIME STEP= 858993459

DURATION OF PUMPING IN SECONDS= 1.718E+09

MINUTES= 2.863E+07

HOURS= 477218.588

DAYS = 19884.108 → 54.5 years

ITERATION STEP NUMBER= 15

DRAWDOWN IN FEET

	2 (2640')	3 (2640')	4 (2640')	5 (2640')	6	7	8	9	10	
13	65.5	65.7	66.1	66.7	67.5	68.5	69.7	70.9	72.2	73.3
	74.1	74.6	75.0	75.1	74.8	74.3	73.6	72.5	71.1	69.4
2640'	67.5	65.6	63.8	62.1	60.6	59.2	58.1	57.1	56.3	55.7
	55.2	54.9	54.7							
14	66.0	66.2	66.7	67.4	68.4	69.6	71.1	72.7	74.4	76.0
	76.9	77.5	78.0	78.3	77.9	77.3	76.6	75.6	73.8	71.7
2640'	69.4	67.1	64.9	62.9	61.2	59.7	58.4	57.4	56.5	55.8
	55.3	55.0	54.8							
15	66.4	66.6	67.2	68.0	69.1	70.6	72.4	74.5	77.0	79.4
	80.0	80.6	81.4	82.3	81.4	80.6	80.0	79.5	77.1	74.4
2640'	71.3	68.4	65.9	63.6	61.7	60.1	58.7	57.6	56.7	56.0
	55.4	55.1	54.9							
16	66.6	66.9	67.5	68.4	69.6	71.3	73.4	76.2	79.8	84.9
	83.3	83.5	84.9	88.2	85.0	83.6	83.5	85.4	80.7	77.5
2640'	73.3	69.6	66.6	64.1	62.0	60.3	58.9	57.7	56.8	56.0
	55.5	55.1	55.0							
17	66.6	66.9	67.6	68.5	69.8	71.6	74.1	77.2	81.0	83.7
	85.0	85.4	86.7	87.3	86.8	85.5	85.3	84.5	82.9	81.9
	74.8	70.3	66.9	64.3	62.2	60.4	58.9	57.7	56.8	56.0
	55.5	55.1	54.9							
18	66.5	66.8	67.4	68.4	69.7	71.5	74.0	77.6	83.7	83.9
	87.7	86.3	89.5	87.5	89.5	86.4	88.0	84.4	84.6	79.0
	73.9	69.9	66.7	64.1	62.0	60.3	58.8	57.6	56.7	55.9
	55.4	55.0	54.9							
19	66.2	66.5	67.1	68.0	69.2	70.9	73.0	75.7	78.9	80.5
	82.4	83.0	84.0	83.8	83.9	82.9	82.4	80.6	78.9	75.6
	72.0	68.8	66.0	63.6	61.6	60.0	58.6	57.4	56.5	55.8
	55.2	54.9	54.7							
20	65.8	66.1	66.6	67.4	68.5	69.9	71.6	73.6	75.6	77.2
	78.5	79.2	79.8	79.9	79.7	79.1	78.2	76.8	75.0	72.6
	69.9	67.3	65.0	62.9	61.1	59.5	58.2	57.1	56.2	55.5
	55.0	54.7	54.5							

APPENDIX C

WATER SUPPLY STUDY

SOUTHERN LEE COUNTY, FLORIDA

APRIL, 1972

by

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Kansas City, Missouri
64111

816-931-2353

ABSTRACT

Investigation of water supply potential in Southeastern Lee County, Florida has shown there is a multilayered aquifer of substantial proportion existing to approximately 350 feet in depth containing water of acceptable quality for public supply. The yield potential appears substantial and at least four to five times greater than that experienced from the Upper Hawthorne aquifer along the West Coast. Additional investigation may show substantially higher amounts with proper spacing of wells and with good management of the surface water.

WATER SUPPLY STUDY
SOUTHERN LEE COUNTY, FLORIDA
APRIL, 1972

INTRODUCTION

Interest and an initial authorization to begin study in the southeastern portion of Lee County, Florida was made by GAC Utilities, Inc., in July, 1970. The purpose of the study was two-fold. First, was to determine the groundwater availability and suitability in quality and quantity to provide for the proposed needs of the Green Meadows project development. The planned size of this project has varied from time to time with different stages of planning progress; however, the expected water consumption for the project itself, is about five to seven mgd in approximately 20 years following initial construction. The second purpose of the study was to determine whether surplus water could be developed in this area and transported westerly to provide additional supplies to both Cape Coral and Florida Cities Water Company, service Ft. Myers Beach and areas along Tamiami Trail.

FIELD TESTING PROGRAM

A review of the records of the Geological Survey office of Ft. Myers, Florida gave information regarding three (3) locations within the project area. These are identified as L-621, L-619, and L-616. These logs showed limestone layers alternating with sand or clays existing to approximately 80 feet in depth. An extensive

clay layer of a thickness of approximately 30 to 40 feet of a green coloration existed over most of the project area. Below 110 feet, more or less, a sandstone unit generally existed to approximately 240 to 250 feet in depth. Occasionally, deeper depths of some sand were encountered to 320 feet. Below this, additional limestones alternating with clay lenses existed to considerable depth in the area. The uppermost limestones have been pumped locally for irrigation purposes in the area. It has been considered by others, that the sandstone unit generally existing from 120 to 320 feet in depth, could provide substantial quantities of water if appropriately developed. The purpose of the Green Meadows groundwater hydrologic study was to develop information in regard to the uppermost limestones and the so-called sandstone unit to determine the approximate suitability of this formation to yield water to wells and to determine the quality of this water. Ten (10) test holes have been drilled covering the area approximately as located on the previous illustration and the driller's interpretation of these formations are included for their information. Water samples have been taken from these wells and in all cases, the deeper waters are satisfactory for public supplies with some water conditioning desirable. These data on water quality are included following the test logs in the appendix.

Subsequent to the initiation of this study, Florida Cities Water Company was acquired by GAC Utilities and concurrently, a study of a similar nature was being conducted for Florida Cities

Water Company. The Florida Cities Water Company was investigating an area between the Tamiami Trail and the Green Meadows project area to see if suitable waters could be developed to supplement their supply at a point closer to the supply pipelines. Attached in the appendix of this report are the driller's interpretation of the test hole formations encountered and the water quality analysis that are available. Generally, it was found that the water was unsatisfactory in the area near the Corkscrew grade road. Discussions were held with the San Carlos Park Development Company and two (2) test holes were drilled in the eastern-most portion of this development. Although the yield looked very promising in the San Carlos Park area, chlorides in the water samples taken were generally in excess of 450 mg/1 (P.P./M.) and were unsatisfactory for public water supply use. One test hole had chlorides in excess of 1200 ppm which apparently is located close to a deep flowing well and has experienced serious contamination. Because of the experience in the accessible areas close to Tamiami Trail, further investigation in this area was abandoned. The next test hole was located along Alico Road at a point approximately five (5) miles east of the Tamiami Trail. At test hole designated "FCWC-5-71", the quality of water was acceptable; however the yield potential was less than desired. The sandstone formation anticipated in the 120 to 220 feet depth was absent producing primarily tight limestones with some yield potential. Test Hole 6-71 was drilled one-half mile to the west and showed an increase in chlorides and total dissolved solids. These data were interpreted to indicate that this location was near the edge

of the transition zone of favorable quality water. Therefore, further development of this formation should be at least one (1) mile in an easterly direction to provide suitable protection from the invasion and infiltration of poor quality water. Test Hole 7-71 for Florida Cities Water Company was drilled to a depth of 300 feet encountering limestones, some gray sand with some black sand indicating the sandstone aquifer unit was still absent but apparently, we were at the beginning of this material. The yield characteristics of the limestone appeared satisfactory and with proper well construction, a satisfactory yield of suitable quality of water was available at this location for public water supply purposes. In a separate report to Florida Cities Water Company, this location was recommended as a suitable location for a well field consisting of approximately five (5) wells located approximately one-fourth mile spacing between wells and should be capable of producing 350 gpm each, (1/2 mgd) for a total of 2-1/2 mgd. It was anticipated that the yield of the formation should be in excess of 500 gpm at this location for testing purposes and to meet peak demands if needed. The water test analysis showed total dissolved solids of 445 ppm with chlorides 72 ppm at the above location. One additional test hole was drilled east of Estero approximately 2-1/2 miles along the Corkscrew grade although the yield characteristics at this location were ample, total dissolved solids were in excess of 1000 ppm with chlorides at 340 ppm.

Static water level has been measured a number of times in many of the holes, and is normally found between 5 and 9 feet below

land surface. It is the intent of the study to have elevations run to available test hole in the project area and to accurately establish the water table elevation and gradient that exists in the area.

WORK TO CONCLUDE STUDY

In the first phase of this investigation, suitable sites and satisfactory quality of water has been identified by test drilling and laboratory analyses of water samples taken. Test Hole 7-71, drilled for Florida Cities Water Company is a satisfactory location as well as Test Holes No. 9, 10, and 12, of the Green Meadows project. GAC Utilities will designate a site near one of the above mentioned test holes as a suitable location for a test production well. As a part of the second phase of this study, the production well of suitable design to meet State Health Requirements is to be constructed and tested at a substantial rate to determine the yield characteristics of the aquifer. Prior to commencing the test, at least one (1) and possibly two (2) additional piezometer wells are to be constructed in the vicinity of the test well to observe the effect of pumpage on the aquifer. The well contractor is expected to install a pump with the capability of pumping at least 700 gpm with 150 feet total pumping head. The test production well is to be cased and cemented to approximately 80 feet in depth in a confining clay layer to leave undisturbed as much as possible, the upper-most limestones aquifers existing in the vicinity. Water sample analyses have indicated some water quality may be superior in some respects in the lower formations and it is anticipated this

will be the primary aquifer to supply water for public supplies.

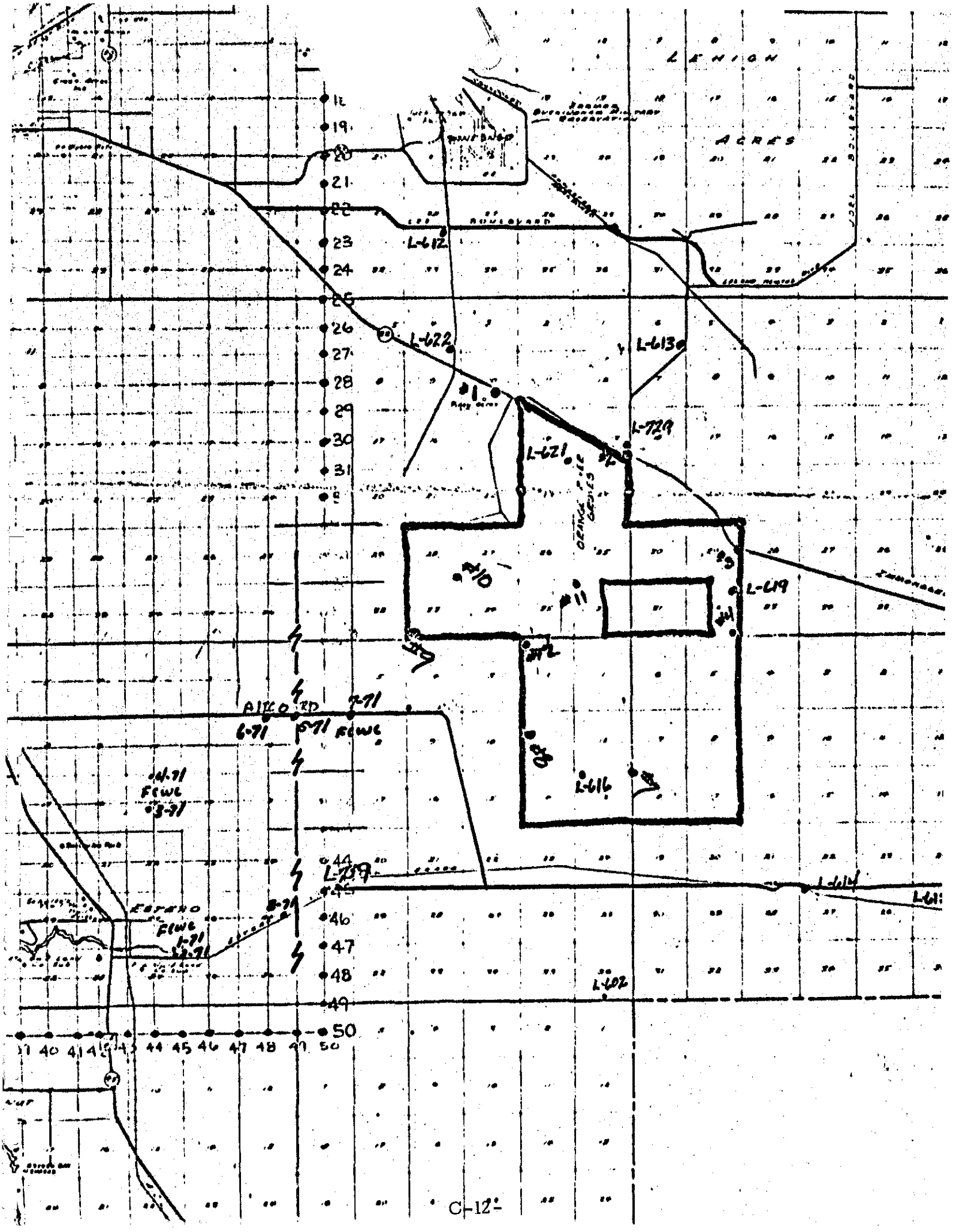
After the conclusion of test pumping a production well, the data will be analyzed and applied to all other test holes constructed in the area by the hydrologist to determine the maximum potential drawdown in the lower aquifer unit due to pumpage at various projected rates expected for future development. These data are to be analyzed and with subsequent computations, to be prepared in a final report available for general distribution to interested parties.

It is the opinion of the hydrologist that transmissivity of the aquifer in the Green Meadows project area would be found as a result of a test, to be in the range of 60,000 to 90,000 gpd/ft. width of aquifer material. Storativity should approach 0.05. Both aquifer coefficient values are from four to five times greater than that experienced from the water supply study of the Upper Hawthorn formation in the vicinity of Cape Coral and the Cypress Lakes well field. This would place the potential yield of the aquifer in the vicinity of Green Meadows at least four and possibly five times greater than that experienced in the previous mentioned areas. The investigative program identified in this report is designed to verify these opinions.

As stated in the Water Supply Study for Western Lee County, Florida, for Florida Cities Water Company, four (4) wells drilled north or northwest of the Cypress Lakes well field by the cable tool method or possibly only two (2) wells of 10 inch diameter, drilled by the reverse air hydraulic circulation method, would provide an additional

one million gallons per day of additional capacity to this facility for the present time. The yield life of these additional wells is expected to be two to three years duration. Upon completion of developing a well field in the southeastern portion of Lee County, the existing wells in the Cypress Lakes plant should be maintained on a stand-by basis to meet peak demands during periods of high use. During periods of low water use, these wells should be maintained in an idle condition to allow recovery of water levels in the vicinity. This will allow for more economical pipeline transmission sized to the high average rate and not required to meet peak demands.

APPENDIX


L-612
L-622
L-613
L-621
L-729
L-619
L-616
L-602
ALICO RD
FCWC
FARMO
FCWC

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Project

No. GAC Utilities, Inc. Date February 25,1971

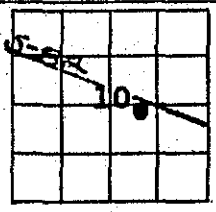
ty Lee County State Florida

TEST HOLE No. 1 and 1-A

Driller Marvin Miller

ation of Test Hole
thwest Corner of Area

¼ SE ¼ Sec. 10 of T 45 S,
26 E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 9.77 (No. 1)

Static Water Level 5.72 (NO. 1-A) Measured 100+ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	6	Sandy Soil	6	
)	9	Marl rock and sand	3	
9	19	Rock	10	
)	39	Marl rock and sand, hard	20	Good
9	55	Limestone rock, with clay and sand	16	Poor
5	75	Green clay with fragments of shell	20	
75	88	Green clay and shell	13	
3	89	Sandstone, hard	1	
89	91	Yellow gravel and sand	2	Fair
1	101	Sandstone, shell and coarse sand	10	Good
1	137	Shell, coarse sand and sandstone layers	36	Good
7	153	Coarse sand, less shell and dark clay color	16	Good
3	163	Coarse sand, shell with light clay color	10	Good
63	194	Soft limestone	31	Fair
4	224	Clay and shell	30	None
24	240	Clay with some sand mixed	16	
0	---	Total Depth Drilled		

g of Test Well 1-A located 2 feet from No. 1 was the same to 61 feet depth.

marks: ~~Test Well No. 1 has 2 inch diameter pipe to 89 feet depth.~~
Test pumped 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well No. 1-A has 2 inch diameter pipe to 40 feet and 61 feet of hole depth.
Test Well No. 1-A test pumped 1 hour at 3 gpm for water sample.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Project

No. GAC Utilities, Inc. Date February 25, 1971

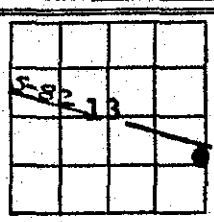
ity Lee County State Florida

TEST HOLE
No. 2 and 2-A

Driller Marvin Miller

ation of Test Hole
rth Center of Area

E ¼ SE ¼ Sec. 13 of T 45 S,
26E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 10.66 (NO. 2)
Static Water Level 5.16 (No. 2-A)
Measured 100+ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	11	Sand	11	
1	15	Rock	4	
15	25	Marl with clay	10	
5	29	Very hard marl	4	Fair
29	50	White marl	21	Good
0	51	Hard pan (very hard)	1	None
1	61	Sandy clay, light color	10	None
1	63	Rock	2	None
3	73	Limestone, firm	10	Good
73	85	Limestone, soft	12	Fair
5	87	Rock, gray in color	2	None
87	97	Limestone, loose	10	Good
7	98	Rock, hard	1	None
98	128	Sandstone with hard and soft layers	30	Good
8	143	Coarse sand and shell	15	Good
143	160	Fine gray sand	17	Fair
0	175	Clay	15	None
5	184	Shell	9	Fair
84	234	Shell rock with some clay	50	Fair
4	238	Clay	4	None

Remarks: Test Well No. 2 has 2 inch diameter pipe to 162 feet depth.
Test pumped for 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well 2-A has 2 inch diameter pipe to 23 feet depth and 50 feet hole depth.
Test pumped for 1 hour for water sample at 60 gpm, full capacity of pump.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

o tract Name Green Meadows Project

r No. GAC Utilities, Inc. Date February 15,197

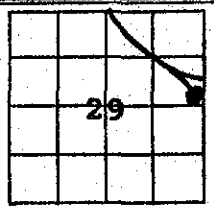
ity Lee County State Florida

TEST HOLE
No. 3 and 3-A

Driller Marvin Miller

ation of Test Hole
ortheast Corner of Area

¼ NE ¼ Sec. 29 of T 45 S,
27 E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 12.60 (No. 3)
Static Water Level 7.00 (No. 3-A)
Measured 100+ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	19	Brown sand	19	
1	29	Limestone, water bearing rock	10	Good
9	31	Rock	2	
	49	Limestone, light to dark clay color	18	Good
9	59	Limestone and clay	10	Fair
	75	Limestone, clay and sand	16	Fair
75	85	Limestone, sand and shell	10	Good
	95	Limestone and sand	10	Good
9	110	Limestone and shell, yellow in color	15	Good
0	111	Shell rock, hard	1	
1	158	Shell and sand	47	Good
8	169	Sandstone with sand in layers	11	Good
)	208	Sand and clay with trace of shell	39	Fair
08	218	Sand and clay	10	Poor
	235	Sand and clay, very soft	17	None
35	239	Clay	4	
9	---	Total Depth Drilled		
of Test	Well 3-A located 2 feet from No. 3 was the same to 50 feet depth.			

marks: Test Well No. 3 has 2 inch diameter pipe to 110 feet in depth.
Test pumped 2 hours for water sample at 60 gpm, pump capacity.
Test Well No. 3-A has 2 inch diameter pipe to 21 feet and 50 foot hole depth.
Test pumped 1 hour for water sample at 60 gpm, pump capacity.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

c tract Name GAC Utilities, Inc.

TEST HOLE No. 4

No. Green Meadows Date April 1971

ity Ft. Myers State Florida Driller M. E. Miller

ation of Test Hole

Elevation of Test Hole

32

Static Water Level

¼ SE ¼ Sec. 32 of T 45S, 27E, Lee Co., Florida

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
	6	Light brown sand		
	7	Hard pan layer		
7	27	Sand and shell		
	29	Hard shell and sand		
	36	White sand and shell		
	41	Lime rock - hard		
	50	White sand and shell		
		Location temporarily abandoned - due to difficulty		

marks: Lost one string of tools at 50 feet. Sand would heave in casing and wedge ools. Casing pipe locked to rock by sand wedge. Lost string of casing pipe.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Green Meadows

No. KC-998-C Date March 18, 1972

y Green Meadows State Florida

TEST HOLE
No. 7

Driller M. Miller

tion of Test Hole Near The Center
The East Side Of Section.

¼ NE ¼ Sec. 13 of T 46 S.,
26 E., Lee Co., Florida.

13

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	4"	Topsoil		
4"	6'	White sand		
6'	9'	Brown sand		
9'	13'	Marl		
13'	17'	Sand		
.7'	20'	Shell rock		
20'	40'	Hard rock		
40'	82'	Sand and shell		
32'	86'	Sand rock (hard)		
86'	126'	Sand and shell		
6'	150'	Sand shell and rock		
50'	170'	Green clay		
0'	228'	Lime rock		
228'	230'	Clay		
0'	Total	Depth		

marks:

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Tract Name Green Meadows

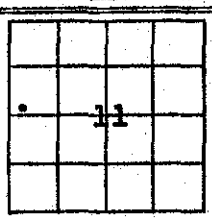
Job No. KC-998-C Date March 18, 1972

TEST HOLE No. 8

City Green Meadows State Florida Driller M. Miller

Location of Test Hole Near The Center Of The West Side Of Section

¼ NW ¼ Sec. 11 of T 46 S., 26 E., Lee Co., Florida.



Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
0	4"	Topsoil		
4"	5'	White sand		
5'	9'	Brown sand		
9'	14'	Marl		
14'	17'	Sand		
17'	43'	Rock		
43'	55'	Sand and shell		
55'	75'	Rock and sand		
75'	85'	Clay and shell		
85'	95'	Clay		
95'	115'	Sand and shell		
115'	125'	Lime rock and sand		
125'	165'	Sand and rock		
165'	Total	Depth		

Remarks:

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Green Meadows

No. KC-998-C Date March 1, 1972

TEST HOLE No. 9

ty Green Meadows State Florida Driller M. Miller

tion of Test Hole Near Fence
rner In The Section Corner

¼ SW ¼ Sec. 33 of T 45 S.,
26 E., Lee Co., Florida.

33

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	½'	Topsoil		
½'	5'	White sand		
5'	10'	Marl		
0'	14'	Clay		
14'	18'	Sand		
8'	42'	Rock		
42'	84'	Soft limestone		
4'	105'	Clay, sand, and shell		
5'	126'	Sand and limestone		
6'	156'	Sand and rock		
6'	168'	Hard rock and sand		
68'	174'	Clay		
4'	218'	Lime rock		
18'	223'	Clay		
3'	Total	Depth		

marks:

Test Pumped At 60 G.P.M.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Green Meadows

No. KC-998-C Date March 1, 1972

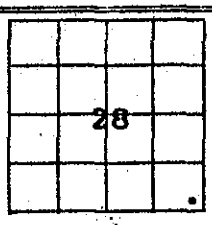
y Green Meadows State Florida

TEST HOLE
No. 10

Driller M. Miller

ition of Test Hole Near the section
orner of 28, 27, 34, & 33

¼ SE ¼ Sec. 28 of T 45 S.,
26 E., Lee Co., Florida.



Elevation of Test Hole

Static Water Level

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	½'	Topsoil		
½'	6'	White sand		
6'	11'	Marl		
1'	15'	Sandy clay		
15'	17'	Sand		
7'	40'	Rock		
40'	70'	Sandy clay		
0'	80'	Coarse sand		
0'	90'	Sand		
0'	100'	Sand and shell		
0'	120'	Sand and meal rock		
0'	130'	Fine sand		
0'	140'	Coarse sand		
40'	160'	Sand and shell		
0'	170'	Sandy clay		
70'	180'	Sand and lime rock		
0'	220'	Lime rock		
0'	230'	Clay		
0'	Total	Depth		

marks:

Test Pumped At 50 G.P.M.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name GAC Utilities, Inc.

TEST HOLE No. 11

h No. Green Meadows Date May 1971

ty Ft. Myers State Forida Driller M.E. Miller

ation of Test Hole West side of
ad 300± feet south of section
rner marker.
¼ NE ¼ Sec. 35 of T 45S,
26E, Lee Co., Florida.

35

Elevation of Test Hole

Static Water Level

Measured ____ Hours After Completion

m	To	Description of Strata	Water Bearing	
0	15	Sand		
	19	White marl rock - hard		
9	27	Lime rock and marl		
	45	White marl		
5	82	Clay and shell		
	108	Loose sand and limestone		
	109	Lime rock - hard		
	120	Shell and sand		
	130	Sand with some shell		
0	138	Lime rock with sand layers		
	148	Lime rock with shell and sand		
8	149	Sandstone - hard		
	155	Sand with trace of shell		
5	165	Layers of sand and sandstone - hard		
	203	Gray sand		
3	221	Limestone and sand		
	241	Limestone with shell and sand		
	255	Clay with trace of shell		
5	Total	Depth		

emarks: Installed 2-inch diameter casing with drive shoe to 130 feet. Test umped well at 45 gpm for 2 hours and collected water sample.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Groundwater Study

b No. KC 998-C Date 24 Sept. 71

TEST HOLE No. 12

Ft. Myers State Florida Driller M.Miller

ation of Test Hole

35

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

¼ SW ¼ Sec. 35 of T 45S, 26E, Lee Co., Florida.

m	To	Description of Strata	Water Bearing	
0	17	Light colored sand		
	49	Layers of hard rock and coarse sand	32	good
9	69	Clay in limestone and sand	20	poor
	84	Limestone and sand, clay filled	15	none
	90	Green clay	6	none
	94	Limestone with green clay	4	none
	103	Limestone with layers of hard rock, water bearing	9	fair
3	140	Limestone (very good water bearing material)	37	V.goo
	156	Hard rock layers with sand	16	good
5	166	Boulders, gray sand (firm) with some shell	10	poor
	186	Gray sand with trace of shell	20	poor
5	196	Gray sand with some limestone	10	poor
	226	Limestone with some clay	30	poor
6	235	Mostly clay with some limestone rock	9	none
	236	Medium rock	1	none
	246	Clay with some shell	10	none
	246	Total depth drilled		

emarks: Installed 82 feet of 2 inch diameter pipe. Test pumped 60+ gpm with 15 inches of vacuum.

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-621

Driller _____

Test Hole Location SE¼, Sec. 14, T 45 S., R 26 E. in Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	6'0"			Sand, fine to med., white to yellow
6'0"	10'0"			Sand, gray, silty
10'0"	20'0"			Limestone, tan
20'0"	40'0"			Limestone, tan; gray marl
40'0"	60'0"			Clay, green
60'0"	75'0"			Sandstone, gray, calcareous; shell
75'0"	80'0"			Limestone, blue-gray
80'0"	95'0"			Limestone, blue-gray, sandy
95'0"	120'0"			Sandstone, gray, calcareous
120'0"	140'0"			Sandstone, gray, green clay
140'0"	160'0"			Clay and limestone, gray
160'0"	170'0"			Clay, green
170'0"	190'0"			Clay, light gray and limestone
190'0"	200'0"			Limestone, light gray, sandy
Continued----				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data obtained from U.S. Geological Survey - Ft. Myers, Florida. Located Green Meadows Area, Drilled by others several years ago.

5000 2-68

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE
No. L-621

Driller _____

Test Hole Location _____
Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-621 **TEST LOG**

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
200'0"	220'0"			Clay, gray, some limestone
220'0"	240'0"			Clay, green and gray
240'0"	260'0"			Clay, dark gray, phosphatic; phosphate grains
260'0"	280'0"			Clay, dark gray, phosphatic, sandy
280'0"	320'0"			Limestone, gray-white, phosphatic
320'0"	340'0"			Same
340'0"	360'0"			Limestone, as above, some gray clay

NOTES: Size of Pit _____ X _____ X _____
DEEP

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-619

Driller _____

Test Hole Location NE ¼, Sec. 32, T 45 S., R 27 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	12'0"			Sand, fine to med., tan to brown
12'0"	20'0"			Limestone, tan
20'0"	85'0"			Limestone, ?
85'0"	120'0"			Clay, green, ?
120'0"	200'0"			Limestone, sandy, ?
200'0"	220'0"			Sandstone, gray
220'0"	240'0"			Same
240'0"	260'0"			Clay, dark gray, sandy
260'0"	280'0"			Sand, gray, clayey
280'0"	320'0"			Sand, med. to coarse
320'0"	380'0"			Limestone, gray, casts, molds
380'0"	400'0"			Limestone, gray and tan
400'0"	440'0"			Clay, gray, phosphatic
440'0"	460'0"			Clay, green
Continued-----				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data From U.S. Geological Survey - Ft. Myers, Florida. Drilled By Others In Green Meadows Area Several Years Ago.

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE
No. L-619

Driller _____

Test Hole Location _____
Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-619 **TEST LOG**

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
460'0"	495'0"			Clay, dark gray, sandy, phosphatic
495'0"	540'0"			Limestone, gray white, phosphatic

NOTES: Size of Pit _____ X _____ X _____ DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE

No. L-616

Driller _____

Test Hole Location NW ¼ Sec. 13, T 46 S., R 26 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0	15			Sand, med., tan; sandstone; shell
15	30			Sandstone, tan, calcareous; shells
30	45			Sandstone, gray; calcareous; shells
45	60			Same
60	75			Limestone, tan and gray; shells
75	105			Limestone, gray; few shells
105	120			Clay, green; some limestone
120	150			Clay, green
150	165			Limestone, gray, sandy
165	180			Sandstone, gray-tan, calcareous
180	210			Sandstone, gray, calcareous; phosphate
210	225			Clay, dark gray-green, sandy
225	240			Sand, very fine, gray; clayey
240	270			Clay, green and gray
270	295			Clay, dark gray, sandy, phosphatic
295	345			Limestone, gray-white, phosphatic

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data Obtained From U.S. Geological Survey - Ft. Myers, Florida.

Drilled In Green Meadows Area By Others Several Years Ago.

THE KANSAS STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES
Environmental Health Laboratory
801 Harrison Street 66612

TOPEKA
KANSAS

E. D. LYMAN, M. D., M. P. H.
Director of Health

May 26, 1971

Layne Western Company, Inc.
1010 West 39th Street
Kansas City, Missouri 64111

Attention: Mr Nuzman

Dear Mr. Nuzman:

Listed below in milligrams per liter are the results of chemical analyses of two samples of water collected in Florida. The samples may be identified as follows:

No. 1 GM No. 1 240' Hole, 89' pipe, collected 4-30-71.

No. 2 GAC Test Hole No. 11, collected 5-13-71.

* * * * *

		No. 1		No. 2	
pH	=	7.3		7.3	
Total Hardness (as $CaCO_3$)	=	326.	mg/l	262.	mg/l
Calcium (as Ca)	=	104.	mg/l	69.	mg/l
Magnesium (as Mg)	=	16.	mg/l	22.	mg/l
Sodium	=	45.	mg/l	50.	mg/l
Total Alkalinity (as $CaCO_3$)	=	276.	mg/l	250.	mg/l
Chloride	=	88.	mg/l	60.	mg/l
Sulfate	=	18.	mg/l	33.	mg/l
Nitrate (as NO_3)	=	1.8	mg/l	1.5	mg/l
Fluoride	=	0.4	mg/l	0.6	mg/l
Iron	=	0.38	mg/l	0.38	mg/l
Manganese	=	0.00	mg/l	0.00	mg/l

Sincerely,

Nicholas D. Duffett, Ph.D.
Director

Howard A. Stoltenberg

Howard A. Stoltenberg, M.A.
Chief, Water Chemistry Section

HAS:glb

Cape Coral Water Treatment Plant Laboratory

LOCATION DESCRIPTION	CASING DIA.	CASING DEPTH	WELL DEPTH	PH	M.ALK.	T.Hd.	Mg.Hd.	Ca.Hd.	CL	T.D.S
Green Meadows No. 1 2/11/71	2"	89	244	7.4	270	314	66	248	80	430
Green Meadows No. 1 2/25/71	2"	89	244	7.3	272	304	72	232	120	410
Green Meadows No. 1-A 2/11/71	2"	40	61	7.2	189	710	246	464	1200	3100
Green Meadows No. 1-A 2/25/71	2"	40	61						1380	3500
Green Meadows No. 2	2"	162	238	7.2	268	198	110	88	60	440
Green Meadows No. 2-A	2"	23	50	7.2	238	250	22	228	30	300
Green Meadows No. 3	2"	110	239	7.4	284	282	88	194	110	620
Green Meadows No. 3-A	2"	21	50	7.2	214	212	10	204	20	230
Irr. Well NW¼ 10-46S-26E	6"			7.2	212	232	34	198	65	270
Irr. Well SW¼ 25-45S-26E	6"			7.4	188	216	12	204	45	250
Irr. Well SE¼ 14-46S-26E	6"			7.0	218	242	12	230	30	280
Irr. Well SE¼ 35-45S-26E	8"			7.1	234	250	12	238	35	280
Flowing Well NW¼ 9-46S-25E	6"			7.6					1000	2600
Green Meadows No. 7-A	2"		105	7.8	272	264	2	262	40	295
Green Meadows No. 7	2"		230	7.7	256	284	30	254	60	300
Green Meadows No. 8-A	2"		105	7.8	276	226	26	200	40	280
Cape Coral--North Pine Island Road	10"	125	225'	7.3	200	294	156	138	180	460

WATER QUALITY DATA
CAPE CORAL WATER PLANT

Location Description	Casing Dia.	Casing Depth	Well Depth	pH	M. Alk.	T. Hd.	Mg Hd.	Ca Hd.	Cl	T.D.S
Green Meadows #12	2"	82'	103'	7.8	186	186	48	138	40	250
Green Meadows #12	2"	82'	136'	7.9	258	272	162	110	40	310
Green Meadows #12	2"	82'	243'	7.8	246	232	72	160	40	330
Green Meadows #9			105'	7.8	290	270		270	80	390
Green Meadows #9			223'	7.6	240	244	88	156	70	350
Green Meadows #10	2"		105'	7.6	254	270	64	206	70	340
Green Meadows #10	2"		230'	7.4	248	158	76	82	70	290
Green Meadows #11-A	2"		50'	7.4	208	230	20	210	170	260
Green Meadows #11	2"	130'	255'	7.6	244	252	92	160	80	370
Green Meadows #3-A	2"	21'	56'	7.2	214	212	10	204	20	235
Green Meadows #3	2"	110'	239'	7.4	284	282	88	194	110	625
Green Meadows #2-A	2"	23'	50'	7.2	238	250	22	228	30	300
Green Meadows #2	2"	162'	238'	7.2	268	198	110	88	60	440
Green Meadows #1-A 2/11/71	2"	40'	61'	7.2	184	710	246	464	1200	3100
Green Meadows 2/25/71	2"	40'	61'						1380	3500
Green Meadows #1	2"	89'	240'	7.4	270	314	66	248	80	430
Green Meadows #1	2"	89'	244'	7.3	280	304	72	232	120	410

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: LAYNE-WESTERN COMPANY

Appearance: CLEAR

Date: SEPTEMBER 20, 1971

Sampled by: CLIENT

Sample Number: 4809

Identification: GM #12 TEST WELL 82' PIPE 243' DEEP PUMP +60 GPM MOST WATER FROM 90'-155' LEVEL

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	366	Sulfate, as SO_4	16
Total Hardness, as $CaCO_3$	240	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	180	Silica, as SiO_2	37
Magnesium Hardness, as $CaCO_3$	60	Copper, as Cu	0.0
Calcium, as Ca	72	Phosphate (Total), as PO_4	0.7
Magnesium, as Mg	14	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	270	pH (Laboratory)	7.8
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	270	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.9
Carbon Dioxide, as CO_2	9	Turbidity, Silica Scale	20
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	330		
Chlorides, as Cl	39		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: J. Hobbs
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

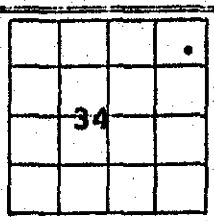
No. KC-277-C Date June 30, 1971

y Ft. Myers State Florida

TEST HOLE No. Estero #1

Driller M. Miller

tion of Test Hole Near the NE corner
a small tract of land located
n the:
¼ NE ¼ Sec. 34 of T 46S,
25 E., Lee Co., Florida.



Elevation of Test Hole

Static Water Level Flowing Well

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	7	Light sand		
	17	Sand with hard pan layers at 7' and 17'		
7	27	Sand (some rust color) and limestone	10	Some
	43	White limestone formation	16	Fair
3	73	Clay, light colored changing to a darker color	30	None
	80	Clay, with a trace of shell	7	None
0	98	Hard limestone with rock -- 4 to 6-inch voids	18	Fair
	108	Compacted limestone with colored sand	10	Poor
0	116	Hard sandstone with gray sand	8	Poor
6	146	Gray sandstone	30	Poor
	176	Compacted sand with limestone color	30	Poor
6	194	Black sand	18	Fair
	201	Black sand with some clay mixed	7	Poor
1	206	Lime rock, Artesian flow started at 4 GPM	5	Fair
	210	Lime rock, water sample taken, flow 10 GPM	4	Good
0	218	Lime rock with dark sand	8	Fair
	238	Shell and lime rock	20	Good
0	261	Lime rock, Artesian flow in excess of 30 GPM	23	V.Goo
	263	Heavy clay	2	None
	Total	Depth Drilled		

arks: Chlorides from flowing well were reported to be 540 mg/l only 42 feet of inch pipe was used in constructing test hole.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Tract Name Florida Cities Water Company

TEST HOLE No. Estero #2

No. KC-277-C Date June 30, 1971

y Ft. Myers State Florida Driller M. Miller

tion of Test Hole Near the SW corner small tract of land located the ¼ NE ¼ Sec. 34 of T 46 S., 25 E., Lee Co., Florida

34

Elevation of Test Hole

Static Water Level Flowing Well

Measured _____ Hours After Completion

m	To	Description of Strata	Water Bearing	
0	10	White sand		
	14	Brown sand	4	Fair
4	24	Sand rock with limestone and white sand	10	Good
	35	Limestone and sand	11	Fair
5	45	Light colored clay and shell	10	Poor
	79	Green clay		
9	89	Clay and limestone		
	109	Layers of hard limestone and sand	20	Fair
0	119	Boulders in limestone and sand	10	Poor
9	175	Limestone with sand and clay	56	Poor
	195	Black sand and clay mixed	20	Fair
5	205	Shell and limestone formation flow at 4 GPM	10	Fair
	212	Shell and limestone formation	7	Good
2	222	Clay color limestone with small gravel	10	Fair
	232	Limestone and gravel	10	Fair
32	252	White shell and limestone flow about 30 GPM	20	Good
	259	Clay colored shell and clay	7	Fair
0	261	Clay	2	None
	Total	Depth Drilled With Churn Drill		

narks: Only 42 feet of 2-inch diameter pipe required to drill test hole original oride content was approximately 550 mg/l. Well was plugged back with cement 195 feet and tested. Chloride's still 460 mg/l after 16 hours pumping. W.L. 3.5 feet below land surface after plugging.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: LAYNE WESTERN CO. INC. Appearance: CLEAR

Date: JUNE 29, 1971 Sampled by: CLIENT

Sample Number: 4543 Identification: WELL #2

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,400	Sulfate, as SO_4	80
Total Hardness, as $CaCO_3$	504	Fluorides, as F	0.8
Calcium Hardness, as $CaCO_3$	282	Silica, as SiO_2	4.0
Magnesium Hardness, as $CaCO_3$	222	Copper, as Cu	0.0
Calcium, as Ca	113	Phosphate (Total), as PO_4	0.8
Magnesium, as Mg	54	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	192	pH (Laboratory)	7.5
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	192	Stability Index	6.3
Hydroxides, as OH	0	Saturation Index	0.6
Carbon Dioxide, as CO_2	12.5	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	234		
Chlorides, as Cl	465		
Iron, as Fe	0.05		
Manganese, as Mn	0.0		

Signed: J. Hobbs
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Florida Cities Water Company

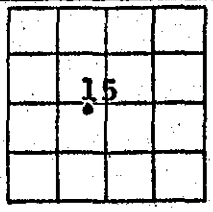
No. KC 277-C Date 29 June, 1971

TEST HOLE No. 3-71

y San Carlos Park State Florida Driller M. Miller

ition of Test Hole East end of San arlos Boulevard near the center Section 15

¼ SW ¼ Sec. 15 of T 46-S, 25-E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level Above land surface

Measured Hours After Completion

m	To	Description of Strata	Water Bearing	
0	6	Gray sand		
6	11	Hard rock and boulders		
11	21	Yellow to orange sand	10	Fair
1	30	White sand with soft limerock	9	Fair
30	38	Soft limestone rock	8	Fair
8	50	Limestone with green clay	12	Poor
50	80	Green clay	30	None
0	96	Clay with shell and sand	16	None
96	103	Water producing sand and limestone - (Water Sample)	7	Good
1	126	Compact sand and shell with some clay	15	Fair
26	141	Limestone and shell	15	Fair
41	151	White limestone	10	Good
1	181	Limestone with some clay	30	Fair
81	211	Limestone with black sand	30	Fair
1	216	Limestone formation (water sample)	5	Good
	216	Total depth of drilling		
		Water sample at 103' had chlorides of 1200 ppm		
		Water sample at 216' had chlorides of 1200 ppm		

marks: At 103', pumped 42 gpm with approximately 28" of vacuum (42'pipe) with 0' of casing pipe at 216' depth, the static level was above ground with well lowing 5 gpm. Pumped more than 60 gpm.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

TEST HOLE No. 4-71

No. KC 277-C Date 2 July, 1971

y San Carlos Park State Florida Driller M. Miller

tion of Test Hole 1/2 mile north of H. 3-71 in San Carlos Develop-nt area.

¼ NW ¼ Sec. 15 of T 46S, 25E, Lee Co., Florida.

15

Elevation of Test Hole

Static Water Level at land surface

Measured Hours After Completion

n	To	Description of Strata	Water Bearing	
0	8	Brown sand		
)	11	Two layers of rock in sand		
11	27	White sand medium to fine	16	Fair
'	44	White marl rock		
44	96	Green clay with some shell	52	None
)	105	Hard limestone rock	9	Fair
05	115	Sand and fine limestone (water sample pumped)	10	Good
'	145	Dense gray sand	30	Fair
.5	155	Sand and clay	10	Poor
55	175	Sand with some clay and limestone, mixed	20	Fair
)	185	Black sand with clay and limestone	10	Fair
85	200	Black sand and limestone (water sample)	15	Good
	200	Total depth of drilling		
		Water sample at 115' had chlorides of 475 ppm		
		Water sample at 200' had chlorides of 445 ppm		

narks: At 115' depth with 63' of casing, well pumped 30 gpm with 28" of vacuum rough a 2" diameter pipe. At 200' depth with 63' of 2" casing pumped ver 60 gpm.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

TEST HOLE No. 5-71

No. KC-277-C Date Sept. 27, 1971

y Fort Myers State Florida Driller M. Miller

tion of Test Hole 5 miles east of .S.41 on Alico (Rock Pit) Road

stimate location in

¼ SE ¼ Sec. 1 of T 46 S, 25 E, Lee Co., Florida

Elevation of Test Hole

Static Water Level About 5 feet

Measured _____ Hours After Completion

m	To	Description of Strata	Water Bearing	
0	9	Sand		
	16	Medium Hard Rock	7	
6	24	Sand	8	
	43	Layers of Rock and Sand	19	Fair
3	47	Solid Rock, hard	4	V.Poo
	77	Sand with heavy clay	30	V.Poo
	79	Hard pan layer	2	None
	106	Lime Rock (Pumped 50 gpm for water sample)	27	Good
	125	Lime Rock and shell (light clay color)	19	Fair
5	140	Rock layers with clay and compacted sand	15	Poor
	157	Gray sand with clay	17	V.Poo
7	177	Limestone and light colored clay with black sand	20	Poor
	195	Limestone, Loose granular formation.	18	Fair
5	205	Limestone and clay	10	Poor
	215	Limestone and clay with black sand	10	Poor
5	230	Clay with some sand	15	None
	Total	Depth of Drilling		

arks: Pumped 1 hour only 15 gpm with 122 feet of 2 inch pipe casing in test hole at 230 feet depth. Estimate yield potential at 250 gpm from 79 to 140 foot depth.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Date: SEPTEMBER 7, 1971

Sample Number: 4758-1

Appearance: CLEAR

Sampled by: CLIENT 5-71

Identification: ALICO ROAD WELL
10 - 84' PIPE 94' HOLE
5 mile East "41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	510	Sulfate, as SO_4	26
Total Hardness, as $CaCO_3$	300	Fluorides, as F	0.40
Calcium Hardness, as $CaCO_3$	216	Silica, as SiO_2	25
Magnesium Hardness, as $CaCO_3$	84	Copper, as Cu	0
Calcium, as Ca	86	Phosphate (Total), as PO_4	0.3
Magnesium, as Mg	21	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	246	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	246	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.5
Carbon Dioxide, as CO_2	19	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	300		
Chlorides, as Cl	96		
Iron, as Fe	0.36		
Manganese, as Mn	0.0		

Signed: Gene Stefura
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: SEPTEMBER 7, 1971

Sampled by: CLIENT 5-71

Sample Number: 4758-2

Identification: ALICO ROAD WELL
#2 - 122' PIPE 230' HOLE
5 mile East of 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	700	Sulfate, as SO_4	0
Total Hardness, as $CaCO_3$	330	Fluorides, as F	0.48
Calcium Hardness, as $CaCO_3$	216	Silica, as SiO_2	23
Magnesium Hardness, as $CaCO_3$	114	Copper, as Cu	0
Calcium, as Ca	86	Phosphate (Total), as PO_4	0.8
Magnesium, as Mg	28	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	156	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.1
Bicarbonate Alkalinity, as $CaCO_3$	156	Stability Index	6.8
Hydroxides, as OH	0	Saturation Index	0.3
Carbon Dioxide, as CO_2	12	Turbidity, Silica Scale	5
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	190		
Chlorides, as Cl	234		
Iron, as Fe	0.20		
Manganese, as Mn	0.0		

Signed: Gene Hendricks
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

No. KC 277-C Date 14 Oct., 1971

TEST HOLE No. 6-71

y Ft. Myers State Florida Driller M. Miller

tion of Test Hole 4.5 miles E. of U.S. n Alico (Rock Pit) Road-Estimate

ation in ¼ SW ¼ Sec. 1 of T 46S, 25E, Lee Co., Florida.

Elevation of Test Hole

Static Water Level

Measured ____ Hours After Completion

m	To	Description of Strata	Water Bearing	
	13	White Sand		
	33	Limestone, rock	20	Fair
	43	Limestone rock, hard layers	10	Fair
	55	Limestone rock, medium hard	12	Fair
	75	Green clay w/some rock particles	20	None
	77	Black rock	1	None
	82	Clay and sand mixed	5	None
	83	Rock layer	1	None
	90	Clay and sand	7	None
	115	Limestone (pump test at 103' - 60+ gpm)	25	Good
	125	Fine limestone material w/sand	10	Poor
	135	Sand and shell, firm	10	Fair
	146	Sand and shell, loose (pumping test - 65+ gpm)	11	Good
	146	Total depth of drilling		

arks: Two (2) inch diameter test hole - Two (2) water samples taken for analysis

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 6-71

Sample Number: 4859-1

Identification: ALICO #1 61' PIPE 103' HOLE 60 GPM 4.5 mile East #41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	710	Sulfate, as SO_4	33
Total Hardness, as $CaCO_3$	360	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	270	Silica, as SiO_2	23
Magnesium Hardness, as $CaCO_3$	90	Copper, as Cu	0
Calcium, as Ca	108	Phosphate (Total), as PO_4	2.8
Magnesium, as Mg	22	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	264	pH (Laboratory)	7.5
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	264	Stability Index	6.1
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	18	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	322		
Chlorides, as Cl	192		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Upchurch
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 6-71

Sample Number: 4859-2

Identification: ALICO #1 61' PIPE 147' HOLE
70 GPM 4.5 Emst = 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	825	Sulfate, as SO_4	34
Total Hardness, as $CaCO_3$	420	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	300	Silica, as SiO_2	24
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	120	Phosphate (Total), as PO_4	0.5
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	258	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	258	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	22	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	314		
Chlorides, as Cl	240		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Wyckoff
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 6-71

Sample Number: 4859-2

Identification: ALICO #1 61' PIPE 147' HOLE
70 GPM 4.5 East #41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	825	Sulfate, as SO_4	34
Total Hardness, as $CaCO_3$	420	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	300	Silica, as SiO_2	24
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	120	Phosphate (Total), as PO_4	0.5
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	258	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	258	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	22	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	314		
Chlorides, as Cl	240		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Hyde
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

TEST HOLE No. 7-71

No. KC 277-C Date 14 Oct., 1971

y Ft. Myers State Florida Driller M. Miller

tion of Test Hole Six miles E. of U.S. on Alico (Rock Pit) Road.

timate location in ¼ SE ¼ Sec. 6 of T 46S, 26E, Lee Co., Florida

Elevation of Test Hole

Static Water Level

Measured ____ Hours After Completion

m	To	Description of Strata	Water Bearing	
0	13	Surface sand		
	47	Hard rock w/sand layers		
7	57	Clay w/shell and rock		
	89	Clay		
9	109	Limestone formation, hard		
	119	Limestone and shell		
	129	Lime rock w/shell and sand		
	139	Lime rock w/shell, black rock and sand		
	169	Gray sand		
9	199	Limestone material in sand		
	219	Limestone sand w/black sand		
9	239	Black sand w/some green clay color		
	259	Black sand w/fine limestone mixed		
9	300	Green clay w/black and white coarse sand		

arks: Pumped two (2) inch diameter hole one (1) hour at 15 gpm with 147 feet of casing pipe in test hole.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: SEPTEMBER 24, 1971

Sampled by: CLIENT 7-71

Sample Number: 4831

Identification: #3 - ALICO #3 WELL
61' PIPE 103' HOLE 60 GPM
6 mile East. - 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	445	Sulfate, as SO_4	12
Total Hardness, as $CaCO_3$	318	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	222	Silica, as SiO_2	17
Magnesium Hardness, as $CaCO_3$	96	Copper, as Cu	0
Calcium, as Ca	89	Phosphate (Total), as PO_4	0.1
Magnesium, as Mg	23	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	276	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	276	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.4
Carbon Dioxide, as CO_2	35	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	337		
Chlorides, as Cl	72		
Iron, as Fe	0.10		
Manganese, as Mn	0.0		

Signed: Gene Hedrick
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 7-71

Sample Number: 4859-3

Identification: ALICO #2 145' PIPE 300' HOL 3GPM 6 Mile East of 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	283	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	180	Fluorides, as F	0.64
Calcium Hardness, as $CaCO_3$	120	Silica, as SiO_2	10
Magnesium Hardness, as $CaCO_3$	60	Copper, as Cu	0
Calcium, as Ca	48	Phosphate (Total), as PO_4	0.2
Magnesium, as Mg	14	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	102	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.5
Bicarbonate Alkalinity, as $CaCO_3$	102	Stability Index	7.6
Hydroxides, as OH	0	Saturation Index	-0.1
Carbon Dioxide, as CO_2	8.7	Turbidity, Silica Scale	23
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	124		
Chlorides, as Cl	63		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Elfstrom
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ract Name Florida Cities Water Company

No. KC 277-C Date 14 Oct., 1971

TEST HOLE No. 8-71

y Ft. Myers State Florida Driller S. J. Boren

tion of Test Hole Corkscrew Grade Road
st of Estero

¼ ¼ Sec. 25 of T 45S,
26E, Lee Co., Florida.

25

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

n	To	Description of Strata	Water Bearing	
	11	Surface sand		
	18	Hard rock		
	39	Lime rock containing shallow water	21	Fair
	86	Clay	47	None
	144	Lime rock - water bearing	58	Good
	174	Limerock w/heavy clay and shell	30	Poor
	180	Black sand	6	Fair

arks:
Two (2) inch diameter test hole pumps good at 60+ gpm w/only 8-10 inches if vacuum

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: OCTOBER 6, 1971

Sampled by: CLIENT 8-71

Sample Number: 4883

Identification: (#1) CORK SCREW GRADE
2.3M. E. US 41
41' Pipe-100'Hole-40GPM

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,100	Sulfate, as SO_4	47
Total Hardness, as $CaCO_3$	468	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	318	Silica, as SiO_2	30
Magnesium Hardness, as $CaCO_3$	150	Copper, as Cu	0
Calcium, as Ca	127	Phosphate (Total), as PO_4	0.4
Magnesium, as Mg	36	Color, Standard Platinum Cobalt Scale	10
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	252	pH (Laboratory)	7.3
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	252	Stability Index	6.1
Hydroxides, as OH	0	Saturation Index	0.6
Carbon Dioxide, as CO_2	27	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	307		
Chlorides, as Cl	340		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Eyeduna
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: OCTOBER 6, 1971

Sampled by: CLIENT 8-71

Sample Number: 4883-1

Identification: #2 CORK SCREW GRADE
2.3 M. E. US 41

METHODS 57' Pipe-184' Hole-60GPM-10" Vac.

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,220	Sulfate, as SO_4	68
Total Hardness, as $CaCO_3$	492	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	342	Silica, as SiO_2	30
Magnesium Hardness, as $CaCO_3$	150	Copper, as Cu	0
Calcium, as Ca	137	Phosphate (Total), as PO_4	0.4
Magnesium, as Mg	36	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	3
Alkalinity (Total), as $CaCO_3$	230	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	230	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	19	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	281		
Chlorides, as Cl	369		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Sfredda
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN, MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Layne-Western Company

Contract Name: Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE
No. L-729

Driller _____

Test Hole Location: South Entrance to Lehigh Acres SE¼ 13 - 45 S. - 26 E.
Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	5'0"			Sand, medium, dark brown
5'0"	9'0"			Clay, white
9'0"	15'0"			Sand, medium, tan.
15'0"	27'0"			Limestone, creamy tan
27'0"	41'0"			Same; sandy
41'0"	50'0"			Clay, light gray
50'0"	60'0"			Clay, green; numerous shell fragments
60'0"	80'0"			Limestone, gray
80'0"	100'0"			Limestone, tan, sandy
100'0"	110'0"			Sand, medium, gray-tan
110'0"	120'0"			Sand, med.-coarse, gray, shell fragments
120'0"	130'0"			Sandstone and sand, gray

NOTES: Size of Pit _____ X _____ X _____ DEEP

4" Diameter Observation Well West Side Of Road. Data Obtained From U.S. Geological Survey - Ft. Myers, Florida.

5000 2-68

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Project

No. _____ Date _____

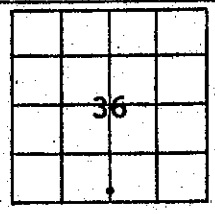
ity _____ State _____

TEST HOLE

No. L-602

Driller _____

ation of Test Hole Near The Center
The South Side Of Section
(South Quarter Corner)
¼ ¼ Sec. 36 of T 46 S.,
26 E., Lee Co., Florida



Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	10	Sand, fine, brown, shells, some clay		
)	40	Sandstone, gray-tan, calcareous		
0	60	Limestone, tan and gray		
)	170	Clay, light gray, few limestone layers		
70	240	Limestone, sandy, tan and gray		
)	295	Clay, green		
5	390	Limestone, gray and tan		
0	410	Clay, dark gray, sandy, phosphatic		
)	450	Limestone, light gray, sandy, phosphatic		
0	475	Limestone, light gray, some phosphorite		

marks: Data Obtained From The U.S. Geological Survey - Ft. Myers, Florida.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Green Meadows Project

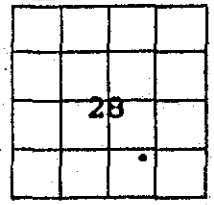
TEST HOLE No. L-612

Job No. _____ Date _____

City _____ State _____ Driller _____

Location of Test Hole Near The S.W. Corner Of Intersection Of Lee Boulevard & Buckingham Road.

NW ¼ SE ¼ Sec. 28 of T 44 S., 26 E., Lee Co., Florida



Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	5	Sand, white to tan		
5	10	Marl, creamy white		
10	20	Limestone, tan		
20	40	Clay, dark green		
40	50	Sand, fine, green, clayey		
50	60	Sandstone, gray, clcareous		
		Lost Circulation--Drilled to 300 ft.--no samples		

Remarks: Data Obtained From The U.S. Geological Survey - Ft. Myers, Florida.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Project

h No. _____ Date _____

ty _____ State _____

TEST HOLE
No. L-612

Driller _____

ation of Test Hole Near The S.W. Cor-
Of Intersection Of Lee Boule-
rd & Buckingham Road.
¼ SE ¼ Sec. 28 of T 44 S.,
26 E., Lee Co., Florida

28

Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	5	Sand, white to tan		
5	10	Marl, creamy white		
10	20	Limestone, tan		
0	40	Clay, dark green		
40	50	Sand, fine, green, clayey		
50	60	Sandstone, gray, clcareous		
		Lost Circulation--Drilled to 300 ft.--no samples		

marks: Data Obtained From The U.S. Geological Survey - Ft. Myers, Florida.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Project

No. _____ Date _____

ity _____ State _____

TEST HOLE No. L-613

Driller _____

ation of Test Hole West Side Of Road, South Lehigh Acres Business Area.

¼ SE ¼ Sec. 6 of T 45 S., 27 E., Lee Co., Florida.

6

Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	10	Sand, brown, white clay med.		
10	30	Limestone and clay marl, white		
30	45	Clay, gray and green, shell fragments.		
45	60	Limestone, gray, sandy		
60	75	Limestone, gray		
75	90	Sandstone, gray, calcareous		
90	105	Same, some phosphate, shell		
105	120	Sandstone, gray, quarty gravel, phosphate, shell		
120	140	Limestone, tan		
140	150	Clay, gray		
150	165	Same		
165	190	Same, some limestone		
190	230	Clay, green		
230	260	Clay, dark gray, sandy, phosphatic		
260	360	Limestone, gray-white, phosphatic		

marks: Data Obtained From U.S. Geological Survey - Ft. Myers, Florida.

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadow Project

h No. _____ Date _____

ty _____ State _____

TEST HOLE
No. L-614

Driller _____

ation of Test Hole South Side Of
orkscrew Grade Road

¼ NW ¼ Sec. 27 of T 46 S.,
27 E., Lee Co., Florida.

27

Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

om	To	Description of Strata	Water Bearing	
0	10	Sand, med., white and brown		
0	20	Limestone, tan, v. hard		
20	33	Same		
3	50	Limestone, tan and gray, few shells		
50	80	Limestone, tan and gray, sandy		
0	110	Same		
_0	160	Clay, light green; some limestone		
60	180	Clay, dark green, phosphatic		
0	200	Sandstone, gray, calcareous		
00	220	Same		
0	280	Clay, light gray		
80	300	Clay, dark green, phosphatic, sandy		
0	310	Same, but dark gray		
310	340	Limestone, light gray-white, phosphatic, some clay		
0	360	Limestone, as above		

marks: Data Obtained From U.S. Geological Survey - Ft. Myers, Florida

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-615

Driller _____

Test Hole Location NE¼ Sec. 25, T 46 S., R 27 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0	15			Sand, tan and white, clayey
15	30			Limestone, sandy, gray
30	45			Limestone, gray; few shells
45	75			Shell, limestone fragments
75	90			Limestone, gray; shell fragments
90	105			Limestone, gray
105	120			Same
120	135			Same
135	150			Limestone, light gray, sandy
150	175			Same
175	220			Clay, green
220	240			Sandstone, gray, calcareous
240	255			Sandstone, gray-tan, clacareous
255	270			Sandstone, as above, shell fragments, sand
270	285			Sandstone, some green clay

Continued---

NOTES: Size of Pit _____ X _____ X _____ DEEP

4" Diameter Observation Well. Data Obtained From U.S. Geological Survey, Ft. Myers, Florida

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE

No. L-615

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-615 **TEST LOG**

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
285	300			Sand, fine, tan
300	330			Clay, green; limestone fragments
330	350			Same
350	360			Clay, green
360	390			Limestone-no samples

NOTES: Size of Pit _____ X _____ X _____ DEEP

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE

No. L-622

Driller _____

Test Hole Location SE Corner, Sec. 4, T 45 S., R 26 E., Lee County, Florida

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	7'0"			Sand, brown, iron stained, fine to med.
7'0"	20'0"			Limestone, light gray and brown
20'0"	30'0"			Clay, light green
30'0"	40'0"			Clay, dark green, shell fragments, phosphate pebbles
40'0"	60'0"			Clay, dark green, shell fragments
60'0"	70'0"			Sandstone, gray, calcareous
70'0"	80'0"			Same
80'0"	100'0"			Same
100'0"	115'0"			Same
115'0"	130'0"			Limestone, and gray clay
130'0"	190'0"			Clay, gray
190'0"	220'0"			Clay, dark gray, sandy, phosphatic
220'0"	250'0"			Clay, gray
250'0"	280'0"			Limestone, gray-white, phosphatic
280'0"	305'0"			Same

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data Obtained From U.S. Geological Survey, Ft. Myers, Florida.

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE
No. L-739

Driller _____

Test Hole Location Near N. ¼ Cor. Sec. 30, T 46 S., R 26 E., Lee Co., Florida
Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	10'0"			Sand, fine-med., brown
10'0"	20'0"			Sand, fine-med., tan
20'0"	25'0"			Sand, fine, white
25'0"	30'0"			Limestone, tan, sandy
30'0"	50'0"			Same with shells
50'0"	55'0"			Limestone, gray
55'0"	70'0"			Limestone, tan & gray, some clay, shells
70'0"	90'0"			Limestone, gray
90'0"				Limestone, tan
	140'0"			Limestone, gray, tan
140'0"	150'0"			Limestone, tan, sandy
150'0"	170'0"			Clay, light gray
170'0"	200'0"			Clay, green, sandy
200'0"	210'0"			Clay, dark gray-green, shell frag., phosphate
Continued------				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data obtained from U.S. Geological Survey, Ft. Myers, Florida

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-739

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-739 #2

TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
210'0"	218'0"			Clay, dark gray-green
218'0"	225'0"			Limestone, gray-white, sandy
225'0"	230'0"			Sand, fine-med., gray-tan
230'0"	240'0"			Sandstone, gray
240'0"	250'0"			Sandstone, gray, and sand

NOTES: Size of Pit _____ X _____ X _____ DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name: Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE
No. L-635

Driller _____

Test Hole Location: Southeastern Lee County, Florida
Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	Static Water Level _____ Measured _____ Hours After Completion FORMATION
0'0"	10'0"			Sand, fine, white
10'0"	20'0"			Limestone, shell, dark brown, sandy silt
20'0"	40'0"			Clay, light gray
40'0"	50'0"			Clay, light gray and dark green
50'0"	60'0"			Clay, dark green
60'0"	70'0"			Clay, green
70'0"	80'0"			Limestone, tan, shell
80'0"	100'0"			Limestone, very hard, some shell
100'0"	110'0"			Limestone, phosp. pebbles
110'0"	120'0"			Clay, light gray, phosp.
130'0"	160'0"			Clay, dark gray, phosphatic
160'0"	250'0"			Limestone, gray-white, phosphatic
250'0"	270'0"			Same, some marle, more phosphate
270'0"	280'0"			Limestone, some green clay
Continued----				

NOTES: Size of Pit _____ X _____ X _____ DEEP

Data Obtained From U.S. Geological Survey - Ft. Myers, Florida.

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-635

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-635 #2 **TEST LOG**

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
280'0"	300'0"			Clay, green
300'0"	340'0"			Limestone, clayey
340'0"	410'0"			Limestone, phosphatic
410'0"	420'0"			Clay, gray-white
420'0"	520'0"			Limestone, gray-white, phosphate, s. clay
520'0"	560'0"			Limestone, light gray, phosphate
560'0"	580'0"			Limestone, light gray to tan, some phosphate
580'0"	600'0"			Limestone, tan; dolomitic
600'0"	740'0"			Limestone, light gray to white, phosphatic
740'0"	780'0"			Limestone, light gray, less phosphate
780'0"	800'0"			Limestone, white
800'0"	820'0"			Dolomite, tan
820'0"	840'0"			Dolomite, tan, white limestone
840'0"	1000'0"			Limestone, tan, dolomitic
Continued-----				

NOTES: Size of Pit _____ X _____ X _____
DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE

No. L-635

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-635 #3 **TEST LOG**

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
1000'0"	1080'0"			Same
1080'0"	1100'0"			Limestone, tan, tough green clay, fine quarty sand
1100'0"	1160'0"			Sand, fine, tan, tan limestone
1160'0"	1180'0"			Limestone, tan
1180'0"	1300'0"			Limestone, light brown (Mobil Pick-Ocala 1240)
1300'0"	1320'0"			Limestone, light brown and gray
1320'0"	1405'0"			Limestone, tan, (Camerinas at 1320)

NOTES: Size of Pit _____ X _____ X _____ DEEP

APPENDIX D

FLORIDA CITIES WATER COMPANY
WATER SUPPLY STUDY
EAST OF U. S. HIGHWAY 41
LEE COUNTY, FLORIDA

October, 1971

LAYNE-WESTERN COMPANY, INC.
1010 West 39th Street
Kansas City, Missouri
64111
AC 816-931-2353

WATER SUPPLY INVESTIGATION
EAST OF U.S. HIGHWAY 41

October, 1971

In December, 1971, authorization was considered for a water supply study to supplement the present water supply for the Cypress Lakes water treatment plant located south of the City of Ft. Myers, Florida.

The study began with the drilling of two (2) test holes on the east side of the Estero community. Chloride content of these wells was up 465 ppm chloride.

Interest was expressed by the developers of San Carlos Park area and two (2) test holes, Test Holes 3-71 and 4-71, were drilled at the eastern extremeties of this development. The south test hole encountered water of 1200 ppm chlorides, and the north test hole, one-half mile north of No. 3, had chloride of 475 ppm. It would appear that Test Hole 3-71 is located very close to a deep flowing well which may be covered over and bringing high chloride water from deep formations up into the shallow aquifers.

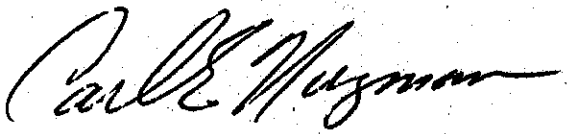
The study was extended to drill some test holes on Alico Road located directly west of the West Coast Rock Company. Test Hole No. 6-71, located 4.5 miles east of U.S. Highway 41, had good water production in the upper limestone formations with chloride content of 172 ppm. Chloride content of water increased to 240 ppm in the lower section of this formation. One-half mile east at Test Hole 5-71 location, the chloride content of the upper water was 96 ppm and increased to 234 ppm in the lower section. Located an additional one (1) mile east, or a total of six (6) miles east of U.S. Highway 41, at Test Hole 7-71, the chloride content of the water sampled was only 63 ppm. This well did not penetrate the typical sandstone unit defined in Test Hole L-739 located three (3) miles to the south. Good production lime rock material was encountered in Test Hole 7-71 from 89 feet through 139 feet.

It is recommended that a test well be constructed at the site of Test Hole 7-71. This test well should be 10 inch diameter hole with casing cemented from 90 feet to the surface by the pressure grout system. It is further recommended that the well be drilled by reverse air circulation method to a depth of approximately 140 feet. It is recommended that the test well be pumped for 500 minutes at a rate of approximately 500 gpm, if possible. After recovery of water levels in this pumping test, it is recommended that the test pump be pulled and the well acidized. The well should again be test pumped at the rate of 500 gpm for 500 minutes duration. The pH of the water should be checked to insure complete removal of all acid has been

accomplished in the 500 minutes of pumping. The continuous yield of this well then may be rated by the hydrologist at a higher or lower rate than that tested. It is anticipated that a lower rate may be recommended.

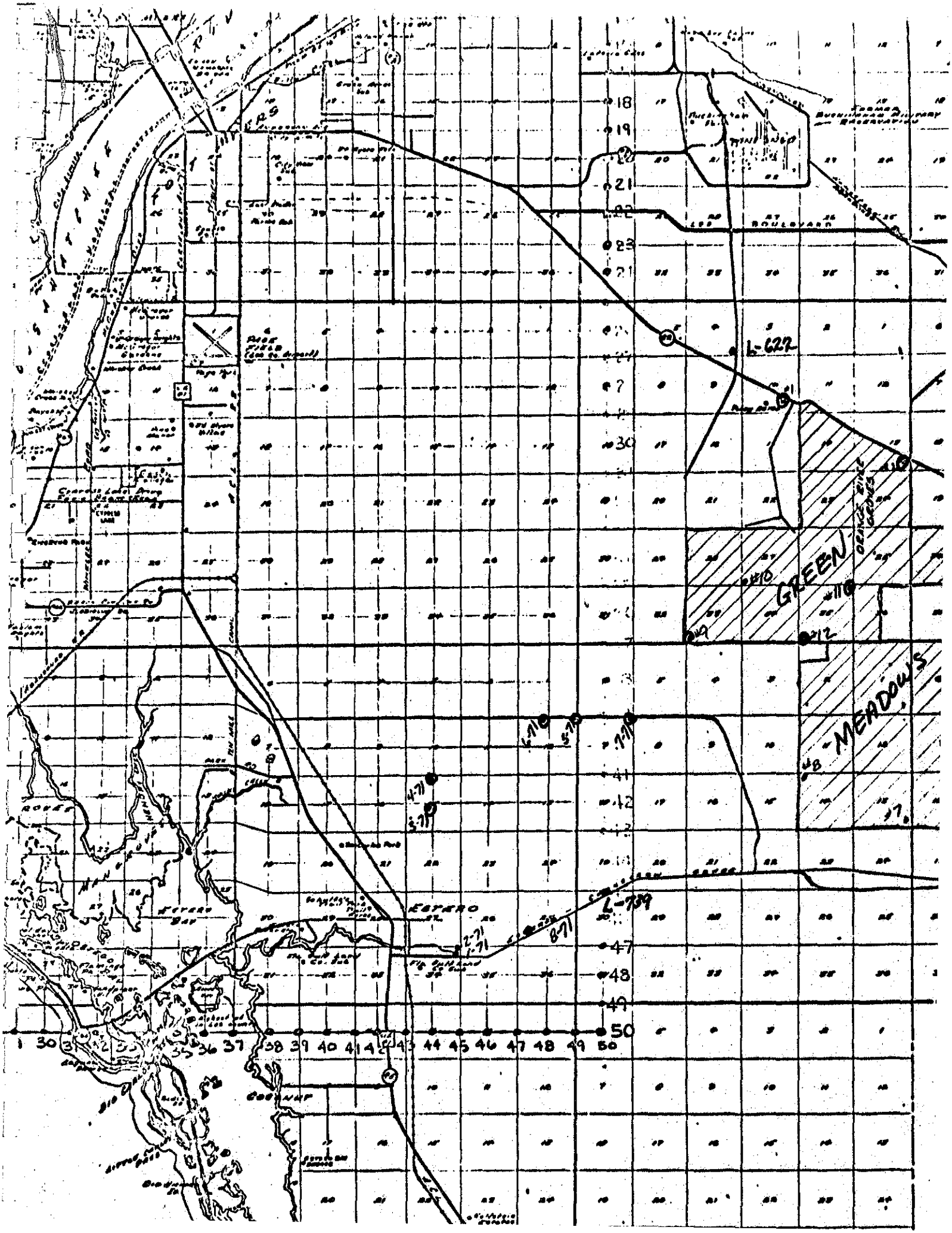
It is the opinion of the hydrologist at this time, that it would be feasible to construct five (5) wells located on one-quarter mile spacing between wells, that are capable of producing 350 gpm each, for a total of 2.5 million gallons per day. These wells should be constructed to the east of Test Hole 7-71, and along the south side of Alico Road. The minimum diameter pipeline which should be considered is 12 inch diameter and may be of asbestos cement material to reduce cost of piping. Pumps (350 gpm) pumping against an estimated head of 210 feet would require 30 hp per unit. Tone control equipment is available which could provide operation of the wells individually from the water treatment plant.

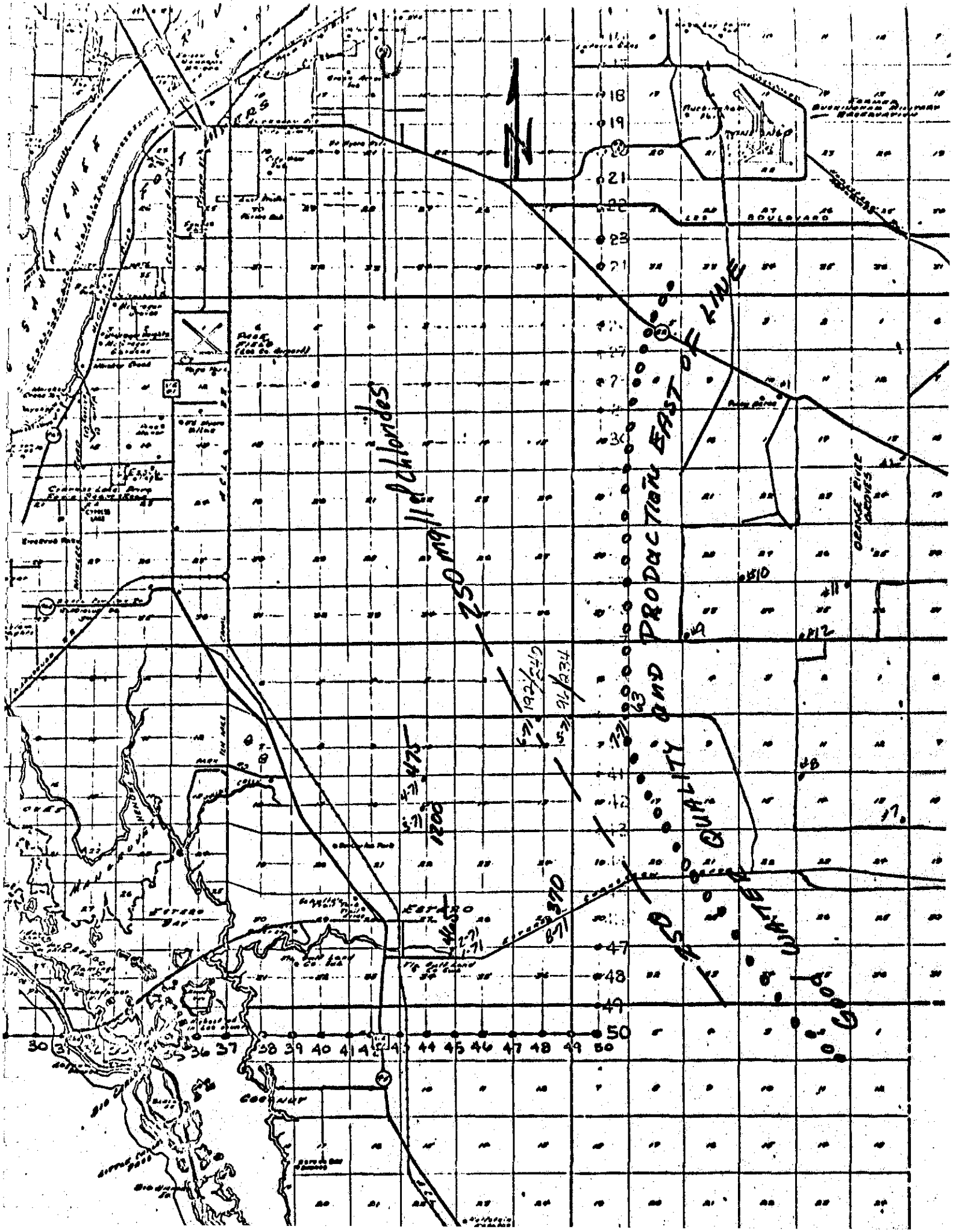
Respectfully submitted,



Carl E. Nuzman, P.E.
HYDROLOGY CONSULTANT
LAYNE-Western Company, Inc.

CEN/mb


L-627
GREEN MEADOWS
L-739
ESTERO


1200 mg/l Chlorides
250 mg/l Chlorides
PRODUCTION EAST OF LINE
GOOD QUALITY WATER
Estero
Coolidge
Orange Fire Ants
Los Angeles Boulevard
Fig Gardens
Fig Gardens Canal
Ten Mile Canal
Caloosahatchee River
Gladiolus Drive
Metro Parkway
Daniels Parkway
Ben Hill Griffin Parkway
Corkscrew Road
Alico Road
Estero Parkway
Coconut Road
Williams Road
Three Oaks Parkway
Old 41
Bonita Beach Road
Bonita Springs
Immokalee Road
Immokalee
Naples
Golden Gate
Golden Gate Canal
Golden Gate Parkway
Pine Ridge Road
Vanderbilt Beach Road
Vanderbilt Drive
Airport-Pulling Road
Collier Boulevard
Goodlette-Frank Road
Radio Road
Tamiami Trail
Tamiami Trail East
Tamiami Canal
Naples Canal
Gordon River
Gordon Pass
Marco Island
Marco Island Airport
Everglades City
Everglades Airport
Chokoloskee
Chokoloskee Bay
Ten Thousand Islands
Big Marco Pass
Wiggins Pass
Wiggins Pass Road
Wiggins Bay
Wiggins Lake
Naples Bay
Gulf of Mexico
Collier County Landfill
Collier County Airport
Collier County Fairgrounds
Collier County Golf Course
Collier County Museum
Collier County Courthouse
Collier County Jail
Collier County Sheriff's Office
Collier County Public Library
Collier County Public Schools
Collier County Public Utilities
Collier County Public Works
Collier County Parks and Recreation
Collier County Tax Collector
Collier County Property Appraiser
Collier County Supervisor of Elections
Collier County Clerk of Courts
Collier County Judges
Collier County Commissioners
Collier County Manager
Collier County Attorney
Collier County Planning Commission
Collier County Zoning Board
Collier County Code Enforcement
Collier County Building Department
Collier County Fire Marshal
Collier County Emergency Management
Collier County Emergency Medical Services
Collier County Sheriff's Office
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Collier County Attorney
Collier County Planning Commission
Collier County Zoning Board
Collier County Code Enforcement
Collier County Building Department
Collier County Fire Marshal
Collier County Emergency Management
Collier County Emergency Medical Services

TEST HOLE EPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. KC-277-C Date June 30, 1971

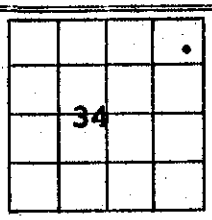
TEST HOLE No. Estero #1

ty Ft. Myers State Florida Driller M. Miller

Location of Test Hole Near the NE corner of a small tract of land located in the:

NE ¼ NE ¼ Sec. 34 of T 46S,

K 25 E., Lee Co., Florida.



Elevation of Test Hole

Static Water Level Flowing Well

Measured Hours After Completio

From	To	Description of Strata	Water Bearing	
0	7	Light sand		
7	17	Sand with hard pan layers at 7' and 17'		
17	27	Sand (some rust color) and limestone	10	Som
27	43	White limestone formation	16	Fai
43	73	Clay, light colored changing to a darker color	30	Non
73	80	Clay, with a trace of shell	7	Non
80	98	Hard limestone with rock -- 4 to 6-inch voids	18	Fai
98	108	Compacted limestone with colored sand	10	Poo
08	116	Hard sandstone with gray sand	8	Poo
116	146	Gray sandstone	30	Poo
46	176	Compacted sand with limestone color	30	Poo
176	194	Black sand	18	Fai
194	201	Black sand with some clay mixed	7	Poo
01	206	Lime rock, Artesian flow started at 4 GPM	5	Fai
206	210	Lime rock, water sample taken, flow 10 GPM	4	Goo
10	218	Lime rock with dark sand	8	Fai
218	238	Shell and lime rock	20	Goc
38	261	Lime rock, Artesian flow in excess of 30 GPM	23	V.Gc
261	263	Heavy clay	2	Non
63	Total	Depth Drilled		

Remarks: Chlorides from flowing well were reported to be 540 mg/l only 42 feet of 2-inch pipe was used in constructing test hole.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

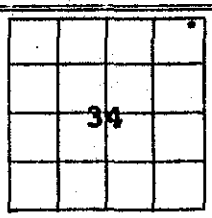
Contract Name Florida Cities Water Company

Job No. KC-277-C Date June 30, 1971

TEST HOLE No. Estero #2

City Ft. Myers State Florida Driller M. Miller

Location of Test Hole Near the SW corner of small tract of land located in the NE ¼ NE ¼ Sec. 34 of T 46 S., 25 E., Lee Co., Florida



Elevation of Test Hole

Static Water Level Flowing Well

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
0	10	White sand		
10	14	Brown sand	4	Fair
14	24	Sand rock with limestone and white sand	10	Good
24	35	Limestone and sand	11	Fair
35	45	Light colored clay and shell	10	Poor
45	79	Green clay		
79	89	Clay and limestone		
89	109	Layers of hard limestone and sand	20	Fair
109	119	Boulders in limestone and sand	10	Poor
119	175	Limestone with sand and clay	56	Poor
175	195	Black sand and clay mixed	20	Fair
195	205	Shell and limestone formation flow at 4 GPM	10	Fair
205	212	Shell and limestone formation	7	Good
212	222	Clay color limestone with small gravel	10	Fair
222	232	Limestone and gravel	10	Fair
232	252	White shell and limestone flow about 30 GPM	20	Good
252	259	Clay colored shell and clay	7	Fair
259	261	Clay	2	None
261	Total	Depth Drilled With Churn Drill		

Remarks: Only 42 feet of 2-inch diameter pipe required to drill test hole original chloride content was approximately 550 mg/l. Well was plugged back with cement 195 feet and tested. Chloride's still 460 mg/l after 16 hours pumping. W.L. 3.5 feet below land surface after plugging.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: LAYNE WESTERN CO. INC. Appearance: CLEAR

Date: JUNE 29, 1971 Sampled by: CLIENT

Sample Number: 4543 Identification: WELL #2

METHODS

This water was analyzed using methods adopted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,400	Sulfate, as SO_4	80
Total Hardness, as $CaCO_3$	504	Fluorides, as F	0.8
Calcium Hardness, as $CaCO_3$	282	Silica, as SiO_2	4.0
Magnesium Hardness, as $CaCO_3$	222	Copper, as Cu	0.0
Calcium, as Ca	113	Phosphate (Total), as PO_4	0.8
Magnesium, as Mg	54	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	192	pH (Laboratory)	7.5
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	192	Stability Index	6.3
Hydroxides, as OH	0	Saturation Index	0.6
Carbon Dioxide, as CO_2	12.5	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	234		
Chlorides, as Cl	465		
Iron, as Fe	0.05		
Manganese, as Mn	0.0		

Signed: J. Hobbs
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. KC 277-C Date 29 June, 1971

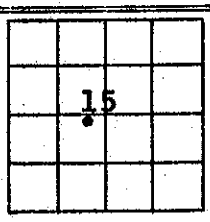
TEST HOLE No. 3-71

City San Carlos Park State Florida

Driller M. Miller

Location of Test Hole East end of San Carlos Boulevard near the center of Section 15

NE ¼ SW ¼ Sec. 15 of T 46-S, R 25-E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level Above land surface

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
0	6	Gray sand		
6	11	Hard rock and boulders		
11	21	Yellow to orange sand	10	Fair
21	30	White sand with soft limerock	9	Fair
30	38	Soft limestone rock	8	Fair
38	50	Limestone with green clay	12	Poor
50	80	Green clay	30	None
80	96	Clay with shell and sand	16	None
96	103	Water producing sand and limestone - (Water Sample)	7	Good
111	126	Compact sand and shell with some clay	15	Fair
126	141	Limestone and shell	15	Fair
141	151	White limestone	10	Good
151	181	Limestone with some clay	30	Fair
181	211	Limestone with black sand	30	Fair
211	216	Limestone formation (water sample)	5	Good
	216	Total depth of drilling		
		Water sample at 103' had chlorides of 1200 ppm		
		Water sample at 216' had chlorides of 1200 ppm		

Remarks: At 103', pumped 42 gpm with approximately 28" of vacuum (42'pipe) with 130' of casing pipe at 216' depth, the static level was above ground with well lowing 5 gpm. Pumped more than 60 gpm.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

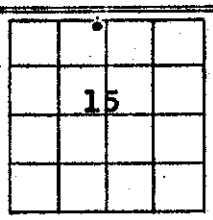
Job No. KC 277-C Date 2 July, 1971

TEST HOLE No. 4-71

ity San Carlos Park State Florida Driller M. Miller

Location of Test Hole 1/2 mile north of T.H. 3-71 in San Carlos Development area.

NE ¼ NW ¼ Sec. 15 of T 46S, 25E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level at land surface

Measured Hours After Completio

From	To	Description of Strata	Water Bearing	
0	8	Brown sand		
8	11	Two layers of rock in sand		
11	27	White sand medium to fine	16	Fai
27	44	White marl rock		
44	96	Green clay with some shell	52	Non
96	105	Hard limestone rock	9	Fai
105	115	Sand and fine limestone (water sample pumped)	10	Goo
115	145	Dense gray sand	30	Fai
145	155	Sand and clay	10	Poo
155	175	Sand with some clay and limestone, mixed	20	Fai
175	185	Black sand with clay and limestone	10	Fai
185	200	Black sand and limestone (water sample)	15	Goo
	200	Total depth of drilling		
		Water sample at 115' had chlorides of 475 ppm		
		Water sample at 200' had chlorides of 445 ppm		

Remarks: At 115' depth with 63' of casing, well pumped 30 gpm with 28" of vacuum through a 2" diameter pipe. At 200' depth with 63' of 2" casing pumped over 60 gpm.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. KC-277-C Date Sept. 27, 1971

TEST HOLE No. 5-71

City Fort Myers State Florida Driller M. Miller

Location of Test Hole 5 miles east of U.S.41 on Alico (Rock Pit) Road Estimate location in SE corner NE ¼ ~~SW~~ SE ¼ Sec. 21 of T. 46 ~~45~~ S, R. 26 ~~25~~ E, Lee Co., Florida.

Elevation of Test Hole

Static Water Level About 5 feet

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	9	Sand		
9	16	Medium Hard Rock	7	
16	24	Sand	8	
24	43	Layers of Rock and Sand	19	Fai
43	47	Solid Rock, hard	4	V.Po
47	77	Sand with heavy clay	30	V.Po
77	79	Hard pan layer	2	Non
79	106	Lime Rock (Pumped 50 gpm for water sample)	27	Goo
106	125	Lime Rock and shell (light clay color)	19	Fai
125	140	Rock layers with clay and compacted sand	15	Poo
140	157	Gray sand with clay	17	V.Po
157	177	Limestone and light colored clay with black sand	20	Poo
177	195	Limestone, Loose granular formation.	18	Fai
195	205	Limestone and clay	10	Poo
205	215	Limestone and clay with black sand	10	Poo
215	230	Clay with some sand	15	Non
230	Total	Depth of Drilling		

Remarks: Pumped 1 hour only 15 gpm with 122 feet of 2 inch pipe casing in test hole at 230 feet depth. Estimate yield potential at 250 gpm from 79 to 140 foot depth.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Date: SEPTEMBER 7, 1971

Sample Number: 4758-1

Appearance: CLEAR

Sampled by: CLIENT 5-71

Identification: ALICO ROAD WELL
@ - 84' PIPE 94' HOLE
5 mile East "41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	510	Sulfate, as SO_4	26
Total Hardness, as $CaCO_3$	300	Fluorides, as F	0.40
Calcium Hardness, as $CaCO_3$	216	Silica, as SiO_2	25
Magnesium Hardness, as $CaCO_3$	84	Copper, as Cu	0
Calcium, as Ca	86	Phosphate (Total), as PO_4	0.3
Magnesium, as Mg	21	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	246	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	246	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.5
Carbon Dioxide, as CO_2	19	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	300		
Chlorides, as Cl	96		
Iron, as Fe	0.36		
Manganese, as Mn	0.0		

Signed: Gene Sfredda
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: SEPTEMBER 7, 1971

Sampled by: CLIENT 5-71

Sample Number: 4758-2

Identification: ALICO ROAD WELL
- 122' PIPE 230' HOLE
5 Mile East of 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	700	Sulfate, as SO_4	0
Total Hardness, as $CaCO_3$	330	Fluorides, as F	0.48
Calcium Hardness, as $CaCO_3$	216	Silica, as SiO_2	23
Magnesium Hardness, as $CaCO_3$	114	Copper, as Cu	0
Calcium, as Ca	86	Phosphate (Total), as PO_4	0.8
Magnesium, as Mg	28	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	156	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.1
Bicarbonate Alkalinity, as $CaCO_3$	156	Stability Index	6.8
Hydroxides, as OH	0	Saturation Index	0.3
Carbon Dioxide, as CO_2	12	Turbidity, Silica Scale	5
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	190		
Chlorides, as Cl	234		
Iron, as Fe	0.20		
Manganese, as Mn	0.0		

Signed: Gene Hedden
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

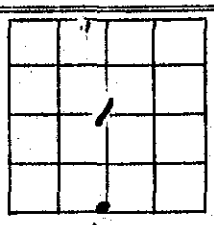
Job No.: KC 277-C Date: 14 Oct., 1971

TEST HOLE No.: 6-71

City: Ft. Myers State: Florida Driller: M. Miller

Location of Test Hole: 4.5 miles E. of U.S. on Alico (Rock Pit) Road-Estimate

Location in (South ¼ corner) 46S ¼ SW ¼ Sec. 2 of T 45S, R 25E, Lee Co., Vlorida.



Elevation of Test Hole:

Static Water Level:

Measured: Hours After Completio

From	To	Description of Strata	Water Bearing	
0	13	White Sand		
3	33	Limestone, rock	20	Fair
3	43	Limestone rock, hard layers	10	Fair
43	55	Limestone rock, medium hard	12	Fair
5	75	Green clay w/some rock particles	20	None
76	77	Black rock	1	None
7	82	Clay and sand mixed	5	None
82	83	Rock layer	1	None
3	90	Clay and sand	7	None
90	115	Limestone (pump test at 103' - 60+ gpm)	25	Good
5	125	Fine limestone material w/sand	10	Poor
5	135	Sand and shell, firm	10	Fair
35	146	Sand and shell, loose (pumping test - 65+ gpm)	11	Good
	146	Total depth of drilling		

Remarks: Two (2) inch diameter test hole - Two (2) water samples taken for analysis

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 6-71

Sample Number: 4859-1

Identification: ALICO #1 61' PIPE 103' HOLE 60 GPM 4.5 MILE EAST #41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	710	Sulfate, as SO_4	33
Total Hardness, as $CaCO_3$	360	Fluorides, as F	0.30
Calcium Hardness, as $CaCO_3$	270	Silica, as SiO_2	23
Magnesium Hardness, as $CaCO_3$	90	Copper, as Cu	0
Calcium, as Ca	108	Phosphate (Total), as PO_4	2.8
Magnesium, as Mg	22	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	264	pH (Laboratory)	7.5
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	264	Stability Index	6.1
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	18	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	322		
Chlorides, as Cl	192		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Hyderia
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 6-71

Sample Number: 4859-2

Identification: ALICO #1 61' PIPE 147' HOLE
70 GPM 4.5 East 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	825	Sulfate, as SO_4	34
Total Hardness, as $CaCO_3$	420	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	300	Silica, as SiO_2	24
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	120	Phosphate (Total), as PO_4	0.5
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	258	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	258	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	22	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	314		
Chlorides, as Cl	240		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Hydrick
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: KC 277-C Date: 14 Oct., 1971

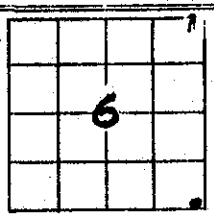
TEST HOLE No.: 7-71

City: Ft. Myers State: Florida

Driller: M. Miller

Location of Test Hole: Six miles E. of U.S. 41 on Alico (Rock Pit) Road.

Estimate location in (SE corner) NE ¼ SE ¼ Sec. 6 of T 46S, 26E, Lee Co., Florida



Elevation of Test Hole:

Static Water Level:

Measured: Hours After Completio

From	To	Description of Strata	Water Bearing
0	13	Surface sand	
13	47	Hard rock w/sand layers	
47	57	Clay w/shell and rock	
57	89	Clay	
89	109	Limestone formation, hard	
109	119	Limestone and shell	
119	129	Lime rock w/shell and sand	
129	139	Lime rock w/shell, black rock and sand	
139	169	Gray sand	
169	199	Limestone material in sand	
199	219	Limestone sand w/black sand	
219	239	Black sand w/some green clay color	
239	259	Black sand w/fine limestone mixed	
259	300	Green clay w/black and white coarse sand	

Remarks: Pumped two (2) inch diameter hole one (1) hour at 15 gpm with 147 feet of casing pipe in test hole.

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Appearance: CLEAR

Date: SEPTEMBER 24, 1971

Sampled by: CLIENT 7-71

Sample Number: 4831

Identification: #3 - ALICO #3 WELL
61' PIPE 103' HOLE 60 GPM
6 MILE EAST. #41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	445	Sulfate, as SO_4	12
Total Hardness, as $CaCO_3$	318	Fluorides, as F	0.50
Calcium Hardness, as $CaCO_3$	222	Silica, as SiO_2	17
Magnesium Hardness, as $CaCO_3$	96	Copper, as Cu	0
Calcium, as Ca	89	Phosphate (Total), as PO_4	0.1
Magnesium, as Mg	23	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	276	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	276	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.4
Carbon Dioxide, as CO_2	35	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	337		
Chlorides, as Cl	72		
Iron, as Fe	0.10		
Manganese, as Mn	0.0		

Signed: Gene Wyelie
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER, CO.

Appearance: CLEAR

Date: OCTOBER 4, 1971

Sampled by: CLIENT 7-71

Sample Number: 4859-3

Identification: ALICO #2 145' PIPE 300' HOLE 3GPM 6 Mile East of 41

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	283	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	180	Fluorides, as F	0.64
Calcium Hardness, as $CaCO_3$	120	Silica, as SiO_2	10
Magnesium Hardness, as $CaCO_3$	60	Copper, as Cu	0
Calcium, as Ca	48	Phosphate (Total), as PO_4	0.2
Magnesium, as Mg	14	Color, Standard Platinum Cobalt Scale	0
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	102	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.5
Bicarbonate Alkalinity, as $CaCO_3$	102	Stability Index	7.6
Hydroxides, as OH	0	Saturation Index	-0.1
Carbon Dioxide, as CO_2	8.7	Turbidity, Silica Scale	23
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	124		
Chlorides, as Cl	63		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Elfstrom
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Tract Name Florida Cities Water Company

Job No. KC 277-C Date 14 Oct., 1971

TEST HOLE No. 8-71

Ft. Myers State Florida Driller S. J. Boren

Location of Test Hole Corkscrew Grade Road
t of Estero

¼ ¼ Sec. 25 of T 45S,
26E, Lee Co., Florida.

25

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing	
	11	Surface sand		
	18	Hard rock		
	39	Lime rock containing shallow water	21	Fair
9	86	Clay	47	None
	144	Lime rock - water bearing	58	Good
4	174	Limerock w/heavy clay and shell	30	Poor
	180	Black sand	6	Fair

Remarks:

Two (2) inch diameter test hole pumps good at 60+ gpm w/only 8-10 inches if vacuum

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Date: OCTOBER 6, 1971

Sample Number: 4883

Appearance: CLEAR

Sampled by: CLIENT 8-71

Identification: (#) CORK SCREW GRADE
2.3M. E. US 41
41' Pipe-100'Hole-40GPM

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,100	Sulfate, as SO_4	47
Total Hardness, as $CaCO_3$	468	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	318	Silica, as SiO_2	30
Magnesium Hardness, as $CaCO_3$	150	Copper, as Cu	0
Calcium, as Ca	127	Phosphate (Total), as PO_4	0.4
Magnesium, as Mg	36	Color, Standard Platinum Cobalt Scale	10
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	252	pH (Laboratory)	7.3
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	252	Stability Index	6.1
Hydroxides, as OH	0	Saturation Index	0.6
Carbon Dioxide, as CO_2	27	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	307		
Chlorides, as Cl	340		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Sfeldins
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: FLORIDA CITIES WATER CO.

Date: OCTOBER 6, 1971

Sample Number: 4883-1

Appearance: CLEAR

Sampled by: CLIENT 8-71

Identification: #4 CORK SCREW GRADE
2.3 M. E. US 41
57' Pipe-184' Hole-60GPM-10" Vac.

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1,220	Sulfate, as SO_4	68
Total Hardness, as $CaCO_3$	492	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	342	Silica, as SiO_2	30
Magnesium Hardness, as $CaCO_3$	150	Copper, as Cu	0
Calcium, as Ca	137	Phosphate (Total), as PO_4	0.4
Magnesium, as Mg	36	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	3
Alkalinity (Total), as $CaCO_3$	230	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.7
Bicarbonate Alkalinity, as $CaCO_3$	230	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	19	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	281		
Chlorides, as Cl	369		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: Gene Sfredda
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

July 1, 1971

Florida Cities Water Company
Sarasota,
Florida

Gentlemen:

TEST DRILLING IN THE
ESTERO, FLORIDA AREA

Two (2) test holes were drilled on a tract of land upon which Florida Cities Water Company obtained an option to purchase. One (1) test hole was located in the southwest corner of this tract and one (1) test hole was located in the northeast corner of this tract. Both test holes penetrated the upper sandstone unit present in the area and were continued into the upper Hawthorne formation which was identified. The delineation characteristic formation between these two (2) aquifer units was black sand encountered from 176' to 201' in both test holes. Upon passing this sand, and entering the top of the upper Hawthorne limestone, Artesian heads were encountered. The flow from these wells increased as a penetration increased in the lime rock. The upper Hawthorne formation was approximately 60' thick in this area. The piezometric head would be approximately 10' above land surface. Partial chemical analysis, performed by Mr. Roland Hahn, showed that chloride content was in excess of 500 parts per million. The water was unusable for its intended purpose and Mr. Marvin Miller was instructed to cement the wells back to approximately 200' depth and again test. The first attempt at cementing Well No. 1 was not successful in that the Artesian head was not shut off in the lower formation. After a short period of pumping, the chloride content remained the same as before. He then proceeded to Well No. 2 and cemented the lower portion of this well. The cement plugging appeared to be successful in that the static water level was reduced to a level of 3.5' below land surface

prior to the commencement of pumping. Over the weekend on June 26 and June 27 of 1971, Test Well No. 2 at Estero was pumped for at least sixteen (16) hours and a water sample submitted to Orlando Laboratories, Inc. for analysis. The results of that analysis and the laboratory report is attached for its information. Although chlorides were reduced approximately 100 parts per million by the cementing action, apparently the black sands in the lower portion of the sandstone aquifer unit are still carrying considerable amounts of high chloride water.

To cement the well back to the 125 to 150' range in depth would severely limit the potential yield of wells at this location. It is doubtful that wells with a capacity in excess of 100 gallons per minute on a continuous use basis could be obtained.

It is, therefore, recommended that this site has little potential use as a water supply to Florida Cities Water Company. The expense of further testing and development is not warranted and unless the land has beneficial use for other purposes, it is suggested that the option be allowed to expire without further water supply testing.

The invoice price for cementing shown on Mr. Marvin Miller's Invoice includes cementing these wells back to land surface which has already been instructed for him to do. Mr. Marvin Miller is proceeding on a second tract of land east of San Carlos Park for exploratory purposes of a potable water supply suitable for use.

Respectfully submitted,

Carl E. Nuzman, P.E.
Hydrology Consultant
Layne-Western Company, Inc.

pj

Enclosure

WATER QUALITY DATA

Cape Coral Water Treatment Plant Laboratory

LOCATION DESCRIPTION	CASING DIA.	CASING DEPTH	WELL DEPTH	PH	M.ALK.	T.Hd.	Mg.Hd.	Ca.Hd.	CL	T.D.S.
een Meadows No. 1 2/11/71	2"	89	244	7.4	270	314	66	248	80	430
een Meadows No. 1 2/25/71	2"	89	244	7.3	272	304	72	232	120	410
een Meadows No. 1-A 2/11/71	2"	40	61	7.2	189	710	246	464	1200	3100
een Meadows No. 1-A 2/25/71	2"	40	61						1380	3500
een Meadows No. 2	2"	162	238	7.2	268	198	110	88	60	440
een Meadows No. 2-A	2"	23	50	7.2	238	250	22	228	30	300
een Meadows No. 3	2"	110	239	7.4	284	282	88	194	110	620
een Meadows No. 3-A	2"	21	50	7.2	214	212	10	204	20	230
r. Well NW¼ 10-46S-26E	6"			7.2	212	232	34	198	65	270
r. Well SW¼ 25-45S-26E	6"			7.4	188	216	12	204	45	250
r. Well SE¼ 14-46S-26E	6"			7.0	218	242	12	230	30	280
r. Well SE¼ 35-45S-26E	8"			7.1	234	250	12	238	35	280
owing Well NW¼ 9-46S-25E	6"			7.6					1000	2600
pe Coral--North Pine Island Road	10"	125	225'	7.3	200	294	156	138	180	460

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

ntract Name Green Meadows Project

Job No. GAC Utilities, Inc. Date February 25,197

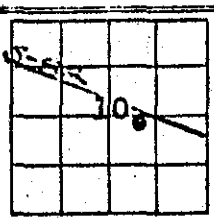
y Lee County State Florida

TEST HOLE No. 1 and 1-A

Driller Marvin Miller

ocation of Test Hole
rthwest Corner of Area

W ¼ SE ¼ Sec. 10 of T 45 S,
26 E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 9.77 (No. 1)

Static Water Level 5.72 (NO. 1-A)

Measured 100+ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	6	Sandy Soil	6	
6	9	Marl rock and sand	3	
9	19	Rock	10	
9	39	Marl rock and sand, hard	20	Goo
9	55	Limestone rock, with clay and sand	16	Poo
55	75	Green clay with fragments of shell	20	
5	88	Green clay and shell	13	
88	89	Sandstone, hard	1	
9	91	Yellow gravel and sand	2	Fai
91	101	Sandstone, shell and coarse sand	10	Goo
1	137	Shell, coarse sand and sandstone layers	36	Goo
137	153	Coarse sand, less shell and dark clay color	16	Goo
3	163	Coarse sand, shell with light clay color	10	Goo
63	194	Soft limestone	31	Fai
94	224	Clay and shell	30	Non
4	240	Clay with some sand mixed	16	
240	---	Total Depth Drilled		

g of Test Well 1-A located 2 feet from No. 1 was the same to 61 feet depth.

Remarks: ~~Test Well No. 1 has 2 inch diameter pipe to 89 feet depth.~~
Test pumped 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well No. 1-A has 2 inch diameter pipe to 40 feet and 61 feet of hole depth.
Test Well No. 1-A test pumped 1 hour at 3 gpm for water sample.

THE KANSAS STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES
Environmental Health Laboratory
801 Harrison Street 66612

TOPEKA
KANSAS

E. D. LYMAN, M. D., M. P. H.
Director of Health

May 26, 1971

Layne Western Company, Inc.
1010 West 39th Street
Kansas City, Missouri 64111

Attention: Mr Nuzman

Dear Mr. Nuzman:

Listed below in milligrams per liter are the results of chemical analyses of two samples of water collected in Florida. The samples may be identified as follows:

No. 1 GM No. 1 240' Hole, 89' pipe, collected 4-30-71.

No. 2 GAC Test Hole No. 11, collected 5-13-71.

* * * * *

		No. 1		No. 2	
pH	=	7.3		7.3	
Total Hardness (as $CaCO_3$)	=	326.	mg/l	262.	mg/l
Calcium (as Ca)	=	104.	mg/l	69.	mg/l
Magnesium (as Mg)	=	16.	mg/l	22.	mg/l
Sodium	=	45.	mg/l	50.	mg/l
Total Alkalinity (as $CaCO_3$)	=	276.	mg/l	250.	mg/l
Chloride	=	88.	mg/l	60.	mg/l
Sulfate	=	18.	mg/l	33.	mg/l
Nitrate (as NO_3)	=	1.8	mg/l	1.5	mg/l
Fluoride	=	0.4	mg/l	0.6	mg/l
Iron	=	0.38	mg/l	0.38	mg/l
Manganese	=	0.00	mg/l	0.00	mg/l

Sincerely,

Nicholas D. Duffett, Ph.D.
Director

Howard A. Stoltenberg

Howard A. Stoltenberg, M.A.
Chief, Water Chemistry Section

HAS:glb

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Green Meadows Project

Job No. GAC Utilities, Inc. Date February 25, 1971

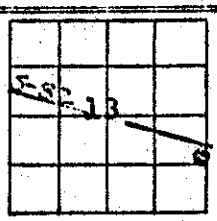
City Lee County State Florida

TEST HOLE No. 2 and 2-A

Driller Marvin Miller

Location of Test Hole
North Center of Area

NE ¼ SE ¼ Sec. 13 of T 45 S, 26E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level 10.66 (NO. 2)

Static Water Level 5.16 (No. 2-A Measured 100+ Hours After Completic

From	To	Description of Strata	Water Bearin	
0	11	Sand	11	
11	15	Rock	4	
15	25	Marl with clay	10	
25	29	Very hard marl	4	Fai
29	50	White marl	21	Goc
50	51	Hard pan (very hard)	1	Nor
51	61	Sandy clay, light color	10	Nor
61	63	Rock	2	Nor
63	73	Limestone, firm	10	Goc
73	85	Limestone, soft	12	Fai
85	87	Rock, gray in color	2	Nor
87	97	Limestone, loose	10	Goc
97	98	Rock, hard	1	None
98	128	Sandstone with hard and soft layers	30	Goc
128	143	Coarse sand and shell	15	Goc
43	160	Fine gray sand	17	Fai
160	175	Clay	15	Nor
75	184	Shell	9	Fai
184	234	Shell rock with some clay	50	Fai
234	238	Clay	4	Nor

Remarks: Test Well No. 2 has 2 inch diameter pipe to 162 feet depth.
Test pumped for 2 hours for water sample at 60 gpm, full capacity of pump.
Test Well 2-A has 2 inch diameter pipe to 23 feet depth and 50 feet hole depth.
Test pumped for 1 hour for water sample at 60 gpm, full capacity of pump.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Green Meadows Project

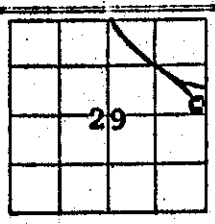
Job No.: GAC Utilities, Inc. Date: February 15,1971

TEST HOLE No. 3 and 3-A

Lee County State: Florida Driller: Marvin Miller

Location of Test Hole: Northeast Corner of Area

NE ¼ NE ¼ Sec. 29 of T 45 S, 27 E, Lee Co., Florida



Elevation of Test Hole:

Static Water Level 12.60 (No. 3)

Static Water Level 7.00 (No. 3-A)

Measured 100+ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	19	Brown sand	19	
19	29	Limestone, water bearing rock	10	Good
[illegible]	31	Rock	2	
31	49	Limestone, light to dark clay color	18	Good
[illegible]	59	Limestone and clay	10	Fair
59	75	Limestone, clay and sand	16	Fair
[illegible]	85	Limestone, sand and shell	10	Good
85	95	Limestone and sand	10	Good
[illegible]	110	Limestone and shell, yellow in color	15	Good
110	111	Shell rock, hard	1	
[illegible]	158	Shell and sand	47	Good
158	169	Sandstone with sand in layers	11	Good
169	208	Sand and clay with trace of shell	39	Fair
[illegible]	218	Sand and clay	10	Poor
218	235	Sand and clay, very soft	17	None
[illegible]	239	Clay	4	
239	---	Total Depth Drilled		

Log of Test Well 3-A located 2 feet from No. 3 was the same to 50 feet depth.

Remarks: Test Well No. 3 has 2 inch diameter pipe to 110 feet in depth.
Test pumped 2 hours for water sample at 60 gpm, pump capacity.
Test Well No. 3-A has 2 inch diameter pipe to 21 feet and 50 foot hole depth.
Test pumped 1 hour for water sample at 60 gpm, pump capacity.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name GAC Utilities, Inc.

Job No. Green Meadows Date April 1971

TEST HOLE No. 4

Ft. Myers State Florida Driller M. E. Miller

Location of Test Hole

NE ¼ SE ¼ Sec. 32 of T 45S, 27E, Lee Co., Florida

32

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

From	To	Description of Strata	Water Bearing
0	6	Light brown sand	
6	7	Hard pan layer	
	27	Sand and shell	
27	29	Hard shell and sand	
	36	White sand and shell	
36	41	Lime rock - hard	
	50	White sand and shell	
		Location temporarily abandoned - due to difficulty	

Remarks: Lost one string of tools at 50 feet. Sand would heave in casing and wedge tools. Casing pipe locked to rock by sand wedge. Lost string of casing pipe.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name GAC Utilities, Inc.

Job No. Green Meadows Date May 1971

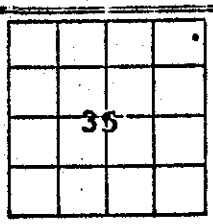
City Ft. Myers State Forida

TEST HOLE No. 11

Driller M.E. Miller

Location of Test Hole West side of road 300± feet south of section corner marker.

NE ¼ NE ¼ Sec. 35 of T 45S, R 26E, Lee Co., Florida.



Elevation of Test Hole

Static Water Level

Measured Hours After Completio

From	To	Description of Strata	Water Bearing
0	15	Sand	
15	19	White marl rock - hard	
19	27	Lime rock and marl	
27	45	White marl	
45	82	Clay and shell	
82	108	Loose sand and limestone	
108	109	Lime rock - hard	
109	120	Shell and sand	
120	130	Sand with some shell	
130	138	Lime rock with sand layers	
138	148	Lime rock with shell and sand	
148	149	Sandstone - hard	
149	155	Sand with trace of shell	
155	165	Layers of sand and sandstone - hard	
165	203	Gray sand	
203	221	Limestone and sand	
221	241	Limestone with shell and sand	
241	255	Clay with trace of shell	
255	Total	Depth	

Remarks: Installed 2-inch diameter casing with drive shoe to 130 feet. Test pumped well at 45 gpm for 2 hours and collected water sample.

THE KANSAS STATE DEPARTMENT OF HEALTH

TOPEKA
KANSAS

DIVISION OF LABORATORIES
Environmental Health Laboratory
801 Harrison Street 66612

E. D. LYMAN, M. D., M. P. H.
Director of Health

May 26, 1971

Layne Western Company, Inc.
1010 West 39th Street
Kansas City, Missouri 64111

Attention: Mr Nuzman

Dear Mr. Nuzman:

Listed below in milligrams per liter are the results of chemical analyses of two samples of water collected in Florida. The samples may be identified as follows:

No. 1 GM No. 1 240' Hole, 89' pipe, collected 4-30-71.

No. 2 GAC Test Hole No. 11, collected 5-13-71.

* * * * *

		No. 1		No. 2	
pH	=	7.3		7.3	
Total Hardness (as $CaCO_3$)	=	326.	mg/l	262.	mg/l
Calcium (as Ca)	=	104.	mg/l	69.	mg/l
Magnesium (as Mg)	=	16.	mg/l	22.	mg/l
Sodium	=	45.	mg/l	50.	mg/l
Total Alkalinity (as $CaCO_3$)	=	276.	mg/l	250.	mg/l
Chloride	=	88.	mg/l	60.	mg/l
Sulfate	=	18.	mg/l	33.	mg/l
Nitrate (as NO_3)	=	1.8	mg/l	1.5	mg/l
Fluoride	=	0.4	mg/l	0.6	mg/l
Iron	=	0.38	mg/l	0.38	mg/l
Manganese	=	0.00	mg/l	0.00	mg/l

Sincerely,

Nicholas D. Duffett, Ph.D.
Director

Howard A. Stoltenberg

Howard A. Stoltenberg, M.A.
Chief, Water Chemistry Section

HAS:glb

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

tract Name Green Meadows Groundwater Study

ob No. KC 998-C Date 24 Sept. 71

TEST HOLE No. 12

Ft. Mye rs State Florida Driller M.Miller

ation of Test Hole

• ¼ SW ¼ Sec. 35 of T 45S,

26E, Lee Co., Florida.

35

Elevation of Test Hole

Static Water Level

Measured Hours After Completion

om	To	Description of Strata	Water Bearing	
0	17	Light colored sand		
	49	Layers of hard rock and coarse sand	32	good
49	69	Clay in limestone and sand	20	poor
	84	Limestone and sand, clay filled	15	none
	90	Green clay	6	none
	94	Limestone with green clay	4	none
	103	Limestone with layers of hard rock, water bearing	9	fair
03	140	Limestone (very good water bearing material)	37	V.go
	156	Hard rock layers with sand	16	good
56	166	Boulders, gray sand (firm) with some shell	10	poor
	186	Gray sand with trace of shell	20	poor
36	196	Gray sand with some limestone	10	poor
	226	Limestone with some clay	30	poor
26	235	Mostly clay with some limestone rock	9	none
	236	Medium rock	1	none
36	246	Clay with some shell	10	none
	246	Total depth drilled		

Remarks: Installed 82 feet of 2 inch diameter pipe. Test pumped 60+ gpm with 15 inches of vacuum.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT

ANALYTICAL LABORATORY DIVISION

Report to: LAYNE-WESTERN COMPANY

Appearance: CLEAR

Date: SEPTEMBER 20, 1971

Sampled by: CLIENT

Sample Number: 4809

Identification: GM #12 TEST WELL 82' PIPE 243' DEEP PUMP +60 GPM MOST WATE FROM 90'-155' LEVEL

METHODS

This water was analyzed using methods adopted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	366	Sulfate, as SO_4	16
Total Hardness, as $CaCO_3$	240	Fluorides, as F	0.55
Calcium Hardness, as $CaCO_3$	180	Silica, as SiO_2	37
Magnesium Hardness, as $CaCO_3$	60	Copper, as Cu	0.0
Calcium, as Ca	72	Phosphate (Total), as PO_4	0.7
Magnesium, as Mg	14	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	270	pH (Laboratory)	7.8
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	270	Stability Index	6.0
Hydroxides, as OH	0	Saturation Index	0.9
Carbon Dioxide, as CO_2	9	Turbidity, Silica Scale	20
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	330		
Chlorides, as Cl	39		
Iron, as Fe	0.0		
Manganese, as Mn	0.0		

Signed: J. Hobbs
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-622

Driller _____

Test Hole Location SE ¼ of SE ¼ Section 4, T45S, R26E.

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	7'0"			Sand, brown, iron stained, fine to med.
7'0"	20'0"			Limestone, light gray and brown
20'0"	30'0"			Clay, light green
30'0"	40'0"			Clay, dark green, shell fragments, phosphate pebbles
40'0"	60'0"			Clay, dark green, shell fragments
60'0"	70'0"			Sandstone, gray, calcareous
70'0"	80'0"			Same
80'0"	100'0"			Same
100'0"	115'0"			Same
115'0"	130'0"			Limestone, and gray clay
130'0"	190'0"			Clay, gray
190'0"	220'0"			Clay, dark gray, sandy, phosphatic
220'0"	250'0"			Clay, gray
250'0"	280'0"			Limestone, gray-white, phosphatic
280'0"	305'0"			Same

NOTES: Size of Pit _____ X _____ X _____ DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-739

Driller _____

Test Hole Location near South Quarter Corner of Section 19, T 46 S, R 26 E
or also described as
Distance and Direction from Permanent Landmark or Previous Test Hole
NW NW¼ of NE¼ of Sec 30, 46S, R26E. TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	10'0"			Sand, fine-med., brown
10'0"	20'0"			Sand, fine-med., tan
20'0"	25'0"			Sand, fine, white
25'0"	30'0"			Limestone, tan, sandy
30'0"	50'0"			Same with shells
50'0"	55'0"			Limestone, gray
55'0"	70'0"			Limestone, tan & gray, some clay, shells
70'0"	90'0"			Limestone, gray
90'0"				Limestone, tan
	140'0"			Limestone, gray, tan
140'0"	150'0"			Limestone, tan, sandy
150'0"	170'0"			Clay, light gray
170'0"	200'0"			Clay, green, sandy
200'0"	210'0"			Clay, dark gray-green, shell frag., phosphate
Continued------				

NOTES: Size of Pit _____ X _____ X _____
DEEP

TEST HOLE REPORT

Layne-Western Company

Contract Name Green Meadows Project

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. L-739

Driller _____

Test Hole Location _____

Distance and Direction from Permanent Landmark or Previous Test Hole

Continuation of L-739 #2 TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
210'0"	218'0"			Clay, dark gray-green
218'0"	225'0"			Limestone, gray-white, sandy
225'0"	230'0"			Sand, fine-med., gray-tan
230'0"	240'0"			Sandstone, gray
240'0"	250'0"			Sandstone, gray, and sand

NOTES: Size of Pit _____ X _____ X _____ DEEP

APPENDIX E

WATER SUPPLY STUDY

in

WESTERN LEE COUNTY, FLORIDA

For: Florida Cities Water Company
Sarasota, Florida
Fort Myers Beach, Florida

By: Carl E. Nuzman, P.E.
Hydrology Consultant
Layne-Western Company, Inc.
Kansas City, Missouri 64111
(816) 931-2353

TABLE OF CONTENTS

INTRODUCTION

A formal proposal was submitted and accepted by Florida Cities Water Company to investigate the water supply situations for additional development in the vicinity of their Cypress Lakes well field located south of the City of Fort Myers, Florida. This report gives the results of the investigation.

Purpose and Scope

The purpose of the investigation is to determine whether sufficient ground water supply exists in the vicinity of the FCWC Cypress Lakes well field and water plant site to warrant building a water softening plant and have sufficient supply to meet future needs. The investigative procedure was to collect data from existing sources and inventory the present water supply situation. Then, test holes were drilled on a wide spacing basis to supplement these data and establish water level and water quality sampling stations. These data were then used in a model simulating the present aquifer condition. The aquifer simulation model was then programmed to include additional development and predict the probable outcome of such development. Both analog and digital computer techniques were used in the aquifer model simulation process.

Acknowledgements

The author received assistance from Mr. Gary Long, the manager of the Fort Myers District of Florida Cities Water Company who gave freely of his time to locate, obtain rights-of-way and collect data for the test drilling operation. Cooperation and assistance was received from Mr. Durwood Boggess, District Geologist of the U.S. Geological Survey, who measured water levels in wells and reported all pertinent geology data collected in the area of study. The test drilling sub-contractor was Mr. Marvin Miller, who did an excellent job. Some pumpage data and sea level elevations were furnished or made by personnel of Henry B. Steeg & Associates of Cape Coral, Florida. A concurrent study of water supply for Cape Coral was conducted for GAC Utilities and appreciation is expressed to this company which allowed wider and more comprehensive coverage ofthe Lee County area to be made for the mutual benefit of both studies. Appreciation for information obtained from the Pine Island Water District, the Florida Natural Resources Commission for data received, and to individuals who allowed water samples to be taken or test holes to be drilled on property under their control.

Population of Area

The present (October 1970) population of Cape Coral is listed at 15,296. The population one year ago was listed at 13,228. Occupancy of Cape Coarl started late in 1958. The average population growth has been approximately 13 percent a year. The population of Cape Coral can be expected to double in ten (10) years.

In 1966, FCWC furnished water to approximately 1500 customers on Fort Myers Beach, representing about 3500 population. The franchise service area has been expanded and now FCWC furnishes water to an equivalent population of 7000. The population of the FCWC franchise area can be expected to double in ten (10) years without further increase in area. If the service area is increased, a greater growth may be realized in time.

GEOLOGIC SITUATION

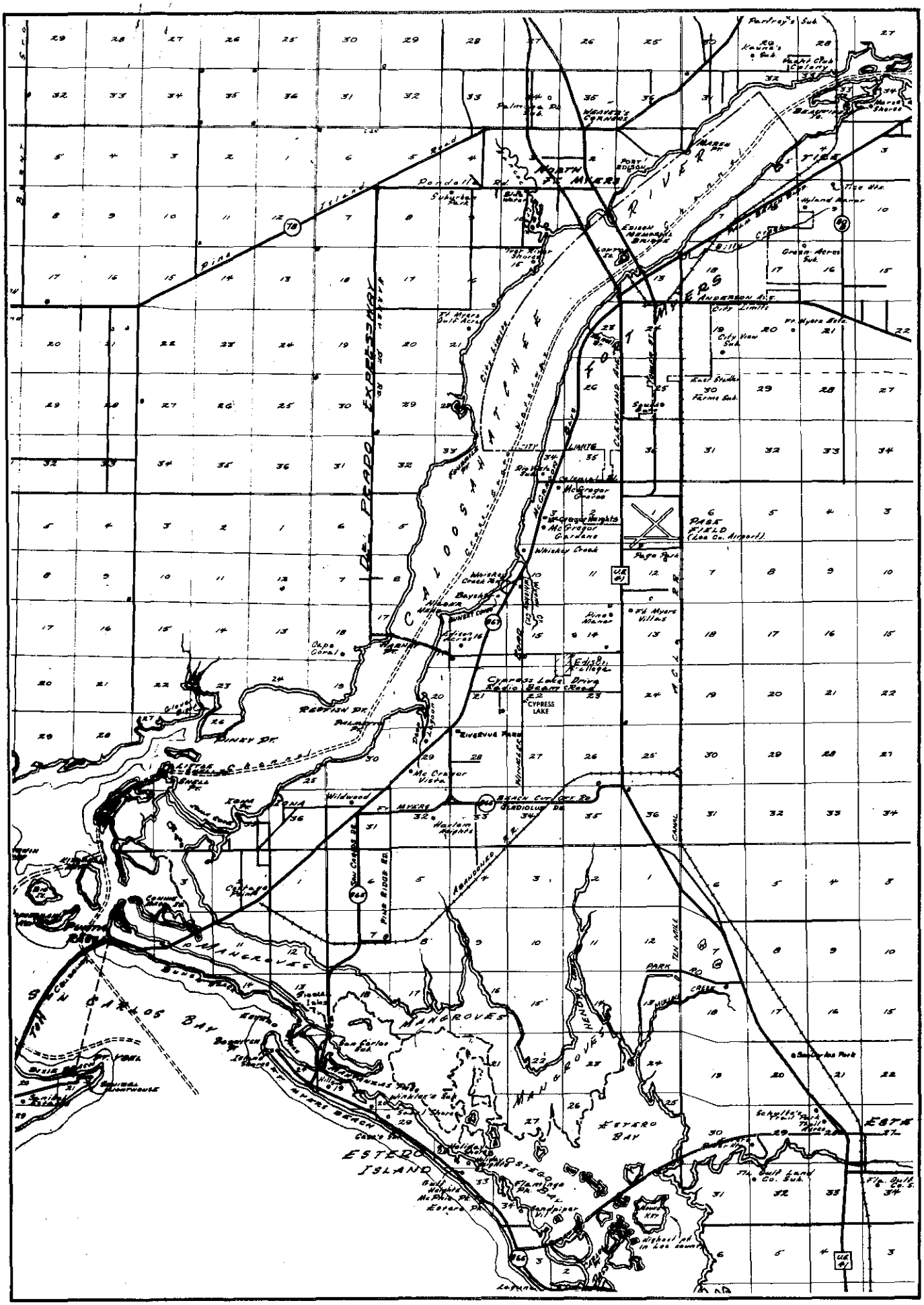
The most productive formation in the area suitable for public water supply development is the upper Hawthorn formation. This aquifer is a firm cocquina type of limestone formation generally encountered about 125 feet below land surface and continues in depth to approximately 225 feet. A green or yellow clay unit is then encountered which can be 200 feet thick, separating the upper Hawthorn aquifer from the lower Hawthorn aquifer. The normal chloride content of water from this aquifer is estimated to be about 80 parts per million (ppm).

The upper Hawthorn is usually protected from surface salt water infiltration by a green clay blanket usually 20 to 30 feet thick. Occasionally some sands are found in small areas on top the clay horizon which makes up the Tamiami formation. The most productive wells developed only in this formation are those of Florida Cities Water Company located at North Fort Myers water plant.

The lower Hawthorn and the Tampa-Suwannee limestone formations have water production capability from approximately 550 feet below land surface to nearly 1,000 feet or more, in depth. The normal chloride content of water from these horizons is about 650 ppm and must be classified as brackish. The existing water pressure level in these aquifers is above land surface and these wells flow, if not restricted.

Nearly ten (10) years ago, or more, some vegetable farming requiring supplemental irrigation was practiced on cleared tracts of land. Many tracts were located in the Cape Coral area and a few tracts were located near the Cypress Lakes well field. These wells had shallow casings and were constructed with open hole to all formations with many wells penetrating to depths of 900 feet. Originally, good water from the upper Hawthorn formation was mixed in the well with poor quality from the lower Hawthorn formation and deeper formations, resulting in a high yield well of usable quality. Very little intra-flow between aquifers occurred because pressure levels in each aquifer were very similar. At the present (1970) time, the water level has been greatly lowered in the upper aquifer allowing brackish water to contaminate this aquifer by intra-flow in old abandoned wells. These abandoned wells have proven to be a serious pollution source deteriorating water quality in the upper Hawthorn formation.

Water levels in various piezometers have been measured by the U.S.G.S. of Ft. Myers. Illustrated is the present water table contours for the condition existing on October 20, 1970, in the study area for only the Upper Hawthorn. The drawdown from the original artesian level has reached 50 feet in small areas. Greater depths have been observed in pumped wells.


FT. MYERS
NORTH FT. MYERS
Pondella Rd.
Pine Island
Del Prado Expressway
Caloosahatchee River
Edison Memorial Bridge
Anderson Ave.
City Limits
Page Field
(Lee Co. Airport)
Cypress Lake Drive
Radio Beach Road
Cypress Lake
Riverside Park
Beach Cswy. Cor. Rd.
Gladiolus Dr.
Pine Ridge Rd.
Summerlin Rd.
Six Mile Cypress Slough
Mangroves
San Carlos Bay
Estero Island
Estero Bay
Fort Myers Beach
Park Rd.
Ten Mile Canal
Henderson Creek
Whiskey Creek
Hanson St.
Dunlap Rd.
Reynolds Dr.
Sunset Dr.
Bayshore
Cape Coral
Pine Manor
Ft. Myers Villas
Harlem Heights
McGregor Vista
McGregor Gardens
McGregor Grove
McGregor Heights
Edgewood Village
Riverside Park
Wildwood
Rivers Edge
Crescent Beach
Gulf Heights
Estero Gardens
Tarpon Point
Bonita Beach
Bonita Shores
Hyland Manor
Pine Isle
Crescent Acres Sub.
Ft. Myers Villas
Ft. Myers Beach
Ft. Myers Gulf Acres
Ft. Myers Shores
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Ft. Myers Beach Villa Sub. No. 84
Ft. Myers Beach Villa Sub. No. 85
Ft. Myers Beach Villa Sub. No. 86
Ft. Myers Beach Villa Sub. No. 87
Ft. Myers Beach Villa Sub. No. 88
Ft. Myers Beach Villa Sub. No. 89
Ft. Myers Beach Villa Sub. No. 90
Ft. Myers Beach Villa Sub. No. 91
Ft. Myers Beach Villa Sub. No. 92
Ft. Myers Beach Villa Sub. No. 93
Ft. Myers Beach Villa Sub. No. 94
Ft. Myers Beach Villa Sub. No. 95
Ft. Myers Beach Villa Sub. No. 96
Ft. Myers Beach Villa Sub. No. 97
Ft. Myers Beach Villa Sub. No. 98
Ft. Myers Beach Villa Sub. No. 99
Ft. Myers Beach Villa Sub. No. 100

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924
TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

City: Ft. Myers State: Florida

TEST HOLE No. FCW 1-70

Driller: Marvin Miller

Location of Test Hole: Cypress Lake Drive & Edison Junior College

SW ¼ NE ¼ Sec. 23 of T 45S, R 24E, Lee Co., Florida

23

Elevation of Test Hole: 6.2' msl (8.18 top pipe)

Static Water Level: 4.59 (below top pipe)

Measured: August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	4'	Sand		
4	10	Rock		
10	40	Shell and sand		
40	50	Brown shell and sand		
50	65	Green clay and shell		
65	70	Green clay		
70	80	Rock and clay		
80	85	White sand rock		
85	105	White sand	20	poor
117	126	White and black rock	9	poor
130	150	Yellow rock	20	fair
160	220	White rock	40	good
220	230	Greenclay and shell	10	none
230	Total depth			

Remarks: Casing - 2" diameter pipe - 126 feet in depth
Test (6 seconds, 5 gallons) 50 gpm with shallow lift pump
Static water level elevation 3.59 feet above msl

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC1-70

ELEVATION TOP OF PIPE 8.18 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.90 feet

ELEVATION LAND SURFACE DATUM 6.28 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		21.8
19 Aug., 1970	4.59	3.59
20 Oct., 1970	5.43	2.75
Apparent Areal Drawdown		18.21 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 73.72 feet m.s.l.

ELEVATION OF CASING POINT - 119.72 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 250 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 10,000 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 5 gpm/ft.

YIELD POTENTIAL 200 gpm

TOTAL DISSOLVED SOLIDS 800 mg/l

CHLORIDES 255 mg/l

ELEVATION OF BOTTOM FORMATION - 213.72 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING Cable- Tool

BOTTOM ELEVATION OF TEST HOLE - 223.72 feet m.s.l.

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

City: Ft. Myers State: Florida

TEST HOLE No. FCW 2-70

Driller: Marvin Miller

Location of Test Hole: East of Edison Junior College

NW ¼ NE ¼ Sec. 23 of T 45S, R 24 E, Lee Co., Florida

Elevation of Test Hole: 6.7 (8.58) top pipe

Static Water Level: 15.64 (T. pipe)

Measured: August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	5'	Sand		
5	20	Rock and sand		
20	30	Sand and shell		
30	50	Shell and clay		
50	60	Shell and sand		
60	65	Green clay		
65	70	Green clay and shell		
70	80	Sand rock		
80	100	Sand		
100	105	Black sand		
105	125	Yellow rock	20	poor
125	210	White rock	85	good
210	225	Black sand, rock	15	poor
225	230	Green clay	5	none
230	Total depth			

Remarks: Casing - 2" diameter pipe - 126' in depth
Test (9 second - 5 gallons) 33 gpm with shallow lift pump
Static water level (-) 7.06 feet below msl

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 2-70

ELEVATION TOP OF PIPE 8.58 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.6 feet

ELEVATION LAND SURFACE DATUM 6.98 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		21.9
19 Aug. 1970	15.64	- 7.06
20 Oct., 1970	14.64	-6.06
Apparent Areal Drawdown		28.96 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 63 feet m.s.l.

ELEVATION OF CASING POINT - 119 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 200 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 17,000 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 8.5 gpm/ft.

YIELD POTENTIAL 350 gpm

TOTAL DISSOLVED SOLIDS 1950 mg/l

CHLORIDES 690 mg/l

ELEVATION OF BOTTOM FORMATION -118 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING Cable-Tool

BOTTOM ELEVATION OF TEST HOLE -223 feet m.s.l

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924
TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

City: Ft. Myer State: Florida

TEST HOLE No. FCW 3-70

Driller: Marvin Miller

Location of Test Hole: College Parkway east of Edison Junior College

SW ¼ SE ¼ Sec. 14 of T 45 S, R 24 E, Lee Co., Florida

Elevation of Test Hole 6.6 msl (8.41 T. pipe)

Static Water Level 16.07 (T. pipe)

Measured August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	21'	White sand and shell		
21	31	Sand w/gray shell		
31	58	Clay		
58	78	Clay w/shell		
78	82	Layer of hard pan		
82	122	Gray sand	40	poor
122	192	Shell and coarse sand	70	good
192	202	hard pan (limestone)	10	none
202	237	Shell and limestone	35	good
237	238	Clay	1	none
238		Total depth		

Remarks:

Casing - 2" diameter pipe 126 feet in depth
Test (6 seconds - 5 gallons) 50 gpm with shallow lift pump

TEST HOLE EVALUATION DATA
IDENTIFICATION NUMBER FCWC 3-70

ELEVATION TOP OF PIPE 8.41 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.3 feet

ELEVATION LAND SURFACE DATUM 7.11 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.0
19 Aug., 1970	16.07	- 7.66
20 Oct., 1970	15.30	- 6.89
Apparent Areal Drawdown		29.66 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 115 feet m.s.l.

ELEVATION OF CASING POINT - 119 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 200 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 21,000 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 10.5 gpm/ft.

YIELD POTENTIAL 420 gpm

TOTAL DISSOLVED SOLIDS 500 mg/l

CHLORIDES 111 mg/l

ELEVATION OF BOTTOM FORMATION - 230 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING Cable-Tool

BOTTOM ELEVATION OF TEST HOLE - 231 feet m.s.l

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

City: Ft. Myers State: Florida

Driller: Marvin Miller

TEST HOLE No.: FCW4-70

Location of Test Hole: End of Brantley Rd.

Near ¼center¼ Sec. 14 of T 45 S, R 24 E, Lee Co. Florida

Elevation of Test Hole 9.1 feet msl (10.52 top pipe)

Static Water Level 11.20 feet

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
1	11	Sand		
11	31	Sandy shell		
31	52	Clay and shell		
52	78	Clay		
78	80	Hard pan		
80	113	Gray sand, fine shell	33	poor
113	147	Shell rock	34	Good
147	231	Shell	84	Good
231	244	Shell and clay	13	poor
244	251	Clay and fine shell	7	none
251	Total depth			

Remarks:

Casing - 2" diameter pipe 126 feet in depth

Test -(5.5 seconds - 5 gallons) 55 gpm with shallow lift pump

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 4-70

ELEVATION TOP OF PIPE 10.52 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.3 feet

ELEVATION LAND SURFACE DATUM 9.22 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.1
19 Aug., 1970	10.22	0.30
20 Oct., 1970	10.14	0.38
Apparent Areal Drawdown		21.80 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 71 feet m.s.l.

ELEVATION OF CASING POINT - 117 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 220 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 25,600 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 13 gpm/ft.

YIELD POTENTIAL 510 gpm

TOTAL DISSOLVED SOLIDS 430 mg/l

CHLORIDES 90 mg/l

ELEVATION OF BOTTOM FORMATION - 235 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING Cable-Tool

BOTTOM ELEVATION OF TEST HOLE - 242 feet m.s.l.

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No. _____ Date _____

City: Ft. Myers State: Florida

TEST HOLE No. FCW-5-70

Driller: Marvin Miller

Location of Test Hole _____

NW ¼ NE ¼ Sec. 14 of T 45 S, R 24 E, Lee Co., Florida

14

Elevation of Test Hole 10.5

Static Water Level _____

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	11'	Brown sand		
11	21	Brown sand, shell		
21	31	Shell and sand		
31	41	Shell and clay		
41	50	Clay with shell		
50	69	Clay		
69	72	Clay and shell		
72	74	Rock		
74	93	Sand	19	poor
93	99	Rock layers	6	poor
99	109	Black shell and sand	10	poor
109	143	Limestone with sand	34	fair
143	233	Limestone shell	90	good
233	234	Clay	1	none
234	Total depth			

Remarks: Casing 2" diameter pipe 126 feet in depth

Test (5 sec. - 5 gallons) 60 gpm with shallow lift pump

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 5-70

ELEVATION TOP OF PIPE 11.81 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.2 feet

ELEVATION LAND SURFACE DATUM 10.61 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.4
19 Aug., 1970	11.20	0.61
20 Oct., 1970	10.70	1.11
Apparent Areal Drawdown		21.79 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION -99 feet m.s.l.

ELEVATION OF CASING POINT -115.4 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 200 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 18,000 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 9.0 gpm/ft.

YIELD POTENTIAL 360 gpm

TOTAL DISSOLVED SOLIDS 800 mg/l

CHLORIDES 225 mg/l

ELEVATION OF BOTTOM FORMATION - 223 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 224 feet m.s.l.

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. _____ Date July, 1970

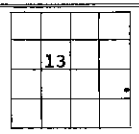
City Ft. Myers State Florida

TEST HOLE No. FCW 6-70

Driller Marvin Miller

Location of Test Hole East side of end of Gorham Avenue

NE ¼ SE ¼ Sec. 13 of T 45 S, R 24 E, Lee Co., Florida



Elevation of Test Hole 15.1 (16.16 top pipe)

Static Water Level 9.73 (below T. pipe)

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
1	4'	Sand		
4	10	Rock		
10	30	Sand, shell		
30	50	Shell		
50	70	Green clay		
70	90	Sand		
90	100	Green clay, sand		
105	120	White sand		
120	140	Black sand	20	poor
140	150	Gray clay	10	none
160	200	White rock	40	good
200	220	Black sand	20	poor
220	Total depth			

Remarks: Casing - 2" diameter pipe 147 feet in depth
Test 13 seconds - 5 gallons 23 gpm with shallow lift pump

LW-62 WICHITA • GARDEN CITY • LIBERAL • KANSAS CITY • DENVER • OMAHA • AMES • ST. LOUIS • AURORA

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 6-70

ELEVATION TOP OF PIPE 16.16 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 0.50 feet

ELEVATION LAND SURFACE DATUM 15.66 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.1
19 Aug., 1970	9.73	6.43
20 Oct., 1970	8.96	7.20
Apparent Areal Drawdown		15.67

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 90 feet m.s.l.

ELEVATION OF CASING POINT - 132 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 190 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 7,600 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 3.8 gpm/ft.

YIELD POTENTIAL 150 gpm

TOTAL DISSOLVED SOLIDS 380 mg/l

CHLORIDES 75 mg/l

ELEVATION OF BOTTOM FORMATION - 185 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 205 feet m.s.l

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924
TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. _____ Date July, 1970

City Ft. Myers State Florida

TEST HOLE No. FCW 7-70

Driller Marvin Miller

Location of Test Hole Warren Bros. Tar plant, Gladiola Drive

SW ¼ SE ¼ Sec. 26 of T 45 S, R 24 E, Lee Co., Florida

26

Elevation of Test Hole 4.7 feet msl (5.76 top pipe)

Static Water Level +7.8 (Flowing)

Measured August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	10'	Rock		
10	30	Brown sand		
40	52	Shell		
52	70	Green clay		
70	84	Green clay and sand		
84	90	White sand		
90	110	Green sand		
110	122	Blue clay		
122	130	White rock	8	good
130	150	Yellow rock	20	poor
150	205	White rock	55	good
205	230	Green clay	25	none
230	Total depth			

Remarks:

Casing - 2" diameter pipe 126 feet in depth

Flowing well 2-1/4" head - flowing approximately 30 gpm

LW-62 WICHITA • GARDEN CITY • LIBERAL • KANSAS CITY • DENVER • OMAHA • AMES • ST. LOUIS • AURORA

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 7-70

ELEVATION TOP OF PIPE 5.76 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 0.90 feet

ELEVATION LAND SURFACE DATUM 4.86 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		21.0
19 Aug., 1970	+ 7.8	13.56
20 Oct., 1970	+ 4.41	10.17
Apparent Areal Drawdown		7.44 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 117 feet m.s.l.

ELEVATION OF CASING POINT - 121 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 225 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 10,800 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 5.4 gpm/ft.

YIELD POTENTIAL 215 gpm

TOTAL DISSOLVED SOLIDS 1900 mg/l

CHLORIDES 666 mg/l

ELEVATION OF BOTTOM FORMATION - 199 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 225 feet m.s.l.

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. _____ Date _____

City Ft. Myers State Florida

TEST HOLE No. FCW-8

Driller Marvin Miller

Location of Test Hole _____

SW ¼ SW ¼ Sec. 24 of T 45 S, R 24 E, Lee Co., Florida.

24

Elevation of Test Hole 10.7

Static Water Level _____

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
0	9'	Sand		
9	11	Rock		
11	25	Sand		
25	40	Shell, coarse sand		
40	50	Clay and shell		
50	78	Clay		
78	80	Hard pan		
80	122	Sand		
122	132	Black shell and coarse sand	10	fair
132	142	Clay and coarse sand	10	poor
142	152	Clay and shell	10	poor
152	168	Shell and limestone	16	good
168	170	Hard pan	2	none
170	212	Shell & Limestone	42	good
212	232	Shell with clay	20	poor
232	240	Clay with shell	8	none
240	Total depth			

Remarks: Casing - 2" diameter pipe 126 feet in depth

Test (4.5 sec. - 5 gallons) 67 gpm with shallow lift pump

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 8-70

ELEVATION TOP OF PIPE 11.57 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 0.8 feet

ELEVATION LAND SURFACE DATUM 10.77 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		21.5
14 Aug., 1970	3.65	7.92
20 Oct., 1970	4.20	7.37
Apparent Areal Drawdown		13.58 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION -111 feet m.s.l.

ELEVATION OF CASING POINT -115 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 210 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 14,300 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 7.1 gpm/ft.

YIELD POTENTIAL 285 gpm

TOTAL DISSOLVED SOLIDS 1100 mg/l

CHLORIDES 360 mg/l

ELEVATION OF BOTTOM FORMATION - 201 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 229 feet m.s.l.

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

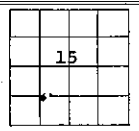
City: Ft. Myers State: Florida

Driller: Marvin Miller

TEST HOLE No. FCW 9-70

Location of Test Hole: Winkler and College Parkway

SE ¼ SW ¼ Sec. 15 of T 45 S, R 24 E, Lee Co., Florida



Elevation of Test Hole 6.6 (8.46 feet top pipe)

Static Water Level 3.02 (T. pipe)

Measured August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	21'	Sand		
21	34	Sand and shell		
34	40	Clay and shell		
40	74	Clay		
74	76	Clay and shell		
76	77.5	Rock		
77.5	80	Hard pan		
80	90	Sand, shell and clay		
90	120	Sand with fine shell		
120	130	Shell, sand and clay	4	poor
130	189	Shell limestone	59	good
189	192	Limestone rock	3	good
192	198	Clay, shell and sand	6	poor
198	201	Limestone rock	3	good
201	211	Shell limestone	10	good
211	226	Shell and clay	15	poor
226	228	Clay with fine shell	2	none
228	229	Hard rock	1	none
229	Total depth			

Remarks: Casing - 2" diameter pipe 126 feet in depth

Test (5 seconds - 5 gallons) 60 gpm with shallow lift pump

TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 9-70

ELEVATION TOP OF PIPE 8.46 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.5 feet

ELEVATION LAND SURFACE DATUM 6.96 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.0
14 Aug., 1970	3.02	5.44
20 Oct., 1970	3.60	4.86
Apparent Areal Drawdown		16.56 feet

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 123 feet m.s.l.

ELEVATION OF CASING POINT - 119 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 220 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 15,900 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 8 gpm/ft.

YIELD POTENTIAL 320 gpm

TOTAL DISSOLVED SOLIDS 850 mg/l

CHLORIDES 285 mg/l

ELEVATION OF BOTTOM FORMATION - 219 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 222 feet m.s.l

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924
TEST DRILLING • WATER WELLS • PUMPS

Contract Name: Florida Cities Water Company

Job No.: _____ Date: July, 1970

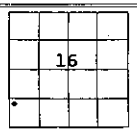
City: Ft. Myers State: Florida

TEST HOLE No. FCW 10-70

Driller: Marvin Miller

Location of Test Hole: Ft. Myers side of Cape Coral bridge

SW ¼ SW ¼ Sec. 16 of T 45 S, R 24 E, Lee Co., Florida.



Elevation of Test Hole: 6.5 feet msl (7.80 top pipe)

Static Water Level: 3.27 (T. pipe)

Measured: August '70 Hours After Completion

From	To	Description of Strata	Water Bearing	
1	10'	Sand		
10	20	Sand and shell		
20	30	Sandy clay and shell		
30	60	Clay and shell	30	none
60	85	Sandy clay	25	none
85	104	Clay and shell	19	none
104	122	Sand and fine shell	18	poor
122	128	Sand, shell and clay	6	poor
128	134	Black clay and shell	6	poor
134	139	Sand, shell and clay	5	poor
139	236	Shell, water rock with sand	97	good
236	239	Clay and shell	3	none
239	241	Clay, fine shell	2	none
241	Total depth			

Remarks:

Casing - 2" diameter pipe 126 feet in depth

Test (7 seconds - 5 gallons) 43 gpm with suction lift pump

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TEST HOLE EVALUATION DATA

IDENTIFICATION NUMBER FCWC 10-70

ELEVATION TOP OF PIPE 7.80 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.0 feet

ELEVATION LAND SURFACE DATUM 6.80 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		22.0
14 Aug., 1970	3.27	4.53
20 Oct., 1970	5.34	2.46
Apparent Areal Drawdown		17.47

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 127 feet m.s.l.

ELEVATION OF CASING POINT - 119 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 180 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 15,600 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 7.8 gpm/ft.

YIELD POTENTIAL 310 gpm

TOTAL DISSOLVED SOLIDS 1000 mg/l

CHLORIDES 351 mg/l

ELEVATION OF BOTTOM FORMATION - 229 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE - 234 feet m.s.l

LAYNE-WESTERN COMPANY, INC.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924
TEST DRILLING • WATER WELLS • PUMPS

Contract Name Florida Cities Water Company

Job No. _____ Date _____

City Ft. Myers State Florida

TEST HOLE No. FCW 11-70

Driller Marvin Miller

Location of Test Hole _____

SW ¼ SE ¼ Sec. 14 of T 45 S, R 24 E, Lee Co., Florida.

Elevation of Test Hole 7.4 feet msl

Static Water Level _____

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
Fill				
1	4'	Sand		
4	6	Rock		
6	16	Sand		
16	26	Sand, shell & Clay		
26	36	Shell & clay		
36	65	Green clay		
65	66	Rock		
66	74	Sand and clay		
74	75	Rock		
75	122	Sand	47	poor
122	140	Shell	18	Fair
140	142	Shell rock	2	good
142	168	Shell	26	fair
168	170	Shell rock	2	good
170	178	Shell	8	fair
178	185	Shell with gray clay	7	poor
185	187	Shell rock	2	good
187	232	Shell	45	good
232	236	Green clay Total depth	4	none

Remarks:
Casing - 2" diameter pipe 126 feet in depth
No test - water too low for suction lift pump

TEST HOLE EVALUATION DATA
IDENTIFICATION NUMBER FCWC 11-70

ELEVATION TOP OF PIPE 8.81 feet m.s.l.

HEIGHT OF PIPE ABOVE LAND SURFACE 1.0 feet

ELEVATION LAND SURFACE DATUM 7.81 feet m.s.l.

ELEVATION OF STATIC WATER LEVEL

DATE	DEPTH TO WATER	ELEVATION
1944-1952		21.9
20 Oct., 1970	30.98	22.17
Areal Drawdown		44.07

FORMATION NAME - UPPER HAWTHORN

ELEVATION TOP OF FORMATION - 67 feet m.s.l.

ELEVATION OF CASING POINT - 118 feet m.s.l.

PRODUCTION CAPABILITY

ESTIMATED PERMEABILITY 200 gpd/sq. ft.

ESTIMATED TRANSMISSIVITY 10,200 gpd/ft.

ESTIMATED STORATIVITY 0.01

EST. SPECIFIC CAPACITY 5.1 gpm/ft.

YIELD POTENTIAL 205 gpm

TOTAL DISSOLVED SOLIDS _____ mg/l

CHLORIDES _____ mg/l

ELEVATION OF BOTTOM FORMATION -224 feet m.s.l.

WELL DIAMETER 2 inches

METHOD OF DRILLING CABLE-TOOL

BOTTOM ELEVATION OF TEST HOLE -228 feet m.s.l.

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

MISCELLANEOUS WELL LOG - CYPRESS LAKES WELL FIELD

Contract Name: Florida Cities Water Company

Job No.: Cypress Lakes Well Date:

City: Fort Myers Beach State: Florida

TEST HOLE No.: 3-D

Driller: Marvin Miller

Location of Test Hole: East of Storage Reservoir

¼ ¼ Sec. of T, R, Co.,

Elevation of Test Hole:

Static Water Level:

Measured: Hours After Completion

From	To	Description of Strata	Water Bearing	
0'	0'6"	Top soil		
0'6"	7	Boulder and sand		
7	18	Marl		
18	63	Green clay		
63	78	Yellow clay		
78	90	Green clay		
90	124	Sandy clay		
124	182	White rock and shell		
182	195	White clay		
195	220	Rock and shell		
220	230	Yellow clay and shell		
230	235	Yellow clay		
	235	Total depth of drilling		

Remarks: Casing is 8 inch diameter pipe 137.5 feet in depth

TEST HOLE REPORT

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

MISCELLANEOUS WELL LOG - CYPRESS LAKES WELL FIELD

Contract Name: Florida Cities Water Company

Job No.: Cypress Lakes Well Field Date:

City: Fort Myers Beach State: Florida

TEST HOLE No.: 1-A

Driller: Marvin Miller

Location of Test Hole: 1300 feet south of Well 2-C

¼ ¼ Sec. of T, R, Co.,

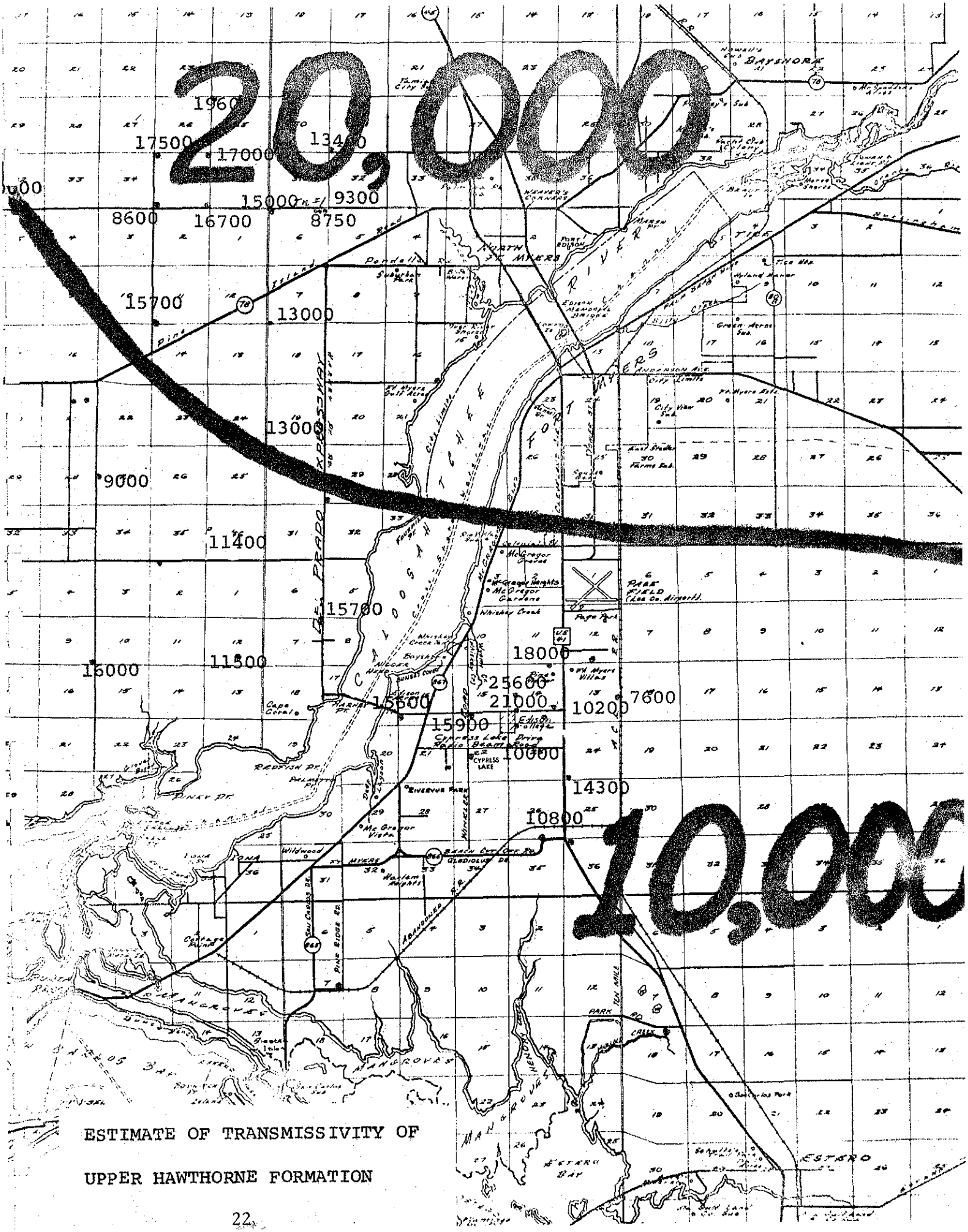
Elevation of Test Hole:

Static Water Level: 5'8"

Measured: Hours After Completion

From	To	Description of Strata	Water Bearing	
0'0"	0'3"	Top soil		
0'3"	6'6"	Rock		
6'6"	17	Marl and shell		
17	32	Light green clay		
32	58	Green clay		
58	67	Light green clay		
67	106	Sandy clay		
106	109	Green clay		
109	128	Green clay with shell	19	none
128	141	Shell rock	13	fair
141	184	Shell with white clay	43	poor
184	228	Gray clay with shell	44	none
228	230	Green clay		
	230	Total depth of drilling		

Remarks: Set 137'10" of 8 inch diameter pipe for casing
Initial test was 35 gpm
Well shot with dynamite near 140 feet to increase yield.



ESTIMATE OF TRANSMISSIVITY OF

UPPER HAWTHORNE FORMATION

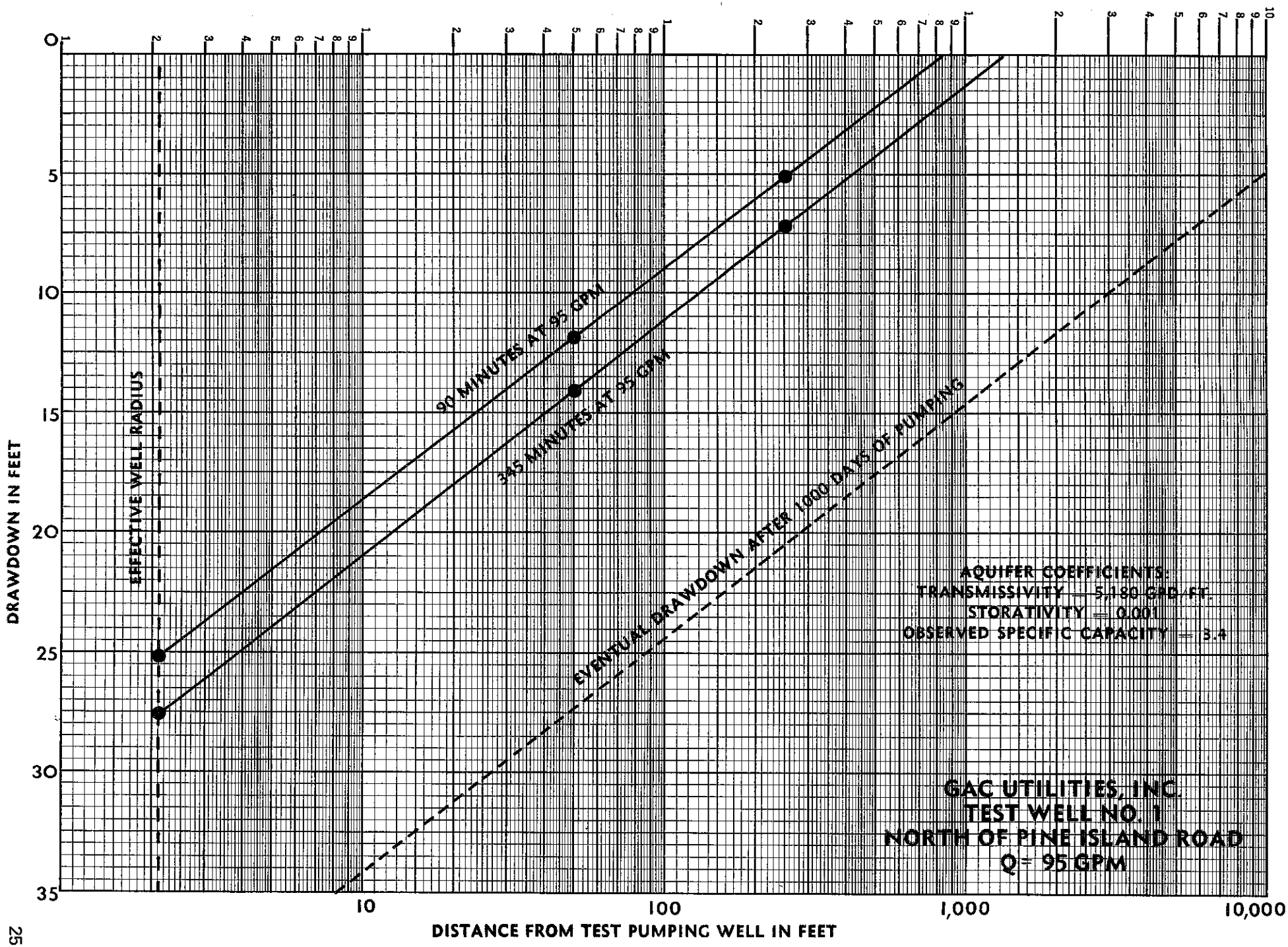
Aquifer Tests

In the final report of the test well program for the Cypress Lakes well field prepared by Bennett & Bishop, Consulting Engineers of Sarasota, Florida, they report their study of data obtained prior to any pumpage, gave a minimum transmissivity of 12,000 gallons per day per foot width of aquifer and a storage coefficient of 0.0008 to be the best average for the test wells. They also report, "Based on this graphic representation, it appears that a safe withwithdrawal of wells in the area can be made on the basis of 12 hours withdrawal and 12 hours recharge at a pumping drawdown for each well of approximately 20 feet, giving maximum drawdown in a series of wells of approximately 35 feet. The withdrawals have been determined on the basis of an average yield per well of 125 gpm ." The present (1970) areal decline of static water level in the vicinity of the well field is 44 feet.

A short eight (8) hour pumping test was conducted upon completion of drilling of Cape Coral Well No. 9, by Layne-Atlantic Company. The analysis of drawdown indicated the transmissivity of the Upper Hawthorn of this well after acidizing was nearly 20,000 gallons per day per foot width of aquifer material.

A short test was conducted on Cape Coral Test Well No. 1 north of Pine Island Road, which indicated a formation transmissivity of 5,180 gallons per day per foot width of material. The production potential in this area was much lower than in other areas of Cape Coral but yields up to 150 gpm are still possible. Later a 72 hour test with recovery measurements was made on this same well. No unusual or severe negative boundary conditions were revealed in the data. The maximum safe yields of this well was computed to be 175 gallons per minute. This well was drilled with cable tool equipment and was stimulated with dynamite at the 170 foot level and also, acidized. This well was located in the tightest, least permeable area of the Upper Hawthorn aquifer, as expected, but obtained the best quality of water available in the area.

Cape Coral Test Well No. 2, located north of Pine Island Road, was a 10 inch diameter well, drilled by the reverse rotary method, using air lift pumping within the drill stem. No acid treatment nor dynamite was used on this well. The specific capacity observed was 2.6 gallons per minute per foot of drawdown. The review of the well log suggests the formation could be slightly better and a significant increase in specific capacity should be obtained by acidizing this well at some future time. The water quality is acceptable and should be stable with many years of use. The suggested safe yield of this well is also 175 gallons per minute even though the well was tested at a pumping rate of 225 gallons per minute with 87 feet of drawdown. It is recommended that the pump setting should be at least 120 feet below land surface. All these wells in the Upper Hawthorn formation after two to three years of use, should be acidized and then cleaned to their original depths.


K+E SEMI-LOGARITHMIC 46 6012
4 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.
DRAWDOWN IN FEET
0
5
10
15
20
25
30
35
EFFECTIVE WELL RADIUS
90 MINUTES AT 95 GPM
345 MINUTES AT 95 GPM
EVENTUAL DRAWDOWN AFTER 1000 DAYS OF PUMPING
AQUIFER COEFFICIENTS:
TRANSMISSIVITY = 5,180 GPD/FT.
STORATIVITY = 0.001
OBSERVED SPECIFIC CAPACITY = 3.4
GAC UTILITIES, INC.
TEST WELL NO. 1
NORTH OF PINE ISLAND ROAD
Q = 95 GPM
10
100
1,000
10,000
DISTANCE FROM TEST PUMPING WELL IN FEET

LAYNE-ATLANTIC COMPANY
WELL TEST DATA

Work Order Number 52001 Customer G.A.C. Utilities Corp. Cape Coral Well Number 10

STATIC WATER LEVEL BEFORE PUMPING Feet 2 Inches 6"

PUMPING TEST BEGAN 10:00 O'CLOCK AM X PM ___ DATE September 25, 1970, 196__

TIME	YIELD IN GALLONS PER MINUTE		DRAWDOWN	PUMPING LEVEL	DATE
10:00 AM	RPM	GPM			
11:00 AM		250	90	93	Sep.25, 1970
12:00 NOON		250	90	93	"
1:00 PM		225	86	83	"
2:00 PM		225	87	90	"
3:00 PM		225	87	90	"
4:00 PM		225	87	90	"
5:00 PM		225	87	90	"
6:00 PM		225	87	90	"

G.A.C. UTILITIES, INC.
Ft. Myers Construction Division 10" WELL
CAPE CORAL, FLORIDA
Del Prado Blvd. LEE CTY.

Sec. 6 - Twsp 44 S. Rge 24 E.
Permit No. 6749

Started: September 15, 1970
Finished: September 29, 1970

0- 10	Top Soil
10- 15	White Shell
15- 25	White Shell, Clay
25-120	White Clay, Shells
120-130	Lime, Shell
130-145	Lime, white and black
145-165	Lime, Gray
165-175	Lime, white-gray, Water Sulphur odor -165'
175-210	Lime, white-gray
210-215	White Lime, brown shells
215-219	Clay, green
219-225	Lime, gray, white - odor in water at 210'

Set 126' 10" - 10" pipe T.C.
Cemented with 85 bags

Static 2'6"

Tested 8 hours - 225 GPM - 90' P.L.
Top of Well capped

PUMPING TEST COMPLETED 6:00 O'CLOCK AM ___ PM X DATE Sep. 25, 1970, 196_
STATIC WATER LEVEL THREE MINUTES AFTER TEST COMPLETED FEET ___ INCHES ___
STATIC WATER LEVEL SIX MINUTES AFTER TEST COMPLETED FEET ___ INCHES ___
USE BACK OF PAGE FOR REMARKS. OPERATOR Don Bridgeman

WATER QUALITY DATA

It appears from the data on the quality of water in the Upper Hawthorn formation, that the original content was about 80 parts per million. The best quality of water is found in areas of tightest formation that have not been contaminated by the flow of water from lower formations through abandoned wells.

The best quality of water found in the vicinity of the Cypress Lakes well field was located in this section of land directly north of the present plant location. The yield potential of this area is also satisfactory so that several additional wells could be constructed in this area to supplement the supply from existing wells. A mile to the south of the present well field, water quality of approximately 700 parts per million of chlorides has apparently existed for many years. Water levels above land surface are still encountered in this area, resulting in some flowing wells.[9] A complete listing of the water quality data analyzed from samples obtained from test wells in the vicinity of the Cypress Lakes well field, are enclosed in their entirety. A summary of water quality data of the Cape Coral test wells and miscellaneous wells in the Cape Coral vicinity are also enclosed for their information.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Co.
Date: June 24, 1970
Sample Number: 3714

Appearance: clear
Sampled by: client
Identification: Test well #1 North Pine Is. Rd. 100 gmp after re-drilling(GAC Utilities)

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	440	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	270	Fluorides, as F	1.0
Calcium Hardness, as $CaCO_3$	150	Silica, as SiO_2	3.6
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	60	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	258	pH (Laboratory)	6.9
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.0
Bicarbonate Alkalinity, as $CaCO_3$	258	Stability Index	7.1
Hydroxides, as OH	0	Saturation Index	-0.1
Carbon Dioxide, as CO_2	65	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	315		
Chlorides, as Cl	75		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne-Atlantic Co.
Date: September 30, 1970
Sample Number: 3918

Appearance: clear
Sampled by: client
Identification: GAC Utilities Cape Coral, Fort Meyers, Fl. 10" well permit # 6749 job#52001 PO# 10316

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105 C	575	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	300	Fluorides, as F	0.6
Calcium Hardness, as $CaCO_3$	168	Silica, as SiO_2	7.4
Magnesium Hardness, as $CaCO_3$	132	Copper, as Cu	0
Calcium, as Ca	67	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	32	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	216	pH (Laboratory)	7.8
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.1
Bicarbonate Alkalinity, as $CaCO_3$	216	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.7
Carbon Dioxide, as CO_2	7	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	263		
Chlorides, as Cl	156		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Company, Inc.
Date: August 14, 1970
Sample Number: 3830-5
Appearance: clear
Sampled by: client
Identification: FCW 9-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	850	Sulfate, as SO_4	0
Total Hardness, as $CaCO_3$	432	Fluorides, as F	0.6
Calcium Hardness, as $CaCO_3$	270	Silica, as SiO_2	7.2
Magnesium Hardness, as $CaCO_3$	162	Copper, as Cu	0
Calcium, as Ca	108	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	40	Color, Standard Platinum Cobalt Scale	2
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	210	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	210	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.4
Carbon Dioxide, as CO_2	28	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	256		
Chlorides, as Cl	285		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne-Western Company Co.
Date: August 14, 1970
Sample Number: 3830-7
Appearance: clear
Sampled by: client
Identification: FCW 10-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1000	Sulfate, as SO_4	55
Total Hardness, as $CaCO_3$	402	Fluorides, as F	1.2
Calcium Hardness, as $CaCO_3$	204	Silica, as SiO_2	6.4
Magnesium Hardness, as $CaCO_3$	198	Copper, as Cu	0
Calcium, as Ca	82	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	48	Color, Standard Platinum Cobalt Scale	2
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	162	pH (Laboratory)	7.3
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.1
Bicarbonate Alkalinity, as $CaCO_3$	162	Stability Index	6.9
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	17	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	197		
Chlorides, as Cl	351		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Co., Inc. — Appearance: clear

Date: August 14, 1970 — Sampled by: client

Sample Number: 3830-1 — Identification: FCW 7-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1900	Sulfate, as SO_4	135
Total Hardness, as $CaCO_3$	608	Fluorides, as F	0.3
Calcium Hardness, as $CaCO_3$	246	Silica, as SiO_2	7.6
Magnesium Hardness, as $CaCO_3$	362	Copper, as Cu	0
Calcium, as Ca	98	Phosphate (Total), as PO_4	0.3
Magnesium, as Mg	88	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	186	pH (Laboratory)	7.1
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	186	Stability Index	6.7
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	30	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	227		
Chlorides, as Cl	666		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Company, Inc. — Appearance: clear

Date: September 9, 1970 — Sampled by: client

Sample Number: 3870-1 — Identification: FCW 8 -70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1100	Sulfate, as SO_4	25
Total Hardness, as $CaCO_3$	378	Fluorides, as F	0.5
Calcium Hardness, as $CaCO_3$	174	Silica, as SiO_2	8.8
Magnesium Hardness, as $CaCO_3$	204	Copper, as Cu	0
Calcium, as Ca	70	Phosphate (Total), as PO_4	0.3
Magnesium, as Mg	50	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	216	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.0
Bicarbonate Alkalinity, as $CaCO_3$	216	Stability Index	6.8
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	29	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	264		
Chlorides, as Cl	360		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne-Western Company, Inc.
Appearance: clear
Date: September 9, 1970
Sampled by: client
Sample Number: 3870-2
Identification: 5 -70 FCW

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	800	Sulfate, as SO_4	15
Total Hardness, as $CaCO_3$	300	Fluorides, as F	0.3
Calcium Hardness, as $CaCO_3$	162	Silica, as SiO_2	8.0
Magnesium Hardness, as $CaCO_3$	138	Copper, as Cu	0
Calcium, as Ca	65	Phosphate (Total), as PO_4	0.3
Magnesium, as Mg	34	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	222	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.0
Bicarbonate Alkalinity, as $CaCO_3$	222	Stability Index	6.8
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	30	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	270		
Chlorides, as Cl	225		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

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WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne-Western Company, Inc.
Appearance: clear
Date: August 14, 1970
Sampled by: client
Sample Number: 3830-6
Identification: FCW - 6-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	380	Sulfate, as SO_4	10
Total Hardness, as $CaCO_3$	240	Fluorides, as F	0.5
Calcium Hardness, as $CaCO_3$	120	Silica, as SiO_2	9.8
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	48	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	210	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.2
Bicarbonate Alkalinity, as $CaCO_3$	210	Stability Index	7.2
Hydroxides, as OH	0	Saturation Index	0
Carbon Dioxide, as CO_2	28	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	256		
Chlorides, as Cl	75		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Company, Inc. — Appearance: clear

Date: August 14, 1970 — Sampled by: client

Sample Number: 3830-3 — Identification: FCW 3-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	500	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	288	Fluorides, as F	0.3
Calcium Hardness, as $CaCO_3$	198	Silica, as SiO_2	7.6
Magnesium Hardness, as $CaCO_3$	90	Copper, as Cu	0
Calcium, as Ca	79	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	22	Color, Standard Platinum Cobalt Scale	2
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	240	pH (Laboratory)	7.1
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	240	Stability Index	6.7
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	39	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	293		
Chlorides, as Cl	111		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne-Western Company, Inc. — Appearance: clear

Date: August 14, 1970 — Sampled by: client

Sample Number: 3830 -8 — Identification: FCW 4 -70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	430	Sulfate, as SO_4	2
Total Hardness, as $CaCO_3$	270	Fluorides, as F	0.5
Calcium Hardness, as $CaCO_3$	150	Silica, as SiO_2	7.0
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	60	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	2
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	240	pH (Laboratory)	7.2
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.1
Bicarbonate Alkalinity, as $CaCO_3$	240	Stability Index	7.0
Hydroxides, as OH	0	Saturation Index	0.1
Carbon Dioxide, as CO_2	33	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	293		
Chlorides, as Cl	90		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Company, Inc. — Appearance: clear

Date: August 14, 1970 — Sampled by: client

Sample Number: 383012 — Identification: FCW 2-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	800	Sulfate, as SO_4	0
Total Hardness, as $CaCO_3$	432	Fluorides, as F	0
Calcium Hardness, as $CaCO_3$	246	Silica, as SiO_2	7.0
Magnesium Hardness, as $CaCO_3$	186	Copper, as Cu	0
Calcium, as Ca	98	Phosphate (Total), as PO_4	009
Magnesium, as Mg	45	Color, Standard Platinum Cobalt Scale	2
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	222	pH (Laboratory)	7.1
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	222	Stability Index	6.7
Hydroxides, as OH	0	Saturation Index	0.2
Carbon Dioxide, as CO_2	35	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	270		
Chlorides, as Cl	255		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 8025A • Orlando, Florida 32806 • 305 424-5606

WATER ANALYSIS REPORT — **ANALYTICAL LABORATORY DIVISION**

Report to: Layne Western Company, Inc.q — Appearance: clear

Date: August 14, 1970 — Sampled by: client

Sample Number: 3830-4 — Identification: FCW 2-70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	1950	Sulfate, as SO_4	140
Total Hardness, as $CaCO_3$	600	Fluorides, as F	0.5
Calcium Hardness, as $CaCO_3$	318	Silica, as SiO_2	7.6
Magnesium Hardness, as $CaCO_3$	282	Copper, as Cu	0
Calcium, as Ca	127	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	68	Color, Standard Platinum Cobalt Scale	3
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	192	pH (Laboratory)	7.0
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	192	Stability Index	6.6
Hydroxides, as OH	0	Saturation Index	002
Carbon Dioxide, as CO_2	38	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	234		
Chlorides, as Cl	690		
Iron, as Fe	0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

WATER QUALITY DATA FROM CAPE CORAL WATER PLANT

LOCATION DESCRIPTION	CASING DIA.	CASING DEPTH	WELL DEPTH	pH	M. ALK	T. HD.	Mg HD.	Ca HD.	Cl	T.D.S.
GAC Obs. Well 1-70	2"	143	229	7.8	185	284	162	122	180	590
GAC Obs. Well 2-70	2"	137	220	7.8	194	304	164	140	230	700
GAC Obs. Well 3-70	2"	137	220	7.9	196	390	212	148	220	720
GAC Obs. Well 4-70	2"	84	230	7.8	242	246	138	108	110	390
GAC Obs. Well 5-70	2"	147	241	--	172	442	242	200	460	1200
GAC Obs. Well 6-70	2"	163	230	--	240	372	182	190	220	700
GAC Obs. Well 7-70	2"	168	235	7.7	178	262	134	128	120	340
GAC Obs. Well 8-70	2"	126	230	--	140	820	460	360	1070	2700
GAC Obs. Well 9-70	2"	126	235	--	182	284	136	148	210	420
GAC Obs. Well 10-70	2"	147	230	--	216	428	228	200	320	960
GAC Obs. Well 11-70	2"	106	205	7.9	216	242	142	100	110	350
GAC Obs. Well 12-70	2"	126	250	--	186	254	122	132	100	376
GAC Obs. Well 13-70	2"	126	215	--	194	320	174	146	350	494
GAC Obs. Well 14-70	2"	42	225	7.4	174	386	238	148	450	1250
GAC Obs. Well 15-70	2"	126	230	7.4	228	320	200	120	180	650
GAC Obs. Well 16-70	2"	126	225	--	228	240	136	104	90	330
GAC Obs. Well 17-70	2"	129	225	--	234	236	136	100	60	330
50 Ft. E. of GAC TH 4-70	2"	10	12	7.4	360	640	400	240	1150	2900
GAC Obs. Well 1-70 @ 102 Ft.	2"	80	102	7.6	180	304	176	128	210	600
GAC Prod. Well #9	8"	120	241	7.3	260	414	176	238	180	650
No. 2 Sewer Plant Well	4"	--	200?	--	196	386	216	170	620	1600
GAC Prod. Well #16	8"	120	241	--	220	269	136	132	160	410
GAC Test Well No. 1 (N-1)	8"	127	227	7.4	232	252	138	114	80	350
North Golden Gate Test No. 1	4"	60	80	7.5	270	264	50	214	30	325
GAC Test WellNo. 2 (N-2)	10"	126	225	7.3	200	294	156	138	180	460

WATER QUALITY DATA FROM CAPE CORAL WATER PLANT

LOCATION DESCRIPTION	CASING DIA.	CASING DEPTH	WELL DEPTH	pH	M. ALK.	T. HD.	Mg. HD.	Ca. HD.	Cl	TDS
C.C. Blk 1255 Lots 35-36	--	--	--	--	--	--	--	--	700	190(
C.C. Blk 1610 Lots 31-32	--	--	--	--	--	--	--	--	600	170(
C.C. Blk 239 Lots 17-18	--	--	--	--	--	--	--	--	570	140(
C.C. Blk 235 Lots 20-21	--	--	--	--	--	--	--	--	540	150(
C.C. Blk 242 Lots 29-30	--	--	--	--	--	--	--	--	630	145(
C.C. Blk 836 Lots 31-32	--	--	--	--	--	--	--	--	150	47(
C.C. Blk 246 Lots 1 - 2	--	--	--	--	--	--	--	--	210	45(
C.C. Blk 285 Lots 19-20	--	--	--	--	--	--	--	--	350	85(
GAC Unit 97 Const. Well	4"	--	985	7.8	180	570	314	256	700	180(
C.C. Condominium	--	--	--	7.8	190	422	270	152	450	140(
C.C. Blk 1744 Lots 21-22	--	--	168	7.5	166	570	330	240	750	215(
C.C. Blk 150 (5337 Cocoa St.)	2"	--	168	--	--	--	--	--	250	--
C.C. Blk 586 (S.E. 33nd Pl.)	--	--	210	--	--	--	--	--	320	--
Sunset Towers Well (cooling)	4"	450	750	7.8	170	560	340	220	690	200(
Flowing Well SE½ 2-44S-23E	--	--	--	--	--	538	--	--	610	180(
Flowing Well E¼ Co 3-44-23E	--	--	--	--	--	514	--	--	570	160(
C.C. Blk 1744 Lots 21-22	--	--	168	7.5	166	570	330	240	750	215(
Price Flowing Well SW Fire T.	--	--	650?	7.3	178	508	350	158	620	170(
C.C. Blk 866 Lots 15-16	--	--	--	7.7	--	--	--	--	260	85(
C.C. Blk 1269 (Voges)	2"	126	168	7.9	190	460	216	244	500	--
C.C. Blk 31 (5338 Nautilus Dr)	--	--	--	--	--	--	--	--	60	--
C.C. Blk 1616 Lots 26-27	--	--	--	--	--	--	--	--	700	--
C.C. Blk 1054	2"	84	108	--	268	310	160	150	160	60(
C.C. Blk 675 (1429 SE 21TR)	--	--	126	7.6	210	290	150	140	160	43(
C.C. Blk 789 (1007 SE 13 Pl)	--	--	--	7.4	192	386	172	214	470	--

WATER LEVEL DATA

A search was made for historic water level information from wells drilled only in the Upper Hawthorn formation. From a few measurements made during 1942, through 1957, a probable water level contour map was developed for the general area. This is shown on the attached illustration.

Recent measurements made during 1970, have been made and are shown in contour form with elevation to mean sea level. In general, the static water level in the Upper Hawthorn formation has declined 30 or more feet in the well field areas. Little or no change has occurred in the northeast portion of the study area, believed to be the general recharge area.

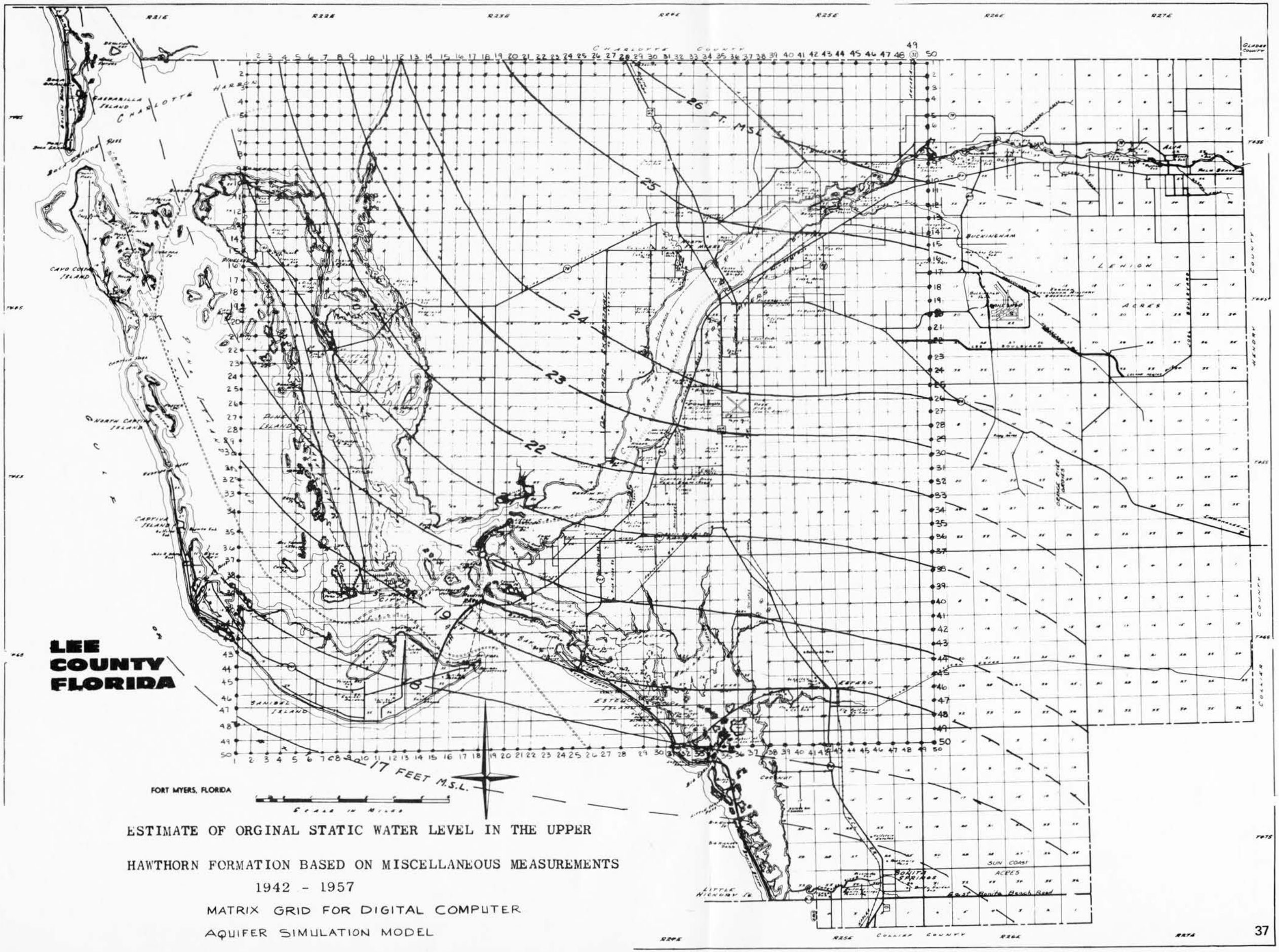
Using the steady-state aquifer flow equation:

$$Q = T * I * L$$

Where Q is the flow in gallons per day, T is the average transmissivity in gallons per day per foot width of aquifer, estimated to be 10,000 gpd/ft, I is the average hydrulic gradient in feet per mile, estimated to be one (1) foot every 2-1/3 miles, and L is the average flow width or horizontal length in miles. The computed steady-state flow in the Upper Hawthorn formation for Western Lee County in a 625 square mile study area, was 150,000 gallons per day. This is a good indication of the original natural recharge to the aquifer system. Some additional recharge can be experienced with development of an aquifer by infiltration or leakage from overlying and underlying aquifers. Some leakage may occur from other aquifers to the Upper Hawthorn aquifer, but indications from pumping tests suggest this may be small in value.

Mention of the hydrograph of Cape Coral observation Well No. L-581, shows the cyclic nature of water pumpage due to seasonal demand. But more important, the high and lows of the yearly cycle are progressively lower each year since records began in 1966. This would confirm the fact that pumpage from the aquifer is greater than the natural recharge. A similar trend is noted also for the Pine Island well field observation well. The fact that the aquifer will recover to some extent and that recharge exists is observed by the recovery of the Fort Myers Beach observation well after pumpage was discontinued in that area. However, the static water level has not returned to the estimated original level prior to major pumpage in the general study area.

LEE COUNTY FLORIDA



ESTIMATE OF ORGINAL STATIC WATER LEVEL IN THE UPPER

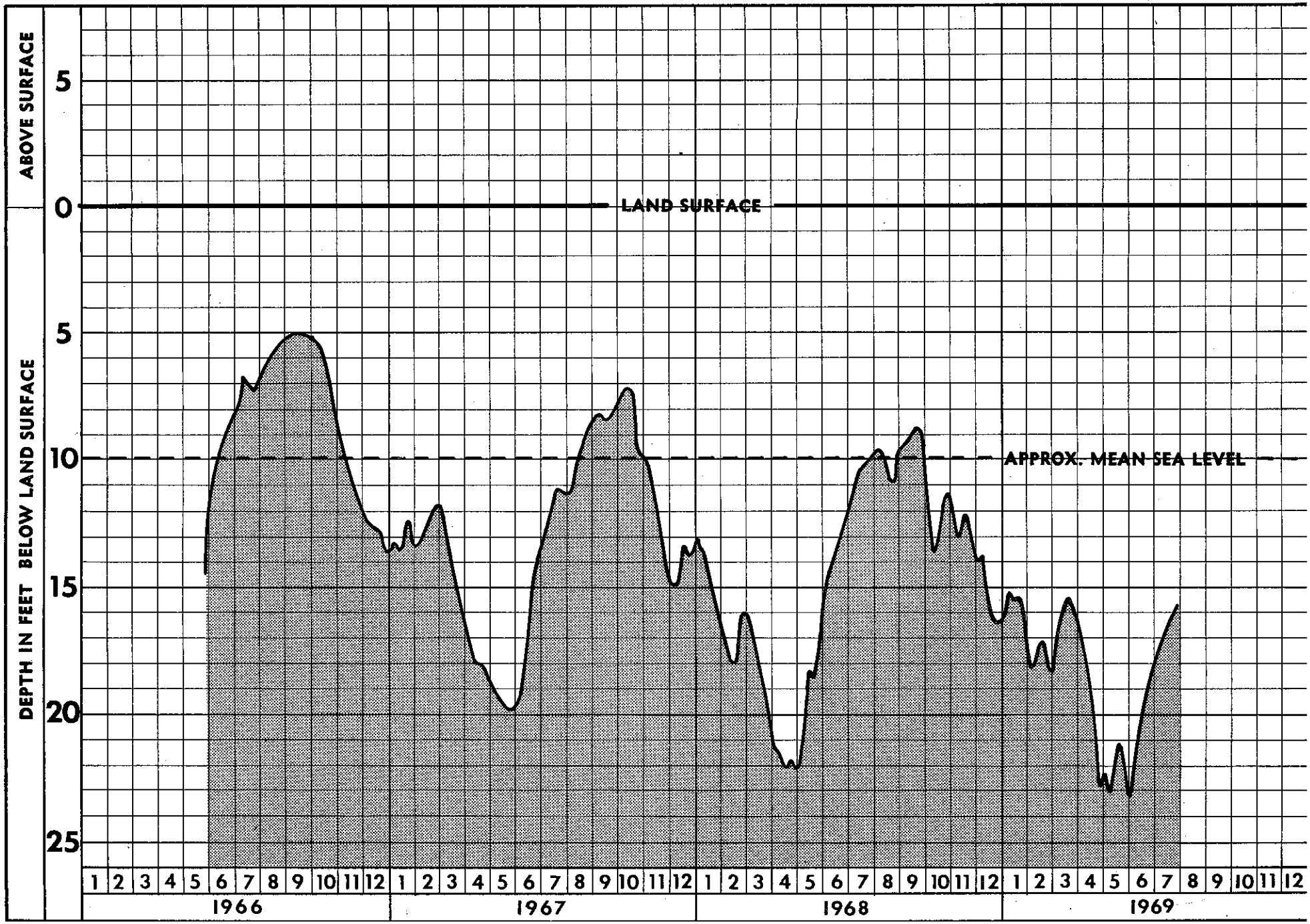
HAWTHORN FORMATION BASED ON MISCELLANEOUS MEASUREMENTS

1942 - 1957

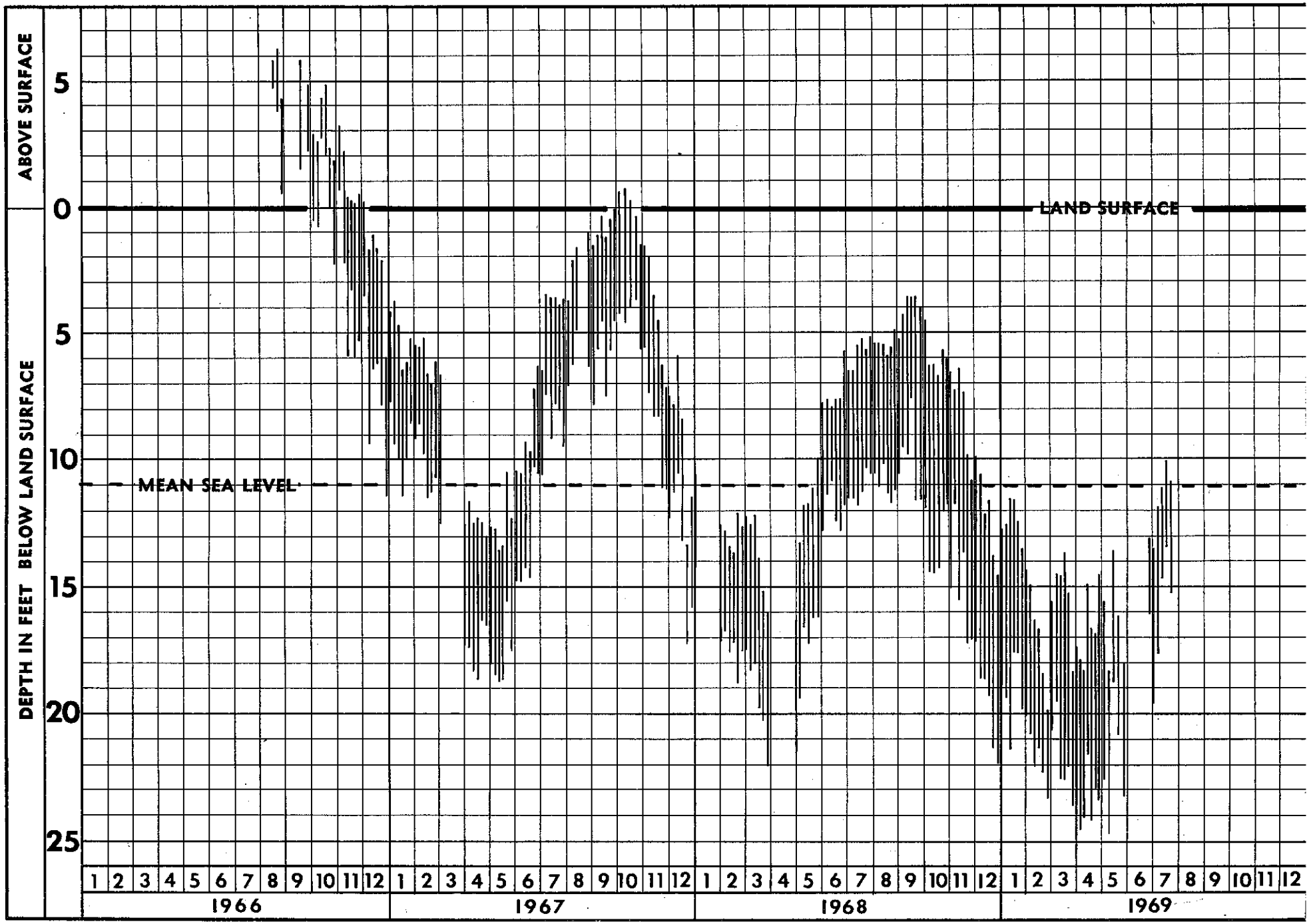
MATRIX GRID FOR DIGITAL COMPUTER

AQUIFER SIMULATION MODEL

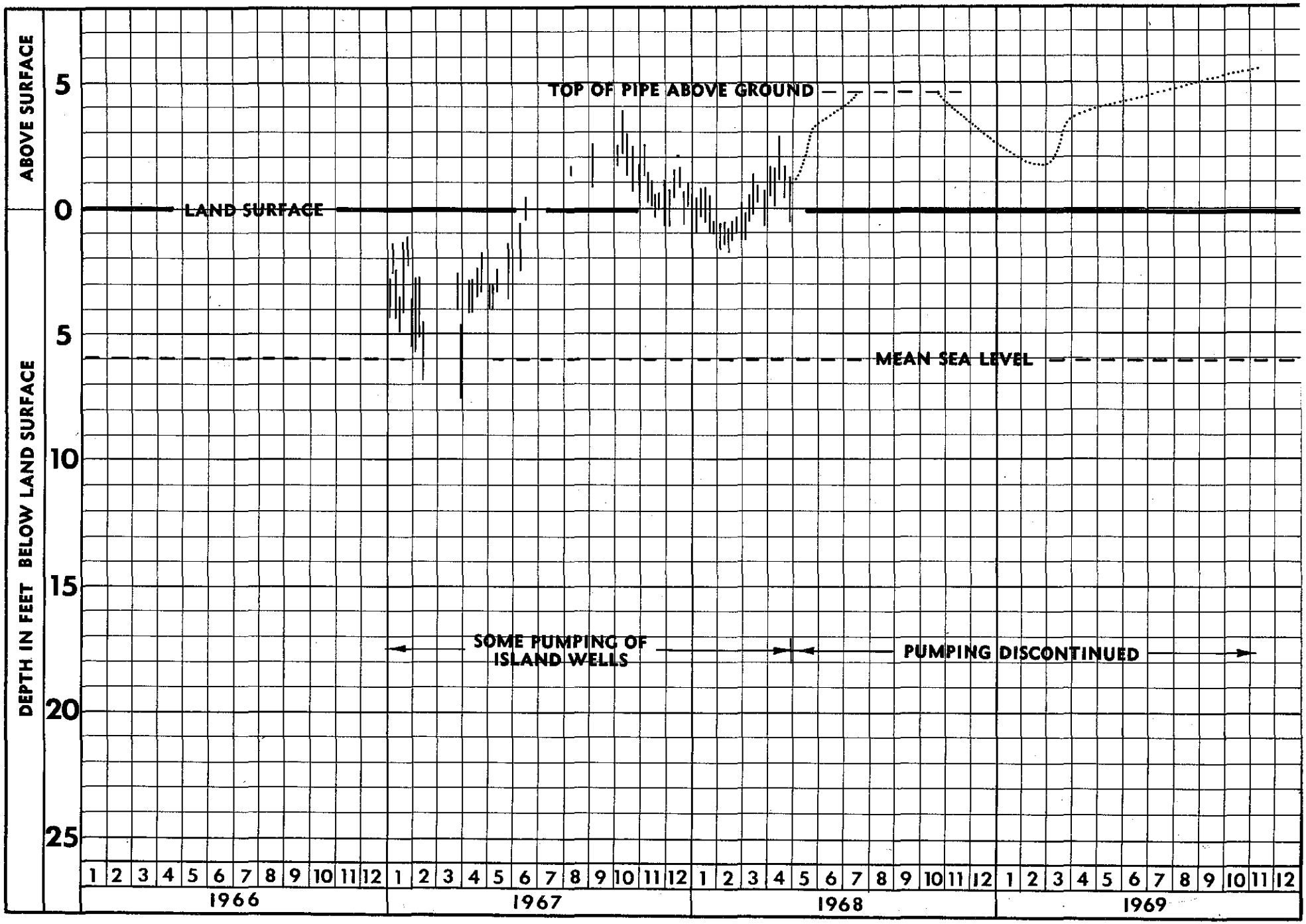
CAPE CORAL OBSERVATION WELL L-581
LOCATED NW¼ OF NW¼ 2-44-23E
IN LEE COUNTY, FLORIDA



PINE ISLAND OBSERVATION WELL L-582
LOCATED IN NE¼ OF NE¼ SEC. 21, T44S, R23E
IN LEE COUNTY, FLORIDA



FORT MYERS BEACH OBSERVATION WELL 439
LOCATED NEAR BASE OF WATER TOWER



9-330

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. { Washington .....
District .....

Water levels - Upper Hawthorn Aquifer October 1970

Local No.	USGS No.	Date	Time	Water level	Height MP (LSD)	Water level (LSD)	Alt. MP (MSL)	Alt. water level (MSL)				
GAC-1	L-1106	10-20-70	1452	+1.89	3.1	+4.99	15.06	16.95	Previous meas. 8-18-70 in error			
2	1107	"	1457	1.07	4.0	+2.93	18.37	17.30				
3	1108	"	1502	2.06	4.2	+2.14	19.40	17.34				
4	1109	"	1523	1.16	4.1	2.94	17.16	16.00				
5	1110	"	—	—	4.3	—	19.99	—	Broke at ground level			
6	1111	"	1537	4.56	4.0	0.56	20.76	16.20				
7	1112	"	1442	6.39	4.3	2.09	15.72	9.33				
8	1113	"	1632	+5.6	5.6	+11.2	11.55	17.15				
9	1114	"	1402	15.55	2.4	13.15	11.95	-3.60				
10	1115	"	1407	5.85	2.5	3.35	15.49	9.64				
11	1116	"	1427	18.16	4.0	14.16	13.02	-5.14				
12	1117	"	1347	17.47	3.1	14.37	9.85	-7.62				
13	1118	"	1324	17.50	3.2	14.30	8.65	-8.85				
14	1119	"	1336	5.74	4.5	1.24	8.85	3.11				
15	1120	"	1528	1.26	1.6	+0.34	15.59	14.33				
16	1098	"	1543	2.82	1.6	1.22	16.57	13.75				
17	1099	"	1545	2.95	1.7	1.26	16.68	13.73				
	L-434	"	1712	+13.5	1.2	+14.7	E 4	E 17.5		High	tide	
	581	"	0852	18.95	3.4	15.55	12.98	-5.97				
	582	"	1608	29.20	7.5	21.70	E 18	E-11.2				
	702	"	1355	13.00	2.7	10.30	10.15	-2.85				
	786	"	1615	21.52	2.2	19.32	E 11	E-11.3				
	1058	"	1620	+6.03	1.3	+7.33	E 7	E 13.0				
	1059	"	1645	+1.83	3.7	+5.53	E 15	E 16.8				
	1060	"	1900	2.82	-0.2	3.02	E 6	E 3.2				
	C-2	10-21-70	0845	+0.70	3.0	+3.70	E 26	E 26.7				
	L-742	10-20-70	0950	17.25	2.2	15.05	E 12	E-5.3				
FC-1	1124	"	1036	5.43	1.9	3.53	8.18	2.75				
2	1125	"	1028	1464	1.6	13.04	8.58	-6.06				
3	1126	"	1002	15.30	1.3	14.00	8.41	-6.89				
4	1127	"	0945	10.14	1.3	8.84	10.52	0.38				
5	1128	"	0937	10.70	1.2	9.50	11.81	1.11				

UNPUBLISHED DATA
SUBJECT TO REVISION

U. S. GEOLOGICAL SURVEY (WRD)
109 SMITH BUILDING
2070 MAIN STREET
FORT MYERS, FLA. 33901

U.S. GOVERNMENT PRINTING OFFICE: 1969—O-783-759

9-330

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. { Washington .....
District .....

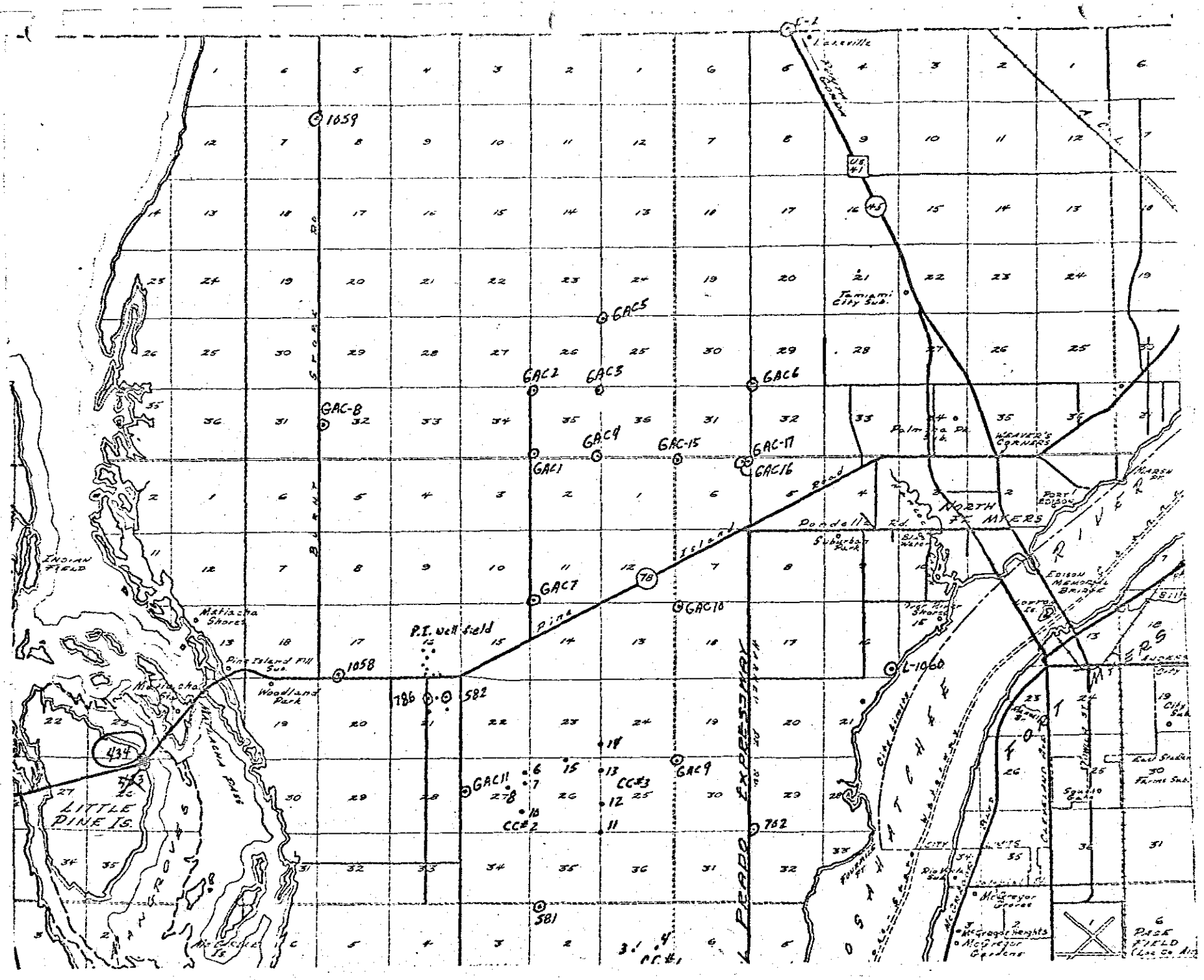
Water levels - Upper Hawthorn Aquifer October 1970

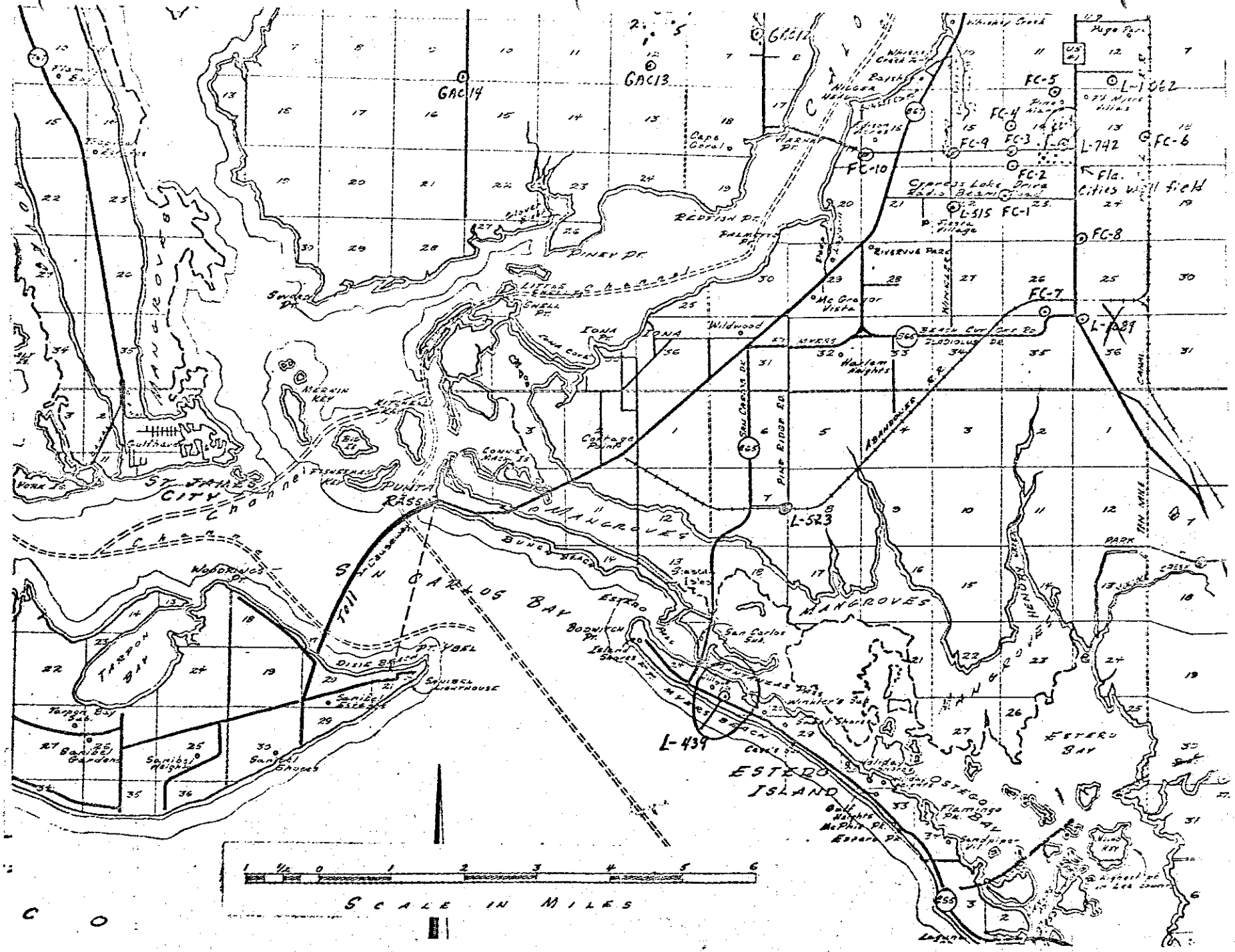
Local No.	USGS No.	Date	Time	Water level	Height (MP) (LSD)	Water level (LSD)	Alt. MP (MSL)	Alt. Water level (MSL)				
EC-6	L-1121	10-20-70	1046	8.96	0.5	8.46	16.16	7.20				
7	1122	"	1132	+4.41	0.9	+5.31	5.76	10.17				
8	1123	"	1102	4.20	0.8	3.40	11.57	7.37				
9	1129	"	1007	3.60	1.5	2.10	8.46	4.86				
10	1100	"	1012	5.34	1.0	4.34	7.80	2.46				
11	1156	"	0955	30.98	1.5	29.48	8.81	-22.17				
	L-439	"	1212	+4.39	0.85	+5.24	E 7	E 11.4				
	515	"	1020	1.22	2.0	+0.78	E 9	E 7.8				
	523	"	1157	+7.0	0.8	+7.80	E 5	E 12.0				
	735	"	1115	+8.2	3.3	+11.5	E 9	E 17.2				
	1062	"	0915	10.52	2.3	8.22	E 15	E 4.5				
Cape Coral		Production wells										
3	L-803	10-20-70	0742	24	1.1	-23	6.70	-17.3				
4	804	"	0737	22	1.5	20	8.20	-13.8				
5	805	"	0732	59	1.8	57	8.20	-50.8				
6	790	"	0834	29	2.6	26	13.29	-15.7				
7	791	"	—	-	2.6	—	13.31	—				
8	792	"	0818	71	3.0	68	13.18	-57.8				
10	794	"	0824	26	3.4	23	13.74	-12.3				
11	796	"	0752	55	-1.1	56	8.80	-46.2				
12	797	"	0755	30	-1.0	31	9.21	-20.8				
13	798	"	0800	29	-1.1	30	10.47	-18.5				
14	799	"	0805	31	-1.0	32	10.09	-20.9				
15	800	"	0810	64	-1.0	65	10.74	-53.3				

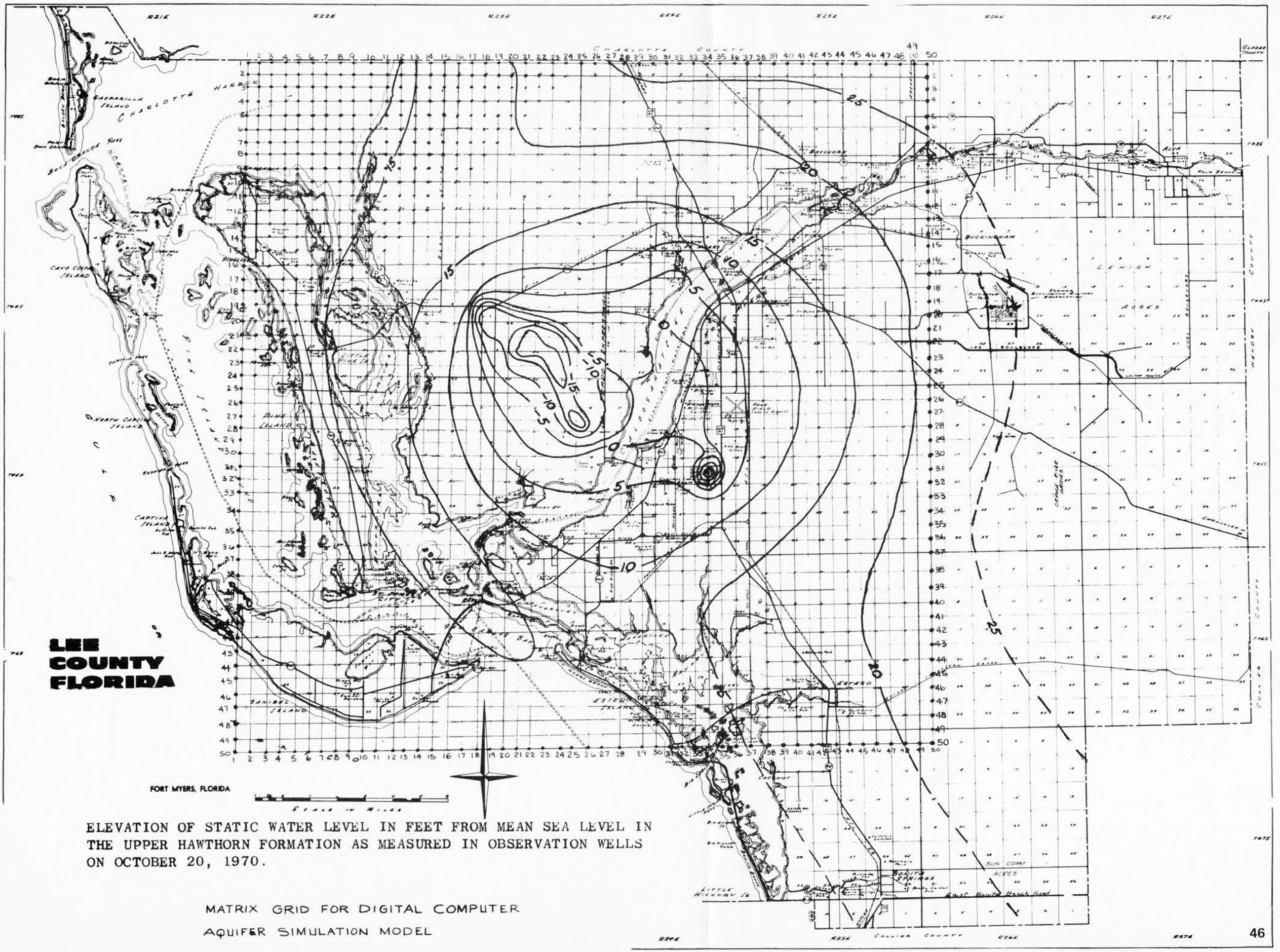
UNPUBLISHED DATA
SUBJECT TO REVISION

U. S. GEOLOGICAL SURVEY (WRD)
109 SMITH BUILDING
2070 MAIN STREET
FORT MYERS, FLA. 33901

U.S. GOVERNMENT PRINTING OFFICE: 1965—O-783-759


1059
GAC5
GAC2
GAC3
GAC6
GAC-8
GAC4
GAC-15
GAC-17
GAC1
GAC16
GAC7
GAC10
1058
L-1060
786
582
GAC11
GAC9
CC#3
CC#2
762
581
P.P. well field
Pine Island
Burnt Store Rd.
Pine Island Rd.
Matlacha Shores
Woodland Park
Matlacha Pass
LITTLE PINE IS.
Tamiami City Sub.
Palmona Park Sub.
NORTH FT. MYERS
Fort Edison
Edison Memorial Bridge
Pine Island Estates
Fort Myers Shores
Fowler's Grove
McGregor Grove
McGregor Heights
McGregor Gardens
Page Field
Peace Freeway
Caloosahatchee River
Fowler St.
Cleveland Ave.
Jacksonville
Seaboard Coast Line R.R.
U.S. #41
78
434
31
A.C.L.


GAC12
GAC13
GAC14
FC-5
L-1062
FC-4
FC-3
L-742
FC-6
FC-9
FC-10
FC-2
FC-1
L-515
FC-8
FC-7
L-439
L-523
Fla. Cities well field
Cypress Lake
Riverside Park
McGregor Vista
Wildwood
Harlem Heights
Fiesta Village
Cortez
Cortez Bridge
Punta Rassa
Cottage Point
Coconut Point
Mangroves
Mangrove Point
Buno Beach
Estero Island
Bowditch Pt.
San Carlos Bay
Tarpon Bay
Sanibel Lighthouse
Sanibel Gardens
Sanibel Heights
Sanibel Shores
Estero Bay
Hendry Creek
Scale in Miles
Charlotte County



ELEVATION OF STATIC WATER LEVEL IN FEET FROM MEAN SEA LEVEL IN THE UPPER HAWTHORN FORMATION AS MEASURED IN OBSERVATION WELLS ON OCTOBER 20, 1970.

MATRIX GRID FOR DIGITAL COMPUTER AQUIFER SIMULATION MODEL

Pumpage Data

Metered data was available from Florida Cities Water Company and Cape Coral. Estimates were made of the raw water pumpage from the Pine Island well field. This was a major portion of the pumpage but in the simulation model, additional pumpage was programmed.

It was found that the two (2) wells used by Cape Coral to irrigate two (2) gold courses, were quite significant. An estimate of 500,000 gallons per day average use was programmed in the model. Some additional pumpage for miscellaneous uses was considered. It was found that apparently there is significant pumpage not considered, located in the North Fort Myers area and the downtown area of Fort Myers. Florida Cities Water Company has only one well in use to some extent at the North Fort Myers water plant that penetrates the Upper Hawthorn formation.

Projected increases used in the simulation model were to double municipal pumpage for a ten (10) year period beginning at the present time. Pumpage has to be programmed in the computer model by steps, so only one large step was considered instead of annual increases as actually expected. Thus, the total computed volume of water extracted should exceed the project annual increase and should be adequate even if growth exceeds the projected use.

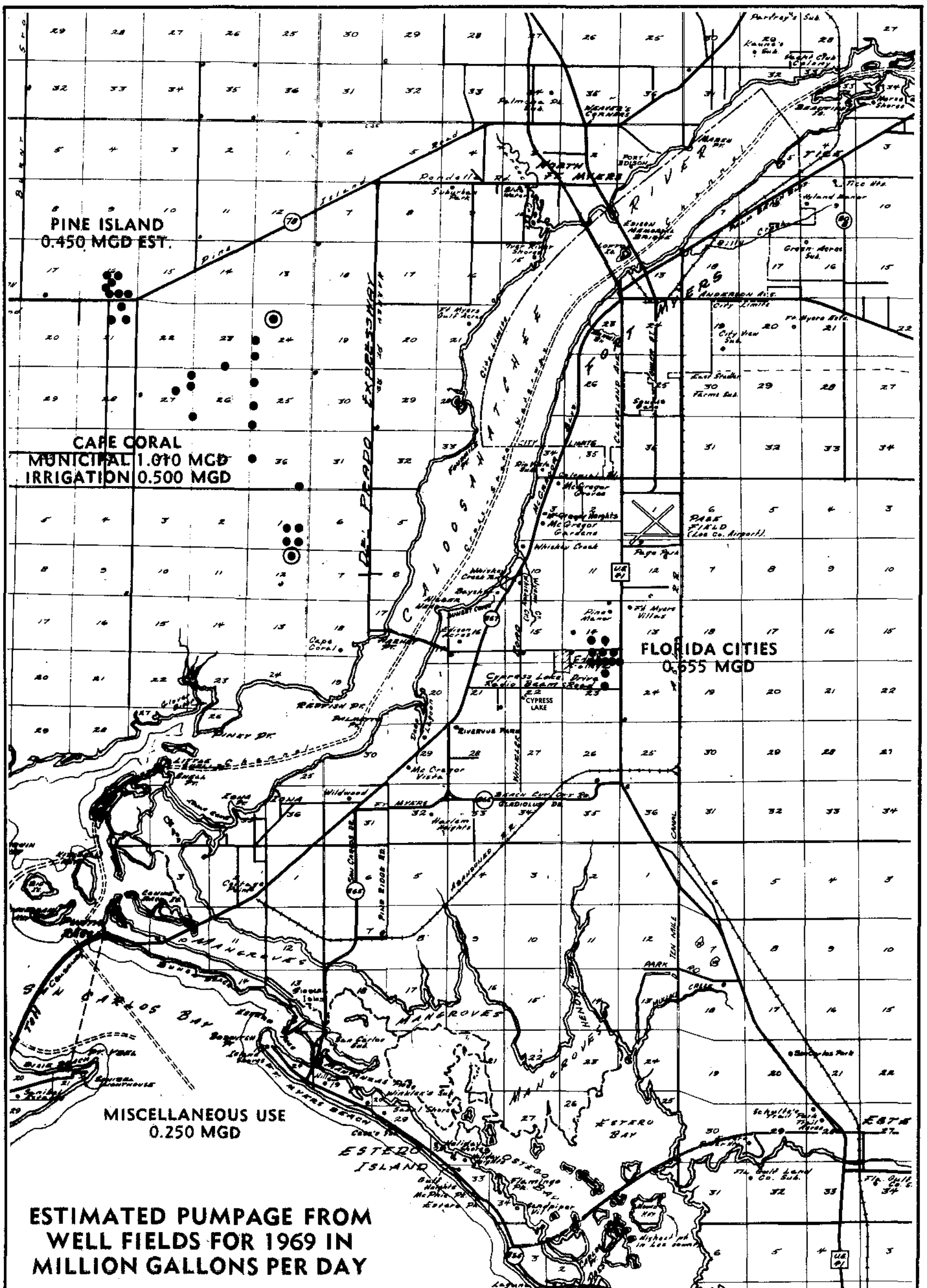
At present, in the FCWC service area, the average annual increase in water pumpage is 300,000 gpd per year, or in ten (10) years, increase 2 mgd over present usage.

AVERAGE MONTHLY WATER USE IN MILLION GALLONS PER DAY

MONTH	YEAR	FLORIDA CITIES	CAPE CORAL	PINE ISLAND
January	1965	--	0.373	--
February	1965	--	0.381	--
March	1965	--	0.414	--
April	1965	--	0.458	--
May	1965	--	0.450	--
June	1965	--	0.318	--
July	1965	--	0.328	--
August	1965	--	0.339	--
September	1965	--	0.351	--
October	1965	--	0.358	--
November	1965	--	0.421	--
December	1965	--	0.434	--
	Average		0.385	
January	1966	--	0.413	--
February	1966	--	0.485	--
March	1966	--	0.540	--
April	1966	--	0.527	--
May	1966	--	0.537	--
June	1966	--	0.412	--
July	1966	--	0.486	--
August	1966	--	0.464	--
September	1966	--	0.476	--
October	1966	--	0.515	--
November	1966	--	0.644	--
December	1966	--	0.655	--
	Average		0.511	
January	1967	--	0.652	--
February	1967	--	0.700	--
March	1967	--	0.783	--
April	1967	--	0.896	--
May	1967	--	0.901	--
June	1967	--	0.640	--
July	1967	--	0.639	--
August	1967	--	0.626	--
September	1967	--	0.628	--
October	1967	--	0.669	--
November	1967	--	0.806	--
December	1967	--	0.779	--
	Average		0.726	0.250 E.

AVERAGE MONTHLY WATER USE
IN MILLION GALLONS PER DAY

MONTH	YEAR		CYPRESS LAKES	CAPE CORAL	PINE ISLAND
January	1968		--	0.849	--
February	1968		--	0.923	--
March	1968		--	0.947	--
April	1968		--	1.073	--
May	1968		0.355	0.750	--
June	1968		0.408	0.664	--
July	1968		0.431	0.669	--
August	1968		0.470	0.719	--
September	1968		0.384	0.723	--
October	1968		0.430	0.846	--
November	1968		0.510	0.858	--
December	1968		0.544	0.943	--
		Average	0.440	0.830	0.350 E.
January	1969		0.635	0.960	--
February	1969		0.740	1.059	--
March	1969		0.737	0.999	--
April	1969		0.767	1.183	--
May	1969		0.584	1.039	--
June	1969		0.579	1.017	--
July	1969		0.629	0.914	--
August	1969		0.638	0.916	--
September	1969		0.542	0.914	--
October	1969		0.575	0.933	--
November	1969		0.672	1.034	--
December	1969		0.759	1.069	--
		Average	0.655	1.010	0.450 E.
January	1970		0.796	1.065	--
February	1970		0.884	1.161	--
March	1970		0.909	1.156	--
April	1970		0.965	1.398	--
May	1970		0.965	1.451	--
June	1970		0.767		--
July	1970		0.860		--
August	1970		-	-	
September	1970		-	-	
October	1970		-	-	--
November	1970		-	-	--
December	1970		-	-	--
		Average			



ESTIMATED PUMPAGE FROM WELL FIELDS FOR 1969 IN MILLION GALLONS PER DAY

AQUIFER SIMULATION

An appraisal of the data accumulated at this point in the investigation, indicates some degree of ground water mining is occurring in Western Lee County, Florida. This was best indicated by the continued decline of water level each year as illustrated by individual well hydrographs. This type of aquifer situation can best be simulated on the digital computer by a mathematical model developed by Bredehoeft, and Pinder of the U.S. Geological Survey which was subsequently modified by Green (University of Kansas) and is available through the Hydrological Engineering Division of Layne-Western Company, Inc. The computer runs were made on a CDC 6400 time sharing machine operated by United Computing Service. Also, a small scale, steady-state analog model was constructed to verify recharge and discharge quantities of the aquifer.

In Western Lee County, the Upper Hawthorn aquifer is ridge shaped with a tight cover with the ridge oriented in a northwest-southeast direction and sloping downward both to the east and to the west. Thus, there is no adequate outcrop area in which a large recharge is available to the aquifer system. The local recharge programmed into the computer model was the equivalent of 150,000 gpd which reduces to 100th of one percent of the average annual rainfall of 50 inches per year. Due to the geologic structure, it is also reasonable to assume the local recharge to lower aquifers such as the Lower Hawthorn and the Tampa-Suwanee would be no greater and probably less, than the Upper Hawthorn formation. However, due to the increased thickness of these aquifers, it is estimated that one and one-half to two and one-half millions gallons per day could be transmitted through the aquifer system from the remote recharge area. Thus, if pumpage in these aquifers reached twice the transmission capability of these formations, or approximately five million gallons per day, ground water mining would again be apparent accompanied by a decline in water level for these formations.

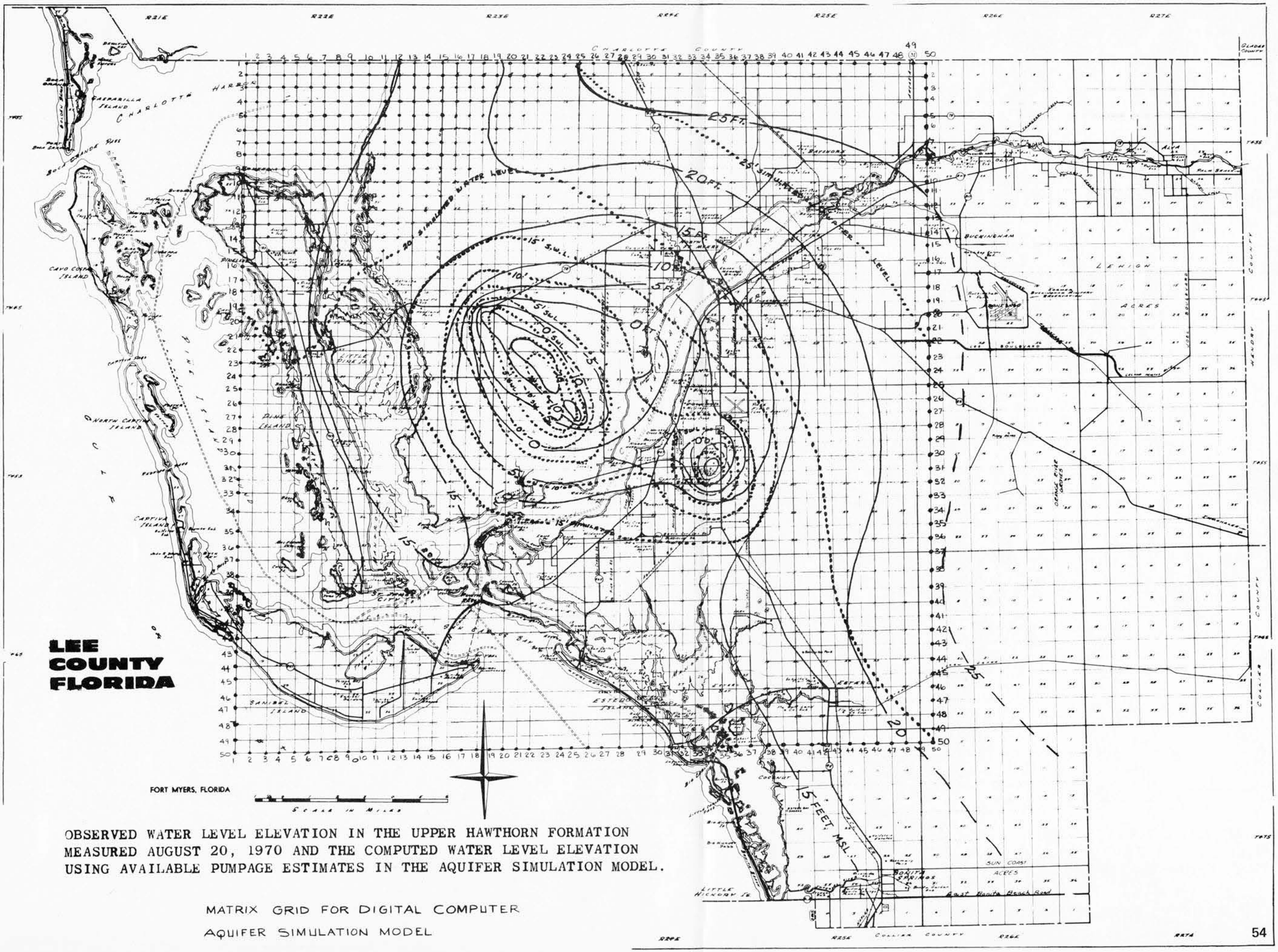
Digital Computer Model

Simultaneous with this study, the author was conducting a study of the water supply situation for GAC Utilities, Inc., for the Cape Coral well field area from the same aquifer system.

These data were modeled on a 50 x 50 matrix covering an area of 25 miles square or a total of 625 square miles. Illustrated is the computed water level for these data compared to the observed condition that existed in August, 1970. A reasonable comparison was obtained. Only the northeast portion of the area shows a significant departure. This appears due to the absence of program pumpage from the aquifer by residents in North Fort Myers and in the downtown area. Irrigation pumpage was added, as shown. The increase in pumpage was programmed in approximately two year steps beginning in 1963, and continuing through 1970. The areal storage coefficient used and developed from the simulation runs, was 0.01. This is equivalent to saying that one percent of the formation modeled is capable of yielding water to wells. The programmed transmissivity was 10,000 gallons per day per foot width of aquifer for the southwest portion of the area and 20,000 gallons per day per foot width of aquifer for the northeast portion of the area.

Future 1980 Water Level

The computer simulation model was then extended in time for a ten year period to approximate the pumpage expected by 1980. The pumpage for municipal use was programmed to double beginning in 1971 for the remainder of the period. The resulting water level elevation is shown in the illustrated drawing followed by the computed drawdown for the same condition. From the results of these computations, it appears obvious that some shortage in water to meet future demands brought on by expanding population in the area will be experienced in six to eight years. The general static water level in the area is projected to be approximately 120 feet and the water level in pumped wells will be at least 40 percent greater. To obtain the projected quantity of water from the aquifer in ten years, many additional wells would have to have been constructed and the yields of each individual well would probably be less than one-half their present capacity.



OBSERVED WATER LEVEL ELEVATION IN THE UPPER HAWTHORN FORMATION MEASURED AUGUST 20, 1970 AND THE COMPUTED WATER LEVEL ELEVATION USING AVAILABLE PUMPAGE ESTIMATES IN THE AQUIFER SIMULATION MODEL.

MATRIX GRID FOR DIGITAL COMPUTER
AQUIFER SIMULATION MODEL

AQUIFER SIMULATION MODEL

CARL E. NUZMAN, P.E., HYDROLOGIST

HYDROLOGIC ENGINEERING DIVISION

LAYNE-WESTERN COMPANY,INC.

1010 WEST 39TH STREET

KANSAS CITY, MISSOURI 64111

AREA CODE (816) 931-2353

IS SIMULATION CONSIDERS THE PUMPING TO COMMENCE IN 1964 AND CONTINUE THROUGH 19

INPUT PARAMETERS

MBER OF NODES IN COLUMN OF MATRIX	50
UMBER OF NODES IN ROW OF MATRIX	50
RIZONTAL GRID SPACING IN PROTOTYPE IN FEET	2640
ERTICAL GRID SPACING IN PROTOTYPE IN FEET	2640
NGTH OF INITIAL TIME STEP INCREMENT IN SECONDS	10
FLOW FLUX TO VERTICAL LEAKAGE FROM CONFINING LAYER IN GPD/SQ FT	0
AXIMUM ALLOTED PUMPING PERIOD IN YEARS	25.00
XIMUM NUMBER OF TIME STEPS ALLOTED	499
UMBER OF TIME STEPS BETWEEN PRINTOUTS ROWS	116
MBER OF TIME STEPS BETWEEN PRINTOUTS COLUMNS	116
ACTION OF ANNUAL PRECIPITATION TO VERTICAL RECHARGE	.0001
ULTIPLICATION FACTOR FOR ADJUSTING STORATIVITY	.01000
LTIPLICATION FACTOR FOR ADJUSTING STATIC WATER LEVEL	1.00
ULTIPLICATION FACTOR FOR ADJUSTING BEDROCK ELEVATION	-225.00
XIMUM TIME FOR THE PUMPING SCHEDULE IN YEARS	17.0
ERAGE INCHES OF PRECIPITATION PER YEAR	50.00
RACTION OF PRECIPITATION THAT REACHES AQUIFER IN INCHES/YEAR	.0050

LEE COUNTY FLORIDA

FORT MYERS, FLORIDA

COMPUTED WATER LEVEL ELEVATION FOR 1980 USING DOUBLE THE PRESENT ESTIMATE FOR MUNICIPAL PUMPAGE.

MATRIX GRID FOR DIGITAL COMPUTER AQUIFER SIMULATION MODEL

Layne-Western Company, Inc. A Marley Company

HYDROLOGY DIVISION · 6909 Johnson Drive · P.O. Box 1322 · Mission, Kansas 66222 · 913/384-0394

June 13, 1979

Florida Cities Water Company
2112 Gulf Gate Drive
P. O. Box 5846
Sarasota, Florida 33581

Attention: Mr. William G. Lee

Regarding: GROUND WATER HYDROLOGY STUDY
GREEN MEADOWS ANALOG MODEL
FLORIDA CITIES WATER COMPANY
FT. MYERS, FLORIDA
APRIL, 1979

Dear Mr. Lee:

We have completed the final report for the above referenced study and are enclosing one (1) for your information.

If you should have any questions regarding the enclosure, please contact us at your convenience.

Thank you.

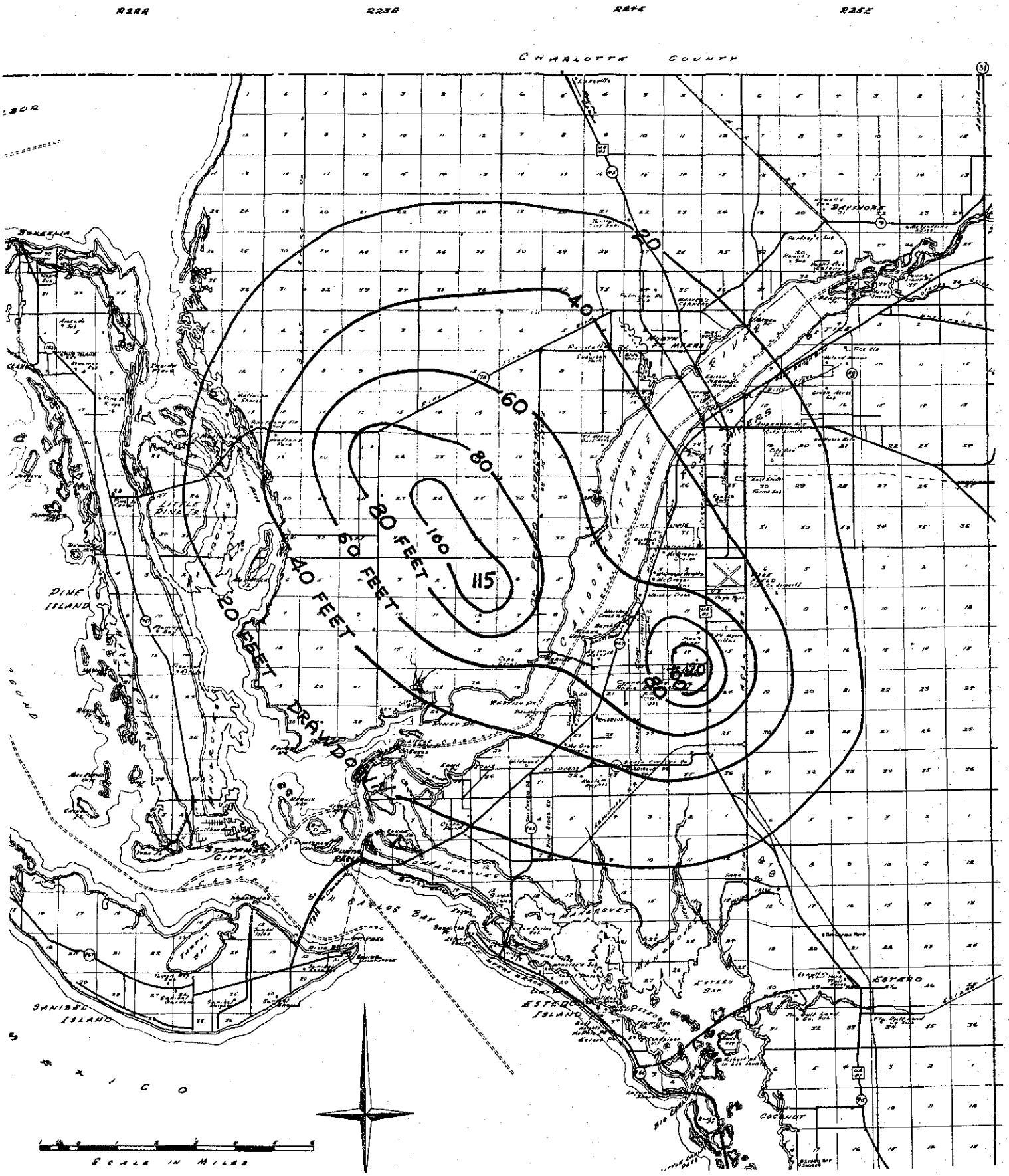
Very truly yours,

Carl E. Nuzman, P. E.
Hydrology Consultant

mkh

Enclosure

cc: James R. Powell
Gerald Blevins
South Florida Water Management District



COMPUTED DRAWDOWN OF WATER LEVEL BY 1980 WITH TWICE THE PRESENT PUMPAGE

SUMMARY AND CONCLUSION

It was found, during the investigation, that the best quality of water from an aquifer for municipal supply, capable of being processed with conventional water treatment equipment, was found in the Upper Hawthorn formation. The original water level in the Upper Hawthorn formation was usually above ground level permitting the construction of flowing artesian wells. Some flowing wells in this formation can still be obtained near the perimeter of the study area. The effective local recharge to the Upper Hawthorn aquifer was approximately 150,000 gallons per day. The geologic shape of the aquifer is such that no distant recharge area exists.

The present (1970) pumpage from the Upper Hawthorn formation in Lee County is at least 2.6 million gallons per day. With the inclusion of pumpage from miscellaneous domestic wells, it is probably 3.0 million gallons per day. This is 20 times the computed natural recharge rate. A serious decline of water level now exists in the Western Lee County area. The present drawdown of water level has equalled or exceeded 50 feet in some small areas. A general decline of 20 feet or more of water level now exists over much of Western Lee County.

The average aquifer flow coefficient of transmissivity is approximately 15,000 gallons per day per foot width of aquifer material. The average aquifer coeffient of storativity, or storage coefficient, is 0.01, a dimensionless number. This is equivalent to indicating that one (1) percent of the aquifer material is capable of yielding water to wells. Higher and lower values of these coefficients can be found in places in the study area.

There is ground water mining now occurring in Western Lee County. Continued growth in the area will increase the demand of water from the Upper Hawthorn formation and this is expected to increase at least to the five (5) million gallon per day level within ten years. The aquifer is capable of supplying this demand of water for at least six to eight years but there will be a significant deterioration in individual well yields requiring supplemental or replacement wells located one-half mile or more distant from present wells to meet the then existing demand.

A trend toward wider spacing of wells for all large water users in the area will be required, to obtain the necessary diversion capacity to meet demands. This will develop a need for additional investment capital to meet the water supply needs. Failure of the aquifer system will first be observed by experiencing shortages of water from wells on peak days, which, if continued, develops into a serious shortage to meet the service area water demands. It is concluded that all water utilities service companies in Western Lee County, will experience water shortages in their supply from the Upper Hawthorn formation within six to eight years.

There are several alternatives to the water supply situation and each must evaluated for their economic feasibility. The first alternative is to do a more efficient job of mining the available supply from the Upper Hawthorn aquifer. Since this is usually the least expensive method, all utility companies should give some immediate thought and develop plans to insure an adequate supply for the interim period. Florida Cities Water Company has an area of acceptable quality of water located north of the Cypress Lakes well field which could be developed with four or five wells on a wide spacing basis, and double the diversion capacity for that facility. Cape Coral can go into the area north of Pine Island Road near Del Prado Boulevard and develop an extensive well field of nine to 12 wells and gain another two million gallons per day to supplement their present supplies. Cape Coral has used good ground water development techniques in spreading their three well fields to develop water over a wide area. The Pine Island Water District can only go to the east and northeast for a few additional wells to supplement their existing wells. The spacing of their existing wells is too close for efficient harvesting of the water. A second alternative would be the desalination of brackish water obtained from deep wells withdrawing water from the Lower Hawthorn and Tampa-Suwanee formations in the area. The quality of water from these formations vary in chloride content from 540 parts per million to 1070 parts per million with total dissolved solids varying from a low of 1400 parts per million to a high of 2700 parts per million. Capacities up to five (5) million gallons per day could be developed from deeper aquifers on a sustained yield basis. Larger capacities could be developed from the deeper aquifers but would seriously shorten the utility and service life of this aquifer system.

A third alternative would be the importation of fresh water from a surplus water area which may exist in Eastern Lee County. There is a major change in geology which will allow a substantial increase in ground water recharge from rainfall in the aquifers that exist in Eastern Lee County. Excellent quality of water with chloride content of 57 parts per million with total dissolved solids at 440 parts per million, have been found, as reported in the Appendix under the Bonita Springs data. A similar quality of water was reported for the North Golden Gate Test Hole No. 1, located in Collier County, under the Water Quality Data section from the Cape Coral water plant. The yield of this well from the 80 foot depth was 555 gallons per minute with only about 17 feet of drawdown. Highwer, individual well yields are expected with better construction techniques. Surplus, fresh water may exist in the Telegraph swamp area, the area in Eastern Lee County south of Lehigh Acres, and the Cork Screw swamp area east of Bonita Springs. These sources are unproven at the present time.

The fourth alternative is to supplement present supplies with surface water as may be obtained from the Lee County water system. Little study was made of this alternative but the reliability of this supply for large amounts of additional water during drought periods, make this source questionable. At times, during the year the quality of water from this source is greatly deteriorated from organic growth and pollution. Some short-term and short-range relief may be obtained from this alternative, but it does not appear feasible to answer the long-range water supply growth of Western Lee County.

A fifth alternative does exist but is not presently popular with the general public. This is the alternative of re-cycling sewage effluent after extensive treatment to the water supply distribution system. If fifty (50) percent of the sewage effluent could be re-cycled through the distribution system, the demand on the ground water system would be reduced proportionally; thus, greatly extending the useful life of the local fresh water aquifer. Further disadvantage

to this alternative becomes apparent because sewage processing is generally accomplished by a large number of small processing units scattered throughout the service area. No central sewage collection system generally exists. The feasibility of this alternative is very questionable.

RECOMMENDATIONS

1. Florida Cities Water Company should take steps immediately to acquire sites to drill four (4) wells north and northwest of the Cypress Lakes well field to supplement their existing supply. These wells should be 10 inch diameter wells with casings cemented to at least 125 feet and drilled to an expected depth of 230 feet. The expected yield of each well will be 175 gallons per minute for a total of 700 gallons per minute on a continuous basis (one mgd). Additional wells may have to be constructed in three to five years to meet peak demands at the Cypress Lakes plant facility.

It is also suggested that two (2) 10 inch diameter wells drilled by the reverse hydraulic air circulation method be constructed in the vicinity of the North Fort Myers water plant of Florida Cities Water Company. An additional one million gallons per day could be developed locally for this facility. All wells in the Upper Hawthorn formation should be acidized every two to three years of use and cleaned to their original depth.

It is recommended that GAC Utilities can develop one to two million gallons per day north of Pine Island Road in the vicinity of Del Prado Avenue. Nine (9) well sites with three (3) alternates were listed in a separate report. The Pine Island Water District may have to develop additional well sites east and northeast of their present wells to meet peak demands if water use increases.

2. It is recommended that well construction be equivalent to that used for Cape Coral Test Well No. 2 in which a 10 inch drill hole was advanced through the productive formation to approximately 225 to 250 feet in depth. Prior to drilling the bottom hole, 10 inch standard weight casing had been pressure grouted with cement grout to approximately 125 feet in depth. Higher yield potentials had been realized by this method. Specific yields or specific capacity of wells of 50 to 150 percent have been achieved over cable tool construction. An additional increase of 50 to 150 percent increase in specific yield has been achieved by using

15 percent strength Muriatic acid with stabilizers and inhibitors added.

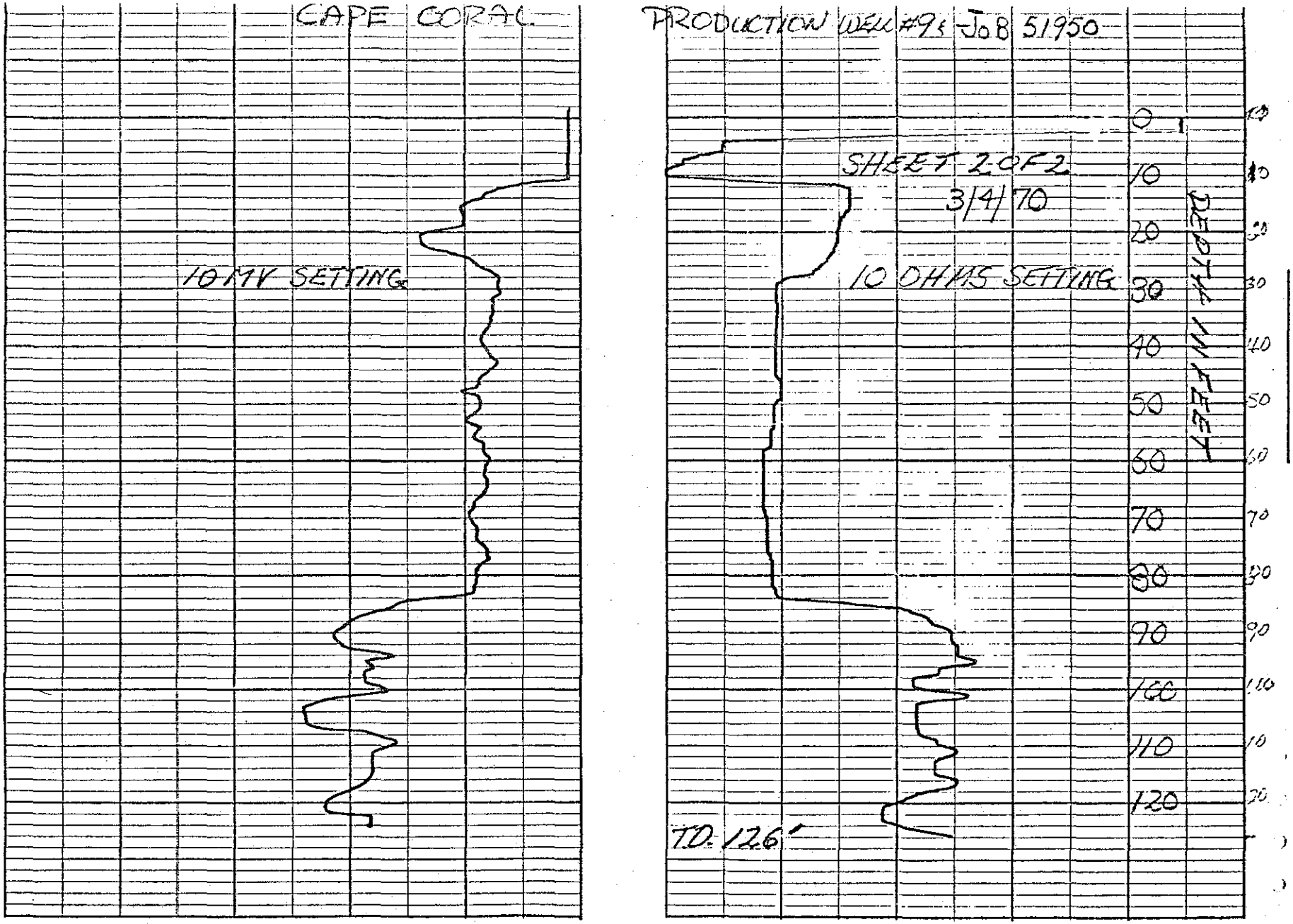
3. Maintenance and service is essential to maintain yield from high capacity water production wells. Every two to three years, all wells should have pumps removed and inspected for any necessary repairs. The well should then be acidized and cleaned to the original depth followed by test pumping to remove the acid residue and check the well's performance characteristics.

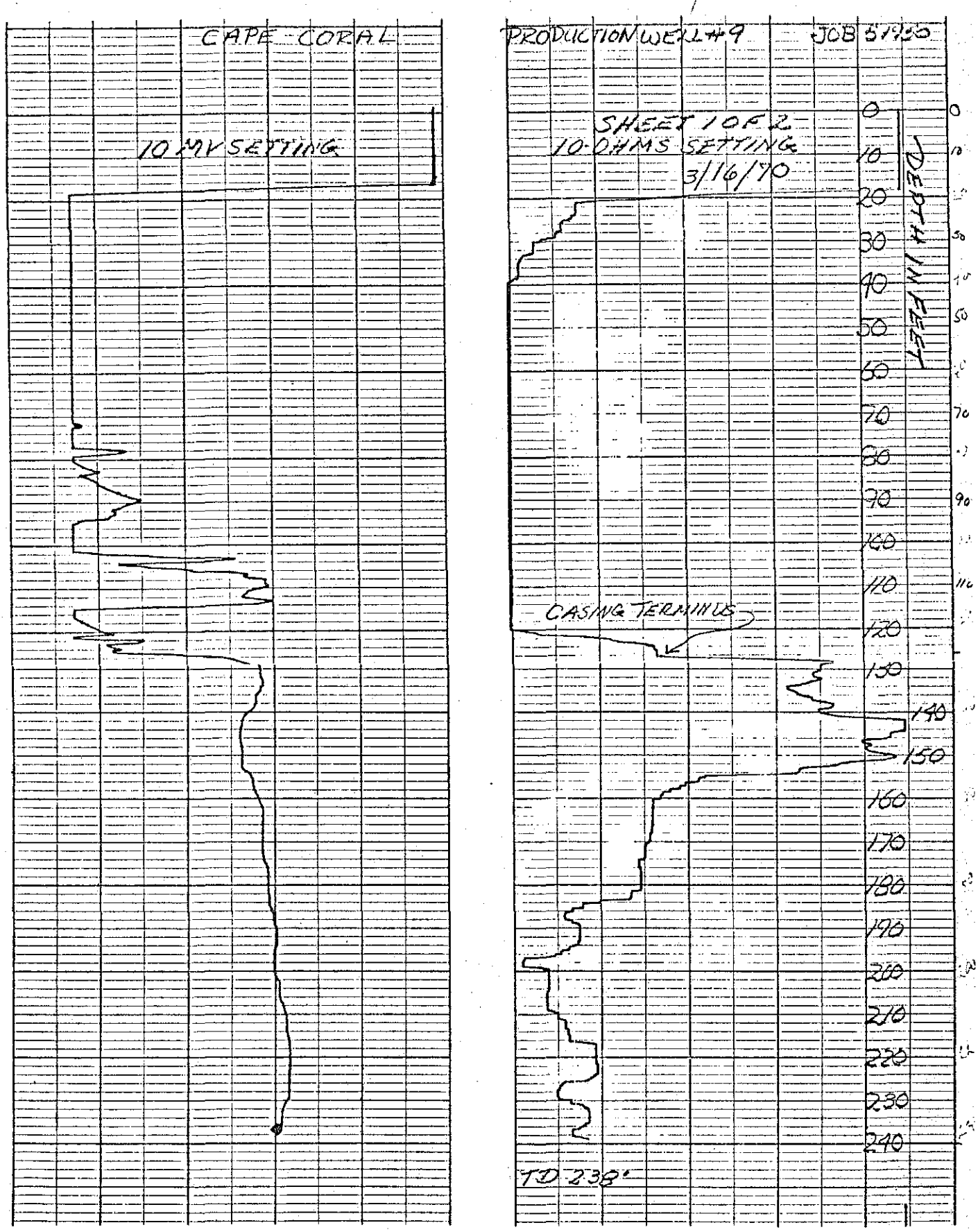
4. As part of the investigative procedure, for both Florida Cities Water Company and Cape Coral, two (2) inch diameter observation wells have been left in place. These observation wells should now be used for routine monitoring of the well system. At least quarterly, and preferably monthly, water levels should be observed and recorded in each observation well. Semi-annually, a water sample should be pumped from each observation well and its chemical content analyzed. Most observation wells can be pumped by a gasoline powered shallow lift pump, but some observation wells such as Florida Cities No. 11, will have to be bailed or pumped with an air lift system. As the areal drawdown increases, fewer wells will be pumped by shallow lift suction systems. The monitoring wells system will provide data in evaluating the adequacy of the supply and as additional data is available, the aquifer simulation model can be reviced and its accuracy improved to better predict the time available to meet the then existing demand. A change in water quality deterioration at an observation point will serve as a warning that the geologic protective system may be breaking down and brackish or salt water intrusion may be imminent. The most serious threat to salt water intrusion is from a vertical movement either by flow through abandoned wells or by vertical infiltration from surface canals dredged through the aquifer protective system. The permeability of the aquifer material is so low that horizontal velocities of the physical movement of water is on the order of one foot per day. At that rate of movement, it would take nearly seven (7) years for salt water to move one-half mile horizontally through the aquifer.

5. It is recommended that attention be given to the development of a supplemental water supply needed in seven to ten years. Considering the state of the art and the potential supply needed, the author is of the opinion that importation water from Eastern Lee County holds the greatest promise of developing an economical supply for Western Lee County. The water use growth potential of the area served by Florida Cities Water Company, Cape Coral, and Pine Island Water District, is approximately one (1) million gallons per day per year. Thus, developing a supply of the order of magnitude of 20 million gallons per day, would supplement the existing supply for a period of 20 years in the future. The closest area where a surplus of fresh water may exist is an easterly county south of Lehigh Acres. The Cork Screw swamp area east of Bonita Springs may be potentially a more productive area. A detailed study of the water supply potential of either or both of these areas should be made in the next one to two years. This work should then be followed by detailed planning and engineering required to transport the raw water to existing centers of use. Untreated water except for chlorination, could be transported to existing water softening plants to increase their utility and extend their economic service life. A preliminary estimate of the cost of a water importation system consisting of ten (10) one million gallon per minute wells each, 18 miles of pipeline capable of ultimately transporting 20 million gallons per day, a storage collection reservoir and booster pumps, was 1.5 million dollars. Acquisition of right-of-way, engineering and fees, and other contingency expense, should not exceed one-half million dollars.

APPENDIX A

GAC UTILITIES DATA


CAPE CORAL
PRODUCTION WELL #9 JOB 51950
SHEET 2 OF 2
3/4/70
10 MV SETTING
10 OHMS SETTING
TD 126'
0
10
20
30
40
50
60
70
80
90
100
110
120
DEPTH IN FEET


CAPE CORAL
10 MV SETTING
PRODUCTION WELL #9
JOB 57150
SHEET 1 OF 2
10-OHMS SETTING
3/16/70
DEPTH IN FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
CASING TERMINUS
TD 238'

G.A.C. UTILITIES, INC.
Ft. Myers Construction Division
CAPE CORAL, FLORIDA . WELL NO. 16
Santa Barbara LEE COUNTY

S.O. #51950

Started: January 28, 1970
Finished: February 26, 1970

0- 10	Soil
10- 25	Shell, Clay, Brown
25- 40	Shell, Clay, Green
40- 85	Shell, Clay, Green
85-123	Lime, Clay, Shell
125-130	Pepper sand and white Lime
130-152	Sandy Lime, Lime stone, Shell
152-158	Lt. Brown Limestone, very much Shell
158-160	White Lime, med.
160-162	Lt. brown Lime, many shells
162-165	White Lime, Shells
165-166	Lt. Brown Lime, Shells
166-172	Lt. Brown Lime, lots of Shells
172-176	Gray Lime, many Shells
176-179	Coarse Shell, trace of Clay
179-180	Brown - Green Lime, some Shells
180-181	Lt. green Lime, Shells
181-182	Gray and white Lime, lots of Shells, Trace of Clay
182-183	Gray Lime, Coarse, Shells
183-185	Gray Lime, Shells, med. hard
185-189	Gray Lime, Shells, med. hd.stks.
189-194	Gray Lime, some Shell, med.
194-199	Gray Lime, lots Shell, Hd. stks.
199-204	Gray, yellow Lime, lots of Shell hd. stks.
204-208	Gray-yellow Lime, lots Shell
208-209	Gray Lime Shell, Lt. brown Lime
209-210	Gray Lime, some Shell - hard
210-211	Gray Lime, gray-green Clay, some Shell
211-212	Green Clay
212-214	Lt. brown Lime and Shell
214-219	Lt. brown Lime, some shell
219-220	Black Clay, pepper Lime
220-221	Yellow clay, pepper Lime
221-226	Gray Lime, brown Stks, pepper Lime
226-228	Gray Lime, Shells, pepper Lime
228-236	Gray Lime, streaks of white Lime, lots Shells
236-240	Lt. brown Lime, some shells some Clay
240-241	Lt. brown Lime, some shells, clay

TOTAL DEPTH: 241'

Set 120' of 8" Pipe, Cemented with 55 Bags
Static at 241' - 16' 8"

Tested 220 GPM 94' P.L. - 8 hour Test
Acidized Well 1000 Gal.
Tested 350 GPM 90' P.L. - 8 hour Test

Locastion: Unit 24 East R/W -
Santa Barbara, Lee County
Twsp. 44S, Rge. 23E,
Section 24, Florida

ORLANDO LABORATORIES, INC.

P. O. BOX 8025A • ORLANDO, FLORIDA 32806 • 305 424-5606

March 12, 1970

Layne-Atlantic Co.
P O Box 5789
Orlando, FL 32805

REPORT OF ANALYSIS: Cape Coral S/D Well #16, Unit 24, East R/W - Santa Barbara, Lee County, Twsp. 44S, Rge. 23E, Sec. 24, Fl.

RESULTS OF ANALYSIS: (55 Gallons)

Date,	Static,	Depth,	No.	Pumping level,	Time to pump,	gpm,	Florides	TH	Cl	TDS
2/10	17'	172	3438-2	25'			0.6	288	90	420
2/10	17'9"	152	" -3	34	2min. 30sec.	21		270	90	375
2/10	17'9"	162	" -4	26'5"	0min. 0sec.	0		282	93	400
2/11	17'	178	3454-2	22'8"	1min. 45sec.	31	0.4	336	75	340
2/11	17'8'	179	3438-5	25'	3min. 0 sec.	18		300	75	345
2/11	17'8'	183	3454-4	24	2min. 45sec.	20		348	75	350
2/11	17'8"	188	" -5	25	2min. 20sec.	20		300	75	345
2/11	17'8"	193	" -6	25'8"	2min. 15sec.	24		360	90	370
2/11	17'4"	198	" -3	23	3min. 0 sec.	18		336	66	340
2/12	17'5"	203	" -9	23'10"	2min. 58sec.	18		312	84	375
2)	17'2"	208	" -8	23'4"	1min. 30sec.	36		294	81	350
2/12	16'3"	213	" -7	19'11"	1min. 55sec.	28		366	75	370
2/13	16'	218	" -10	21'7"	1min. 40sec.	33	0.1	342	75	380
---	---	221	3446 *	---	----------	---	0.1	410	204	270
2/16	16'7"	221	3454-11	20'11"	2min. 0sec.	27		354	165	580
2/16	16'10"	226	" -14	23'9"	1min. 25sec.	38		330	75	390
2/16	16'4"	231	" -12	20'11"	1min. 45sec.	31	0.0	330	75	390
2/16	16'4"	236	" -13	21'2"	1min. 35sec.	34		294	75	370
2/19	16'10"	241	" -1 *	94'	7hrs. 30min.	220	1.2	300	105	470
3/4		241	3463 **	90'	6hrs. 0min.	350	1.2	600	183	420
				Canal Water Analysis (Drilling Water Supply)						
2/13			3438-1*				0	282	66	350
2/13			3438-6					282	75	400
2/13			3438-7					318	75	420

NOTE * complete analysis
** complete analysis, after acidizin
TH - Total Hardness
Cl - Chloride
TDS - Total Dissolved Solids
GPM - Gallon per minute

Respectfully submitted,

ORLANDO LABORATORIES, INC.

L Morgan
Laurel Morgan
Chemist

LM/ie

Orlando Laboratories, Inc.

P. O. Box 20254 • Orlando, Florida 32814 • 305 424-5606

WATER ANALYSIS REPORT

Report to: Layne-Atlantic Co.

Date: February 19, 1970

Sample Number: 3454-1

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

Identification: Cape Coral Depth 241

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Twelfth Edition, 1965, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	470	Sulfate, as SO_4	5
Total Hardness, as $CaCO_3$	300	Fluorides, as F	1.2
Calcium Hardness, as $CaCO_3$	180	Silica, as SiO_2	9.0
Magnesium Hardness, as $CaCO_3$	120	Copper, as Cu	0
Calcium, as Ca	72	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	29	Color, Standard Platinum Cobalt Scale	5
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	sulfurous
Alkalinity (Total), as $CaCO_3$	240	pH (Laboratory)	7.1
Carbonate Alkalinity, as $CaCO_3$	0	pHs	7.0
Bicarbonate Alkalinity, as $CaCO_3$	240	Stability Index	6.9
Hydroxides, as OH	0	Saturation Index	0.1
Carbon Dioxide, as CO_2	37	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	293		
Chlorides, as Cl	105		
Iron, as Fe	0.05		
anese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.
P. O. Box 20254 • Orlando, Florida 32814 • 305 424-5606

WATER ANALYSIS REPORT

Report to: Layne-Atlantic Co.

Date: March 4, 1970

Sample Number: 3463

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

Identification: Cape Coral well#16

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Twelfth Edition, 1965, APHA AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	600	Sulfate, as SO_4	15
Total Hardness, as $CaCO_3$	420	Fluorides, as F	1.2
Calcium Hardness, as $CaCO_3$	258	Silica, as SiO_2	7.2
Magnesium Hardness, as $CaCO_3$	132	Copper, as Cu	0
Calcium, as Ca	110	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	39	Color, Standard Platinum Cobalt Scale	5
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	246	pH (Laboratory)	6.8
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.8
Bicarbonate Alkalinity, as $CaCO_3$	246	Stability Index	6.8
Hydroxides, as OH	0	Saturation Index	0
Carbon Dioxide, as CO_2	75	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	300		
Chlorides, as Cl	183		
Iron, as Fe	0.1		
Manganese, as Mn	0		

Signed L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

Orlando Laboratories, Inc.
P. O. Box 20254 • Orlando, Florida 32814 • 305 424-5606

WATER ANALYSIS REPORT

Report to: Layne -Atlantic Co.

Date: February 13, 1970

Sample Number: 3438-1

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

Identification: Sample #1 canal water 8:45 am 2/9/70

METHODS

This water was analyzed using methods adapted from "Standard Methods for the Examination of Water and Wastewater," Twelfth Edition, 1965, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	350	Sulfate, as SO_4	30
Total Hardness, as $CaCO_3$	282	Fluorides, as F	0
Calcium Hardness, as $CaCO_3$	240	Silica, as SiO_2	7.0
Magnesium Hardness, as $CaCO_3$	42	Copper, as Cu	0
Calcium, as Ca	96	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	10	Color, Standard Platinum Cobalt Scale	20
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	216	pH (Laboratory)	7.3
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	216	Stability Index	6.5
Hydroxides, as OH	0	Saturation Index	0.4
Carbon Dioxide, as CO_2	21	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	263		
Chlorides, as Cl	66		
Iron, as Fe	0.2		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)
INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 20254 • Orlando, Florida 32814 • 305 424-5606

WATER ANALYSIS REPORT

Report to: Layne-Atlantic Co.

Date: February 13, 1970

Sample Number: 3438-2

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

Identification: 2/11/70 30-min pumping-T.D. 172' pumping level-25' static level-17'

JOB NO.: 51950 WELL NO. 16

METHODS

This water was analyzed using methods adopted from "Standard Methods for the Examination of Water and Wastewater," Twelfth Edition, 1965, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	420	Sulfate, as SO_4	15
Total Hardness, as $CaCO_3$	288	Fluorides, as F	0.6
Calcium Hardness, as $CaCO_3$	192	Silica, as SiO_2	9.0
Magnesium Hardness, as $CaCO_3$	96	Copper, as Cu	0
Calcium, as Ca	77	Phosphate (Total), as PO_4	0.6
Magnesium, as Mg	24	Color, Standard Platinum Cobalt Scale	15
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	240	pH (Laboratory)	7.3
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	240	Stability Index	6.5
Hydroxides, as OH	0	Saturation Index	0.4
Carbon Dioxide, as CO_2	24	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	293		
Chlorides, as Cl	90		
Iron, as Fe	2.0		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Orlando Laboratories, Inc.

P. O. Box 20254 • Orlando, Florida 32814 • 305 424-5606

WATER ANALYSIS REPORT

Report to: Layne-Atlantic Co.

Date: February 16, 1970

Sample Number: 3446

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

Identification: PO # 12654 Well # 16 depth 221'

METHODS

This water was analyzed using methods adopted from "Standard Methods for the Examination of Water and Wastewater," Twelfth Edition, 1965, APHA, AWWA and WPCF.

RESULTS

Determination	p.p.m.	Determination	p.p.m.
Total Dissolved Solids, @ 105°C	410	Sulfate, as SO_4	30
Total Hardness, as $CaCO_3$	270	Fluorides, as F	0.1
Calcium Hardness, as $CaCO_3$	240	Silica, as SiO_2	5.0
Magnesium Hardness, as $CaCO_3$	30	Copper, as Cu	0
Calcium, as Ca	96	Phosphate (Total), as PO_4	0.9
Magnesium, as Mg	7.3	Color, Standard Platinum Cobalt Scale	25
Alkalinity (Phenolphthalein), as $CaCO_3$	0	Odor	0
Alkalinity (Total), as $CaCO_3$	240	pH (Laboratory)	7.4
Carbonate Alkalinity, as $CaCO_3$	0	pHs	6.9
Bicarbonate Alkalinity, as $CaCO_3$	240	Stability Index	6.4
Hydroxides, as OH	0	Saturation Index	0.5
Carbon Dioxide, as CO_2	19	Turbidity, Silica Scale	0
Carbonates, as CO_3	0		
Bicarbonates, as HCO_3	293		
Chlorides, as Cl	204		
Iron, as Fe	0.5		
Manganese, as Mn	0		

Signed: L Morgan
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1)

INSPECTIONS, ANALYSIS, QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

ORLANDO LABORATORIES, INC.

P. O. BOX 8025A • ORLANDO, FLORIDA 32806 • 305 424-5606

February 13, 1970

Layne-Atlantic Co.
P O Box 5789
Orlando, FL 32805

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

REPORT OF ANALYSIS: # 3438

Sample #:	Date:	Lab-No.:	Depth of well:	Pumping Level:	Static Level:	Gpm:	Time
3438-3	2/10/70	3	152'	34'		55	2 1/2mi
-4	2/10/70	4	162'	26'5"	17'9"		10 min
-5	2/11/70	5	179'	25'	17'8"	55	3 min.
-6	2/10/70	(canal)					
-7	2/11/70	(canal-in)					

RESULTS OF ANALYSIS: # 3438

Sample # :	Chloride, as Cl	Total Hardness, as TH	TDS
3438-3	90	270	375
-4	93	282	400
-5	78	300	390
-6	75	282	400
-7	75	318	420

Respectfully submitted,

ORLANDO LABORATORIES, INC.

L Morgan
Laurel Morgan
Chemist

LM/ie

ORLANDO LABORATORIES, INC.

P. O. BOX 8025A • ORLANDO, FLORIDA 32806 • 305 424-5606

February 20, 1970

Layne-Atlantic Co.
P O Box 5789
Orlando, FL 32805

Permit No. 6499 - S.O.#51950
Cape Coral S/D Well No. 16
Unit 24, East R/W
Santa Barbara, Lee County
Twsp 44S, Rge. 23E, Sec. 24, Florida

REPORT OF ANALYSIS: # 3454

Sample #:	Date:	Lab-No.:	Depth of well:	Pumping Level:	Static Level:	Gpm:	Time
3454-2	2/11/70	2	178'	22'8"	17'	55	1min 45sec
-3	2/11/70	3	198'	23'	17'4"	"	3min
-4	2/11/70	4	183'	23'11"	17'8"	"	2min 45sec
-5	2/11/70	5	188'	25'	17'8"	"	2min 20sec
-6	2/11/70	6	193'	25'8"	17'8"	"	2min 15sec
-7	2/12/70	7	213'	19'11"	16'3"	"	1min 55sec
-8	2/12/70	8	208'	23'4"	17'2"	"	1 1/2 min
-9	2/12/70	9	203'	23'10"	17'5"	"	2min 58sec
-10	2/13/70	10	218'	21'7"	16'	"	1min 40sec
-11	2/16/70	11	221'	20'11"	16'7"	"	2 min
-12	2/16/70	12	231'	20'11"	16'4"	"	1min 45sec
-13	2/16/70	13	236'	21'2"	16'4"	"	1min 35sec
-14	2/16/70	14	226'	23'9"	16'10"	"	1min 25sec

RESULTS OF ANALYSIS: # 3454

Sample #:	Chloride, as Cl	Total Hardness, as TH	TDS
3454-2	75	336	340
-3	66	336	340
-4	75	348	350
-5	75	300	345
-6	90	360	370
-7	75	366	370
-8	81	294	350
-9	84	312	375
-10	75	342	380
-11	165	354	580
-12	75	330	390
-13	75	294	370
-14	75	330	390

Fluoride, as F # 3454-2 0.4 ppm #3454-12 0 ppm

Respectfully submitted,

ORLANDO LABORATORIES, INC.

L Morgan
Laurel Morgan, Chemist

INSPECTION ANALYSIS QUALITY CONTROL, RESEARCH & DEVELOPMENT IN MICROBIOLOGY, BIOCHEMISTRY & CHEMISTRY.

Cape Coral S/D Well #10 - Lake No. 24

Santa Barbara, Lee County

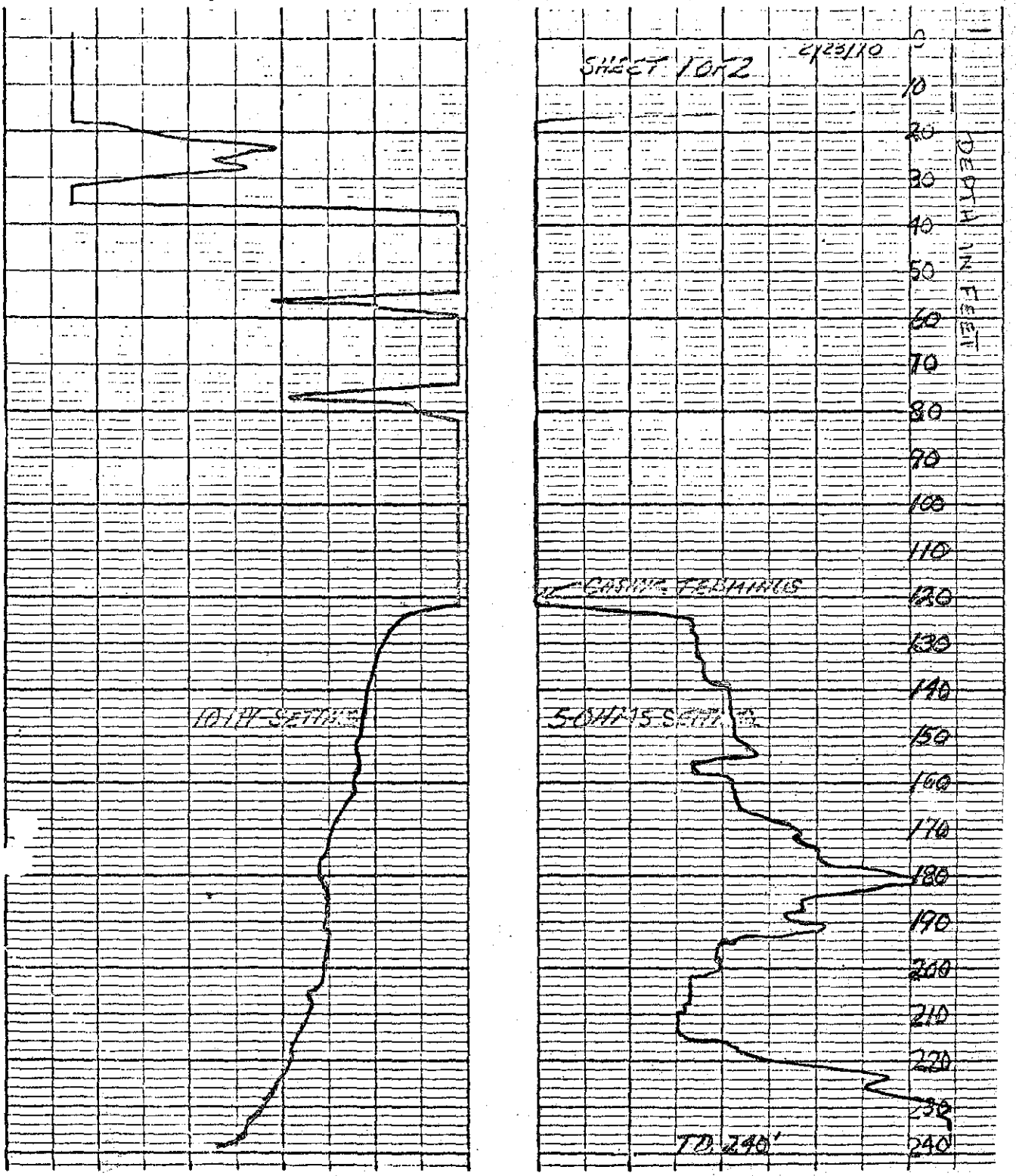
Twsp. 44S, Rge. 23E, Sec. 24, Florida

Serial No. _____ Your Order No. _____ S. C. No. 51950

From LAYNE-ATLANTIC CO.

"World's Largest Water Developers"

MEMPHIS - TENNESSEE



GAC UTILITIES, INC.

WATER QUALITY ANALYSIS

CAPE CORAL TEN INCH DIAMETER TEST

WELL NO. 2, NORTH OF PINE ISLAND ROAD

WELL DRILLED BY LAYNE-ATLANTIC COMPANY

ANALYSIS BY CAPE CORAL WATER PLANT PERSONNEL

	4 HRS. PUMPING	7 HRS. PUMPING
pH	7.3	7.3
M. Alk.	200	200
Total hardness ($CaCO_3$)	294	294
Mg hardness ($CaCO_3$)	150	156
Ca hardness ($CaCO_3$)	144	138
Chlorides	180	180
Total dissolved solids	450	460

APPENDIX B

NORTH FORT MYERS DATA

Layne-Western Company, Inc.

WATER SUPPLY SERVICES SINCE 1924

TEST DRILLING • WATER WELLS • PUMPS

MISCELLANEOUS WELL LOG AT FCWC NORTH FORT MYERS WATER PLANT

Contract Name North Fort Myers, Florida

Job No. _____ Date _____

City _____ State _____

TEST HOLE No. Well No. 6

Driller Marvin Miller

Location of Test Hole
South County Park Road

¼ ¼ Sec. _____ of T _____, R _____, _____ Co., _____.

Elevation of Test Hole _____

Static Water Level _____

Measured _____ Hours After Completion

From	To	Description of Strata	Water Bearing	
0'0"	0'6"	Top soil		
0'6"	1'0"	Sand		
1	2	Soft lime rock		
2	7	Marl		
7	9	Sand and shell		
9	13	Rock		
13	47	Green clay		
47	48	White clay		
48	52	Sand and shell	4	good
52		Green clay (total depth)		

Remarks: Set 10'5" of 20 inch diameter surface casing, used 10 feet of wire wound screen and 38 feet of 8 inch diameter casing. Screen gravel packed in 20 inch diameter drill hole.

#4 WELL

20" GRAVEL PACK WELL

0'-6'	White Sand
6'-10'	Brown Sand
10'-14'	Rock
14'-20'	Marl, Shell & Little Sand
20'-38'	Light Green Clay
38'-46'	Shell & Marl
46'-48'	Green Clay

8" WELL NO. 7

0'-4"	Top Soil
4"-6'	White Sand
6'-18'	Marl
18'-28'	Light Green Clay
28'-30'	Marl & Shell
30'-35'	Green Clay
35'-39'	Hard Pan (Shell)
39'-45'	Light Green Clay
45'-54'	Hard Pan (Sand & Shell)

APPENDIX C

BONITA SPRINGS DATA

Interview with Mr. D. H. Boggess, District Geologist
Address: Smith Building, 2070 Main Street
Ft. Myers, Florida

Test Location #731 NW¼, NE¼, NE¼ Sec. 25 Twp.46S, R 27E.
located near Cork Screw Road

0'0" - 25'0"	Sand shell zone
25'0" 150'0"	Limestone, dolomite
150'0" 215'0"	Green clay
218'0" 243'0"	Producing limestone formation
165'	Casing in well
3.89 feet	Static water level below surface
10.89 feet	Pumping water level at 60 gpm
8.6 gpm/ft. D.D.	Specific capacity of well

COMMENTS REGARDING WATER PRODUCTION

1. This well cased out some good dolomite formation that would be useful in production.

2. The formation is generally too loose to stand open hole. The well needs to be screened.

3. Water quality generally acceptable.

72 ppm of chlorides
Water temperature 26.5 deg. C. (79.6 deg. F)
Conductivity 350 micro mohs

PML LABORATORIES

M. B. WHITE, M.D.
DIRECTOR, CLINICAL RESEARCH

J. S. BRACKEN, M.D.
DIRECTOR, BIOLOGICAL SCIENCES

WM. F. MAHONEY, M.D.
DIRECTOR OF ELECTRONICS & INSTRUMENTATION

I. M. CHAMELIN, Sc.D.
DIRECTOR, CHEMICAL & PHYSICAL SCIENCES

Research & Development Division

1928 HILLVIEW AVENUE / SARASOTA / FLORIDA

TELEPHONE / 958-0396

ACCESSION NO.: 237 DATE RECEIVED 8-23-68 DATE OF REPORT 8-26-68

SAMPLE OF: Water U.S. Geological Survey Well

FOR: PARTIAL ☐ COMPLETE ☒ ORDER NO.:

SUBMITTED BY: Florida Cities Water,

SOURCE: 2112 Gulf GateDrive, Sarasota, Fla.

231

CERTIFICATE OF ANALYSIS

	Parts per Million
Total Dissolved Solids @ 103° C.	440
Total Hardness (Versenate)	190
Alkalinity as $CaCO_3$	220
Non-Carbonate Hardness	0
Bicarbonate, HCO_3	268
Iron, Fe	0.04
Sulfates, SO_4	30
Chlorides, Cl	57
Calcium, Ca	44
Magnesium, Mg	19
Fluorides, F (Distillation)	0.48
Carbon Dioxide, as CO_2	17
Bicarbonate, as $CaCO_3$	220
Carbonate, as $CaCO_3$	0
Hydroxide, as $CaCO_3$	0
Color (Standard Cobalt Scale)	10
Odor	None
pH (Field)	N.D.
pH (Laboratory)	7.4
pHs	7.6
Stability Index	7.8
Corrosive	Maybe
Scale Forming	Maybe
Appearance	Satisfactory

Respectfully submitted,
PML LABORATORIES

By: _____, Analyst

PML LABORATORIES

M. B. WHITE, M.D.
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Research & Development Division

1928 HILLVIEW AVENUE / SARASOTA / FLORIDA

TELEPHONE / 958-0396

ACCESSION NO.: 236 DATE RECEIVED 8-23-68 DATE OF REPORT 8-26-68

SAMPLE OF: Water N.E.Section 25 Ward Ranch
N.E. near Bonita SPRINGS

Shallow Irrigation Well - est depth 37 feet

FOR: PARTIAL ☐ COMPLETE ☒ ORDER NO.:

SUBMITTED BY: Florida Cities Water,

SOURCE: 2112 Gulf Gate Drive, Sarasota, Fla.

CERTIFICATE OF ANALYSIS

	Parts per Million
Total Dissolved Solids @ 103° C.	405
Total Hardness (Versenate)	290
Alkalinity as $CaCO_3$	280
Non-Carbonate Hardness	10
Bicarbonate, HCO_3	342
Iron, Fe	1.44
Sulfates, SO_4	Less than 5
Chlorides, Cl	33
Calcium, Ca	108
Magnesium, Mg	5
Fluorides, F (Distillation)	0.18
Carbon Dioxide, as CO_2	43
Bicarbonate, as $CaCO_3$	280
Carbonate, as $CaCO_3$	0
Hydroxide, as $CaCO_3$	0
Color (Standard Cobalt Scale)	50
Odor	None
pH (Field)	N.D.
pH (Laboratory)	7.1
pHs	7.1
Stability Index	7.1
Corrosive	Maybe
Scale Forming	Maybe
Appearance	Satisfactory

Respectfully submitted,
PML LABORATORIES

By: _____, Analyst

Well #3 at Bonita Springs

105'--132'	Shell with white clay
132'--145'	Green clay with shell
145'--148'	Sand with shell
148'--196'	Sand
196'--210-	Green clay
210'--214'	Gray clay
214'--258'	Green clay
258'--262'	Hard Lime Rock
262'--275'	Soft lime rock

Total depth 275'

Total casing 207' 10"

Total casing 40' 10" at time of 72 hr. test

PML
LABORATORIES

M. B. WHITE, M.D.
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ACCESSION NO.: 275 DATE RECEIVED 12/16/63 DATE OF REPORT 12/18/63

SAMPLE OF: Water Well #3 Venice Spring 11/14/63 11:45 AM Sample #1

FOR: PARTIAL ☐ COMPLETE ☒ ORDER NO.:

SUBMITTED BY: Florida Citrus Water

SOURCE: 2112 Gulf Gate Drive Sarasota, Fla.

CERTIFICATE OF ANALYSIS

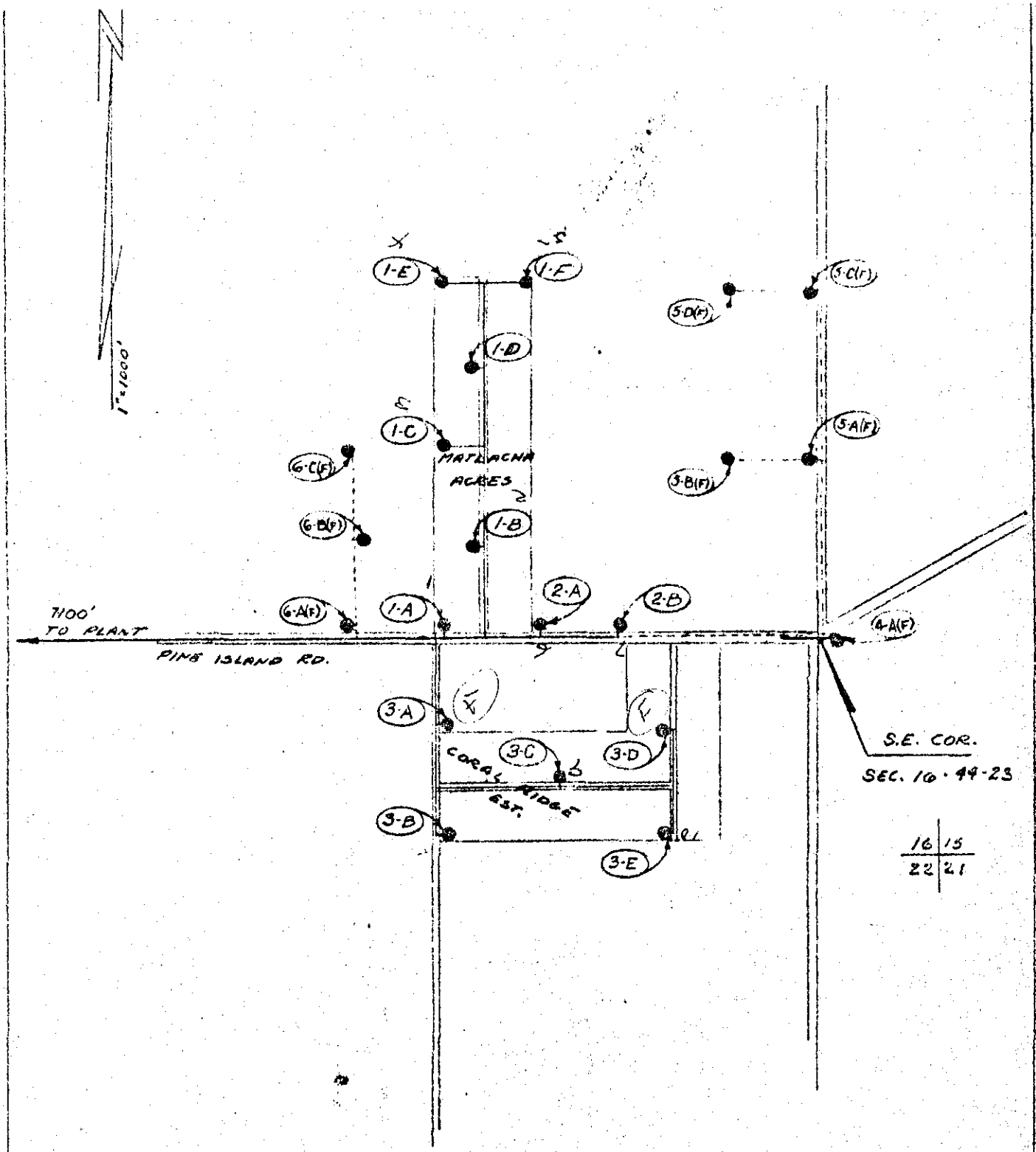
	Parts per Million
Total Dissolved Solids @ 103° C.	553
Total Hardness (Versenate)	230
Alkalinity as $CaCO_3$	270
Non-Carbonate Hardness	0
Bicarbonate, HCO_3	330
Iron, Fe	0.08
Sulfates, SO_4	66
Chlorides, Cl	90
Calcium, Ca	65
Magnesium, Mg	27
Fluorides, F (Distillation)	0.60
Carbon Dioxide, as CO_2	7
Bicarbonate, as $CaCO_3$	270
Carbonate, as $CaCO_3$	0
Hydroxide, as $CaCO_3$	0
Color (Standard Cobalt Scale)	15
Odor	None
pH (Field)	N.D.
pH (Laboratory)	7.8
pHs	7.4
Stability Index	7.0
Corrosive	Maybe
Scale Forming	Maybe
Appearance	Satisfactory

Respectfully submitted,
PML LABORATORIES

By: _____ Analyst

APPENDIX D

PINE ISLAND WELL FIELD DATA



2-B WELL IN PRESENT DEV.

5-B(F) WELL FOR FUTURE DEV.

SUPPLY WELL SITE PLAN

EXHIBIT B

GREATER PINE ISLAND WATER ASSOCIATION, INC.

SUPPLY WELLS

Well No.	GPM @ 31' Drawdown 15"	1 hr.	2 hr.	4 hr.	6 hr.	12 hr.	GPM @22' 12 hr. Drawdown	Cl_2 ppm.	Cl_2 Composite	Actual Pumping
1A	143	127	122	118	118	116	82	93	7.6	82
1B	194	183	183	174	174	172	122	309	37.7	122
1C	254	236	236	236	235	233	167	393	66.0	168
1D	165	150	150	143	143	142	101	393		
1E	174	165	157	150	150	148	105	262	29.6	105
1F	206	194	194	194	183	180	128	282	36.1	128
2B	165	137	137	132	132	130	92	102	9.4	92
2D	157	137	137	132	127	120	85	99	8.4	85
3A	110	100	94	94	87	80	57	123		
3B	118	110	103	103	103	102	72	180	13.0	72
3C	94	88	88	88	88	86	61	78	4.8	61
3D	94	94	94	89	82	75	53	57		
3E	132	127	127	122	122	120	85	96	8.2	85
Total						1706	1210		221	1000

[illegible], [illegible] & ASSOCIATES, INC.

EXHIBIT E

WATER ANALYSIS TABULATION

GREATER PINE ISLAND WATER ASSOCIATION, INC.

BENNETT, BISHOP & PASSALACQUA, INC.

EXHIBIT "D"

*parts per million

Component \ Well No.	1-A	1-B	1-C	1-D	1-E	1-F	2-A	2-B	3-A	3-B	3-C	3-D	3-E	Remarks
Total Dissolved Solids *	470	875	1050	1050	825	825	480	450	522	615	405	525	440	
Total Hardness *	318	474	522	522	481	481	298	318	298	323	273	305	305	
Alkalinity as $CaCO_3$ *	230	240	210	210	230	230	210	210	210	230	240	220	210	
Non-Carbonate Hardness *	88	234	312	312	251	251	88	108	88	93	33	85	95	
Bicarbonate, HCO_3 *	280	294	256	256	280	280	256	256	256	280	294	270	256	
Iron, Fe *	0.06	0.08	0.08	0.14	0.12	0.12	0.12	0.08	0.06	0.12	0.14	0.06	0.08	
Sulfates, SO_4 *	5-	50	91	87	50	64	20	15	13	34	5-	14	15	
Chlorides, Cl *	93	309	393	393	282	282	102	99	123	180	78	57	96	
Calcium, Ca *	58	68	89	89	79	79	58	58	58	68	58	53	53	
Magnesium, Mg *	42	74	73	73	69	69	37	42	37	37	31	42	42	
Flourides, F *	1.10	1.4	1.2	1.1	1.2	1.4	1.08	1.5	0.96	0.8	0.8	1.24	1.1	
Carbon Dioxide, CO_2 *	2	2	2	2	2	2	16	12	12	2	2	12	10	
Bicarbonate, $CaCO_3$ *	230	240	210	210	230	230	210	210	210	230	240	220	210	
Carbonate, $CaCO_3$ *	4	2	4	4	4	4	0	0	0	4	4	0	0	
Hydroxide, $CaCO_3$ *	0	0	0	0	0	0	0	0	0	0	0	0	0	
Color (Std. cobalt) *	5	5	5	5	5	5	5	5	5	5	5	5	5	
Odor	None	None	None	None	None	None	None	None	None	None	None	None	None	
pH (Field)	N.D.	N.D.	N.D	N.D	N.D	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
pH (Lab.)	8.3	8.3	8.3	8.3	8.3	8.3	7.4	7.5	7.5	8.3	8.3	7.5	7.6	
pHs	7.4	7.4	7.4	7.4	7.4	7.4	7.5	7.5	7.5	7.4	7.4	7.6	7.5	
Stability Index	6.5	6.5	6.5	6.5	6.5	6.5	7.6	7.5	7.5	6.5	6.5	7.7	7.4	
Corrosive	±	±	±	±	±	±	±	±	±	±	±	±	±	
Scale Forming	±	±	±	±	±	±	±	±	±	±	±	±	±	
Appearance	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	Sat.	
Phenolphthalein Alk. *	35	35	35	35	30	30	N.D.	N.D.	N.D.	35	40	N.D.	N.D.	
Methyl Orange *	295	205	175	175	200	200	N.D.	N.D.	N.D.	295	200	N.D.	N.D.	

APPENDIX E

WELL CONSTRUCTION SPECIFICATIONS

GENERAL SPECIFICATIONS

WATER SUPPLY WELL

I. SCOPE OF WORK

These specifications are intended to provide the information necessary for all parties concerned with the contract to know the conditions and determine the amount of equipment, materials and work required to successfully complete a water supply well for municipal use.

These specifications are for a large diameter well to be constructed in lime rock with the producing water zone to be of open hole construction. All these specifications are in accordance with what is considered to be good practice by the water well industry and the American Water Works Association in the United States. The work covered by these specifications will meet the specific requirements of any local or state health department or other appropriate regulatory agencies as may have jurisdiction at the location desired.

II. PERSONNEL AND DRILLING EQUIPMENT

The Contractor certifies he has been in business of constructing similar type water supply wells for _____ years. The Contractor further states that _____ who has been employed by the Contractor for _____ years

will be assigned to this job as field superintendent. The Contractor will list three (3) clients and the name of the responsible official from whom a reference of quality of work can be obtained.

_____

_____

_____

Further, the Contractor will list the manufacturer's name, model number and age of equipment to be used in the construction of the water supply well or wells, specified herein.

_____

_____

_____

III. PERMITS

The Contractor shall obtain a permit from the State Board of Health to drill the new well or wells, immediately following notice to proceed with this contract. The Contractor shall furnish both the Owner and the Engineer with a copy of the permit. No field operation shall commence until the necessary approvals have been obtained.

IV. MOBILIZATION AND DEMOBILIZATION

This item in the bid schedule includes moving on and off the site, all materials and equipment necessary for constructing and developing the well, or wells. It also includes cleaning up the

site upon completion of the contract.

V. CONSTRUCTION OF WELL

The well shall be a large diameter, lime rock well, drilled by the rotary process. Unconsolidated material above the water bearing lime rock formation shall be completely cased off and sealed so as to prevent contamination of the lime rock or corrosion of the casing by soil and water above the water bearing formation. In order to provide maximum development of the lime rock formation, no drilling mud will be used in this formation. Cuttings and formation water will be removed during the drilling process by the air reverse circulation method. No other drilling process is acceptable.

Contractor shall drill the well at the location agreed upon with the Owner and in compliance with regulations and recommendations. Any drilling fluid pits required should be positioned at least 15 feet from the proposed pump foundation pad or the top of the well. Contractor shall dispose of drilling fluid and cuttings and discharge water in a manner acceptable to the Owner. The Contractor shall drill a _____inch diameter hole to accomodate the outer casing to a depth of_____feet. This depth may be adjusted somewhat because of conditions encountered at the site and payment will be on the basis of the unit price per lineal foot of hole drilled. The top of the casing shall be a minimum of two (2) feet

above the final ground surface or pump house floor base. This _____inch diameter casing shall be joined as it is being placed by either welded or threaded connections to form a water-tight casing. The well will not be accepted if straightness or vertical alignment is unsatisfactory to the extent that it interferes with the installation of a pump. If doubt exists, as to the plumbness and alignment, the Contractor may be required by the Owner to conduct an Eastman alignment survey or equal, at no extra cost, to the owner.

After the surface casing has been installed, centered and plumb, the three (3) inch annular space between the walls and the drilled hole and the outside of the casing shall be filled with a neat cement grout under pressure. The grout shall be pumped to the bottom of the hole under pressure through a separate, temporary pipeline. The cement shall be mixed at the site and the mixing and pumping shall be a continuous operation until the grout has filled the entire annular space as evidenced by its overflowing at the surface. The mixture shall weigh approximately fifteen (15) pounds per gallon and at no time during the cementing operation, shall the weight fall below fourteen (14) pounds per gallon. The Contractor is cautioned that he must have sufficient pumping and mixing equipment together with separate stand-by equipment, as well as sufficient supply of cement at the site before this

operation is begun as the cementing, once started, shall be a continuous operation until the grout overflows at the surface. The Contractor shall guarantee the effectiveness of the cement seal around the casing and that there will be no leakage around the casing anywhere along its entire length.

Drilling into the lime rock aquifer horizon shall be resumed after the grout mentioned above, has set for 72 hours. The diameter of the hole drilled in the lime rock shall be not more than five-eighths (5/8) inches smaller than the inside diameter of the surface casing. The hole shall be drilled by the rotary process in order to secure straightness, alignment and concentricity with the outer casing. This hole shall be drilled to the bottom of the_____formation expected to be encountered_____ feet below ground surface. Additional depth may be specified by the Owner.

The total contract price shall be subject to adjustment in accordance with the unit adjustment prices given in the proposal form.

VI. MATERIALS

The well casing forming the permanent well shall be constructed of new, durable, and non-toxic material sufficient to protect the well against structural deficiencies during

construction and against entry of pollutants during the expected life of the well. Only new, and unused API-5L or A-53 seamless or electric weld black pipe may be used. The casing will be _____inch I.D. with a thickness of _____inches and a weight of _____pounds per foot for a plain end condition.

The neat cement grout shall be a mixture of Portland cement and not more than six (6) gallons of water per bag (94#) of cement. The use of Bentonite (up to 2% by weight of cement) to reduce shrinkage may be used. The water used shall be fresh, clean and potable. If the water is questionable, it shall be tested in accordance with ASTM C109.

VII. DEVELOPING THE WELL

The well shall be developed by any acceptable method selected by the Contractor. A preliminary pumping test shall be provided for a period of four (4) hours to determine the potential yield, drawdown, and recovery. After developing, the Contractor shall remove any formation materials brought into the well by the development process.

VIII. TESTING THE WELL

After the completion of the preliminary pumping test, or tests, the Owner may elect to conduct a final pumping test for a period of at least 500 minutes to secure information for the

selection of permanent pumping equipment. The Contractor shall furnish a deep well turbine pump capable of discharging _____ gallons per minute. The Contractor shall provide the necessary power to operate the pump continuously, for the duration of the test. After drilling, development, and preliminary testing, the well shall be allowed to set idle for at least 12 hours for the water level to return to its normal static level. This water level shall be carefully measured and recorded to the nearest one hundredth of a foot from the top of the casing prior to the commencement of pumping. The well shall then be pumped continuously for 500 minutes at a rate determined by the Owner, not to exceed _____gallons per minute. Immediately after commencement of the pumping, the water level shall be measured and recorded to the nearest one hundredth of a foot and the water level during recovery shall also be measured every minute for the first 15 minutes, every five minutes for the next 45 minutes and every 30 minutes for the remainder of the period.

Accidental interruptions may, if so agreed, upon between the Contractor and Owner, be compensated for by correspondingly increasing the time of pumping test. No accidental interruption may exceed 5% of the proposed pumping time. Should the Contractor be unable to continue the test, he shall re-start the test at his own expense, only after a 12 hour rest period for the static water

level to return to its original condition. The time stated for the duration of the final test is a minimum, and the Owner reserves the right to require the Contractor to extend the test period to _____hours or to make additional tests not to exceed a combined pumping test time of _____hours.

IX. ACIDIZING

If so directed, in order to increase the yield of water from the well, after the final pump test, the Contractor shall remove the test pump and acidize the well. Before removing the pump from the well, the Contractor shall run a test on the pump to obtain four points on the head - capacity curve and a capacity horsepower curve. After acidizing, a similar number of points shall be obtained and the results compared. Acidizing shall be performed by using compressed air to displace the acid into the formation.

Prior to acidizing, pre-treatment with a solution of 50# of sodium tripolyphosphate or an equivalent phosphate, shall be introduced through the acidizing tube installed in the well to within 20 feet of the bottom. The solution shall be displaced into the formation with 300 gallons of water. The solution shall then be surged with air to properly mix the phosphate and produce a scouring effect in the well bore. The solution shall then be pumped to waste.

Upon completion of the pre-treatment with phosphate, 500 gallons of 15% hydrochloric acid solution shall be used containing a non-toxic inhibitor to prevent damage to the casing and a non-toxic stabilizer to prevent after-precipitation of dissolved minerals. The chemical used as inhibiting and stabilizing ingredients shall be acceptable to the Florida Board of Health. The acidizing process shall be subject to the approval of the Florida State Board of Health. The acid solution shall be introduced through the tubing set to a depth as authorized by the Owner and the acid shall be displaced in the formation with 500 gallons of water.

A suitable sealing arrangement shall be provided between the well casing and acid tubing to develop pressure of at least 500 pounds per square inch on the well. The sealing arrangement shall be provided with the necessary valves and pressure gauges to determine the pressure in the annulus so that additional acid, water, or air, can be introduced into the well and acid, or water, can be vented or pumped from the well.

If the pressure in the well does not develpp to 500 psi after operating the compressor for one hour, then watever pressure that is developed, shall be retained for an additional one (1) hour or until the pressure drops below 250 psi. Then, the waste valve shall be opened and the well shall be pumped at a rate to produce approximately 50% drawdown to clear the well of spent acid.

The Owner may elect to have the Contractor prepare and introduce a second 500 gallons solution of acid treatment into the well in the exact same manner as hereinbefore described. The acid tubing shall be pulled back in the well to an upper water bearing formation as determined by the Owner. After the acidizing treatment, the well shall be pumped clear of all sediment and discoloring matter until no acid reaction is shown on litmus paper. A test pump shall then be installed and an additional final pumping test shall be provided in accordance with these specifications. The additional pump test shall be a duplication of the final pump test previously described.

X. DISINFECTING THE WELL

The well shall be disinfected after the well has been tested for yield but before removing the test pump from the well, and before collecting any samples for determining micro-biological quality.

The well shall be disinfected by introducing a chlorinated lime or chlorine solution into the well in such a manner that a concentration of at least 50 ppm of available chlorine exists in all parts of the well at static conditions. The chlorine solution shall be introduced into the well in such a manner that the well surface above the static level will be completely flushed with the solution. A minimum of two (2) hours contact time shall be provided before pumping the well to waste.

XI. CONTRACTOR'S RESPONSIBILITY

The Contractor shall be responsible for performing all the work in strict accordance with the specifications. If evidence indicates that the well is not constructed in accordance with these specificatins, to the satisfaction of the Owner, proper changes shall be made by the Contractor, or if proper changes cannot be made, the Contractor shall abandon such well, without cost to the Owner, and drill a new well. If the Con - tractor is not responsible for installing the permanent pump, the well shall be temporarily capped in such a manner as to prevent any pollutants from entering the well.

XII. GUARANTEES

Contractor shall guarantee that all materials, equipment and work performed are free from defects in workmanship, design, or materials for a period of one (1) year after completion. If, within one (1) year of completion, the well should fail to perform, due to any such defects, it shall be repaired and restored to operating condition within a reasonable period of time at no cost to the Owner. As a condition of acceptance, the Contractor shall demonstrate to the Owner, that the full depth of the well is free of any obstruction and clear of any formation materials.

XIII. ABANDONMENT CLAUSE

If the well fails to conform to the specifications, and the Contractor is unable to correct the condition at his own expense, it shall be considered an abandoned hole and the Contractor shall immediately start a new well at a nearby location specified by the Owner. The Contractor may salvage as much casing and materials as possible, from the abandoned hole. The salvage material shall remain the property of the Contractor. They may be used in a new well, if not damaged. The abandoned hole shall be filled with impermeable material and sealed in such a manner as to avoid accidents and to prevent it acting as a channel for pollution of water bearing formations.

XIV. WELL LOG AND FORMATION SAMPLES

The Contractor shall keep an accurate log of the well as the drilling progresses. The log shall include the depth, thickness and nature of each formation encountered as well as a physical sample of each formation. Samples shall be taken at regular intervals of 5 feet and at every change in formation. A complete record of the casing and casing lengths with location of any packers, plugs or seals, shall be furnished. All test data including static water level measurements, length of test, rate of discharge, and all drawdown measurements will be complete and furnished to the Owner. Two (2) water samples, one collected after one (1) hour of pumping, and one near the end of the final

test will be collected by the Contractor and submitted to an approved laboratory for analysis of chemical constituents. The results of such analysis will be sent to the Owner. The Contractor will also electric log the well and provide a copy of the electric log to the Owner.

PROPOSAL SCHEDULE

ITEM NO.	WORK OR MATERIAL	QUANTITY OF UNITS	UNIT PRICE	TOTAL AMOUNT
1.	Mobilization and/or demobilization	lump sum	$_____	$_____
2.	Drilling ____inch diameter hole accommodate surface casing	$_____lin.ft.	$_____	$_____
3.	Furnishing and installing _____inch diameter surface casing	$_____lin.ft.	$_____	$_____
4.	Grouting_____dia. surface casing	lump sum		$_____
5.	Drilling _____dia. hole beneath surface casing for open hole completion	$____lin.ft.	$_____/ft.	$_____
6.	Acidizing	lump sum/ treatment	$_____	$_____
7.	Conducting 500 minute final pumping test	Lump sum/ test	$_____	$_____
8.	Continuation of pumping past 500 minutes	_____hrs.	$_____/hr,	$_____
9.	Completed well using expected dimensions only (total of above items)	lump sum		$_____

10. Completion time of well_____day_____month_____year.