CONSTRUCTION AND TESTING OF FLORIDAN AQUIFER WELLS RO-1 AND RO-2 FOR THE NORTH MARTIN COUNTY WATER TREATMENT SYSTEM JENSEN BEACH, FLORIDA

INTRODUCTION

On November 21, 1989, Martin County authorized Hutcheon Engineers, a division of Kimley-Horn and Associates, Inc., to provide professional engineering services related to the expansion of the North Martin County Water System. On October 3, 1990, Hutcheon Engineers authorized Geraghty & Miller, Inc. to plan, provide specifications, and inspect the construction and testing of a Floridan aquifer test-production well and two Floridan aquifer production wells at the water plant facility. The site location map is shown on Figure 1 and a site plan is shown as Figure 2. The test-production well was installed to define the geologic and hydrologic conditions of the Florida aquifer, the extent of the production horizons, and the quantity and quality of water available for withdrawal at the site, and to provide hydrogeological information to support a water-use application to the South Florida Water Management District (SFWMD). The test-production well was designed so that testing could be performed and so that it subsequently could be used as a production well upon successful completion of the program. The additional production wells would be installed if site conditions warranted.

This report contains information relevant to the drilling and testing during construction of the wells, a brief description of the geologic and hydrologic conditions in the vicinity of the wells, analyses of the data from the pumping tests, and a discussion of the impacts of future withdrawals. Well-construction details, geologic and geophysical logs, and water-quality data also are included.

FINDINGS

1. Two wells were completed during this program. Well RO-2 was drilled first as the test-production well. Based on its success, the drilling contractor was directed

to proceed with Production Well RO-1. A third well was not drilled, at the option of Martin County.

2. The hydrogeology of the site consisted of approximately 170 feet of sandy surficial sediments overlying 500 feet of confining clays, which, overlie limestone. Within this limestone are highly permeable flow zones which comprise the Floridan aquifer. The Floridan aquifer at this site is confined or artesian, meaning that water levels in the aquifer are higher than the top of the aquifer. Under non-pumping conditions and without the influence of significant adjacent users, the wells flow water naturally at land surface.

3. Test-Production Well RO-2, completed in the depth interval from 965 and 1260 feet, produced water at a free-flow rate of 1500 gallons per minute (gpm). Static water level in this well in December 1990 was 29 feet above land surface, or approximately 44 feet above National Geodetic Vertical Datum (NGVD).

4. Production Well RO-1, completed in the depth interval from 1060 to 1289 feet, produced water at a free-flow rate of 1200 gpm.

5. Water produced from the wells has a chloride concentration of approximately 1200 milligrams per liter (mg/L), pH of 7.35 units, and a total dissolved solids concentration of 2400 mg/L.

6. Transmissivity of the upper Floridan aquifer at the site is approximately 450,000 gallons per day per foot (gpd/ft). The storage coefficient at the site is approximately 0.0004 and the leakance of the confining units to the aquifer is approximately 0.0085 gallons per day per cubic foot (gpd/cu ft). The major contribution of water due to leakage is from deeper flow zones within the aquifer.

7. Based on interpretations of the constant-rate pumping tests performed, withdrawals of 10 million gallons per day from the well field (pumping 2 wells

at 3500 gpm) will produce declines of approximately 2.5 feet in the producing zone at a distance of 2 miles from the well field.

WELL CONSTRUCTION

Meridith Corporation of Orlando, Florida began well construction on September 12, 1990. In order to honor well designations submitted on drawings in the permit application, the first well drilled was identified as Well RO-2. The second well drilled was identified at RO-1. For both wells, a similar construction procedure was followed:

a. A nominal 15-inch-diameter pilot hole was drilled by the mud-rotary method to 200 feet below land surface.

b. A nominal 40-inch-diameter hole then was reamed to the casing setting depth at 190 feet; 30-inch outside diameter steel outer casing then was installed and cemented in place.

c. A nominal 15-inch-diameter pilot hole then was drilled by the mud-rotary method to a depth determined by Geraghty & Miller to be suitable to install inner casing. For Well RO-1, this depth was 1104 feet; for RO-2, this depth was 1016 feet.

d. The pilot hole then was geophysically logged by Southern Resource Exploration (gamma, spontaneous potential, single-point resistance, fluid resistivity and caliper logs).

e. A nominal 25-inch-diameter hole then was reamed to the selected depth; 12-inch inside diameter Fiberglass-reinforced plastic (FRP) inner casing (top 140 feet is 16-inch inside diameter casing connected by a casing reducer) then was installed and cemented in place. For Well RO-1, this casing was set at a depth of 1063 feet; for Well RO-2, this depth was 967

feet. Temperature logs were conducted to confirm the top of each cement stage.

f. Plumbness and alignment tests then were conducted on the inner casing.

g. A nominal 12-inch-diameter borehole then was drilled below the casing using the reverse air-rotary method. For Well RO-1, the final total depth drilled was 1289 feet; for Well RO-2, this depth was 1260 feet. Figure 3 presents as-built diagrams of the completed wells.

h. The open-hole section then was geophysically logged (gamma ray, single point, spontaneous potential, fluid resistivity, flow meter, caliper and fluid velocity logs).

i. The open-hole section then was developed for a period of 40 hours, by surging and pumping.

j. A 4-hour step-rate pumping test was conducted on each well.

k. A 24-hour constant-rate pumping test was conducted on each well.

HYDROGEOLOGIC CONDITIONS

GEOLOGIC CONDITIONS

According to Land, Rodis and Schneider (1973), south Florida is underlain by metamorphic and igneous basement rocks covered by approximately 15,000 feet of marine sediments. Interest in this report is focused on the upper portion of the Floridan aquifer which yields brackish water in this area. The Floridan aquifer is overlain by confining beds of the Miocene-aged Hawthorn Formation, which is in turn

overlain by the Miocene, Pliocene, and Pleistocene-aged sediments of the surficial aquifer.

From land surface to a depth of approximately 170 feet, the sediments are comprised of sandstone, limestone, and clay with varying amounts of unconsolidated shell and sand. The sandstone is generally light gray to dark gray and is comprised of quartz and phosphatic minerals. This material is fine- to medium-grained and poorly- to well-cemented with small shell fragments. These sediments are Pleistocene in age and correspond to descriptions of the Pamlico Sand and Anastasia Formation in Martin County (Lovejoy, 1987).

In the interval between 170 feet and 650 feet, the sediment is predominantly composed of an olive-gray, plastic clay with various (usually small) amounts of sand and shell. Marl, which is a carbonate mud, predominates from 650 feet to about 760 feet. At this location, the marl occurs as a light olive-gray, soft, plastic sediment with some quartz and phosphatic sands. Below 760 feet, the marl decreases in volume and is interbedded with layers of moderately well-cemented limestone and shell. These formations correspond to descriptions of the Hawthorn Formation and possibly the older Suwannee Limestone.

Between 760 feet and about 1260 feet, the limestone consists of a fossiliferous, white to very pale orange limestone (in the lower part) which contains numerous, sometimes large, foraminifera. The formation corresponds to descriptions of the Ocala Limestone. The strata is soft to moderately hard, and poorly to moderately cemented. Occasional lenses of sand, shell, phosphate and chalk are also present. Porosity within the limestone appears to be intergranular and vugular. Geologic logs from Wells RO-1 and RO-2 are presented in Appendix A. Figure 4 presents a hydrostratigraphic cross section including the Floridan aquifer wells and the previously constructed injection well at the water plant.

BOREHOLE GEOPHYSICS

The changes in the character of the rock within the open portion of the borehole were too subtle for obvious identification by field examination and description of the cuttings. However, several of the geophysical surveys run on Wells RO-1, and RO-2 did show changes in the character of the rock that could be correlated. Gamma-ray log correlations indicate that rock units composing the Floridan aquifer in Well RO-2 are found approximately twenty feet lower in Well RO-1, revealing a southeasterly dip component of the strata. Examination of the resistivity logs indicates that at depths of approximately 1100 feet, electrical resistance increases. This appears to be a reflection of the strata becoming moderately hard and well cemented. Geophysical logs are found in Appendix B.

HYDROLOGIC CONDITIONS

The Floridan aquifer is confined by the overlying Hawthorn Formation. The aquifer itself consists of stratified layers of more or less permeable limestones. It has been described as consisting of an upper Floridan and a lower Floridan unit, separated by intra-aquifer confining beds. This gives the aquifer somewhat of a leaky confined character, wherein withdrawals from the upper Floridan aquifer are replenished by upward leakage from the lower Floridan aquifer through the intra-aquifer confining beds.

The water level in Well RO-2 had a measured static head of 29.2 feet above ground level (approximately 44.2 feet above NGVD) on November 14, 1990. Well RO-1, located 1300 feet to the southeast had a measured water level of 28.6 feet above ground level (approximately 43.6 feet above NGVD) on February 11, 1991.

The flow of waters in the Floridan aquifer is not uniformly distributed throughout its thickness, but usually occurs as "flow zones". Analysis of the drilling logs and flow meter logs indicates that the main producing interval within Wells RO-1 and RO-2 is

found at depths between 1130 and 1260 feet. Within this interval, the aquifer is composed of pale orange to light-gray colored, moderately hard, vuggy limestone.

WATER QUALITY

During the drilling (reverse-air rotary), development, and testing of the pilot holes of Wells RO-1 and RO-2, the specific conductance and chloride concentration of water samples were monitored. Table 1 presents a summary of the data collected. The specific conductance and chloride concentration of the water produced from completed Well RO-1 was 3820 micromhos per centimeter (umhos/cm) and 1210 milligrams per liter (mg/L), respectively. The specific conductance and chloride concentration of the water produced from completed Well RO-2 was 4200 umhos/cm and 1273 mg/L, respectively. A detailed analysis of the water produced from Well RO-2 is contained in Appendix C. This analysis includes all primary and secondary drinking water standards.

Sand content testing also was performed during the development and testing of Wells RO-1 and RO-2. This was performed by collecting discharge water samples in 5-gallon buckets and allowing solids to settle to the bottom. The water then was poured off and the solids were collected and analyzed for weight and composition. Analysis of the samples at the end of the final pumping test from each well indicated that sand content was less than one part per million as a weight fraction. The sand grains that were present were comprised almost 70 percent of carbonate grains and 30 percent quartz grains.

PUMPING TESTS

STEP-RATE TESTS

Upon completion of development, a step-rate test was conducted. Step-rate tests are used to anticipate performance of a well during a constant-rate test, as a

"shakedown" test of the facilities and equipment to be utilized in a constant-rate test, and to aid in predicting future well performance. In step-rate tests, the wells are pumped for some period of time at a constant rate as water levels are measured in the pumped well. At the end of each pumping step, the water level is allowed to recover for at least the same length of time as the pumping period. Then, the pumping rate is changed and the process repeated for another constant rate. The duration of each pumping phase remained the same as for the first step.

Step-rate test data are summarized in Table 2. Pumping and recovery periods were each one-half hour. As can be seen, specific capacity generally declines with increased pumping rate. This is caused by higher frictional losses related to higher formation, entrance, and borehole velocities of water. From the test data, a predictive equation can be developed by linear regression analysis to estimate the self-induced drawdown resulting from pumping each production well at any given rate for the same pumping period as was used in the step-rate test. Table 3 presents the equations developed from the step-rate test results.

CONSTANT-RATE TESTS

Well RO-1

A constant-rate pumping test was conducted on Well RO-1 on February 13, 1991. The well was pumped for a period of 24 hours at a rate of 2060 gpm. Pre-pumping and post-pumping water levels in the well were monitored for 24 hours also. Water levels were recorded with a data logger equipped with pressure transducers and backed up with hand measurements using an electric probe. During this pumping test, Well RO-2, located 1350 feet away, was used as an observation well.

During this test, the water level in Well RO-2 showed a steady decline throughout the test when plotted against the logarithm of time. At the end of the 24-hour pumping period, the water level had declined approximately 1.9 feet. The recovery

of water levels in the well also were monitored. After six and one-half hours, the water level had recovered to its pre-pumping (original) level.

Well RO-2

A constant-rate pumping test was conducted on Well RO-2 on February 20, 1991. For this test, the well was pumped at a rate of 2140 gpm for 24 hours and Well RO-1, located 1350 feet away, was used as an observation well. Pre-pumping and post-pumping water levels again were monitored for 24 hours.

During this test, the water level in Well RO-1 showed a steady decline throughout the test when plotted against the logarithm of time. At the end of the 24-hour pumping period, the water level had declined 1.8 feet. After pumping, the water level recovered to within 0.2 feet of its pre-pumping level after six hours.

The data developed during testing, including constant-rate pumping, recovery of water levels in wells, and step-rate tests which assessed aquifer respond to pumping at several levels of stress, were plotted and analyzed. Based on the results of all the tests, the best estimate for values of transmissivity, storage coefficient, and leakance were determined. Values for the aquifer coefficients are presented in Table 4.

PREDICTION OF FUTURE PUMPING LEVELS

Predictions of future pumping levels are important in order to assure that wells produce at their optimum efficiency during periods when they are critically needed. Typically, predictions of pumping levels can be made by cautious application of aquifer coefficients derived from analysis of constant-rate pumping tests, and the performance of individual pumped wells. This information may be applied in an analytical model or computer model.

Conservative averages of the aquifer coefficients derived from the pumping tests were input into an analytical model that simulates steady-state, leaky artesian conditions. Leakage results primarily from the upward movement of water from deeper permeable zones within the Floridan aquifer. A transmissivity value of 450,000 gpd/ft and a leakance value of 0.0085 gpd/cu ft were employed in the model. Withdrawal was simulated from two wells, producing a cumulative total of 1.7 million gallons per day (600 gpm each), which is Martin County's currently permitted average daily withdrawal from the Floridan aquifer. Results of the model are presented in Figure 5.

The modelling results indicate that average daily withdrawals from the Floridan aquifer at the Martin County Water Treatment Plant site will not impact the nearest permitted user (the River Club, located 2.25 miles to the southeast) by more than 10 percent. Given the relatively high transmissivities of the aquifer in the vicinity of the site, additional modelling has indicated withdrawals of approximately 10 million gallons per day may be made before the nearest permitted user becomes impacted. Of course, the County probably would wish to install additional wells to obtain such a large capacity, since the current wells were not designed to produce such high flows.

REFERENCES

Land, L.F., Rodis, H.G., and Schneider, J.J. 1973. Appraisal of the Water Resources of Eastern Palm Beach County, Florida. Florida Bureau of Geology Report of Investigations No. 67.

Lovejoy, D.W. 1987. The Anastasia Formation in Palm Beach and Martin Counties, Florida. Symposium on South Florida Geology, Miami Geological Society Memoir 3.

TABLE 1. Floridan Water Quality and Quantity Produced During Drilling and Testing of Wells RO-1 and RO-2

Date	Well #	Depth	Flow Rate (gpm)	Chlorides (mg/L)	Conductivity (umhos/cm)
10/30/90	RO-2	1016	120	3200	4350*
10/31/90	RO-2	1047	200	4242	4600*
10/31/90	RO-2	1108	400	4242	4200*
11/1/90	RO-2	1139	500	3300	4400*
11/1/90	RO-2	1160	650	3060	4200*
11/1/90	RO-2	1200	800	3060	4000*
11/5/90	RO-2	1230	1000	2100	3000*
11/5/90	RO-2	1260	1100	2000	2900**
11/6/90	RO-2	1260	1600	1450	3400**
11/7/90	RO-2	1260	1600	1400	3700**
11/9/90	RO-2	1260	2450	1215	2900**
11/12/90	RO-2	1260	2560	1150	2800**
11/13/90	RO-2	1260	2540	1090	2500**
11/14/90	RO-2	1260	NMF	1180	2950[T]
1/29/91	RO-1	1105	175	2500	NR*
1/30/91	RO-1	1197	370	1606	5800*
1/30/91	RO-1	1259	1100	1182	4250*
2/1/91	RO-1	1289	1150	1000	3350*
2/1/91	RO-1	1289	1500	1030	3680*
2/5/91	RO-1	1289	1200	1200	3100**
2/6/91	RO-1	1289	3000	1500	3800**
2/7/91	RO-1	1289	3000	1121	3200**
2/11/91	RO-1	1289	NMF	NR	NR[T]
2/13/91	RO-1	1289	2130	1210	3820[T]
2/20/91	RO-2	1260	2100	1273	4200[T]

Notes: NMF signifies "no meaningful figures"

NR signifies "not recorded"

* denotes data collected while drilling open hole

** denotes data collected during logging and development

[T] denotes data collected during step-rate tests and constant-rate tests

TABLE 2. Summary of Step-Rate Tests for Wells RO-1 and RO-2

Well	Step	Rate (gpm)	Static (dtw)	Pumping (dtw)	Drawdown (feet)	Specific Capacity
RO-1	1	1400	+28.6	+7.9	20.7	67.6
RO-1	2	1850	+28.6	+0.6	28.0	64.7
RO-1	3	2020	+28.3	-8.9	37.2	53.8
RO-1	4	2200	+28.3	-17.1	45.4	48.1
RO-2	1	1780	+29.2	+7.8	21.4	83.0
RO-2	2	2045	+29.1	+0.6	28.5	71.7
RO-2	3	2240	+28.9	-2.0	30.9	72.6
RO-2	4	2440	+28.9	-5.8	34.7	70.4

Notes: dtw signified "depth to water", in feet, above (+) or below (-) land surface.

Pumping and recovery steps were 30 minutes each.

Specific Capacity computed using initial static water level.

Specific Capacity expressed as gallons per minute per foot of drawdown.

TABLE 3. Predictive Drawdown Equations

Well Tested	Formula to Predict Drawdown	Predicted for Time (minutes)	Correlation Coefficient
RO-1	$s=0.146Q+2.234\text{-}29Q^{(0.66523)}$	30	0.93
RO-2	$s=0.004Q+2.60734\text{-}5Q^{(1.77065)}$	30	0.89

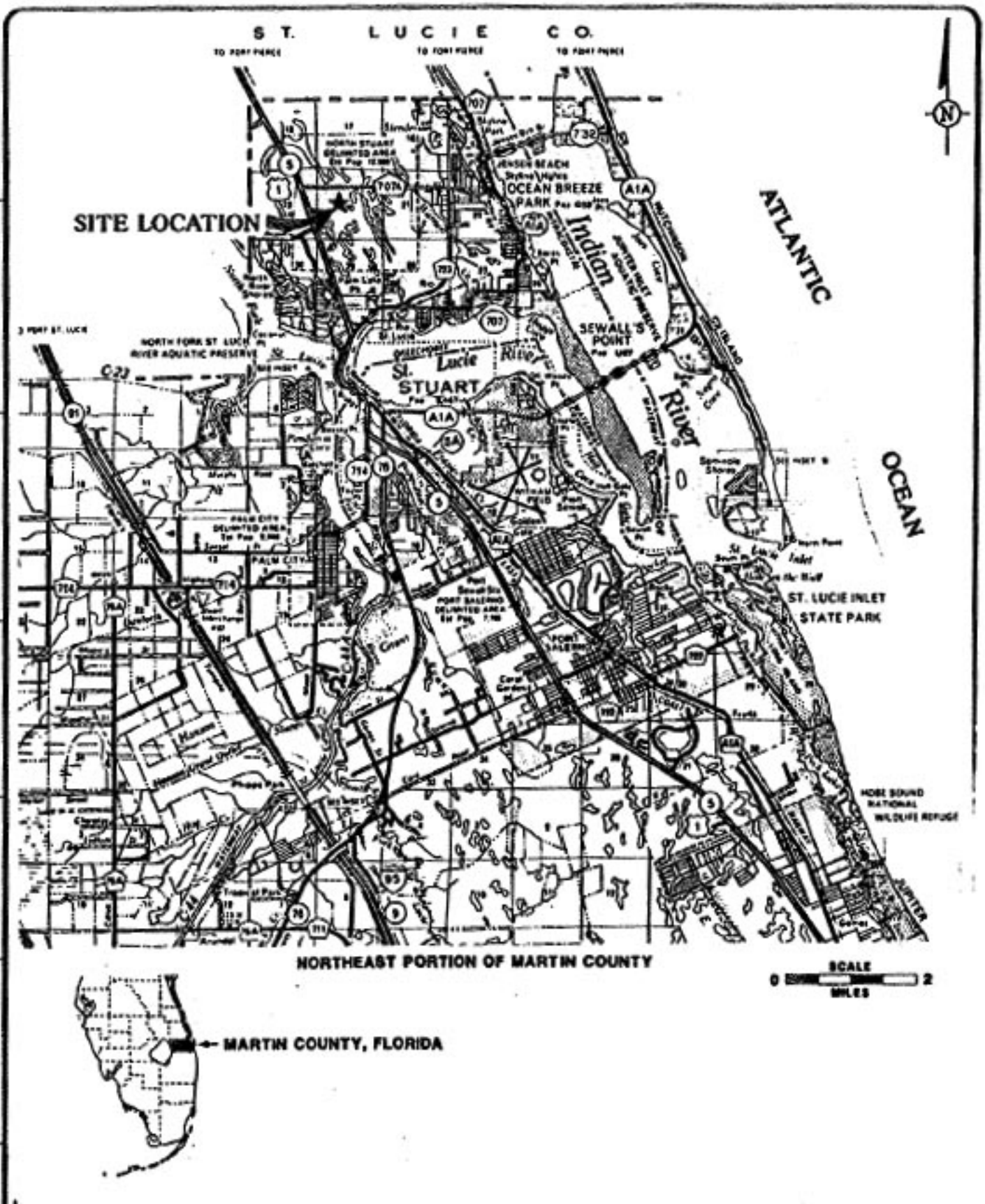
Notes: s = Drawdown in feet

Q = Discharge rate in gallons per minute

Reference: Rorabaugh (1954)

TABLE 4. Aquifer Coefficients, Floridan Aquifer

Well	Transmissivity (gpd/ft)		Storage Coefficient (dimensionless)		Leakance (gpd/cu ft)	
	Hantush (1956)	Walton (1960)	Hantush (1956)	Walton (1956)	Hantush (1956)	Walton (1960)
RO-1	445,370	428,689	0.00039	0.00036	0.0093	0.0094
RO-2	534,087	613,110	0.00044	0.00036	0.0076	0.0034



DRAFTED: S. CLIFFS | APPROVED: R. VERRASTRO | CHECKED: R. VERRASTRO | DRAWING: N/A | FILE NO.: HUTCHEON | PROJECT NO.: FP21388 | DWG DATE: 10/26/91

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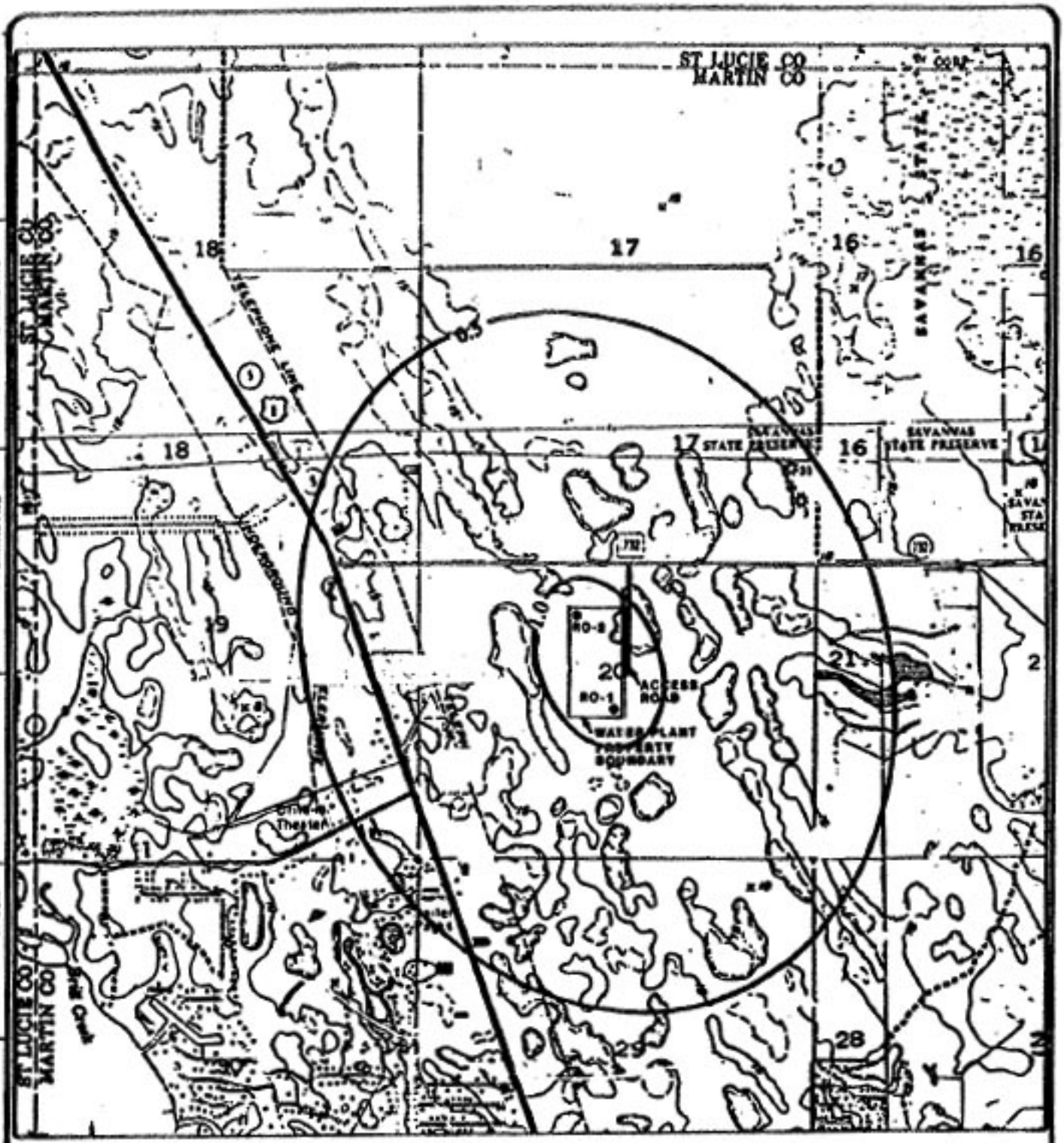
SITE LOCATION MAP

HUTCHEON ENGINEERS
N. MARTIN COUNTY WATER SYSTEM

FIGURE
1



MODELLED PARAMETERS

TRANSMISSIVITY = 450,000 gpd/ft

LEAKANCE = 0.0085 gpd/ft³

LEGEND

● FLORIDAN AQUIFER SUPPLY WELL

1.0 DRAWDOWN IN FEET

GERAGHTY & MILLER, INC.
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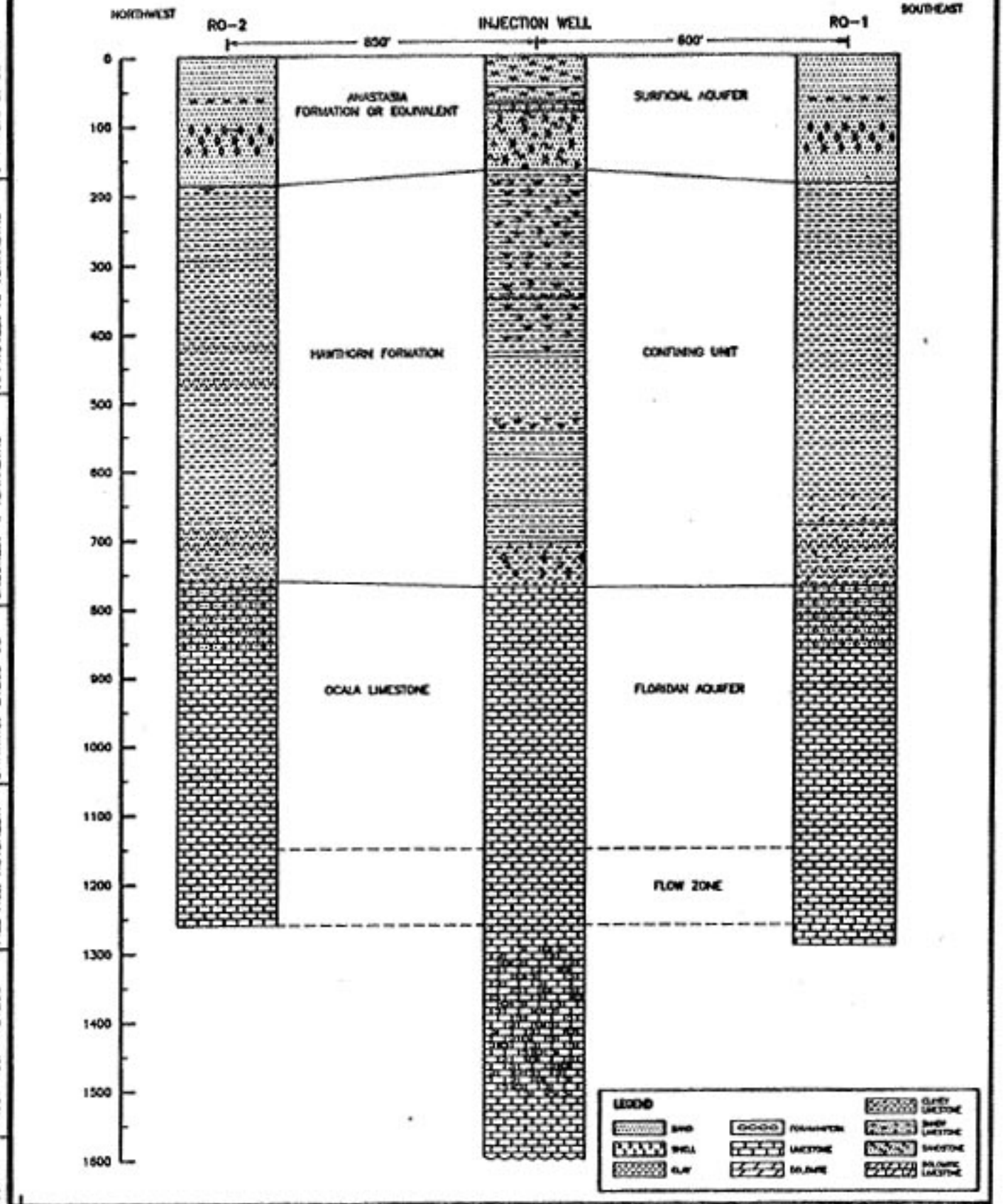
IMPACT OF 1.7 MGD FLORIDAN AQUIFER WITHDRAWAL

HUTCHEON ENGINEERS
N. MARTIN COUNTY WATER SYSTEM

FIGURE
5



DRAFTER: B. OLIVA | APPROVED: R. VERRASTRO | CHECKED: R. VERRASTRO | DRAWING: 21205-GC | FILE NO.: HUTCHEON | PROJECT NO.: PT21205 | DWG DATE: 30DEC91

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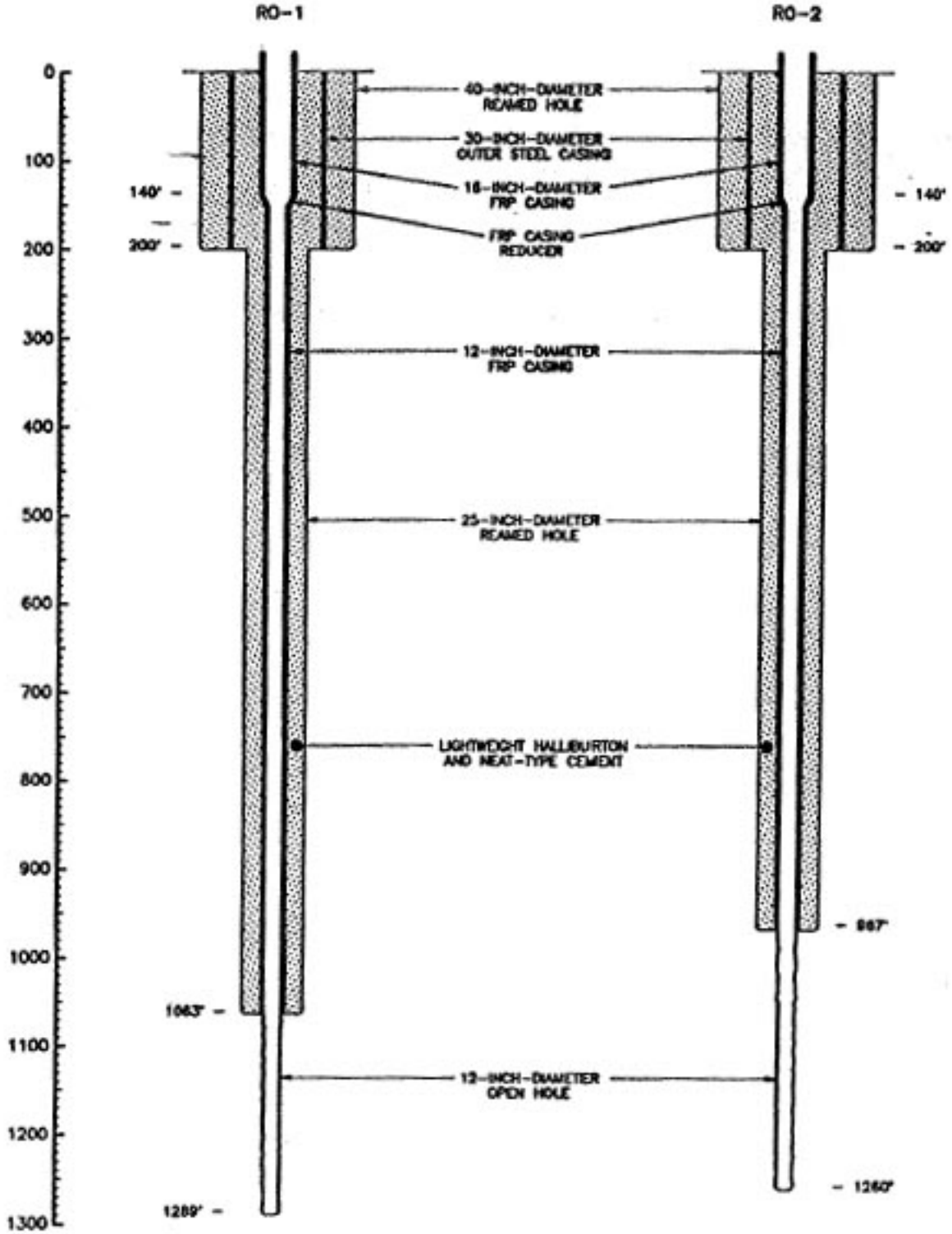
HYDRO-STRATIGRAPHIC CROSS SECTION

HUTCHEON ENGINEERS
N. MARTIN COUNTY WATER SYSTEM

FIGURE
4



DRAFTER: B. OLIVA | APPROVED: R. VERRASTRO | CHECKED: R. VERRASTRO | DRAWING: 21205-RD | FILE NO.: HUTCHEON | PROJECT NO.: P721205 | DWG DATE: 3000C91

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AS-BUILT CONSTRUCTION DIAGRAM
RO-1 AND RO-2

HUTCHEON ENGINEERS
N. MARTIN COUNTY WATER SYSTEM

FIGURE
3

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407-1241 · (407) 842-2849

HUTCHEON ENGINEERS
4431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-01D
Report Date: 12/19/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
FAC 17-550 SECONDARY INORGANICS

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of McGinnes Laboratories.

Param ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
1016	Calcium, Ca	01D	93	mg/L	EPA 215.1	1	11/28/90	RAC
1017	Chloride, Cl-	01D	1,210	mg/L	EPA 325.3	200	11/23/90	CAP
1022	Total Copper, Cu	01D	<0.01	mg/L	EPA 220.2	0.01	11/26/90	RAC
1025	Fluoride, F-	01D	0.92	mg/L	EPA 340.2	0.05	11/28/90	CAP
1028	Total Iron, Fe	01D	0.05	mg/L	EPA 236.1	0.01	11/30/90	RAC
1032	Total Manganese, Mn	01D	<0.005	mg/L	EPA 243.1	0.005	12/04/90	RAC
1055	Sulfate, SO4	01D	150	mg/L	EPA 375.4	20	11/27/90	DLO
1095	Total Zinc, Zn	01D	0.030	mg/L	EPA 289.1	0.005	11/26/90	RAC
1901	Carbon Dioxide(nomograph)	01D	11.0	mg/L	CALC.	0.5	12/03/90	TPC
1905	Color, APHA	01D	33	units	EPA 110.2	1	11/20/90	JYA
1920	Total Odor Number	01D	1,535	T.O.N.	EPA 140.1	1	11/20/90	JYA
1924	pH	01D	7.35	units	SW 9040	---	11/20/90	KRS
1926	Conductivity (field)	01D	3,820	umhos/cm	EPA 120.1	10	11/20/90	KRS
1927	Total Alkalinity, CaCO3	01D	158	mg/L	EPA 310.1	4	11/20/90	CAP
1930	Total Dissolved Solids	01D	2,420	mg/L	EPA 160.1	1	11/23/90	JYA
1996	Temperature	01D	25.2	deg. C	EPA 170.1	---	11/20/90	KRS
1997	pHs	01D	7.31	units	CALC	---	12/07/90	TPC
2909	Foaming Agents, MBAS	01D	0.06	mg/L	EPA 425.1	0.02	11/21/90	TPC
9996	Dissolved Oxygen, O2	01D	3.1	mg/L	EPA 360.1	0.1	11/20/90	KRS
	Corrosivity, L.I.	01D	0.04	L.I.	CALC.	---	12/07/90	TPC
	Calcium Hardness, CaCO3	01D	233	mg/L	CALC	3	11/28/90	RAC

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #872320. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

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HUTCHEON ENGINEERS
4431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-01G
Report Date: 12/18/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
Comment: Analysis for Total Organic Carbon was performed by PPB Laboratories, DHRS #82282.

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of McGinnes Laboratories.

Parm ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
	Hydrogen Sulfide, H2S	01G	0.33	mg/L	EPA 376.1	0.05	11/20/90	GJP
	Total Potassium, K	01G	26.5	mg/L	EPA 258.1	0.6	11/28/90	RAC
	Ammonia Nitrogen, N	01G	0.6	mg/L	EPA 350.2	0.1	11/26/90	JYH
	Total Silica, Si	01G	14.8	mg/L	SM 425C	0.1	12/05/90	G.L.
	Total Strontium, Sr	01G	< 0.5	mg/L	SM 303A	0.5	12/04/90	RAC
	Total Organic Carbon, C	01G	2.5	mg/L	EPA 415.1	2.0	11/26/90	PPB

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #872320. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

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4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 (407) 842-2849

HUTCHEON ENGINEERS
4431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-01E
Report Date: 12/18/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
Comment: All radiological analyses conducted by Penbroke Laboratories, DHRS #84172.

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of McGinnes Laboratories.

Param ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
4000	Gross Alpha	01E	4.+-17	pCi/L	EPA 900	1.0	11/25/90	P.L.
4020	Radium 226	01E	3.7+-2	pCi/L	EPA 903.1	0.1	12/14/90	P.L.
4030	Radium 228	01E	.1+-.3	pCi/L	EPA 904.1	0.1	12/14/90	P.L.

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #87232G. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Penbroke Laboratories
Analyst

Thomas Colgan
Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE WEST PALM BEACH, FLORIDA 33407-1241 (407) 842-2849

HUTCHEON ENGINEERS
6431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-01C
Report Date: 12/18/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
FAC 17-550 PRIMARY INORGANICS -
SODIUM & TURBIDITY ONLY

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of
McGinnes Laboratories.

Param ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
0100	Turbidity	01C	20	N.T.U.	EPA 180.1	2	11/20/90	GJP
1052	Sodium, Na	01C	467	mg/L	EPA 273.1	3	11/28/90	RAC

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #87232G. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4188 WESTROADS DRIVE WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

HUTCHEON ENGINEERS
4431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-018
Report Date: 12/18/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
FAC 17-550 PRIMARY ORGANICS
Comment: Primary Organics analyzed by ABC Research Laboratory, DHRS #82135.

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of McGinnes Laboratories.

Param ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
2005	Endrin	018	<.0002	mg/L	SM 509A	0.0002	12/04/90	ABC
2010	Lindane	018	<.0002	mg/L	SM 509A	0.0002	12/04/90	ABC
2015	Methoxychlor	018	<0.001	mg/L	SM 509A	0.001	12/04/90	ABC
2020	Toxaphene	018	<0.005	mg/L	SM 509A	0.005	12/04/90	ABC
2105	2,4-D	018	<0.001	mg/L	EPA 515	0.001	12/12/90	ABC
2110	2,4,5-TP (Silvex)	018	<0.001	mg/L	EPA 515	0.001	12/12/90	ABC

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #87232G. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

ABC Research Laboratory
Analyst

Thomas Colgan
Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE WEST PALM BEACH, FLORIDA 33407-1241 (407) 842-2849

HUTCHEON ENGINEERS
4431 EMBARCADERO DRIVE
WEST PALM BEACH, FL 33407

9011273-01A
Report Date: 12/18/90

Attn: GLEN MILLER

Project ID: JENSEN BEACH WATER PLANT
Sample ID: NEW R.O. WELL
FAC 17-550 PRIMARY INORGANICS

Date Received: 11/20/90
Date Collected: 11/20/90 12:15:00

Water samples collected by K. Stewart of McGinnes Laboratories.

Param ID#	Test Name	Sample Number	Result	Units	Method	Detection Limit	Date Started	Analyst
1005	Total Arsenic, As	01A	<0.002	mg/L	EPA 206.2	0.002	12/03/90	NRW
1010	Total Barium, Ba	01A	0.03	mg/L	EPA 208.2	0.02	11/30/90	NRW
1015	Total Cadmium, Cd	01A	<0.005	mg/L	EPA 213.2	0.005	11/26/90	RAC
1020	Total Chromium, Cr	01A	<0.005	mg/L	EPA 218.2	0.005	11/30/90	NRW
1025	Fluoride, F-	01A	0.92	mg/L	EPA 340.2	0.05	11/28/90	CAP
1030	Total Lead, Pb	01A	<0.002	mg/L	EPA 239.2	0.002	12/03/90	NRW
1035	Total Mercury, Hg	01A	<0.001	mg/L	EPA 245.1	0.001	11/28/90	RAC
1040	Nitrate, N	01A	< 0.1	mg/L	EPA 352.1	0.1	11/26/90	LJJ
1045	Total Selenium, Se	01A	<0.005	mg/L	EPA 270.2	0.005	12/03/90	NRW
1050	Total Silver, Ag	01A	<0.01	mg/L	EPA 272.1	0.01	11/29/90	RAC

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #87232G. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Thomas Colgan
Project Manager
DHRS Laboratory ID Nos.86140/EB6070

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE WEST PALM BEACH, FLORIDA 33407-1241 (407) 842-2849

Client: HUTCHEON ENGINEERS
4431 Embarcadero Drive
West Palm Beach, FL 33407

December 18,1990

Sample: Sample was taken by Kathy Stewart of McGinnes Laboratories on 11/20/90. Received in the lab on 11/20/90.

Project: REVERSE OSMOSIS WELL #2 Job No. 90-11-273-01F

Analysis: FAC 17-550 VOLATILE and UNREGULATED ORGANIC CONTAMINANTS

PARAM ID	PARAMETER	SAMPLE NUMBER	RESULT, mg/L	EPA METHOD	DL	DATE/TECH
2946	Ethylene Dibromide	01F	<0.00001	504	0.00001	12/11 HLW
2969	Para-dichlorobenzene	01F	<0.00005	524	0.00005	11/30 HLW
2976	Vinyl Chloride	01F	<0.0005	524	0.0005	11/30 HLW
2977	1,1-dichloroethene	01F	<0.001	524	0.001	11/30 HLW
2980	1,2-dichloroethane	01F	<0.00005	524	0.00005	11/30 HLW
2981	1,1,1-trichloroethane	01F	<0.00005	524	0.00005	11/30 HLW
2982	Carbon Tetrachloride	01F	<0.00005	524	0.00005	11/30 HLW
2984	Trichloroethene	01F	<0.00005	524	0.00005	11/30 HLW
2987	Tetrachloroethene	01F	<0.00005	524	0.00005	11/30 HLW
2990	Benzene	01F	<0.0002	524	0.0002	11/30 HLW
PURGEABLES						
2210	Chloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2212	Dichlorodifluoromethane	01F	<0.0001	524	0.0001	11/30 HLW
2214	Bromomethane	01F	<0.0005	524	0.0005	11/30 HLW
2216	Chloroethane	01F	<0.0005	524	0.0005	11/30 HLW
2218	Trichlorofluoromethane	01F	<0.0001	524	0.0001	11/30 HLW
2224	Trans-1-3-dichloropropene	01F	<0.0001	524	0.0001	11/30 HLW
2228	Cis-1,3-dichloropropene	01F	<0.0005	524	0.0005	11/30 HLW
2251	Methyl-tert-butyl-ether	01F	<0.001	524	0.001	11/30 HLW
2380	Cis-1,2-dichloroethene	01F	<0.0005	524	0.0005	11/30 HLW
2408	Dibromomethane	01F	<0.0005	524	0.0005	11/30 HLW
2410	1,1-dichloropropene	01F	<0.0005	524	0.0005	11/30 HLW
2412	1,3-dichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2414	1,2,3-trichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2416	2,2-dichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2931	1,2-dibromo3-chloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2941	Chloroform	01F	<0.0005	524	0.0005	11/30 HLW
2942	Bromoform	01F	<0.0005	524	0.0005	11/30 HLW
2943	Bromodichloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2944	Dibromochloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2962	p-Xylene	01F	<0.0002	524	0.0002	11/30 HLW
2964	Methylene Chloride	01F	<0.0005	524	0.0005	11/30 HLW
2965	o-chlorotoluene	01F	<0.001	524	0.001	11/30 HLW

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE WEST PALM BEACH, FLORIDA 33407-1241 (407) 842-2849

Client: HUTCHEON ENGINEERS
4431 Embarcadero Drive
West Palm Beach, FL 33407

December 18,1990

Sample: Sample was taken by Kathy Stewart of McGinnes Laboratories on 11/20/90. Received in the lab on 11/20/90.

Project: REVERSE OSMOSIS WELL #2 Job No. 90-11-273-01F

Analysis: FAC 17-550 VOLATILE and UNREGULATED ORGANIC CONTAMINANTS

PARAM ID	PARAMETER	SAMPLE NUMBER	RESULT, mg/L	EPA METHOD	DL	DATE/TECH
2946	Ethylene Dibromide	01F	<0.00001	504	0.00001	12/11 HLW
2969	Para-dichlorobenzene	01F	<0.00005	524	0.00005	11/30 HLW
2976	Vinyl Chloride	01F	<0.0005	524	0.0005	11/30 HLW
2977	1,1-dichloroethene	01F	<0.001	524	0.001	11/30 HLW
2980	1,2-dichloroethane	01F	<0.00005	524	0.00005	11/30 HLW
2981	1,1,1-trichloroethane	01F	<0.00005	524	0.00005	11/30 HLW
2982	Carbon Tetrachloride	01F	<0.00005	524	0.00005	11/30 HLW
2984	Trichloroethene	01F	<0.00005	524	0.00005	11/30 HLW
2987	Tetrachloroethene	01F	<0.00005	524	0.00005	11/30 HLW
2990	Benzene	01F	<0.0002	524	0.0002	11/30 HLW
PURGEABLES						
2210	Chloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2212	Dichlorodifluoromethane	01F	<0.0001	524	0.0001	11/30 HLW
2214	Bromomethane	01F	<0.0005	524	0.0005	11/30 HLW
2216	Chloroethane	01F	<0.0005	524	0.0005	11/30 HLW
2218	Trichlorofluoromethane	01F	<0.0001	524	0.0001	11/30 HLW
2224	Trans-1-3-dichloropropene	01F	<0.0001	524	0.0001	11/30 HLW
2228	Cis-1,3-dichloropropene	01F	<0.0005	524	0.0005	11/30 HLW
2251	Methyl-tert-butyl-ether	01F	<0.001	524	0.001	11/30 HLW
2380	Cis-1,2-dichloroethene	01F	<0.0005	524	0.0005	11/30 HLW
2408	Dibromomethane	01F	<0.0005	524	0.0005	11/30 HLW
2410	1,1-dichloropropene	01F	<0.0005	524	0.0005	11/30 HLW
2412	1,3-dichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2414	1,2,3-trichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2416	2,2-dichloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2931	1,2-dibromo3-chloropropane	01F	<0.0005	524	0.0005	11/30 HLW
2941	Chloroform	01F	<0.0005	524	0.0005	11/30 HLW
2942	Bromoform	01F	<0.0005	524	0.0005	11/30 HLW
2943	Bromodichloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2944	Dibromochloromethane	01F	<0.0005	524	0.0005	11/30 HLW
2962	p-Xylene	01F	<0.0002	524	0.0002	11/30 HLW
2964	Methylene Chloride	01F	<0.0005	524	0.0005	11/30 HLW
2965	o-chlorotoluene	01F	<0.001	524	0.001	11/30 HLW

Client: HUTCHEON ENGINEERS
4431 Embarcadero Drive
West Palm Beach, FL 33407

Project: REVERSE OSMOSIS WELL #2 Job No. 90-11-273-01

PARAM ID	PARAMETER	SAMPLE NUMBER	RESULT, mg/L	EPA METHOD	DL	DATE/TEC
2966	p-chlorotoluene	01F	<0.001	524	0.001	11/30 HL
2967	m-dichlorobenzene	01F	<0.010	524	0.010	11/30 HL
2968	0-dichlorobenzene	01F	<0.010	524	0.010	11/30 HL
2978	1,1-dichloroethane	01F	<0.0005	524	0.0005	11/30 HL
2979	trans-1,2-dichloroethylene	01F	<0.0005	524	0.0005	11/30 HL
2983	1,2-Dichloropropane	01F	<0.0005	524	0.0005	11/30 HL
2985	1,1,2-trichloroethane	01F	<0.0005	524	0.0005	11/30 HL
2986	1,1,1,2-tetrachloroethane	01F	<0.0005	524	0.0005	11/30 HL
2988	1,1,2,2,-tetrachloroethane	01F	<0.0005	524	0.0005	11/30 HL
2989	Chlorobenzene	01F	<0.0005	524	0.0005	11/30 HL
2991	Toluene	01F	<0.0002	524	0.0002	11/30 HL
2992	Ethylbenzene	01F	<0.0005	524	0.0005	11/30 HL
2993	Bromobenzene	01F	<0.0005	524	0.0005	11/30 HL
2995	m-Xylene	01F	<0.0002	524	0.0002	11/30 HL
2996	Styrene	01F	<0.010	524	0.010	11/30 HL
2997	0-Xylene	01F	<0.0002	524	0.0002	11/30 HL
PESTICIDES						
2031	Dalapon	01F	<0.05	515	0.05	12/12 ABC
2036	Oxamyl	01F	<0.020	531	0.020	12/12 ABC
2037	Simazine	01F	<0.01	505	0.01	12/04 ABC
2040	Pichloram	01F	<0.05	515	0.05	12/12 ABC
2041	Dinoseb	01F	<0.05	515	0.05	12/12 ABC
2043	Aldicarb sulfoxide	01F	<0.020	531	0.020	12/12 ABC
2044	Aldicarb sulfone	01F	<0.020	531	0.020	12/12 ABC
2045	Metolachlor	01F	<0.001	505	0.001	12/04 ABC
2046	Carbofuran	01F	<0.020	531	0.020	12/12 ABC
2047	Aldicarb	01F	<0.020	531	0.020	12/12 ABC
2050	Atrazine	01F	<0.020	505	0.020	12/04 ABC
2051	Alachlor	01F	<0.001	505	0.001	12/04 ABC
2065	Heptachlor	01F	<0.0001	505	0.0001	12/04 ABC
2356	Aldrin	01F	<0.0001	505	0.0001	12/04 ABC
2364	Dieldrin	01F	<0.0001	505	0.0001	12/04 ABC
2440	Dicamba	01F	<0.05	515	0.05	12/12 ABC
2959	Chlordane	01F	<0.001	505	0.001	12/04 ABC
2326	Pentachlorophenol	01F	<0.05	515	0.05	12/12 ABC

Client: HUTCHEON ENGINEERS
4431 Embarcadero Drive
West Palm Beach, FL 33407

Project: REVERSE OSMOSIS WELL #2 Job No. 90-11-273-01F

PARAM ID	PARAMETER	SAMPLE NUMBER	RESULT, mg/L	EPA METHOD	DL	DATE/TECH
BASE NEUTRAL EXTRACTABLES						
2042	Hexachlorocyclopentadiene	01F	<0.010	625	0.010	12/04 JWH
2063	Dioxin (scan)	01F	ND	625	----	12/04 JWH
2262	Isophorone	01F	<0.010	625	0.010	12/04 JWH
2270	2,4-Dinitrotoluene	01F	<0.010	625	0.010	12/04 JWH
2282	Dimethylphthalate	01F	<0.010	625	0.010	12/04 JWH
2284	Diethylphthalate	01F	<0.010	625	0.010	12/04 JWH
2290	Di-n-butylphthalate	01F	<0.010	625	0.010	12/04 JWH
2294	Butyl benzyl phthalate	01F	<0.010	625	0.010	12/04 JWH
2298	Bis(2-ethylhexyl)-phthalate	01F	<0.010	625	0.010	12/04 JWH
2378	1,2,4-trichlorobenzene	01F	<0.010	625	0.010	12/04 JWH
2388	PCB-1016	01F	<0.010	625	0.010	12/04 JWH
2390	PCB-1221	01F	<0.010	625	0.010	12/04 JWH
2392	PCB-1232	01F	<0.010	625	0.010	12/04 JWH
2394	PCB-1242	01F	<0.010	625	0.010	12/04 JWH
2396	PCB-1248	01F	<0.010	625	0.010	12/04 JWH
2398	PCB-1254	01F	<0.010	625	0.010	12/04 JWH
2400	PCB-1260	01F	<0.010	625	0.010	12/04 JWH
9089	Dioctylphthalate	01F	<0.010	625	0.010	12/04 JWH
ACID EXTRACTABLES						
9108	2-Chlorophenol	01F	<0.010	625	0.010	12/04 JWH
9112	2-methyl-4,6-dinitro-phenol	01F	<0.010	625	0.010	12/04 JWH
9115	Phenol	01F	<0.010	625	0.010	12/04 JWH
9116	2,4,6-trichlorophenol	01F	<0.010	625	0.010	12/04 JWH

Method: All analyses were performed using DER and EPA approved methods per McGinnes Laboratories Quality Assurance Plan #87232G with the exception of EPA Method 531, 505, and 515 which were performed by ABC Research Laboratories, DHRS #82135/E82031.

Technician

Thomas Colgan
Project Manager
DHRS Laboratory I.D. Nos. 86140/E86070